PHANTOM FG Mk 1

AIRCREW MANUAL
WEAPON SYSTEM

BY COMMAND OF THE DEFENCE COUNCIL

(Ministry of Defence)

Prepared by Ministry of Defence (AFD) RDT3

This publication is incomplete without confidential document
CD 101B-0901 & 2-15D

NOTES TO USERS

1. This Manual is complementary to the Phantom FG1 Aircrew Manual (AP 101B-0901-15A) and Flight Reference Cards (AP 101B-0901-14A), which are subject to separate amendment procedures. The Manual is divided by marker cards as follows:

Preliminary matter
Part 1 — Introduction
Part 2 — Lead Computing Optical Sight System
Part 3 — Missile Control System
Part 4 — Ancillary Equipment
Part 5 — Navigation Computer Set
Part 6 — Armament

Each Part is divided into Chapters as listed on its marker card. Each sheet is identified by a Part, Chapter, Page reference at the foot of the page. Thus a page bearing the reference 1—2 Page 5 is Page 5 of Part 1 Chapter 2.

2. A supplement to this Manual (CD 101B-0901 & 2-15D) is issued containing text of a security classification higher than 'UK Restricted'. The supplement is issued separately, is subject to separate amendment procedures but is an integral part of this Manual.

3. This Manual and its associated Flight Reference Cards aim to provide the best operating instructions and advice currently available. Although they provide guidance for most eventualities, they are not substitutes for sound judgement and good airmanship; moreover, they assume an adequate knowledge of the pertinent volumes of AP 3456 series. Furthermore, circumstances might require aircrew to depart from or modify the prescribed procedures and drills. Consequently the Manual and Flight Reference Cards should not be regarded as documents which are to be adhered to inflexibly at all times, except that, instructions including the word 'must' are mandatory.

4. Amendment Lists will be issued as necessary and each amendment list instruction sheet will state the main purpose of the amendment and include a list of modifications. The List of Pages will also be updated with each amendment. New or amended matter of importance will be indicated by symbols positioned in the text thus: ◀..... ▶ or thus: ◆.....◆ to show the extent of amended text and thus: ⋈ or thus ◆◆ to show where text has been deleted. The number of the amendment list by which a sheet was initially issued or re-issued will appear at the bottom of the odd-numbered pages and any amendment symbols on either page forming a sheet will therefore refer to that amendment list. However, when a new chapter is issued with an amendment list, or an existing chapter is completely revised, this fact will be noted within the heading of the chapter and the amendment symbols will not appear.

5. The following conventions are observed throughout this Manual:

a Words in large capital letters in the text indicate the actual markings on the controls concerned.

b **WARNINGS** are inserted only where the serious consequences of not following a certain procedure might otherwise be overlooked.

c Information which requires to be emphasised is printed in italics.

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

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

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

PART 1

CHAPTER 1—GENERAL DESCRIPTION OF THE WEAPON SYSTEM

Contents

Illustration

Introduction

1. *Aircraft Role.* The role of the Phantom FG1 is air defence. This manual describes the air-to-air weapons system: a Missile Control System (MCS), three types of air-to-air missile and a 20 mm gun pod.

2. *Weapons.* The aircraft can be fitted with Skyflash/Sparrow and Sidewinder missiles and a SUU-23A gun pod.

3. *Major Components.* A Navigational Computer Set (AN/ASN-39) has no function in the air-to-air weapons system (Fig 1), the major components of which, excluding weapons, comprise:

a. AN/APG-60 radar set with an AN/AWA-9 Missile Control Group which, together, form the AWG-11 MCS.

b. ASN-70 Vertical Flight Reference Set (VFRS).

c. Attitude Reference Computer Set (AJB-7).

d. Central Air Data Computer (CADC).

e. Lead Computing Optical Sight System (LCOSS).

f. Radar Warning Receiver (RWR).

MISSILE CONTROL SYSTEM

Radar Characteristics

4. The main controls for the AWG-11 MCS are in the rear cockpit but identical displays are provided in both cockpits. The MCS combines the characteristics of several different types of radar:

a. *Pulse Doppler.* Pulse doppler has advantages over conventional airborne pulse radars, in that it uses high mean power to detect targets which would otherwise be hidden in ground clutter when 'looking down'. Pulse doppler is the primary radar mode and is an invaluable facility in the air defence role.

b. *Pulse Expansion and Compression (Chirp).* A Chirp radar uses pulse expansion and compression to obtain the greatest possible detection range from a given power output, without affecting resolution characteristics.

c. *Monopulse.* Monopulse radar techniques are used to obtain accurate air-to-ground ranges.

d. *Mapping Radar.* Normal pulse techniques are used in high and low level mapping modes.

e. *Continuous Wave (CW) Illuminator.* The CW illuminator is used to spotlight an airborne target to provide guidance information for Skyflash or Sparrow semi-active homing air-to-air missiles.

Radar Modes

5. The MCS radar can be used in seven different modes:

Radar Mode	*Role in Which Employed*
Pulse doppler	Air-to-air intercept
Pulse modes:	
Pulse	Air-to-air intercept
Visual identification	Air-to-air identification
High mapping	Navigation
Low mapping	Navigation
Air-to-ground	Navigation
Pilot lock mode	Air-to-air attacks

Electronic Counter Counter Measures

6. The MCS radar has a capability against several forms of electronic counter measure (ECM). These measures and the radar characteristics used to counter them are described in the Confidential Supplement.

◆ IFF Interrogator (1980 update)

7. An IFF interrogator is added to the MCS as part of the 1980 weapon system update. The equipment, controlled by the navigator, is used to challenge and identify radar-detected targets. Responses from interrogated targets are displayed on the radarscope for interpretation (see CD 101B-0901 & 2-15D). ◆

Built-in-Test

8. The built-in-test (BIT) facility is used to test the serviceability of the AWG-11 MCS before, during, and after flight to isolate the particular component at fault as described in the Confidential Supplement.

ASSOCIATED EQUIPMENT

AN/ASN-70 Vertical Flight Reference Set

9. The ASN-70 VFRS provides primary pitch and roll information to stabilise the APG-60 radar, and to position the Attitude Director Indicator (ADI); it also provides primary roll information to the LCOSS to position the reticle roll tabs.

AN/AJB-7 Attitude Reference and Bombing Computer Set

10. In the air defence role the main function of the AJB-7 is to provide heading information to the ADI, HSI, BDHI and NCS, when the Compass System Controller (CSC) is switched to PRIMary. A secondary function is to supply roll and pitch to the Remote Attitude Indicator (rear cockpit). With the CSC set to STBY, pitch, roll and heading are fed to the ADI, HSI and BDHI; heading to the NCS; roll and pitch to the Remote Attitude Indicator and APG-60 radar; and roll information to the LCOSS.

Central Air Data Computer

11. The CADC supplies voltage analogues of static pressure, TAS and angle of attack to the AWG-11, LCOSS and the Navigational Computer Set. TAS and altitude are fed to the VFRS.

Lead Computing Optical Sight System

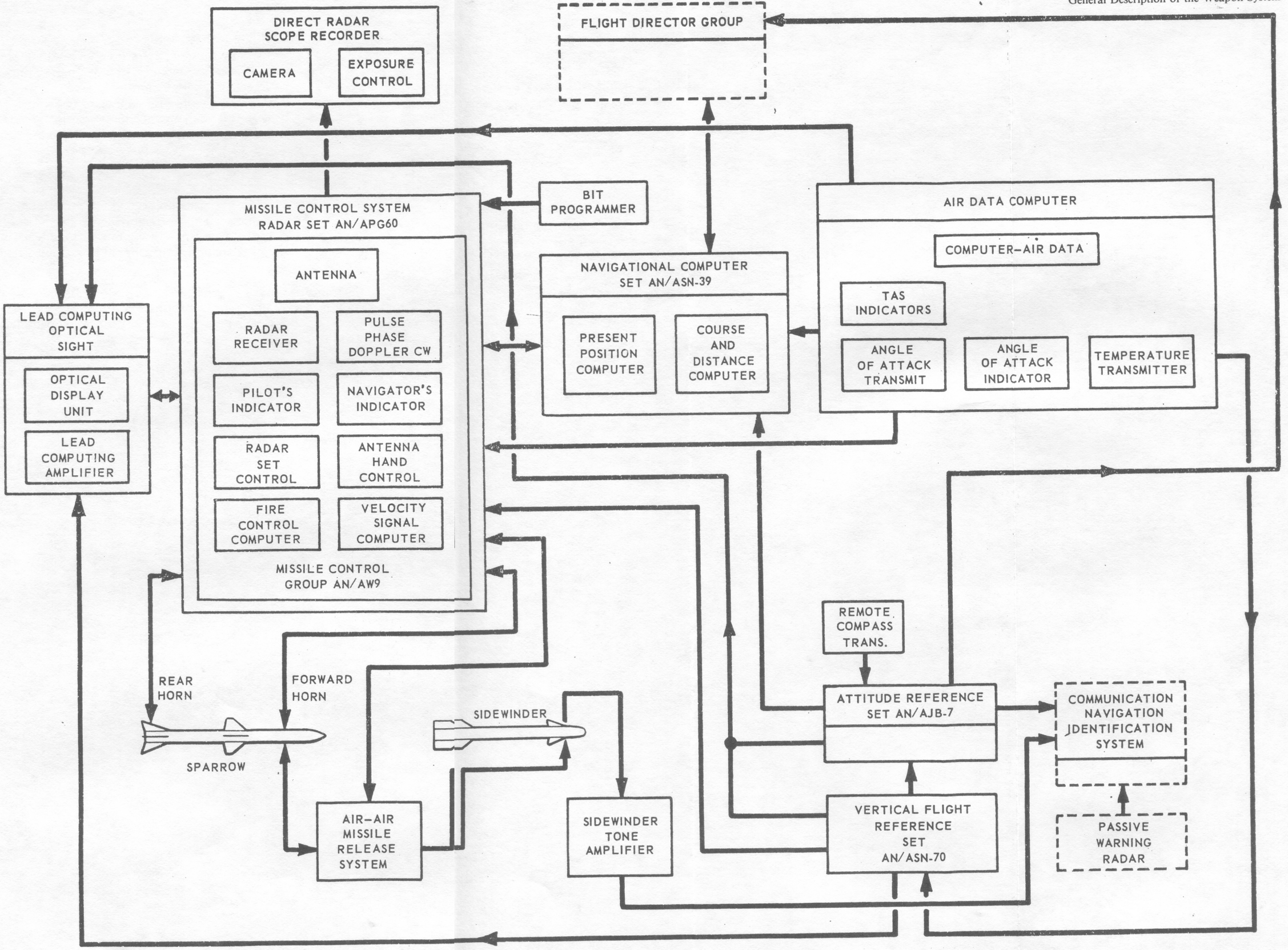
12. In the air-to-air mode the LCOSS indicates prediction angle during gun attacks.

AN/ASN-39 Navigational Computer Set

13. The AN/ASN-39 Navigational Computer provides a continuous display of aircraft position, and steering information to base or a selected destination.

Radar Warning Receiver

14. The Radar Warning Receiver provides visual and aural indications of the presence of illuminating radars in specific frequency bands.



1—1 Fig 1 Weapon System Interconnection (Simplified)

◆ **Telescope Sighting System**

15. Mod 782 introduces a telescope sighting system (TESS) in the rear cockpit. The periscopic telescope enables the navigator to obtain early visual identification of potential targets within the field of view. ◆

WEAPON DELIVERY

Air-to-Air

16. *Sparrow/Skyflash Attacks.* When the radar is locked on to the target and a missile is selected and armed, the fire control computer feeds a simulated doppler frequency of the target to the missile thus establishing a datum frequency around which to search prior to missile/target lock on. When the target is in range and the trigger is pressed, the computer feeds commands to correctly align the missile antenna (Head Aim), provides initial aiming corrections (English Bias), selects an optimum altitude band for the autopilot and gives final target doppler data. The missile tracks the target by comparing the CW signal received directly from the interceptor with that being reflected from the target. The interceptor has therefore to maintain either radar lock-on or boresight tracking until missile/target interception occurs.

17. *Sidewinder Attacks.* Radar is not necessary to fire the infra-red Sidewinder missile but is normally required to detect and close with the target. The missile is best employed in rear hemisphere attacks so that it can more readily sense the jet efflux of the target as indicated by an aural tone when within the target's emmission zone and maximum range of the missile seeker head.

18. *Gun Attacks.* The gun is fired using lead angle and range information provided by the LCOSS. Gravity drop and velocity jump compensation are also provided.

PART 1

CHAPTER 2—LAYOUT OF THE CONTROLS AND INDICATORS

(Completely revised at AL9)

Contents

Illustrations

General

1. Weapon and radar system controls and indicators briefly described in this chapter are described in greater detail in chapters on the individual systems. Details of missile and radar controls are found in the Confidential Supplement to this Manual.

Front Cockpit Controls

2. *Pilot's Controls and Control Panels*

Control/Control Panel	*Location*	*Function*
Armament safety override switch	Left cockpit wall	Bypasses landing gear control handle armament safety switch.
Sidewinder controls:	Auxiliary armament control panel	
COOLANT CONTROL — ON/OFF switch		Controls coolant to Sidewinders.
AURAL TONE CONTROL knob		Sidewinder audio tone volume control.
MODE — BST/SEAM/CAL switch		Selects boresight, Sidewinder expanded acquisition mode or missile calibration mode.
SIDEWINDER CAL light		Indicates missile calibration mode.
OUTBD JETTISON switch	Fuel system control panel	Stores jettison control for outboard pylons
CTR JETTISON switch	Fuel system control panel	Stores jettison control for centre station.
Reticle stiffness CAGE/RET/STIFF switch	No 1 engine throttle	At STIFF, sets LCOSS ranging circuits to equivalent of 1500 feet range. At CAGE the reticle is caged to radar boresight. Spring-loaded to return to RET.
Missile and master armament control panel	Main instrument panel	See para 3.

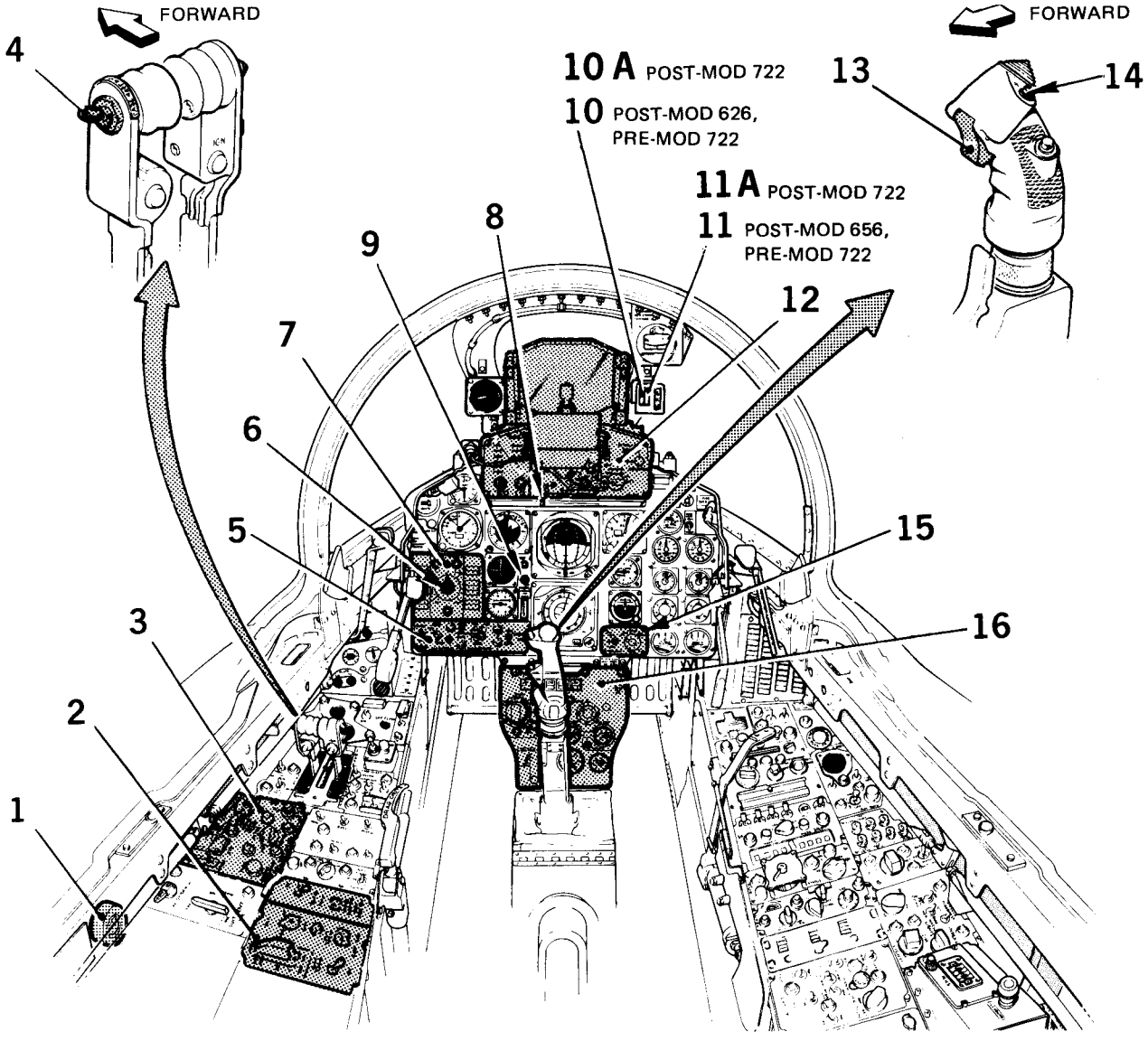
(continued)

Control/Control Panel	*Location*	*Function*
Missile status panel	Main instrument panel	See para 4.
RWR PRF audio ON/OFF switch	Main instrument panel	Cancels non-alarm RWR audio signals to headset.
Pilot's display recorder ON/OFF switch	Adjacent to LCOSS	Controls the pilot's display recorder (Telford camera) attached to LCOSS.
MISSILE SELECTED repeater light (post-mod 626, pre-mod 722)	Adjacent to AOA indexer lights	Comes on when Sparrow/Skyflash missile is selected.
RADAR light (post-mod 722)	Adjacent to AOA indexer lights	Comes on when Sparrow/Skyflash missile is ready for launching (missile can be launched subject to interlocks).
SEAM LOCK repeater light (post-mod 649, 656 and 658, pre-mod 722)	Adjacent to MISSILE SELECTED light	Comes on when IR lock is achieved.
HEAT light (post-mod 722)	Adjacent to RADAR light	Comes on when Sidewinder is ready for launching.
LCOSS	Main instrument panel	See para 5.
Multiple weapons control panel	Below main instrument panel	See para 6.
Trigger switch	Control column	Releases missiles and fires the gun.
Stores release button (pre-mod 656) SEAM lock enable button (post-mod 656)	Control column	Stores release function not used. Post-mod 656, initiates/rejects IR lock.

3. *A/A Missile and Master Arm Control Panel.* The A/A Missile and Master Arm control panel (Fig 1) at the lower left of the main instrument panel has the following controls:

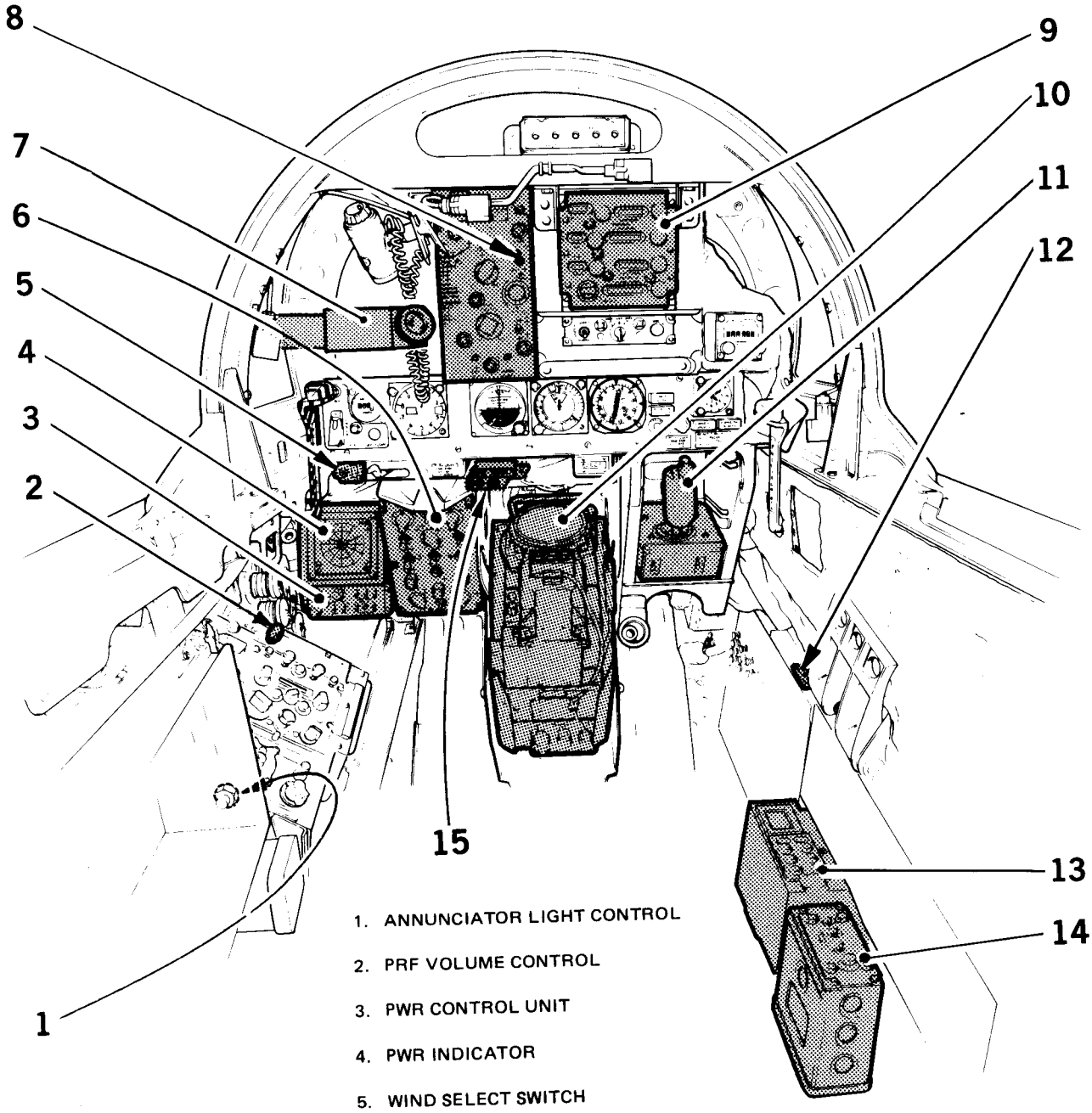
Control	*Function*
CW RDR — ON/STBY/OFF switch	Controls power supplies to Skyflash/Sparrow missile launching circuits and CW radar tuning
INTLK — OUT/IN/DOG/DOG INHIBIT selector knob	Controls interlocks and dogfight facility of Skyflash/Sparrow missiles
MSLS-GUNS selector switch	Selects missile type or the gun. Controls LCOSS presentation in conjunction with the reticle mode switch for the weapon selected
AUTO CLEAR/NON CLEAR switch	Controls clearing of gun firing chambers
MASTER ARM — ARM/SAFE switch	Controls all armament circuits except jettison

4. *Missile Status Panel.* At the left of the main instrument panel (Fig 1), the missile status panel contains 16 lights to indicate the missile readiness state at each station; a TK light illuminates to show that the forward fuselage missiles cannot be fired because of a store (fuel tank) at station 5. Post-mod 649, 656 and 658, a SEAM LOCK light which illuminates when SEAM IR lock is achieved and a SEAM OUT light which illuminates to indicate Sidewinder boresight (BST) selection or a BIT fault detection replace two of the missile readiness lights. A PUSH TO JETT switch jettisons the missiles.



1. ARMAMENT SAFETY OVERRIDE SWITCH
2. AUXILIARY ARMAMENT CONTROL PANEL
3. FUEL SYSTEM CONTROL PANEL
4. CAGE/RET/STIFF SWITCH
5. A/A MSLS AND MASTER ARM PANEL
6. EXTERNAL STORES EMERGENCY RELEASE BUTTON
7. MISSILE STATUS PANEL
8. PILOT'S DISPLAY RECORDER SWITCH
9. PRF AUDIO SWITCH
10. MISSILE SELECTED REPEATER LIGHT (POST-MOD 626, PRE-MOD 722)
10A. RADAR LIGHT (POST-MOD 722)
11. SEAM LOCK REPEATER LIGHT (POST-MOD 656, PRE-MOD 722)
11A. HEAT LIGHT (POST-MOD 722)
12. LCOSS OPTICAL DISPLAY UNIT
13. TRIGGER SWITCH
14. STORES RELEASE BUTTON (PRE-MOD 656) SEAM LOCK ENABLE/REJECT BUTTON (POST-MOD 656)
15. NAV FUNCTION SELECTOR SWITCH
16. MULTIPLE WEAPONS CONTROL PANEL

1—2 Fig 1 Front Cockpit Layout



1. ANNUNCIATOR LIGHT CONTROL
2. PRF VOLUME CONTROL
3. PWR CONTROL UNIT
4. PWR INDICATOR
5. WIND SELECT SWITCH
6. RADAR SET CONTROL PANEL
7. TELESCOPE SIGHTING SYSTEM
8. CNI NAV/COMP SWITCH
9. NAV COMPUTER CONTROL PANEL
10. RADAR SCOPE
11. ANTENNA HAND CONTROL
12. JETTISON SAFETY SWITCH
13. MCS BIT CONTROL PANEL
14. DIRECT RADAR SCOPE CAMERA (DRSC) CONTROL
15. AIR-TO-AIR IFF INDICATOR LIGHTS PANEL (POST-MOD 606)

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1—2 Fig 2 Rear Cockpit Layout

Front Cockpit Controls

5. *Pilot's Radarscope and LCOSS.* The pilot's radarscope and LCOSS controls above the main instrument panel (Fig 1) are:

Control	*Function*
SCALE/RET knob	Outer knob controls LCOSS reticle brightness Inner knob controls radarscope scale marker brightness
BRT/HOR ADJ knob	Outer knob adjusts scope horizon line Inner knob adjusts scope brightness
MODE control knob	Controls operation and testing of the LCOSS
OPR/ERASE button	Activates or erases the radarscope picture
RETICLE DEPR control knob	Controls depression of the LCOSS reticle
VEL/Range scale lights	Refer to the Confidential Supplement
Radar mode lights	Indicates attack conditions for the radar
SHTR-CL/OPEN switch	Controls shutter operation to allow the LCOSS reticle display to appear or to be erased
INT/RED levers	Controls the intensity of light and colour respectively from the radar display to the LCOSS

6. *Multiple Weapon Control Panel.* The multiple weapon control panel on the pedestal below the main instrument panel (Fig 1) has a STA SEL indicator switch (CTR) which selects and indicates the centre station (with SUU-23A fitted) for use. The BOMB ARMing switch controls the missile monitoring pod camera heaters (post-mod 5059 and 5062). Post-mod 715, the switch is re-labelled MMP CAMERA HTRS (see Part 6, Chapter 1, para 20).

Rear Cockpit Controls

7. *Navigator's Controls and Control Panels*

Control/Control Panel	*Location*	*Function*
RWR PRF volume control	Left Console	Adjusts the volume of the RWR audio signals in both headsets when ALL is selected.
RWR control unit	Lower left main instrument panel	Controls the operation and testing of the RWR system.
RWR indicator	Lower left main instrument panel	Indicates the relative bearing of detected pulse threats, the quadrant containing the source of detected CW threats and whether a threat is TWS, P or CW.
RAD WIND/MAN WIND select switch	Main instrument panel	Inhibits the radar derived wind, from the pulse doppler servos, to the NCS when in the MAN WIND position.
Radar set control panel	Main instrument panel	See classified supplement: CD 101B-0901 & 2-15D.
Telescope sighting system (post-mod 782)	Left of main instrument panel	Improves vis-ident range.

