BAE HAWK T.1A

For DCS World

DCS:HAWK

FLIGHT MANUAL

0.0.20.8

Contents

Disclaimer:

This flight manual is for the sole purpose of flying the VEAO Simulations Ltd Hawk Mk T.1A in the DCS: World Flight Simulator.

The content of this manual should not be relied upon in any way to fly real aircraft and VEAO Simulations Ltd take no responsibility for actions arising from using the content in the real world.

In Memoriam

This product is dedicated to the memory of Jim Mackonochie who sadly passed away on 23rd April 2013.

Without your wisdom, guidance and passion we could not have achieved your dream.

A visionary, a gentleman, a legend and most of all a true friend.

You will always be remembered.

As the wind blows, way up high,
I soar like a bird into the sky.
As I spread my wings, in flight,
Do not cry, do not fight.
I am amongst the clouds, and rain and sun,
Where I belong, where I came from.
Remember me close, remember me near,
For true flying legends, are always here.

26-09-1947 - 23-04-2013

Introduction

The Hawk first entered service with the RAF in 1976, both as an advanced flying-training aircraft and a weapons-training aircraft. The Hawk T1 version is currently used at RAF Valley for fast-jet pilot advanced flying training with No 208(R) Squadron, and at RAF Scampton by the RAF Aerobatic Team, the Red Arrows.
The T1A is used for weapons and tactical training on No 19(R) Squadron at RAF Valley, and by No 100 Squadron at RAF Leeming for advanced fast-jet weapons systems officer training and operational support- flying. In its weapons and tactical training role the Hawk is used to teach air combat, air-to-air firing, air-to-ground firing and low-flying techniques and operational procedures.

The Hawk is an all-metal, low-wing, tandem seat aircraft of conventional design. The wing has a moderate sweep with 2º dihedral and trailing edge slotted flaps. A one-piece all-moving tailplane is also swept back with 10º dihedral.
The fuselage comprises three main parts. The front fuselage accommodates two equipment bays and a pressurised cabin containing two tandem cockpits. The centre fuselage contains the engine, a fuselage fuel tank, a gas turbine starting system and a ram air turbine; the latter providing emergency hydraulic power should the two normal hydraulic systems fail. The rear fuselage houses the jet pipe bay and an airbrake hinged to its under surface.
The Hawk is powered by a Rolls- Royce Turbomeca Adour 151 turbofan engine, which is an un-reheated version of the engine powering the Jaguar GR3 aircraft.

While the Hawk T1 is used solely in the advanced flying-training role, the Hawk T1A is equipped to an operational standard and is capable of undertaking a number of war roles.
The T1A has four under-wing pylons cleared to carry Sidewinder AIM-9L air-to-air missiles, rocket pods, practice bombs and bombs, and can carry a 30mm Aden cannon in a pod underneath the fuselage centre-line.
The cannon can be fired at the same time as any of the pylon-mounted weapons are selected for release or firing.
Aiming facilities for the aircraft's attack modes are provided by an integrated strike and interception system.

General In-Sim Controls

During the manual it will talk about pushing buttons, turning control dials and flicking switches. The following are general principals when using the Hawk T.1A within the DCS World simulator.

Buttons are pushed using the left mouse button click.

Switches are generally in two orientations; vertical and horizontal.

Vertical switches use the function; left click for Up, right click for Down.
Horizontal switches use the function; left click for left, right click for right.

Dials are usually rotary dials and there are two mouse functions available; click and drag and middle mouse wheel.

Click and dragging the mouse downwards will rotate the dial clockwise.
Click and dragging upwards will rotate the dial counter-clockwise.

Whilst the cursor is over the dial use the middle mouse wheel downwards direction to rotate clockwise, upwards for counter-clockwise.

The speed of the mouse wheel rotation will increase or decrease the rotation of the dial in-sim.
The faster you rotate the mouse wheel the faster the dial will rotate.
For precision movements, rotate the mouse wheel slowly.

Electrical Systems

DC Generator	One engine-driven 9kw generator
Supply	28 volts
Batteries (two)	24 volts
AC Supply	115 volts 400hz single-phase

Overview

An engine-driven 9kw 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.
Two static inverters, supplied from the Generator busbar, provide the main AC power requirements; in addition, some equipment is supplied from individual static invertors. The T.1A has an additional static inverter to provide power for the armament installation.
An external DC power supply can be connected for aircraft servicing purposes and to supply power for operational readiness states and for engine starting.

General

Primary DC power is provided by an engine-driven 9kw DC generator which supplies 28 volts to a Generator busbar. AC power 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 400Hz to the AC busbar. A third 115 volts 400Hz 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).
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 by a switch to an Essential Services busbar. A diode protected supply from each Battery busbar supplies certain services from a common outlet.

An external DC supply can be connected and used for servicing purposes. The external DC supply can also be used for engine starting and for charging the batteries.

A simplified diagram of the electrical system is below at Fig. 1

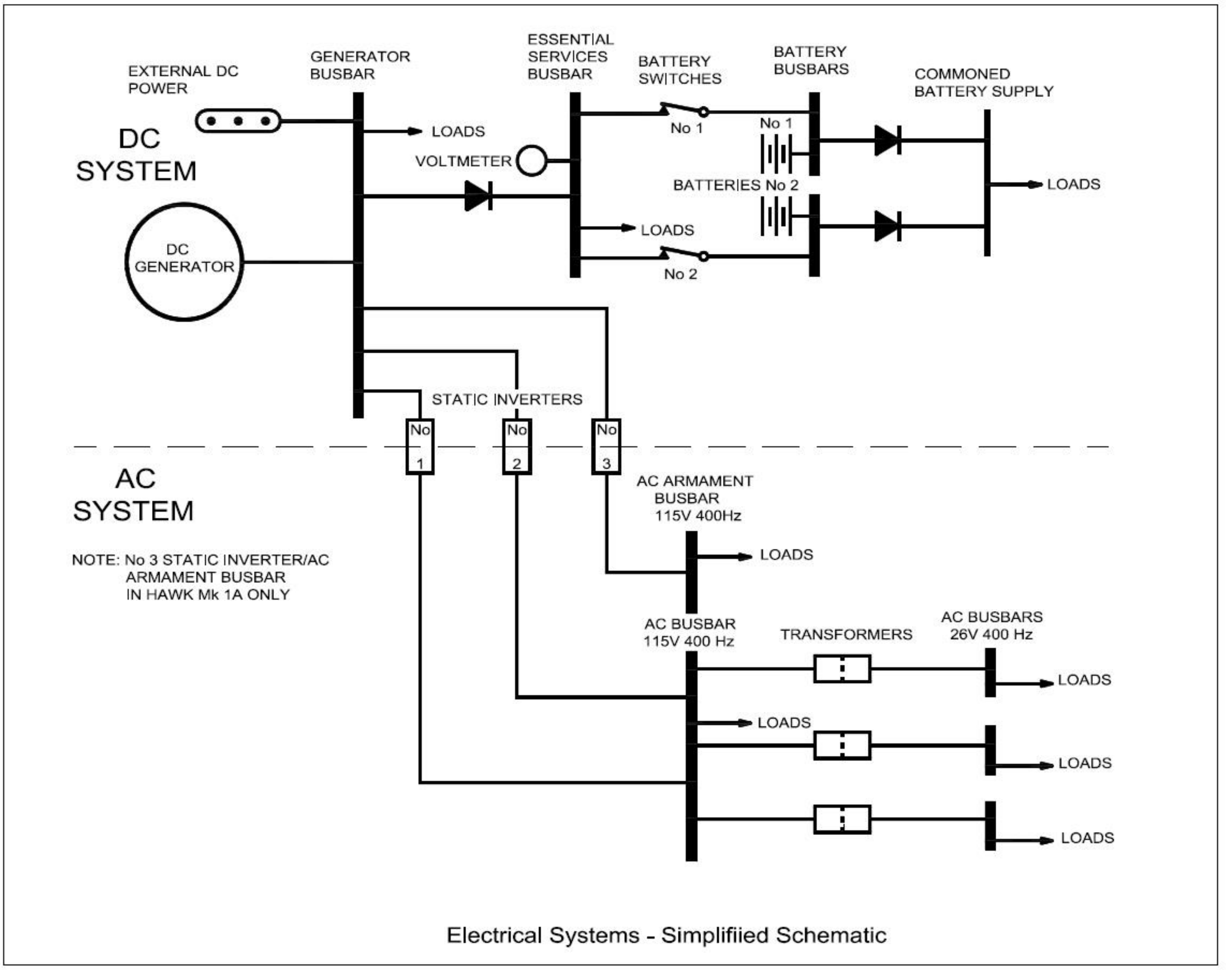


Figure 1 - Electrical Systems - Simplified Schematic

DC System

DC Generator
The 9Kw 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

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 protector circuits in the overvoltage unit, to take the generator offline if the voltage exceeds 30+/-0.5 volts and to illuminate the GEN caption on the CWP. 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 energised when the engine start/relight button is pressed; the generator is taken off line. The generator must be reset after a successful relight.

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-energised and the GEN caption is illuminated on the CWP. The relay is time delayed (1.5 seconds) to prevent operation of the undervoltage unit by a transient undervoltage condition.

Battery Supplies

General

The two 24 volts 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) energises 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 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 systems (CCS).

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 busbar supply, provided the battery switches are on.
Fully charged batteries should support Essential Services busbar for

approximately 25 minutes; battery power may be conserved by selective load shedding.

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.

Alternative Supplies

a. When the UHF-NORMAL/BATT switch is at NORMAL, the CCS and the main UHF transceiver are powered from the Essential Services busbar; when the switch is at BATT, they are powered from the common 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

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) 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. 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. The voltmeter indicates generator voltage when the generator is on line.

Inertia Switches

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. The energized crash relay also connects the commoned battery supply to operate the engine bay fire extinguisher.

External Supply

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 central warning system (CWS) is muted.

If either of the battery switches or both of the engine start master switches are set to on, the external power supply remains connected to the Generator and the Essential Services busbars; this enables the engine starting system to be powered from the external DC supply. The batteries are charged from the external DC supply before the engine is started while the battery switches are on.

AC System

AC Supplies

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 online 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. A third 115 volts, 400 hz single-phase static inverter, No 3, is supplied with DC from the Generator busbar; it's 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 output is within specified limits.

Inverter Control

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 been cleared the inverter is automatically reset but after an output fault is cleared the inverter must be reset manually. Manual resetting of each inverter is controlled by the AC 1 RESET and AC 2 RESET and AC 3 RESET button respectively.

Inverter Failure Warning

Warning that an inverter has failed or is off line is indicated by illumination of an AC 1, AC 2 or AC 3 caption.

Normal Use

Before Flight

Before Engine Starting on Internal Batteries

a. Check that external DC power supply is disconnected.
b. Set both battery switches to on. Check that the GEN, AC 1, AC 2 and AC 3 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.

After Engine Starting on Internal Batteries

a. Check that the GEN, AC 1, AC 2 and AC 3 captions are out. If the GEN caption remains illuminated, press the DC RESET button and check that the caption goes out. If an AC caption 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.

Before Engine Starting on External DC Supply

a. Check that the external DC power is disconnected.
b. Set both battery switches to on. Check that the GEN, AC 1, AC 2 and AC 3 captions are illuminated and hat the voltmeter reads a minimum of 23 volts. Check the voltage of the batteries by selecting BATT 1 and BATT 2 switches off and on in turn; the voltmeter should read a minimum of 23 volts for each battery.
c. Set both battery switches off.
d. Have the external DC supply connected. Check that the voltmeter reads a minimum of 25 volts and that the GEN, AC 1, AC 2 and AC 3 captions are not illuminated.

After Engine Starting on External DC Supply

a. Set both battery switches on.
b. Have the external DC supply disconnected.
c. Check that the GEN, AC 1, AC 2 and AC 3 captions are out. If the GEN caption remains illuminated, press the DC RESET button and check that the caption goes out. If an AC caption remains illuminated, press the appropriate AC RESET button and check that the caption goes out.
d. Check that the voltmeter indicates between 27 and 29 volts.

In Flight

In flight the GEN, AC 1, AC 2 and AC 3 captions should remain out and the voltmeter should indicate between 27 and 29 volts.
In flight, if either engine start/relight button is pressed the generator is automatically taken off line and the GEN, AC 1, AC 2 and AC 3 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

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

Malfunctioning

DC Generator Failure

Generator failure is indicated by the GEN caption being illuminated and by the voltmeter indicating 25 volts or less. As the generator busbar voltage falls the inverters are tripped off line and the AC 1, AC 2 and AC 3 captions are illuminated. 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, AC 2 and AC 3 captions but if necessary the inverters may be rest manually. If the generator cannot be reset, switch off all non-essential services and land as soon as possible.

Note: if the FPR caption remains illuminated following the resetting of the DC generator, switch the FUEL PUMP switch off and then on to extinguish the caption.

If the generator cannot be reset:

a. The services connected to the Generator busbar are lost, i.e:

- AHRS
- Fuel booster pump
- Main altimeter
- Main attitude indicator
- Horizontal Situation Indicator
- ILS localiser/ glideslope receiver
- ISIS control unit
- Navigation mode selector

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

Following the loss of the generator, voltage decreases immediately to that of the batteries, i.e. 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. The battery switched should be then set to off; the voltmeter needle then deflects fully to the left and subsequently no attempt should be made to determine battery voltage form the voltmeter.

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 sub-para b and c below. Listed in sub-para a are the standing loads on the busbar. 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 will then be lost.

a. Standing Loads

Accident data recorder	1.0
Airbrake indicator	-
Cabin pressurization - Off, NORMAL, DEMIST or FLOOD selected (control valve solenoid energized)	1.0
Central warning captions	-
Engine bleed valve control	1.0
Engine control amplifier - T6/NL control	1.0
Trim indicators - Aileron and rudder	-
Tailplane position indicator	-
Fatigue meter	-
Fire-wire control unit	1.0
Flap indicator	-
Fuel contents gauge	-
Landing gear indication	-
Landing gear external indicator light (when landing gear locked down)	-
Cabin temperature control	-
Oxygen flow indicator	-
EHMS	2.4

b. Selectable Loads

Pitot tube heater	13.8
Landing/taxy lamp	7.6
Anti-collision light	6.9
Single anti-collision light	4.3
Cockpit lighting (normal)	2.7
Navigation lights	2.1
Main UHF transmit	3.1
Standby UHF transmit	1.2
VHF transmit	2.6
Cabin pressurization - Off, NORMAL, DEMIST or FLOOD selected	2.5
IFF: Maximum	2.2
Receive	0.6
Anti-skid control (landing gear down)	1.0
Landing gear control (normal)	-
Weapon control - MASS at UNLOCK LIVE (and No 1 battery busbar)	-
VOR receiver	1.0

c. Short Duration Selectable Loads

Seat pan height adjustment	12.8
Airbrake control - out	-

Flap control (normal)			-
Trim control	aileron		-
	rudder		-
	tailplane (main or standby)		1.3
AC reset			-
DC reset			-
Engine - start/relight button pressed			7.6
Start master switch -			
	START selected		13.8
Ram air turbine (RAT) reset			-
ILS marker light test			-
Weapon control			-
Towed target release			-

After the UHF and 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	4.1
		run	1.7
UHF	transmit		3.1
	receive		0.9
Communications control system			0.3
Turn-and-slip indicator -		start	2.6
		run	0.6
DGI		start	0.8
		run	0.6

Undervoltage and Time Delay Unit Failure

Failure of the fuse connecting the undervoltage and time delay unit to the Essential Services busbar causes the GEN caption 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 must be monitored at frequent intervals. If the generator subsequently fails the AC 1, AC 2 and AC 3 captions are illuminated and the voltmeter indicates battery voltage (approximately 24 volts).

Battery Failure

An unserviceable battery may cause the generator to be tripped off line and prevent it from being reset. If this occurs, the unserviceable battery must be isolated. Set the battery switches off/on in turn; if the voltmeter registers an increase when either switch is at off, that switch should be left 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

Failure of the No 1 or the No 2 or the No 3 static inverter is indicated by the AC 1, AC 2 or AC 3 caption, respectively, being illuminated. Failure of all three inverters may cause the 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.

Single Inverter Failure

If a single inverter is tripped off line the associated AC 1, AC 2 or AC 3 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 the No 1 or No 2 inverter is sufficient to power all the loads on the AC busbar.

No 1 and No 2 Inverter Failure

If both the 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.
If both inverters remain offline, the main attitude indicator, the horizontal situation indicator and the AHRS are unreliable. The standby flight instruments, i.e. standby attitude indicator, turn-and-slip indicator and DGI continue to operate.

Table 1 - Electrical Systems Controls and Indicators

Item	Marking	Location	Function
Front Cockpit Only			
Battery switches (two) (on, forward)	BATT1 BATT2	Left Console	Connect associated battery to Essential Services busbar
DC Voltmeter	BATT VOLTS	Lower left panel	Indicates voltage at Essential Services busbar
Inverter reset button	AC3 RESET	Left Console	Brings No. 3 inverter on line
Both Cockpits			
Generator reset button	DC RESET	Left Panel	Brings generator on line
Inverter reset buttons (two)	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 caption	AC1 AC2	CWP	Indicate associated inverter is disconnected from AC busbar.
	AC3		Indicates No 3 inverter is disconnected from the Armament busbar

Electrical Systems Cockpit Locations

Central Warning System

General

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 pushbutton 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.

