AER.1F-PA200-1

FLIGHT MANUAL

PANAVIA 200 TORNADO

ITALIAN SERIES AIRCRAFT

This publication is incomplete without AER.1F-PA200-1A. See LOAP AER.1F-PA200-01 for current status of Flight Manuals and Flight Crew Checklists.

For comprehensive listing of the current Flight Manual, Performance Data, Checklists, Safety and Operational Supplements, refer to page L of this manual.

PUBLISHED UNDER AUTHORITY OF THE
D.G.C.A.A.A.S.

Prepared by AERITALIA – GAD
Direzione Assistenza Velivoli, Torino

FLIGHT MANUAL

PANAVIA 200 TORNADO

ITALIAN SERIES AIRCRAFT

This publication is incomplete without AER.1F-PA200-1A. See LOAP AER.1F-PA200-01 for current status of Flight Manuals and Flight Crew Checklists.

For comprehensive listing of the current Flight Manual, Performance Data, Checklists, Safety and Operational Supplements, refer to page L of this manual.

PUBLISHED UNDER AUTHORITY OF THE
D.G.C.A.A.A.S.

Prepared by AERITALIA – GAD
Direzione Assistenza Velivoli, Torino

1 January 1990

LIST OF EFFECTIVE PAGES

Note: The portion of the text or illustration affected by the change is indicated by a vertical line on the outer margin of the page. The portion of illustrations affected by a change is indicated by a pointing hand.

INSERT LATEST CHANGED PAGES DESTROY SUPERSEDED PAGES
Dates of issue for original and changed pages are:
Original .... 0 .... 1 January 1990

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 672 CONSISTING:

0 Pages SECRET
0 Pages CONFIDENTIAL
642 Pages RESTRICTED
30 Pages UNCLASSIFIED
0 Pages blank

Page No.	*Change No.
Title	0
A thru L	0
M blank	0
i thru iii	0
iv blank	0
v thru xiii	0
xiv blank	0
1-1 thru 1-143	0
1-144 blank	0
2-1 thru 2-37	0
2-38 blank	0
3-1 thru 3-70	0
4-1 thru 4-198	0
5-1 thru 5-83	0
5-84 blank	0
5-85 thru 5-91	0
5-92 blank	0
5-93	0
5-94 blank	0
5-95	0
5-96 blank	0
5-97	0
5-98 blank	0
5-99	0
5-100 blank	0
5-101	0
5-102 blank	0
5-103	0
5-104 blank	0
5-105	0
5-106 blank	0
5-107	0
5-108 blank	0
5-109	0
5-110 blank	0
5-111	0
5-112 blank	0
5-113	0
5-114 blank	0
5-115	0
5-116 blank	0
5-117	0
5-118 blank	0
5-119	0
5-120 blank	0
5-121	0
5-122 blank	0
5-123	0
5-124 blank	0
5-125	0
5-126 blank	0
5-127	0
5-128 blank	0
5-129	0
5-130 blank	0
5-131	0
5-132 blank	0
5-133	0
5-134 blank	0
6-1 thru 6-19	0
6-20 blank	0
7-1 thru 7-7	0
7-8 blank	0
FO-1 thru FO-22	0
Index-1 thru Index-12	0

* Zero in this column indicates an original page

CAUTION

- This publication is valid only if it is composed of the above listed pages and duly amended.
- Copies of this publication may be obtained as follows:
  FA activities, as directed by specification ILA-NL-9004-0001-00B00
  COSTARMAEREO activities, as directed by specification AER.00-00-8
- Any deficiency and/or mistake in this publication shall be reported as directed by specification AER.00-00-4.

AIRCRAFT MODIFICATION AND SOFTWARE INFORMATION

MODIFICATION

Due to embodiment of modifications, certain differences exist in the build, location or function of equipments between individual aircraft.
This list contains only those MODs and OTs which through their influence on equipment functions and aircraft behaviour, affect aircrew activities.
(*) An asterisk near the mod number indicates that the mod. is embodied on all IT/IS Tornado; this mean that the mod. reference within the text is deleted.

SOFTWARE

The information contained in this manual is based on MC software standard OFP SS7 load 108 which is compatible with the 64K and 128K computers.

PL80		PIT		Short Title	System/Equipment Affected
MOD. No.	Date	OT. No.	Date		
00011		713	890630	Provision of an External APU Start Facility	Secondary Power System Controls and Indicators, Section 1. Pre-flight Checks, Section 2
00218		364A	840410	Changes to Pitot Probe	Engine Operation, Section 5
(*) 00245		261	850422	To introduce Warning of Jet Pipe resonance	Engine Section 1
(*) 00409	810825			Relocation of Refuel Probe Dimmer	Flight Refueling, Section 5
00448		452C	890418	Changes to Engine Vibration Warning System	Engines, Warning Equipment, Section 1
00450		279	820125	Changes to NWAMS	Integrated Display and Control Section 4
00477		347	830509	Install. of RA Low Height Repeat Indicator	TFR, Section 4
00541		263A	870506	Change to Engine Ignition System	Engine Ignition and Relight System, Section 1.
00555		673B	890418	Introduction of SPILS Hardware	Primary Flight Control System Section 1 Angle of Attack and Manoeuvres, Flight Control System, Section 5
00562		343A	871105	Change L/R OIL P Warning (CWP)	Engines, Section 1. Introduction, Section 3. Warning Equipment, Section 4.

PL80		PIT		Short Title	System/Equipment Affected
MOD. No.	Date	OT. No.	Date		
(*) 00590	801013			Introduction of Static Wedge Type B in Lieu of Type B	Ground Stability and Operation, Section 5
00629		342	830509	Changes to Ice Detection System	ECS Warning equipment Section 1. Pre Flight Checks, Section 2. Engine Operation, Section 5. Instrument Flight Pocedures, Istruments Approaches, Turbolence and Thunderstorms, Section 7.
00644		585A	850520	Change to Engine Starting system	Engines, Section 1. Starting Engines, Section 2.
00839		798A	890623	Increase of temperature operating range of canopy locking mechanism	Enviromental Conditions Section 5.
00859		583C	890418	Changes to CWP's	Engines, ECS, Section 1. Engine Failure, Section 3. Warning Equipment, Section 4. Engine Operation, ECS, Section 5.
00905		583C	890418	Changes to CWP,s (SMS A/B)	Warning Equipment, Section 4.
00921		390A	871105	Changes to CWP's (ECS)	ECS, Section 1. Climb/Cruise, Section 2. ECS failure, Section 3. Warning Equipment, Section 4. ECS, Section 5.
00924		428C	890418	Air Distribution to Ejection Seat Headrests	ECS section 1 Enviromental Conditions, Section 5.
00942		759B	890418	HUD Revised CCIL and Safety Modification	Integrated Display and Control, Section 4. Weapon Aiming, Section 5
00964		582	841130	To introduce a stiffened front cross member to the main computer rack.	Armament and External External Stores, Section 5.
00996		645	851007	Removal of Ejection Seat Pich Control Unit	Ejection Seat, Section 1. Pre Flight Checks, Section 2.
(*) 01209		135	830509	Additional bonding between fuel pipes	Flight Refueling, Section 5.

PL80		PTT		Short Title	System/Equipment Affected
MOD. No.	Date	OT. No.	Date		
01229		648A	881122	Introduce Parachute Assemblies MBEU 8012PA-206	Enviromental Conditions Section 5
01253		510B 755A	890623 890623	Change to TTU	Engine Operation Section 5.
(*) 01331		486	840228	Bonding lead to Flight Refuel Probe Interface Unit	Flight Refueling, Section 5.
01332		430A	861001	Isolation of Engine HP6 BOV.s	Engines section 1 Armament system, Section 4.
01361		542B	890418	Engine Oil Pressure Time Delay	Engine, Section 1. Engine Operation, Normal Acceleration and Manouvre, Section 5.
01399		569A	890418	Change to Lift Dump Indicator	Engines Thrust Reversal system, Secondary Flight Control system, section 1
01415		937/ 938	890829	Introduction of 4 seconds. Delay PSP	Ejection Seat section 1. Abandoning Section 5.
01431		730B	890531	Mk 103 Engine	Engines, Section 1
01436		672A	890418	To Introduce a Reinforced Heat Exchanger Fairing	Engine Operation Section 5.
01445		708A	890623	Change to Wander Lamp Stowage	Lighting System Section 1
01460		794B	890623	Taileron Leading Edge Protection	Armament and External Stores Section 5
01461		583C	890418	Change to CWP (SPILS)	PFCS, Section 1. Warning Equipment, Section 4.
01464		720B	890418	Introduction of autom. Autothrottle Disconnect Indication	AFDS Warning Equipment, Section 1 Warning Equipment, Section 4.
01485		221	851010	Inibition of GMR Failure Warning on CWP in the R/C	Integrated System Reversionary Modes Section 4.
01537	870203			Removal of Redundant HP6 BOV's	Engine, Section 1

PL80		PTT		Short Title	System/Equipment Affected
MOD. No.	Date	OT. No.	Date		
01560		882A	890531	Improvements to LH Links Bay (GUN)	Armament and External Stores, Section 5.
01570		712	860915	15 sec. Engine Oil Pressure Warning Delay	Engine Operation, Normal Accelerations and Manouvres, Section 5.
01625		787A	890623	Introduction of 10 Mile Map Facility to the CRPMD	CRPMD Section 4
01661		878A	890623	Change to V/UHF	Communication Equipment, Section 1
01655 01663		823B 822A	890623 890828	Change to Crash Panel	Engine, Electrical Power Supply System, Section 1
01662		821	891016	Introduction of DC Voltmeter	Electrical Power Supply System, Section 1. Pre Flight Check, Taxiing Section 2. Electrical System Failure Section 3. Instrument Markings, Section 5.
01670	890414			Delation of reheat operation lights	Engine Section 5.
01724		915	890110	Improvements of AOA Probes	Flight Control System, Section 5
01742		909	881212	Change to CCE Station Box	Communication Equipment, Section 1
01749	891025			Enhancement of the status Indication of the TF/AFDS in the Front Cockpit	AFDS, Section 5.
01882	900207			Revised cockpit indicators for radar phase 1 upgrade	AFDS, Section 5.
10137		425A	840410	Intro 64K Computer with Increased Computing Speed	Computing, Section 5.
10229	811203			Fuel Gauging System Introducing a combined junction box, wir. + brack. provis.	Pre Flight Checks Section 2. Fuel system, Section 5.
(*) 10572	790807			Introduction of MK8 standard of the CSAS Lateral Computer	Crosswind, Section 5

PL80		PIT		Short Title	System/Equipment Affected
MOD. No.	Date	OT. No.	Date		
10777		719B	891610	Strengthening APU/SPS bay pannel	External Store Configuration, Section 5
10781		449	831110	Introduction Cowl Fence in LH Engine Air Intake	Engines, Section 1. Engine Operation Section 5.
10809		488A	861201	Installation of HF/SSB radio Equipment	Communication Equipment Section 1. Navigational Aids, Section 4.
10829		601A	871105	Change to WPU	Engines, Section 1 Armament and External Stores, Section 5.
10841	810303			Removal of HDDR Film Remaining Indicator	Recorders, Section 1
(*) 10866		512	840416	Intro of a pressure relief valve-RCOV	Engine, Section 1 Engine Failure, Fuel System Failure, Section 3
10912		742A	890418	Nose Radar Program Update EV2	Sensing, T-P-SW-X107-01-P-D Differences, Integrated System Revisionary Mode, Section 4.
10914		809B	890623	Change to BDHI	Instruments, Section 1
10938		718B	890623	Changes to Gearbox Standard	Engine Operation, Section 5
10963		665	860215	Change to WPU Software	Armament and External Stores, Section 5.
10977		916A	891018	Change to SPS Control Unit	Hydraulic Power Supply System, Section 1 Flameout/Relighting, Section 3.
11019	821209			Improvement to One Shoot Battery	SPS, Section 1. Electrical System Failures, Section 3. EPS, Section 5.
11029		600A	850415	IFU BITE Malfunction	Integrated System Revisionary Modes, Section 4
11042		585A	850520	Change to Engine Starting system	Engine, section 1
11045		746B	890701	Modify MLG Air Spring for T.O. at 28500 kg.	Mass section 5.

PL80		PTT		Short Title	System/Equipment Affected
MOD. No.	Date	OT. No.	Date		
11047		687A	860515	Intro 128K Main Computer	Computing, Section 5.
11063		686A	890418	Replacement of AAMU (air to air missile unit)	Armament and External Stores, Section 5.
11133	891023			Nose Radar LRU-1 upgrade	AFDS, Section 5.
11159		857	890829	HF/SSB to introduce a new type of double-shielded coax cable	HF/SSB, Section 5.
11183/ 11317	880818	973	900928	Nose Radar — Intro of an Improved Oil Accumulator into LRU2	Forward Locking Sensor Section 5
11188	900620			Intro of enhanced SMS	Weapon Aimimg, Section 5.
11294		968	901030	Intro of 224K-F main computer	Computing, Section 5.
13011		608	850520	HMERU LMERU modifications	Release Launch and Jettison Limitation Table, Section 5.
13016		890	880715	Improvement to B/B Pod Flood Light	Flight Refuelling Section 5.
13023		754A	890418	Role equipment improvement of HM and LM ERU's	External Stores configurations, Section 5.
13045		732A	890418	Intro of target of opportunity (TOO) moding for Kormoran into MCU	Weapon Aiming and Release Lunch-Firing, Section 5.
16045	810819			Introduction of MC OFP Tape	Weapon Aiming, Section 5.
16046	810526			Introduction of MC OFP Tape	Weapon Aiming, Section 5.
16064		594	850305	Update of Strike OFP to Production Std. T-P-SW-X701-01-P.	Computing, Section 5.
16071		691	860603	Update of Strike OFP to Production Std. T-P-SW-X702-01-P.	Computing, Section 5.
16100		692	860603	MC Software Standard OFP SS7 load 107	Computing Section 5.

PL80		PIT		Short Title	System/Equipment Affected
MOD. No.	Date	OT. No.	Date		
16120		771	870521	MC Software standard OFP SS7 load 108	Computing, Section 5.
16130		944	900109	Intro of 5th production upgrade SS7 Standard SW IT-P-MCC P200B	Avionic System, Section 5.
20116		783A	890531	Radar altimeter, introduction of dinamic gain control unit	External Stores Configurations, Section 5.
20160	860428			HF Power Reduction	HF/SSB Section 5.
20167		783A	890531	Rad. Alt. to change card A-15 to maintain memory mode time within specification limits	External Stores Configurations, Section 5.
30847		212	860315	Isolation of Engine HP6 BOV's	Engines section 1
30871		155	830730	Redesigned RHFCU oil seal	Normal Accel. and Manoeuvres, AFDS Section 5.
(*) 30882		155	830730	To reduce the probability of RHT Light-up surges with F40 Fuel	Engine Operation Section 5.
30887		178	841130	Dual Bypass Oil System	Engine Operation, AFDS, Section 5.
31054		252	870728	Engine A/B Modification	Engine Operation, Air Speed and Mach, Section 5.
31154		267	880405	Improvement to Rear Bearing Oil Chamber Cooling	Engine Operation, Air Speed and Mach, Section 5.
31191	860320			Change to Reheat BUZZ Indication	Engine section 1. Warning Equipment section 4.
31194		269	880405	Introduction of new Mastron air/air cooler with reduced pressure	Engine Operation section 5.
31208	860128			Change to TBT Warning Level	Engines, Section 1.
40946		271	880405	Isolation of Engine HP6 BOV's	Engines section 1

PL80		PIT		Short Title	System/Equipment Affected
MOD. No.	Date	OT. No.	Date		
40960	810508			Installation of New Engine T7 Probe	Engines, Section 1.
41134	850525			Introduction of Modified Seal	Engine Operation Section 5.
50189		270	880405	Revised rear bearing chamber seals to improve chamber pressurizzation	Engine Operation, Air Speed and Mach, Section 5.