(continued)

Control/Control Panel	*Location*	*Function*
CNI — NAV/COMP switch	Main instrument panel	Controls the information displayed on the BDHI.
Navigation computer control panel	Main instrument panel	Controls the mode and function of the NCS in flight and allows manual insertion of basic flight plan data.
Radarscope and antenna hand control	Below main instrument panel	See para 8
INBD OUTBD PYLONS & MISSILE JETTISON SAFETY SWITCH — READY/SAFE	Right console	Prepares or isolates pylon and missile jettison circuits.
MCS BIT control panel	Right console	Controls the BIT programme for the radar.
Air-to-air IFF indicator lights	Below main instrument panel	See classified supplement: CD 101B-0901 & 2-15D.

8. *Navigator's Radarscope Controls.* Fig 2 shows the location of the navigator's radarscope and all associated controls, ie, Radar Set Control panel, Antenna Hand Control, MCS BIT control panel and radarscope camera controls. The function and purpose of all these controls can be found in CD 101B-0901 & 2-15D.

PART 2

CHAPTER 1 — LCOSS

(All text completely revised by AL5)

Contents

Illustrations

Introduction

1. The Lead Computing Optical Sight System (LCOSS) (only fitted to ex-RN aircraft post-mod 457/671) presents a head-up display of weapon aiming and aircraft attitude data using an electronically-controlled reticle consisting of a centre dot aiming mark, roll tabs and an analogue bar controlled by signals from LCOSS units and other aircraft systems. The LCOSS displays:

a. Radar boresight line position for use with air-to-air missiles.

b. Prediction angle for air-to-air gun attacks.

c. Target radar range, presented by the analogue bar.

d. Aircraft roll attitude, presented by the roll tabs.

2. The LCOSS requires 115V, 400 Hz, 3-phase AC and 28V DC power supplies. The main components of the system are:

a. Optical Display Unit (ODU).

b. Pilot's Radar Indicator (PRI) and ODU mount.

c. Lead Computing Gyroscope (LCG).

d. Lead Computing Amplifier (LCA).

e. Lead Computing Gyroscope mount.

3. The ODU and the PRI are coupled together as a single unit known as the Command Indicator. The ODU above the front cockpit main instrument panel produces a collimated display for weapon aiming, houses the optical system for the PRI and carries the controls for the operation of the LCOSS and the PRI.

4. The reticle image is formed by passing light through one fixed and two movable reticle forming discs, the former producing the centre dot, 25 and 50 milliradian diameter rings, and the roll alignment tabs, and the latter forming the roll tabs and the analogue bar. After passing through the discs, light is reflected by a servo-operated movable mirror, through a collimating lens which focuses the image at infinity, and thence on to the combining glass (Fig 1).

5. By controlling the position of the movable mirror through electrically-operated azimuth and elevation servo motors, the reticle position on the combining glass can be varied to suit the sighting requirements. Control of the movable reticle forming discs is by roll tab and analogue bar servos. The inputs to the servo motors are obtained as follows:

Servo Motor	*Input Source*	*Use*
Azimuth	LCG	Azimuth component of the air-to-air prediction angle
	LCA	To position the reticle to the radar boresight line for missile attacks
Elevation	LCG	Elevation component of the air-to-air prediction angle
	LCA	To position sight line to RBL for missile attacks
Roll tab	VFRS or AJB-7	Aircraft roll attitude
Analogue bar	AWG-11	Radar range to target
	LCA	Ensures bar is out of view if radar range signals are absent

6. The PRI and ODU mount is attached to the aircraft structure by three vibration isolators which minimise reticle jitter. The attachment points allow boresighting adjustment and, theoretically, a Command Indicator may be replaced without reharmonisation; in practice, however, reharmonisation is likely to be necessary if the Command Indicator has been disturbed. The PRI is fully described in CD 101B-0901 & 2-15C and -15D.

Lead Computing Gyroscope

7. The LCG computes the prediction angle in the air-to-air guns mode only. The unit is enclosed in a spherical metal case, pressurised with dry nitrogen and heated to maintain a constant operating temperature, and housed in the upper equipment bay.

8. The LCG consists of a gyro magnet, an accelerometer, a gyro torque motor and an eddy-current dome gyroscope with elevation and azimuth pick-off synchros.

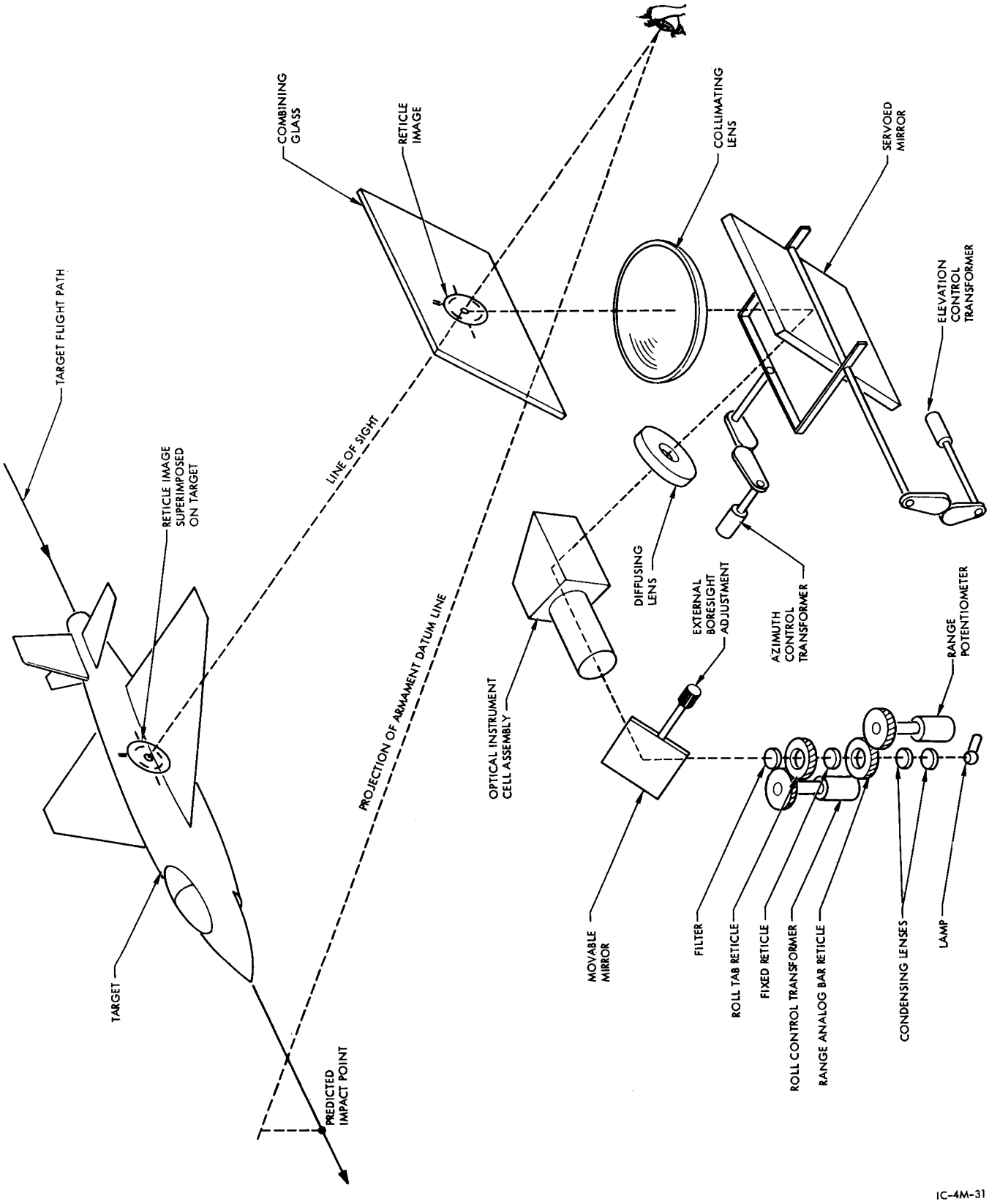
9. Lead angle in the air-to-air gunnery mode depends upon target crossing speed at right angles to the line of sight and is computed from the product of sightline spin and bullet time of flight. Sightline spin is obtained by tracking the target with the reticle centre dot. Time of flight of the bullet is proportional to target range and air density as supplied by the radar and the CADC respectively.

10. The gyroscope normally has its spin axis aligned with the Radar Boresight Line (RBL). If the aircraft is turned to keep the centre dot on the target, the gyroscope precesses then lags behind the gun bore line by an amount depending upon precession rate (sightline spin) and gyro sensitivity. Gyro sensitivity is made proportional to radar range and air density supplied via a range computing servo and a magnetic current loop; since bullet time of flight is dependent upon range and air density, gyro sensitivity must also be a measure of time of flight.

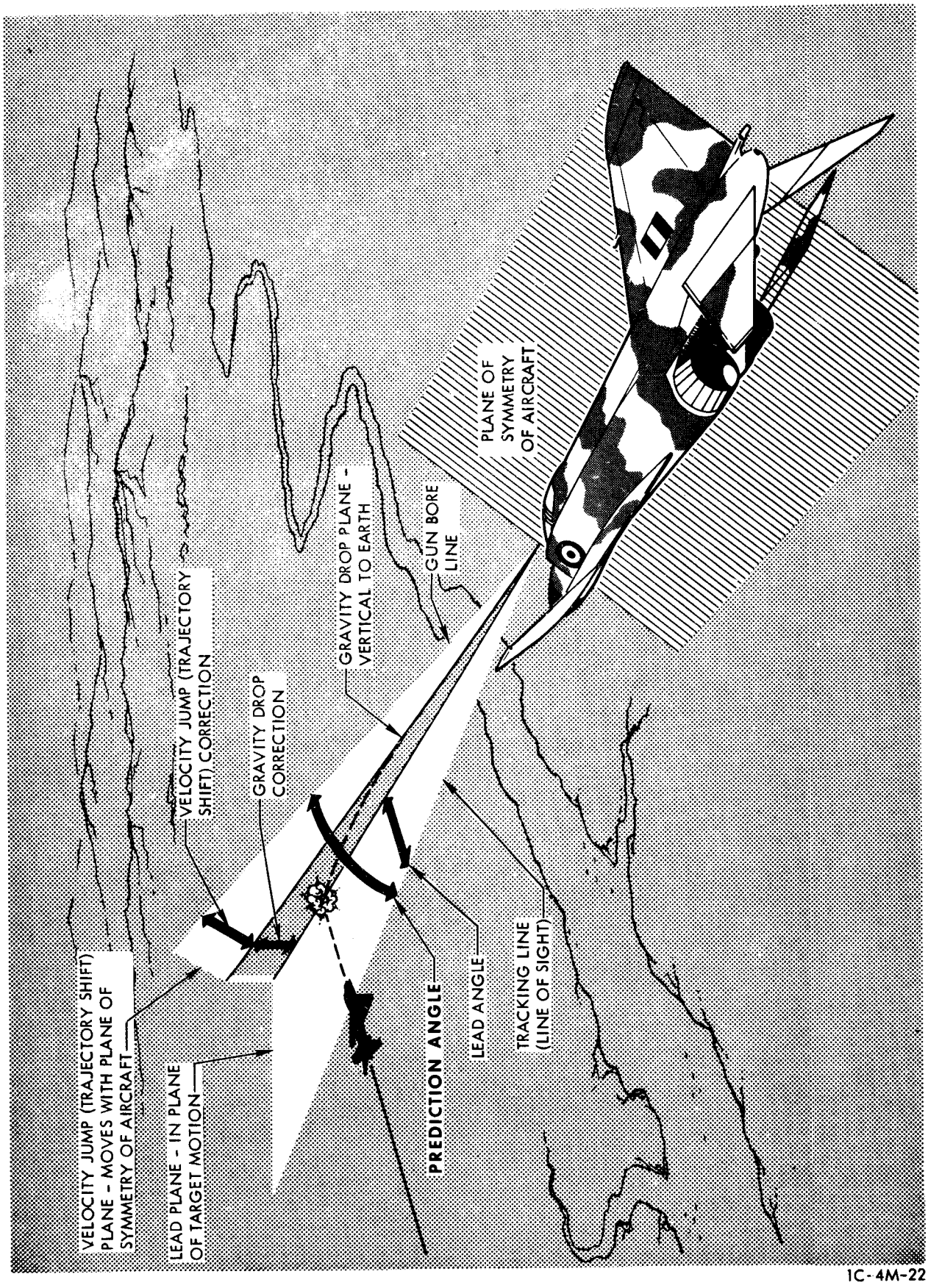
11. Gyro displacement from its datum position produces signals from elevation and azimuth pick-offs on the gyro gimbals to energise servo motors controlling the movable mirror. In turn, the reticle position on the combining glass is moved to give the required lead angle.

12. Two additional forces affect the path of the bullet, velocity jump and gravity drop (Fig 2). Velocity jump, sometimes termed trajectory shift, is largely the result of the difference between aircraft flight path and gun bore line, causing the bullet to adopt a resultant initial path between the two. As velocity jump occurs in the plane of symmetry of the aircraft, sight compensation must be made in this plane. Gravity drop compensation, however, is required in the vertical plane regardless of aircraft attitude. The LCG provides compensation for these forces by employing a pendulum torque motor accelerometer to measure aircraft normal acceleration as the resultant of centrifugal acceleration and gravity. The accelerometer generates analogue voltages which precess the gyro in elevation, depressing the sightline appropriately. However, with bank applied, compensation for the gravity component is perpendicular to the aircraft wings whereas it should be in the vertical plane. This error is always in the prediction plane and, provided a co-ordinated turn is flown, is almost a constant fraction of the lead angle. It is largely compensated by decreasing the gyro sensitivity to reduce the lead angle, but is only correct in certain conditions, eg at a given TAS/AUW.

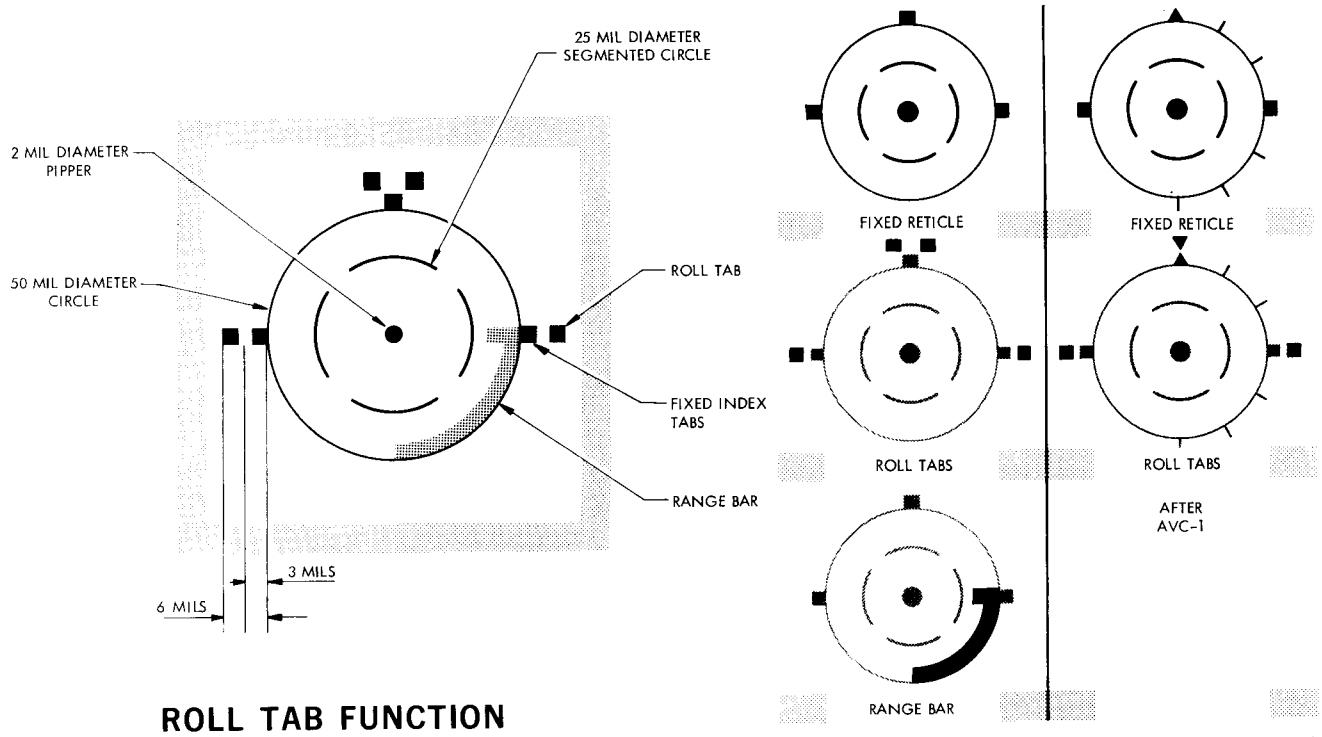
13. When radar range is unobtainable or not locked on, a fixed range voltage, equivalent to 1500 feet



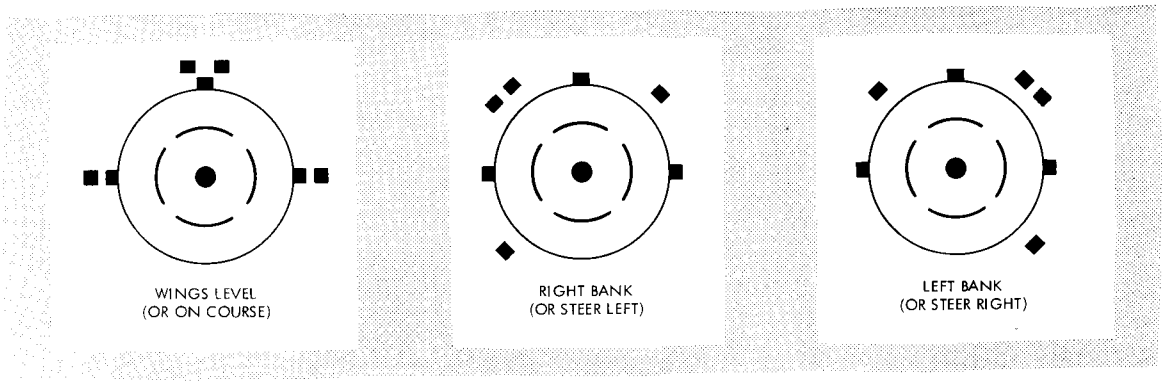
2 — 1 Fig 1 Reticle Display Projection



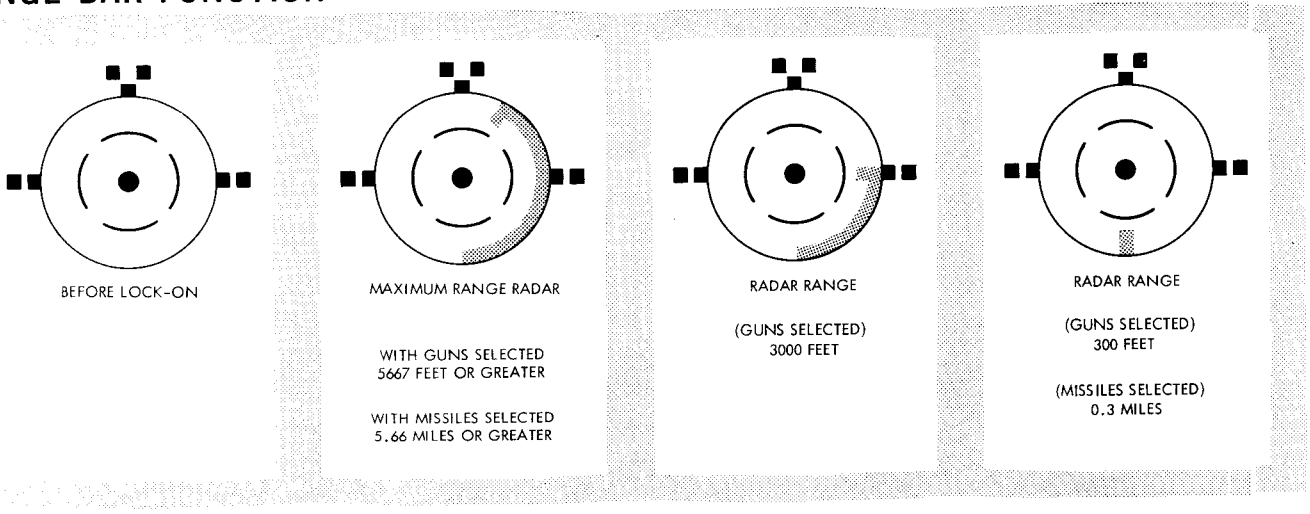
2 — 1 Fig 2 Air-to-Air Prediction Angle



ROLL TAB FUNCTION



RANGE BAR FUNCTION



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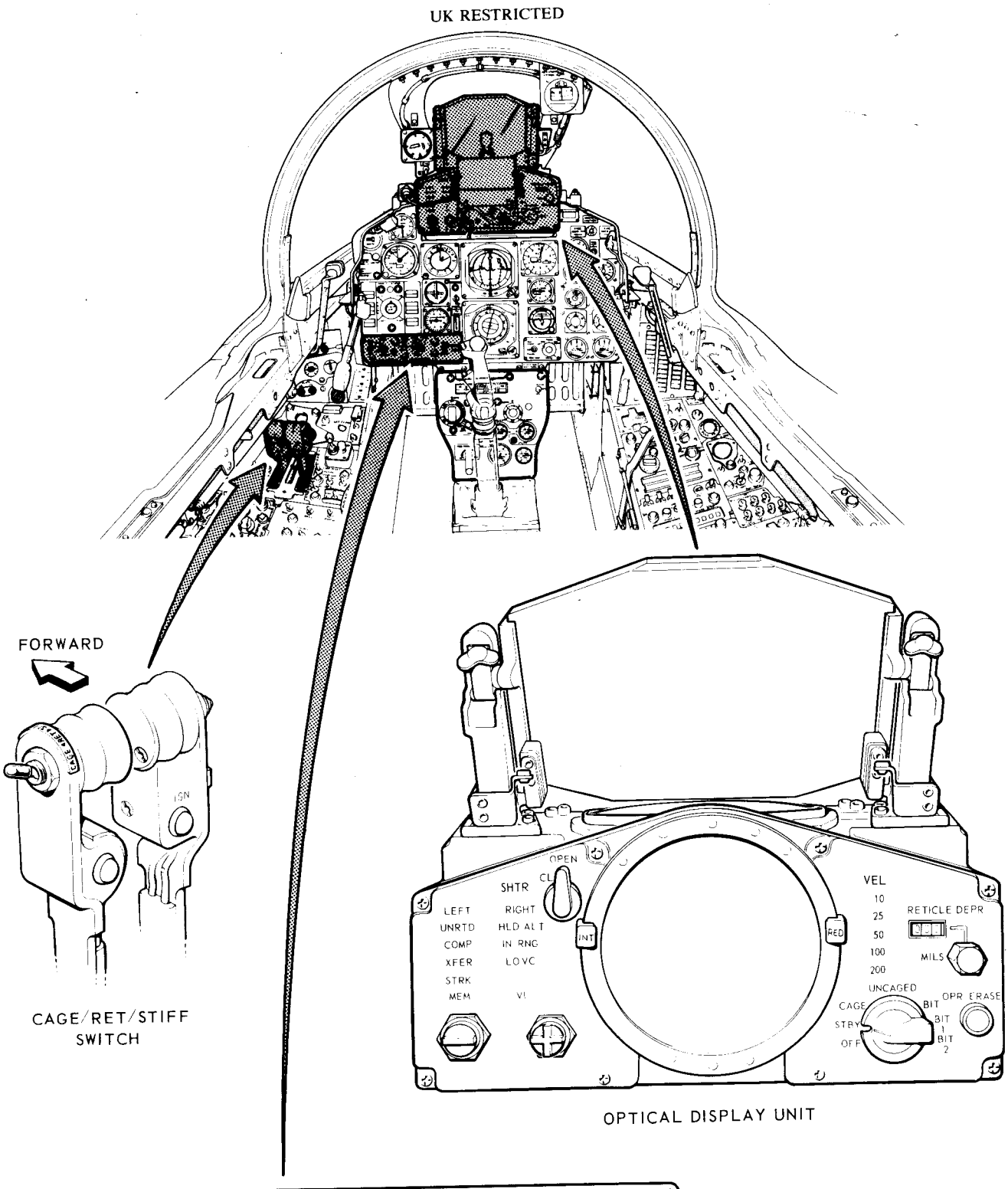
2—1 Fig 3 Reticle Display
◆ *(Mod 645 fleet embodied)* ◆



2—1 Fig 4 LCOSS Controls and Indicators

range is supplied to the gyroscope. This facility can be manually selected when the 'reticle stiffness' switch on the port engine throttle control is selected to STIFF.

Lead Computing Amplifier

14. The LCA contains the amplifiers for the four reticle servos and amplifiers for prediction angle computation and correction. Operation mode changing and built-in-test (BIT) switching is carried out by relays within the unit which also supplies voltages for operational and BIT modes.

Lead Computing Gyroscope Mount

15. The mount secures the gyroscope to the aircraft structure and isolates the LCG from shock and vibration.

Controls and Indicators

16. The reticle display (Fig 3) consists of a 2-mil diameter centre dot aiming mark, a 25-mil diameter segmented circle and a 50-mil diameter full circle. Attached to the outside of the 50-mil circle are three fixed index tabs, used as an alignment reference for the roll tabs which, positioned outside the fixed reference tabs, rotate around the display indicating roll attitude. If left bank is applied for example, the roll tabs move clockwise in relation to the fixed reference tabs, indicating a roll to the left.

17. An analogue bar appears on the inside of the 50-mil circle only when a target has been acquired by radar lock-on. The bar covers a clockwise arc of 170° from the maximum to the minimum (6 o'clock position) range. Range scale markers are positioned on the 50-mil circle. Range indications are:

◆◆

Length of Arc	*Radar Range*	
	GUNS Selected	*MSLS Selected*
170°	5667 feet or more	5·66 miles or more
90°	3000 feet	
0°	300 feet or less	0·3 miles or less

18. The colour of the displayed image is red. The 25-mil and 50-mil circles may be used in estimating target range when compared with the target's wing span. The speed of contraction or expansion of the bar gives an indication of range rate.

19. The controls and indicators (Fig 4) affecting LCOSS operation are tabulated below. Provided the

Control	*Location*	*Switch Position*	*Function*
SHTR	ODU	CL	Prevents display of reticle Shades PRI from light from above
		OPEN	Allows reticle to be displayed
RET INT	ODU	Variable	Varies reticle display intensity
RETICLE DEPR	ODU	Variable	Allows manual reticle depression between 0 and 245 milliradians. The setting is displayed in an adjacent window
MODE	ODU	OFF	Removes power from LCOSS
		STBY	Power applied, no reticle display
		CAGE	Reticle appears, caged to Radar Boresight Line (RBL)
		UNCAGE	Sight ready for operation
		BIT BIT 1 BIT 2	Built-in-test positions
CAGE/RET/STIFF switch	Port throttle	STIFF	Ranging circuits set to equivalent of 1500 feet

(continued)

Control	*Location*	*Switch Position*	*Function*
		CAGE	Duplicates MODE switch CAGE position
MSLS-GUNS switch	Missile control panel	OFF	LCOSS display fixed to RBL
		A/G FIXED	Manual depression function of sight available
		A/A	Sight computes prediction angle
		SP III SW	Reticle caged to RBL

WPN selector switch is maintained at OFF, as is normal in the air-to-air role, selections on the weapon delivery MODE switch do not affect LCOSS presentations.

Note: Where reference is made to the Radar Boresight Line (RBL), this line is positioned at 0° in azimuth and 2° (35 mils) below the aircraft water line. The settings of the RETICLE DEPR control are related to the water line and not to the RBL, eg a setting of 010 mils is 010 mils below the water line.