Each caption on the CWP is illuminated by a twin-filament lamp whenever the caption's 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 supplied from the Essential Services busbar.

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

The layout of the captions on each CWP is similar and, with the exception of the OXY caption, identical captions are lit simultaneously on both panels. The OXY captions operate independently in association with the respective cockpit oxygen system. If, for any reason, the rear cockpit oxygen system is turned off for solo flight the rear cockpit CWP OXY caption is continuously lit.

Fire Extinguisher Pushbutton
A fire extinguisher pushbutton (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 energised by commoned supplies from No 1 and No 2 Battery busbars.

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

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.

Audio Warning

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 energised 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 re-generated.

Testing the CWS

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 tones 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 depressed, the attention lights and the audio warning are cancelled.

Muting the CWS

With the LP fuel cock set to off, connection 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

Before starting the engine, when the batteries are switched on check that the HYD, GEN, HYD 1, FPR, AC 1, HYD 2, TRANS*, SKID, AC 2, OIL and AC 3, (T Mk 1A) captions illuminate, Check that when a test switch is held at TEST, all unlit captions on both CWP illuminate, the attention lights and audio warning tone are activated and the fire extinguisher button illuminates, When the test switch is released, check that all indications revert to the pre-test state.

*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.

Malfunctioning

Audio Warning

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

Central Warning Panel

Attention Lights

Table 2 - Central Warning Panel Captions

Caption	Indicating	Caption	Indicating
Red Captions			
FIRE	Fire in engine bay	T6NL	TGT or N1. above approximately 685 +5 / -0 C or 108% respectively
EOHT	Engine LP cooling air temperature exceeds approximately 400ºC	START	Fire in air producer bay
HYD	Total hydraulic failure	CPR	Cabin altitude exceeds 30,000ft
OXY	Low oxygen pressure in associated cockpit (downstream of shut-off valve)	GEN	Essential Services busbar 25 volts or less
Amber Captions			
HYD 1	No.1 hydraulic system pressure 41±4 bar or less	HYD 2	No2. hydraulic system pressure 113.5±7.5 bar or less. (Remains on with RAT operating)
FUEL*	160 (approx) kg fuel remaining	FPR	Low fuel pressure. Pressure rise across booster pump less than 0.27 bar or, pressure at engine filter outlet is less than 2.4 bar
AC 1	No1. inverter off line	AC 2	No.2 inverter off line
AC 3	No3. inverter off line	JPOHT	Jet pipe bay temperature exceeds 150ºC
TRANS	Low air pressure in fuel tanks; possible loss of fuel transfer	OIL*	Engine oil differential pressure below 0.7 bar
ECA	Failure of either of both amplifier lanes or fault in amplifier controlling circuits	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
* Activation of these captions is delayed for approximately 10 seconds to prevent			

operation by short term symptoms caused by negative g.

Fuel System

General

Fuel is contained in a fuselage bag tank and an integral wing tank. 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 pressurised 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 defueling. During suction defueling the tanks are pressurised via an external air pressure connection, so that the fuselage bag tank is held firmly in position.

Fuel Tanks

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 2 shows the minimum guaranteed capacities of the tanks: normally a higher indicated content can be expected due to the tanks exceeding the guaranteed minimum.

Table 3 – Fuel Tank Capacities – Usable Fuel

Tank	Kg (0.79SG)	Kg (0.77SG)	Litres	Gallons
Fuselage	645	629	818	180
Wing	627	612	795	175
Total	1272	1241	1613	355

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

Fuel Transfer

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.

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.

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 Pressurisation

The fuel tanks are pressurised 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 defueling 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.

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 fall slightly below the datum pressure the TRANS caption illuminates, If fuel tank pressurisation 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 of fuel venting to atmosphere via the datum air source.

Tank Venting

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.

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 condition it is held closed by a weighted arm to prevent fuel loss, Vapour from the outer sections f the wing tank is vented into the fuselage tank.

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.

Reservoirs
During refuelling any fuel remaining in the outer wing tank vent pipes is pushed up into two reservoirs in the fuselage tanks. 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

Fuel is supplied to the engine from the negative-g compartment via the booster pump, a bypass valve and an LP cock. A tapping downstream of the LP cock delivers fuel to the GTS.

Booster Pump

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 vale, 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 0.17 bar the switch closes and the FPR caption illuminates.

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 shut-down during engine starting or relighting. Thirty 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-energised.

Booster Pump Bypass Valve

If the booster pump fails, the bypass valve, downstream of the pump, opens to allow an engine-driven LP pump to draw fuel directly from 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, should they be uncovered.

Low Pressure Fuel Cock
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. The LP cock is normally left open; it is closed only during emergency procedures.

Fuel Low Level Warning

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 approx. 160kg).
However the mass of fuel indicated when the float switch closes depends on the type of fuel, the temperature and the aircraft altitude. In level flight the warning is given when the fuel tank contents indication is approximately 160kg.

When the low level float switch closes activation of the CWS is delayed for 10 seconds by a time delay relay, thereby minimising pilot distraction by intermittent warnings triggered during aerobatics. When the flaps and/or the landing gear are down a hold-on relay is energised 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-energised when the flaps and landing gear are raised or when the batteries are switched off.

Controls and Indicators

The controls and indicators associated with the fuel system are listed in Table 4.

Table 4 - 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 kgx100	Right panel both cockpits	Indicates usable fuel contents
Fuel low level caption	FUEL	CWP both cockpits	Indicates approximately 160kg remaining in level flight
Fuel low pressure caption	FPR	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 bar
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

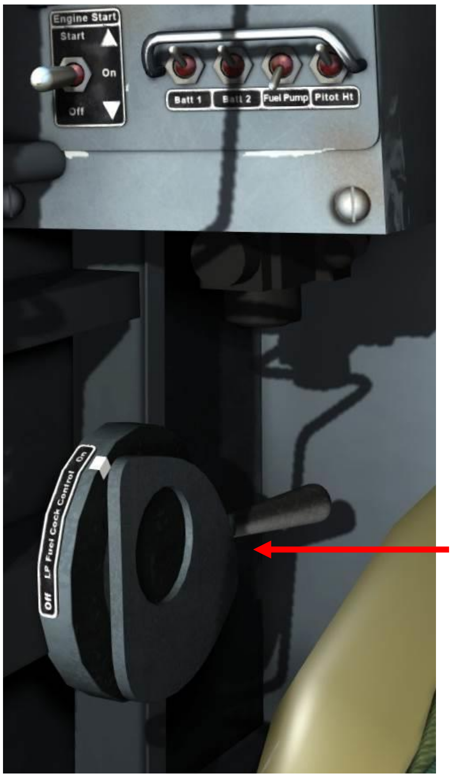
Fuel for a gas turbine air producer, which is part of a gas turbine starting (GTS) system, is tapped from downstream of the LP cock; it passes through a filter and an electrically-operated shut-off valve to a dual fuel/oil pump which delivers the fuel to the distribution block of the gas turbine air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

Refuelling

Refuelling is only possible form the ground. The T.1A does not have the capability for in-flight refueling.

Fuel Systems Cockpit Locations

FRONT
COCKPIT



LP Fuel cock is located to the left hand side of the seat below the left hand panel.

Normal Use

In Flight

Monitor the fuel contents. When the indicated fuel contents fall to approximately 160kg, the FUEL caption is illuminated; check the fuel contents gauge and cross-check against anticipated time to the 160kg fuel state.

Note: At high IAS, low altitude and low fuel states (300kg or below), the fuel low-level warning light may illuminate, but extinguish 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 power setting (below 90%) is maintained, all indicated fuel is available.

Malfunctioning

Tank Air Pressure Failure
Failure of the tank air pressurization system is indicated by the TRANS caption illuminating. Fuel continues to flow to the collector tank by gravity flow. 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 fall to approximately 160 kg the FUEL caption is illuminated but the total fuel remaining is more than 160 kg, i.e. the fuel in the collector tank plus that in the outer sections of the wing tank. At altitude, maximum power may be limited following the loss of tank pressurization.

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

Fuel Pressure Failure
The FPR caption 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 loss of pressure may be due to booster pump failure but other malfunctions can also activate the warning system, E.g. 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 will be unable to determine the cause of the warning. Failure of the booster pump does not seriously affect engine performance in normal flight.

Following the illumination of the FPR caption, reduce power to the minimum practicable and descend as low as practicable. Avoid negative-g manoeuvres and land as soon as possible. When the immediate action has been initiated, check 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

Valve Fails Open

If the vent tank vapour release valve fails open, fuel venting occurs causing the apparent fuel consumption to be higher than expected. A landing should be made as soon as practicable.

Valve Fails Closed

At altitude, failure of the vapour release valve to open affects the rate of fuel transfer into the collector tank. The failure is indicated by the FUEL caption illuminating 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 relight drill if flameout has occurred. If the FUEL warning continues, recover and land as soon as possible. If, after remedial action, the FUEL warning goes out, there is no immediate emergency but flight should not be prolonged unnecessarily.

Engine Systems

General Description

The Adour MK 151 is a turbofan engine which has a 2 stage low pressure (LP) 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.

An external gearbox, driven from the HP shaft, is at the forward end of the engine below the compressor section. The gearbox provides drives for:
a. LP fuel pump.
b. HP fuel pump.
c. Engine oil pumps.
d. HP shaft tacho-generator.
e. DC generator.
f. Hydraulic pumps (two).

The Adour engine is started by a gas turbine starting (GTS) system in which air from a gas turbine air producer powers a starter motor which drives the HP shaft through the engine external gearbox. Following flameout, the engine may be relit with or without the use of the GTS system.

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

Controls and Indicators
The controls and indicators for the engine are listed in Table 5 and for the fire protection systems in Table 6.

TABLE 5 – 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 aircraft fuel system to engine fuel system and to air producer gas turbine
Both cockpits			
Start master switch (gated from ON to OFF)	ENG START— 0FF/ 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
HP cock/throttle Lever	Idle position indicated by mark on quadrant	Left console	Controls I-IP fuel shut-off 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 indicator (black/green)	ROTATION	Right panel	Black: Indicates LP shaft speed below I00 RPM or rotating in wrong direction; or starting sequence completed or cancelled Green: Indicates LP shaft speed I00 RPM in correct direction of rotation; it also shows green whilst start/ relight button is pressed and, post-mod 893, when airbome, for 30 seconds after button is released or until throttle is advanced beyond Idle whichever occurs first
Air producer start indicator (black/ green)	GTS	Right panel	Black: Indicates air producer shut down or speed below datum Green: Indicates air producer

			speed at or above datum

TABLE 5 – Engine Controls and Indicators - continued

CONTROL/ INDICATOR	MARKING	LOCATION	FUNCTION
Start/relight button	RELIGHT	Throttle lever	When pressed, with start master switch at ON, ignition switch at NORMAL and the throttle lever in the range HP Off to Idle: a. Initiates start sequence b. Energizes igniter plugs for duration of press and, post-mod 893, when airborne, for 30 seconds after button is released or until throttle is advanced beyond Idle whichever occurs first c. Offloads DC generator in flight d. At any throttle position, transfers booster pump to Essential

			Services busbar for duration of GTS system operation and for 30 seconds after shutdown of GTS
TGT indicator	°C X I00 TGT	Right panel	Indicates turbine exhaust gas temperature
RPM indicator	PERCENT RPM	Right panel	Indicates HP shaft speed as a percentage (when shaft speed exceeds approximately 11%)
TGT/NL over-limit caption	T6NL	CWP	Indicates if TGT reaches 685°C or LP shaft speed (NL) exceeds 108%
LP cooling air overheat caption	EOHT	CWP	Indicates if LP cooling air temperature exceeds approximately 400°C
Oil low pressure Caption	OIL	CWP	Indicates if differential pressure below 0~7 bar
Fuel low pressure caption	FPR	CWP	Indicates pressure rise across booster pump

			is less than 0-27 bar or pressure at engine filter outlet is less than 2-4 bar

TABLE 5 – Engine Controls and Indicators - continued

CONTROL/ INDICATOR	MARKING	LOCATION	FUNCTION
Engine control amplifier lane failure caption	ECA	CWP	Indicates failure of either or both amplifier lanes or of a fault in amplifier controlling circuits
Jet pipe bay overheat caption	JPOHT	CWP	Indicates if jet pipe bay temperature exceeds 150°C

Airflow

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. Tappings at the HP compressor outlet supply air for engine and aircraft systems.

Bleed Valve

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. Closing of the bleed valve is indicated by an increase in idle RPM of approximately 3% and a decrease in TGT of approximately 50°C.

HP Compressor Bleeds

Air is tapped from the compressor section for cooling 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 caption comes on.

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

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

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 inter-connected.
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 in 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.

Engine Fuel System

General

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). 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.

Automatic limitation of fuel flow is effected by an LP shaft speed (NL) limiter and a TGT limiter which operate through the ECA to regulate a fuel trim valve. Limitation of RPM is provided 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 engine is fuel-flow limited by a flow control unit.

LP Fuel Supply

The LP pump maintains fuel pressure at the HP pump inlet to prevent cavitation within that pump. A pressure switch in the supply line downstream of the LP filter, closes to light the FPR caption if the pressure falls below 2.4 bar.

HP Fuel Supply

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. The 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 functions to reduce pump output if RPM rise to their permitted maximum, between 103% and 104%. Thus, tor a particular throttle valve setting the pump servo pressures modifies HP pump output to give a corresponding fuel flow (and hence RPM). The pump output is further modified to take account of changes in airspeed and altitude. Fuel flows which would induce engine over-temperaturing or over-speeding are automatically controlled.

Fuel Control Unit

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 over-fuelling as the throttle is opened; it has no effect on engine deceleration.

Flow Control Unit

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

Fuel Trim Valve

The fuel trim valve functions to maintain NL and TGT within limits. The valve reacts to inputs from the ECA and through the flow control unit effects a reduction in pump output.

HP Valve

The HP valve is a shut-on 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

The SIFCU automatically controls the fuel flow required 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. Movement of the diaphragm, in response to pressure changes, actuates a fuel metering mechanism.

Engine Control Amplifier

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. LP shaft correct rotation signal.

TGT and NL Control

Reference values of the normal permitted TGT and NL are stored in the ECA. When either a TGT of 660°C or an NL of 1O4% 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.

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°C or 108% respectively, the T6NL caption comes on.

Amplifier Lane Failure Warning

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

LP Shaft Correct Rotation Signal and Indicators

LP shaft speed sensing probes supply signals to the ECA. When, during engine starting, the LP shaft speed reaches I00 RPM in the correct direction, a relay in the ECA closes to connect a DC supply to the ignition units and to energize the ROTATION indicators which change from black to green. The indicators remain green until the starting cycle is completed or cancelled; they then revert to black. The indicators also show green whenever a start/ relight button is pressed and, when airborne, for 30 seconds after the button is released; they revert to black when the button is released or, when airborne, 30 seconds after the button is released.

Engine Oil System

Oil Tank

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

Oil Circulation

A pressure pump draws oil from the tank and delivers it, through a fuel-cooled oil cooler and a filter, to the engine and to the external gearbox. 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

A differential pressure switch monitors the pressure difference between feed oil pressure and the scavenge oil pressure at an internal gearbox. If the differential falls below 0.7 bar the switch closes to light the OIL caption. To eliminate transient low-pressure warnings caused by manoeuvres involving negative g. activation of the caption is delayed for at nominal 10 seconds.

Engine Ignition System

Ignition Units and Igniter Plugs

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 l0 mm beyond the Idle position; 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

The GTS system 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 starter motor. 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 starter motor 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 starter when engine RPM are above 20%. The air producer uses fuel from the aircraft fuel system but has its own ignition system, fuel pumping and control system. The air producer and the starter motor each have independent lubrication systems.

Air Producer

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. In the T Mk 1A, power for the motor and igniter plugs can be provided from an external DC supply via the Generator and Essential Services busbars provided the battery switches are off when the external supply is initially connected; the batteries may be switched on after the external supply is connected. 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, to prevent overheating of the DC motor in the GTS, allow an interval of 3 minutes between each air producer start and an interval of at least 20 minutes to elapse after three consecutive start cycles of the air producer.

Protection circuits within the starting system automatically shut down the GTS 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 must be investigated. The aircraft must not be flown if such a malfunction occurs during a ground start. If the GTS fails or is reluctant to start during an air start, one of the start master switches must be set to OFF for a minimum of 5 seconds and then reset to ON.

Starter Motor

The starter motor is a centripetal free turbine driven by air ducted from the air producer. The motor drives the engine HP shaft via the external gearbox and provides assistance until approximately 45% RPM have been achieved, when the starting system is automatically shut down.