STATUS OF FLIGHT MANUAL, FLIGHT CREW CHECK LISTS, SAFETY AND OPERATIONAL SUPPLEMENT

This page provides a comprehensive listing of the current Flight Manual, Performance Data, Flight Crew Check List and Safety/Operational Supplements.

Flight Manual

AER.1F-PA200-1 1 January 1990

Current Limitations

Nammo Release to Service, Issue 2 Change 12

Performance Data

AER.1F-PA200-1A	15 March 1982	ch. 5	15 April 1987

Check Lists

AER.1F-PA200-1CL-1	1 January 1990
AER.1F-PA200-1CL-2	1 February 1988

FM Safety Supplements

*	AER.1F-PA200-1SS-14	19 December 1989	HIRTA for PATRIOT radar

FM Operational Supplements

*	AER.1F-PA200-1S-25	7 June 1990	Krueger Flap Tornado A/C

CL Operational Supplements

*	AER.1F-PA200-1CL-1S-01	23 October 1989	FCC pen and ink amend.

Performance Data – Operational Supplements

* Last supplement superseded, information now incorporated in relevant publication. All previous OS/SS incorporated/deleted.

THIS PAGE LEFT INTENTIONALLY BLANK

TABLE OF CONTENTS

Section I DESCRIPTION AND OPERATION 1-1

Section II NORMAL PROCEDURES 2-1

Section III EMERGENCY PROCEDURES 3-1

Section IV INTEGRATED NAVIGATION AND WEAPON AIMING SYSTEM 4-1

Section V OPERATING LIMITATIONS 5-1

Section VI FLIGHT CHARACTERISTICS 6-1

Section VII ADVERSE WEATHER OPERATIONS 7-1

Alphabetical Index Index-1

SCOPE

This manual contains necessary information for safe and efficient operation of the Tornado aircraft. These instructions provide you with a general knowledge of the aircraft and its characteristics and specific normal and emergency operating procedures. Your experience is recognized; therefore, basic flight principles are avoided. This manual provides the best possible operating instructions under most circumstances. However multiple emergencies, adverse weather, terrain etc. may require modification of the procedures.

PERMISSIBLE OPERATIONS

The flight manual takes a "positive approach" and normally states only what you can do. Unusual operations or configurations are prohibited unless specifically covered herein. Clearance must be obtained before any questionable operation which is not specifically permitted in this manual is attempted.

HOW TO BE ASSURED OF HAVING LATEST DATA

See AER.1F-200-01 for a listing of all current flight manuals and checklists. Also, check the flight manual title page, the title block and status page of the latest supplement.

ARRANGEMENT

This manual is divided into seven fairly independent Sections and one Appendix to simplify reading it straight through or for using it as a reference manual. This Appendix, containing Performance Data, is issued as a separate volume AER.1F-PA200-1-A. A confidential supplement AER.1F-PA200-1-1, containing classified information, is also issued as a separate volume.

SAFETY SUPPLEMENTS

Information involving safety will be promptly forwarded to you in a safety supplements. Urgent information is published in interim safety supplements. Interim supplements are forwarded in teletype form and will be replaced by a formal supplement.
The supplements have to be inserted in the following order: Operational Supplements on top of the Flight Manual and Safety Supplements on the top of the Operational Supplements.
The supplement title block and status page should be checked to determine the supplement's effect on the manual and other outstanding supplements.

OPERATIONAL SUPPLEMENTS

Information involving changes will be forwarded to you by operational supplements. The procedure for handling operational supplements is the same as for safety supplements.

CHECK LISTS

The flight manual contains itemized procedures with necessary amplifications. The checklist contains itemized procedures without the amplification. Primary line items in the flight manual and checklist are identical. If a formal safety or operational supplement affects your checklist, the affected checklist page will be replaced by an interim change.

CHANGE SYMBOL

The change symbol, as illustrated by the black line in the outer margin in this paragraph, indicates text and tabular illustration changes made to the current issue. Changes to illustrations (except tabular and plotted illustrations) are indicated by a pointing hand or a shaded area box located at the upper right side of the illustration. The box is divided into eight equal parts which represent eight proportional areas of the illustration. The shaded area of the box represents the area of the illustration which contains a change.

WARNINGS, CAUTIONS AND NOTES

The following definitions apply to Warnings, Cautions and Notes:

WARNING

OPERATING PROCEDURES, TECHNIQUES, ETC., WHICH COULD RESULT IN PERSONAL INJURY OR LOSS OF LIFE IF NOT CAREFULLY FOLLOWED.

CAUTION

OPERATING PROCEDURES, TECHNIQUES, ETC., WHICH COULS RESULT IN DAMAGE TO EQUIPMENT IF NOT CAREFULLY FOLLOWED.

NOTE

An operating procedure, technique, etc., which is considered essential to emphasize.

"SHALL", "WILL", "SHOULD" AND "MAY"

The words "shall" or "will" shall be used to express a mandatory requirement. The word "should" shall be used to express nonmandatory provisions. The word "may" shall be used to express permissiveness.

YOUR RESPONSIBILITY — TO LET US KNOW

Every effort is made to keep the flight manual current. Review conferences with operating personnel and a constant review of accident and flight test reports assure inclusion of the latest data in the manual. We cannot correct an error unless we know of its existence. In this regard, it is essential that you do your part. Comments, corrections, and questions regarding this manual are welcomed. These should be reported in compliance with the regulations and forms detailed by the specification AER.00-00-4.

THIS PAGE LEFT INTENTIONALLY BLANK

LIST OF ABBREVIATIONS

A

A	Accept (symbol)
A; a	Angle of incidence
A/A	Air-to-Air
A/amps	Ampere
A/B	Airbrakes
A.C., AC, a.c.	Alternative Current
A/C	Aircraft
A/coll	Anti collision
A/G	Air-to-Ground
AAM	Air-to-Air Missile
AAMU	Air-to-Air Missile Unit
AAO	Air-to-Air Override Button
AAR	Air-to-Air Refuelling
AAT	Air-to-Air Track Mode
ACC	Accumulator (hydraulic)
ACCEL	Acceleration, Accelerate
ACFC	Air-Cooled Fuel Cooler
ACPT, ACCPT	Accept
ACT	Actuator (hydraulic)
ACU	Automatic Control Unit
AD	Air Data
AD + SR	Air Data and SAHR Mode
ADC	Air Data Computer
ADC	Air Data Computing
ADD	Airstream Direction Detection
ADF	Automatic Direction Finder
ADI	Attitude Director Indicator
ADL	Armament Datum Line
ADR	Accident Data Recorder
ADS	Air Data System
AFDC	Autopilot and Flight Director Computer
AFDS	Automatic Flight Director System
AFP	Automatic Flight Plan
AGC	Automatic Gain Control
AGG	Air-to-Ground Guns
AGL	Above Ground Level
AGM	Air-to-Ground Missile
AGR	Air Ground Ranging
AGTY	Agility
AICP	Air Intake Control Panel
AICS	Air Intake Control System
AIM	Air Intercept Missile
Aj	Area, jetpipe (nozzle area)
ALN	Align
ALT	Altitude
ALT/ALTER	Alternative
AM	Airmix (O2 regulator)
AMPL	Amplifier
AMSL	Above Mean Sea Level
ANT	Antenna
AOA	Angle of Attack
AP	Autopilot
AP ENG	Autopilot Engage
AP MON	Autopilot Monitoring
APFD	Autopilot Flight Director
app., approx	Approximate, approximately
APP/APRCH	Approach
APPR., APPROX	Approximate, approximately
APU	Auxiliary Power Unit
ARB	Attack Release Button
ARI	Attitude Repeater Indicator
ARU	Airfoil Release Unit
ASAP	As Soon As Possible
ASI	Airspeed Indicator
ASM	Air System Master
ASO	Automatic Steering Override
AT	Autothrottle
ATC	Air Traffic Control
ATTD	Attitude
ATTK	Attack
ATU	Antenna Tuning Unit
AUTO	Automatic
AUTO P	Autopilot
AWFL	Air Worthiness Flight Limitation

B

B	Brillance
B SCN	B Scan
B/B	Buddy/Buddy
BAA	Best Available Altitude
BARO	Barometric
BARO IN	Barometric Inertial Height
BATH	Best Available True Heading
BATT	Battery
BATT MSTR	Battery Master (switch)
BCN	Beacon
BDHI	Bearing Distance and Heading Indicator
BITE	Built-In Test Equipment
BOV	Blow Off Valve

BRG	Bearing
BRSL	Bomb Release Safety Lock
BRST	Boresight
BRT	Bright, brightness

C

C	Celsius
C	Compatible
C/FUS	Centre Fuselage (tank)
CAL	Calibration,calibrate
CAS	Calibrated Airspeed
CAT	Clear Air Turbolence
CBLS	Carrier Bomb Light Store
CCE	Communications Control Equipment
CCIL	Continuously Computed Impact Line
CCIP	Continuously Computed Impact Point
CCP	Communication Control Panel
CCS	Communication Control System
CCU	Central Control Unit (FTI)
CFS	Control Frequency Selector
CG	Centre of Gravity
CHAN	Channel
CLPU	Closed Loop Pull Up
CMD TRK	Command Track
CMO	Contour Mapping ON
CMP	Central Maintenance Panel
CMPTR	Computer
COMP	Compass Mode
CON	Console
CONFIG	Configuration
CONT INV	Contrast Inversion
CONT.D	Continued
CONT, contr	Control
CONV	Converter
CO2	Carbon Dioxide
CP	Conrol Panel
CPCV	Cabin Pressure Control Valve
CPGS	Cassette Preparation Ground Station
CPU	Central Processing Unit
CR	Crash Recorder
CRAM, cr	Clearance Range Ahead Monitor
CRCU	Control and Remote Compensator Unit
CRCU	Control and Remote Compensator Unit (SAHR)
CRPMD	Combined Radar and Projected Map Display
CRT	Cathode Ray Tube
CSAS	Command and Stability Augmentation System
CSD	Constant Speed Drive
CSI	Combined Speed Indicator
CTR	Center
CU	Control Unit
CUE	Control Unit Electonic
CURS	Cursors
CVO	Cancel Visual Offset
CVR	Cockpit Voice Recorder
CWP	Central Warning Panel
CWS	Central Warning System

D

D.C., DC, d.c.	Direct Current
D/N	Day/Night (Switch)
DAMP	Damper, damping
DAU	Data Acquisition Unit
dB	Decibel
DCP	Doppler Control Panel
DEC	Declination
DEC	Decrease
DECU	Digital Engine Control Unit
Deg/sec	Degrees/Seconds
DEL	Delete
DEP	Depression
DEST	Destination
DEST, D	Destination
DF	Direct Finding
DIFF	Differential
DIM	Dimmer
DIR	Direct
DIS	Display
DIS, DIST	Distance
DL	Direct Link
DN	Down
DME	Distance Measuring Equipment
DP + SR	Doppler + SAHR Mode
DPPLR, DPLR	Doppler
DR	Director
DR	Drift
DSC	Digital Scan Converter
DTG	Distance to Go
DU	Display Unit
DWN	Down
DYN	Dynamic

E

E	East
E	Empty
EAS	Equivalent Air Speed
ECM	Electronic Counter Measures
ECP	Engine Control Panel

ECS	Enviromental Control System
EED	Electro Explosive Devices
EFH	Estimated Flight Hours
EGTF	Enhanced Ground Test Facility
EHP	Emergency Hydraulic Pump
ELEV	Elevation
ELPC	Electric Low Pressure Controller
EMER., EMERG.	Emergency
EMERG RAM AIR	Emergency Ram Air
EMERG TRANS	Emergency Transfer
EMGY	Emergency
ENC	Emergency Nozzle Closure
ENG	Engine
ENT	Enter
EPS	Emergency Power System
EPSC	Electric Power System Controller
EQM	Equipment Format
ERA	Emergency Ram Air
ERR	Error
ERU	Ejection Release Unit
ES	E-Scope
ESRRD	E-Scope Radar Repeater Dysplay
EU	Electronics Unit
EXT	Extended
EXT	Extinguisher

F

F	Filter
F	Fire
F	Front
F	Full
F/C	Front Cockpit
F/R pump	Front/Rear Pump
FA, F/A	Fix Attack
FAF	Final Approach Fixpoint
FAIL	Failure
FCU	Fuel Control Unit
FD	Flight Director
FES	Fast Erection Synchronization
FFK	Fixed Function Keyboard
FIX	Fixing
FKPT	Fixpoint
FL	Flap
FLT	Flight
FLT INS	Flight Instruments
FLT PLN	Flight Plan
FLW	Follow
FM	Frequency Modulation
FOD	Foreign Object Damage
Form	Formation
FPS	Frame Per Second
FR VLV	Flight Refuelling Valve
FREQ	Frequency
FREQ AGTY	Frequency Agility
FRIG	Frequency Response Input Generator
Frz	Freeze
FS	Frequency Sweep
Ft/min	Feet per Minute
FT, ft	Feet
FTI	Flight Test Instrumentation
FUS	Fuselage
FW, FWD	Forward

G

G	Gain
G	Guard (channel)
G, g	(Unit of) gravity
GCA	Ground Controlled Approach
GCU	Generator Control Unit
GEN	Generator
GEU	Gun Electronics Unit
GEU	Gyro and Electronics Unit
GLU	Ground Loader Unit
GMR	Ground Mapping Radar
GND ACT	Ground Activation
GPCU	Ground Power Control Unit
GRID	Grid Data
GS, G/S	Ground Speed
GTF	Ground Test Facility
GVNR	Governor

H

H	Height
H	Horizontal
HAS	Hardened Aircraft Shelters
HDD	Head Down Display Recorder
HDG	Heading
HDG/DR	Heading/Drift
HE	High Energy
HF	High Frequency
HF/SSB	High Frequency Single Sideband
HI	High
HIRTA	Hintensity Radio Transmission Area
HLWSCA	High Lift and Wing Sweep Control Assembly
HOJ	Home-on-Jam
HP	High Pressure
HP SOC	High Pressure Shut-Off Cock
HSI	Horizontal Situation Indicator
HT	Height

HT FIND	Height Finding
HT Fix	Height Fixing
HTR	Heater
HUD	Head-Up Display
HYD	Hydraulic
Hz	Hertz (cycles per second)

I

I	Inertial Navigator (Symbol)
I/BD	Inboard
I/C	Intercommunication
IAS	Indicated Airspeed
IC	Incompatible
ICO	Instinctive Cut-Out
IDG	Integrated Drive and Generator
IF	Immediate Frequency
IFD	In-Flight Display
IFF	Identification Friend or Foe
IFF/SIF	Identification Friend or Foe/Selective Identification Feature
IFM	In-Flight Monitor
IFR	Instrumental Flight Rules
IFU	Interface Unit
IGNSEL	Ignition Selective (switch)
ILS	Instrument Landing System
IMC	Instrumental Meteorological Condition
IMCP	Intake Manual Control Panel
IN	Inertial Navigation
INBD	Inboard
INC	Inclination
INC	Increase
INCDU	Inertial Navigator Control and Display Unit
IND	Indicator
INSR	Insert
INST	Instrument
INT	Intelligence point
INT	Intercommunication
INT	Intermittent
INT	Internal
INT	Interval
INTER	Interconnect
IP	Intermediate Pressure
IP BOV	Intermediate Pressure Blow-Off Valve
IPI	Initial Position Insertion
IPP	Initial Present Position
ISA	International Standard Atmosphere