System Limitations

20. The maximum sightline displacement of the reticle is 0 to 245 milliradians in elevation and ±104 milliradians in azimuth. Lead angle computation is limited to the following:

a. 750 feet to 4000 feet in range.

b. 1000 feet/second range rate.

c. 60,000 feet altitude.

d. 7°/second rate of turn.

e. 2·2M in speed.

f. 6g normal acceleration.

Built-in Tests (BIT)

21. Built-in self-test circuits allow pre-and in-flight checks to evaluate system performance as follows:

a. Set the SHTR control to OPEN. Select STBY at the LCOSS MODE switch and allow 5 minutes for the system to warm up. Then select CAGE and set the RETICLE DEPR control to 010 mils. Adjust the RET INT control as required.

b. With the VFRS or AJB-7 in operation, select BIT at the MODE switch. The reticle display should appear as in 'A' of Fig 5, with the centre dot aligned with the RBL. If the test is made in flight, the roll tabs conform to the aircraft roll attitude and the analogue bar should not appear unless the radar is locked-on to a target.

c. Move the head to the right until the display is partly cut off as in 'B' of Fig 5. Keeping the head in this position, select BIT 1 and check that the reticle traverses 25 ±4 mils in azimuth as at 'C' of Fig 5. Note that the extreme right-hand of the display is cut off, the roll tabs rotate 90° clockwise and the analogue bar rotates to the 3 o'clock position. Move the RETICLE DEPR control and note corresponding movement of the reticle; reset to 010 mils.

d. Move the head up until the top of the display is partly cut off as in 'D' of Fig 5. Keeping the head steady, select BIT 2 and check that the display is depressed 25 ±4 mils in elevation as at 'E' of Fig 5. Note that the extreme top of the display is cut off, the roll tabs rotate to 0° roll angle and the analogue bar shows maximum range.

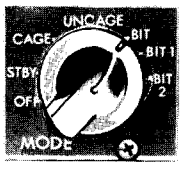
Note 1: The behaviour of the roll tabs in BIT described in para 21 b assumes attitude reference is in operation; otherwise the roll tabs position is arbitrary. At BIT 1 and BIT 2 the roll tabs position is as described, whether or not attitude reference is in operation.

Note 2: If an incorrect displacement of the reticle occurs in BIT 1 or BIT 2, any of the elevation, azimuth or range servo loops is defective and could result in inaccurate displays in all modes of operation. If an incorrect display of the roll tabs occurs, the LCOSS can be used for sighting but with the loss of roll information. If the analogue bar malfunctions, lead computation may be inaccurate and the range display should not be used.

Harmonisation and Interface Checks

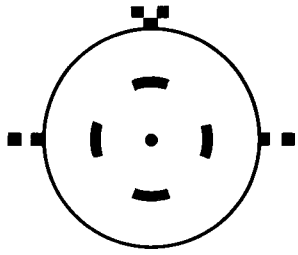
22. A spot check of the LCOSS harmonisation is made by comparing the position of the reticle at a specific sight depression with the reflection of the collimating lens housing in the combining glass. The pilot's eye must be aligned with the forward edge of the metal surround of the collimating lens and the highest point of the radome. Select the MODE to UNCAGED, the MSLS-GUNS switch to A/G FIXED and rotate the RETICLE DEPR control to 243 mils; the bottom of the 50-mil circle should just begin to disappear behind the collimating lens housing reflection. This check is only valid to

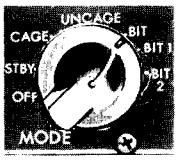
BIT



A

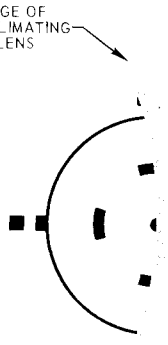
- BIT Mode
- Set 10 Mils Dep.
- Pipper at RBL.
- Roll tab level flight or actual flight attitude.



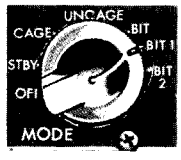


B

- BIT Mode
- Pilot moves head right

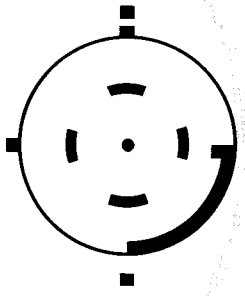


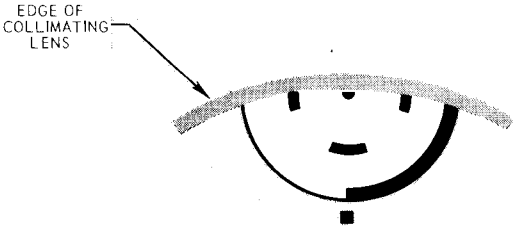
BIT 1



C

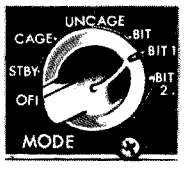
- Select BIT 1
- Reticle moves left 25 ± 4 mils.
- Roll tabs rotate 90° CW.
- Range bar at 3-o'clock.



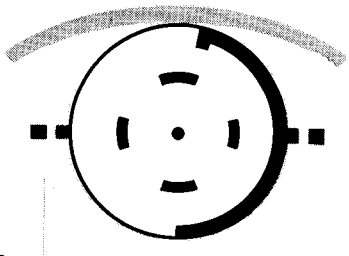


D

- BIT 1 Mode.
- Pilot moves head up.

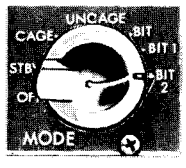


BIT 2



E

- Select BIT 2.
- Reticle moves down 25 ± 4 mils.
- Roll tabs indicate level flight.
- Range bar at max displayable range.



F4M-806

2–1 Fig 5 Built-in-Test Display

about ± 10 mils and any error found does not necessarily represent the error throughout the range of reticle movement. An interface check can be made by setting the MODE to CAGE (reticle at RBL position) and comparing the position of the centre dot with that obtained when the MSLS-GUNS switch is at A/G FIXED, the RETICLE DEPR control is at 35 mils and the MODE is reset to UNCAGED. The minimum acceptable variation in the position of the centre dot is 2 mils.

Attack Modes

23. *Missile Mode.* In the missile mode a radar lock is attained on a hard manoeuvring target by utilising the LCOSS as an aiming reference, using either the BST or PLM mode of the radar. The reticle is fixed to the RBL in azimuth and elevation. When radar lock-on has been established radar range is presented by the analogue bar. Accurate tracking with the reticle pipper is necessary to achieve lock-on. Thereafter, with 'radar' missiles selected, the target must be illuminated by radar until weapon intercept. The selected missile is launched, when the target enters the displayed range bracket, by the trigger on the control column. Switch positions for this mode are:

MSLS-GUNS switch	SP III or SW
CW RDR switch	ON (if SPIII selected)
LCOSS MODE switch	UNCAGED
Radar MODE switch	BST (or press nosewheel steering switch for PLM)
WPN selector	OFF
MASTER ARM switch	ARM

24. *Gun Mode.* In the air-to-air gun mode, the reticle is uncaged and the aircraft flown on a pursuit course, tracking the target with the centre dot. The prediction angle is automatically applied by the LCG, if radar ranging is operating; if not, the prediction angle is correct only for a fixed 1500 feet range resulting in under-deflection if the gun is fired at longer ranges or over-deflection if fired at shorter ranges. When tracking targets at long range with high lead angles, the high gyro sensitivity may be countered by selecting the reticle stiffness switch on the port engine throttle to STIFF, so that sensitivity becomes equivalent to 1500 feet range. When lead angle and/or range have been reduced, the switch must be released and tracking re-established before opening fire. The analogue bar indicates target range provided the radar is locked on. If the reticle stiffness switch is at STIFF, the bar continues to show radar range and not the 1500 feet range which the sight is now computing. The switch positions for this mode are:

MSLS-GUNS switch	A/A
LCOSS MODE switch	UNCAGED
Radar	Locked-on
Reticle stiffness switch	STIFF or RET
WPN selector switch	OFF
AUTO CLEAR/NON-CLEAR switch	As required
STA SEL button	CTR 40 seconds before firing
MASTER ARM switch	ARM

PART 2

CHAPTER 2

(Not Issued)

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PART 2

CHAPTER 3 — TELFORD CAMERA RECORDER

Contents

Description

1. A Telford Type 1007/5 gunsight camera fitted to the LCOSS ODU photographs the LCOSS display and field of vision ahead of the aircraft. The camera has up to 50 feet of standard 16 mm film and operates at a film speed of 16 frames per second at an exposure time of ·004 second.

2. The camera is attached to a mounting bracket on the ODU by two studs on the camera body which engage with spring-loaded catches on the bracket (Fig 1). At the top of the camera body is an adjustable lens assembly, covered by a hinged flap mirror which must be raised before filming; images of the target area and LCOSS display are superimposed on the mirror and photographed via the lens. A small knob on top of the mirror can serve as the rear element of a standby sight. The camera body is divided into a film compartment and an operating mechanism compartment.

3. *Lens.* A 1″ focal length F1.9 lens has a manually adjustable iris with click stops down to F16 focussed at infinity. The camera field of view is 22° vertically and 16° in azimuth.

4. *Film Compartment.* The film is fitted to a feed spindle and fed through a film tension arm, a guide block, a spring-loaded pressure plate and a guideway to a take-up spindle (Fig 2). The pressure plate holds the film firmly in the optical plane against an aperture plate. A spring-loaded arm positioned against the feed spool is connected to a contents indicator.

5. *Operating Mechanism.* A governed DC motor drives the film take-up gear, two shutters and the film claw movement via an escapement mechanism activated by a DC solenoid. An event marker, controlled by a solenoid energised by the trigger, causes a flag to appear in the film aperture.

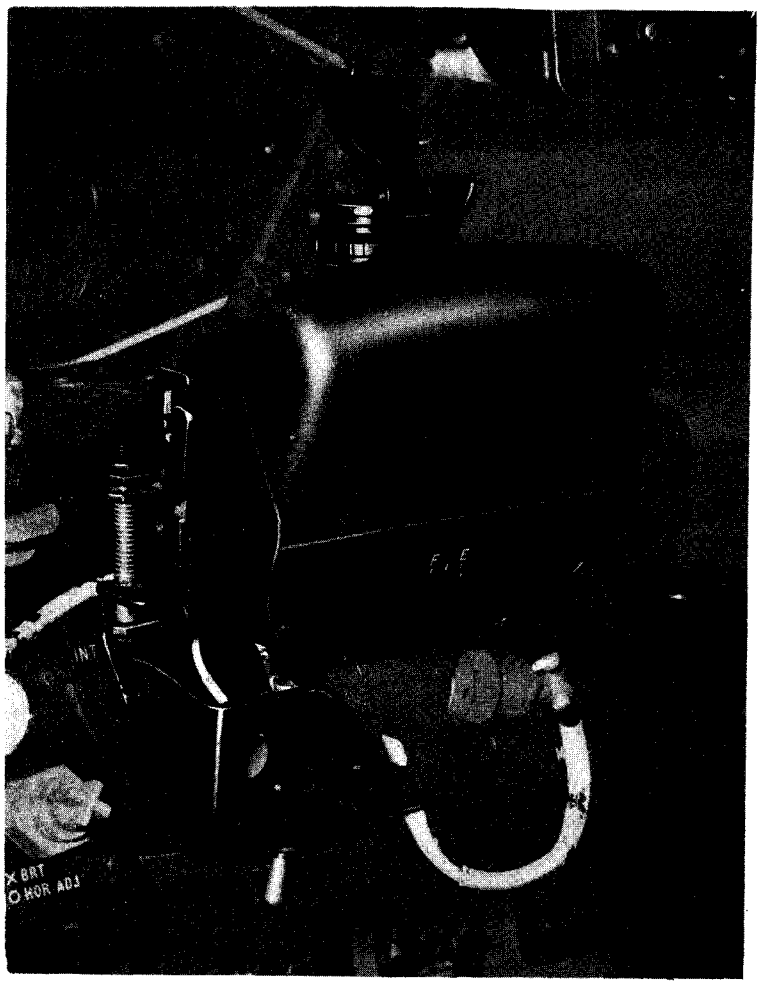
6. *Power Supplies.* 28V DC is supplied from the RH busbar, via No 3 circuit breaker panel.

7. *Controls and Indicators.* A GUNSIGHT CAMERA — ON/OFF switch is on the camera mounting (Fig 1). A film contents indicator with three lines denoting F (full), half-full and E (empty) is on the camera case.

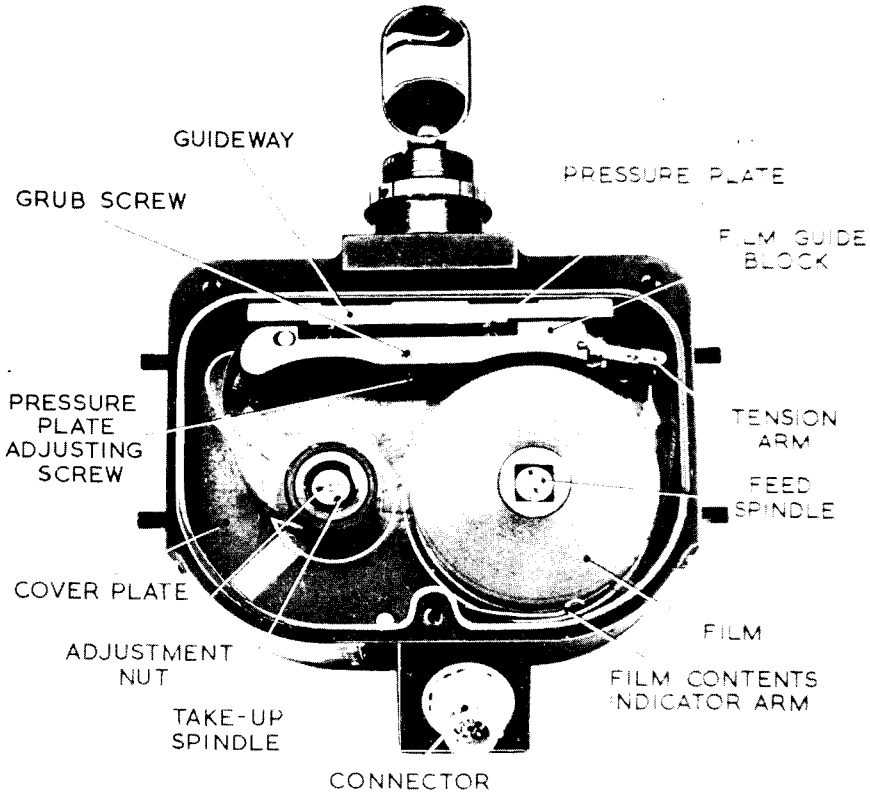
Operation

8. *Pre-Flight.* Check contents indicator reads F and set the lens aperture as desired. Check installation security, lead connection, and flap mirror operation.

9. *In-Flight Operation.* Raise flap mirror and readjust lens aperture. Set MSLS-GUNS selector as required, GUNSIGHT CAMERA—ON/OFF switch to ON and, if required for live attacks, MASTER ARM switch to ARM. The camera now runs continuously. When the trigger is pressed the camera ON/OFF switch springs to OFF but filming continues for approximately two frames after trigger release. (The event marker solenoid operates to mark all frames whilst the trigger is pressed.) Alternatively, filming can be stopped by applying a finger pressure of 4 lb to the camera ON/OFF switch to break the magnetic hold to the ON position. Post-SEM/PHANTOM/RE/024/STC, the camera continues to run after the trigger is released until the camera ON/OFF switch is manually selected OFF; a small force is required to break the magnetic hold.



2 — 3 Fig 1 Recorder and Mounting Bracket



2 — 3 Fig 2 Film Compartment

Ministry of Defence
June 1986

AP101B-0901-15B

PHANTOM FG Mk 1

AIRCREW MANUAL - BOOK 2

ADVANCE INFORMATION LEAFLET 2/86

Insert this leaflet in AP101B-0901-15B to face page 2 of Part 2, Chapter 3, and remove and destroy AIL 1/86 which this AIL replaces.

This AIL describes the operation of the Phantom Weapon Sight Recorder (PWSR) which has already been introduced into service as a special trial fit (STF/PHANTOM/3B/86/STC) on selected aircraft. An equivalent SEM will replace the STF instructions in due course and all aircraft will be capable of having the PWSR fitted. The PWSR is also known as the Davall camera.

PHANTOM WEAPON SIGHT RECORDER

Introduction

1. The introduction of the Phantom Weapon Sight Recorder (PWSR) requires a modified centre glare shield, the introduction of an ON/OFF switch and its mounting bracket, and modifications to the optical display unit (ODU).

2. When the above modifications have been incorporated, the Telford camera cannot be fitted.

Description

3. The PWSR is a 16 mm cine camera which is fitted into a new camera bracket assembly consisting of a sight bracket and support plate assembly which is harmonised to the ODU. There is a removable film magazine which can be replaced in flight if necessary.

Note: When the camera is to be fitted, the glare shield bridging piece is removed from the centre glare shield. Conversely, when the camera and its bracket are removed, the glare shield bridging piece is refitted.

4. The camera is positioned to film the pilot's forward view through the ODU via a fixed periscope mounted on top of the camera which deflects the forward view onto the camera lens.

5. *Magazine*. The film magazine holds between 50 ft (15 m) and 60 ft (18 m) of 16 mm double perforated film, the capacity depending upon the thickness of the film base, ie, 0.15 mm or 0.1 mm respectively. On the right side of the camera is a spring-loaded magazine latching and ejection mechanism which allows single-handed magazine changing. The film transport drive automatically engages with the camera driving gear on magazine replacement. On the corner of the magazine are two indicators: the upper shows the quantity of unexposed film remaining in percentage terms; the lower shows the correct functioning of the film transport mechanism when the camera is operating. The magazine is inserted into the camera with these indicators facing the pilot. The running time of the magazine is 2.5 minutes with 60 ft of film, or 2 minutes with 50 ft of film. Normally

0.1 mm base film is loaded, giving a 2.5-minute total running time. The camera operates at 16 frames per second.

6. *Camera Controls*

a. *Overrun Setting.* A rotary switch on the face of the camera marked OVER RUN - 0/2.5/5/10 allows the pilot to set the amount of camera overrun required in seconds. The camera automatically continues to run for the set period after the trigger is released or the operate switch is set to OFF (see para 7 and 8).

b. *Test Button.* When the test button is pressed and released the camera runs for approximately 2.5 seconds.

c. *Film Speed Control.* A second rotary switch marked ASA is used to set the film speed. The four positions, 1, 2, 3 and 4, correspond to film speeds of 50, 100, 200 and 400 ASA respectively. The switch is set appropriately to meet the film processing requirements as briefed. If no advice on ASA setting is given, position 2 is to be used. The lens iris aperture is automatically controlled between f2 and f16 by a servo system sensitive to ambient light conditions.

7. *Camera Operate Switch.* A 2-position toggle switch marked ON (up)/OFF (down) is fitted to the left of the ODU. With ON selected the camera runs. When OFF is selected the camera stops after continuing for the overrun period set (para 6a).

8. *Trigger.* With the camera operate switch set to OFF and the MASTER ARM switch to ARM, trigger press starts the camera and event-marks the film. Trigger release removes the event-marking and the camera continues to operate for the set overrun period.

Note: With the camera operate switch to ON and the film therefore running, selection of the MASTER ARM switch to ARM and trigger press produces event-marking for the duration of the trigger press. On trigger release the camera continues to run until the camera operate switch is set to OFF and the overrun period has expired.

Constraints

9. *Obstructed Captions.* In certain sitting positions the camera may obstruct the RADAR, HEAT and AOA indexer lights.

10. *Standby Compass.* The installation of the PWSR affects the accuracy of the standby compass unless the compass is re-swung after fitting the PWSR.

11. *Pick-Up Phenomena.* During trial installation work it was noted that the camera runs for 2.5 seconds when the fuel booster pumps are switched on prior to engine start. Similarly, if the MSLS/GUNS switch is cycled between the SW and SP III positions, the camera runs for less than 0.5 seconds.

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

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

PART 3—MISSILE CONTROL SYSTEM

Refer to CD 101*B*-0901 & 2-15*D*

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PART 4

CHAPTER 1 — CENTRAL AIR DATA COMPUTER

Contents

Introduction

1. A brief description of the Central Air Data Computer (CADC) is given in Part 1, Chapter 2 of AP 101B-0901-15A dealing with the outputs to basic flight instruments and angle-of-attack indicators, whereas the purpose in this Manual is to describe more fully those outputs to the following systems:

a. Missile Control System (MCS).

b. Lead Computing Optical Sight System (LCOSS).

c. Navigation Computer Set.

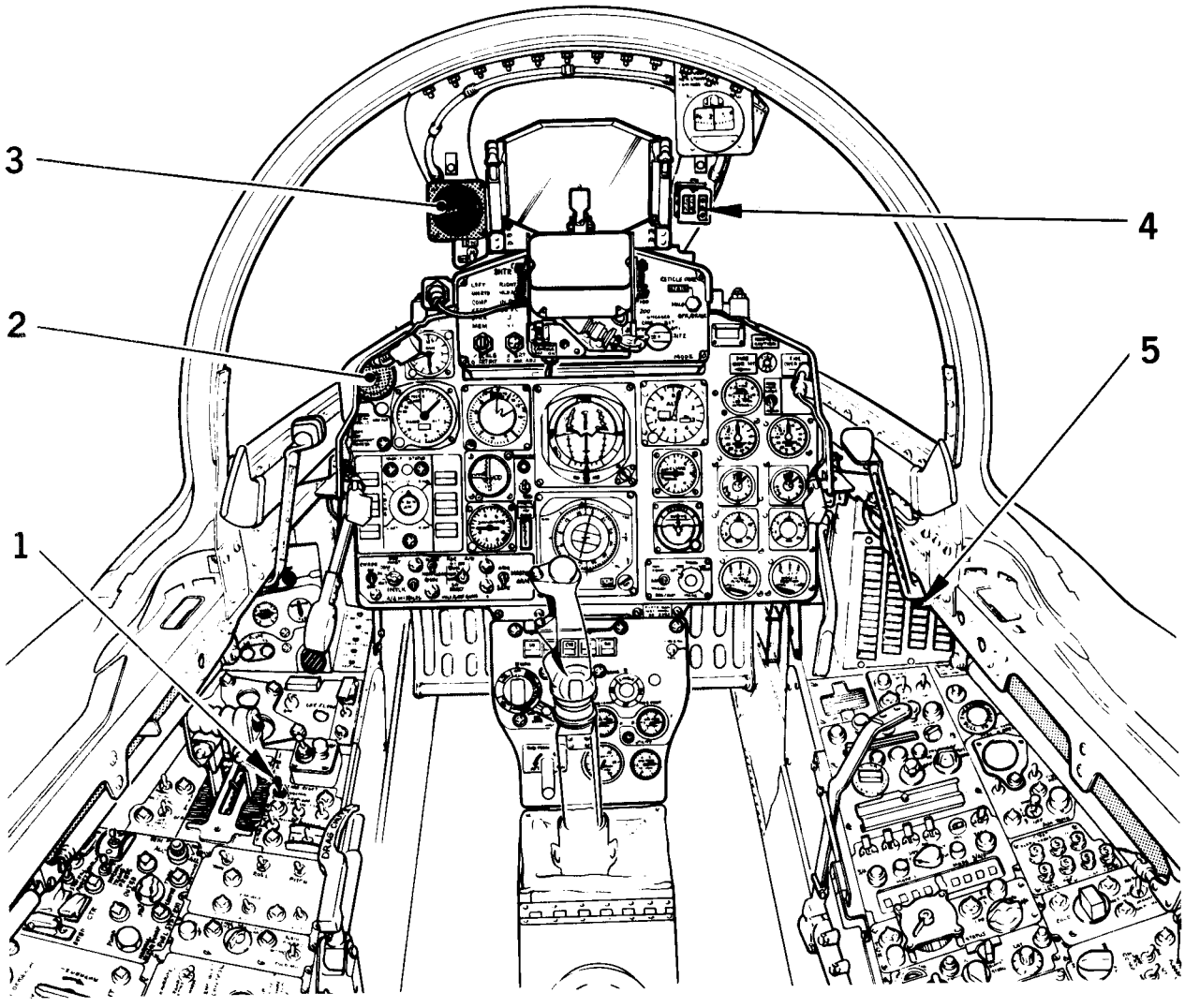
d. VFRS.

Parameters

2. *CADC Inputs.* The source and symbology of inputs to the CADC are:

CADC Input	*Symbol*	*Aircraft Source*
Indicated static pressure	Psi	Static ports to the rear of the radome
Total pressure	Pt	Pitot tube on the fin
Indicated angle-of-attack	αi	Forward port fuselage probe
Total temperature	Tt	Electrical resistance temperature transmitter adjacent to the port air conditioning inlet duct

Engine bleed air is an additional CADC input in the conversion of Psi to true static pressure (Ps).



1. CADC SWITCH
2. TRUE AIRSPEED INDICATOR
3. ANGLE OF ATTACK INDICATOR
4. ANGLE OF ATTACK INDEXER LIGHT
5. STATIC CORR OFF LIGHT

PH 3972

4 – 1 Fig 1 CADC Controls and Indicators

3. *CADC Outputs.* CADC outputs as voltage analogues are:

CADC Output	*Symbol*	*Application*
True static pressure	Ps	LCOSS
Natural logarithm of true static pressure	LnPs	MCS
True airspeed	TAS	MCS NCS VFRS
True angle-of-attack	αt	MCS

Cockpit Controls and Indicators

4. *CADC Switch.* The CADC switch on the engine control panel in the forward cockpit (Fig 1) is labelled RESET CORR / NORM / CORR OFF spring-loaded to NORMAL from the RESET CORR position. The switch controls a fail-safe relay circuit in the static pressure compensator (SPC) so that, with NORM selected, indicated static pressure (Psi) corrected for compressibility and pressure errors is fed as true static pressure (Ps) to CADC ancillary modules. Uncorrected static pressure (Psi) is the output if CORR OFF is selected.

5. *Indicator Light.* The STATIC CORR OFF light in the right vertical panel of the forward cockpit illuminates if the fail-safe relay is de-energised, either because of a malfunction or a selection of CORR OFF. To re-energise the relay and extinguish the light, select RESET CORR.

Static Pressure Compensator

6. *Normal Operation.* With the CADC switch at NORM and the STATIC CORR OFF light out, the SPC receives Psi at one side of a diaphragm and balances a beam, only when Psi is accurately corrected for mach number and αi, at the other. The result is an output of Ps.

7. *Reversionary Mode.* When the fail-safe relay is de-energised, Psi is routed to the log pressure controller and pressure ratio transducer, with consequent reduction in the accuracy of their final outputs. The fail-safe relay is de-energised and the STATIC CORR OFF light is illuminated whenever:

a. Diaphragm failure occurs.

b. The fulcrum carriage is driven to either limit of its movement.

c. Error detection occurs corresponding to a greater change of pressure than 0·005 inches of mercury (1·7 mb).

d. The relay power supplies fail.

e. The CADC switch is selected to CORR OFF.

Pressure Transducers

8. *Log Pressure Controller.* Using an evacuated bellows within a Ps (or Psi) filled case, and an E and I induction pickoff and servo motor, the log pressure controller positions two shafts, one proportional to Ps, and the other to the natural logarithm of true static pressure (LnPs).

a. The Ps shaft positions a wiper arm on a potentiometer fed by voltages from the LCOSS to produce voltage analogues of Ps to the LCOSS for lead angle computation.

b. The LnPs shaft positions a wiper arm on a further potentiometer excited by voltages from the MCS, to produce voltage analogues of LnPs to the launch signal computer in the MCS to compute missile average relative velocity, used to develop missile steering signals and determine maximum and minimum launch ranges and altitude switching signals.

9. *Pressure Ratio Transducer.* The pressure ratio transducer is a force balance instrument which receives Ps from the SPC (or Psi in the event of a malfunction) and total pressure (Pt) from the tailplane pitot tube. By definition, total pressure is the sum of impact pressure, or pitot excess, and static pressure. By applying to a balance beam forces proportional to Pt-Ps and Ps through a differential and an evacuated bellows respectively, the transducer servo motor is energised by an E and I inductive pickoff to provide a shaft rotation linear with the ratio true static pressure to total pressure, ie Ps/Pt. This output, after cam-conversion to voltage analogues of various mach number functions, is used extensively in CADC computations of true static temperature, TAS and true angle-of-attack, and in the feedback loop to the SPC servo motor.