Engine Starting Operation

With the battery switches set on, or the battery switches off and an external DC supply connected, the LP cock lever at ON, the throttle lever at HP Off, both start master switches at ON and the ignition switch at NORMAL, the air producer is started by pressing momentarily a start/relight-button. (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 20 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 starter motor; the dump valve closes and the air producer accelerates to full power. The starter motor 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 l00 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.

When the ROTATION indicator shows 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 l0 seconds of Idle being selected. The engine should accelerate to reach starter cut-out speed, approximately 45% RPM, in 22:3 seconds of 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. When the engine has been started using an external power supply, the supply should be disconnected and both battery switches set to on.

After the RPM have stabilized the throttle should be opened slowly to accelerate the engine through approximately 65% to close the bleed valve, after which the throttle should be returned 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:l% before take-off. Any sudden change in the idling characteristics should be investigated.

During engine starting, the start cycle can be discontinued by setting the throttle lever to HP Off; the GTS continues running and, following a wet start, may be used to carry out a dry crank (see Dry Cranking below). However, if it is intended to terminate the GTS starting cycle the start master switch must be set to OFF; subsequently the 3-minute interval must be observed before a further start is attempted.

Note: Any attempt to restart the GTS in less than 3 minutes, in addition to causing overheating of the starter motor, may result in the igniting of any fuel spilled within the engine since the ignition units are activated when a start/relight button is pressed.

Dry Cranking

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 must be set to ISOLATE before the start master switch is set momentarily to START. The throttle lever should be retained at HP Off throughout. The air producer automatically reverts to idle after 45 seconds. If a dry crank is initiated from an air producer idling condition the start master switch must not be selected to START until engine RPM are below 20%.

Relighting

General

The engine relighting system allows a flamed out engine to be relit using an immediate relight, a cold relight (assisted) or a cold relight (unassisted) procedure. In the immediate relight and the cold (unassisted) relight procedures the GTS is activated and may run up to idle but it is not used. In the cold relight (assisted) procedure the GTS is activated and used when the aircraft is below 20,000 feet; however the windmilling RPM must be below 20% before making the relight because starter engagement is inhibited above that RPM. For all relight procedures the throttle must be set to HP Off. Except in the case of an immediate relight the bleed valve should be open (45% RPM or below) before relighting is initiated. As the engine runs down following flameout, 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 after off-loading has occurred. When a start/relight button is pressed, and post-mod 893, for 30 seconds after the button is released. the engine igniter plugs are energized (provided the throttle is within l0 mm of the idle stop), the DC generator is off loaded and the booster pump is powered from the Essential Services busbar. At stabilised idle RPM following a successful relight, the throttle should be opened slowly to maximum and a check made that the bleed valve closes by 61+4% RPM; as the throttle is opened cross-check RPM and TGT for surge free engine operation. The DC supplies must not 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 must not be pressed for longer than 30 seconds.

Note: If the GTS system has been activated it will normally be running at idle (GTS indicator green) after a successful immediate or cold relight (unassisted) procedure. Regardless of the GTS indication, shut the system down by setting either of the start master switches to OFF for a minimum of 5 seconds and then resetting it to ON.

Immediate Relight

An immediate relight may be attempted at any airspeed and altitude providing the engine RPM are not too low (below 30% RPM an overtemperature condition may occur). With the start master switch at ON 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. Pre-mod 893, the button should be held pressed until the engine has relit. If a relight is not obtained within 30 seconds of selecting Idle the throttle must be returned to HP Off to prevent overfuelling and if the relight button is held pressed it should be released. A further 30 seconds should be allowed to elapse, if practicable, to drain the engine and cool the GTS system starter motor before initiating a cold relight. After a successful relight, shut down the GTS system.

Cold Relight – Assisted

The aircraft should be below 20,000 feet (unless the GTS is already running following previous relighting attempts above this altitude) at an IAS between I65 and 250 knots with the throttle at HP Off, both start master switches at ON and the ignition switch at NORMAL. The relight is initiated 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, post-mod 893, 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 15,000 feet; within 20 seconds below 15,000 feet). 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. Pre-mod 893, the ROTATION indicator shows green and the engine igniter plugs are energized. Set the throttle to Idele. When the engine has accelerated to 45% RPM the GTS system shuts down; the engine igniter olugs are de-energized and, after a 30 second delay, the booster pump is restored to the Generator busbar. To prevent overfuelling, the throttle must be returned to HP Off if a relight is not achieved within 45 seconds of selecting START.

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

Cold Relight – Unassisted

An unassisted relight is carried out below 25,000 feet at a minimum of 250 knots 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 indicator shows green) whilst simultaneously the throttle is advanced to the Idle position. The button is released when the engine lights up; post-mod 893, the button need not be held pressed once the ROTATION indicator shows green. Approximately 30 seconds after 45% RPM have been exceeded, the booster pump is restored to the Generator busbar. After a successful relight, shut down the GTS system.

WARNING: In all relight procedures, when the throttle is advanced to Idle, it is essential that it is held against the idle stops to ensure that the igniters can be energized.

Ram Air Turbine (RAT) Deployed

Fire Protection Systems

General

The fire protection systems 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. An extinguishing facility is provided in the engine bay only. A fireproof bulkhead separates the engine bay from the jet pipe bay. Ventilation of the engine bay is by mm 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. The controls and indicators associated with the fire protection systems are on the CWP and are listed in Table 6.

Table 6- Fire Protection Systems Controls and Indicators

Control/ Indicator	Marking
Fire warning caption	FIRE
Fire extinguisher pushbutton and light	F
Air producer bay fire warning caption	START

Fire Detection and Warning

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.

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 pushbuttons and the FIRE captions. If the air producer fire-wire is activated a relay in the control unit closes and DC is supplied to illuminate the START captions. If the temperature in the affected bay falls below the critical value the warning lights go out and the detection system is automatically reset; re-setting may take up to 45 seconds.

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

Fire Extinguishing

Methyl-bromide or BCF, from an extinguisher bottle in the fuselage, is discharged through a spray ring into the engine bay when an extinguisher pushbutton 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

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

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 JPOHT captions together with all other unlit captions on the CWP in both cockpits, and the lamp in the fire extinguisher pushbuttons, illuminating.

The fire detection and warning system should not be tested in flight. The system should be tested before engine start up and again after flight (during engine shut down) and before heat from the cooling engine has had time to dry out the fire wire, i.e., the system should be tested when optimum conditions for moisture contamination have been experienced, when the aircraft has been parked in moist conditions or has encountered moisture in flight.

Malfunctioning And Abnormal Conditions

Engine Surge, Stall or Overtemperature

Engine surge is indicated by a sudden increase in TGT accompanied by a rumbling or banging noise; engine stall is indicated by an increase in TGT accompanied by a decrease or stagnation of RPM. If engine surge or stall is experienced the throttle lever should immediately be set to Idle. During recovery from a surge or a stall, the engine should be used cautiously.

TGT/NL Overlimit

If the T6NL caption illuminates throttle back to Idle immediately and check TGT. If the TGT is excessive action should be taken as for engine surge, stall or overtemperature. If, however, the TGT was not excessive the warning may be due to excessive NL; high power should be avoided with maximum of 90% RPM above 20,000 feet and 95% below 20,000 feet.

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

Engine Control Amplifier Failure

Failure of one lane of the ECA is indicated by a steady illumination of the ECA caption. In the event of a failure of only one lane the other lane has full authority and the ECA functions normally. Total ECA failure, also indicated by a steady illumination of) the ECA caption, usually results in a fuel no-trim condition causing TGT and RPM to increase. Engine limitations are easily exceeded and must therefore be kept within limits by manual throttle control; above 20,000 feet, 90% RPM must not be exceeded, below 20,000 feet, 95% RPM must not be exceeded.

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 must be operated carefully to avoid surge. At medium altitude and low IAS, flameout may occur at the idle stop; therefore, when decelerating, the throttle should not be brought
back to less than 70°/o RPM. A landing should be made as soon as possible following an ECA failure.

Note: Momentary flashes of the ECA caption should be ignored since a lane change due to a lane failure results in the ECA caption staying on together with the attention lights operating.

Bleed Valve Failure

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

Low Fuel Pressure

A warning of low fuel pressure, indicated by illumination of the FPR caption, may result from LP pump failure, filter blockage, booster pump low pressure or from other fuel system failures but the particular cause cannot be identified in flight. Only the minimum practicable power should be used and manoeuvres involving negative g should be avoided.

Oil Pressure Failure

Loss of oil pressure is indicated by the illumination of the OIL caption. If the caption illuminates during stable level flight, the aircraft should be landed as soon as possible and RPM restricted to the minimum practicable. Throttle handling should be smooth and progressive to avoid high transient bearing loads and, where engine acceleration is unavoidable, the extent of the RPM increase and the duration at the higher power setting should be limited. Illumination of the OIL caption may be accompanied by vibration which is indicative of bearing failure and may lead to engine seizure. Engine seizure may be preceded by increasing vibration, and momentarily, snatchdowns of RPM. The EOHT caption may illuminate.

GTS Fuel Supply Failure

lf 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 unassisted relight procedure will be available and following a relight a landing should be made 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; the sortie should be terminated as soon as possible. If any of these symptoms are observed during starting on the ground, the sortie should be abandoned.

Engine RPM Indication Failure

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, the aircraft should be landed as soon as practicable.

Hydraulic Power Supplies

General

Two independent hydraulic systems, designated No 1 and No 2, supply hydraulic power for the operation of the powered flying controls. The No l system additionally supplies power for the normal operation of general services, i.e. 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 pushbutton in either cockpit. A hand pump in the No l system can be used for pressurising the general services and a wheelbrakes' accumulator on the ground when the engine is not running.

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 2071+/-10 bar. Pressure switches initiate warning of pressure failure, which is indicated by the illumination of captions on the CWP. Relief valves in the systems ensure that line pressures do not become excessive. The No l 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.

The No 1 system powers one half of each PFCU and, when system pressure is 103+/-7 bar 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.

Table 7 - 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 approx130 bar
Pressure gauges	HYD 1	Left console	Indicates No 1 system pressure

(2)	HYD 2	Left console	Indicates No 2 system pressure or, RAT pump pressure
System low pressure captions	HYD 1 (amber) HYD 2 (amber) HYD (red)	CWP CWP CWP	Indicates No 1 system pump output pressure has fallen to 41 +/- 4 bar or below Indicates No 2 system pump output pressure has fallen to 113.5 +/- 7.5 bar or below (remains on with RAT operating) Indicates total hydraulic failure

Controls and Indicators
The controls and indicators for the hydraulic systems are similar in both cockpits; they are listed in Table 7.

Reservoirs

The reservoir in each system is charged with nitrogen at 3.5 to 5.5 bar. The maximum fluid content of the No 1 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.

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 (No1 system) and left (No 2 system) side of the fuselage.

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

Accumulators

The two flying controls accumulators, nitrogen-charged to 76+/- 3.45 bar, 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 bar, provides power to extend the RAT jack if the No 2 system pressure falls below 103+/- 7 bar 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.

A wheelbrakes accumulator, nitrogen-charged to 86+/-3.45 bar, is supplied by the No 1 hydraulic system pump.

Each accumulator has a nitrogen charging/test point and an adjacent pressure gauge. Those points for the No l 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.

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

No 2 System Pump Bypass Valve

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 caption to illuminate. 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 I37 bar, the HYD 2 caption extinguishes. Irrespective of the increased pump output pressure following the valve closure, the HYD 2 caption 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

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.

The RAT is automatically extended whenever No 2 system pressure falls below 103+/- 7 bar. At this pressure a shuttle valve operates to allow RAT accumulator pressure to the reverse 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.

A RAT cut-out valve regulates RAT pump output between 169 +/- 3.45 and

203 +/- 3.45 bar. Indication that the RAT is functioning is given by the HYD 2 pressure gauge cycling between 160 and 210 bar as control column demands are made. When operating, the RAT pump recharges both its own and the No 2 system flying controls accumulator.

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 and thereby restore 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 reverse 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 will be 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.

The output of the RAT pump is dependent on airspeed. At sea level, the pump develops maximum output at speeds in excess of I30 knots; at 105 knots the output is reduced to 75% of maximum.

Extension of the RAT can be tested on the ground with the engine running. In flight, with the engine throttled back, the RAT can be tested functionally. For both tests the No 2 system hydraulic pressure must be reduced by continuous movement of the control column until 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. 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. After a test has been completed and the HYD 2 caption has extinguished, the HYD 2 RESET button must be pressed to retract the RAT.

During engine shutdown, the RAT extends when ‘No 2 system pressure falls,to 103 +/-7 bar. When pressure has dissipated the RAT is retracted automatically by spring action and its bay doors close.

Normal Use

Before Flight

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

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 bar.

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

Check that the pressure in both systems remains at approximately 207 bar. A transient drop in HYD 1 pressure occurs during operation of the landing gear, flaps or airbrake, but pressure should restore when the operation of a service is complete.

With the engine throttled back RAT functioning can be checked, if necessary, by moving the control column continuously to reduce No 2 hydraulic system pressure until the HYD 2 caption illuminates and the RAT extends. Functioning of the RAT is indicated by the HYD 2 pressure gauge reading cycling between approximately 160 and 210 bar, as the RAT pump cuts in and out. The HYD 2 caption may extinguish, depending on the idle RPM used during the test. To retract the RAT increase engine RPM to above 75% and press the HYD 2 RESET button. Check that the HYD 2 pressure gauge indicates approximately 200
bar 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, in-flight checks should only be carried out during scheduled flight testing of the system.

Oil Tank

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

Oil Circulation

A pressure pump draws oil from the tank and delivers it, through a fuel-cooled oil cooler and a filter, to the engine and to the external gearbox. 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

A differential pressure switch monitors the pressure difference between feed oil pressure and the scavenge oil pressure at an internal gearbox. If the differential falls below 0.7 bar the switch closes to light the OIL caption. To eliminate transient low-pressure warnings caused by manoeuvres involving negative g. activation of the caption is delayed for at nominal 10 seconds.

Engine Ignition System

Ignition Units and Igniter Plugs

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 l0 mm beyond the Idle position; therefore, to achieve light up it is essential that, during starting and relighting, the throttle is held against the idle stop.

During engine shutdown, the RAT extends when No 2 system pressure falls to approximately 103 bar. It retracts when the system pressure has dissipated.

Malfunctioning

General

In all cases of hydraulic system failure, land as soon as possible.

A non-return valve is in each of the No 1 and the No 2 hydraulic system pressure lines to the tailplane PFCU. The NRV act to cause a hydraulic lock and prevent a sudden nose-down tailplane runaway if hydraulic failure occurs in extreme conditions of high tailplane loading, i.e. airbrake extended at high speeds, where the remaining hydraulic system may be unable
to cope with the high loads.

No 1 System
lf No 1 system pressure falls to approximately 103 bar, the system pressure is confined to the operation of the PFCU only and:
a. The landing gear must be lowered using 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.

If No 1 system pump output pressure falls below approximately 41 bar, the HYD 1 caption illuminates and the system fails.

The illumination of the HYD 1 caption 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 re-select the landing gear up.

No 2 System
If No 2 system pump output pressure falls to approximately 113 bar, the HYD 2 caption
illuminates. If the pressure continues to fall to approximately 103 bar, the RAT extends; the No 2 system pressure then increases and the pressure indication cycles between approximately 160 and 210 bar.

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. Set a minimum of 76% RPM and press the HYD 2 RESET button to retract the RAT.

If the failure is caused by loss of hydraulic fluid or of reservoir nitrogen pressure, the RAT is inoperative and there will be no cycling of the HYD 2 pressure indication.

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

Total Hydraulic Failure

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

Accumulators

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.

Hyd 2 Reset button and pressure indicators location

Flight Controls

General

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

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.

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

The dual control columns, which are inter-connected, are linked by push-pull rods to hydraulically-operated powered flying control units (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.

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
The controls and indicators for ailerons, tailplane and rudder are listed in Table 8.

Powered Flying Control Units

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 side or 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.

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 centralises 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

Aileron
The range of aileron movement is approximately +/- 12°.

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 I7°; the scale has major graduations at 5° intervals.

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.

Table 8 — 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	Unmarked	Top of control column	Control tailplane trim actuator main motor

to centre-off (two in each cockpit)			
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 —- two, rear cockpit. — one)	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 pedals 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

Trimming

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.

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 must be operated together to effect operation of the actuator. The amount of trim applied is shown on the AILERON trim indicator by a pointer which moves against an unnumbered are 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 7 seconds.

Tailplane Trim

The main motor of the tailplane trim actuator is controlled by two switches on the control column in each cockpit. Both switches must be operated together to effect operation of 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 must be operated together to effect operation of 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

4 seconds.

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 un-numbered 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.

Flaps

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.

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 must be pulled out from the UP position before MID or DOWN can be selected; the rear cockpit selector must 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.

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 MID, 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 can not be selected from the rear cockpit. Control is returned to the front cockpit by setting the front cockpit flap selector to the same setting as the rear cockpit selector and then setting the rear cockpit selector to PUPIL. With the flaps selected to either 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.