K

K	Kilo (1000 Units)
K	Knots
K	Kormoran Missile
K	Scaling Stage
KCAS	Knot Calibrated Airspeed
KF	Kalman Filter
Kg/min	Kilogrammes per Minute
KG, kg	Kilogramme
KHz	Kilohertz (kilocycles per second)
KIAS	Knots Indicated Air Speed
Km	Kilometer
KN, kN	Kilo Newton
kPa	Kilo Pascal
KT, kt	Knots
KTS, kts	Knots
KVA	Kilo Volt Ampere
KW	Kilo Watts

L

L	Left
L	Limitation
lb	Pound
LCK ON	Lock-On
LCN	Load Classification Number
LCP	Laser Control Panel
LD	Lift Dump
LE	Leading Edge
LED	Light Emitting Diodes
LF	Left/Forward
LFD	Longitudinal Fuselage Datum
LG	Landing Gear
LH (L.H.)	Left Hand
LHW	Low Height Warning
LIM	Limiter
LIN	Linear
LIS	Lock-in-Surge
LK AHD	Look Ahead Mode
LL	Leight Weight in Loft Attack
LOC	Localizer
LOG	Logarithm
LOS	Line of Sight
LOX	Liquid Oxygen
LP	Low Pressure
LPC	Low Pressure Controller
LRF	Laser Rabge Finder
LRU	Line Replacement Unit

M

M	Mach (number)
M	Magnetic
M	Mapping

m	Meters
M + RS	Map and Radar Standby
MAC	Mean Aerodynamic Cord
MACE	Minimum Area Crutchless Ejector
MAG	Magnetic Heading
MAIN	Main Mode
MALF	Malfunction
MAN	Manual
MAP	Mapping
MASS	Master Armament Safety Switch
MAX., max	Maximum
MB SET	Millibar Setting
MB/mb	Millibar
MC	Main Computer
MCCP	Main Computer Control Panel
MCD	Magnetic Chip Detector
MCP	Mode Control Panel
MCST	Main Computer Self Test
MD	Manoeuvre Demand
MDC	Micro Detonating Cords.
MDU	Magnetic Detector Unit
MEAS	Measurement
MECH	Mechanical
MECU	Main Electronic Control Unit
MED	Medium
MEM HDG	Memorized Heading
MFCU	Main Fuel Control Unit
MFK	Multi Functional Keyboard
MFLS	Mode and Failure Logic System
MFP	Manual Flight Plan
MHz	Megahertz (megacycles per second)
MI	Magnetic Indicator
MIC	Microphone
MID	Middle, intermediate
MIN, min	Minute
MINS	Minutes
Mk	Mark
MKR	Marker
ML	Medium Weight in Loft Attack
MLG	Main Landing Gear
mm	Millimeter
MMV	Main Metering Valve
MNVR	Manoeuvre
MON	Monitoring
MOT	Motor
MRAD	Milliradiant
MRCP	Mapping Radar Control Panel
MRI	Monopulse Resolution Improvement
MS/MTR	Milliseconds/Meter
M sec	Milliseconds
MSL	Mean Sea Level
MSL	Missile
MSTR	Master
MTR	Marked Target Receiver
mtr	Meter
MVG	Moving
MVR	Maneuver
MVT	Moving Target
MWCA	Multi Weapon Carriage Adapter
MWCS	Multi Weapon Carriage System

N

N	Navigator
N	Newton
N	Normal
N	North
NA	Not Applicable
NAV	Navigation
NE	Never Exceed Limit
NFX	Next Fixpoint
NG	Nose Gear
NH	High pressure rotor speed
NHC	Navigator's Hand Controller
NI	Intermediate pressure rotor speed
NL	Low pressure rotor speed
NLG	Nose Landing Gear
NM/kg	Nautical Miles per Kilogramme
NM, N MILES	Nautical Miles
NMCP	Navigation Mode Control Panel
NML, NORM, NRM	Normal
No.	Number
NRV	Non Return Valve (check valve)
NSAS	Nosewheel Augmentation System
NTH	North
NTH UP	North Up Mode
NWAMS	Navigator's WAMS
NWS	Nose Wheel Steering
N3	Hight Pressure Rotor Speed

O

O	On-Top (Symbol)
O RIDE, O-RIDE, O/R	Override
OAT	Outside Air Temperature
OB	Outboard
OBS	Omni Bearing Selector
OBST	Obstruction
OCAMS	On-Board Checkout and Monitoring Sub-System
OFP	Operational Flight Program
OFS	Offset
OHEAT	Overheating
OL	Oleo
OLPU	Open Loop Pull Up

OTF	On-Top Fix
OUTBD	Outboard
OXY	Oxygen

P

P	Parking
P	Pilot
P	Pitch (axis)
P	Pitot pressure
P	Position Transducer
P	Pressure
P/R	Pitch/Roll
P/R MD	Pitch/Roll Maneuver Demand
Pa	Pascal
PA	Power Amplifier
PAR	Precision Approach Radar
PCU	Power Control Unit
PDL	Pitch Direct Link
PDR	Pressure Drop Regulator
PDU	Pilot's Demand Unit
PDU	Pilot's Display Unit
PE	Pressure Error
PEC	Personal Equipment Connector
PERSIST	Persistance
PEZ	Compressor Outlet Pressure
PFCS	Primary Flight Control System
[illegible]	Plan Fixing
[illegible]	Pilot's Hand Controller
PIO	Pilot Induced Oscillation
PL	Projection Lamp
PLB	Personal Locator Beacon
PLN	Plan
PMD	Projected Map Display
PN	Part Number
POS, PPSN	Position
PP	DC bus
PP	Present Position
PPI	Plan Position Indicator
PPI	Present Position Indicator
PRE FLT	Preflight
PRE FLT CHK	Preflight Check
PRF	Pulse Repetition Frequency
Ps	Static Pressure
PSI	Pounds per Square Inch
Pso	Free Stream Static Pressure
PSP	Personal Survival Pack
PSU	Program Storage Unit
Pt	Total Pressure
PTO	Power Takeoff
PTO	Power Takeoff
PTT	Press-to-Transmit
Pt2	Total Pressure, HP Compressor
PWAMS	Pilot's WAMS

Q

q	Reduction in Pitch Stick Force
QFE	Barometric Pressure at Airfield Level
QFN	Qualification
QNH	Barometric Pressure at Sea Level
QRB	Quick Release Box
QRF	Quick Release Fitting
QUAD	Quadruplex
QUAD ACT	Quadruplex Actuator

R

R	Radar (Symbol + Read-out)
R	Rear
R	Rejected
R	Repeat
R	Right
R	Roll (axis)
R/B	Range and Bearing
R/C	Rear/Cockpit
R/E	Receiver/Exciter
RA	Radar Altimeter
RAD	Radio
RAD ALT, R ALT	Radar Altimeter
RADAR	Radio Detection and Ranging
Rain disp	Rain dispersal
RAT	Ram Air Turbine
RCL	Recall
RCN	Reconnaissance
RCOV	Recirculation Change-Over Valve
RCV	Receive
RCV/XMT	Receive-Transmit
RDE	Rapid Data Entry
RDL	Reference Designation Letter
RDR	Radar
RDU	Radar Display Unit
RDY	Ready
REC	Receive
REC, RECDR	Recorder
Recce	Reconnaissance
RECORD	Recorder
RESD	Reserve Destination
REV	Reverse
REVN	Reversionary
RF	Radio Frequency
RFCI	Remote Frequency Channel Indicator
RH	Radar Height
RH (R.H.)	Right Hand
RHFCU	Reheat Fuel Control Unit
RHH	Radar Height Hold

RHT	Reheat
RKB	Reversionary Keyboard
RN	Random Noise
ROL	Read-Out Line
RPD	Rapid
RPD HTR	Rapid Heater
RPM	Revolution per Minute
RPMD	Repeater Projected Map Display
RPTR	Repeater
RT, rt	Right
RTE	Route
RTO	Refused Takeoff (Rejected Takeoff)
RWE	Radar Warning Equipment
RWR	Radar Warning Receiver
RX	Receiver

S

S	Scavenge pump
S	South
S	Static Pressure
S-S	Scan-to-Scan
SAHR	Secondary Attitude and Heading Reference
SAS	Stability Augmentation System
SBS	Standby-Sight
SBY, STBY, STDBY	Standby
SCAN CONV	Scan Converter
SCANC	Scanning Valve
SCH	Set Clearance Height
SCSAB	Signal Conditioning Switching and Amplification Boxes
SEC, sec	Second
SEL	Selector/Selected
SETAC	Sector TACAN
SHLDR	Shoulder
SIM	Simulation
SL	Sea Level
SLDE	Slide
SLVE	Slave
SLW, SL	Slew
SMS	Store Management System
SOC	Shut-off Cock
SPD	Speed
SPILS	Spin Prevention and Incidence Limiting System
SPOIL	Spoiler
SPS	Secondary Power System
SPWA	Special Weapon A Bus
SPWB	Special Weapon B Bus
S-S	Scan-to-Scan
SS	Single Shot
SS	Software Series
SSB	Single Side Band
SSR	Secondary Surveillance Radar
STAB	Stability (augmentation)
STB	Stabilized
STBY, STDBY	Standby
STC	Sensivity Time Control
STD	Standard
STWI	Specific Threat Warning Indications
SYNC, SYN	Synchronize/Synchronization
SYS., SYST	System

T

T	Tacan (Symbol)
T	Temperature
T	Test
T.O. T/O	Takeoff
T/R	Transmit/Receiver
TA	Terrain Avoidance (CMO)
TACAN, TAC	Tactical Air Navigation (system)
TAIL	Taileron
TAS	True Airspeed
TASH	True Airspeed, Horizontal
TBT	Turbine Blade Temperature
TE	Trailing Edge
TEL	Telephone
TEL	Time Early/Late
TEMP	Temperature
TF	Terrain Following
TF MON	Terrain Following Monitoring
TFC	Terrain Following Computer
TFR	Terrain Following Radar
TGT	Target
TGT	Turbine Gas Temperature
TH	True Heading
THROT	Throttle
TOO	Target of Opportunity
TOT	Time Over Target
TP	Tail Plane
TR	Thrust Reverse
TRAIN	Training (mode)
TRANS	Transfer (fuel)
TRK	Track
TRK ERR	Track Angle Error
TRU	Transformer Rectifier Unit
TTU	Triplex Transducer Unit
TTI	Total Inlet Temperature
TUP	Turbo Union Publication
TV	Television
TV/TAB	TV/Tabular Display
TVM	Television Guided Missile
TI	Intake Temperature

U

U/C	Undercarriage
U/FUS	Under Fuselage (tank)
U/L	Unlocked
U/WING, U/WG	Under Wing (tank)
UHF	Ultra High Frequency
UP	Upper
UTIL	Utilities (hydraulic)
UTM	Universal Transversal Mercator System

V

V	Speed
V	Visual (Symbol)
V	Volt
V DC	Volts Direct Current
V/UHF	Very High and Ultra High Frequency
VAB	Lift Off Speed
VAR	Variation
VAS	Voice Actuated Switch
VCP	Vapor Core Pump
VEL	Velocity
VERT	Vertical
VHF	Very High Frequency
VIB	Vibration
VMC	Visual Meteorological Conditions
VMO	Variable Metering Orifice
VOL	Volume
VOR	VHF Omnidirectional radio Range
VOS	Voice Operated Switch
VOT/MON	Voter-Monitor
VRF	Visual Flight Rules
VROT	Rotation Speed
Vs	Stall speed
VSI	Vertical Speed Indicator
VSTALL	Stall speed
VTO	Takeoff speed
VV	Velocity Vector
VV	Vertical Velocity

W

W	West
W/S demist	Wind Screen Demist
W/V	Wind Direction/Velocity
WAMS	Weapon Aiming Mode Selector
WCP	Weapon Control Panel
WFG	Waveform Generator
WG	Wing
WOG	Weight On Ground
WPT	Waypoint
WPU	Weapon Programming Unit
WRB	Weapon Release Button
WRNG	Warning
WS	Wing Sweep
WS	Working Store
WS, W/S	Windscreen

X

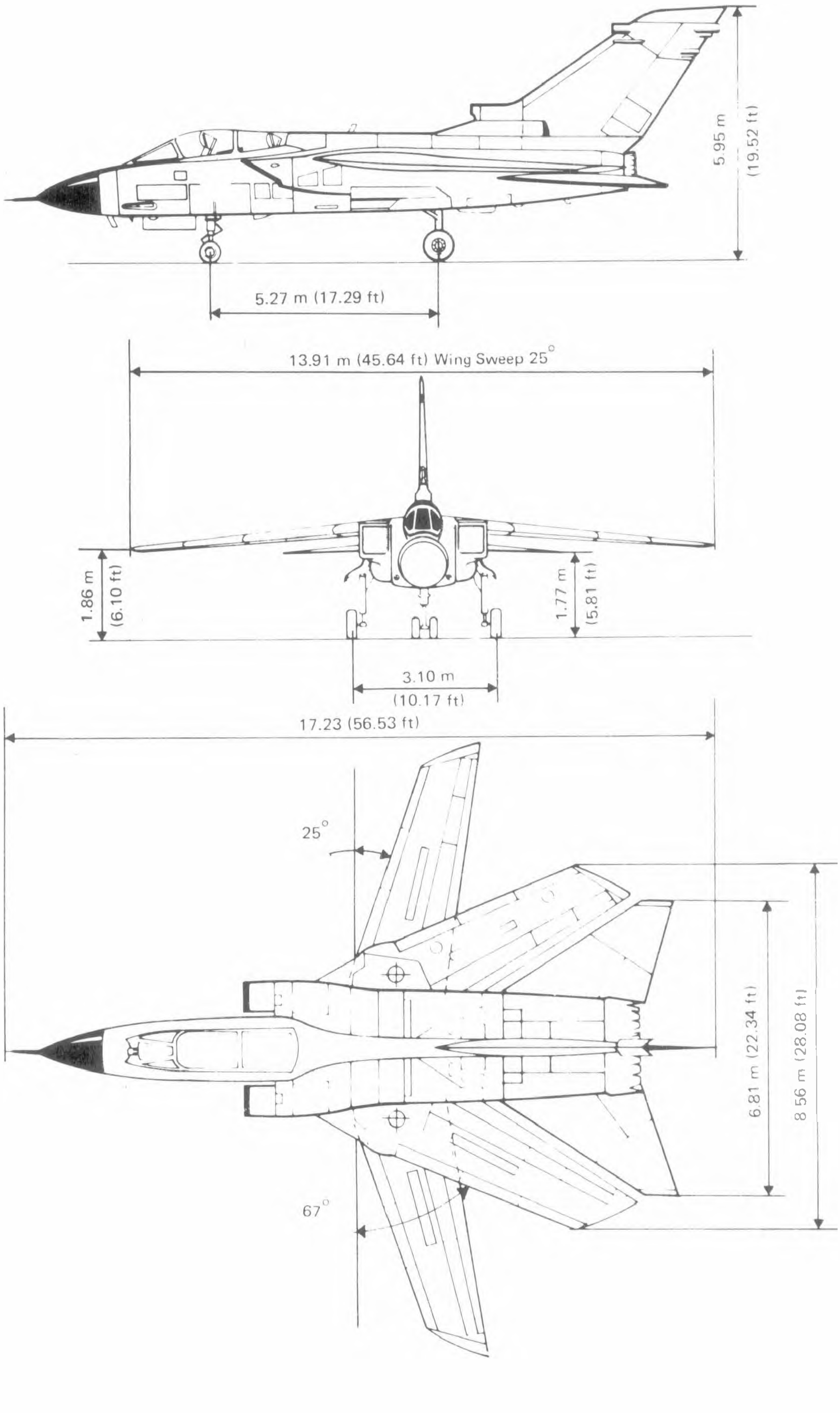
X	Roll Axis
X DRIVE	Cross Drive
X TRK	Across Track
X-Feed	Cross Feed
XP	AC bus

Y

Y	Yaw (axis)

Z

Z	Yaw (Axis)
ZCL	Zero Command Line


5.95 m
(19.52 ft)
5.27 m (17.29 ft)
13.91 m (45.64 ft) Wing Sweep 25°
1.86 m
(6.10 ft)
1.77 m
(5.81 ft)
3.10 m
(10.17 ft)
17.23 (56.53 ft)
25°
67°
6.81 m (22.34 ft)
8.56 m (28.08 ft)

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION I

DESCRIPTION AND OPERATION

TABLE OF CONTENTS

Title	Page
The Aircraft	1-1
Engines	1-2
Secondary Power System	1-28
Fuel Supply System	1-32
Fuel Transfer System	1-33
"Buddy-Buddy" (B/B) Refuelling System	1-38
Electrical Power Supply System	1-46
Hydraulic Power Supply System	1-51
Landing Gear System	1-56
Arresting Hook System	1-62
High Lift Devices	1-63
Primary Flight Control System	1-63
Secondary Flight Control System	1-77
Autopilot and Flight Director System	1-82
Pitot-Static System	1-92
Air Data System	1-94
Instruments	1-96
Canopy	1-103
Canopy Micro Detonating Cords (MDC) System	1-106
Ejection Seats	1-107
Environmental Control System	1-112
Oxygen System	1-118
Lighting System	1-123
Communication Equipment	1-125
Recorders	1-135

THE AIRCRAFT

The TORNADO Multi-Role Combat Aircraft (MRCA) is a two place (tandem), land-based, all-weather supersonic long range fighter bomber. The primary mission of the aircraft is high speed low level attack with various offensive and defensive capabilities. Mission capabilities include: long range high altitude intercepts utilizing air-to-air missiles and/or guns; long range attack missions utilizing conventional weapons as primary armament and close support missions utilizing a choice of missiles, bombs, other external stores, and two guns. An automatic low altitude terrain following system enhances penetration capability. Power is provided by two RB199-34R axial-flow, three-spool turbofan engines equipped with afterburners, and thrust reversers.