Temperature and True Airspeed Servo

10. *Temperature.* For the total (ram) temperature (Tt) measured by the external probe to be of any value, the deceleration experienced by the air within the probe must be determined so that the temperature rise can be calculated and subtracted from Tt

to obtain true static temperature (Ts). This deceleration is a function of mach number and it can be shown that:

$$Ts = \frac{Tt}{1+0{\cdot}2M^2}$$

where both temperatures are absolute values. This equation is solved within the CADC with inputs derived from the Ps/Pt shaft and the electrical resistance temperature transmitter.

11. *True Airspeed.* TAS is dependent on mach number and the local speed of sound, which is itself dependent on local temperature. Computation of TAS in the CADC is by solving the equation,

$$TAS = \frac{f(M)\,Tt}{\sqrt{1+0{\cdot}2M^2}}$$

with inputs derived similarly to those outlined in para 10. The MCS launch signal computer receives TAS as an AC voltage analogue from the CADC to compute main beam clutter and maximum side lobe clutter signals, and to add to missile average relative velocity to determine the total missile velocity used in computing maximum and minimum launch ranges. TAS as a DC voltage analogue is also fed to the MCS launch signal computer for computation of lead angle error. TAS information is utilised in the VFRS for flight path angle computations and in the NCS to determine position with due allowance for wind effect, ie groundspeed.

Angle of Attack Computations

12. *Definitions.* Indicated angle of attack (αi) is the angle between the longitudinal axis of the aircraft and the angle at which the angle of attack transmitter probe aligns itself, as fed directly to the angle of attack indicators, the SPC servo motor, and to a section of the MCS. True angle of attack (αt) is that angle between the radar boresight line and the vector of the aircraft's centre of gravity. It can be shown that, for a given indicated angle of attack, the true angle of attack varies with mach number.

13. *Outputs.* True angle of attack is computed using cam-operated potentiometers driven by the Ps/Pt shaft and a voltage analogue of αi from the angle of attack transmitter. A voltage analogue of αt is applied to the MCS launch signal computer for:

a. Lead angle error and transformation of missile average relative velocity into aircraft co-ordinates.

b. Main beam clutter and maximum side lobe clutter signals.

Power Supplies

14. The CADC requires power supplies of 115V AC, 400 Hz, 3-phase and 28V DC.

Summary

15. It is emphasised that no attempt has been made in this Chapter to comprehensively describe all CADC inter-connections with aircraft systems. In particular, no mention has been made of several CADC outputs applied to the flight director group, which, although a necessary adjunct to the attack system, is not within the scope of this Manual.

PART 4 — ANCILLARY EQUIPMENT

CHAPTER 2 — ATTITUDE REFERENCES

List of Contents

Introduction

1. Two instruments provide attitude reference; the Vertical Flight Reference Set (VFRS) and Attitude Reference Set (AN/AJB-7). Both are described in this Chapter with emphasis on the information they each provide to the weapons system. For ease of reference, the controls and indicators for both equipments are tabulated together at the end of the chapter.

VFRS — GENERAL DESCRIPTION

Purpose

2. The VFRS provides the following data when the CSC is set to PRIM:

a. Pitch, roll, flight path angle and vertical acceleration to the MCS.

b. Pitch and roll to the ADI.

c. Roll to the LCOSS.

Components and Function

3. The two axes Vertical Flight Reference Sensor develops pitch, roll and vertical acceleration data, the latter through an accelerometer. The VFRS computer, with airspeed and altitude fed from the Air Data Computer, and vertical acceleration from the Sensor, computes flight path angle.

4. Precise pitch and roll outputs are obtained by maintaining the vertical spin axis with pendulum-referenced erection circuits. These circuits, which are unaffected by accelerations, eliminate vertical errors caused by turns or rapid changes in speed.

Operating Limits

5. The VFRS provides reliable flight path data within the following limits:

a. Airspeed — 150 kts to 1,500 kts.

b. Altitude — −1,000 ft to 29,000 ft.

c. Roll — 360°.

d. Pitch — 360°.

e. Vertical Acceleration (G) — −10G to +10G.

f. Flight Path Angle — ±0·1° plus 3% flight path angle.

Associated Equipments

6. There are no operating switches or controls for the VFRS. Associated equipments are:

Associated Equipment	*Function*
Missile Control System AN/AWG-11	Obtains pitch, roll, flight path angle and vertical acceleration from VFRS.
Air Data Computer Set	Provides true airspeed and altitude to VFRS.
Attitude Reference Set (AN/AJB-7)	Receives VFRS pitch and roll attitude, with CSC set to PRIM, for Attitude Director Indicator display.
LCOSS	Receives VFRS roll information with CSC set to PRIM.

Power Supplies

7. Power is supplied to the VFRS direct from a ground power source, or from the aircraft distribution system via the left main 28V DC busbar and left main 115V AC busbar.

AN/AJB-7 — GENERAL DESCRIPTION

Purpose

8. The AJB-7 performs the functions of an all-altitude flight reference system and is able to provide a continuous pictorial display of aircraft attitude through 360° of pitch, roll and azimuth (heading). With the CSC switched to PRIM, the AJB-7 roll and pitch channels act as a standby for the VFRS becoming the primary reference in these two axes when the CSC is switched to STBY. However, the AJB-7 is the only source of heading (magnetic) information to the Flight Director Group, ADI, NCS and MCS.

Components and Function

9. The components of the AJB-7 comprise:

a. A Displacement Gyroscope Assembly which is a 2 gyro, no gimbal lock, all attitude reference, throughout 360° of roll, pitch and yaw. A vertical gyro provides pitch and roll information, and a directional gyro yaw information.

b. A Switching Rate Gyroscope which prevents erection of the vertical gyro to a false gravity vertical and inaccurate azimuth slaving during turn rates of 15° per minute, or greater.

c. A Rate Gyroscope Transmitter which produces a voltage proportional to the rate of turn and drives the rate of turn pointer on the ADI.

d. A Compass Adaptor Compensator is included that receives magnetic heading information from an instrument known as the Compass Transmitter. This heading input is processed in the Compensator and distributed to the ADI and other aircraft systems.

System Input and Output Signals

10. Input signals to the AJB-7 are as follows:

From		*Input Signals to AJB-7*
System	*Component*	*Signal*
VFRS	VFRS Sensor	Pitch and roll (CSC switch to PRIM) for display on ADI.
VFRS	VFRS Computer	Failure of VFRS components to ADI warning flags.
Flight Director Group	FDG Computer	Steering signals to ADI pointers.

11. Output signals from the AJB-7 are as follows:

To		*AJB-7 Output Signals*
System	*Component*	*Signal*
Flight Director Group	FDG Computer	a. Roll b. Magnetic heading
	Horizontal Situation Indicator	Magnetic heading to compass card
	Bearing-Distance-Heading Indicator	Magnetic heading
Flight Control Group	Control Amplifier	a. Pitch b. Roll c. Magnetic heading
TACAN	Receiver-Transmitter	Magnetic heading
NCS	Amplifier Computer	Magnetic heading
MCS	Velocity Signal Computer	Pitch and roll (CSC at STBY) for antenna stabilisation
LCOSS	Lead Computing Amplifier	Roll for reticle roll tabs (CSC at STBY)

Dynamic Errors of the AJB-7

12. The dynamic errors listed are maximum values for aircraft manoeuvring rates of: 40°/sec pitch or 40°/sec yaw, or 300°/sec roll.

Roll angle	25°
Pitch angle	2°
Magnetic heading	2·25° (0·75° static)
DG heading	0·75°/hr
Horizontal Steering	15°
Rate of Turn Indicator	9°/min

Power Supplies

13. The AJB-7 uses power from the 115V AC essential busbar and the 28V AC and 28V DC essential busbars.

CONTROLS AND INDICATORS

Controls and Indicators for the VFRS and AJB-7

14. The controls and indicators relating to VFRS and AJB-7 operation are:

Location	*Control or Indicator*	*Function*
	VFRS ONLY	
Front cockpit right vertical panel	PRIMARY GYRO OFF light	Extinguishes 60 seconds after power on. Illuminates if VFRS fails. May momentarily illuminate during violent manoeuvres due to pendulum erection drag.
Front cockpit left console	CADC RESET/CORR/CORR OFF switch	Engages static pressure compensator (SPC) in CADC. SPC engaged by holding RESET CORR switch until STATIC CORR OFF light extinguishes. NOTE: Outputs from CADC are erroneous until SPC is engaged.
Front cockpit right vertical panel	STATIC CORR OFF light	Illuminates when aircraft electrical system is activated. Extinguishes when CADC SPC is engaged.

Location	*Control or Indicator*	*Function*
	VFRS and AJB-7	
Compass System Controller	PRIM/STBY switch	Selects the source of pitch and roll signals displayed by the ADI and applied to the Missile Control System, and roll to the LCOSS. The PRIM position selects VFRS and STBY selects the AJB-7.
	Mode Switch (COMP-DG-SLAVED and SYNCH)	Selects the mode of operation of the azimuth (heading) system.
	LAT control and N/S switch	The LAT control adjusts for earth rate compensation in the DG mode. The N/S switch is for use in the respective hemisphere of operation.
Attitude Director Indicator	OFF flag	Indicates failure of the VFRS (on PRIM) or AJB-7 (on STBY). Visible, for about 60 secs in the start-up cycle.
	Sphere	Indicates aircraft pitch, roll (from VFRS in PRIM; AJB-7 in STBY) and heading (from AJB-7).
	Vertical director warning flag	Visible only in FDG TACAN mode if TACAN information is unreliable.
	Vertical displacement warning flag	Visible for approx 60 secs after power is applied to VFRS. Thereafter only visible when VFRS fails, and radar is on.
Remote Attitude Indicator (rear cockpit)	Aircraft attitude in pitch and roll	Pitch and roll information supplied direct from AJB-7 only.

PART 4

CHAPTER 3 — RADAR WARNING RECEIVER (ARI 18228/3)

(Issued by AL5)

Contents

Illustrations

Introduction

1. The radar warning receiver (RWR) equipment ARI 18228/3 provides visual and audible warning of illuminating radars in certain frequency bands, and indicates the relative direction and type of radar transmitter, whether track-while-scan (TWS), pulse lock (P) or continuous wave (CW)/interrupted continuous wave (ICW, ie, pulse doppler). Audible warning is given in the headsets of both crew members. Visual indications include warning lights and CRT vector traces on an indicator in the rear cockpit where the system control unit contains the operating switches and built-in-test controls.

Components and Location

2. The system comprises the following main components:

a. A power unit.

b. RF heads.

c. A receiver.

d. A control unit.

e. An indicator.

3. *Power Unit.* The power unit in the upper equipment bay uses 115V 400 Hz single-phase AC to generate the stabilised DC voltages required. Primary 28V DC is routed via the power unit.

4. *RF Heads.* Two RF heads on the tail fin cap, one facing forward and one facing aft, each contain six antennae, the combination of 12 antennae giving a coverage of 360° in azimuth and 45° in the vertical plane. The RF heads, which also contain bandpass filters (for frequency bands E/H, I and J), crystal video detectors and pre-amplifiers, are connected to the receiver by co-axial cables.

5. *Receiver.* The receiver, adjacent to the power unit, processes RF head outputs to provide video and audio signals. The receiver is suppressed by input suppression pulses from Tacan and during UHF radio transmissions.

6. *Control Unit.* The control unit (Fig 1) contains all controls for operating and testing the system. Illumination of the unit facia is by two integral lamps controlled by the aft cockpit instruments light controls.

a. *Power Switch.* When the power switch is set to ON the system is ready for operation in approximately 20 seconds. The switch must be pulled to unlock it when selecting OFF from ON.

b. *Pulse Switches.* Three ALL/ALARM switches, one for each frequency band (E/H, I and J), control the mode of operation of the CRT and audio warning in each band. The ALL position allows a coded CRT trace to be displayed and an

audio tone corresponding to the PRF of the illuminating pulse radar to be heard for any pulsed signal detected in the selected band. At ALARM, only those signals with a PRF, duration and strength above preset levels are CRT-displayed as before; a 2·1 kHz warning tone is heard only if the ALARM ON/OFF switch (para 6 d) is ON.

c. *CW Switches.* Three CW IN/OUT switches, one for each frequency band E/H, I and J, control whether indications of CW illumination in each band are displayed and heard.

d. *ALARM ON/OFF Switch.* For pulsed signals, the 2·1 kHz tone is heard only if the ALARM switch is ON, one or more of the pulse switches is at ALARM, and a signal meeting the threat criteria is detected in one of the selected bands. For CW signals, the same tone is heard only if the ALARM switch is ON and a CW signal is detected within one of the bands selected to CW IN. If the ALARM switch is OFF, full control is retained over the remaining warning functions.

e. *Brilliance Control.* The BRILL control varies the CRT display brilliance.

f. *Dimmer Control.* The DIM control varies the light intensity of indicator lights and CRT translucent front panel.

g. *TEST Selector and Button.* A 12-position TEST selector and button are used to conduct a built-in-test of the system.

7. *Indicator.* The indicator (Fig 1) contains a CRT, six indicator lights and associated circuitry. The CRT has a green phosphor circular screen covered by a translucent panel inscribed with four concentric circles divided into 30° segments by radial lines. The CRT displays coded vector traces, with the radial position indicating relative bearing of the pulse radar transmitter and the vector length giving some indication of relative received signal strength (but see Note). A TWS light at top left of the indicator is lit by a track-white-scan threat signal; similarly, a white P light at top right is operated by a pulse threat signal. A CW threat signal causes the coded illumination of one of four green quadrant lights at each corner of the indicator.

Note: Caution should be exercised in drawing conclusions from comparisons of the length of CRT traces for two reasons. Firstly, signal strength at the receiver depends not only on the range of the source but also its power, and secondly, weak signals are boosted in the RWR in order to allow them to be seen more clearly and may be displayed as longer traces than stronger unboosted signals.

Audio System

8. A PRF VOLUME PASSIVE ECM rotary control on the navigator's left console (post-mod 408) or main instrument panel (post-mod 428) adjusts the volume of audio input from the radar warning receiver to both crew headsets. It is not effective when the audio control switch is set to ALARM. A PASSIVE WARNING PRF AUDIO — ON/OFF switch on the pilot's main instrument panel is used to mute the audio input from the radar warning receiver to the pilot's headset; it is also not effective when the audio control switch is in the ALARM position.

Indications of Illuminating Radar

9. *Visual Indications*

a. *Pulse Signals.* Pulse or track-while scan radars give vector traces on the CRT supplemented by P or TWS light illumination. All signals in a particular band are CRT-displayed with a pulse switch at ALL; at ALARM the CRT remains blank until a signal meeting the threat criteria is received, whereupon all signals in that band are displayed amongst which the threat signal is usually easily identified. Signal frequency bands are indicated on the CRT trace by the following codes:

E/H Dashed trace

I Solid trace

J Dotted trace

b. *CW Signals.* A CW signal causes a green quadrant light to illuminate (provided the CW switch for that band is at CW IN) as follows:

E/H Slow flashing

I Continuous

J Rapid flashing

High priority CW threats lock out lower priority threats regardless of the order in which threats are detected. The order of priority may be altered by a link panel in the receiver.

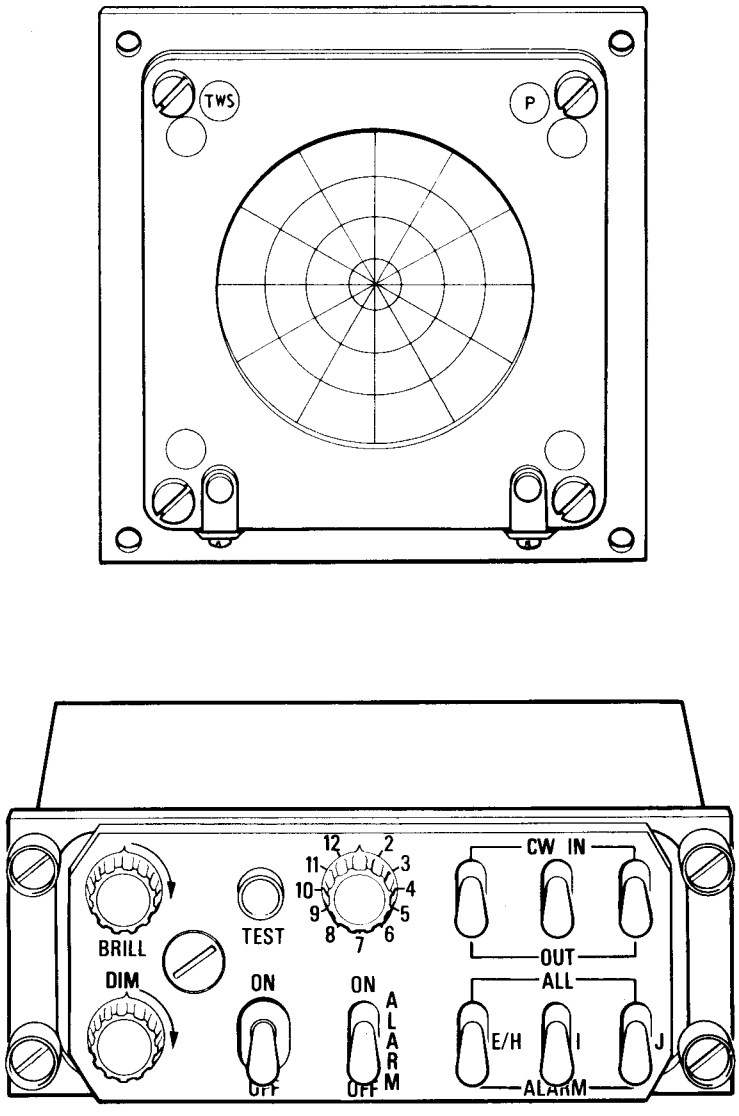
10. *Audible Indications*

a. *Pulse Signals.* With a pulse switch at ALL for any particular band, an audio tone at the pitch of the PRF is heard irrespective of the position of the ALARM switch. With a pulse switch at ALARM, a 2·1 kHz tone is heard if the threat criteria in that particular band are met and the ALARM switch is ON.

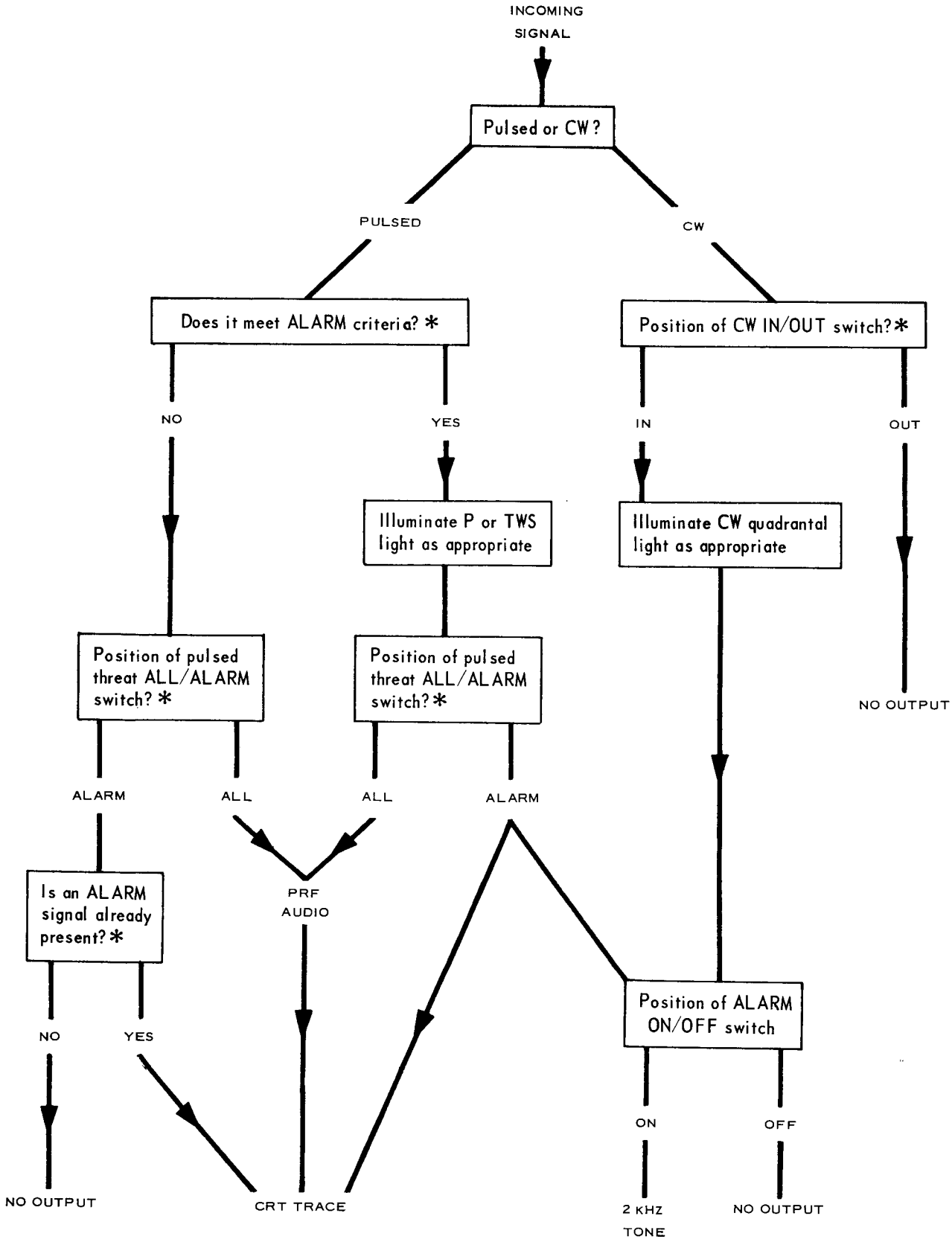
b. *CW Signals.* The CW switch for the illuminating frequency band must be at CW IN and the ALARM switch at ON to produce a 2·1 kHz tone.

11. *Variations.* In practice, the following indications can occur:

a. Selection of CW IN for a particular band both clears the display of video and silences the normal



4 – 3 Fig 1 Control Unit and Indicator



* For the appropriate frequency band

4–3 Fig 2 Flowchart of System Operation

audio in that band (ALARM tone functions normally) for 0·5 seconds in every 1·5 seconds.

b. Exact frequencies at which a particular band begins and ends vary from set to set and signals at frequencies close to changeover points may appear in either the higher or lower band and sometimes in both.

c. When illuminated by an E/H-band, slow-scanning pulse radar, vector coding is not readily apparent and signals tend to appear as a solid line, the code for I band.

d. As the J band signal increases in amplitude, ie, vector length increases, the dots become elongated and appear as dashes.

e. Some signals produce splayed or split vectors, making it difficult to determine the indicated bearing. The mean of an evenly distributed splay or split TWS vector presentation should be taken as the best approximation of bearing. In an asymmetrical splay, the longest vector provides the most reliable guide to threat radar bearing.

Power Supplies

12. With 28V DC and 115V AC RH busbars live, 28V DC is routed from the power unit to the control unit power switch and, with ON selected, to a relay in the power unit to apply 115V AC to start cooling fans in the power unit, receiver and indicator. Power is being correctly applied if the CRT translucent screen is illuminated, as varied by the DIM control.

Pre-Flight Built-in Testing

13. Complete a pre-flight partial BIT as follows:

a.

Power switch	ON
ALARM switch	OFF
CW switches	All CW IN
Pulse switches	All ALARM
TEST switch	1

b. Whilst depressing the TEST button, check that all six indicating lights illuminate at intensities variable via the DIM control, and that RWR signals are not received.

c. Select ALARM switch ON and TEST switch to 7. Press the TEST button momentarily and check that:

(1) The TWS light illuminates and a 2·1 kHz tone is heard after 0·5 seconds and for 3·5 seconds.

(2) A solid vector appears at 0·5-second intervals, twice as a forward vector and twice as a rear vector.

Note: Local radar sufficiently close to the aircraft produces a vector display during test 7 due to breakthrough. The full BIT procedure is in AP 101B-0901-1G.

Summary of System Operation

14. A summary of system operation is given in Fig 2.

Intentionally Blank

PART 4

CHAPTER 4—AIR COMBAT MANOEUVRING RANGE/ INSTRUMENTATION SYSTEM

(Issued at AL8)

Contents

Illustrations

Introduction

1. The air combat manoeuvring range (Fig 1) is used for training in air-to-air combat without firing live weapons. The interceptor is fitted with an airborne instrumentation sub-system (AIS) pod which is tracked by the range. Interceptor flight and weapon system data are transmitted by the pod when interrogated by a ground station on the range. At the ground facility, the data is processed for real-time display to the range training officer and also recorded for playback and display during de-briefing.

2. Weapon firings and missile trajectories are accurately simulated while the interceptor is flown in a typical combat environment. Simultaneously, all manoeuvring action of the interceptor and target is displayed to the range training officer in real-time on ground control consoles. Post-sortie replay on off-line display consoles, permits performance evaluation by both the range training officer and the crews. A typical range covers an airspace of 700 square miles to an altitude of 55,000 feet.

3. The system allows aircrew to recognise weapons envelope boundaries and to observe the results of simulated missile firings against manned high performance aircraft under realistic but controlled air combat manoeuvring engagement conditions. Fig 2 illustrates a typical air combat manoeuvring range/instrumentation system consisting of the following sub-systems:

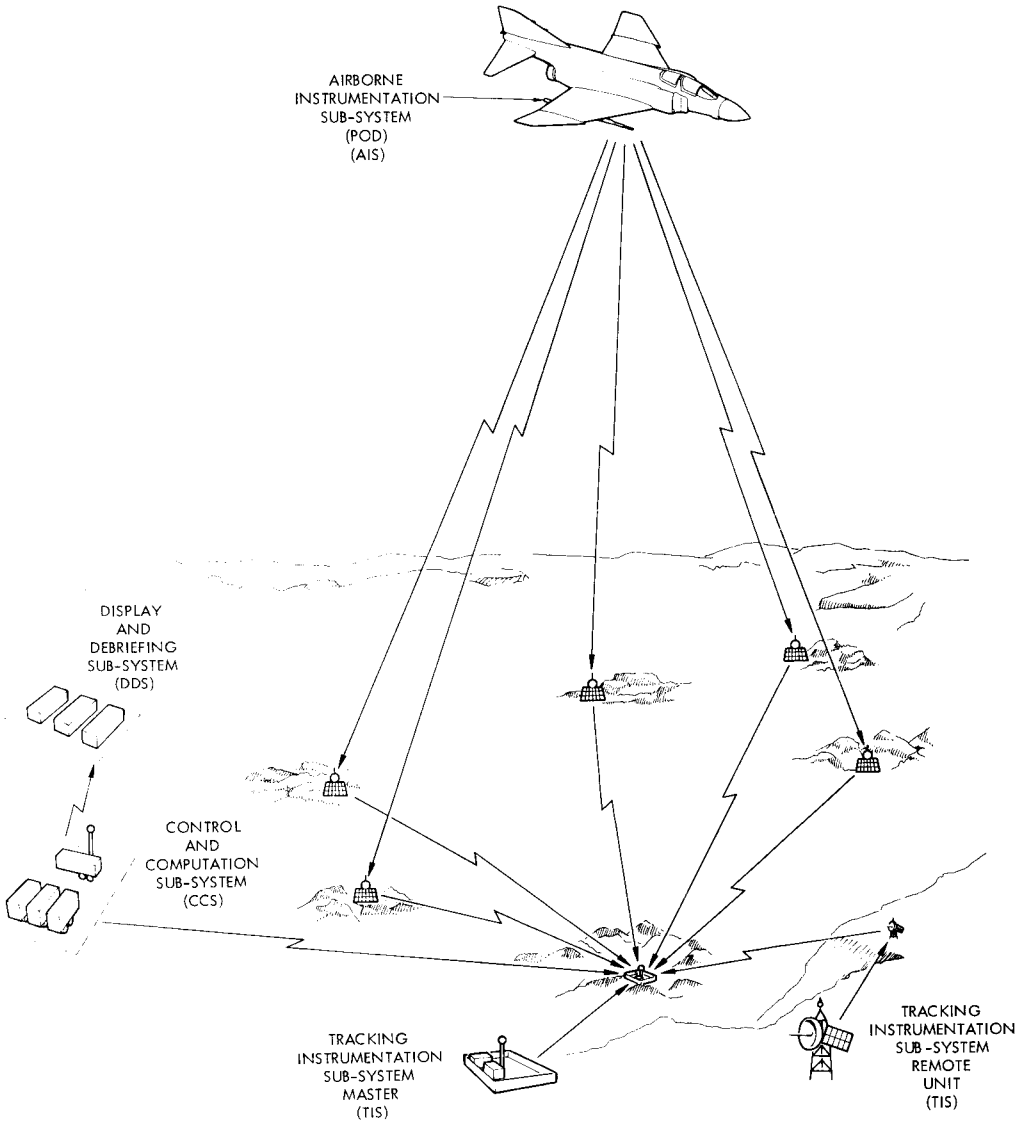
a. Tracking instrumentation sub-system (TIS).
b. Control and computation sub-system (CCS).
c. Display and de-briefing sub-system (DDS).
d. Airborne instrumentation sub-system (AIS).