Standby Lowering System

If the No 1 hydraulic system fails, the flaps are lowered to fully down when the locking knob in the centre of the T-handle is pressed and the handle is pulled fully out. 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 over- board 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.

Airbrake

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. If the landing gear standby lowering system is used the airbrake automatic retraction facility does not operate.

Controls and Indicators

An AIR BRAKE — IN/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 is on the centre panel in both cockpits. The indicator is de-energized to show black when the airbrake is fully retracted or when the electrical supply is not established. The indicator 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 the airbrake operation to be tested on the ground.

Operation

In flight, operating an AIR BRAKE switch extends or retracts the airbrake provided that the landing gear is up. To prevent over-stressing 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 must be selected in and sufficiently high airloads must he maintained to close the airbrake before the landing gear standby lowering system is used.

Testing

On the ground, holding the AIRBRAKE 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

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.

After starting the engine, check the flying controls for full and free movement 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.

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. Check the rear cockpit override facility by making a simultaneous but opposite selection in both cockpits; check that the rear cockpit selection prevails.

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 cock-pit operate the switches individually; there should be no indication of trim change. Check the rear cockpit override facility by making a simultaneous but opposite selection in both cockpits; check that the rear cockpit selection prevails.

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. Check the rear cockpit override facility

by making a simultaneous but opposite selection in both cockpits; check that the rear cockpit selection prevails.

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. Return the trim to neutral. 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. Check the rear cockpit override facility by making a simultaneous but opposite selection in both cockpits; check that the rear cockpit selection prevails. Lower the switch cover and check that main trim is again functioning.

Flaps
For solo flight the rear cockpit flaps selector must 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 front cockpit selector to the same setting as the rear cockpit selector and then set the rear cockpit selector to PUPIL.

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 magnetic indicator independently from both cockpits. Check the rear cockpit override facility by making simultaneous but opposite selection in both cockpits; check that the rear cockpit selection prevails.

In Flight

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
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).

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) must then be used. If a similar feature occurs in the front cockpit the standby trim switches must 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.

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

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

Rudder Trim
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.

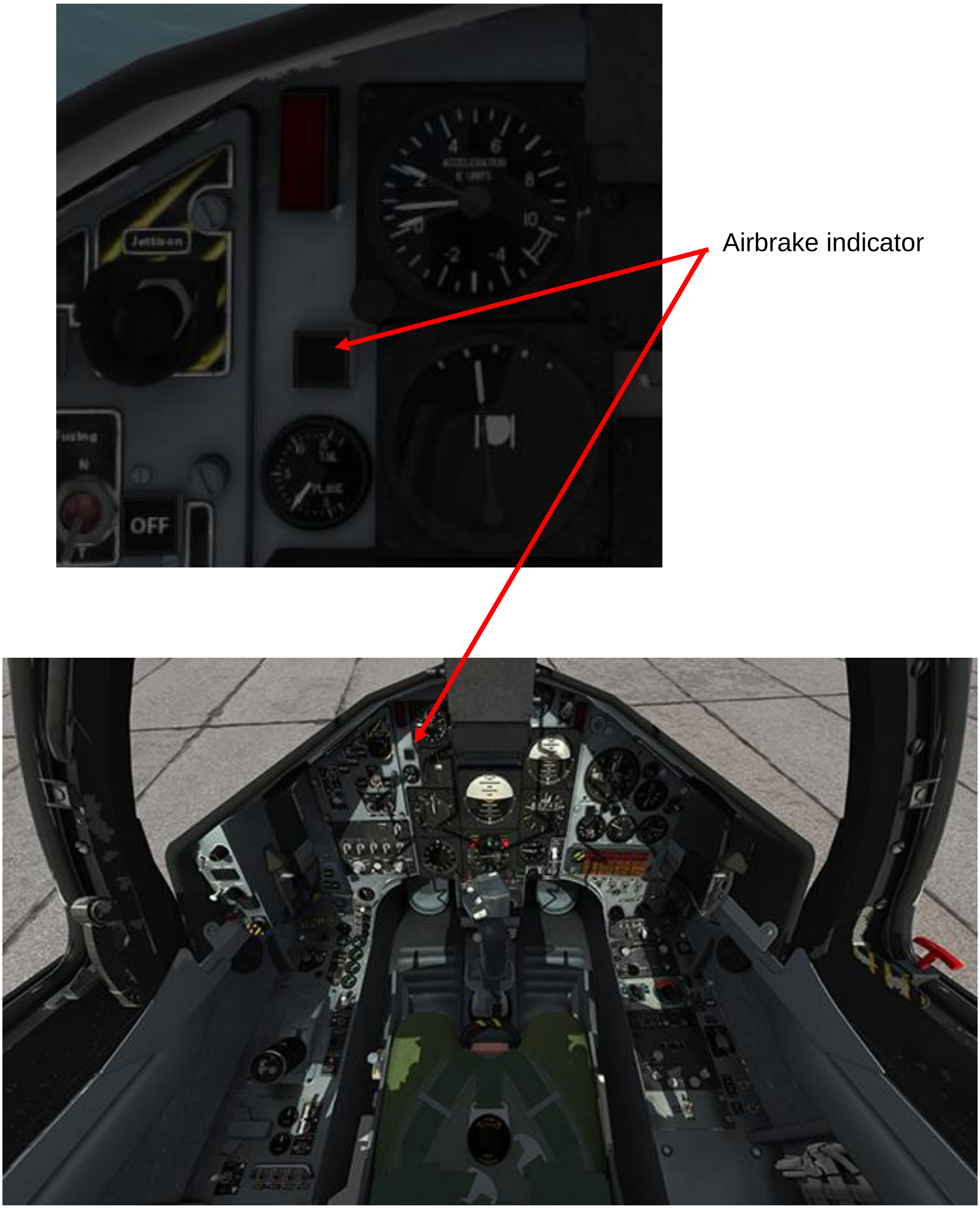
Flaps
If the flaps fail to lower using the normal system, select DOWN at the normal selector and then operate the T-handle of the flap standby lowering system. The standby lowering system gives full flap only; the flaps cannot subsequently be retracted.

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 illuminate. 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 extinguish. Speed should be reduced to below 200 knots. No attempt should be made to raise the flap.

Airbrake
If the airbrake fails to operate, carry out the drills in the Flight Reference Cards.

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 or HYD 2 caption illuminates the airbrake is not to be extended. If, in the event of a HYD 1 or HYD 2 caption illuminating, the airbrake is extended it should immediately be selected in and the airspeed reduced to below 300 knots/0.60M without the assistance of the airbrake.


Airbrake indicator
OFF

Landing Gear, Wheelbrakes and Anti-Skid

General

The landing gear consists of left and right mainwheel units and a fully castering nosewheel unit. Hydraulically operated wheelbrakes are fitted to the mainwheels.

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. An emergency retraction facility is provided.

The mainwheel units retract inward into wheelbays in the wing, forward of the spar; fairing doors on each main unit leg retract with the unit. Wheelbay doors are hydraulically sequenced to close after the legs retract; the reverse sequence occurs on lowering and the wheelbay doors remain open with the landing gear down.

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.

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 toe pads on the rudder pedals; differential braking is provided.

Landing Gear

Controls and Indicators

The controls and indicators for the landing gear system are listed in Table 9 and shown in Figure 2.

Position Indicator
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 (in white on black background)-Unit locked up

Operation

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

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 (see section below), 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 must be depressed for solo flight.

Standby Lowering System

High pressure nitrogen from a storage bottle is used to lower and lock the landing gear if No 1 hydraulic system fails.
The standby system is operated by pulling a. U/C T-handle fully outwards after first depressing a locking button integral with the handle. The system operates irrespective of the setting of the landing gear selector buttons.

Table 9 - 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

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: A voltage of at least 14 volts is required to detonate the cartridge.

Figure 2. Landing Gear Control and Indicators

Wheelbrakes And Anti-Skid

Wheelbrakes

Hydraulically-operated wheelbrakes, incorporating a selectable electro-hydraulic cross-coupled anti-skid system, are fitted to the main wheels. 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.

The rudder pedals consist of toe block, heel bar and cup. 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.

A pressure-sensitive by-pass valve and a restrictor in each brake pressure line minimises brake response time and improves 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.

A brakes SUPPLY pressure gauge, on the left console in each cockpit, indicates the brakes accumulator pressure. When the accumulator is fully charged the supply gauge indicates between 195 and 2l0 bars. If the No 1 hydraulic pump fails, a fully charged accumulator provides at reserve of power, which is sufficient to bring the aircraft to a braked stop, with anti-skid protection, after landing.

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.

Anti-Skid

The anti-skid system provides automatic protection against mainwheel skidding at the wheel speed equivalent of ground speeds in excess of 10 to 13 knots. 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 mainwheel. 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 lit if either ANTI SKID switch is off or if the anti-skid system fails.

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 (i.e. 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.

Normal Use

Before Flight

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. 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.

During the internal checks, check that brake pressure at each mainwheel is between 85 and 100 bars provided the wheelbrakes accumulator pressure supply is above this figure.

When the chocks have been removed after engine starting, allow the aircraft to roll forward gently. Check the action of the brakes. 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.

In Flight

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

After lowering the landing gear, check that the unit indicators show green and that the DOWN selector is fully in. Check that the wheelbrakes 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.

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

Landing

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 two to three times per second. At low speed these fluctuations are more marked.

After Landing

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

If the landing gear fails to lower when DOWN is selected, check that HYD 1 pressure is normal and check the position of the selector in the rear cockpit, if occupied. 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.

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.

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 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 be extinguished. Reduce speed to 200 knots. Do not attempt to raise the landing gear.

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 l 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.

Wheelbrakes

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 mainwheels 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 mainwheels 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.

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.

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.

Residual Brake Pressure

If residual brake pressure in excess of 10 bars is indicated after completion of the Before Landing Checks. Select the anti-skid system off and use the brakes without anti-skid protection. If residual brake pressure actually exists, i.e. 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.

Anti-Skid

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

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.

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.

Anti-Skid Control Value 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. 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 will not achieve pressure at the wheel with the faulty valve. Once rudder effectiveness is lost, loss of directional control is likely. If a single brake failure is suspected during the landing run but the gauge indications appear normal, anti-skid control valve failure should be assumed.

Tyre Burst

If a tyre bursts on landing or during the landing roll the erratic rotation of the affected wheel may activate the brake pressure to both wheels unpredictably. Loss of directional control is likely. Cease braking immediately and select anti-skid off. Directional control may than 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.

Air Conditioning, Pressurisation and Anti-G

Air Conditioning And Pressurisation

General

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 pressurisation 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. On the ground and when air conditioning is switched off in flight, the cabin is ventilated by ram air.

Controls and Indicators

The controls and indicators associated with air conditioning and pressurisation are listed in Table 10.

Pressure Regulating and Shut-Off Valve

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

Air Conditioning System

The air conditioning system receives and cools a proportion of the air tapped from the engine HP compressor; the remainder bypass 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 a 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.

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.

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 intake is low; i.e. 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 greater volume of cooling air to be drawn through the heat exchanger. A solenoid operated shit-off valve controls the injection of air into the inducers. The valve is energised 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 up-lock microswitch on the right mainwheel leg. When the landing gear is lowered the microswitch opens, the shut-off valve solenoid is de-energised and the valve opens. The solenoid is energised and closes the valve when the

landing gear is locked up.

Table 10 - Air conditioning and pressurisation controls and indicators

Control / Indicator	Marking	Location	Function
Cabin conditioning control switch	OFF/NORMAL/DEMIST/FLOOD (Guarded at OFF) A catch to the right of the switch must be pushed out-board 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 micro-switches 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 (red)	CWP, both cockpits	Indicates cabin altitude exceeds 30,000 feet

Water Extractor

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

Cabin Ventilation

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 grills 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 the temperature by adding HP compressor air to the conditioned supply.

Ram Air

When the aircraft is on the ground, or 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 energised 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; pressurisation of the cabin then takes place.

Temperature Control

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.

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 WARM or COOL 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 7 and 15 seconds to motor from fully closed to fully open.

Canopy Seal

The internal and external controls of the canopy 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 pressurise the cabin does not leak to atmosphere. When the canopy is unlocked, the control valve closes and the canopy deflates to atmosphere.

Pressurisation

General

With the cabin sealed, the cabin is pressurised 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 given by a CPR caption on the CWP.

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 into the fuselage aft of the cabin. Pressurisation 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

The cabin pressure altimeter indicates cabin pressure in terms of altitude. Corresponding normal values of aircraft and cabin altitude (when pressurised) are shown below.

Aircraft Altitude (feet)	Cabin Altitude (feet)
10,000	7,800
20,000	12,700

30,000	16,800
40,000	20,100

Cabin Altitude Warning

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 caption on the CWP and the attention lights come on and the audio warning is received.

Pressurisation Safety Valve

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

Forward Equipment Bay Cooling

The conditioned air discharged into the forward equipment bay provides the cooling required for the satisfactory operation of the avionic equipment.

Anti-g System

General

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.

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.

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 aft, the system is “off” and, in the case of failure of the g-sensitive valve, the anti-g suit deflates.

The g-sensitive control valve responds to the application of positive-g. When g in excess of approximately 2g 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.
The relief valve limits the maximum pressure in the suit to avoid over-inflation.

Test Button
The test button is a rubber diaphragm on top of the anti-g valve unit. Pressing the button operatives 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

Before starting the engine, check that the canopy is locked and that the cabin conditioning switch is at NORMAL. To minimise 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 must be made independently in each cockpit. On the ground at idle RPM the cabin conditioning system is not very effective; when stationary, increasing RPM to between 60 and 70% provides effective cabin conditioning.

Note: The anti-g test button should be pressed gently a small amount, otherwise over-inflation of the suit occurs with severe discomfort to the wearer.

In Flight

After take off adjust the CABIN AIR TEMP switch as required for comfort. Especially in hot and humid conditions, too low a temperature can cause ice to form in the spray piped 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. Prior to 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.

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 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 no cooler than the six o'clock position in automatic mode. It should be noted 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 six o'clock position can lead to sudden fogging during a descent and/or when engine RPM are reduced.

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

Malfunctioning

Pressurisation Failure

If the cabin is under-pressurised above an aircraft altitude of 8000 feet, the failure can only be detected by comparing aircraft and cabin altimeter readings. If a discrepancy is observed, check the setting of the cabin conditioning switch.

If the cabin altitude exceeds 30,000 feet the CPR caption comes on, and the attention lights and audio warning are activated; the validity of the warnings should be checked 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. Land as soon as practicable.

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

Canopy Seal Failure

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

Temperature Control Failure

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 FEED 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 to the system. To reduce this risk the temperature control valve should be inched open by making short (1 second) selections, allowing for the delay which occurs between a selection and a temperature change in the cabin.

Manual Control Failure

If with MANUAL FIXED selected, overheating or overcooling persists, descend below 25,000 feet aircraft altitude 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 fuel state permits. An overcooling failure condition can be relieved by setting the cabin conditioning switch to FLOOD.

Anti-g System Failure

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

Oxygen Systems

General

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.

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

The oxygen system controls and indicators, which are similar in each cockpit, are listed below.

Control / Indicator	Marking	Location
Main supply selector (2 position rotary switch)	OXYGEN - ON/OFF	Right console
Main supply contents gauge	OXY	Right panel
Flow magnetic indicator (main system only)	OXY	Right panel
Regulator changeover 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 (main system only)	OXY	CWP

Oxygen Flow Indicator

Oxygen Main Supply Selector

Main Supply Selector

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

The main supply contents gauge is a direct reading gauge showing cylinder pressure in terms of contents. The gauge scale is graduated in eights 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 must be considered empty.

Main Supply Flow Indicator

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 associated 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 indication in time with the user's breathing. A 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 must immediately check the integrity of the indicator by breathing more deeply.

Main Supply Low Pressure Warning

The main supply low pressure warning is controlled by the low pressure switch which closes to illuminate the OXY caption when the main system pressures to the associated seat is below 3.10 to 3.45 bar. 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 bar or above, the warning is cancelled.

Malfunctioning

General

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 must always be regarded as genuine unless be 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. It should be noted that a failure downstream of the main supply selector affects the associated cockpit only.

Flow Indications

Steady black
If the flow indicator shows steady black (no flow) confirm that the main system is selected ON,

Steady White Bar
If the flow indicator shows a steady white bar (continuous flow) confirm that the main system is selected ON,

Flight Information Displays And Instruments

General

A primary flight instrument display, on the centre panel of each cockpit, comprises a combined airspeed 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 (SAI) 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.

An attitude and heading reference systems (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 glideslope and localiser information and Tacan range and bearing information or Tacan range, bearing and steering information is presented on each HSI by selection at a navigation mode selector in the front cockpit.
Power for either system is from the AC busbar, if this supply fails, a display of attitude and direction is provided by SAI and the DGI respectively.
The CSI, HSI, main altimeter, main attitude indicator, VSI and the DGI have integral lighting (see Lighting System).

Pitot-Static System

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 minimise 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 switch PITOT HT switch at the aft end of the left console in the front cockpit.