Air is supplied to the engines through variable-geometry intakes which match air flow to engine demand. Each engine provides a drive to an associated accessories gearbox; the two gearboxes can be interconnected (X-drive). An Auxiliary Power Unit (APU) also provides a drive to the right gearbox and can thus drive all accessories and provides engine starting. The APU cannot be used in flight. In the event of a double engine flame-out or double generator failure an Emergency Power System (EPS) can supply, for a limited period, hydraulic pressure for limited rate taileron operation and DC power to an emergency fuel pump to allow in-flight relight of the right engine.

The aircraft is fitted with cantilever shoulder wing and a conventional rudder and taileron. Wing sweepback is variable in flight or on the ground by manual control; any sweep angle between 25° and 67° may be selected. Forward wing sweep provides take-off and landing capabilities at minimum speed. For all other regimes the wings are manually swept in accordance with desired mach number and mission phase. This feature provides the aircraft with a highly versatile operating envelope.

Primary flight controls consist of two tailerons which are moved symmetrically for pitch control and differentially for roll control, and a conventional rudder for yaw control. Roll control at lower airspeeds is supplemented by two sets of wing spoilers: during the landing ground roll the two spoilers can operate as lift dumpers. These controls are normally operated through a Command and Stability Augmentation System (CSAS). The CSAS is a triplex "fly-by-wire" system which process pilot's demands autopilot commands into stabilized electrical signals. These signals command hydraulically

powered control units which drive the control surfaces.
Lift augmentation for take-off and landing is provided by the following high-lift devices: full-span leading edge slats, full-span double slotted trailing edge flaps, and krueger flaps on the leading edge of the fixed portion of each wing i.e. "wing nib". Fuel is carried in fuselage tanks, integral wing tanks, and jettisonable external tanks. Fuel system operation is normally automatic but can be sequenced manually if desired.
The aircraft is fitted with an inflight refuelling facility through an extendible refuelling probe. On the ground it may be refuelled either by single point or by gravity.
Electrical power is provided by two AC generators driven at constant speed, each driven from each accessory gearbox and feeding separate but normally interconnected busbars.
A Transformer-Rectifier Unit (TRU) is supplied from each of the two main AC busbars, each TRU feeding DC at 28 volts to an associated busbar. Both TRU also feed a third DC busbar. An AC-fed battery charger provides charging current and power support to a busbar supplied directly from the aircraft battery.
Two separate and independent systems supply hydraulic power to primary flying controls, via protected circuits and aircraft utilities; each pump is driven independently by each gearbox and supplies pressure to one system only.
Landing gear extension and retraction is hydraulically powered; in an emergency the gear can be extended by use of nitrogen pressure. Wheel brakes and nosewheel steering are also hydraulically powered. The nosewheel steering system incorporates yaw augmentation when asymmetric loads occur.
Bleed air tapped from the 4th stage of each engine HP compressor is cooled and fed to the cabin, equipment compartment, canopy sealing, wing slot seals and nose radar. This provides cabin conditioning and pressurization, cooling air for the equipment compartments and nose radar, and pressurisation of the wing slot seals and radar waveguide.
If system failure occurs, ram air can be fed into the cabin and cooling air supplied to the equipment compartments by electric fans.
Engine intake ice protection is assured by electrically-heated mats, the windscreen and sensor probes are also heated. The windscreen is also equipped with a washing system.
A centralised warning system is installed to warn the crew of failures arising at critical points in the aircraft systems. Initial warnings are audio/visual or visual only, in order to attract the crew members attention to the appropriate caption on the central warning panel.
The integrated navigation and weapon aiming system uses a digital Main Computer (MC) to process data from navigation sensor, forward looking sensors and a number of navigation and weapon aiming controls. The outputs from the MC are used to provide displays of navigation, steering and weapon aiming data to the crew. The steering data is also used by the Autopilot and Flight Director System (AFDS) to provide an automatic route following capability.
The communications radio installation includes a main V/UHF transmitter-receiver, an emergency UHF transmitter-receiver and a HF transmitter-receiver. A telebriefing facility is provided and a Cockpit Voice Recorder (CVR) is fitted. The complete installation, including audio warnings, is integrated by a Communication Control System (CCS). IFF is also fitted. Radio navigation aids include Tacan.
A wide range of external stores may be carried on underfuselage and underwing pylons; outboard wing pylons normally carry ECM pods. Underwing pylons are constantly kept aligned with the fuselage longitudinal datum by a swivel mechanism.
The aircraft has an active and passive ECM capability.

AIRCRAFT DIMENSIONS

Length (overall including pitot static boom)	17.23 m
Wing span swept fully forward	13.91 m
Wing span swept fully aft	8.52 m
Height (to top of vertical fin)	5.95 m
Distance between main landing gear wheels	3.10 m
Turning radius	see Section II

AIRCRAFT GROSS MASS

For specific aircraft masses refer to the associated Basic Weight Check List and Loading Data Manual AER 1F-PA200-5, to the handbook of Weight and Balance data T.O.1-1B-40.
The approx, average gross masses are as follows:

Operating mass	14000 kg
Operating mass plus a full internal fuel load	18700 kg
Operating mass plus a full internal fuel load plus two external wing tanks	21550 kg

FLIGHT CREW

The flight crew consists of an aircraft commander (AC) and a navigator (NAV) seated in tandem.

ENGINES

The aircraft is powered by two TURBO UNION RB199 MK101 (Figure 1-1, sheet 1 of 2) and Post mod. 01431: MK103 (Figure 1-1, sheet 2 of 2), twelve compressor stages three-spool axial flow turbofan engines, equipped with reheat and thrust reverser. The engines are mounted side by side in the lower section of the rear fuselage and are interchangeable. The sea level, standard day uninstalled thrust rating of the engine is in the 39kN (8500 pounds) class and 68kN (15000 pounds) class with reheat in operation. Provision is made for starting the engines with an auxiliary power unit (APU), mounted on the gearbox of the right engine. Electrical power for the engine igniter plugs is supplied by two high energy ignition units. Each engine is supplied with an airflow through a separate inlet duct located below the intersection of the wing and fuselage. An automatic controlled movable ramp is used in each inlet duct to control air flow to the engines. Additional engine inlet air is provided during ground, take-off and a low-speed high-power operation, through two auxiliary inward opening intake doors located in the outboard side of the nacelle. These features allow optimum engine performance through a wide range of airplane operating conditions. Air for each engine is routed through a single duct for both the basic engine and fan section. The airflow from the fan divides into two streams, the hot main stream and the cold by-pass flow. The by-pass air flows through the annular duct surrounding the intermediate pressure (IP) and the high pressure (HP) compressors, the combustion chamber and the turbine section, to rejoin the main flow through a colander in the jet pipe.

The core stream flows from the inner portion of the fan, through the IP and HP compressor to the annular combustion chamber, where a controlled quantity of fuel is added to the air and the mixture ignited by two igniter plugs. The gas is expanded through the turbine to the jet pipe where the hot gas mixes with the cold by-pass stream. The turbine section of the engine consists of a single stage turbine, to drive the six stage high pressure compressor, an intermediate single stage turbine to drive the three intermediate pressure compressor, and a two stage turbine to drive the three stage low pressure (LP) compressor. The turbines are mechanically independent of each other.

High and low pressure compressor speed is indicated by individual tachometers as a percentage of nominal maximum RPM. A red and black striped failure flag covers the digital display in the event of a system malfunction, power failure, or is switched off.

During reheat operation, fuel is added to the hot gas stream in the exhaust section by:

- a primary flow introduced through the vaporizers
- a gutter ring flow introduced through fuel spray rings

The by-pass stream is injected with fuel through jets between the radial fingers of the reverse colander.

The area of the nozzle is fully variable in the reheat condition, and is held in a nominal nozzle area position throughout the dry range. To reduce engine thrust for taxing purposes, the nozzle may be fully opened by operating a separate TAXI NOZZLE lever. The throttle movement is then restricted to below MAX DRY (approx. 72% NH).

A bucket type thrust reverser is located at the rear of each jet pipe to reduce aircraft landing distance. The system operates only when the aircraft weight is on the ground. Pilot's throttle lever interlocks prevent simultaneous selection of the reheat and thrust reverser.

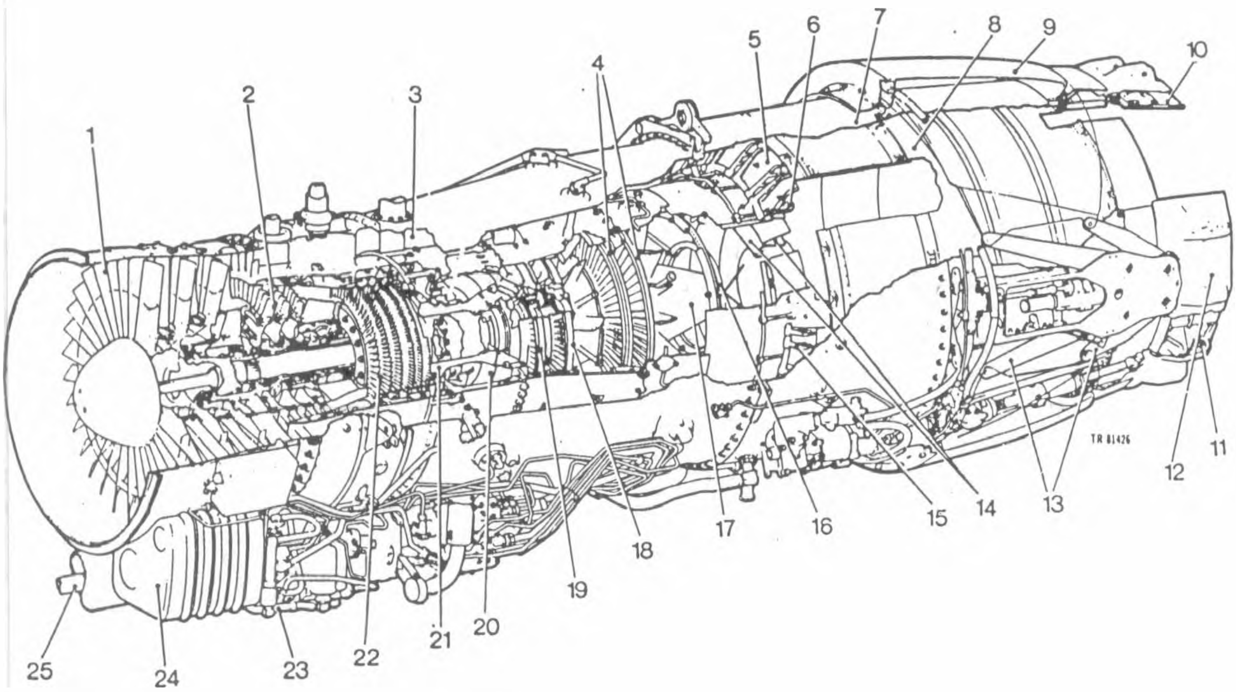
The engine system covers the following items:

- Engine air system
- Engine air intake
- Engine oil system
- Engine fuel control system
- Engine reheat system
- Engine variable nozzle system
- Engine ignition and relight system
- Engine starting system
- Engine thrust reversal system
- Throttles
- Engine instruments and controls
- Engine overheat and fire detection system
- Engine fire extinguisher system

ENGINE AIR SYSTEM

Engine compressor bleed air taken from the compressor at various points is utilized for the following functions:

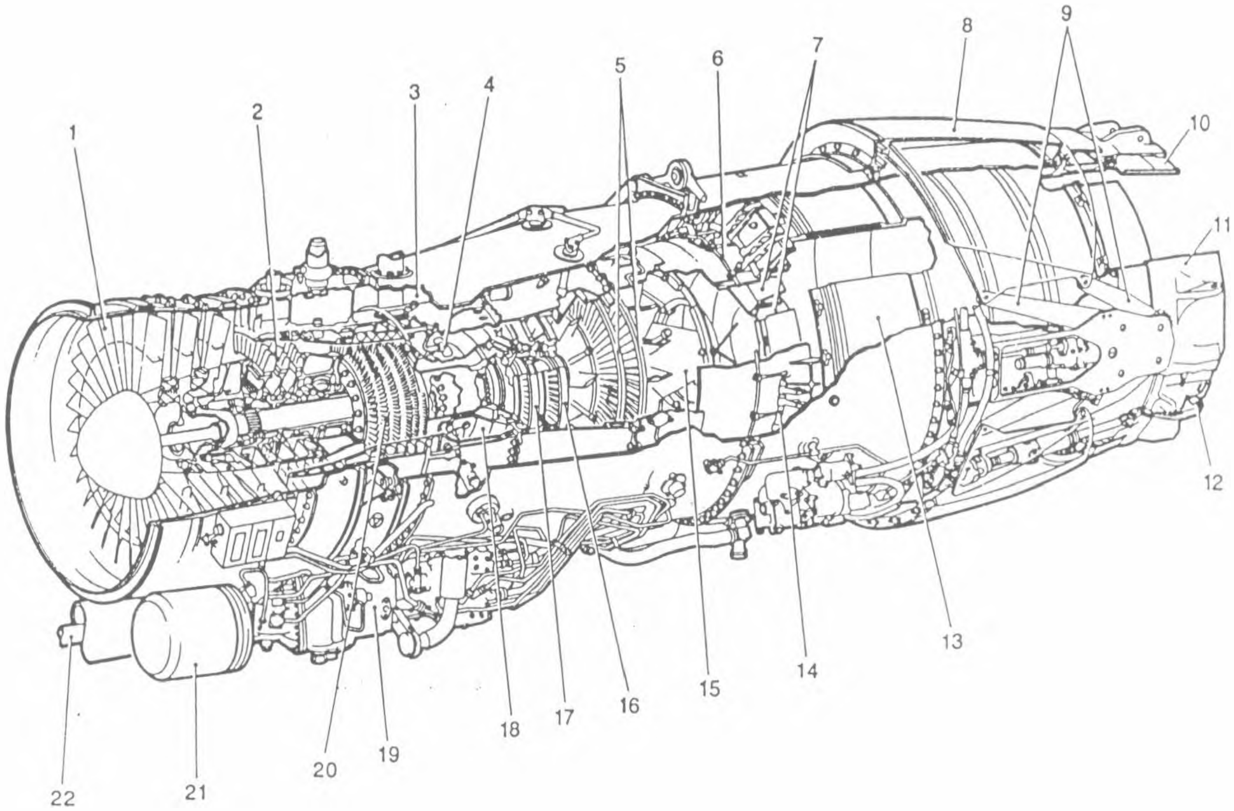
MK-101 ENGINE — ENGINE PRINCIPAL FEATURES