Tracking Instrumentation Sub-System

4. The TIS contains the distance measuring equipment (DME) which determines aircraft range to each interrogator station for up to 20 aircraft. The TIS also functions as a computer-controlled communication interface between the AIS pod on the aircraft and the CCS. The TIS comprises a master station and up to seven interrogator stations situated on the range. One of the interrogator stations can be co-located at the master station. The remote interrogator stations consist of ground-to-air and ground-to-ground receiver-transmitters. The remote stations relay master station transmissions to all AIS equipped aircraft on the range and relay air-to-ground transmissions back to the master station.

Control and Computer Sub-System

5. The CCS contains computers and communicates with the TIS master station and the DDS. The CCS



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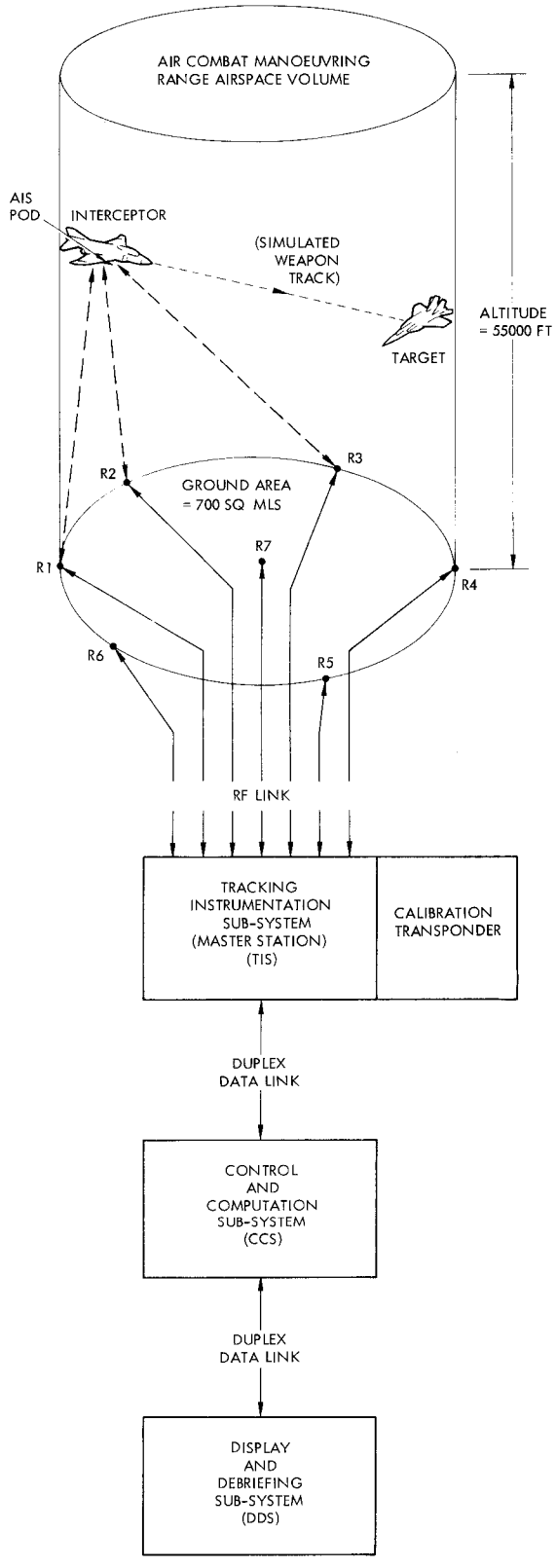
4—4 Fig 1 General Configuration of Air Combat Manoeuvring Range



AIS PODS:

AIRCRAFT INERTIAL SENSOR, AIR DATA, AND WEAPON STATUS DATA

TIS INTERROGATOR STATIONS

1 UP TO SEVEN INTERROGATOR STATIONS R1 TO R7, ONE OF WHICH CAN BE LOCATED AT THE MASTER STATION

2 UPON SELECTION, THE INTERROGATOR STATION INTERROGATES AN AIS POD. ALL INTERROGATOR STATIONS RELAY AIS RESPONSE TO TIS MASTER STATION

TIS MASTER

1 DME AND COMPUTER - CONTROLLED COMMUNICATION INTERFACE

2 RANGE CALIBRATION

CCS

1 PROGRAMME CONTROL OF ACMR FUNCTIONS

2 COMPUTATION OF AIR-CRAFT POSITION, ATTITUDE, VELOCITY AND ACCELERATION

3 WEAPON SIMULATION PROGRAMMES

DDS

1 DUAL CONTROL DISPLAY CONSOLES

2 SELECTABLE CONTROL AREA: LIVE REPLAY

3 ALPHANUMERIC STATUS AND GRAPHIC TRACKING DISPLAYS

PH 11042

4—4 Fig 2 Air Combat Manoeuvring Range/Instrumentation System—Block Diagram

computes aircraft position, velocity, acceleration, attitude and angular rate by processing the range observations from the TIS and the data from the AIS pod.

Display and De-briefing Sub-System

6. The DDS provides graphic and alphanumeric displays for conducting live operations and post-sortie de-briefing. UHF communications are provided so that the range training officer can communicate with aircraft operating on the range. Voice communication is also provided with the CCS and TIS. The DDS consists of two separate display facilities; one for live operations and the other for replay and de-briefing. During live operations, the DDS records all data received from the CCS on magnetic tape for later replay. Live operations and de-briefing can be performed simultaneously.

Airborne Instrumentation Sub-System

7. The AIS is contained within a pod (Fig 3) which is carried on the outboard Sidewinder station of the left inboard pylon. The pod mates with the Sidewinder umbilical connector, which provides the electrical power and weapon system data.

8. The AIS pod is the airborne terminal of the air combat manoeuvring range system. The pod contains a transponder, air date sensor and inertial sensor that provide interceptor flight data for transmission to the ground to determine the position and attitude of the interceptor relative to the air combat manoeuvring range. Further weapon system data are applied to the AIS pod via the umbilical for transmission to the range.

9. The AIS pod operates from standard aircraft power available from the launcher. Each transmission between ground interrogator stations and the AIS pod consists of a digital data message and ranging tones. The AIS pod receives a message from one of the ground interrogator stations and then transmits attitude, velocity, acceleration, angular rate, pressure and aircraft weapon system data.

10. The data transmitted from the ground to the pod contains attitude and velocity component corrections. The attitude and velocity components are derived in the CCS based on range measurements from the TIS, combined with attitude, velocity and pressure components from the pod. The corrections are used to update the inertial reference unit in the AIS pod, and form a closed loop between the AIS, TIS and the CCS.

11. Post-mod 705, 5075 and 5078, the following weapon system data can be applied to the AIS pod for transmission to the range:

a. *Gun.* Trigger press and centreline select.

b. *Sidewinder.* Trigger press, missile audio, acquisition (SEAM) and acquisition L/R (SEAM).

c. *Sparrow/Skyflash.* Trigger press, head aim pitch, head aim yaw and sweep select.

d. *Weapon System.* Master arm.

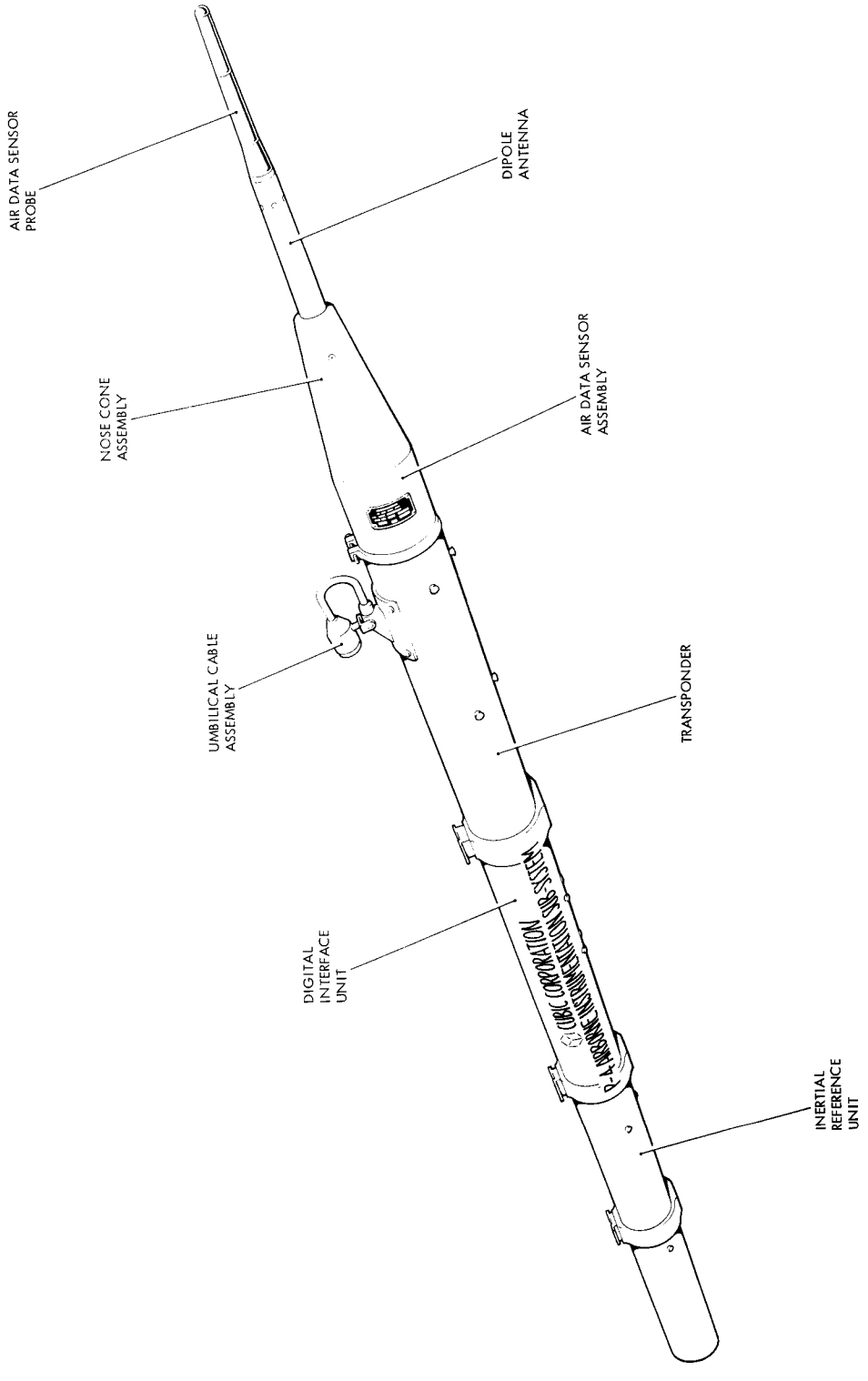
12. To allow the application of the above weapon system data to the AIS pod, the aircraft is to be equipped as follows:

a. Sparrow/Skyflash training missile with a training aid unit (TAU) installed, fitted to the left rear Sparrow/Skyflash station (Station 3).

b. Sidewinder acquisition missile fitted to the inboard station of the left inboard pylon (Station 2).

c. AIS pod fitted to the outboard station of the left inboard pylon (Station 2).

13. Gun, Sidewinder or Sparrow/Skyflash data is selected by the normal weapon system selection switches. For utilisation of the AIS pod with different aircraft modification standards refer to Table 1.



PH 11043

4—4 Fig 3 Airborne Instrumentation Sub-System Pod

Table 1—AIS Pod Utilisation

Modification state	*Station 2*		*Station 3*	*Station 8*		*Remarks*
	Inbd	*Outbd*		*Inbd*	*Outbd*	
Any mod state	AIS pod	—	N/A	—	—	Pod fitted at any station: a. Station with pod not selected; range tracking of interceptor.
	—	AIS pod	N/A	—	—	
	—	—	N/A	AIS pod	—	b. Station with pod selected; range tracking of interceptor and Sidewinder BST data.
	—	—	N/A	—	AIS pod	
Pre-mod 705, 5075 and post-mod 5078 or Pre-mod 705 and post-mod 5075, 5078	Acqn Miss	AIS pod	N/A	Acqn Miss	AIS pod	a. Station with pod selected; range tracking of interceptor and Sidewinder BST data. b. (Pre-SEAM aircraft) station with acquisition missile selected; range tracking of interceptor and Sidewinder BST data. c. (Post-SEAM aircraft) station with acquisition missile selected; range tracking of interceptor and Sidewinder SEAM data.
	—	—	N/A			
Post-mod 705, 5075 and 5078	Acqn Miss	AIS pod	SP/SF training missile with TAU fitted	—	—	a. Station with pod selected; range tracking and Sidewinder BST data. b. Station with acquisition missile selected; range tracking and Sidewinder SEAM data. c. Gun selected; range tracking and gun data. d. Station 3 selected; range tracking and SP/SF data.

PART 4

CHAPTER 5—TELESCOPE SIGHTING SYSTEM

(Issued with AL9)

Contents

Introduction

1. Mod 782 introduces a telescope sighting system (TESS) to improve the daylight capability for identifying aircraft by effectively increasing the visual identification (vis ident) range. Allowance has been made for the possible future addition of a night vision option.

2. To accommodate the TESS in the rear cockpit the transparency in the left cockpit fairing (adjacent to the main instrument panel) is replaced by a new fairing having an aperture to allow the telescope head to protrude into the airstream. With the telescope in position, a locking ring holds the telescope head firmly in the aperture and the body assembly is attached via an anti-vibration mounting to the left side of the rear cockpit main instrument panel. A blank is used to close the aperture when the telescope is not installed.

DESCRIPTION

Construction

3. The TESS (Fig 1) comprises three assemblies which are independently sealed to ensure that internal optical surfaces remain clean during assembly changes and that cockpit pressure is maintained should the outer head be removed or damaged (eg, by a birdstrike). The assemblies are:

a. *Head Assembly*. The head assembly protrudes into the airstream and contains a forward facing window and a 90° prism.

b. *Body Assembly*. The body assembly houses the main part of the optical system consisting of a telephoto lens and a prism. The prism directs the line of sight from the eyepiece via the telephoto lens to the 90° prism in the head assembly.

c. *Eyepiece Assembly*. The eyepiece assembly is angled to the body to facilitate ease of access for the navigator. The assembly contains the exit lens and a 'broken cross' reticule. A flexible rubber eye guard is provided which may be folded back when TESS is being used by an operator wearing an AR 5 respirator.

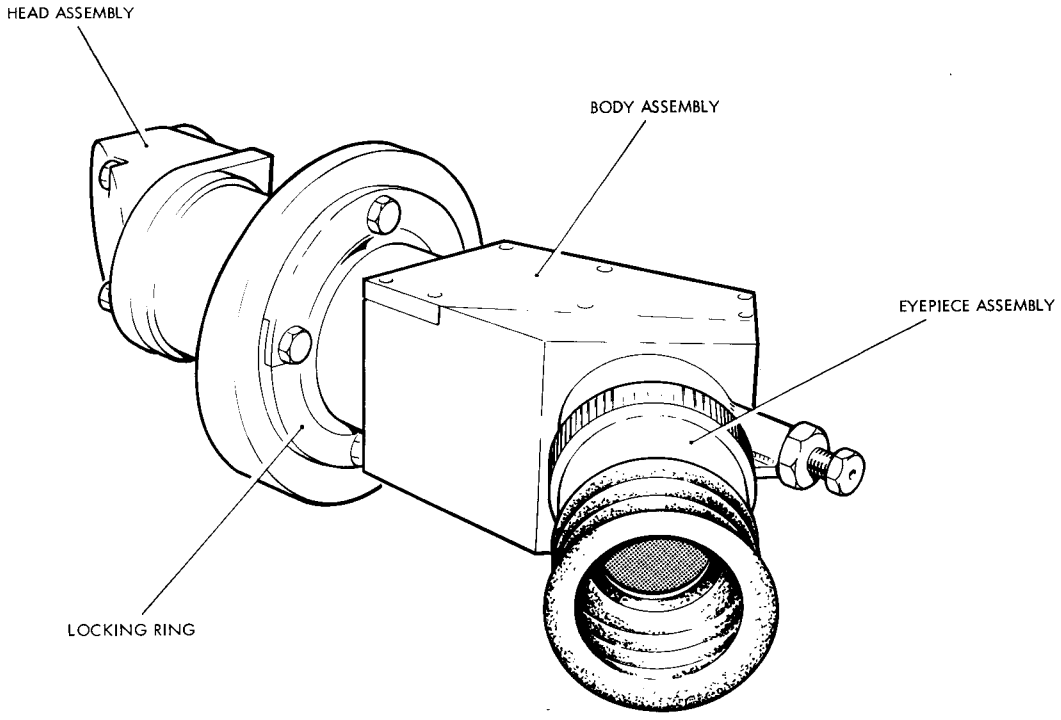
Optical System

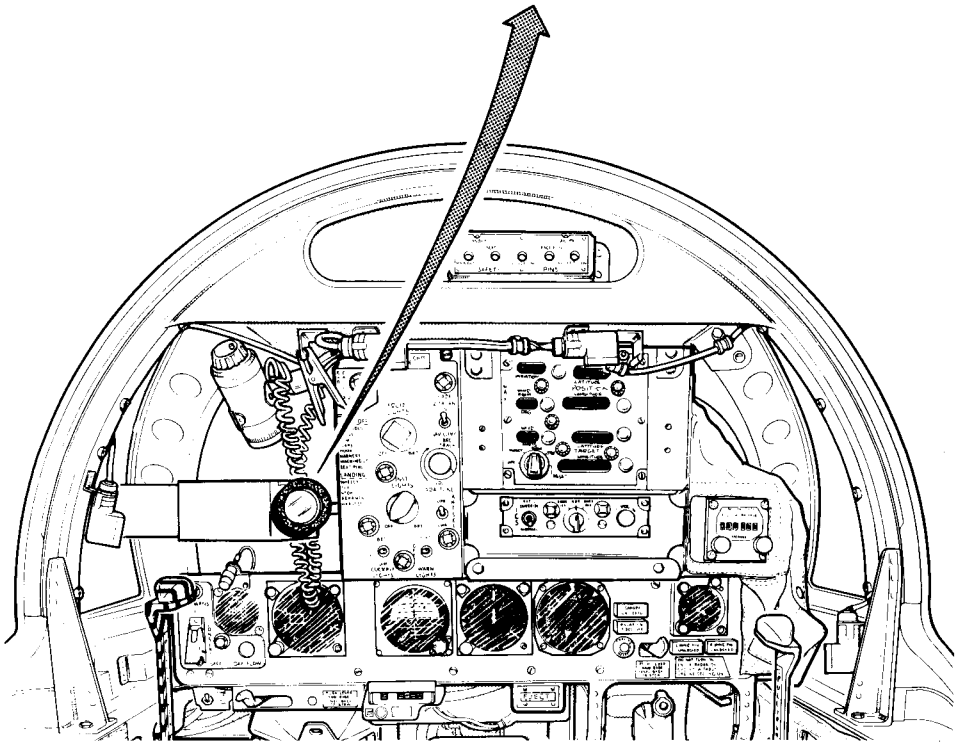
4. The focus of the telephoto lens is fixed at infinity and gives a magnification of x10; the two prisms provide image erection and a line of sight parallel to the aircraft fore and aft axis. The line of sight is adjusted by a harmonisation procedure when the TESS is installed in the aircraft; the head, window and eyepiece assemblies are replaceable without the need for re-alignment. The nominal performance of the system is as follows:

Type:	Monocular.
Magnification:	x10 minimum.
Field of View:	6° minimum.
Exit pupil:	5mm diameter minimum.
Objective focus:	Fixed at infinity.
Eyepiece focus:	Fixed

Operation

5. There are no operating controls. To identify a target, the aircraft should be flown so that the target is boresighted to ensure that it falls within the TESS field of view.





REAR COCKPIT LOOKING FORWARD

PH. 11470

4—5 Fig 1 Telescope Sighting System

PART 5 — NAVIGATION COMPUTER

CHAPTER 1 — NAVIGATIONAL COMPUTER SET

List of Contents

Illustrations

Introduction

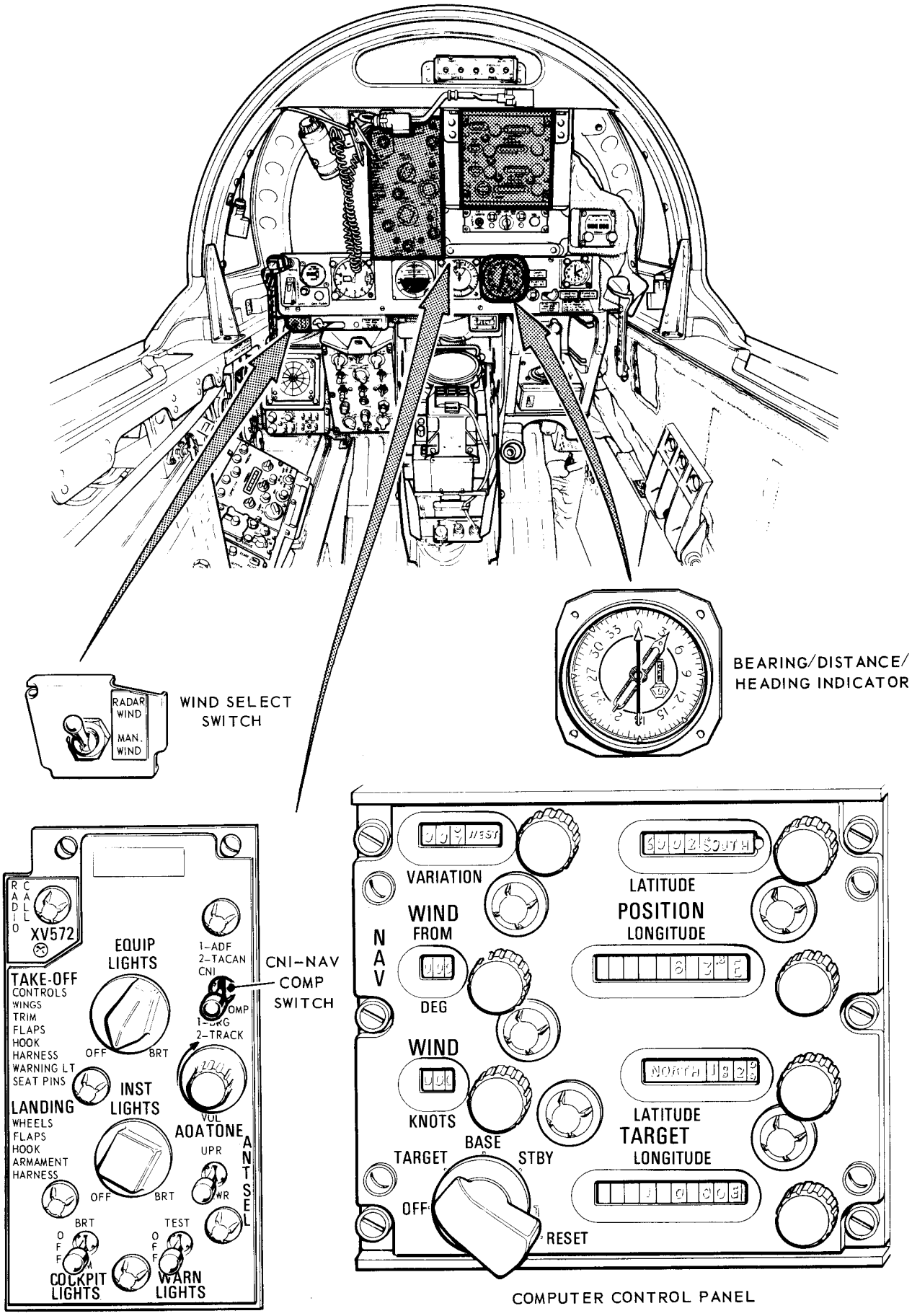
1. The navigational computer set (NCS) AN/ASN-39 is an analogue computer which, given the required inputs, can compute the present position of the aircraft and steering demands to a selected destination.