The pitot-static system supplies the following cockpit instruments:

- Mail altimeter (repeater in rear cockpit)
- Standby altimeters
- VSI
- CSI

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 provides a datum for the controller in the cabin pressurisation system.

Pressure Operated Instruments

Main Altimeter

A Mk 3B servo-type altimeter in the front cockpit gives indications of altitude on a counter 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 electronically 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, E.g. 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).

Altimeter Pressure Datum

Both the Mk 3B and 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.

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 1013.25Mb and is not affected by changing the setting of the millibar scale.

Altimeter Ground Test

A 2 position switch, spring-loaded to OFF, and 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, which is collectively marked GROUND USE ONLY with the ignition switch, enables the operation of the electrical parts of both altimeters to be tested. The rear cockpit switch enables the Mk 3C altimeter servo to be tested in isolation from the Mark 3B servo. When the front cockpit switch is held on, with power applied to the altimeters, the altitude indication on both altimeters should progressively increased 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 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 on, the rear cockpit indication should increase to 11,100 ± 200 feet. The altimeter test switches must not be operated in flight.

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 has no affect on the serviceability of the front cockpit altimeter but causes the red and black striped bar to obscure the altitude counter of the rear cockpit altimeter, rendering it unusable.

Standby Altimeter

A Mk 19F altimeter is on the right panel in each cockpit and can be used as a standby if the Mk 3B or Mk 3C altimeters are unserviceable. Height is indicated by two pointers and by a black and white disc which is viewed through spiral a slot and replaces the third pointer of other altimeters.
The longer pointer makes one rotation for each 1000 feet and the shorter pointer makes one rotation for each 10,000 feet; the leading edge of the white sector of the disc indicates total height as it moves through the slot. The slot, which covers the height range zero to 60,000 feet, is marked with unnumbered increments representing 10,000, 20,000, 30,000, 40,000 and 50,000 feet; the amount of white visible is proportional to the tens of thousands of feet and the slot is completely filled at 60,000 feet. A millibar setting control is provided.

Note: The tens of thousands increment marks against the slot are related to the numerals on the outer scale of the instrument, I.e. the 10,000 feet increment is opposite 1, the 20,000 feet is opposite 2 and so on; therefore the 10,000 feet height band in which the aircraft is flying is readily indicated by the leading edge of the white sector.

Vertical Speed Indicator (VSI)

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 (CSI)

The CSI gives an 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 0 knott 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 correct relationship between airspeed and mach number.


FT/MIN
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X 10
MACH
MACH

Electrically Operated Instruments

Standby Flight Instruments Power Switch

A 2 position switch, STBY INST-ON/BATT, is on the centre panel in each cockpit.
When the switch is set to ON, a 28 volt DC supply from the Essential services busbar provides power for the turn-and-slip indicator, the SAI and the DGI. When the switch is set to BATT, these instruments are powered by commoned supplies form No 1 and No 2 battery busbars.

Main Attitude Indicator

The main attitude indicator in each cockpit is of the moving ball type; it receives pitch and roll attitude signals from the AHRS displacement gyroscope assembly in the main equipment bay. The attitude indicators and the vertical gyro unit form the attitude indication system. 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 5º intervals, read against a fixed yellow aircraft symbol. The division lines are numbered at 30º, 60º and 90º of climb or dive. The words CLIMB and DIVE are marked at the 45º 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 30º divisions up to 90º and 10º subdivisions to show bank angles up to 30º.

Fast Erect Button

A spring loaded button marked ERECT is on the AHRS control unit in the front cockpit. Momentary operation of the button increases the rate at which the AHRS vertical gyro erects. To ensure that the vertical gyro has attained a sufficiently high rotation speed before fast erection is initiated, the button must not be operated until 60 seconds have elapsed from the AHRS being switched on.

Thereafter, the button should only be used in unaccelerated flight conditions.

A 2 position switch spring-loaded to off and marked ATT FAST ERECT is on the centre panel in the rear cockpit.

The switch offers similar facilities and should be used in the same way as the ERECT button.

Power Supplies

The main attitude indicators and the AHRS are powered by a 115 volts 400 Hz supply from the AC busbar 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.

Turn-and-Slip Indicator

Each turn-and-slip indicator has a pointer which indicates direction 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 rotational speed of the gyro drops to a level whereby accuracy is impaired.

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 3 minutes to spin up to its operating speed; do not use the instrument within this period.

Standby Attitude Indicator (SAI)

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.

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 (15.5° bank). The normal erection rate is nominally 3° per minute.

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 (i.e. 180º bank) such that when the instrument indicates level inverted flight the aircraft nose is 24º below the horizon. Smaller pitch errors are present at all intermediate angles of bank e.g. 6º nose up error at 60º bank, 12º nose up error at 90º bank. The instrument has full freedom in roll but reaches gimbal stops in pitch at 97º climb and 73º dive when it undergoes a 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 ± 60º pitch has been exceeded.

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 cage position (within 3º of datum). This may take up to 60 seconds. The knob must not 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 30º and 60º divisions, while the caging knob is pressed in. The caging knob must not be used until at least 30 seconds after power has been applied to the instrument.

Power Supplies

The SAI 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 3 minutes to spin up to its operating speed; do not use the instrument within this period.

Directional Gyro Indicator (DGI)

The DGI has a rotating compass card graduated at 5º intervals and with alpha-numeric markings at 30º 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 around 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 85º 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.

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 3 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.


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Flight Navigation Instruments

Attitude and Heading Reference System (AHRS)

General

The AHRS supplies heading signals to the HSI and Tacan and pitch and roll signals to the main attitude indicators. The heading reference part of the system can be operated in either Slaved or DG mode. The AHRS consists of a displacement gyroscope assembly (DGA) and an electronics control amplifier in the main equipment bay, a detector unit in the fin and an AHRS control unit on the leg panel in the front cockpit.

Displacement Gyroscope Assembly

The DGA is an all attitude device. It contains a vertical gyro to provide pitch and roll information to the main attitude indicators via the electronics control amplifier and directional gyro (DG) to provide a stable heading reference to the electronics control amplifier. When the AHRS is switched on the vertical gyro is automatically fast erected in pitch and roll so as to be within 0.25º of the local vertical within 1.5 minutes of power being applied. If power to the AHRS is subsequently interrupted for longer than 40 ± seconds the initial fast erection of the vertical gyro is automatically carried out when power is re-applied. It is essential therefore that the aircraft is in straight and level unaccelerated flight when power is re-applied for 1.5 minutes afterwards to ensure that the vertical gyro is erected to the correct datum, otherwise erroneous data is presented on the main attitude indicator. The normal erection rate of the vertical gyro is 1.0 ± 0.5º per minute but a manually initiated fast erection facility erects the gyro at 29 ± 5º per minute.

In the DG mode the DG operates as an earth rate corrected free gyro, heading compensated for transport rate at a fixed ground speed of 350 knots. In the Slaved mode the DG is slaved to magnetic heading signals from the detector unit. The normal slaving rate is 1.5 ± 0.5º per minute.

Automatic fast synchronisation of the DG to detector unit heading takes place when the AHRS is switched on following fast erection of the vertical gyro and when the AHRS is switched from DG mode to the Slaved mode provided the aircraft is in straight and level unaccelerated flight.

In flight, slaving errors can be eliminated by manually initiating fast synchronisation at a PUSH TO SYNC control on the AHRS control unit; the control should only be operated when the aircraft is in straight and level unaccelerated flight. If the aircraft is not in straight and level flight and manual fast synchronisation is initiated then the DG is synchronised to erroneous magnetic heading signals from the detector unit; heading signals from the AHRS to the HSI and the TACAN are incorrect.

Automatic and manually initiated fast synchronisation takes place at a rate of greater than 30º per second. If power to the AHRS is interrupted (HSI power failure warning flag displayed) for less than 40 ± 10 seconds, the system enters a free gyro mode and, unless extreme manoeuvres have been carried out in this mode, will remain erect; if however, the accuracy of the system is suspect then straight and level unaccelerated flight should be achieved and manual fast erection and fast synchronisation initiated.

Note: If the aircraft is turning or accelerating when the slaved mode is selected from the DG mode, automatic fast synchronisation is inhibited and it is necessary to initiate manual fast synchronisation when the aircraft has resumed straight and unaccelerated flight.

Electronics Control Amplifier

The electronics control amplifier contains the electronic circuits to process the output signals from the DGA and develops the gyro torquing signals in response to gyro output signals.
The stable heading reference from the DGA is used by the electronics control amplifier to provide free or slaved heading to the HSI and TACAN. The amplifier also provides a correction signal for the effects of coriolis acceleration acting on the detector unit. A 3 position switch in the electronics control amplifier provides an approximation of magnetic variation for use in deriving true heading; true heading information is required for proper earth-rate correction of the vertical gyro. The amplifier contains a removable magnetic deviation compensation module which provides compensation for coefficient A, B and C errors.

AHRS Control Unit

The AHRS control unit has the following controls and indicators:

a. Heading Mode Selector.
The heading mode selector is a 3 position rotary switch marked OFF/DG/SLV; it selects either power off to the system (OFF), the directional gyro (DG) or the slaved (SLV) mode of operation.

b. Synchronisation Indicator.
The synchronisation indicator, marked SYN IND, has a centre zero movement with a pointer which is displayed left (-) or right (+) of centre to indicate the direction in which the DG is desynchronised from magnetic heading in the slave mode; a three-quarters to full scale deflection indicates a synchronisation error of 5^{o}.
When the pointer is displayed in the slaved mode it can be re-centralised, indicating that the DG is synchronised, by pressing the PUSH TO SYNC control. In the DG mode the pointer is parked in the upright position.

c. Synchronisation and Set Heading Control.
The synchronisation and set heading control is a push-to-turn control marked PUSH TO SYNC. In the slaved mode fast heading synchronisation at greater than 30^{o} per second is initiated when the control is pressed and turned. Rotation of the control in counter-clockwise (-) or clockwise (+) direction results in a negative or positive heading change respectively; the rate of heading change depends on the amount the control is turned.
In the slaved and DG modes the HSI and the main attitude indicator power failure warning flags are displayed while the PUSH TO SYNC control is pressed; the warning flags are also displayed in the Slaved mode while fast synchronisation is taking place. A synchronisation repeater marked

COMPASS SYNC is on the right console in the rear cockpit.

d. Latitude Control.
The rotary latitude control, marked LAT, is preset to the latitude of operation to establish a correction for apparent drift of the directional and vertical gyros due to Earth's rotation. The control also establishes a correction for transport rate drift of the DG.

e. Fast Erect Button.
A button type switch, marked ERECT, causes the vertical gyro to be erected at 29 ±5º per minute when pressed. When the AHRS is in the fast erection mode the main attitude indicator and HSI power failure flags are displayed.

AHRS Control Unit

Horizontal Situation Indicator (HSI)

An HSI, 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 5º intervals and is marked alphanumerically at 30º 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 the 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 the track (COURSE) counter t the top right of the 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 set to TACAN, a Tacan radial set on the track index and 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 form the Tacan is less than 90º from the selected Tacan radial. Conversely the "from" flag shows white whenever the bearing from the Tacan beacon is 90º 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, E.g. 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 Localizer or Tacan Bearing Warning.
A red flag, with NAV in white letters, appears below the COURSE counter when the ILS localizer 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.


N MILES
COURSE
000
GS
NAV
DG
N
E
S
W
3
6
12
15
21
24
30
33
HDG
OFF
DG
SLV
HSI

Miscellaneous Instruments

Accelerometer

An accelerometer calibrated from -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 pointers can be rest by pushing a PUSH TO SET knob on the instrument face.

Standby Compass

An E2C 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 lighting panel.

Normal Use And Management

Before Flight

DGI

With the battery switches on, or 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.

Turn-and-Slip Indicator

Check that 3 minutes after batteries are switched on, or the external DC supply is connected, the underspeed warning flag clears. Whilst taxying, check the instrument for correct indications.

Accelerometer

In the front cockpit, reset the accelerometer; in the rear cockpit check that the accelerometer has been reset.

Altimeters

a. Main.
Do not attempt to adjust the millibar scare until AC power is on line. Check that the warning bar has 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 to zero ±35 feet. Set the appropriate barometric pressure.

b. Standby.
Set QFE on the millibar scale and check that the altimeter indicates zero +40/-35 feet. Set the millibar scale as required.

AHRS

With AC power on line check that the mode selector is set to SLV and that the correct latitude is set at the control unit. Check the heading indicated by the HSI compass card against the E2C compass. If necessary, synchronize the DG by pressing the PUSH TO SYNC control.

Attitude Indicators

a. Main.
With DC and AC power on line and the AHRS mode selector set to SLV, check that the warning flag clears. If necessary, operate the fast erect system but not until 60 seconds have elapsed from switch-on.

b. Standby.
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.

HSI

With AC power on line and the AHRS control unit mode selector set to SLV, 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 rear cockpit HSI and that the track (COURSE) counters indicate correctly; set as required.

In Flight

Periodically check that the AHRS remains synchronised. Achieve straight and level unaccelerated flight before selecting the slaved mode from the DG mode. If power to the AHRS is interrupted and then re-applied, and manual synchronisation becomes necessary, or if synchronisation becomes necessary for any other reason, establish the aircraft in straight and level unaccelerated flight, cross check the attitude indicator, natural horizon and the turn-and-slip indicator, and with the slip ball trimmed to the centre press the PUSH TO SYNC control.

Malfunctions

Standby Instruments

If the power failure warning flag on either the standby attitude indicator or the DGI are displayed, set the STBY INST switch to BATT. If a warning flag then remains displayed, the associated instrument is unserviceable and the switch can be returned 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.

If the warning flag is displayed on the turn-and-slip indicator, the turn indications are unreliable and must not 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

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 is obscured by the red and black striped bar. The front cockpit altimeter remains serviceable but in the rear cockpit the standby altimeter must be used.

AHRS

If the main attitude indicator information is unreliable when cross-checked against the standby attitude indicator and the main attitude indicator power flag is not displayed, achieve straight and level unaccelerated flight and then press and hold the ERECT button until the main attitude indicator display is erected. When the display is erected release the ERECT button and monitor the performance of the main attitude indicator against the standby attitude indicator.

If when operating in the SLV or DG mode, 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. If the check shows that both the attitude indicator and the HSI power failure flags are displayed then consider the AHRS as unreliable and use the standby attitude indicator and E2C 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 power failure and do not use it; use the appropriate standby instrument(s).

If, when operating in SLV mode with the HSI power failure flag not displayed, the HSI heading is incorrect when compared to the E2C compass and the AHRS cannot be synchronised, select the DG mode and align the HSI heading with E2C heading. If unsatisfactory heading performance is obtained in the DG mode use the E2C as the heading reference.

General Equipment

Cockpit Access And Canopy

Canopy

The sideways-opening canopy operates 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.

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, the quick release pin should be removed to free the strut.

A cabin pressurizing seal strip is around the canopy base.

Canopy Controls

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 pushbutton integral with an external lock/unlock handle. When either the front or the rear cockpit catch is pressed outboard both levers are free to move. When either safety catch is pressed the canopy seal is deflated.

To open the canopy, click on the safety catch then the operating lever in turn. Next click the grab handle just up from the lever and the canopy will open.

To close the canopy, reverse the procedure; click the grab handle, close the lever by clicking it and lock the safety catch by clicking it.

Left control+C will operate the canopy grab handle mechanism.

The canopy will not open when the safety catch is engaged and the grab handle is forward.

Miniature Detonating Cord System —Canopy Shattering

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.

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.

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 must be removed before flight and placed in the stowage in the front cockpit, on the left side.

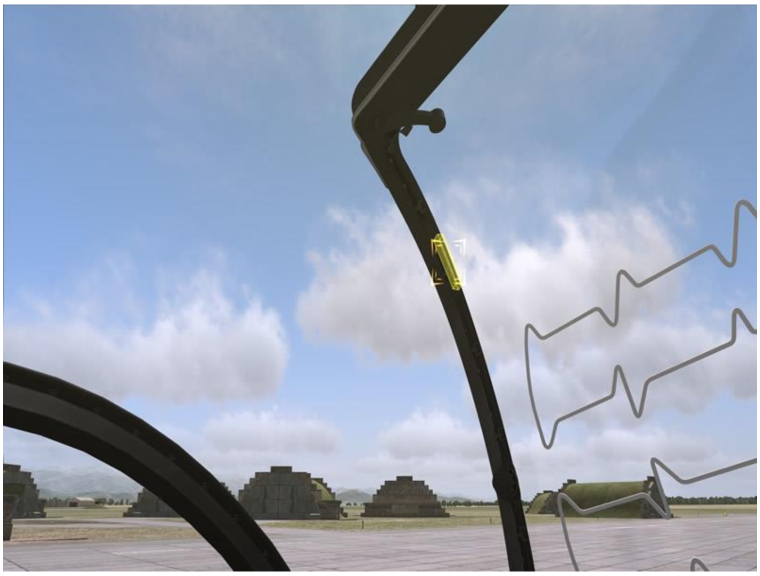
The MDC firing unit detonators are fired by:

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 must be removed by the occupant and placed in a stowage on the left side of the canopy frame of the associated cockpit, after strapping in.