1	LP COMPRESSOR (FAN)	14	REHEAT FLAMEHOLDERS
2	IP COMPRESSOR	15	BY-PASS STREAM REHEAT FUEL SPRAYS
3	BY-PASS DUCT	16	FLAMEHOLDER RING
4	LP TURBINE	17	EXHAUST DIFFUSER
5	BY-PASS	18	IP TURBINE
6	PRIMARY VAPOURIZER	19	HP TURBINE
7	JET PIPE	20	FLAME TUBE
8	JET PIPE HEATSHIELD	21	COMBUSTION CHAMBER
9	THRUST REVERSER BUCKET	22	HP COMPRESSOR
10	PROPELLING NOZZLE FLAP	23	EXTERNAL GEARBOX
11	SHROUD ROLLER	24	OIL TANK
12	PROPELLING NOZZLE SHROUD	25	PTO SHAFT
13	THRUST REVERSER LINKS		

Figure 1-1 (Sheet 1 of 2)

MK-103 ENGINE – ENGINE PRINCIPAL FEATURES



1 LP COMPRESSOR
2 IP COMPRESSOR
3 BYPASS DUCT
4 VAPORIZER
5 LP TURBINE
6 PRIMARY FUEL MANIFOLD
7 FLAME HOLDER RINGS (GUTTERS)
8 THRUST REVERSER BUCKET
9 THRUST REVERSER LINKS
10 NOZZLE FLAP
11 NOZZLE SHROUD
12 SHROUD ROLLER
13 JET PIPE
14 BYPASS FUEL MANIFOLD
15 EXHAUST DUCT AND CONE
16 IP TURBINE
17 HP TURBINE
18 ANNULAR COMBUSTION CHAMBER
19 EXTERNAL GEARBOX
20 HP COMPRESSOR
21 OIL TANK
22 PTO SHAFT

Figure 1-1 (Sheet 2 of 2)

AIR SYSTEM BLEED SOURCES AND UTILIZATION

Air bleed from the compressor stages supplies the following aircraft and engine services:

Pre mod. 01431 (MK101)

Bleed Sources	Utilization
LP compressor delivery air	Fuel tank pressurization External tanks fuel transfer
IP compressor delivery air	IP BOV (Pre mod. 40946) Radial IP BOV (Post mod. 40946) Pressurization of bearing chambers IP compressor balancing chamber Air mixture chamber * Main fuel control unit
HP compressor third stage air	IP turbine stator and rotor cooling First stage LP turbine stator cooling Air mixture chamber * Pyrometer lens purging
HP compressor fourth stage air	Aircraft services (ECS) HP4 bleed valve Variable nozzle air motor
HP compressor delivery air (sixth stage)	IP BOV actuator Turbine pressure ratio transducer Main fuel control unit Reheat fuel control unit Thrust reverser air motor HP6 bleed pressure regulating valve-to-aircraft fuel cooling system HP stator and rotor cooling IP turbine rotor disc cooling HP6 BOV HP6 BOV solenoid Air mixture chamber * HP compressor balancing chamber

* The air mixture chamber distributes cooling air to the IP and LP turbine rotor discs.

Post mod. 01431 (MK103)

Bleed Sources	Utilization
LP compressor delivery air	Fuel tank pressurization External tanks fuel transfer
IP compressor delivery air	Radial IP BOV IP compressor balancing chamber Air mixture chamber * Main fuel control unit
HP compressor third stage air	IP turbine stator and rotor cooling First stage LP turbine stator cooling No's. 5, 6 and 7 bearings chamber pressurization, via heat exchangers Air mixture chamber * Pyrometer lens purging
HP compressor fourth stage air	Aircraft services (ECS) HP4 bleed valve Variable nozzle air motor
HP compressor delivery air (sixth stage)	Radial IP BOV solenoid Turbine pressure ratio transducer Main fuel control unit Reheat fuel control unit Thrust reverser air motor HP6 bleed pressure regulating valve-to-aircraft fuel cooling system HP stator and rotor cooling IP turbine rotor disc cooling Air mixture chamber * HP compressor balancing chamber

* The air mixture chamber distributes cooling air to the IP and LP turbine rotor discs and also transfers heat by convenction to the inner surface at the rotor outer fairing for anti-icing purposes.

IP Blow-Off Valve (IP BOV)

When the IP BOV is opened, a part of the IP compressor air is dumped into the by-pass duct. This moves the IP compressor working line away from the surge line thereby improving the surge margin.

The control unit electronic (CUE) controls the operation of the IP blow-off valves, which will open when one of the following condition exists:

- NH is below 80%
- NH deceleration >2.5%/sec (with a 2 sec closing delay)
- The gun firing trigger is pressed (with a 1 sec closing delay) (Post mod. 10829: 3 sec closing delay)
- And as a function of free stream total pressure and X-drive clutch position i.e. when Pto <27 kPa with X-drive not engaged, and when Pto <58 kPa with X-drive engaged

When the IP BOV is open, a loss of thrust will occur.

HP4 Bleed Air

HP4 bleed air is used for the environmental control system (ECS). Normally each engine will supply half of the aircraft required bleed flow for the ECS. If the HP4 delivery pressure differs by a certain amount between the engines (staggered throttle setting different acceleration characteristics) the higher pressure engine will supply the whole bleed flow.

HP6 Blow-Off Valve (HP6BOV)

When the HP6 BOV is opened, a part of the HP compressor air is dumped into the by-pass duct. The valve is opened by the CUE when:

- NH deceleration >1%/sec and the free stream total pressure is less than 30 kPa (with a 2 sec closing delay)
- The gun firing trigger is pressed (with a 1 sec closing delay)
- And as a function of free stream total pressure and X-drive clutch position i.e. when Pto <27 kPa with X-drive not engaged, and when Pto <28 kPa with X-drive engaged

Post mod. 01332, 01537, 30847
HP6 Blow Off Valve (HP6 BOV) deleted.

ENGINE AIR INTAKES

System Description

The variable area intakes match air mass flow to engine demand and flight conditions in supersonic flight. Intake area is determined by movable ramps, which are operated by the Air Intake Control System (AICS). Two auxiliary, spring-loaded, inward opening intake doors are provided for ground, take-off, and low-speed high-power operation. The AICS consists of an Automatic Control Unit (ACU), and an electro-hydraulic ramp actuator for each air intake, and a common Air Intake Control Panel (AICP) on the front cockpit right console. Each ACU receives inputs from its associated side pitot probe, side static vent, AOA probe, and static pressure tapping in the air intake bleed chamber. The ACU operates dual servo valves on the ramp actuators. In the event of failure a solenoid valve will close and freeze the intake ramps in the position in which they were at the time of failure.
Normal operation of the system will position the ramps between −6.0 degrees and +18 degrees as a function of Mach number, AOA and engine demand. A mechanical lock is provided in each actuator, and can be engaged only with the ramps in the fully open position (−7 degrees) by selecting the associated override switch to ORIDE. If hydraulic pressure is available and NORMAL is reselected the mechanical locks will disengage.
The OPEN indication on the AICP will illuminate when the ramps have reached the −1.0 degrees position, but no indication is given of engagement of the mechanical locks in this position.

Post mod. 10781
A cowl fence is fitted in the forward position on the left hand engine air intake. It reduces the risk of engine surge at subsonic flight speeds and high AOA's.

Air Intake Control Panel

The AICS control panel (C, Figure 1-5) contains the following controls:

RAMP POSITION INDICATORS

Two RAMP POS two-way indicators show the intake ramp positions: OPEN or black and white stripes when the intake ramps are not open.

RAMPS TEST PUSH BUTTON/INDICATOR

A TEST push button, guarded by a transparent cover, initiates a pre-flight BITE test when pressed. Three separate captions show:

- White for TEST
- Green for GO
- Red for NO GO

RESET PUSH BUTTON/INDICATORS

Two combined push button/warning lights, marked FAIL-PUSH TO RESET. If a system fails the associated warning light illuminates. Pressing the PUSH TO RESET button causes the system to resume operation, if the failure was only a transient one.

RAMPS OVERRIDE SWITCH

Two two-position toggle switches, marked NORM/ORIDE, are guarded by black and yellow striped covers in the NORM position. Lifting the guards and selecting the switches to ORIDE unlocks the ramps during emergency operation and drive the intake ramps under hydraulic power to the fully open −7 degrees position, where the mechanical lock engages.
With hydraulic utility pressure available, selecting NORM will disengage the mechanical locks. It is therefore mandatory to maintain the ORIDE position when a hydraulic failure is indicated. The ORIDE position can also be operated to engage the mechanical locks if no actual failure has been sensed by the system.

Central Warning Panel

On the central warning panel in both cockpits an amber warning caption RAMP illuminates if either or both hydraulic actuator lock are frozen.

BITE Test

Before take-off and below 70% NH a pre-flight BITE-test should be carried out by pressing the TEST button (white illumination) on the AICP. If both system are functioning correctly the green GO indication on the AICP will light up. A malfunction in either system will cause the red NO GO indication to light up.
During the BITE test the two FAIL indications and the RAMP indications on the CWP will also come on when the fail mode is checked. On satisfactory completion of the test the TEST and GO indications shall be extinguished by pushing the illuminated buttons a second time. The BITE system is inoperative during flight.

Air Intake Automatic Operation

The AICS will automatically schedule intake airflow throughout the flight envelope to match flight conditions and engine demand. At speeds below Mach 1.3 the ramps are held fully open. During acceleration at approximately Mach 1.3 the ramps are stepped to the 0 degree position, and progressively scheduled to the fully closed position thereafter. The RAMP POS indicators will show black and white stripes.
During deceleration the ramps are progressively scheduled from the fully closed position, and at approximately Mach 1.1 are stepped to the fully open position.
At constant Mach number an increase of AOA will progressively open the intakes and vice versa. Actual ramp position in supersonic flight above Mach 1.3 is a function of all signals received in the ACU: side pitot and side static pressure, Mach number, incidence (a) and engine demand (bleed air static pressure).

ENGINE OIL SYSTEM

The oil system (Figure 1-2, sheet 2 of 2) is self contained within the engine, and provides circulation of oil to lubricate and cool the engine main bearings, the engine gearbox, oil and fuel pump drives and bearings.
Oil is drawn from the tank by a pressure pump and delivered to a pressure filter, excess oil is returned to the inlet side of the pressure pump through a differential pressure relief valve. Separate tappings are provided downstream of the filter to feed the engine main bearings, which are located in three separate chambers. Pressure oil is also fed to the gearbox, to the oil pumps assembly, and to two accumulators which provide a supplementary feed to the No. 4 bearing in negative g conditions.
A non return valve is fitted in the pressure delivery line, downstream of the pressure filter, to prevent oil flowing back to the pump should a failure in the pump occur. Oil from the gearbox and intermediate and rear bearing chambers is returned by scavenge pumps to the oil tank via a fuel cooled oil cooler, which is protected from overpressure by a pressure relief valve. The front bearing chamber is scavenged by the pressure pump. Scavenge filters are fitted in

the oil return lines. Magnetic chip detectors in each filter provides an indication of engine wear and warning of engine components breakdown. The bearing chambers and the accumulator are vented by means of a Cyclon type oil separator, which separates vent air from oil mist. The separated oil is returned to the oil tank through the gearbox oil return line. The Cyclon type oil separator and the oil tank are vented to the external gearbox which in turn is vented overboard via a centrifugal breather and a pressure maintaining valve. This valve provides minimum positive pressure in the system to prevent pressure pump cavitation and to assist oil return to the scavenge pumps.

Central Warning Panel

A pressure switch illuminates an amber (Post mod. 00562: red) L OIL P or R OIL P warning caption (Post mod. 01361: after a 3 sec time delay) on the central warning panel in each cockpit should differential pressure in the main oil system between the oil feed and the scavenge oil fall below 105 kPa. A second switch, set at 35 kPa will illuminate the CWP captions immediately when the pressure in the supplementary system delivery line falls below this value.
Engine oil temperature is sensed by a thermistor type temperature probe in an oil feed line and is set to initiate an amber L OIL T or an R OIL T warning caption on the central warning panel in the front cockpit should oil temperature rise above 165 degrees C.

ENGINE OIL SYSTEM - MK 103 (POST MOD. 01431)

The oil system (Figure 1-2, sheet 1 of 2) is self contained within the engine, and provides circulation of oil to lubricate and cool the engine main bearings, the engine gearbox, oil and fuel pump drives and bearings.
Oil is drawn from the tank by a pressure pump and delivered to a pressure filter, excess oil is returned to the inlet side of the pressure pump through a differential pressure relief valve. Separate tappings are provided downstream of the filter to feed the engine main bearings, which are located in three separate chambers. Pressure oil is also fed to the gearbox, to the oil pumps assembly, and to the HP fuel pump.
A non-return valve is fitted in the pressure delivery line, downstream of the pressure filter, to prevent oil flowing back to the pumps should a failure in the pump occur.
Oil from the gearbox and from the bearing cases is returned to the tank by four scavenge pumps via a fuel cooled oil cooler which is protected from overpressure by a pressure relief valve. Scavenge filters are fitted in the oil return lines. Magnetic chip detectors in each filter provides an indication of engine wear and warning of engine components breakdown. The bearing chambers are vented by means of breathing line which go to the centrifugal oil separator, fitted in the gearbox.
Here the oil is separated from the air and is returned to the oil tank through the gearbox oil return line.
The oil tank is vented to the external gearbox which in turn is vented overboard via a centrifugal breather and a pressure maintaining valve. This valve provides minimum positive pressure in the system to prevent pressure pump cavitation and to assist oil return to the scavenge pumps.