GENERAL DESCRIPTION

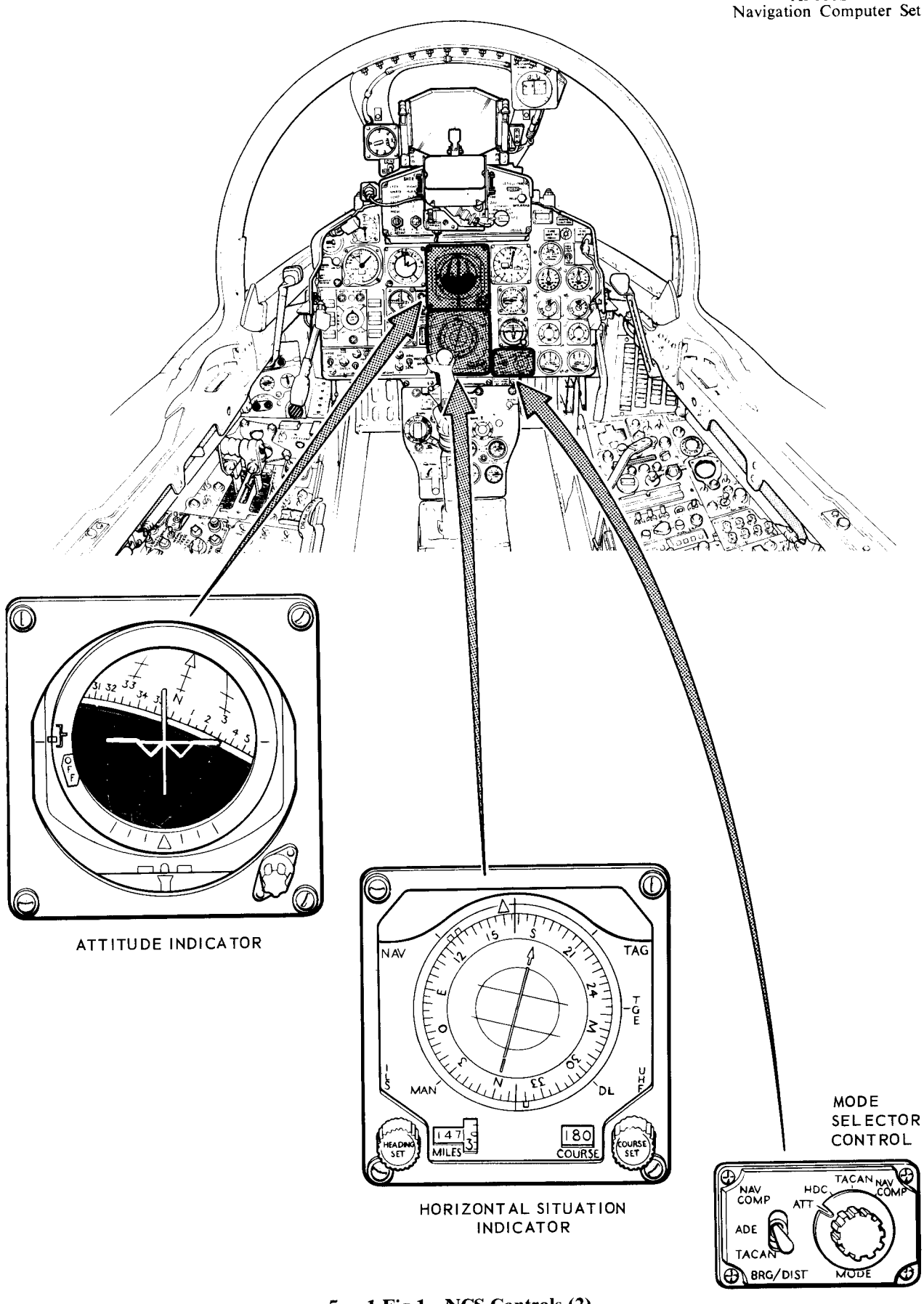
Information Sources and Computations

2. *NCS Inputs.* The required NCS inputs are:

Input	*Supplied by*
Magnetic heading	Attitude Reference Bombing Computer (AJB-7)
Magnetic variation	Manual insertion on the Computer Control Panel
True airspeed	Central Air Data Computer (CADC)
Wind direction	AWG-11 (MCS) for radar wind or manual insertion on the Computer Control Panel
Wind speed	AWG-11 (MCS) for radar wind or manual insertion on the Computer Control Panel
Latitude and longitude of Base	Manual insertion on the Computer Control Panel
Latitude and longitude of Target	Manual insertion on the Computer Control Panel



5 — 1 Fig 1 NCS Controls (1)



5 — 1 Fig 1 NCS Controls (2)

3. *NCS Outputs.* NCS outputs are displayed as follows:

Output	*Displayed At*
Latitude and longitude of aircraft present position	POSITION LATITUDE and LONGITUDE counters on the Computer Control Panel
True ground track relative to true heading (relative ground track or drift angle)	Horizontal Situation Indicator (HSI) in the front cockpit and Bearing-Distance-Heading Indicator (BDHI) in the rear cockpit as magnetic track relative to magnetic heading after resolution in the FDG computer
Great circle bearing from the present position to the preset base or target, relative to true heading (relative bearing)	HSI and Attitude Indicator in the front cockpit and the BDHI in the rear cockpit. Becomes relative to magnetic heading after resolution in the FDG computer
Great circle distance from the present position to the preset base or target	HSI in the front cockpit, and the BDHI in the rear cockpit
True heading and drift angle	To MCS Velocity Signal Computer to resolve radar wind into N-S components

4. *Range of Operation.* The range of operation for the various parameters are:

Parameter	*Range*
Compass heading	0° to 360°
True airspeed	150 to 1500 knots
Magnetic variation	180°E to 180°W
True wind direction	0° to 360°
Wind speed	0 to 200 knots
Distance to Target or Base	1999 nm
Present position, Base or Target latitude	72°N to 72°S
Present position, Base or Target longitude	360° continuously

NOTE: Beyond 72° latitude, the equipment continues to operate but with lesser accuracy as latitude increases.

System Components

5. *Computer Control Panel.* The computer control panel is in the rear cockpit on the left vertical console, Fig 1. The computer mechanisms consist of low inertia motors, linear autosyns, resolvers, a control transformer, a synchro transmitter, mechanical differentials, integrators and interconnecting gearing.

6. *Amplifier-Computer.* The amplifier-computer in the rear cockpit (Fig 1) contains 6 amplifier modules, one component board, 3 servo-mechanisms and a transformer which supplies 22V AC 400 HZ to the servo-motors in the amplifier-computer and the computer control panel. Power supplies of 115V AC 400 HZ, 26V AC 400 HZ and 28V DC are routed through the amplifier-computer to the computer control panel: the function selector in the computer control panel distributes the voltages to both units.

Associated Equipment

7. The following equipment is associated with, but not part of, the NCS:

a. The air data computer (CADC), which supplies TAS.

b. The AJB-7, which supplies magnetic heading.

c. The attitude director indicator (ADI), supplying steering signals from the NCS on the vertical director pointer.

d. The AWG-11 missile control system which supplies radar wind through the RADAR WIND switch.

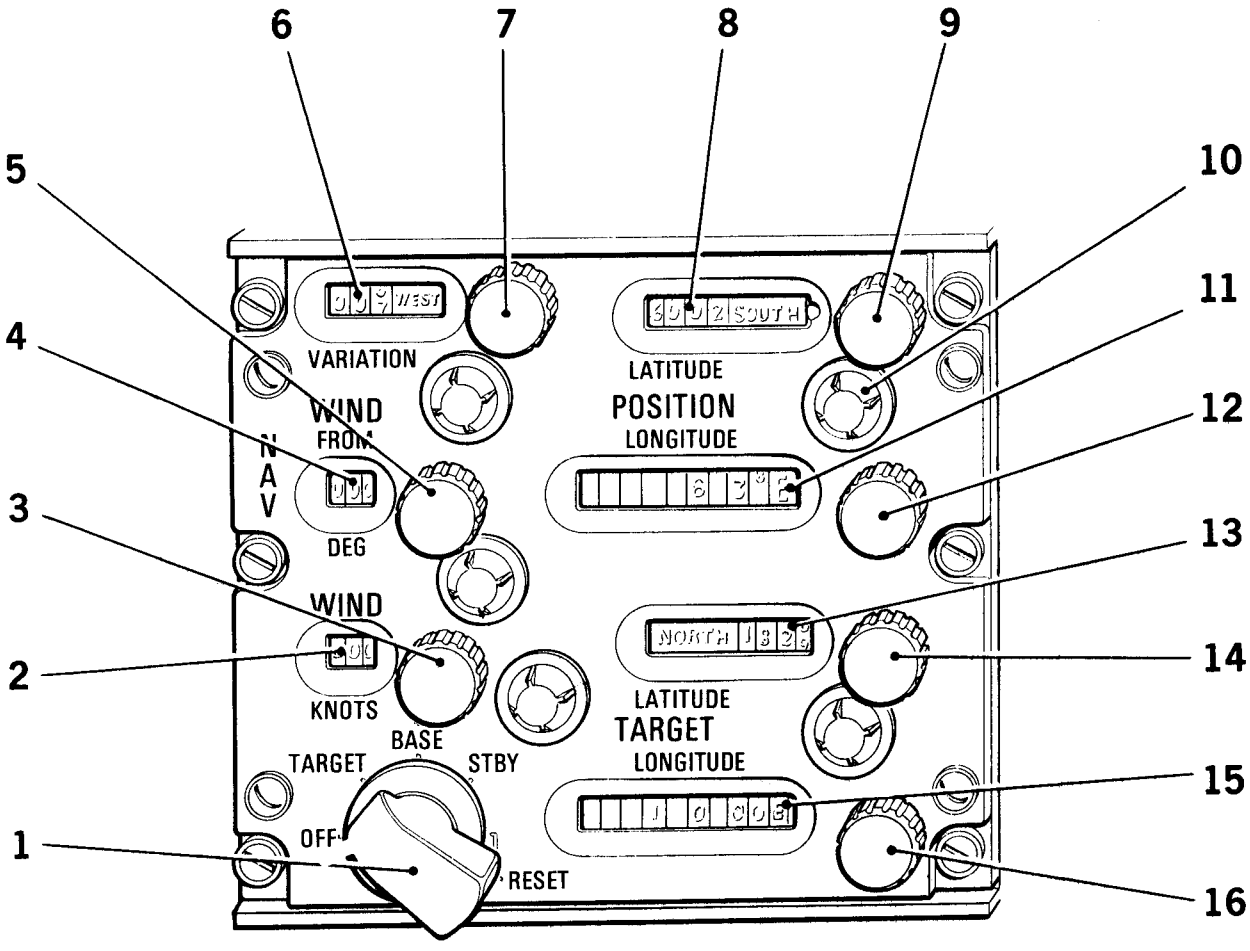
e. The flight director group (FDG) mode control which selects the data source for the HSI and the ADI. The flight director computer processes some NCS outputs.

f. The communication, radio navigation and identification system (CNI) which controls the BDHI displays from the NCS by the CNI-NAV COMP switch.

Controls and Indicators

8. *Computer Control Panel.* The following controls are located on the computer control panel, Fig 2:

Control	*Position*	*Function*
Function selector knob	OFF	Disconnects all NCS power supplies (switch is interlocked with manual release to prevent inadvertent selection of OFF).
	TARGET	Computes steering information from POSITION co-ordinates to pre-selected TARGET co-ordinates.
	BASE	Computes steering information from POSITION co-ordinates to those previously set into the memory circuits in RESET.
	STBY	Power is supplied to the NCS.
	RESET	Cancels previously memorised co-ordinates and memorises current POSITION co-ordinates (interlocked with manual release to prevent inadvertent selection of RESET).
WIND KNOTS counter		Displays manually set wind speed in knots.
WIND KNOTS control knob		Inserts wind speed.
WIND FROM DEG counter		Displays manually set true wind direction in degrees.
WIND FROM DEG control knob		Inserts true wind direction.
VARIATION counter		Displays the manually set magnetic variation in degrees East or West.
VARIATION control knob		Inserts magnetic variation.
POSITION LATITUDE counter		Continuously displays aircraft latitude.
POSITION LATITUDE control knob		Inserts or updates base or present latitude.
POSITION LONGITUDE counter		Continuously displays aircraft longitude.
POSITION LONGITUDE control knob		Inserts or updates base or present longitude.
TARGET LATITUDE counter		Displays target latitude.
TARGET LATITUDE control knob		Inserts target latitude.
TARGET LONGITUDE counter		Displays target longitude.
TARGET LONGITUDE control knob		Inserts target longitude.



1. FUNCTION SELECTOR
2. WIND KNOTS COUNTER
3. WIND KNOTS CONTROL KNOB
4. WIND FROM DEGREES COUNTER
5. WIND FROM DEGREES CONTROL KNOB
6. MAGNETIC VARIATION COUNTER
7. MAGNETIC VARIATION CONTROL KNOB
8. POSITION LATITUDE COUNTER
9. POSITION LATITUDE CONTROL KNOB
10. PANEL LAMP (FIVE)
11. POSITION LONGITUDE COUNTER
12. POSITION LONGITUDE CONTROL KNOB
13. TARGET LATITUDE COUNTER
14. TARGET LATITUDE CONTROL KNOB
15. TARGET LONGITUDE COUNTER
16. TARGET LONGITUDE CONTROL KNOB

5 — 1 Fig 2 Computer Control Panel

1B-0901-1

9. *Miscellaneous Controls.* The following controls and indicators are related to, but not part of, the NCS:

Control	*Location*	*Function*
CNI-NAV COMP switch	Main instrument panel in rear cockpit	Selects either TACAN/ADF or NCS data for BDHI display.
BDHI		Displays bearing, distance, heading, ground track and drift information.
RADAR WIND-MANUAL WIND switch	Left vertical panel in rear cockpit	Selects either RADAR WIND or MANUAL WIND for the NCS.
HSI	Main instrument panel in front cockpit	Displays range, bearing, distance, ground track and heading information.
ADI		Displays bearing and steering information.
MODE selector knob—NAV COMP		FDG uses NCS output to compute ground track and command heading.
BRG/DIST switch —NAV COMP		Selects NCS range and bearing data for HSI display.

Present Position Computer

10. The present position computer (PPC) is a group of servo-mechanisms contained in the computer control panel with their amplifiers in the amplifier-computer. The PPC receives magnetic heading from the AJB-7 and TAS from the CADC. Magnetic variation and the latitude and longitude of the starting position, the base and destination are set manually. Wind speed and wind direction can be set manually or exceptionally, fed automatically from the APG-60 radar set. The PPC resolves and adds true airspeed and wind velocity vectors to derive cartesian components of aircraft ground speed which are integrated with respect to time to produce distance and converted to change of latitude and longitude. The north-south mileage is converted directly into degrees and minutes of latitude and passed to the POSITION LATITUDE counters, whilst the east-west mileage is multiplied by the secant of present latitude and the modified mileage converted to degrees and minutes of longitude and passed to the POSITION LONGITUDE counters. The PPC thus continuously computes the change in latitude and longitude from pre-selected or updated datum co-ordinates to provide continuous indication of aircraft present position.

Track and Distance Computer

11. Track and distance computation is the solution of the spherical triangle (each side of which is a segment of a great circle) formed on the earth's surface by the geographic north pole (true north), the present position, and the pre-selected target or base. Latitude and longitude of base and target are inserted using the POSITION and TARGET controls. The base co-ordinates are retained by memory circuits and, as aircraft present position is available continuously from the PPC, 2 sides of the spherical triangle and the angle between them are known making it possible to solve for the third side and angle representing the great circle distance and the great circle bearing or track angle respectively.

Power Supplies

12. The NCS is powered by 115V AC 400 HZ and 28V DC. Circuit breakers for these services are located on the right-hand rear cockpit wall.

PART 5 — NAVIGATION COMPUTER

CHAPTER 2 — MANAGEMENT OF THE NAVIGATION COMPUTER SET

List of Contents

Pre-Start Checks

1. To set up the system for flight:

Function switch	RESET
VARIATION	Set variation
WIND KNOTS	Set to forecast wind speed
WIND DEG	Set to forecast direction
TARGET LAT : LONG counters	Set to target co-ordinates
POSITION LAT : LONG counters	Set to the co-ordinates of final destination

If final destination is different from start point:

Function switch	STBY
POSITION LAT : LONG counters	Set to start point co-ordinates
Function switch	OFF

After Engine Start

2. Function switch — STBY

After Take-off

3. Function switch — TARGET
CNI—NAV COMP switch — NAV COMP

In-Flight Procedures

4. *Position Updating.* Present position may be updated at any time with the function switch in STBY, TARGET or BASE. All that is required is to set the POSITION counters to the geographical co-ordinates of a fix derived visually, from either of the radar mapping modes, or from TACAN range and bearing.

NOTE: Memory of the co-ordinates of final destination or base is lost if the function switch is put to RESET in flight.

5. *Variation.* Variation may be updated at any time the function switch is in STBY, TARGET or BASE by setting the VARIATION counter to the local value at the aircraft's known, or assumed, position.

6. *Wind Updating*

a. *Radar Wind.* With the RADAR WIND/MAN WIND switch in the RADAR WIND position, wind information to the NCS is supplied from the APG-60 radar. The Radar Set Control switches should be set as follows:

(1)	Function switch	OPR or EMER
(2)	PD SRCH switch	VEL
(3)	MODE switch	PD
(4)	AZ switch	WIDE
(5)	ANT switch	NORM
(6)	RANGE switch	Any position

The radar updates the wind every two minutes but, as this information is derived solely from

antenna co-ordinates, it is not accurate and navigational data produced from it should be treated with the utmost caution. Radar wind updating is not possible in any mode other than PD.

b. *Manual Wind.* Selection of MAN WIND at the RADAR WIND/MAN WIND switch disables the APG-60/NCS slaving and allows the insertion of manual wind into the navigation computer.

Navigation Displays

7. *Front Cockpit.* When the MODE and BRG/DIST switches on the Flight Director Group selector panel are both set to NAV COMP:

a. The HSI displays:

(1)	Lubber line	Magnetic heading
(2)	Course pointer	Magnetic track
(3)	Course counter	Magnetic track
(4)	Command heading marker	Magnetic heading to destination
(5)	Bearing pointer	Magnetic bearing to destination
(6)	Distance counter	Distance (in nms) to destination

b. The ADI displays:

Vertical direction pointer	Steering indication to destination

8. *Rear Cockpit.* With the CNI-NAV COMP switch at NAV COMP, the BDHI displays:

a.	Lubber line	Magnetic heading
b.	Single bar pointer	Magnetic bearing to destination
c.	Double bar pointer	Magnetic track
d.	Distance counter	Distance (in nms) to destination

PART 6

CHAPTER 1—ARMAMENT CONTROLS

Contents

Illustrations

Introduction

1. The weapons system comprises the missile system and the SUU-23A gun pod. Several switch panels and the trigger on the pilot's control column enable the crew to select, fire and/or jettison the various weapons. Many controls have interrelated functions. To avoid confusion and duplication, each panel with its relevant switches is described in this Chapter. The power supplies for the weapon system are taken from all available busbars except the right main 28V AC and 14V AC and left main 28V AC busbars.

EXTERNAL SAFETY SWITCHES

Undercarriage Control Handling Safety Switches

2. When the undercarriage control handle is in the GEAR DOWN position, the emergency stores and armament safety switches prevent inadvertent ground arming of weapons and/or release of centre-line mounted stores. These switches are tripped when the control handle is moved to the GEAR UP position.

3. *Armament Safety Switch.* With the undercarriage control handle in the GEAR UP position and the MASTER ARM switch set to ARM, the armament safety switch connects 28V DC from the right main busbar to the armament busbar. In the GEAR DOWN position all power is removed from the armament busbar.

4. *Emergency Stores Switch.* The emergency stores switch connects 28V DC from the essential busbar to the EXT STORES EMER REL button.

5. *Port Main Undercarriage Scissor Switch.* In the port main undercarriage bay a sealed unit plunger switch at the upper scissor link of the undercarriage leg is closed (plunger is pushed in) when aircraft weight is off the undercarriage, ie strut fully extended, to

connect 28V DC from the essential busbar to the EXT STORES EMER REL button, bypassing the undercarriage handle safety switch to permit weapon jettisoning with undercarriage down.

FRONT COCKPIT

Armament Safety Override Button

6. The ARMAMENT SAFETY OVERRIDE button (Fig 1), operates a plunger on three individual double pole switches ganged together by a common plunger shaft. When the undercarriage control handle is in the GEAR DOWN position and the button is pressed, the armament safety switch in the control handle is electrically bypassed and 28V DC is connected from the right busbar to the holding coil of the switch, keeping it depressed. The holding coil is de-energised and the ARMAMENT SAFETY OVERRIDE button returns to the original position whenever:

a. External power is disconnected.

b. The ARM BUS CONTROL circuit breaker (D11 on No 1 panel) is pulled and reset.

c. The undercarriage control handle is in the GEAR UP position.

Auxiliary Armament Control Panel

7. The auxiliary armament control panel (Fig 1) contains the SIDEWINDER COOLANT CONTROL switch, the AURAL TONE CONTROL knob and, post-mod 649, 656 and 658, the SIDEWINDER MODE switch and CAL light. The COOLANT CONTROL switch initiates cooling of the missile seeker head when ON is selected provided the armament busbar is energised. Cooling is also initiated through the normally closed contacts of the switch when the MSLS GUNS switch is placed to SW. The AURAL TONE CONTROL knob regulates the volume of the aural tone from the Sidewinder missile. When BST is selected on the BST/SEAM/CAL MODE switch, the reversionary Sidewinder boresight mode is engaged and the SEAM power is switched off. This position is normally used when SEAM failure occurs. The SEAM position on the MODE switch may be considered the normal mode switch selection. In this position the SEAM circuitry is energised and either slave or scan modes of missile operation are automatically selected, dependent upon whether the missile control radar is locked-on or not. When CAL is selected, Sidewinder missile seeker head calibration is initiated. During calibration, the SIDEWINDER CAL light illuminates steadily; it flashes when calibration is complete, at which point SW REJECT should be selected on the MSLS/GUNS switch to initiate calibration of the next missile.

Fuel Control Panel

8. The fuel control panel (Fig 1) incorporates two guarded STORES JETTISON switches for selective jettison of stores or fuel tanks from the outboard wing and centreline stations. The outboard wing pylons are jettisoned by selecting the OUTBD switch up whatever the position of the undercarriage control handle or the undercarriage. The centreline Multiple Weapons Adapter and fuel tank or stores are jettisoned by selecting the CTR switch forward, but the undercarriage control handle must be in the GEAR UP position or the port main oleo must be fully extended to make the scissors switch.

External Stores Emergency Release

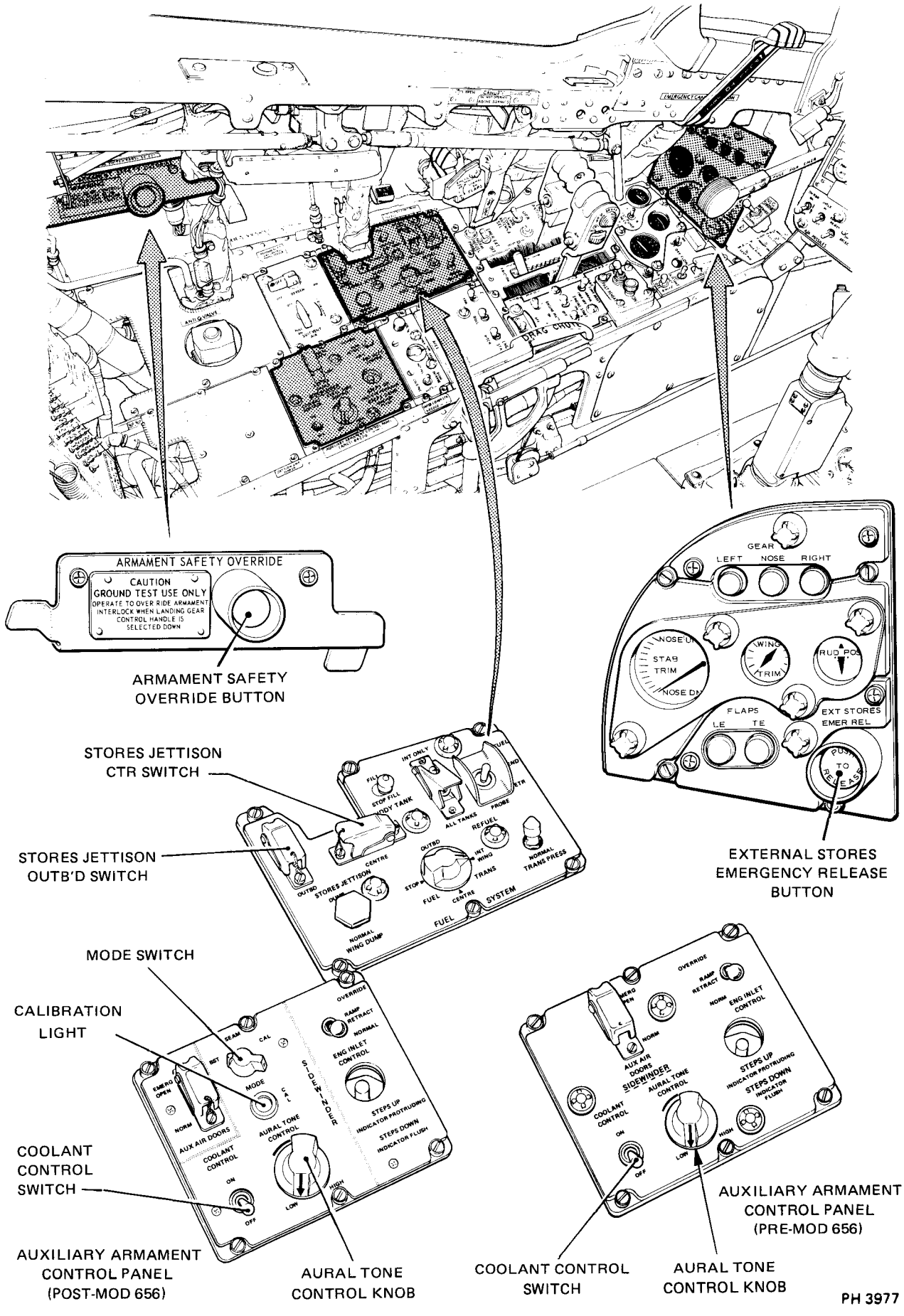
9. The EXT STORES EMER REL button (Fig 1) jettisons the wing pylons, fuselage mounted missiles and applicable stores on the centreline rack by connecting 28V DC from the essential busbar to the emergency stores switch when the undercarriage is up, or, when the undercarriage is down (strut extended), through the scissors switch to the EXT STORES EMER REL button.

Missile Status Panel

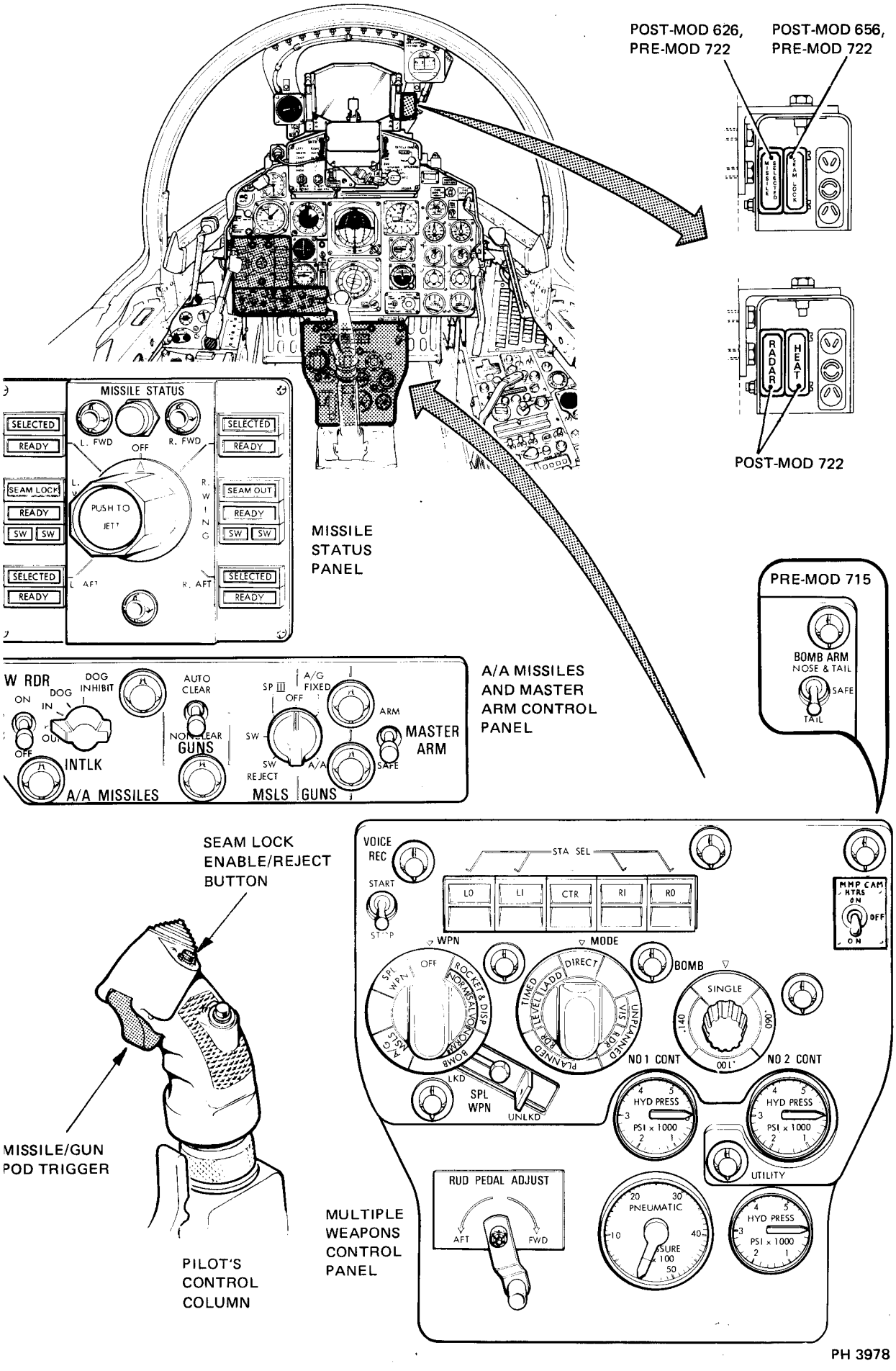
10. The missile status panel (Fig 2) has a selective jettison button, 16 missile status lights, and a TK light which indicates carriage of a 500-gallon centre-line fuel tank. Post-mod 649, 656 and 658, two of the missile status lights are replaced by a SEAM LOCK and a SEAM OUT light.