Note: This is currently inoperable.

See the following page for indications of where the canopy opening/closing mechanism are.



LIGHTING SYSTEM

Overview

The BAE Systems Hawk Mk T.1A has integral internal and external lighting. The aircraft internal lighting comprises general cockpit lighting and the lighting of control units and indicators by integral lights and pillar lights.
The external lighting consists of a landing/taxi 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 switch 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.

Internal Lighting

General
The aircraft internal lighting comprises general cockpit lighting and the lighting of control units and indicators by integral lights and pillar lights.

Cockpit Lighting

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 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.

In each cockpit the main lights are powered from the Essential Services busbar via the 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 EMERGENCY, 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 on/off switch.

Main Lights Master Switch

Each main lights master switch, in addition to controlling the main strip lights and the map reading light, also controls the integral lighting of indicators as shown in Table 11.

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 and the MCP caption lights is also automatically reduced.

Emergency Lights Switch   Compass Light Switch

Main Lights Master Switch and Dimmers

Dimmer Controls

Three rotary dimmer controls, PORT, STBD and CENTRE, 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 form 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 11.

Table 11 - Internal Lighting Control (Both Cockpits)

Control / Marking	Function
Main lights master switch - PANEL	• Controls DC supply from Essential Services busbar to: o PORT and STBD dimmer controls o Map reading lights o Flaps position indicator pillar lights o Indicator integral lights for front cockpit: ▪ Landing gear, airbrake, air producer start, engine rotation and ▪ WCP busbar on ▪ Pylon selected ▪ WCP role indicator ▪ ADR status o Indicator integral lights for rear cockpit: ▪ WMP busbar ▪ Navigation mode selected repeater o Controls AC supply to CENTRE dimmer control
Rotary dimmer - PORT	• Controls intensity of left panel main strip lights. In front cockpit controls intensity of UHF transceiver integral lighting.
Rotary dimmer - STBD	• Controls 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: VHF transceiver, IFF control unit, ILS control unit and Tacan control unit.
Rotary dimmer - CENTRE	• Controls integral lighting on centre panel in: CSI, HSI, main altimeter, main attitude indicator, VSI, DGI, AHRS control unit and 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

External Lighting

General

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/Taxi Lamp

The landing/taxi lamp, which has a 250 watt filament, is in the nose cone. The lamp is controlled by the LAND-TAXI switch.

Navigation Lights

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

Two anti-collision 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 white flashing light. The left-hand and right-hand ANTO-COLLISION light switches are marked LOWER and UPPER respectively. 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. The two power units are 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 approximately 60 times a 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. In this way the combined flash rate is approximately 120 times per minute.

Landing / Taxi Light Switch   Navigation   Anti-Collision Switches

Communication System

General

Introduction

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.

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 this equipment 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

Power for the communications system and associated equipment is provided as follows:

a. Essential Services Busbar
   CCS
   UHF (main and standby)
   VHF
   [FF/SSR
   ILS marker light test
   Telebrief (T Mk IA)
   VOR (post-mod 9531
b. Generator Busbar
   ILS
c. AC Busbar
   Tacan

When the communications power switch marked UHF — NORMAL/BATT is at BATT, power for the CCS, the main UHF and (post-SEM 067) the telebrief facility is from the comrnoned supplies from No 1 and No 2 Battery busbars.

Navigation Mode Selector

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.

Communications Control System

General

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.

Station Boxes

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.

Each station box has the following controls and switches:

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 selector on both station boxes is set to similar positions and simultaneous transmissions are made from each cockpit, the transmission from the front cockpit is inhibited.

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.

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 (see amplifier selector para below) is set to FAIL.

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.

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 (see amplifier selector para 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.

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 J B; 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 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.

(2) At FAIL, the station box standby microphone amplifier intercom circuit is selected and connected to the associated main telephone amplifier and the 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.

Transmit Switches

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

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. The mute switches have no effect on audio signals from the telebrief centre.

UHF Communications

Main UHF

General

An AN/ARC 164 transceiver provides radio communication facilities in the UHF range 225.000 to 399.975 MHz. it is possible to select any one of 7000 channels, spaced at intervals of 0.025 MlHz. 20 of the channels can be preset for rapid selection. A separate guard receiver, preset to 243.000 MHz, is also provided.

Controls and indicators

General
The controls and indicators comprise those on the control panel of the UHF transceiver and an aerial selector switch in each cockpit.

Transceiver Control Panel
The control panel of the UHF transceiver has the controls and indicators shown in Table 12.

Standby UHF

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 the rear cockpit.

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.

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 must 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.

Before solo flight the rear cockpit standby UHF switch must be checked as set to MAIN and the aerial selector switch checked as set to FRONT.

Table 12 - Main UHF Transceiver Controls

Controls/Marking		Function
4-position rotary function switch selecting:	OFF	Power off
	MAIN	Transmitter and main receiver operational
	BOTH	Transmitter and both main and guard receivers operational
	ADF	Inoperative in this installation
3-position rotary mode switch selecting:	MANUAL	Gives tuning authority to manual frequency selectors
	PRESET	Gives tuning authority to preset channel selector
	GUARD	Selects transmitter and main receiver to the 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	
Five rotary frequency selector	From left to right the knobs are used to manually change frequency in steps of 100, 10, 1, 0.1 and	

knobs and digital indicators	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

VHF Communications

General

A VHF set (ARI 23259/1), on the right console in the front cockpit, provides radio communication facilities in the VHF range 116.000 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 121.500 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

The control panel for the VHF set is on the front face of the transceiver and has the controls and indicators shown in Table 13.

Table 13 - VHF Transceiver Controls

Controls/Marking	Function
5-position rotary function switch selecting:	
OFF	-Power Off
T/R	-Selects transmitter and main receiver
T/R GUARD	-Selects the guard receiver in addition to the transmitter and main receiver
D/F)	-Inoperative in this installation

RETRAN)

Operation

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 head- phones in a cockpit when an amplifier selector on the station box in that cockpit is selected to FAIL.

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

A station box on the right panel in each cockpit provides for selection and control of the UHF(main and standby) and VH F 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.

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.

Each station box has the following controls and switches:

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. Trans- missions can be made from both cockpits simultaneously provided that one is on VHF and the other is on UHF. If the function selector on both station boxes is 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 it the amplifier selector (see 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 (see 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 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.
2) At FAIL, the station box standby microphone amplifier intercom circuit is selected and connected to the associated main telephone amplifier and the standby telephone amplifier in the J B; 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.

VHF COMMUNICATIONS

General

A VHF set on the right console in the front cockpit, provides radio communication facilities in the VHF range 116.000 to 149.975 MHz. A possible 1360 communication frequencies are provided, spaced at 0.025 MHz intervals. A separate
guard channel, preset to I21.500 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.

Table 13—VHF Transceiver Controls

Controls/ Marking		Function
5-position rotary function switch selecting:	OFF	Power Off
	T/R	Selects transmitter and main receiver
	T/R GUARD	Selects the guard receiver in addition to the transmitter and main receiver
	D/F	Inoperative in this installation

	RETRAN	
Two rotary frequency selectors and a digital indicator:	MEGACYCLES	The 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 pushbutton		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

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.

TACAN

General

A Tacan installation 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 the tracking of a specific Tacan radial, as selected at the front cockpit HSI, to be made. The system has 126 channels available and has a built-in test facility. The system comprises the following units:

- Control unit.
- Range unit.
- Bearing unit.
- Range converter unit.

Unit Location

The control unit (which houses the transceiver) 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

Control Unit

The control unit has the following controls:

1) Function Selector

The function selector is a 3-position rotary switch which provides the following facilities:

a) OFF

The AC supply is disconnected. With TACAN selected at the navigation mode selector, the NAV flag alarm is displayed on the HIS and the range counter is obscured.

b) 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; the range counter, however, remains obscured.

c) 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.

2) 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 the units position; the controls select the frequency of both transmitter and receiver.

3) Built-In Test Switch

A pushbutton, marked TEST, when held pressed, makes a built-in test.

4) Mode Selector

The 2-position switch, marked X/Y, selects the mode of operation. The selector should be set to X; in this mode 126 channels are available. With Y selected the equipment continues to operate in the X mode.

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.

Range Converter Unit

The range converter unit converts information from the range unit to a form suitable for the HSI.

Bearing Unit

The bearing unit processes the bearing information and provides the following indications 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
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 HSl 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 HIS 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. Move the track index through 090 and 270 degrees and check that the to-/from-flag display is reversed.
i. Release the TEST button. Check that the range counter is obscured by the yellow bar and the bearing pointer rotates smoothly counter-clockwise.

Instrument Landing System (ILS)

General

The ILS installation (ARI 18227/2) comprises a localiser and glideslope receiver and a marker receiver. The localiser and glideslope 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; glideslope 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 glideslope of the selected ILS ground installation is shown on the HSI; marker audio signals are fed to the CCS. If the glideslope 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 glideslope indications may be obtained out to 25 NM and 10 NM respectively at
2000 feet AGL.

Controls and Indicators

The ILS control unit (which houses the localiser and glideslope receiver) has the controls and indicators shown in Table 14.

Table 14—ILS Control Unit—Controls and Indicators

Controls/ Marking		Function
3-position rotary mode selector:	OFF	Power off
	ILS	Connects the power supply to the system
	VOR	Inoperative in this installation
Four, rotary frequency selector thumb-wheels and digital indicators	MHZ	From left to right, the knobs are used to manually change localiser receiver frequency in steps of 10, 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

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

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 ground 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 ground station.

Units

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 alternatively switched to the transponder at 42 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.

Control Unit

c) 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

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

The control unit has the following controls and indicators:

a) Function Selector.

The function selector is a 3-position rotary switch selecting:

OFF Power off
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
XMT The transponder is fully operational. If, however, XMT is selected directly from OFF, there is a warm-up delay of approximately 2.5 minutes before the transponder becomes operational

b) Mode Switch

The mode selector is a 2-position switch, marked 1 and 3/A/B, which 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 SPl 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 initial selection of the facility.

f) Test Switch

The button TEST switch is used, in association with two parallel-wired green lights, to test the installation. 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

The 3-position switch, marked CU/off/PS, is spring-loaded to off. The switch is used during servicing to isolate faults between the control unit (CU) and the transponder (PS); do not use it in flight.

Normal Use

General

When using the communications system it should be noted 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 this equipment 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, at 2 MHz spacing, from 116.000 MHz upwards.

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.

WARNING: If a frequency change or a UHF aerial change is made while a transmit button is pressed, damage to the UHF/VHF equipment or the UHF equipment respectively results.

Note: Special care is necessary when making selections on the IFF/SSR control unit as the miniaturized switches are particularly susceptible to damage.

Ground Intercom

With either an external DC power 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: The UHF and VHF transceivers should be checked (see below) before the telebrief is connected.

Engine Start on Internal Power
Before solo flight check that the rear cockpit standby UHF switch is set to MAIN and the UHF aerial selector switch is set to FRONT. Ensure that headset and PEC connections are properly made, then continue as follows:

a. External DC power supply disconnected.
b. No l and No 2 battery switches on.
c. Communications power switch set to NORMAL.

Engine Start on External Power
Before solo flight check that the rear cockpit standby UHF switch is set to MAIN and the UHF aerial selector is set to FRONT. Check that the telebrief facility is connected if required. Ensure that the headset and PEC connections are properly made, then continue as follows:

a. No 1 and No 2 battery switches off.
b. External DC power supply connected.
c. Communications power switch set to NORMAL

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.

UHF Aerial Selector Switch
Set the UHF AE switch as required.

Main UHF Transceiver
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.

Standby UHF Transceiver
a. Set STBY UHF switch to A; check transmission and reception.
b. Set STBY UHF switch to MAIN.

Note: When the telebrief is connected UHF transmissions are inhibited; the standby UHF should therefore be checked before the telebrief is connected.

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.

IFF/SSR
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.

ILS
a. Set mode selector to ILS.
b. Test ILS MARKER indicator light.

Tacan
a. Set function selector OFF.
b. Set mode selector to X.

Telebrief
With the telebrief connector plugged in check that the TELE/BRIEF light is on.

Systems Operation

UHF

Note 1: VHF transmissions may break through on UHF tuned to the 2nd or 3rd harmonic of the VHF frequency.

Note 2: 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 (243.000 MHz) select GUARD, or select MANUAL and set 243.000 MHz manually.

d. Set the UHF AE switch as required.

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: When the telebrief is connected VHF transmissions are inhibited.

IFF/SSR
In flight, with function selector set to XMT and correct mode and code selected, the
transponder replies automatically to interrogation.

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 hearing are displayed when the Tacan system is operating.

Tacan

a. On the Tacan control unit select the required channel, set the mode selector to X 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.

Malfunctioning And Emergency Use

Electrical Failure

AC Inverters
If both No 1 and No 2 inverters come offline (AC1 and AC2 captions

illuminated) and cannot be reset, the IISI is inoperative; neither Tacan derived information nor ILS information can be displayed.

Generator
If the generator comes offline (GEN caption illuminated) and cannot be reset, ILS and Tacan are inoperative. To ensure continued communication facilities, set the UHF - NORMAL/BATT switch to BATT.

Communications Failure

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.

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.

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.
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 the1020 Hz tone signal is obtained.

Note: The 1020 Hz bone 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.

VHF Transceiver
If receiver serviceability is suspect, press the RCVR button. Serviceability is *confirmed if the 800 Hz tone signal is obtained.*

Armament

Introduction

The armament installation enables the aircraft to carry rockets, practice bombs, cluster bombs, Sidewinder missiles and a gun. Four underwing pylons can be fitted, two left and two right; the pylons are interchangeable but non-jettisonable. Each pylon is equipped to carry a rocket launcher containing I8 x 68 mm SNEB rocket projectiles (RP), a practice bomb carrier (PBC) or a carrier bomb light stores (CBLS) No 100 Mk 1 or Mk 3 for carrying 2 x 28 lb (ballistic) practice bombs. Each pylon is additionally equipped to carry a Mk.82 or dual Mk.82's on a twin rack or a Sidewinder missile launcher; 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). Only one weapon can be used at any one time, i.e. either bomb or RP or gun. 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.

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. There is also 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.

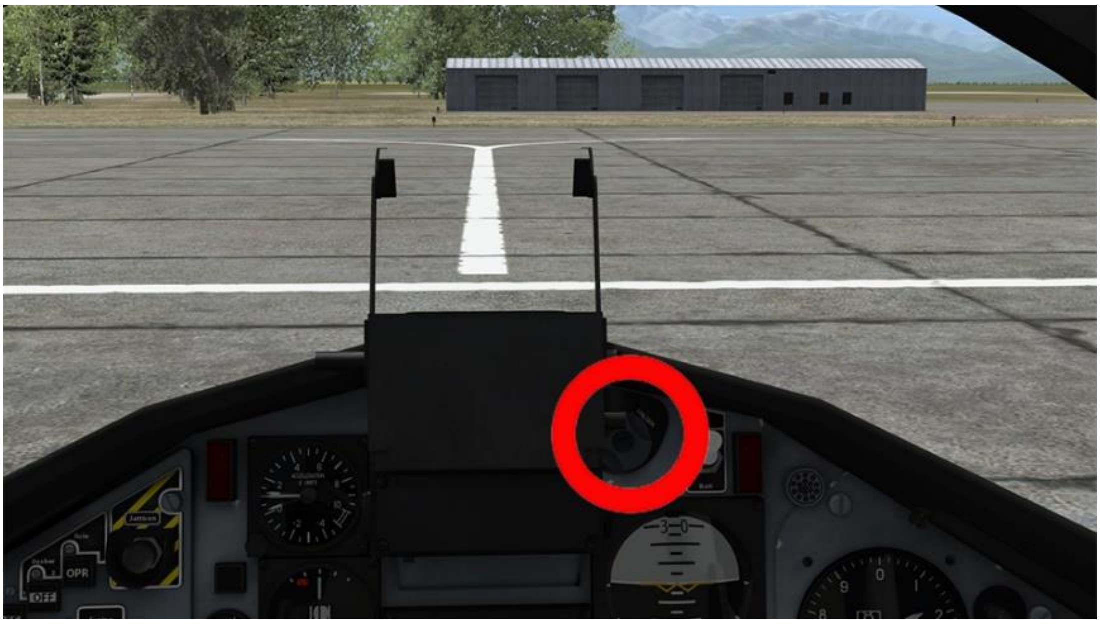
Armament Controls And Indicators

Master Armament Safety Switch

DC supplies to the armament installation are controlled by the MASS in the from cockpit. The MASS is on the centre instrument panel and comprises two switches mounted in a key-controlled switch assembly which is centrally-positioned in a control knob. 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 tums. 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 must not be allowed to turn with the knob; should it do so it may not be possible to reset the switch correctly.

Note: The key must only be used to unlock or lock the MASS; it is not to be used to turn the control knob (which must be turned separately). When not in use, the key is to be stowed in the rubber grommet adjacent to the sighthead.

Refer to the QuickStart guide for arming instructions.