Central Warning Panel

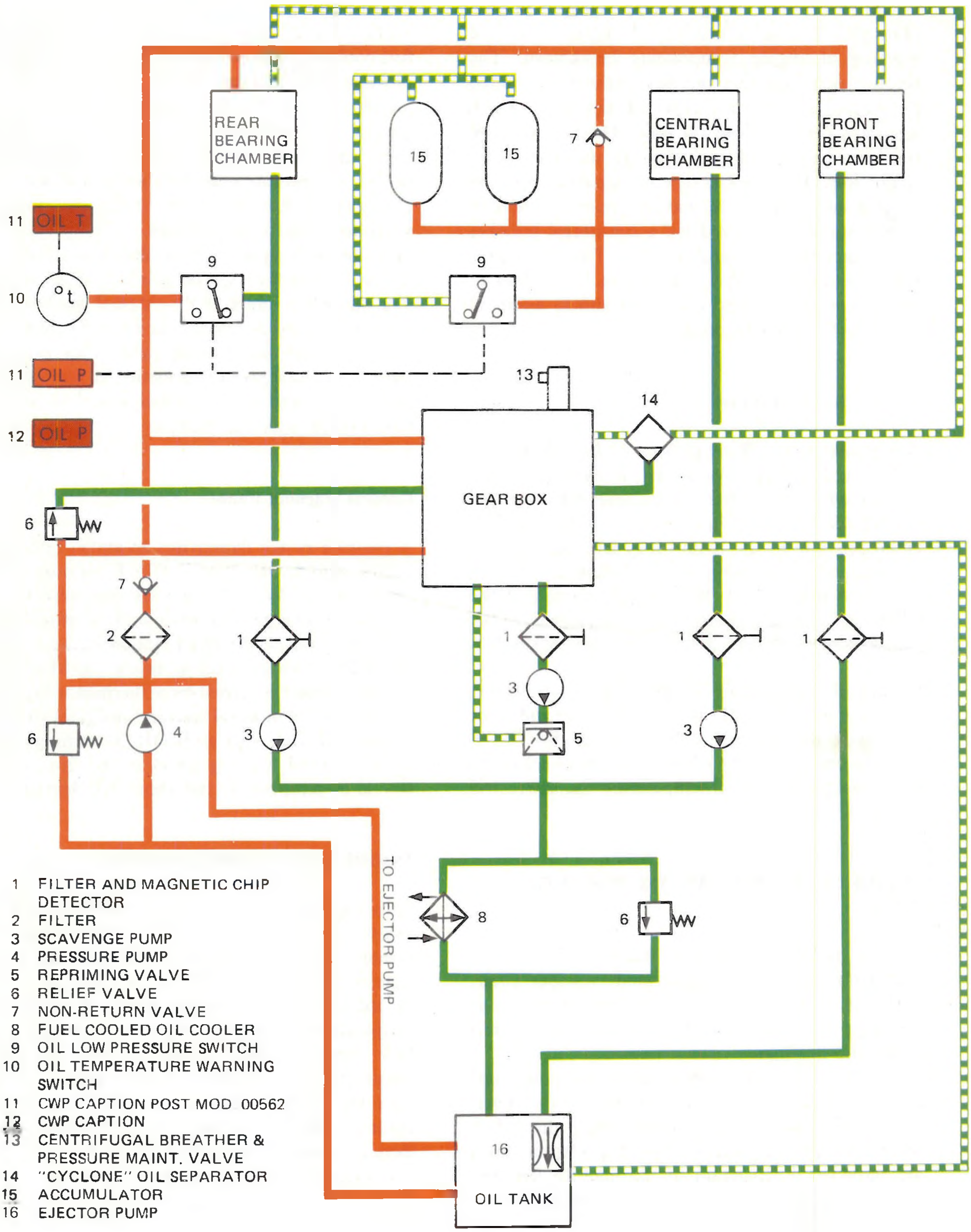
A pressure switch illuminates an amber (Post mod. 00859: red) L OIL P or R OIL P warning caption (Post mod. 01361: after a 3 sec time delay) on the central warning panel in each cockpit should differential pressure in the main system between the oil feed and the scavenge oil fail below 105 kPa. Engine oil temperature is sensed by a thermistor type temperature probe in an oil feed line and is set to initiate an amber L OIL T or an R OIL T warning caption on the central warning panel in the front cockpit should oil temperature rise above 165 degrees C.

ENGINE FUEL CONTROL SYSTEM

Each engine fuel control system automatically provides optimum fuel flow for any throttle setting. The system responds to several engine operating parameters, and makes it unnecessary to adjust the throttle in order to compensate for variations in inlet air temperature, altitude or airspeed. The main engine fuel control unit (MFCU) is a hydro-pneumatic/mechanical system that adjusts and supplies the fuel flow to the burners in response to control unit electronic (CUE) signals routed through electric channel known as lanes.
The engine fuel system consists mainly of:

- A HP, engine driven gear type pump
- A fuel metering valve, in conjunction with a pressure drop control unit, establishes the metered fuel flow to the burners
- A pressure raising valve to maintain a minimum system pressure

RB199 MK101 OIL SYSTEM – SCHEMATIC



1 FILTER AND MAGNETIC CHIP DETECTOR
2 FILTER
3 SCAVENGE PUMP
4 PRESSURE PUMP
5 REPRIMING VALVE
6 RELIEF VALVE
7 NON-RETURN VALVE
8 FUEL COOLED OIL COOLER
9 OIL LOW PRESSURE SWITCH
10 OIL TEMPERATURE WARNING SWITCH
11 CWP CAPTION POST MOD 00562
12 CWP CAPTION
13 CENTRIFUGAL BREATHER & PRESSURE MAINT. VALVE
14 "CYCLONE" OIL SEPARATOR
15 ACCUMULATOR
16 EJECTOR PUMP

SUPPLY LINE — SCAVENGE LINE — BREATHER LINE

Figure 1-2 (Sheet 1 of 2)

RB199 MK103 OIL SYSTEM – SCHEMATIC

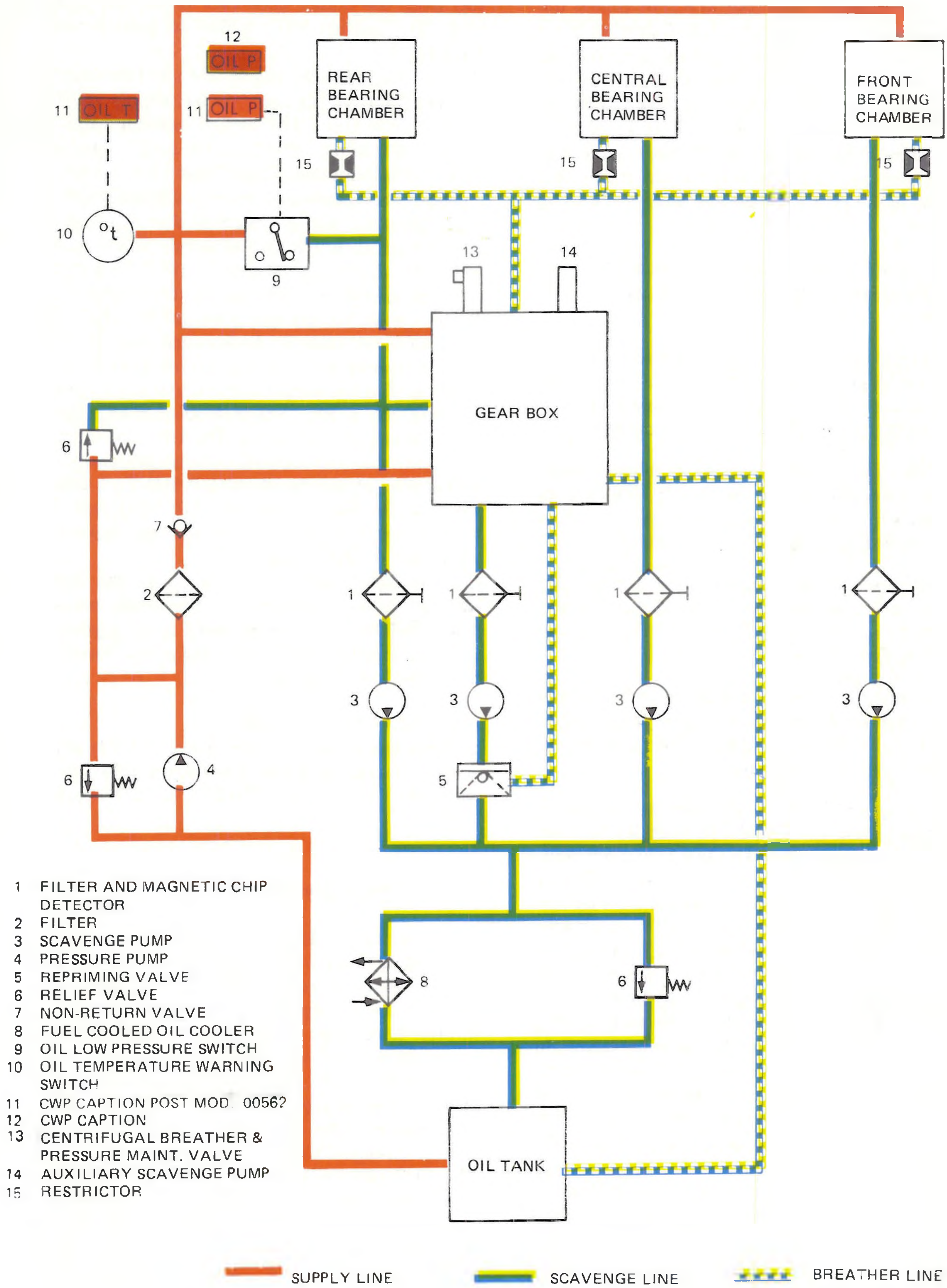


Figure 1-2 (Sheet 2 of 2)

- A HP shut-off cock (HP SOC) to isolate the engine from all main system fuel supplies when the engine is shut down and in its open position, to admit the metered main fuel flow to the burners. The opened and the closed positions of the HP SOC are controlled by an opening solenoid and a closing solenoid respectively. The opening solenoid also admits the starter fuel flow to the starter jets during the engine starting cycle
- A dump valve to drain overboard all fuel downstream of the HP SOC at engine shutdown
- A pneumatic servo system (acceleration control) which adjusts the metering orifice of the fuel metering valve during engine acceleration as a function of the HP compressor pressure ratio
- An emergency spill valve and its solenoid limits the fuel flow to the burners in response to signals from the overspeed governor to prevent overspeeding of the LP and HP spools
- A thermostatic recirculation valve which limits the fuel temperature within the engine fuel system by maintaining sufficient fuel flow through the system
- A check valve that is fitted in the starter fuel line to maintain the system in a fully primed condition and to prevent seepage of fuel into the engine when it is stationary

Basically, engine RPM is demanded by throttle lever position and the actual HP shaft RPM is detected by a pulse probe. The two values are compared in the CUE and the difference in the form of an electronic signal is used to control the fuel metering valve in the main engine fuel control unit. The electronic signal is received in the metering unit by an electric pressure control solenoid. The solenoid adjusts, by means of a hydropneumatic servo system, the magnitude of the fuel variable metering orifice (VMO) in the metering valve. In conjunction with the VMO pressure drop controller, this orifice establishes the required fuel flow. Adjustable mechanical stops are incorporated which allow the adjustment of over and underfuelling for acceleration and deceleration.
In the event of CUE failure, maximum acceleration and deceleration are governed by the fuel control system.
A combined NL/NH overspeed governor operates independently of the CUE to energize an emergency electric pressure control solenoid whenever NL reaches 106.5% or NH reaches 105%. The solenoid opens an emergency spill valve, which spills surplus fuel from the burner lines back to the HP pump inlet, thus limiting the fuel flow to prevent overspeeding.
An HP SOC shuts the engine down by isolating the burners from the main engine fuel supply and returning the output from the fuel metering valve to the inlet side of the HP pump. The cock is operated by two solenoid valves ("open" and "close"). During engine ground starting, the open solenoid valve is energized automatically 5 seconds after initiating an engine start, to provide a fuel supply to the starter jets and to the opening side of the HP SOC, but the SOC remains closed until the throttle is selected to IDLE. When the throttle is selected to IDLE, the close solenoid valve is de-energized and the HP SOC is opened, and remains latched open by fuel pressure. The fuel supply to the starter jets is cut off automatically at 60% NH or 40 seconds after operating the engine start switch. The HP cock remains open until the close solenoid valve is again energized by selection of the throttle to HP SHUT. A dump valve in the line between the HP SOC and the burners opens to dump fuel in the line overboard when the HP SOC closes.
For airborne starting or relighting, the open solenoid valve is energized by the relight button. This provides a fuel supply to the starting jets and also opens the HP SOC, when the pilot's throttle is not in the SHUT position.

Post mod. 01431 (MK 103)
The combined NL/NH over speed governor energize the emergency electric pressure control solenoid whenever NL reaches 106.5% or NH reaches 105.0%.

Main Electronic Control

Engine rating is selected by demands from the pilot's throttle lever which is mechanically connected to the pilot's demand unit (PDU). The PDU produces an AC signal in direct proportion to the throttle lever angle. This signal is amplified and converted to a DC signal and fed to one of the two lanes in the CUE. Lane 1 is the normal control channel through the CUE. Lane 2 is used if lane 1 fails, and provides a duplicate channel with full control through CUE.
The CUE uses the PDU signal, together with other engine operating data, as a basis for a command signal to the MFCU. An electric pressure control solenoid receives the command signal and controls the fuel metering valve to set up the required engine fuel flow.
In addition to lanes 1 and 2 for dry engine control, the CUE contains a single lane for reheat control.

Lane 1 and lane 2 incorporate the following functions:

NH CONTROL

The required HP shaft RPM (NH) is selected on the throttle and a PDU signal, proportional to the RPM selected, is fed to the CUE. The actual NH is detected by a pulse probe and is fed, as a frequency signal to the CUE. The two values are compared in an error unit and, if different, the resulting error signal enters an error integrator from where it emerges as a smoothed output, proportional to the input signal strength and duration. This output is then fed through a "lowest fuel wins" logic circuit. This circuit compares all error signals from the limiter error units within the CUE and passes as its output a signal, demanding the lowest fuel flow to achieve the required result. This output passes to a current driver, which converts the signal to the required current to operate the electric pressure control solenoid. The solenoid adjusts the fuel metering valve that establishes an engine fuel flow to give the RPM selected. At a selected throttle lever position the NH speed remains constant, regardless of aircraft speed or altitude, except when overriden by any limiters.

ACCELERATION CONTROL

The engine RPM rate of change during acceleration is limited by the CUE as a function of the free stream total pressure Pto. This function is defined as follows:
7% NH/sec ^{2} at Pto $\leq$ 100 kPa, decreasing linearly to 0.7% NH/sec ^{2} at Pto = 0 kPa. This means, for example, that the engine acceleration rate on the ground is approx. 7% NH/sec ^{2}, while at 36.000 ft and Mach 1.0 it is approx. 3.5% NH/sec ^{2}.

DECELERATION CONTROL

The conditioned NH signal is differentiated to give NH rate and passed to a rate limiter set to 6% NH/sec ^{2} (Post mod. 01431: 7% NH/sec ^{2}).
A tendency to exceed the limit causes an error signal to be passed to the "highest fuel wins" circuit via an error integrator, thus modifying the LPC solenoid signal and increasing fuel flow until the rate of deceleration is on the limit.

IDLING CONTROL

The idle NH speed is established by the idle schedule of the CUE. An idle function generator computes the schedule from inputs of ambient static pressure, free stream total pressure and intake total temperature, and applies an output to the governor shaper modifying the NH signal demanded by the throttle position (Figure 1-3).