11. The state of Skyflash/Sparrow missiles carried is indicated by eight FWD and AFT SELECTED and READY lights. With the CW RDR switch ON, the MASTER ARM switch SAFE and the radar FUNCTION switch set to a transmitting mode, the missiles begin to tune; when successfully tuned the SELECTED lights illuminate steadily. The associated READY lights illuminate only when the MASTER ARM switch is selected to ARM. Forward fuselage-mounted missiles cannot be selected, fired or jettisoned if the TK light is illuminated. If a missile does not tune (SELECTED light not illuminated), the next missile in the firing sequence is fired when the trigger is depressed provided the SELECTED and READY lights for that missile are first illuminated.

12. The state of Sidewinder missiles is indicated by four SW lights and the L and R WING READY lights which illuminate for the next available missile in the firing sequence when the MASTER ARM switch is selected to ARM, and the MSLS-GUNS selector is set to SW. A subsequent station is manually selected using the spring-loaded SW REJECT position, repeating this procedure until the desired SW and READY lights illuminate. Normally the firing circuits step to the next available station whenever the trigger is operated and released. Post-mod 649, 656 and 658, the SEAM LOCK light above the L WING READY light illuminates during SEAM operation to indicate that a successful IR lock has been achieved. The SEAM OUT light above the R WING READY light



6 – 1 Fig 1 Front Cockpit Left Console



6—1 Fig 2 Front Cockpit Armament Controls and Indicators

◀ *(Mod 722 incorporated)* ▶

illuminates to indicate either that BST has been selected on the SIDEWINDER MODE switch (ie, SEAM circuits de-energised) or that the SEAM BITE has detected a fault.

13. To selectively jettison any missile, the PUSH TO JETT knob is rotated to the required missile station and the knob centre depressed. When wing missiles are dropped, both missile and pylon are jettisoned. Fuselage missiles are jettisoned by firing the missile ejectors. The missiles remain unarmed and the rocket motors do not ignite on jettison. The JETTISON SAFETY switch in the rear cockpit must be set to READY before missiles can be jettisoned.

A/A Missiles and Master Arm Control Panel

14. The A/A missiles and master arm control panel (Fig 2) contains a CW RDR switch, a Skyflash/Sparrow INTLK switch, AUTO CLEAR/NON CLEAR switch, MASTER ARM switch, and a MSLS-GUN selector switch. They control missile and CW illuminator power, interlock selection, DOG-fight mode selection, gun clearing, weapon arming, and missile or gun selection.

15. *CW Radar Switch.* The CW RDR switch has three positions, ON/STBY/OFF. The OFF position removes power from the Skyflash/Sparrow missile control and firing circuits and turns off the CW transmitter. The STBY position applies power to preheat the missiles. The ON position energises the CW transmitter if the FUNCTION switch on the radar set control is in any position but OFF, TEST 1 or B + OFF, and activates the tuning drive and launching circuits. CW transmissions cannot be made with the aircraft weight on the undercarriage. The CW RDR switch must be at OFF to allow pulse mode transmissions on the ground.

16. *Interlock Selector.* The INTLK selector controls the Skyflash/Sparrow interlocks and modes. At IN, the aim dot must be within the ASE circle with the IN RNG light on the ODU illuminated before the missile can be launched. However, the interlocks are bypassed if locked on within 5 NM range, when operating in the Pilot Lock mode (PLM) or if not locked on in the BST mode. The OUT position bypasses the interlocks. In the DOG or DOG INHIBIT position, the interlocks are out. DOG manually selects the short range (dogfight) mode for Skyflash/Sparrow missiles and DOG INHIBIT inhibits the dogfight mode in any flight conditions (see CD 101B-0901 & 2-15D).

17. *Weapons Selector Knob.* Three of the positions on the MSLS-GUNS selector, SPIII, SW and SW REJECT, apply to the missiles; A/G FIXED and A/A apply to the gun (only fitted to ex-RN aircraft post-mod 457/671). The OFF position removes power from missile select relays, disables the missile launching circuits and renders the gun safe.

a. The SPIII position selects Skyflash/Sparrow missiles for firing and switches the fire control computers to Skyflash/Sparrow functions. The SW position selects Sidewinder missiles for firing and switches the fire control computers accordingly, and also activates the cooling of the seeker heads if the COOLANT CONTROL switch is in the OFF position. The spring-loaded SW REJECT position steps the magnetic sequencing switch to the next Sidewinder station each time it is actuated and released.

b. The A/G FIXED position is not used in flight. The A/A position selects guns and the LCOSS computes the lead angle and positions the reticle.

18. *Gun Clear Switch.* The GUNS AUTO CLEAR/NON CLEAR switch selects the gun mode of operation. The NON CLEAR mode is used when the gun is to be fired in short bursts. When the trigger is released the barrel assembly spins down, some rounds are ejected overboard but all the barrel chambers are loaded ready for the next firing burst. In AUTO CLEAR unfired rounds are ejected overboard. As the barrel assembly decelerates, the barrel chambers are left empty and remaining rounds are held in the feed chute. When a 'last round' switch is operated the gun automatically reverts to the AUTO CLEAR mode. After firing with NON CLEAR selected but with a not yet empty storage drum a final burst should be fired in AUTO CLEAR to clear the gun.

19. *Master Arm Switch.* The MASTER ARM switch has two positions, SAFE and ARM. At SAFE, the armament busbar is de-energised to prevent normal release of all weapons. At ARM, the armament busbar is energised, if the undercarriage handle is up, and release voltages are supplied to all weapons systems. The switch is normally left at SAFE until just before weapon release.

Multiple Weapons Control Panel

20. The multiple weapons control panel (Fig 2) contains five STAtion SELector buttons, BOMB ARMing switch, WPN selector knob, delivery MODE selector knob and BOMB interval selector knob. All controls except the STAtion SELector buttons are redundant in the air-to-air role. In the missile monitoring pod role (post-mod 5059 and 5062), the BOMB ARMing switch, with positions NOSE & TAIL/SAFE/TAIL, controls the missile monitoring pod camera heaters. Post-mod 715, the switch is re-labelled MMP CAM HTRS, ON/OFF/ON, and is re-wired to operate independently of MASTER ARM switch settings.

21. *Station Selector Buttons.* The five STA SEL push-on/push-off buttons are labelled LO (left outboard), LI (left inboard), CTR (centre), RI (right inboard) and RO (right outboard). The top half of the buttons illuminate (green) when power is supplied to

the aircraft. Pre-STI/PHANTOM/456 the bottom half of each button is illuminated (amber) when the button is pushed-on to select the station, regardless of the position of the MASTER ARM switch or the weapon load configuration. The amber light is extinguished when the station is de-selected.

22. *Weapon Selector Switch.* The WPN selector switch must invariably be selected to OFF; all other positions are not used in the air-to-air role. The delivery MODE switch is ineffective when the WPN selector is OFF.

Pilot's Miscellaneous Controls and Indicators

23. The trigger on the pilot's control column is used to fire the missiles and the SUU-23A gun pod. Post-mod 626, pre-mod 722 a MISSILE SELECTED repeater light adjacent to the AOA indexer light illuminates when a Sparrow/Skyflash missile is selected. On post-mod 722 aircraft the MISSILE SELECTED repeater is replaced by a RADAR light which indicates that the Sparrow/Skyflash missile is ready for launching subject to interlock limitations. Post-mod 649, 656, 658, pre-mod 722 the stores release button on the control column is pressed to acquire SEAM lock and pressed again to break SEAM lock, and a SEAM LOCK repeater light adjacent to the AOA indexer light illuminates when a successful IR lock has been achieved. Post-mod 722 the SEAM LOCK repeater is replaced by a HEAT light which indicates that a Sidewinder missile is ready for launching.

REAR COCKPIT

Jettison Safety Switch

24. A jettison safety switch, labelled IN/BD-OUT/BD PYLONS & MISSILE JETTISON SAFETY SWITCH—READY/SAFE above the No 1 circuit breaker panel on the right-hand rear cockpit wall controls the jettison circuits to prevent unintentional jettison. The switch must be set to READY before flight to permit stores to be jettisoned from any station.

JETTISON

Emergency Jettison

25. The term 'jettison' means the ejection of weapons, multiple weapons adapters (if fitted) and the wing station pylons. Depressing the EXT STORES EMER REL button simultaneously ejects centreline multiple weapons adapter, inboard and outboard wing station racks and pylons, and fuselage mounted missiles, provided the undercarriage control is in the UP position (the emergency stores switch closed), or the weight of the aircraft is off the undercarriage (to close the scissors switch on the left main undercarriage strut). Additionally, the jettison safety switch in the rear cockpit must be set to READY.

Selective Jettison

26. The following methods of selective jettison are possible:

a. The centreline fuel tank or gun pod, and the multiple weapons adapter can be jettisoned by selecting forward the STORES JETTISON—CTR switch on the fuel control panel. The undercarriage control handle must be in the UP position and the jettison safety switch must be at READY.

b. The left, or right, inboard pylons and carried weapons can be jettisoned separately by positioning the missile jettison selector on the MISSILE STATUS panel to L WING or R WING, as appropriate, after first checking that the jettison safety switch is at READY before pressing the PUSH TO JETT button.

c. The outboard wing pylons and carried stores are jettisoned together by positioning the STORES JETTISON—OUTBD switch, on the fuel control panel, to up. The jettison safety switch must be at READY.

d. Each fuselage-mounted missile can be jettisoned individually by selecting L FWD, R FWD, L AFT, or R AFT at the MISSILE STATUS panel and pressing the PUSH TO JETT button, having ensured that the jettison safety switch is first set to READY.

PART 6

CHAPTER 2—PYLONS AND MISSILE LAUNCHERS

Contents

Illustrations

Introduction

1. The weapons systems enable the aircraft to carry, fire or jettison air-to-air missiles and a gun pod; external fuel tanks can also be carried. There are nine weapon/fuel suspension points; stations 3, 4, 6 and 7 are exclusive to the Skyflash/Sparrow missile (Fig 1). Fig 2 shows the stores loading and adapters.

SUSPENSION EQUIPMENT

General

2. The aircraft suspension equipment comprises:

a. *Fuselage Stations (No* 3, 4, 6 *and* 7).
Aero 7A missile launcher (for Sparrow/Skyflash missile) or cover assemblies.

b. *Inboard Wing Stations* (*No* 2 *and* 8).
Inboard pylon with two LAU 7A missile rail launchers (for Sidewinder missile).

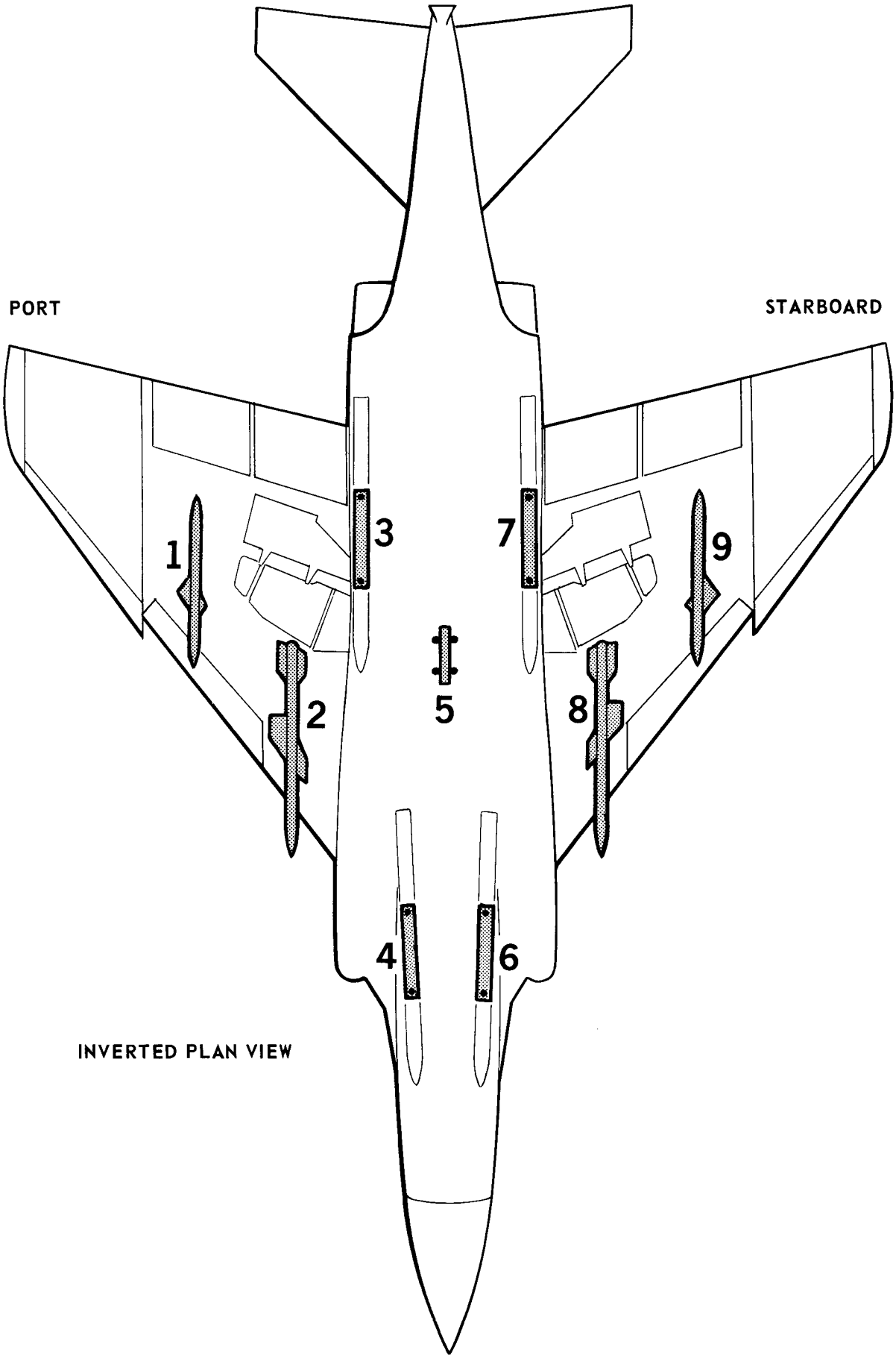
c. *Outboard Wing Stations* (*No* 1 *and* 9).
Outboard pylon (for fuel tank or missile monitoring pod).

d. *Centreline Station* (*No* 5).
Aero 27A bomb rack Mk 1 for fuel tank or with an MWA for the gun pod.

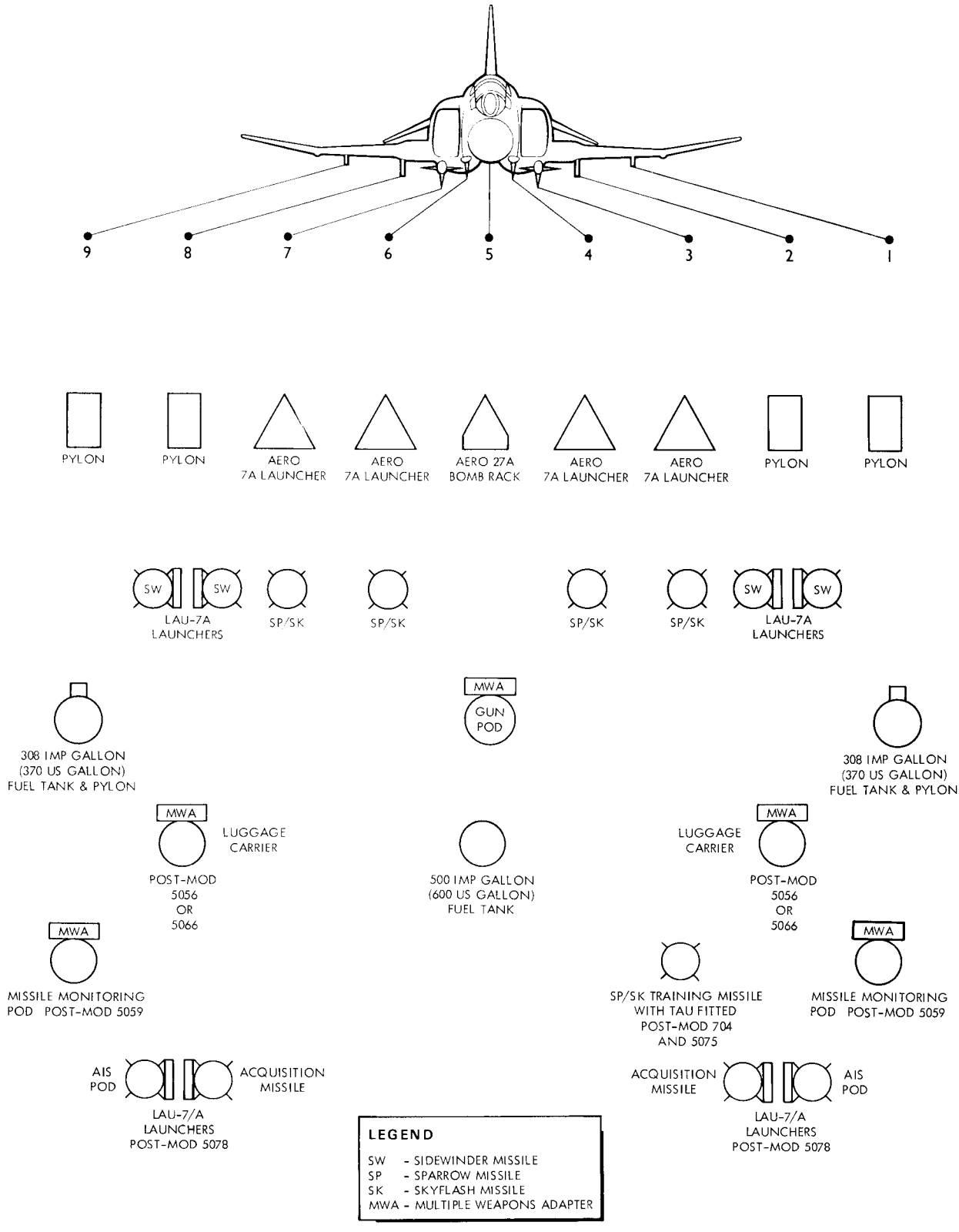
Pylons

3. *Outboard Pylons.* Outboard pylons are attached to wing stations 1 and 9. The suspension and release mechanism consists of a hook at the front end which engages with a retractable wing support fitting lug. A bearing pad at the centre of the pylon holds it in correct alignment. A recess at the rear of the pylon engages a restraint post. An electrical plug assembly routes aircraft power through the pylon to the jettison cartridges. Radhaz filters, between the cartridge contacts and the safety pin switch, suppress RF interference which could cause accidental detonation of the ejector cartridges.

4. *Inboard Pylons.* Inboard pylons are fitted to wing stations 2 and 8. The front end of the pylon is attached to the wing by an explosive bolt screwed into the wing. The cartridge may be removed from the bolt without removing the pylon. The aft end of the pylon is supported by a mounting cam which allows 11° nose-down rotation of the pylon on jettison. Electrical power is fed to Sidewinder firing relays and jettison cartridges and through the pylon to the LAU 7A missile launchers. On post-mod 5078 pylons, an AIS pod adapter cable is installed, which enables the carriage and operation of an AIS pod and Sidewinder acquisition missile. The Sidewinder acquisition missile



6 — 2 Fig 1 External Store Stations



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◀ 6—2 Fig 2 Stores Loading and Adapters ▶

is carried on the inboard LAU-7A launcher and the AIS pod on the outer LAU-7A, which, together, provide limited AIS pod operation for Sidewinder status data, including SEAM on post-SEAM aircraft.

4A. *Left Wing Inboard Pylons.* On left wing inboard pylons post-mod 5075, the electrical harness is modified and includes a socket which mates with the AIS pod adapter cable. On post-mod 705 aircraft fitted with a post-mod 5075 and 5078 pylon full utilisation of an AIS pod is available for Sidewinder (in conjunction with Sidewinder acquisition missile), Sparrow/Skyflash (in conjunction with a Sparrow/Skyflash training missile) and SUU-23/A gun status data.

5. *Stores Loading Table*

Stores (See Note)	*Stations*										
	9	8		7	6	5	4	3	2		1
		OUTBD	INBD						INBD	OUTBD	
Sparrow/Skyflash missile				1	1		1	1			
Sparrow/Skyflash training missile								1			
Sidewinder missile		1	1						1	1	
Sidewinder acquisition missile			1						1		
AIS pod		1								1	
SUU-23/A gun pod						1					
Fuel tank 500 gal						1					
Fuel tank 308 gal	1										1
Aero-1/A or BLU-27B luggage cont		1							1		
Missile monitoring pod	1										1

Note: The Release to Service document should be consulted in all cases as certain restrictions and limitations may apply.

Aero 7A Missile Launcher

6. Aero 7A launchers, mounted internally to the fuselage structure each with four attachment bolts, are self-contained, gas-operating mechanisms, capable of suspending and launching (ejecting) the Skyflash/Sparrow missile from stations 3, 4, 6 and 7. Ejection force is supplied by two gas generating cartridges electrically ignited when the trigger switch is pressed. Electrical power for missile motor ignition is supplied through a missile motor plug attached to the aft ejector foot, and for the missile guidance control system through the umbilical plug. This missile motor lower connector and the umbilical plug are pulled from the missile when it is released. A safety pin behind a panel adjacent to the launcher renders it safe on the ground both electrically and mechanically.

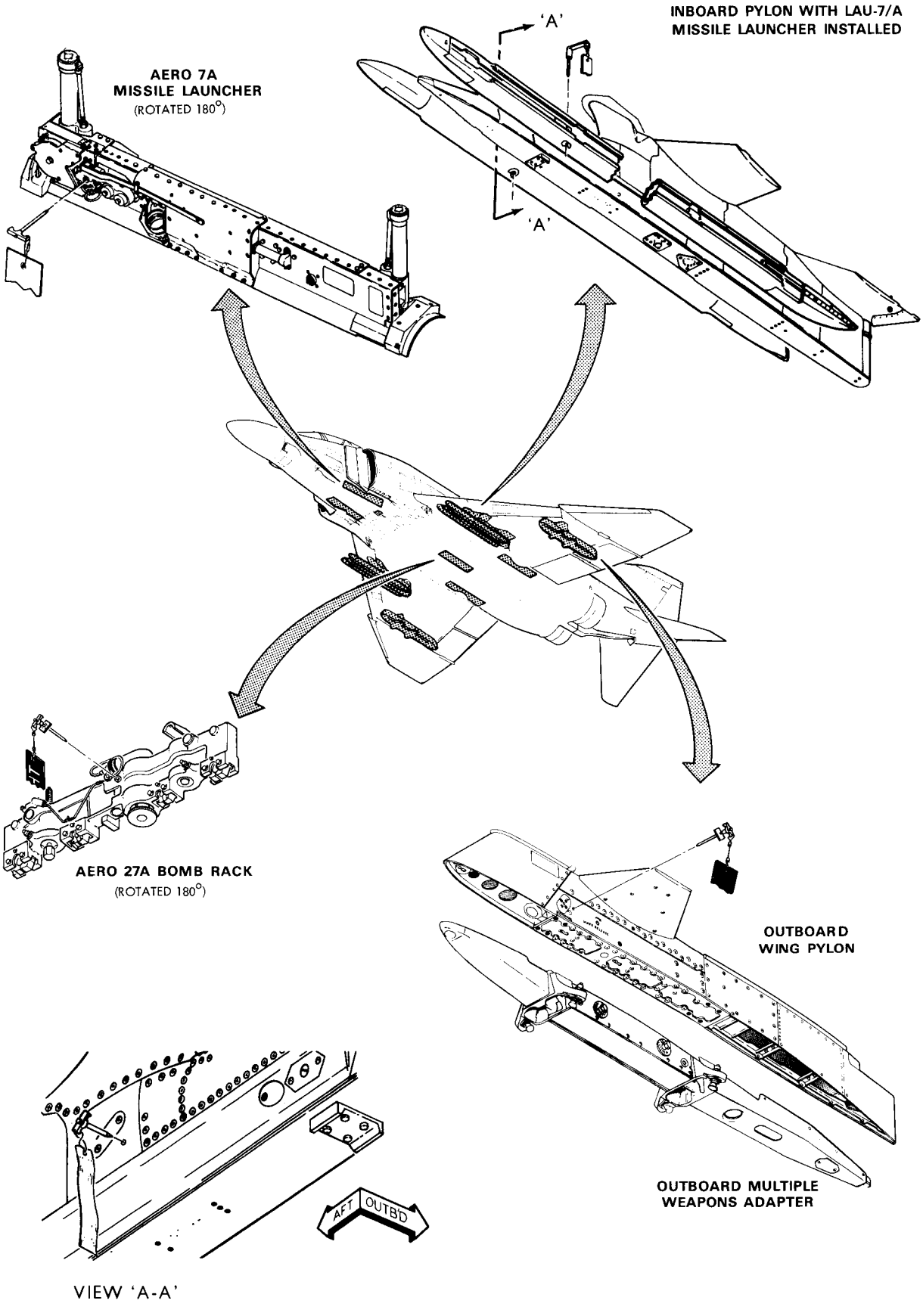
7. *Missile-gone Switch.* The missile-gone switch steps the firing pulse to another station, after a missile has fired, by activating the missile-gone relay to de-energise the master fire and the missile select and sequencing relays.

LAU 7A Missile Launcher

8. The LAU 7A missile launchers attached to the inboard pylons suspend Sidewinder missiles or, post-mod 5078, a Sidewinder acquisition missile and an AIS pod on the outboard and inboard LAU-7A launchers respectively. The major internal components consist of a power supply (for captive flight and missile firing), a mechanism assembly (for missile carriage and release), and a nitrogen receiver assembly (to provide cooling gas for the missile seeker head). A safety circuit prevents accidental release during arrested landings. A dual purpose safety pin permits latching and unlatching of the forward snubber during missile loading and unloading, and provides an electrical safety break between the launcher power supply and the rear striker point for the missile motor. The snubbers prevent movement of the missile in captive flight.

Aero 27A Bomb Rack

9. The self-contained ejector bomb rack has a 4-tandem hook suspension for fuel tank or MWA. Rack hook release and ejection are effected by two gas generating powder cartridges in a breech housing, two different cartridges being used in the primary and secondary circuits. An electrical safety switch opens the cartridge firing circuits when the safety pin is installed preventing inadvertent firing. The rack may be adjusted in pitch to accommodate various types and sizes of stores.



PH 11145

◀ 6—2 Fig 3 Suspension Equipment ▶

Multiple Weapons Adapter

10. The multiple weapons adapter (MWA) attached to the Aero 27A bomb rack at station 5 for the carriage of the gun pod contains an electrical connector to route power supplies; latches and sway braces secure the gun pod. A luggage carrier, made either from a converted Aero 1A fuel tank (post-mod 5056) or converted BLU-27B fire bomb (post-mod 5066), may be suspended on either the left or right inboard pylon via a MWA and special attachment beam. The Aero 1A luggage carrier has two doors, one aft on the left hand side and one forward on the right hand side, secured by Dzus fasteners; the BLU-27B carrier has a 2-part door on the left side, hinged at the upper and lower edges and secured by quick-release fasteners. Eye bolts or buckles are attached to the floor of the carrier to allow luggage to be secured. Loading must not exceed the weight or location marked on the outside of the carrier.

Safety Pins

11. Safety pins are fitted to all pylons, launchers, missile ejector racks and the Aero 27A bomb rack:

Quantity (per unit)	*Station or Unit*	*Function*
1	Station 5 Aero 27A bomb rack	Breaks electrical circuits and locks mechanism
1	Stations 2 and 8 inboard pylons	Breaks electrical circuit
1	Stations 3, 4, 6 and 7 Aero 7A launchers	Breaks electrical circuits and locks mechanism
1	Stations 2 and 8 LAU 7A launchers	Locks electrical switches and mechanism
1	Stations 1 and 9 outboard pylons	Breaks electrical circuit and locks mechanism

PART 6

CHAPTER 3 — SUU-23A GUN POD

Contents

Illustrations

Introduction

1. *General.* The SUU-23A gun pod (Fig 1 and 2) consists of a GAU-4A self-powered 20 mm automatic gun, inertia type starter, gas drive, a rate of fire governor and a linkless ammunition feed and storage system.