Weapon Control Panel

General
The WCP allows for the selection of any pylon-loaded store, except Sidewinder missiles, for release or firing, or the gun for firing. The WCP also allows pylon-loaded stores, except Sidewinders and their launchers, to be jettisoned.

Controls and Indicators
The WCP has the following controls and indicators:

a. Power Indicators
Two magnetic indicators, 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 indicators 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 the button should not be held pressed for longer than 3 seconds.

c. Role Indicator

A magnetic indicator, 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 when cluster bombs are carried or to TRG when either RL, PBC or 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 is used to select rockets, practice bombs or cluster bombs for firing or release.

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 magnetic indicator is above each pylon select switch. Each indicator shows OFF in white on a black background or green depending on the setting of the associated pylon select switch.

g. Bomb Fuzing Switch

A 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 J B role selector is set to OPS. The selected pylon fuzing unit(s) is(are) energised when the bomb/RP 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.

Weapon Monitor Panel

General
The WMP has the following controls and indicators:

a. Power Indicators
Two magnetic indicators, 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 indicators 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 supplies to jettison relays in each pylon; all other weapon control circuits are bypassed. To prevent damage to the jettison relays the button should not be held pressed for longer than 3 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/RP 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 Sidcwinders, from the front cockpit. Selection of override also prevents a complete discharge of rockets from a launcher, the completion of a stick of cluster bombs or gun firing once either have been initiated. Selection of override does not prevent release or firing from the rear cockpit or jettisoning from either cockpit.

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 indicators are then integrally lit.

Bomb Release Intervalometer

The bomb release intervalometer is on the leg panel in the front cockpit and is for use when releasing a stick of cluster bombs. The intervalometer is a 4-position switch marked INTERVALOMETER —100/200/400/600 which enables bomb release intervals of 100, 200, 400 or 600 milliseconds to be selected.

Missile Control Panel

General
A Sidewinder AAM can be carried on a launcher installed on each of the pylons. The MCP 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.

Controls and Indicators
The MCP has the following controls and indicators:

a. AAM Switch
The AAM switch is a spring-loaded oblong pushbutton 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 pushbutton 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 energised. The release or firing of other pylon-loaded stores is inhibited while the SELECT caption is illuminated. The Sidewinder control circuits are de-activated 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 pushbuttons which are marked PORT and STBD respectively. When the AAM switch is pressed either the PORT or the STBD pushbutton 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 must 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 energised 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. The tone is cut off when boresight/target alignment is achieved; the tone is restored when target and boresight become misaligned.

f. Reject Pushbutton
A round spring-loaded REJECT pushbutton enables the selected missile to be rejected and the unselected missile to be selected.

Note: The pushbutton 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 Pushbutton

The jettison pushbutton is marked J and 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.

Weapon Control And Release

General

The MASS must be set to UNLOCK LIVE to connect DC supplies to No 1 and No 2 Armament busbars and the nosewheel leg uplock microswitch must 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 magnetic indicators show black; if both indicators show OFF no armament facilities are available.

For gun firing, the gun electrical connection must be made and the landing gear retracted.

Practice Bomb Release

With the MASS at UNLOCK LIVE and the nosewheel leg locked up, set the weapon type selector to PB.
Select the PORT and/or STBD PYLON SELECT switch(es) to ON as required and check that the associated pylon magnetic indicators show green; the equivalent pylon indicator(s) on the WMP are illuminated. When the bomb/RP button is pressed a signal is passed to the CBLS, on the pylon or pylons selected, to release a practice bomb. When the bomb/RP button is released the system is reset. Bombs are released from the CBLS in the order left then right when viewed from the rear.

MK82 Release

With the MASS at UNLOCK LIVE and the nosewheel leg locked up, set the weapon type selector to B.
Select the PORT and/or STBD PYLON SELECT switch(es) to ON as required and check that the associated pylon magnetic indicator(s) show green; the equivalent pylon indicator(s) on the WMP are illuminated.
When the bomb/RP button is pressed a release signal is passed to the selected pylon ERU. When both pylons have been selected the release signal is passed to the left pylon ERU and then, after the selected interval, to the right pylon ERU. When a stick of bombs is released the bomb/RP button must be held pressed until both bombs have been released. A hang-up of the first bomb in a stick does not prevent the release of the second bomb.

Rocket Firing

With the MASS at UNLOCK LIVE and the nosewheel leg locked up, set the weapon type selector to RP.
Select the PORT and/or STBD pylon select switch(es) to ON as required and check that the associated magnetic indicator(s) show green; the equivalent pylon indicator(s) on the WMP are illuminated.
When the bomb/RP button is pressed, a release signal is passed to the M155 rocket launcher(s) to release either a single rocket or a salvo from each selected launcher.

Gun Firing

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.
Pressing the gun firing trigger connects AC power to the gun firing pin to fire the gun.

Sidewinder Firing

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.
When the bomb/RP button is pressed a firing signal is passed to the missile launcher. When the bomb/RP button is released the illuminated missile selected indicator is extinguished and the previously unlit indicator is illuminated. The second missile can then be fired.

Jettisoning

a. Pylon-Loaded Stores except Sidewinders
With the MASS at UNLOCK LIVE, all pylon-loaded stores, except Sidewinders, i.e. MK82, plus practice bombs and rocket launchers plus rockets, 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.

Limitations

General

The Hawk T Mk 1A is released for use in the flying training and weapon training roles and additionally for air defence and war roles. It is released for use by day and night from tarmac and concrete runways only, subject to the further limitations set out below.

Solo Flying

Solo flying is to be carried out from the front cockpit.

Mass

a. The maximum mass for take-off is 5700 kg.
b. The maximum normal mass for landing is 5000 kg.

The maximum total mass which may be stowed in the personal kit containers is 26 kg.

Altitude

The aircraft is cleared for flight up to FL 480 but the aircraft is subject to engine/airframe vibration, particularly at high altitude. If heavy vibration is encountered it must be alleviated by changing engine RPM, altitude or airspeed.

Temperature

The aircraft is cleared for operation at ground level air temperatures in the range minus 25°C to + 30°C subject to the following conditions:

a. The aircraft may be cold soaked down to minus 40°C, subject to observance of the appropriate Service Cold Weather procedures. in particular, the batteries must be removed during cold soaking to prevent their temperature falling below minus 5°C.

b. Operation of the aircraft; in conditions of snow, ice, slush or freezing rain should be undertaken only with extreme caution.

Icing Conditions

With the engine running continuous anti-icing is provided for the engine LP compressor nose fairing but no ice protection is provided for the air intakes or the airframe; prolonged flight in icing conditions must therefore be avoided.

Airspeed

Airframe
The airspeed limitations from airframe considerations are:

a. Basic aircraft with or without gun pod, ammunition or wing pylons.
(1) 550 knots up to the altitude at which this equals 0.90M.
(2) 0.90M up to altitude at which this equals 475 knots.
(3) 475 knots up to the altitude at which this equals 1.20M.
(4) 1.20M above the altitude at (3) above.
b. Basic aircraft with or without gun pod and with either two Sidewinders (or one Sidewinder
with launcher and adaptor on the other wing) or two BL-755, CBLS, PBC or M155.
(1) 500 knots up to the altitude at which this equals 0.80M.
(2) 0.80M up to the altitude at which this equals 370 knots.
(3) 370 knots up to altitude at which this equals 0.88M.
(4) 0.88M above the altitude at (3) above.

c. Basic aircraft with or without gun pod, with one BL-755 and an unloaded pylon on the other wing or an AIS pod together with launcher and adaptor on the starboard pylon and a Sidewinder on the port pylon.
(1) 500 knots up to the altitude at which this equals 0.80M.
(2) 0.80M up to the altitude at which this equals 370 knots.
(3) 370 knots up to the altitude at which this equals 0.85M.
(4) 0.85M above the altitude at (3) above.

The airspeed/mach number limits, together with the approximate altitude at which changeover from airspeed to mach number and vice versa occur.

Landing Gear

The maximum speed for operating the landing gear, using the normal or the standby system, or for flight with the landing gear down, is 200 knots.

Flaps

The maximum speed for lowering flap, using the normal or the standby system, or
for flight with flap extended is 200 knots.

Airbrake

The airbrake may be operated throughout the flight envelope.

Normal Acceleration

Flaps Extended
The normal acceleration limits with flaps extended are from zero-g to + 2.5g up to a maximum of 200 knots.

Airbrake Extended
The normal acceleration limits with airbrake extended are:

a. Above 0.90M +1.0g (nominal).

b. Below 0.90M +7.2g

Zero-g or Negative-g Flight
Flight under zero-g or negative-g conditions must not exceed 30 seconds. A minimum interval of 10 seconds must be allowed between periods of zero-g or negative-g
flight. The interval is to be timed from either the restoration of positive-g or the extinguishing of the FUEL and OIL captions on the CWP, whichever is the later.

Manoeuvres

The use of flaps for manoeuvring other than during take-off, practice stalling, approach and landing, is prohibited.

Gentle Rolling Manoeuvres
The aircraft, in any configuration, is cleared for gentle rolling and turning manoeuvres within the limits referred

Rapid Rolling Manoeuvres
Rapid rolling manoeuvres (i.e. the use of full aileron to achieve large roll attitude changes or roll accelerations) are permitted below 35,000 feet subject to the following considerations and the limitations in Roll Limits below.

a. With flaps and landing gear retracted the use of full aileron for turn reversals involving bank angle changes of less than 180° is permitted at speeds below 200 knots provided the aircraft is clear of pre-stall buffet.

b. A rapid rolling manoeuvre must be fully completed and sideslip minimized before any other manoeuvre is started.

c. Rudder must be kept as close to neutral as possible during rapid rolling; the use of rudder
to augment the rate of roll is prohibited.

d. With a Sidewinder mounted asymmetrically (launcher and adaptor on the other wing) or a
BL-755 mounted asymmetrically (unloaded pylon on the other wing) not more than half
aileron should be applied. The need for caution in the rapid application of aileron is especially important in rolls initiated with positive-g towards the asymmetrically mounted store.

Roll Limits

a. Table 15 - Basic Aircraft, With or Without Wing Pylons or Gun Pod

Maximum Change of Bank Angle (Degrees)	Speed Range	Normal Acceleration at Entry* (g)
720	200 to 500 knots or 0.81M	+1
360	200 to 500 knots or 0.81M	Zero to +3
180	200 to 500 knots or 0.81M	Minus 2 to +5.3

* The normal acceleration at entry to the manoeuvre must be below that for buffet onset.

b. When Carrying CBLS, PBC, Sidewinder, BL-755 or Matra 155 RL. As in Table 1 amended as follows:

(1)Maximum change of bank angle 360°

(2)Maximum speed 450 knots or 0.72M

Stalling

The aircraft is cleared for intentional stalling with the landing gear up or down and with the
flaps in the up, mid or fully down position, in all cleared configurations. The minimum height for stall entry is 10,000 feet AGL; intentional stalling is not to be continued below 7000 feet AGL.

Spinning

The aircraft is cleared for erect spins with the landing gear, flaps and airbrake retracted, with or without gun pod and/or pylons without stores, launcher or adaptor, subject to the following
conditions and limitations:

a. Only the entry techniques given are to be used.

b. Recovery action must be initiated after 4 turns.

c. The maximum height for spin entry is FL 300. (The recommended height band for entry is FL 250 to FL 300.)

d. The throttle must be set to idle prior to entry and must remain at Idle during the spin.

e. The ailerons must be kept sensibly neutral throughout entry, spin and recovery.

f. Engine instruments must be monitored for surge throughout entry, spin and recovery. If surge is encountered the throttle is to be set to HP Off immediately.

g. The minimum height for initiation of spin recovery is 15,000 feet AGL

h. Recovery action must be taken immediately if:
(1) The IAS increases through 180 knots, or falls through 100 knots.
(2) Transient side forces feel large to the pilot.
(3) Aerodynamic forces prevent the pilot holding the rudder at full deflection.
(4) Engine surge is encountered.

i. After recovery, the engine must be checked for surge-free operation by noting that RPM
lead TGT when the throttle is opened.

j. If recovery has not been achieved by 5000 feet AGL, the aircraft is to be abandoned.

Deliberate inverted spinning is prohibited.

Aerobatics

The aircraft is cleared for aerobatics with flaps and landing gear retracted.

Flick manoeuvres and stall turns are prohibited.

If, during vertical manoeuvres, it becomes obvious that the manoeuvre cannot be completed
without loss of control, the throttle must be set to Idle. After recovery the engine is to be checked for surge-free operation.

Crosswind

The aircraft may be operated within the following crosswind component limitations:

a. Take-off and landing (dry/wet runway) — 25 knots.

b. Take-off and landing with asymmetric stores and the wind from the adverse side (loaded
wing downwind):

Sidewinder on one wing (launcher and adaptor on other wing) — 15 knots.

BL-755 on one wing (unloaded pylon on other wing) — 8 knots.

Landing in pairs may be carried out in crosswind components up to 15 knots.
Landing in pairs when asymmetric stores are carried is not permitted.

Aircraft Approach Criteria

a. Aircraft Category
The aircraft category is Category C.

b. Standby Pressure Instrument Allowance
The standby pressure instrument allowance is 100 feet. This includes up to 20 feet pressure
error correction.

Handling

Starting, Taxying And Take Off

General
The checks referred to in this chapter are listed in the Flight Reference Cards.

WARNING 1: 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, i.e. the aircraft is to be left in the Safe for Parking or Safe for Servicing condition, as applicable, as defined below:

a. Safe for Parking. Safety pin fitted to the ejection seat firing handle, the MDC firing unit and the canopy MDC firing handle in each cockpit.

b. Safe for Servicing. In addition to the safety pins fitted under sub-para a, safety pins must also be fitted to the ejection seat main gun sear, rocket initiator sear and the manual separation firing unit sear in each cockpit.

WARNING 2: Ensure that the MASS in the front cockpit is set to LOCK SAFE at all times except from just before take-off to immediately after landing.

Preparation for Flight

On arrival at the aircraft carry out the Safe for Parking Checks, then carry out the Initial, External, Ejection Seat and Internal Checks; additionally, if the aircraft is to be flown solo, carry out the Solo Flight Checks.

Starting the Engine

Before starting, the following considerations should be borne in mind:

a. The aircraft should be heading into wind; with the tail facing into wind a hotter than normal start may result.

b. Access steps must be removed and the canopy must be closed and locked.

Start the engine in accordance with the drills in the Flight Reference Cards. 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.

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 a TGT of 570°C 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 must first 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.

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.

During engine starting, No 2 hydraulic pump remains off-loaded, and the fuel pump is powered from the Essential Services busbar.

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 TOT of approximately 50°C. To reduce the possibility of HP compressor blade damage, closure of the bleed valve should not be delayed.

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 4 complete circles is to be carried out to ensure that control surface response and control column feel is satisfactory.

Failure to Start

If the engine fails to start at the first attempt, refer to the Starting Failures drill in the Flight Reference Cards. 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.

Allow 3 minutes between air producer start cycles to avoid air producer starter motor overheat, and an interval of 20 minutes after 3 consecutive cycles. After 3 unsuccessful air producer start attempts have the cause investigated.

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

Carry out the After Start Checks.

Taxying

Carry out the Taxying Checks. Release the parking brake and increase the RPM to approximately 70% to start the aircraft moving. As the aircraft moves off, check the brakes. The brakes are very effective and should therefore be applied progressively. To prevent overheating, excessive use of the brakes should be avoided; the high idling thrust, however, may require the use of brakes to maintain a slow taxying speed.

Differential braking gives good directional control, and the fully castering 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 are sufficient to maintain taxying speed on level ground. The fuel consumption at idle is approximately 3 kg/minute.

Carry out the Before Take-Off Checks. A tailplane indicator setting of zero is satisfactory for the clean aircraft. However, at high masses (i.e. with fuselage and/or wing stores) or at forward CG (e.g. two heavy pilots) a setting of 2° nose-up gives a more comfortable control column load during the post-take-off acceleration. If asymmetric stores are carried, both aileron and rudder should be trimmed towards the light store: aileron 1/2 deflection, rudder 1/3 deflection, as seen on the respective trim gauges.

WARNING: The aircraft must not be flown if a surge, stall or overtemperature occurs or the T6NL caption illuminates on the ground.

Take-Off Procedures

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.

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.

d. 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 BL 755 stores are carried, rotation should be delayed by 5 knots. When Sidewinder missiles are carried the NWLO speed should be increased to 100 knots; the aircraft is particularly sensitive in pitch in this configuration especially at aft CG.

e. Maintain the nosewheel off attitude until 120 knots is reached, then fly the aircraft off by easing the control column further aft to rotate the aircraft to the take-of f attitude. If the rotation is delayed a slight hopping from one mainwheel 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 rotation should be delayed until 130 knots.

f. When safely airborne retract the landing gear and flaps, observing speed limitations; trim changes are negligible.

Maximum Performance Take-Off

a. Proceed as for a normal take-off until the nosewheel has been raised. At VR (obtained from the ODM) firmly and smoothly rotate the aircraft 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. Rotation beyond the onset of buffet should be avoided since it may increase the take-off distance to clear 50 feet.

c. When carrying Sidewinder missiles with a forward aircraft CG, care must be taken 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.