TEMPERATURE LIMITER

The CUE determines the TBT limit as a function of intake temperature (T1) and Post mod. 01431: free stream total pressure Pto. Actual turbine blade temperature (TBT) is compared to this value. If actual TBT exceeds the limit value, the resulting error signal is passed via an error integrator and the "lowest fuel wins" logic circuit to produce an electric pressure control solenoid signal. The signal reduces engine fuel flow until engine temperature is on the datum. The datum can be changed as follows:

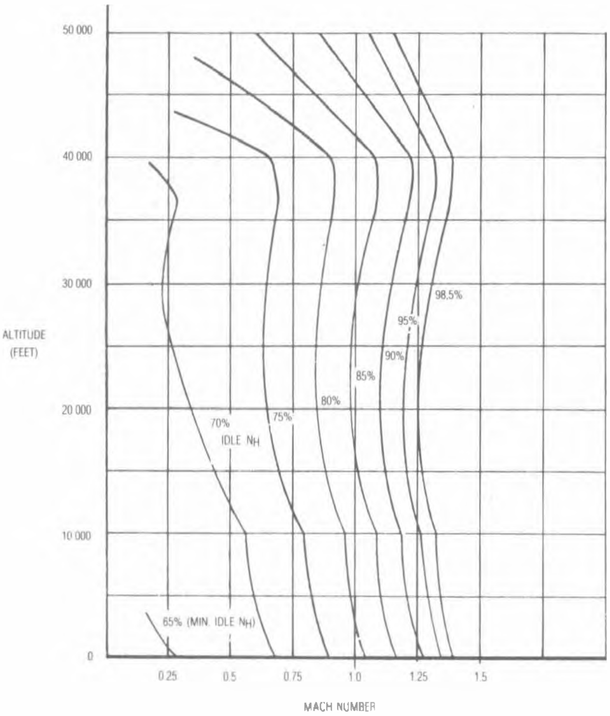
- Selecting the TBT switch to DATUM the maximum normal cleared thrust is obtained
- Selecting the TBT switch from DATUM to LOW decreases the normal maximum TBT by 36 degrees C
- Selecting the throttle to COMBAT increases the datum by 15 degrees C (Post mod. 01431: 23 degrees C) for each TBT switch position

Lane Control

The aircraft is fitted with a CUE 300 (Post mod. 01431: CUE 400) in which lane 1 is a normal operating channel and lane 2 is a standby duplicate channel, which is also functioning but is not selected. Both lanes have reversionary channels; lane 1 reversionary as well as lane 2 reversionary have an NH governor and a TBT limiter.
Should a failure on lane 1 be detected a "safety select" feature automatically transfers control to lane 2, if lane 2 is serviceable (if lane 2 is already failed, control is automatically transferred to lane 1 reversionary). A lane control failure illuminates the amber L THROT or R THROT captions on the central warning panel (CWP) in the front cockpit. The captions cancel when a successful automatic transfer to lane 2 is followed by selecting LANE 2 on the engine control panel. Whenever lane 2 is selected lane 1 is de-energized. The captions re-appear, together with the REHEAT caption, and remain lit if a failure of lane 2 transfers control to lane 2 reversionary. Switching to a reversionary lane causes reheat, if lit, to be maintained frozen at the selected position when the failure occurred. When reheat is cancelled the nozzle will go to emergency nozzle closure (ENC) automatically. Engine handling with a throttle warning on lane 2 shall be carried out with reference to the NH and TBT indicators. If NH

IDLE SCHEDULING

MK 101



MK 103

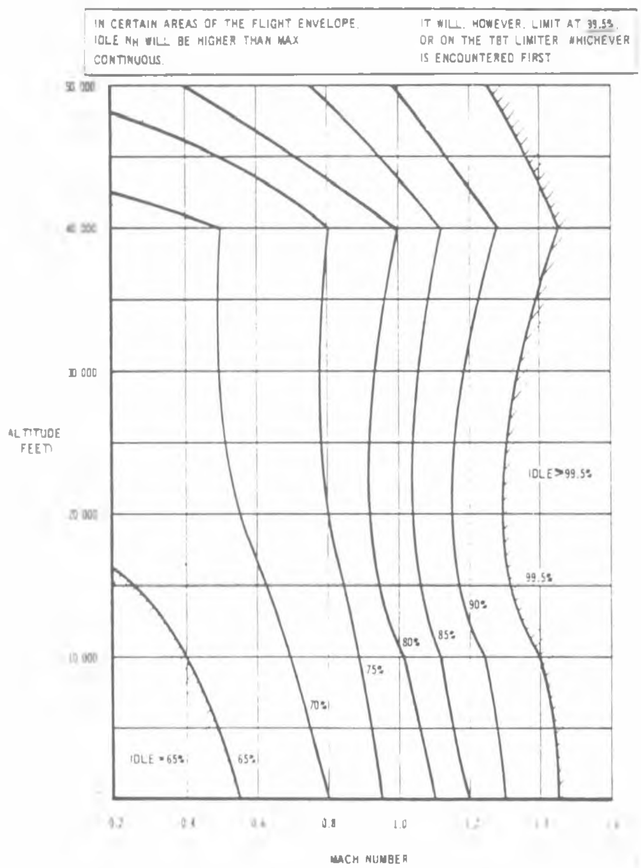


Figure 1-3

cannot be controlled, lane 2 reversionary has failed. There is no automatic transfer of control from lane 2 reversionary to lane 1 reversionary, however, lane 1 recersionary may be gained by selecting LANE 1 on the engine control panel. The failure of both reversionary channels releases electronic control and engine speed can increase until restrained by the emergency overspeed governors (see "ENGINE FUEL CONTROL SYSTEM").

If lane 2 has failed, the CUE 300 still accepts a lane 2 selection from a serviceable lane 1, with the consequence of an engine run-up to the overspeed governor limit if lane 2 reversionary has also failed.

(Post mod. 01431:)
If lane 2 has a detected fault the CUE 400 will not except a lane 2 selection from a serviceable lane 1. In this case control will stay on lane 1 and the THROT caption on the CWP will illuminate).

CUE LANE TEST

Two LANES TEST buttons on the engine control panel allow testing of the CUE automatic lane changeover by simulating a failure on the lane selected by the ENG CONTROL switch. The tests may be carried out both before or after starting the engines. After starting, however, the test shall not be carried out at other than idle RPM.
With LANE 1 selected, pressing and holding the appropriate LEFT or RIGHT button initiates the automatic change to Lane 2 and activates the amber L THROT or R THROT CWP warning. The LEFT button **only** also simulates oil, fuel and TBT over-temperature conditions resulting in the TBT indication being driven in excess of 925° C for **both** engines and activation of L and R TBT, OIL T and FUEL T warning captions on the CWP. Releasing the button cancels the warnings and reselects Lane 1.

NOTE

> If an engine is cold, the appropriate CWP TBT caption may not come on until after about 2 minutes running.

With LANE 2 selected, pressing and holding a LANES TEST button initiates the automatic changeover to LANE 2 reversionary. When both buttons are pressed, the same indications will appear as for LANE 1 testing plus illumination of an amber REHEAT caption on the front cockpit CWP. Only with running engines the nozzle will go to ENC, which shall be reset after releasing the buttons by

pressing the relight button on the appropriate throttle. When LANE 1 is reselected the L or R THROT indication may illuminate during the transfer and extinguish when the transfer is completed.
A lanes test with LANE 2 selected will cause setting of the REHEAT indication on the maintenance panel which should be reset.

Engine Vibration Detection

Engine vibration is detected by transducers located at the front and rear of engine body. Signals equivalent to vibration levels are fed from the two transducers to an engine vibration amplifier. Whenever the vibration levels exceed 50 mm/sec (front) or 35 mm/sec (rear), the engine vibration amplifier activates the amber L VIB or R VIB captions on the CWP. Activation of the amber L/R VIB captions is registered by the crash recorder and engine vibration exceeding 40 mm/sec (front) or 24 mm/sec (rear) is registered on the Central Maintenance Panel.

Post mod. 00859.
The red captions are removed. The red L/R VIB captions are inoperative (except during CWP TEST 1). An engine vibration amplifier test datum of 2 mm/sec allows a system check, thus the amber L/R VIB captions illuminate during CWP TEST 2 after engine start. Up to 75% NH may be required to bring the VIB captions on steadily.

Post mod. 00245.
The amber L/R VIB captions can also be activated by the CUE if reheat buzz (detected by a buzz transducer and amplifier) exceed a predetermined level.

Post mod. 31191.
Reheat buzz indication is deleted.

ENGINE REHEAT SYSTEM

Reheat augments engine thrust by injecting fuel into the engine exhaust stream in the reheat section where it is ignited by a hot streak ignition system. Selection of the reheat is achieved by moving the throttle lever beyond the MAX DRY position detent. This initiates the operation of a sequence timer in the reheat electronic control, which drives the nozzle and the reheat fuel control unit (RHFCU) through a priming, settling, ignition and topping-up sequence. After the light up sequence the nozzle is positioned according to the degree of reheat selected by the throttle.
The reheat fuel flow is scheduled by the CUE as a function of nozzle area or via RHFCU as a function of compressor delivery pressure HP shaft speed and intake temperature.
The system takes 3 seconds from MAX DRY to MAX REHEAT at sea level, and 3.5 seconds to cancel.

Reheat Fuel System

The reheat fuel system supplies fuel to both the hot main stream reheat zone and to the cold bypass stream reheat zone. The reheat fuel system consists of the following major components:

- Vapor core pump (VCP) and inlet valve
- Main metering valve (MMV) and primary metering valve
- Pressure drop regulators (PDR)
- Dual throttle valves and colander pressurizing valve
- Light-up and cancellation controls
- Emergency shut-off valve
- Shut-off, primary and dump valve (SOPDV)

After the light-up sequence, reheat fuel flow is scheduled by the RHFCU (via CUE) as a function of nozzle position, which in turn is a function of the throttle demand.
A vapor core pump, driven by the engine gearbox and controlled via an inlet valve supplies high pressure fuel to the RHFCU. The fuel passes through a main metering valve with two orifices, one of which meters hot zone fuel flow and the other the cold zone fuel flow. The area of the orifices is controlled by the fuel turndown actuator to give the fuel flow required for the degree of reheat selected. Both orifices are also controlled by HP compressor delivery pressure to allow for changes of air mass flow through the engine.
Normal cancellation of reheat is achieved by moving the throttle to the dry range, which selects the nozzle to the closed position. The fuel turndown actuator follows the nozzle position until the actuator reaches a present angle whereupon it closes completely, shutting off the fuel.
In the event of an electronic reheat system failure during reheat operation, reheat is frozen, the amber REHEAT caption on the front cockpit lights up and when the throttle is moved back into the dry

range an emergency shut down solenoid valve cancels and latches reheat and nozzle area gauge indicates the ENC value. In the event of reheat electronic control system failure when in dry power, the reheat is inhibited and the REHEAT caption, on the CWP, comes on. However, if it is a transient failure, it can be reset by pressing the relight button on the relevant throttle.

Reheat Electronic Control System

Reheat selection and modulation is made on the throttle lever, which is mechanically connected to the Pilot's Demand Unit (PDU). The PDU signal is fed via a signal channel logic circuit to the reheat control within the CUE. The reheat control uses the PDU signal together with other relevant input data to drive three actuators. One to select a nozzle position, one to control the reheat fuel flow as a function of actual nozzle position and one to control the reheat fuel flow as function of intake temperature.
When the throttle lever is moved beyond the MAX DRY position detent, the resulting PDU signal initiates the operation of a sequence timer in the reheat control to drive the nozzle position actuator and the fuel turn-down actuator through the light-up sequence. Subsequent to reheat light-up, change-over switches are operated by the sequence timer to move control of the nozzle position actuator from the sequence timer to an error unit in the reheat control. A nozzle position feedback signal (Aj) is compared with the selected nozzle position signal from the PDU in the error unit. Any resulting error signal is used to drive the nozzle position actuator.
The reheat electronic control system maintains the dry running nozzle area when reheat is off.
The reheat control system provides a partial protection against reheat blow out or failure to light. At approach and take-off conditions with reheat nozzle above 70-75% Aj the nozzle will automatically cancel to dry nozzle area in the event of reheat blow out or failure to light. Automatic cancellation may not occur at demanded reheat settings of less than approximately 70-75% Aj. In this case a thrust considerably less than maximum dry will be experienced until the pilot moves the throttle back to MAX DRY. In either case further reheat selections may be made after moving the throttle back to the dry range.
If the reheat control system or if both LANE 1 and LANE 2 main control lanes fail, a safety logic will freeze the reheat control, allowing reheat to be maintained at the position existing at the time of failure. If it is required to shut down reheat, movement of the throttle to the dry range will remove power from the solenoid of the emergency shut-down valve, which after a delay of three seconds (to prevent interference with normal shut-down sequence) will close the reheat pump inlet valve, shutting down reheat fuel.
The safety logic will energize the emergency nozzle close valve 0.5 seconds after fuel supply shut-down. A latching system will prevent reselection of reheat.
The reheat light-up sequence will take place only if the following conditions are fulfilled:

- The thrust reverse buckets are not deployed
- NH is above approximately 87%
- Sufficient time for purging (5 seconds) (Post mod. 01431: 1.5 ÷ 5 seconds, depending on Pto) has elapsed since the previous cancellation of reheat

Angle of turn-down actuator is less than 5 degrees.

Reheat Ignition

The function of the reheat ignition system is to ignite the fuel in the reheat section and initiate reheat operation. Advancing the throttle into the reheat range satisfies the fuel flow requirements for reheating the hot gas stream and the by-pass stream.
During ignition the "hot shot" system injectes a timed and metered spray of fuel into the combustion chamber through a hot shot injector to create a flame streak, which ignites the reheat fuel from the primary vaporizers.

ENGINE VARIABLE NOZZLE SYSTEM

The variable nozzle system opens and closes the engine exhaust nozzle for reheat modulation.
The moving shroud, multi-petal, variable area nozzle comprises 14 pairs of interlocking petals hinged to the rear of the jet pipe. Rollers mounted in the moving shroud run on tracks in the flaps to vary nozzle area in proportion of the fore and aft movement of the shroud. The shroud is positioned by four screws jacks driven through flexible ring shafting by an air motor.
The nozzle area control is a pneumatic-mechanical unit that sets the nozzle area according to the throttle reheat demand. The nozzle area is varied only during reheat operation between 32 and 102% (Post mod. 10781: 100% on the left engine) indicated (Post mod. 01431: between 28% and 98% indicated). During dry engine run the nozzle actuation system is electrically controlled to maintain a fixed area of approx. 16% (Post mod. 01431: fixed area of approx. 12 ± 2.5%). Selecting the TAXI

NOZZLE lever to OPEN operates a microswitch to provide signals to the CUE to fully open the nozzles, thereby reducing thrust to an acceptable level for taxiing. The lever selection also positions mechanical stops which limit the throttles at 17.5 degrees (which corresponds to approx. 75% NH) before the MAX DRY detent.
Airborne nozzle opening is inhibited by means of WOG switch.
A solenoid valve in the nozzle actuation system is energized by the reheat safety logic in the CUE, following a reheat control failure (see "REHEAT ELECTRONIC CONTROL SYSTEM"). The valve operates to close the nozzle until the position in the air motor reaches the limit of its travel, giving a minimum (ENC) area of 5 to 13% indicated (Post mod. 01431: minimum (ENC) area of 5 to 9% indicated). Pressing the throttle relight button attempts to reset the reheat safety logic for the associated engine.
If the reset is successful the nozzle area increases from ENC to 16% indicated (Post mod. 01431: 12%). Reheat will not reset if electronic control is on a reversionary control lane.