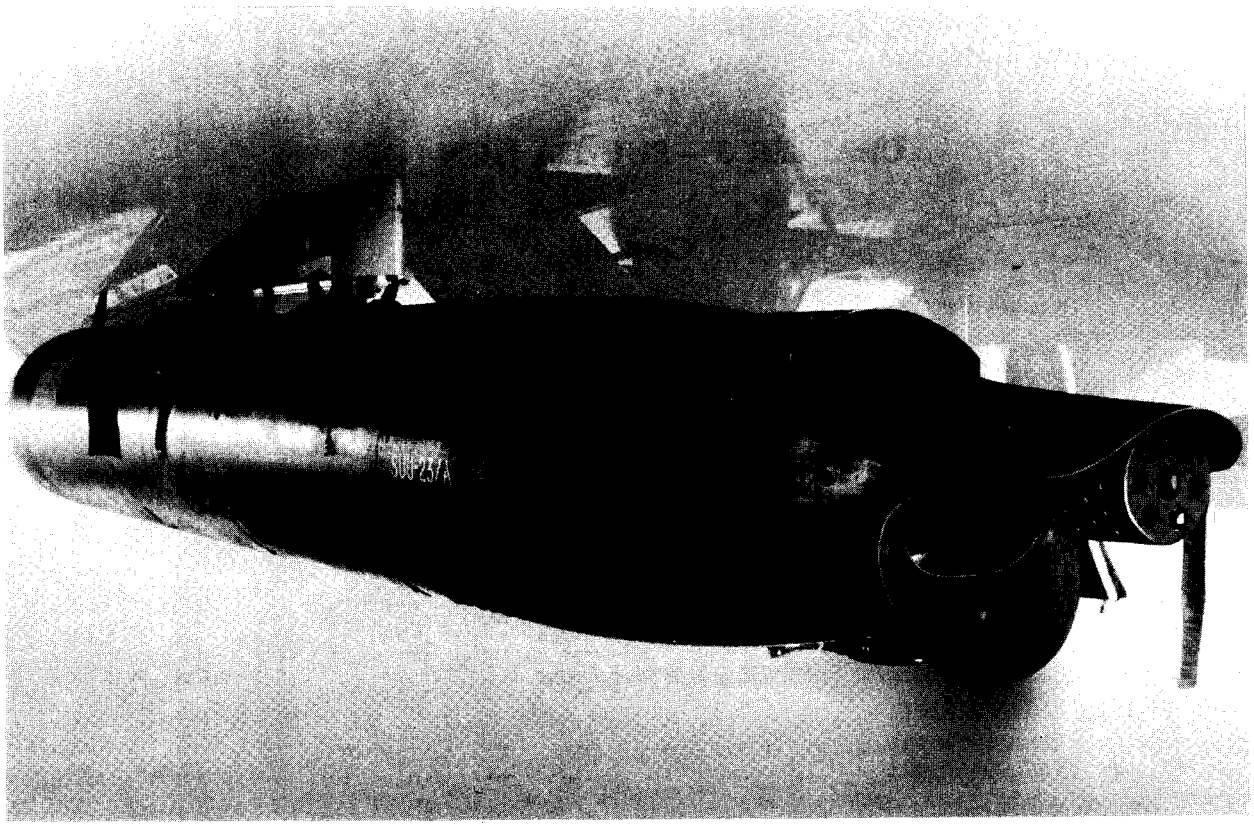
2. *Installation.* The gun pod, carried on the centreline (station 5), is fitted to the Aero 27A bomb rack by a multiple weapons adapter (MWA) which routes power and fire control circuits.

TECHNICAL DESCRIPTION

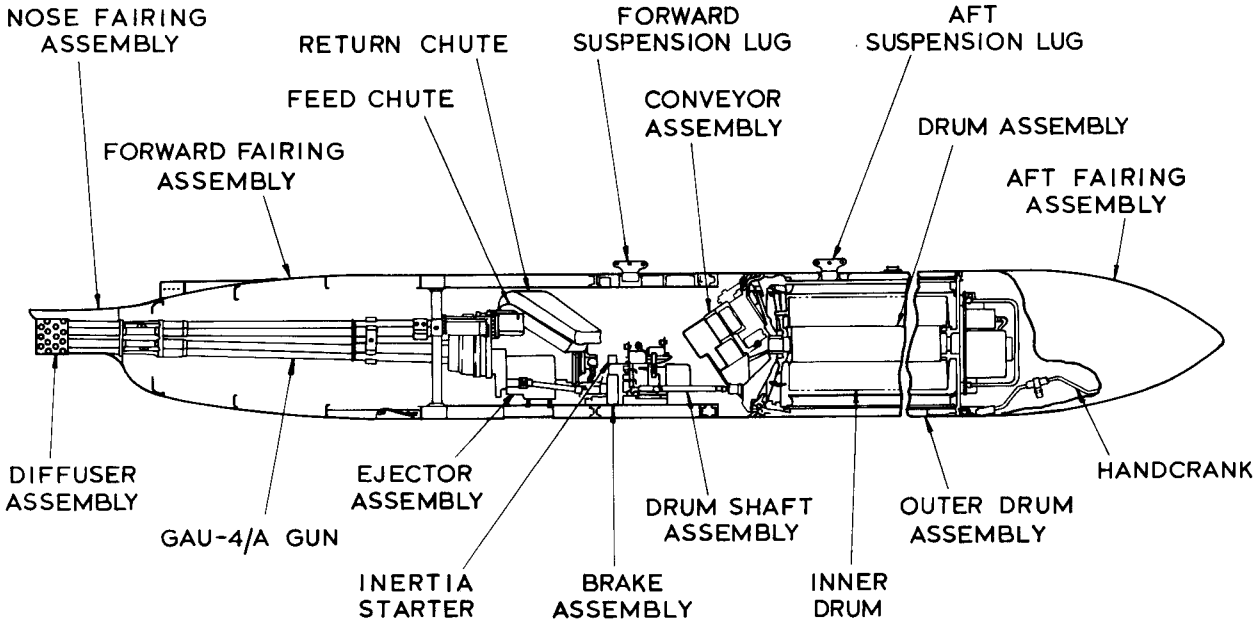
Leading Particulars

3. The leading particulars of the gun pod are:

Overall length	16 feet 7 inches (5·05 m) approximately
Overall diameter	1 foot 10 inches (0·56 m)
Weight loaded (1234 rounds)	1730 lb (784·7 kg)
Weight empty (40 to 70 rounds)	1075 lb (487·6 kg)
Rate of fire	Either 6000 or 4000 rounds per minute by operation of a selector switch in the gun pod body
Muzzle velocity	3380 feet/sec (1030 m/sec)
Duration of fire	13 seconds approximately at 6000 rounds per minute and 18 seconds at 4000 rounds per minute
Number of barrels	Six
Length of barrel	5 feet (1·5 m)
Rotation	Anti-clockwise (from rear)
Electrical supplies	Arming and clearing: 28V DC Inertia starter: 115/200V AC 3-phase Firing: 320V DC
Suspension	Two lugs at 30 inches spacing



6 — 3 Fig 1 The Gun Pod



6 — 3 Fig 2 Gun Pod — Schematic

Description

4. The gun pod consists of four main components, the pod, ammunition storage drum and feed system, inertia starter, and the GAU-4A gun.

Gun Pod

5. The gun pod is built in five individual sections which are readily detachable from each other comprising:

a. *Nose Fairing.* The nose fairing is a formed stainless steel structure which, with the muzzle blast diffuser, diverts blast pressures away from the aircraft.

b. *Forward Fairing.* The forward fairing encloses the gun barrels.

c. *Gun Support Section.* The gun support section houses the gun assembly, the inertia starter and the feed and conveyor system.

d. *Drum Unit Section.* The drum unit section houses the ammunition storage drum.

e. *Aft Fairing.* The aft fairing provides access to the control panel.

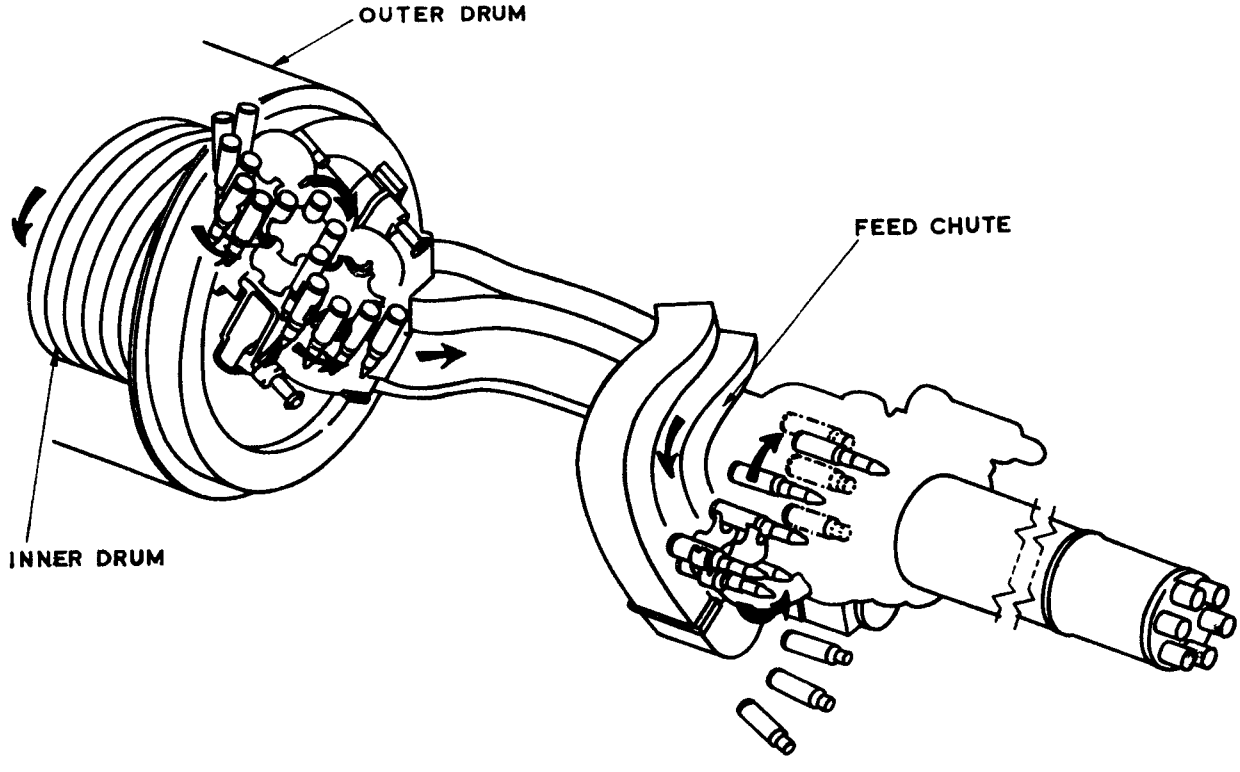
Ammunition Storage Drum and Feed System

6. *Storage Drum.* The cylindrical storage drum (Fig 3) consists of:

a. *Outer Drum.* Ammunition is stored, without links, radially around the longitudinal axis of the drum, with the base of the rounds towards the outer edge. The rounds are held in place by 30 partitions along the inner surface of the drum and are driven along the length of the partitions by an inner drum. A 'last round' switch projects into the path of the rounds when the ammunition in a particular partition is expended and the firing circuit is interrupted to prevent the endless belt becoming empty, as it depends for its integrity on rounds filling the individual elements; otherwise, the system may jam if the elements disengage.

b. *Inner Drum.* The inner drum has a mounting ring at each end and its outer surface has strips spot-welded to form a double helix. As the inner drum rotates within the outer, the helix transports the rounds along the outer drum partitions towards a scoop disc.

c. *Scoop Disc.* The scoop disc is mounted at the forward end of the inner drum and guide rails form a continuation of the helix. Two sets of gear-driven sprockets are positioned diametrically opposite each other to be at each end of the double helix. These sprockets transfer the rounds from the storage drum partitions to retainer partitions in the exit cover, by passing them through openings in the scoop disc. The fixed scoops and scoop extension provide positive control of rounds.



6—3 Fig 3 Ammunition Storage Drum and Feed System

d. *Exit Cover.* The exit cover contains a retainer gear and partitions. The partitions control the position of the rounds between the scoop disc and the exit cover.

7. *Feed Conveyor and Ejector System.* The feed conveyor consists of the exit unit, ammunition chuting, feed unit and ejector unit.

a. *Exit Unit.* The exit unit fixed to the exit cover is geared to the retainer gear and comprises two gear-driven sprocket and shaft assemblies. The sprockets remove the rounds from the retainer partitions and place them in the linked elements of the endless conveyor belt. The drum is loaded by disconnecting the system temporarily at the exit unit. Linked ammunition is fed into the loading chute while the drum is rotated by the hand crank and the links are stripped from the rounds and ejected.

b. *Chuting.* The chute controls and routes the interlocked conveyor elements transporting the rounds to the feed unit, allowing free flow in one direction only.

c. *Feed Unit.* The feed unit mounted on, and geared to, the gun assembly consists of four gear-driven sprockets and the guides necessary to give positive control to the rounds and conveyor elements as they pass through the unit.

d. *Drive Assembly Unit.* The drive assembly, which is an ejector unit, is also mounted on, and geared to, the gun assembly and consists of gear-driven sprockets to accept the spent cases, and live rounds during transition periods, and eject them with sufficient force to clear the aircraft.

8. The drum assembly, exit unit, feeder unit, gun and drive assembly are all initially synchronised by timing pins in each unit, so that their complementary actions do not cause misfeeding or jamming.

Inertia Starter

9. The inertia starter is used to provide the initial gun rotor assembly acceleration to half the selected firing rate, at which point the rotor assembly accelerates to firing rate sustained by gas pressure. The 1.5 HP inertia starter motor operates when STA SEL-CTR is selected. With the undercarriage up, the MSLS-GUN switch at A/A, MASTER ARM switch at ARM and the trigger depressed, the inertia starter is engaged with the gun rotor assembly via a disc clutch to accelerate the rotor assembly to half selected firing rate in less than 0·3 seconds. Thereafter, gas drive increases and maintains the firing rate to the selected rate (±3%) as electronically governed by a disc brake mounted on the inertia starter assembly.

GAU-4A Gun

10. The GAU-4A is a 20 mm automatic gun with six rotating barrels, each having its own bolt assembly operating in slides in a rotor. The rounds are electrically fired. The main components of the gun are the barrel assembly, the gas drive and the rotor assembly.

11. *Barrel Assembly.* Barrels are spaced equally around the rotor, clamped and supported by a centre clamp and a diffuser. The diffuser supports the muzzle end of the barrels and, with the nose fairing, vents the hot gases to forward and side.

12. *Gas Drive.* The gas drive is a piston operated cam, driving a roller follower clamped between barrels 1 and 6. The cylinder and clamps together provide the centre clamp; the cylinder is within the barrel cluster. Gun gas from four of the barrels is ported to the cylinder.

13. *Rotor Assembly.* The rotor assembly (Fig 4) is the major unit of the gun driven initially by the inertia starter and maintained by the gas drive. The rotor is mounted within a housing and uses cams and gears to effect feeding, chambering, locking, firing, extraction and ejection.

14. *Housing.* The housing inner surface supports the cam path for guiding the bolt assembly in the firing and clearing modes (Fig 5). The forward part of the firing cam has a dwell portion holding the bolt assembly locked while the round is fired and the shell leaves the barrel. An insulated cam, forward of the dwell portion, forces the firing pin into contact with the round and an electrical contact in the insulating cam fires the round. The feed unit is attached to the housing, and, by a guide bar, feeds the rounds to the bolt assembly.

15. *Guide Bar.* The guide bar fitted in the feed/eject opening performs two functions:

a. Guides the rounds from the feed unit to the extractor lips on the bolt assembly face.

b. Moves the spent cartridge cases from the extractor lips to the ejection chute.

16. *Rotor Tracks.* Six sets of rotor tracks are attached to ribs along the rotor body, each composed of a front, centre and removable track, the latter permitting bolt assembly removal.

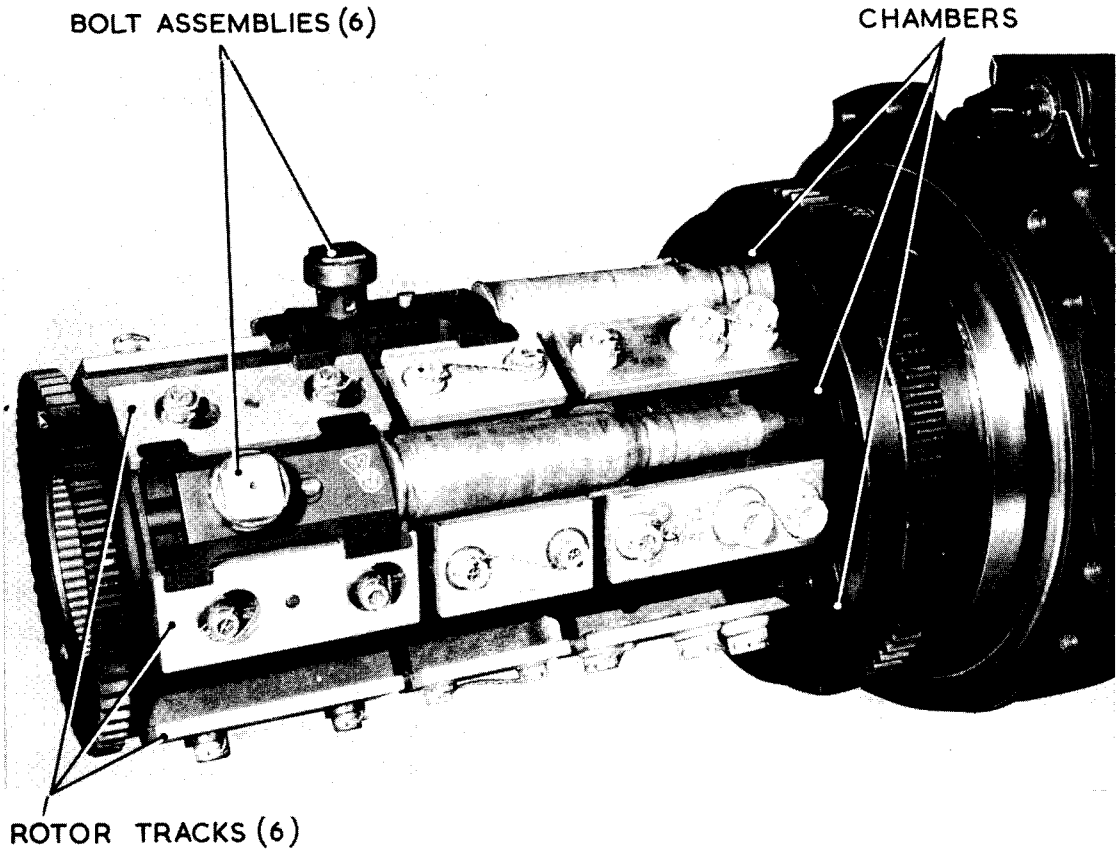
17. *Bolt Assembly.* The bolt assembly:

a. Transports the round from the feeder to the chamber.

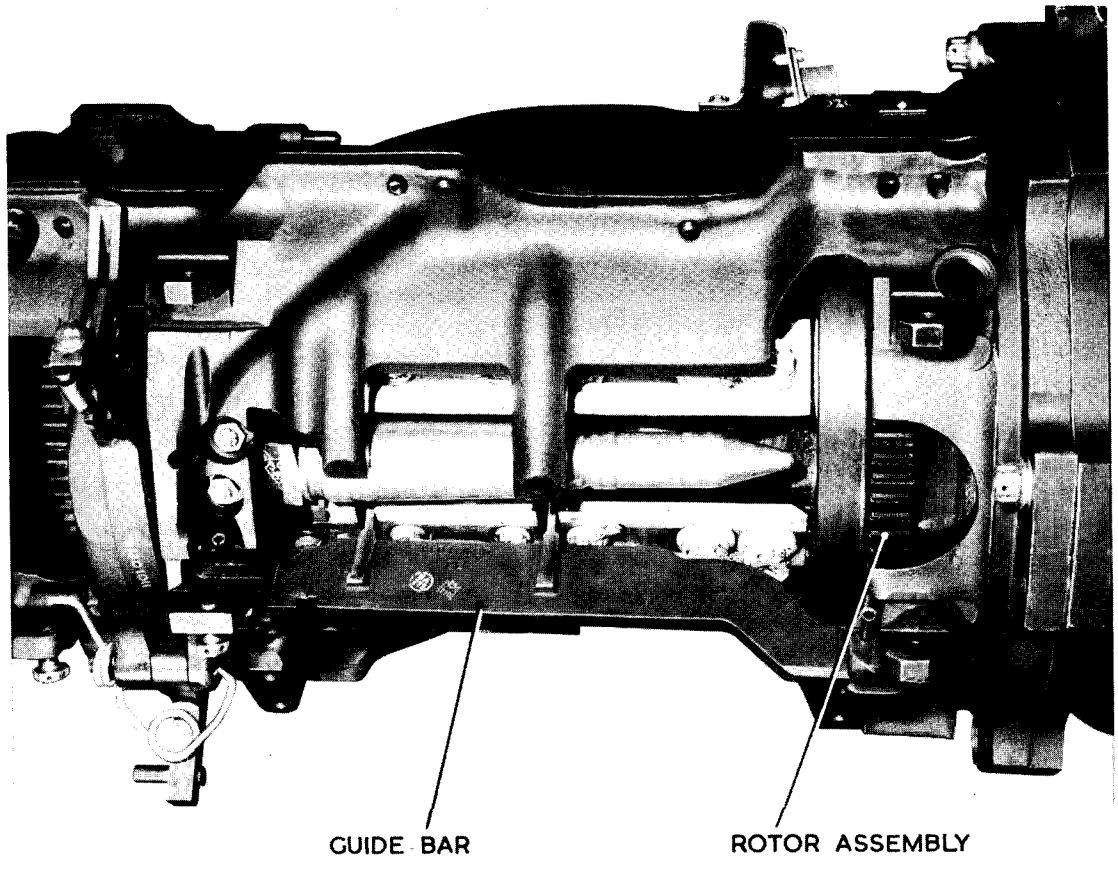
b. Locks the round in the firing position.

c. Transmits the firing voltage to the round.

d. Transports the spent case or unfired round to the ejection chute.



6 — 3 Fig 4 Rotor Assembly



6 — 3 Fig 5 Rotor Assembly in Housing

18. *Bolt Operation.* An extractor lip, on the face of the bolt, engages the rim of the round until it is ejected. The bolt is transported forward by the bolt shaft in the cam path until the round is chambered, when the bolt shaft is forced down by the locking cam, locking the bolt for firing. Simultaneously the insulated contact cam forces the firing pin into contact with the round. The electrical contact transfers the firing voltage to the round. After firing, the bolt shaft unlocks the bolt and transports it to the rear where the guide bar ejects the spent case into the ejection chute.

19. *Clearing Cycle.* The firing voltage is maintained for 0·2 seconds after trigger release to fire the rounds in the firing cam before clearing. After cease fire, when the disc clutch is disengaged, the brake is applied and the clearing function is initiated; however due to mechanical and electrical linkage, the firing rate slows to half the selected firing speed before clearing actually starts, as controlled by the gun clear switch:

a. *NON CLEAR.* NON-CLEAR is used when firing short bursts in rapid succession. Live rounds are ejected whenever the gun is rotating but not firing. Live rounds could remain in the chamber, or at any intermediate position.

b. *AUTO CLEAR.* AUTO-CLEAR is used when the gun needs to be made safe or cooled. Firing continues until the rate slows by approximately 25% when the clearing solenoid is operated causing the pivoted clearing cam sector to enter the main cam path. The bolt shaft is forced down, locking the bolt to the rear against spring tension in the rotor. This action causes the bolts to be held to the rear so that no live round is in, or in transit to, the chamber. Any live rounds are transported, by the bolts at the rear, direct to the ejector chute. In AUTO CLEAR, at least 3 seconds should be allowed between firing bursts.

20. In the transition from the clearing to the firing cycle the rounds are fed into the gun by the feeder. The clearing cam pivots out of the main cam path, the bolt shaft is forced up by the spring in the rotor, allowing the bolt to be guided into the main cam path. Three to eight live rounds are ejected during this transition.

Note: The final burst must be fired with the switch at AUTO-CLEAR to clear the gun. If the 'last round' switch is activated while firing in the NON-CLEAR mode the gun automatically transfers to AUTO-CLEAR.

FUNCTIONING

Actuation of the Gun

21. The inertia starter is actuated, and continues to run, whenever the centre station is selected by the STA SEL switch. When the MASTER ARM switch is placed to ARM and the trigger is pressed, the clutch engages, accelerating the rotor system and the feed system of the storage drum and conveyor system.

Auto Clear Operation

22. *Firing*

a. Firing voltage available at the firing contact.

b. Disc clutch engaged, brake released.

c. Gun accelerates ejector system and ejects from three to eight live rounds.

d. Gun fires, accelerating to 4000 or 6000 rounds/ minute. Time from pressing trigger to firing is about 0·1 to 0·2 seconds.

23. *Cease Fire*

a. Disc clutch disengaged, brake applied.

b. Firing voltage maintained for approximately 0·2 seconds.

c. Gun decelerates, clearing solenoid operates, actuating the clearing cycle.

d. At half firing speed approximately, the bolts are retained at the rear in the clearing cam.

Non Clear Operation

24. *Firing (Previously Fired in AUTO CLEAR).* The sequence is the same as para 22.

25. *Cease Fire*

a. Disc clutch disengaged, brake applied.

b. Firing voltage maintained for approximately 0·2 seconds.

c. Bolts remain in the firing cam path, rounds or spent cases are held chambered or partially chambered.

Operation when Previously Fired in Non Clear

26. *Firing, Either Mode Selected*

a. Firing voltage available at the firing contact.

b. Disc clutch engaged, brake released.

c. Gun starts to fire as soon as first bolt passes the firing position.

d. Gun accelerates to speed in approximately 0·2 to 0·4 seconds.

27. *Cease Fire, Either Mode Selected.* Similar to either para 23 or 25, depending on mode selected.

Note: Live rounds will be jettisoned at the beginning and the end of each firing burst whatever the AUTO-CLEAR/NON-CLEAR switch setting.

MANAGEMENT

External Checks

28. a. Barrel movement not excessive.

b. Clearing cam holdback tool removed.

c. Rounds counter.

d. Inertia motor lead connected.

e. Gun firing lead connected.

f. Electrical connection secure.

g. Rate of fire selected to 4000 or 6000 rounds per minute.

h. Panels, nose and tail cones secure.

In-Flight Checks

29. With the undercarriage lever UP, select:

a. MSL-GUN selector to A/A.

b. Gun clear switch as required.

c. WPN selector OFF.

d. STA SEL switch to CTR at least 40 seconds before firing.

e. MASTER ARM switch to ARM.

30. Setting the MASTER ARM switch to ARM connects power to the trigger. When the trigger is pressed, power is supplied to the firing circuits through a 'nosewheel up' relay to prevent gun firing with the nosewheel extended.

31. The gun pod is made safe when the MASTER ARM switch is selected to SAFE, or when the STA SEL-CTR button selection is cancelled. The gun automatically stops firing when the ammunition is exhausted by the action of the 'last round' switch which interrupts the firing circuit and initiates braking of the barrel assembly.

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PART 6

CHAPTER 4—SPARROW MISSILE

Refer to CD 101*B*-0901 & 2-15*D*

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PART 6

CHAPTER 5—SIDEWINDER MISSILE

Refer to CD 101B-0901 & 2-15D

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PART 6

CHAPTER 6 — SKYFLASH MISSILE

Refer to CD 101*B*-0901 & 2-15*D*