Flapless Take-Off

If a take-off is made with the flaps up, raise the nosewheel off the runway at 100 knots. 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 care must be taken not to exceed the landing gear limiting speed.

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.

Take-Off With Towed Banner Target
Make a normal take-off but raise the nosewheel at 100 knots 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. The effect of towing the target is to increase the ground roll by about 50 feet.

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 120 knots the brakes are subsequently to be inspected for distortion and wear.

b. To abandon a take-off set the throttle to HP Off or to Idle as necessary, lower the flaps fully and use the emergency braking technique. 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 subsequently be taxied.

Note 2; Maximum take-off abort speeds (i.e. VSTOP) are given in the ODM.

Note 3: The decision to close the HP cock, to eliminate the high idling thrust of the engine, depends on IAS, runway length and headwind.

Engine Failure After Take-Off

An engine failure after take-off can be defined as an engine failure at any point from unstick up to 300 knots. In some circumstances, if sufficient height and speed are available, it may be possible to turn back towards the airfield and land; if so, use excess speed to carry out the turn.

Handling In Flight

ENGINE CONTROL AND HANDLING

Engine Control

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.

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, e.g. at maximum power and minus 5°C, sea level static conditions, there is a reduction of approximately 20°C TGT and 0.9% RPM.

A check of engine serviceability can be made before take-off by comparing the stabilised indicated HP RPM (NH) and TGT at maximum throttle with the minimum acceptable values, using the following procedure:

a. Obtain the HP RPM and LP RPM (NL) figures from the F700 or the placard in the cockpit. (The figures are unique for each engine.)

b. Obtain the predicted outside air temperature (OAT). (For take-off if significantlv different.)

c. Using predicted OAT and NL read off:

(1) The predicted TGT.

(2) The % RPM to be deducted from the placard value of HP RPM.

d. Subtract the % RPM obtained at c (2) from the placard HP RPM.

e. The values of RPM and TGT obtained in d and c (1) are the minimum stabilised values which should be seen during the maximum power checks prior to take-off.

Note: For the purpose of this check the stabilisation period is between 20 seconds and one minute after selecting maximum power.

Placard HP RPM	101%
Placard LP RPM	104%
OAT	minus 5°C

From minus 5°C move upward to intersect the 104% NL line of the upper graph and, from the right-hand side, read off the minimum TGT (642°C). On the lower graph, move up from minus 5°C to intersect the 104% NL line; move horizontally to the left-hand side and read off the % RPM (minus 4.05) to deduct from the placard HP RPM. Thus, placard HP RPM (101 %) minus the % RPM correction (4.05) provides the minimum acceptable HP RPM (96. 95%).

Engine Handling

Unless in emergency, the engine must not be shut down from a high power setting.

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 must be set to HP Off.

The minimum speed for engine relighting using the cold relight (unassisted) 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 550°C.

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.

During recoveries from the climbing vertical the engine must be at idle RPM.

After recovery the engine must he 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

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 be 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.

Possible causes of airframe vibration arc 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.

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. Sustained operation in this RPM band should be avoided when vibration is encountered.

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 decrease, the onset of vibration may be abrupt as
the decreasing RPM enter 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 power climb, the climb is discontinued. If the throttle is left in its set position and speed increased, the vibration ceases as the aircraft descends through the onset altitude.

If the power 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.

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

Thrust pulsation may occur at any altitude when the engine is operating at full power. 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 will rock fore-and-aft when held at full power on the brakes before take-off but this is acceptable.

Engine Icing

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 air frame. It is therefore recommended that flight in icing conditions should be avoided.

If icing conditions exist at take-off the ground running times must 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 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, care must be taken not to exceed the stated limits when carrying out acrobatics or air combat manoeuvres at medium altitudes.

General

The controls are light and precise, and the aircraft is very responsive throughout its speed range. The forward view from both cockpits is good but the rearward view is restricted by the fuselage and ejection seat.

Climbing

The recommended climbing speed without wing stores is 350 knots converting to 0.73M, using full power within the engine limitations. When wing stores are carried, the recommended climbing speed is 300 knots converting to 0.65M.

Flying Controls

Ailerons
Roll control is good throughout the speed range, and aileron forces are independent of
speed. 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.

Tailplane
Pitch control is generally light and responsive, particularly at high speed. The force required for any manoeuvre depends on the distance the control column is displaced from the trimmed position and the amount of applied g is independent of airspeed. It follows therefore that, when larger tailplane deflections are required, for example at low airspeed, the stick forces are heavier; at high airspeed however, since only small deflections are usually required, the stick forces are lighter.

Rudder
The rudder forces are light at low airspeed and become progressively heavier as speed increases. Application of rudder produces a moderate rolling moment. There are areas within the flight envelope, normally above 300 knots, where the response to rudder is roll in the opposite direction but the effect is easily corrected with aileron. With the landing gear and the flaps down the response to rudder is normal. 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

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 power applied immediately.

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.

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. Because of these trim changes limitations on the use of
the airbrake are imposed except when the gun pod is carried. The trim changes in the gun pod configuration, whilst acceptable, remain significant.

Power
Changes of power setting cause negligible trim changes.

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

General
The speed limitations must 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.

Transonic Flight
At full power the maximum speed obtainable in level flight is approximately 0.87M. In level flight the transonic envelope starts at about 0-78M, and is characterised 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.

Transonic Dives
A dive angle of about 20° or more is required to give a supersonic mach number. The aircraft should be trimmed at 0.75M before entering the dive and this trim setting should be maintained 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 high mach numbers, at low incidence values, some roll reversal may be apparent at very small aileron angles.

Transonic Dive Recovery
To prevent excessive g, the recovery from a transonic dive must be initiated with a pull to not more than 2.5g. 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 must be countered by moving the control column forward to attempt to maintain 2.5g; 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 will then recover. Below 0.90M replace the hand
on the control column and re-establish control. The accelerometer must be monitored throughout the dive recovery.

Wing Stores
With wing stores fitted, the flight characteristics up to 0.90M are broadly similar to those described in Transonic Dives & Transonic Dives Discovery above. However, the stores are destabilising in pitch, and the random pitch motion which develops between 0.86 and 0.90M is likely to be more severe.

Low Speed Handling

General
The low speed behaviour of the aircraft is docile; the aircraft is fully controllable down to the
point of stall (CL max) and the controls remain effective even beyond the stall. The stall itself is not obvious but the aircraft may be flown under control until the control column is fully aft.
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 will occur with stores and CG position (as described in Effect of Stores below).

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. lf the control
column is moved fully back the speed will reduce to a wings level minimum control speed of about 115 knots depending upon the rate of deceleration, the speed being lower at the higher rates of deceleration with a more pronounced 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 and pitch oscillations may occur.

Flaps and Landing Gear Down

a. A nominal power setting of 80% RPM simulates an intermediate approach and is suitable
for practice with MlD flap. With MID flap selected the onset of buffet is at about H3 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. The minimum control speed achieved with wings level is about 105 knots, depending on the deceleration rate. With the control column held fully aft the sink is more pronounced and the aircraft develops a moderate pitching oscillation.

b. A power 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 pitch oscillation. The onset of buffet is at about 105 knots and the stall at about 102 knots. lf the control column is moved fully back, the speed will reduce to a minimum control speed of about 99 knots and 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.

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.

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 centre of gravity position and stores configuration. As speed isdecreased (AOA increased) beyond 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.

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 1 or 2 knots higher than described above.

Recovery
Recovery at any stage is immediate upon moving the control column forward.

Table 16-Buffet Onset, Stalling Speed and Minimum Control Speed

Configuration	Nominal RPM (%)	Buffet Speed (IAS)	Stall Speed (CL max IAS)	Min Control Speed (IAS)
Flap and Landing Gear Up	Flight Idle	130	124	115
Mid Flap and Landing Gear Down	80	113	109	105
Full Flap and Landing Gear Down	80	105	102	99

Stalling Speeds
Table 1 summarises the approximate buffet onset, stalling speed, and minimum control speeds (with control column fully back) at a mass of 4600 kg (1000 kg fuel, without external stores).

Stalling Due to Acceleration

The amount of pre-stall buffet warning in manoeuvre increases with mach number. 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.

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.

Spinning

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 will be consistent. If the controls are mishandled the characteristics will 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. In all cases the aircraft should recover when the recommended spin recovery action of centralising the controls is taken.

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 an altitude of 25,000 to 30,000 feet. 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 (e.g. 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 stabilises at about 4 seconds/tum. Height loss in the stabilised spin is 800 to 1500 feet/tum. 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 tum. The airspeed and TGT should be monitored throughout the spin, and recovery must 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.

c. Spin Recovery

WARNING: If recovery (i.e. rotation ceased, speed increasing and the aircraft responding normally to the controls) has not been achieved by 5000 feet AGL-EJECT.

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. It should be noted 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.

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.

Engine Behaviour

TGT must be monitored during spinning, and a precautionary check must always 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 power setting is above idle at entry. The surge is unlikely to be audible unless the engine is at a high power 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 must be made that TGT and RPM rise normally as the throttle is opened. If an engine surge occurs during the spin, spin recovery action must be taken immediately and the throttle set to HP Off.

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.

Mishandling the Controls

Although mishandling of the controls generates a spin of agitated or oscillatory motion the normal spin recovery action is always effective. If a spin develops through mishandling, recovery action must 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. The application of full outspin aileron however causes the spin to stabilize at an IAS between 150 and 160 knots. Outspin aileron must not be applied intentionally.

(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 must not be applied intentionally. Using the rear view
mirror, the aileron neutral position is easily seen.

c. Effect of Landing Gear, Flaps, Airbrake and Power
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. The airbrake, if inadvertently extended, should be left out and normal recovery action, which is fully effective, taken.

Rapid Rolling

Rapid rolling is permitted within the limitations given in Part 2. To prevent high structural loads on the rear fuselage, the control column must not be moved rearwards (from its longitudinal position at entry) during rapid rolling, even to counteract a reduction in normal acceleration. Avoid full aileron rapid rolling when buffet is encountered. The rudder bar must 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 at high incidence, particularly if some inadvertent aft control column movement has occurred. The presence of high foot forces always indicates high structural loads.

Aerobatics

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. Recovery from the climbing vertical should be made 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 must not be carried out with the FUEL caption illuminated.

Note: Use of flaps in manoeuvres is prohibited.

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

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 power is being used; the throttle setting may have to be reduced slightly when recovering to the starting altitude and speed.

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.

Formation Flying

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.

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.

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

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. When approaching the stall in the approach configuration with a BL755 under one wing full aileron is required to keep the wings level. 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. The recommended basic threshold speed with asymmetric underwing stores is 120 knots; in this condition it is particularly important not to hold off and an additional allowance of 5 knots for adverse crosswind components and gusts is necessary.

Instrument Flying

The instrument layout is good and the instruments are easily read, allowing accurate flight path changes to be made.

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

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

The descent configurations and settings are:

a. Rapid/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
Set the throttle to Idle and, with the airbrake IN, descend at 0.70M/300 knots.

c. Instrument Descent
Set 80% RPM, select the airbrake OUT, and descend at 0.70M/300 knots.

Gliding

The recommended gliding speed for best range is 180 knots, reducing to 170/165 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 wind-milling engine and one with a seized engine is small enough to neglect.

Note: A flamed-out engine may cease to windmill during a prolonged glide at speeds below those recommended.

Flying in Turbulence

The recommended speed band for flight in turbulence is 300 to 325 knots.

Operating in icing Conditions

Icing degrades the aircraft's performance, behaviour and handling qualities. Engine icing information is given earlier in this chapter. 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, the landing should be made 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 ?aps are selected up from the mid position.

Circuit Procedure And Landing

General

The checks referred to in this chapter are listed in the Flight Reference Cards.

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

Start the downwind leg at 190 knots with 75% RPM set. Carry out the Before Landing Checks. If residual brake pressure in excess of 10 bar is indicated after the Before Landing Checks have been completed, the anti-skid should be switched off. With MID flap selected and landing gear down allow the airspeed to decay to 160/150 knots at the end of the downwind leg (use the higher speed when more than1000 kg of fuel remains).

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 knots. Progressively reduce the airspeed to 140/ 13O knots by the end of the turn (use the higher speed when more than 1000 kg of fuel remains). 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.

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), 115 knots (with external stores) and 120 knots (with asymmetric stores). Steep approaches are not recommended.

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, RPM should not be reduced below 70%.

Landing Procedure

Note: Because brake pressure at the wheels is relieved for up to a maximum of 2 seconds under skid conditions with anti-skid on, the aircraft could deviate significantly from the intended path in the event of a tyre burst on landing. Aircraft are therefore to be operated on the nominal centre line of the runway except when landing in pairs.

WARNING: 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 toepads.

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. In the event of a tyre burst 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.

Landing at High AUW

When landing at a mass above 5000 kg care must be taken to avoid high vertical velocities at touchdown; the approach should therefore be shallower than normal.

Braking

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 pressure are applied at high groundspeeds. In normal circumstances, to retain
good directional control during the landing run and to minimise 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.

Flooded or Icy Surfaces
Due to the considerable loss in braking effectiveness, flooded or ice covered surfaces should be avoided 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.

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.

Aerodynamic Braking
The use of 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. The nosewheel should therefore be lowered on to the runway by 70 knots.

WARNING: Following prolonged or heavy braking, brake efficiency will be 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

Carry out a normal approach and touchdown. After touchdown, keep the nosewheel clear of the runway and smoothly select full power, checking that the engine responds correctly to throttle movement. After unstick, at a safe height, raise the landing gear and flaps simultaneously.

Overshooting

Open the throttle smoothly to the power required and raise the landing gear and flaps simultaneously at a safe height.

Instrument Approach

The settings shown in Table 17 are recommended for an instrument approach; the power settings apply to an aircraft without external stores.

Table 17-Instrument Approach Settings

Approach Stage	RPM (%)	Flaps	Landing Gear	Airspeed (knots)
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 feet AGL

Flapless Landing

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. A wider than normal downwind leg should be flown; the circuit should be adjusted to achieve a long, shallow approach and the threshold crossed at 135 knots + 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 I60 knots. On the approach, speed is slow to decrease and care must be taken to avoid an excessive nose-up attitude. Below 200 feet 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

Mid flap only should be used when landing in conditions of airframe icing. 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 will be affected by the reduced drag at mid flap; a wider and shallower approach than normal should be flown. 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

Landing in crosswinds using the crab technique presents no difficulty. In strong crosswind conditions, a large rudder deflection may be necessary to align the nose with the runway just before 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 crosswind components and gusts is necessary.

Airbrake-Out Landing

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 extra power 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

For a practice forced landing (PFL), glide at 180 knots with the throttle at ldle. flaps up, landing gear up and airbrake in, aiming for a high key at 4500 feet 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 retracted. Glide at 165 knots (170 knots above 1000 kg fuel mass or with external

stores). Aim to achieve the low key position abeam the intended touchdown point at 3000 feet. When certain of reaching the desired touchdown point select full flap. To lose excess height, begin to dive as the flap passes the mid position; speed increase will be slight. Owing to the high rate of descent with full flaps, initiate a flare at 300 feet (speed should not be allowed 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 will ensure
that adequate control is available. lf an overshoot is intended, overshoot action is to be initiated at not less than 300 feet; abrupt attitude changes are to be avoided.

lf an engine failure after take off (EFATO) occurs between unstick and 250 knots there is insufficient energy to effect a safe forced landing and the aircraft should be abandoned. Between 250 and 300 knots it may be possible to turn back and land on the airfield. Above 300 knots it is usually possible to achieve a low key position for a forced landing.
Following an EFATO set the throttle to HP Off, release the banner target if towed and, if time permits, switch off the fuel pump and close the LP cock. Glide initially at 180 knots and aim to intercept the flight path for an initial aiming point one third of the way along the runway. Once this is achieved lower the landing gear on the standby system then glide at 165/ I70 knots. When certain of reaching the aiming point lower the flaps on the standby system and maintain a minimum approach speed of 150 knots.

WARNING: lf speed falls below 165/170 knots when gliding flapless with landing gear down the high rate of descent and limited margin above pre-stall buffet make it doubtful that a successful roundout can be completed.

Checks After Landing
Carry out the After Landing Checks.

Following a braked landing at a mass in excess of 5000 kg, during which braking is commenced at a speed in excess of 120 knots, have the brakes inspected for distortion and wear.

Shutdown Procedure

Before carrying out the Shutdown Checks normally allow 30 seconds at Idle for the RPM and TGT to stabilise and check that HYD 1 and HYD 2 pressures are normal. One minute after shutdown move the control column in circles of approximately 2 inches in diameter (measured at the top of the hand-grip) about neutral monitoring HYD 1 and HYD 2 gauges. During this period HYD 1 and HYD 2 pressures decay and the RAT extends. After HYD 1
pressure falls to 60 bar it drops rapidly to zero and HYD 1 caption illuminates. HYD 2 pressure should be approximately 75 bar. Move the control column through a further 4 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.