ENGINE IGNITION AND RELIGHT SYSTEM

The function of the engine ignition system is to initiate ignition of the fuel in the combustion chambers during the starting cycle, and to provide an engine ignition source in the event of a flame-out. Ignition is achieved by the high energy electrical discharges from two surface discharge ignitor plugs in the combustion chamber ignitor tubes. Power to each plug is supplied by a high energy ignition unit (HE), each comprising two circuits; an AC circuit which is non-operative and a DC circuit for engine starting and relighting.
For engine starting the ignition circuits are energized when the ENGINE START switch is selected to LEFT or RIGHT and remains energized for 40 seconds (Pre mod. 00541: 30 seconds) after releasing the switch, or until the engine accelerates through 60% NH, whichever is the sooner.
For engine relight on a windmilling engine, the ignition circuits are energized for 40 seconds (Pre mod. 00541: 30 seconds) by pressing the relight button on the throttle. This also energizes the HP cock opening solenoid to provide a 40 seconds (Pre mod. 00541: 30 seconds) fuel supply to the starter jet. When the IGNITION switch on the ENG CONTROL panel on the front cockpit right console is set to the NORM position, automatic ignition is provided by the CUE which activates the DC circuit whenever the throttle lever position is at IDLE or above and:

a. NH deceleration is outside predefined boundaries (flameout)

b. $NH/\sqrt{\theta}$ is below 55% NH

c. Weapons firing

CAUTION

WHEN THE HP COCK IS SHUT, IT WILL NOT REOPEN WHEN THE THROTTLE IS SELECTED TO IDLE, UNLESS THE OPENING SOLENOID IS ENERGIZED, AS NO FUEL IS AVAILABLE TO OPEN THE HP SOC MECHANICALLY AGAINST SPRING PRESSURE. THE OPENING SOLENOID IS ENERGIZED BY THE ENGINE START SWITCH EITHER PRESSING A RELIGHT BUTTON, OR BY THE AUTO IGNITION FUNCTION OF THE CUE.

NOTE

NH is a parameter which is dependent on air inlet total temperature (Tt1). The relationship between automatic relight and temperature is shown by the chart in Figure 1-4; essential relight is initiated early (i.e. at higher minimum % NH) with temperature increase.

Auto-ignition by the CUE can be switched off by the ignition switch on the ENG CONTROL panel from NORM to OFF.

Relight Push Buttons

A relight push button (A, 5, Figure 1-5) is located on the rear of each throttle lever. Pressing a relight button will:

- Activate the associated engine DC igniter circuit for 40 seconds (Pre mod. 00541: 30 seconds)

AUTOMATIC RELIGHT /√Θ

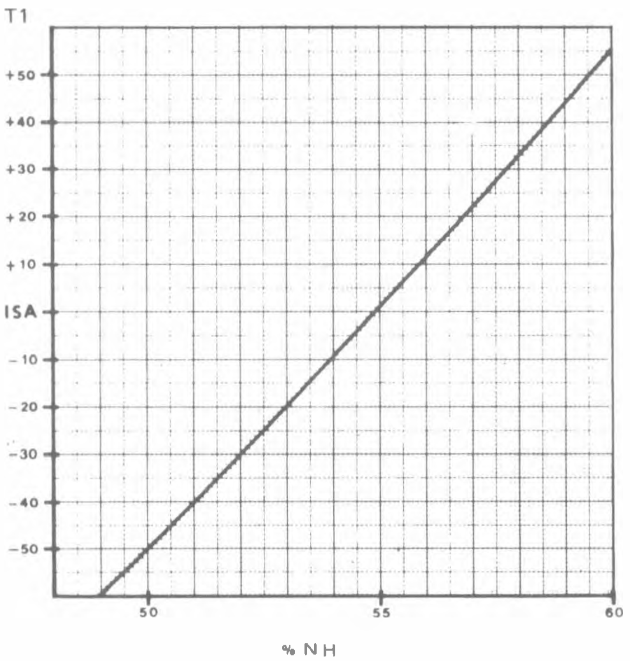


Figure 1-4

- Energizing the opening solenoid of the HP SOC for 40 seconds (Pre mod. 00541: 30 seconds) to provide fuel to the starter jets
- Open the HP SOC after moving the throttle form SHUT to IDLE

ENGINE STARTING SYSTEM

Ground starting of the engines is achieved by the secondary power system. The HP shafts of left and right engines are connected to airframe mounted accessory gearboxes by power take-off shafts. An auxiliary power unit (APU) drives the right accessory gearbox through a friction clutch. The accessory gearboxes can be interconnected by a cross-drive shaft and clutch, allowing both engines to be driven by the APU or either engine.

For engine starting a torque converter is installed on each gearbox. With the APU running and driving the right gearbox, selecting the ENGINE START switch to the appropriate position will cause the torque converter to fill with oil and the selected engine to rotate via the power take-off shaft. Engine ignition system will also be initiated. The APU is automatically shut down when engine speed reaches 60% NH (Post mod. 01431: 59% ± 2% NH). The second engine is started in a similar manner, but with the gearbox being driven by the running engine.

To cancel start, the start cancel pushbutton shall be pressed and the throttles shall be selected to the HP SHUT position. (Post mod. 00644, 11042: start can be cancelled by selecting only the throttles to the HP SHUT position).

ENGINE THRUST REVERSAL SYSTEM

The thrust reverser comprises two "buckets" attached to the jet pipe by means of eight movable links. Driven by an air motor through flexible ring shafting, the links swing rearwards to position the buckets downstream of the nozzle, deflecting the jet efflux forward to provide a reverse thrust of approximately 50% of the corresponding forward thrust from IDLE to MAX DRY setting.

Strakes in each bucket deflect the lower regions of the jet efflux sideways to reduce hot gas re-ingestion by the engines. A re-ingestion audio warning is given at 60 knots using the low-pitched (600 Hz) interrupted tone. The system can either be activated after landing or prearmed in flight to operate immediately following touchdown. Rocking the right throttle outboard in the dry range feeds a signal to an electronic logic unit, which supplies control signals to both engine thrust reversal actuator systems. The bucket lock mechanism is disengaged and the buckets deployed within one second, provided that the aircraft weight is on the landing gear, i.e. the right weight on ground (WOG) switch is closed. The system may be preselected prior to touchdown, provided that the LIFT DUMP magnetic indicator shows grey (Post mod. 01399: a white cross on grey background). An OL (oleo switch circuit) indication in flight denotes a WOG microswitch circuit failure, and to preselect the system under these circumstances presents the danger of bucket deployment in the air and shall therefore be avoided.

The airbrakes, if extended, are automatically retracted upon thrust reverser deployment.

THROTTLES

A set of throttles (A, 6, Figure 1-5) is provided in the front cockpit. A throttle lever controls each engine from HP SHUT in the full aft position to COMBAT in the full forward position, passing through IDLE, MAX DRY and MAX REHEAT positions. The levers can be rocked outboard in the dry range only to select reserve thrust and/or lift dump.

A latch on each throttle quadrant prevents inadvertent selection of the throttle levers to HP SHUT. The latches shall be pressed forward to allow the throttle levers to be moved from IDLE to HP SHUT.

Taxi Thrust Selector

A selector lever (A, 1, Figure 1-5) which when lifted and rotated forward displays TAXI NOZZLE OPEN in red, and fully opens the nozzles, thereby reducing thrust for taxiing purposes. With taxi thrust selected, throttle movement is restricted to approx. 75% NH and reverse thrust is inhibited, although the throttles may still be rocked outboard. In the normal thrust position the selector displays TAXI NOZZLE SHUT in white.

ENGINE INSTRUMENTS AND CONTROLS

Engine Start Panel

The engine start panel (A, Figure 1-5) comprises the following controls:

ENGINE START SWITCH

The engine start switch is a three-position toggle switch, spring-loaded to the center of position marked LEFT/RIGHT. Selecting LEFT or RIGHT initiates the start cycle of the corresponding engine.

START CANCEL BUTTON

The start cancel button is a push-button, which when pressed closes the fuel supply to the engine starter jets, deenergizes the igniter units, empties the torque converters and resets the engine start cycle. A green light integral with the button illuminates during the engine start cycle.

Engine Control Panel

The engine control panel (B, Figure 1-5) carries the following controls:

IGNITION SWITCH

The engine ignition switch is a two-position latch-toggle switch marked IGNITION – OFF/NORM. If the OFF position, automatic ignition by the CUE is switched off.
In the NORM position, automatic operation of the DC ignition system and energizing of the HP cock opening solenoid to provide the started jet fuel is initiated by the CUE (see ENGINE IGNITION SYSTEM).

TURBINE BLADE TEMPERATURE SWITCH

The turbine blade temperature switch is a two-position latch-toggle switch, marked TBT – DATUM/LOW, which may be selected as required. In position DATUM the TBT datum is set to flight clearance setting.
In position LOW the TBT datum is reduced by 36 degrees C.

LANES TEST BUTTONS

Two push buttons marked LANES TEST – LEFT/RIGHT, when held pressed simulate a failure of LANE 1 (ENGINE CONTROL switch in lane 1 position) to test the automatic transfer of engine control from lane 1 to lane 2. (For detailed information refer to "ENGINE OPERATION, Pre-taxi checks").

ENGINE CONTROL SWITCHES

Two two-position toggle switches, marked ENG CONTROL – LEFT/RIGHT – LANE 1/LANE 2, to select the required engine control lane.
LANE 1 – Normal operating lane
LANE 2 – Standby operating lane.

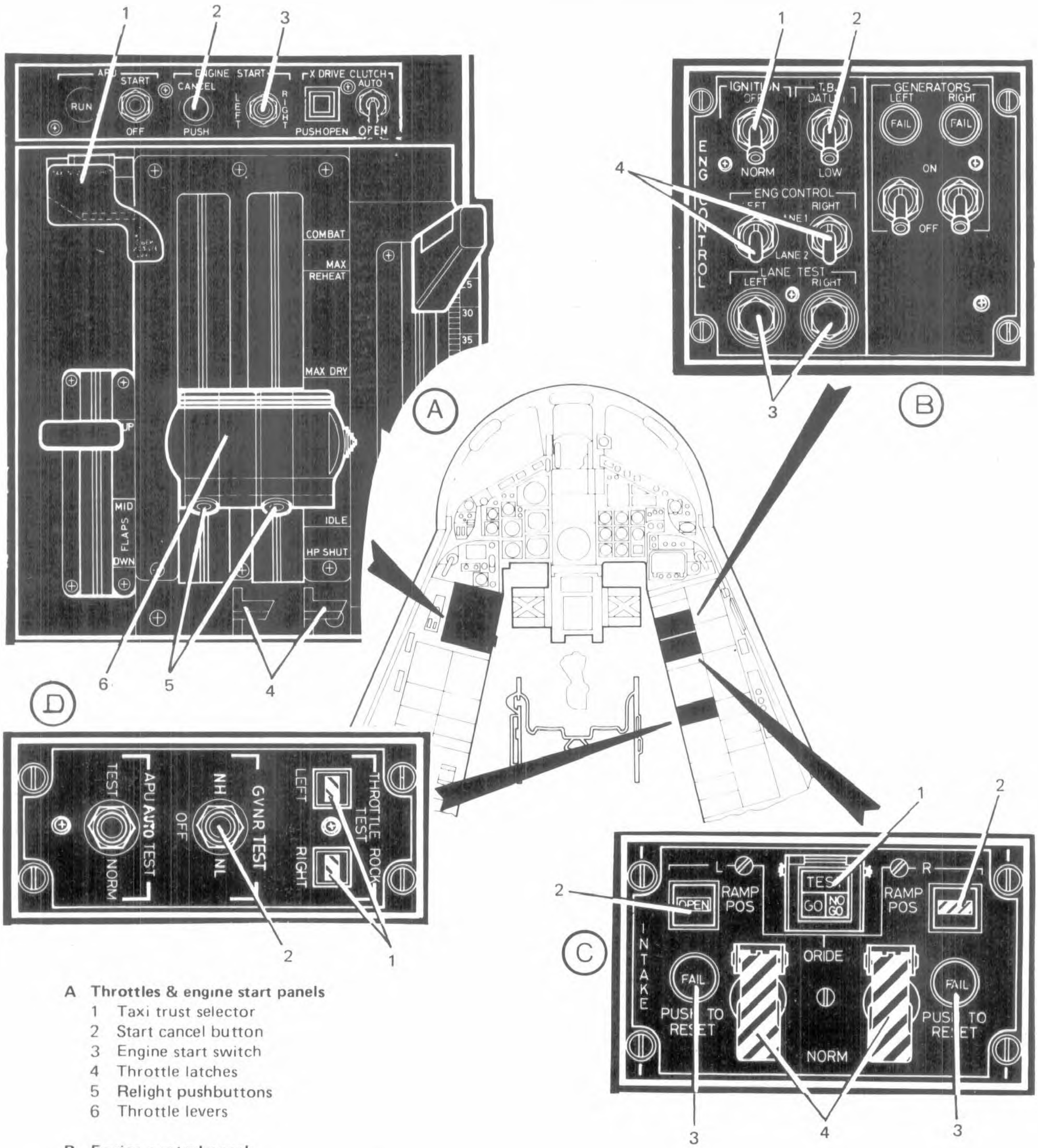
Engine Test Panel

The engine test panel (D, Figure 1-5) carries the following controls:

THROTTLE ROCK TEST INDICATORS

The throttle rock test indicators are two magnetic indicators marked LEFT and RIGHT, which show the result of a throttle rock test.
With electrical power applied to the aircraft, or subsequent to a throttle rock test, the display should be white, indicating that the LD and TR selection circuits are serviceable. A black and white striped display indicates a circuit malfunction or a power off condition.

ENGINES CONTROL AND INDICATORS



A **Throttles & engine start panels**
1 Taxi trust selector
2 Start cancel button
3 Engine start switch
4 Throttle latches
5 Relight pushbuttons
6 Throttle levers

B **Engine control panel**
1 Ignition switch
2 TBT switch
3 Lanes test buttons
4 Engine control switches

C **Air intake control panel**
1 Ramp test pushbutton/indicator
2 Ramp position indicators
3 Reset pushbutton/indicators
4 Ramps override switches

D **Engine test panel**
1 Throttle rock test indicators
2 Governor test switch

Figure 1-5

CAUTION

THE THROTTLE ROCK TEST SHALL ONLY BE CARRIED OUT WITH THE ENGINES RUNNING AT IDLE RPM.

GOVERNOR TEST SWITCH

The governor test switch is a three position toggle switch marked GVNR TEST – NH/OFF/NL, spring-loaded to OFF, and is used to check the operation of the HP and LP overspeed governors. When NL is selected, RPM indicators display the letters NL and indicate NL compressor speed.

Engine Temperature Indicators

Two indicators (4, 7, Figure 1-6) provide a rotating pointer display (0 – 10 X 100° C) in increments of 100 degrees centigrade, and a repeat digital read-out (0-999) of engine operating temperature. From 0 to 545 degrees C TBT, T7 is indicated. Above 545 degrees C TBT, TBT is indicated. Should a TBT sensor fail, temperature indicator reverts to the T7 mode. A red and black striped flag indicates a display failure, or power off condition, however as the indicator cannot indicate temperatures below 0 degrees C, the flag will appear if the instrument is sensing less than 0 degrees C, e.g. before engine start. To test the correct behaviour of the indicator, the appropriate lanes test button should be pressed. The instrument should read 925 ± 5 degrees C within 5 seconds with the flag not visible.
The T7 temperature sensor is situated behind the LP turbine outlet, and TBT is sensed by two pyrometric pickups looking at the intermediate pressure turbine blades.

NOTE

Although the T7 indicator will give evidence of light-up, temperature indications are likely to be inaccurate, particularly in the case of engines not incorporating mod. 40960 when T7 may indicate more than 675 degrees C. As long as the T7 flag on the indicator is visible these values may be ignored.

Nozzle Area Indicators

Two indicators (5, 6, Figure 1-6), with a rotating pointer display nozzle area as a percentage (0 to 100%) in increments of 5%.

Engine RPM Indicators

Two engine RPM indicators (1, 2, Figure 1-6), provide a rotating pointer and a hundreds, tens, and units digital read-out of NH or NL spool speed as a percentage of a nominal maximum RPM. A red and black striped failure flag covers the digital display when a system malfunction occurs, or at power off conditions. NH or NL flag indicate which spool speed is being displayed.

NL/NH Indication Changeover Switch

The NH/NL indication changeover switch (9, Figure 1-6) is a two-position toggle switch marked NL/NH, spring-loaded to NH, and selects the spool speed to be displayed on both RPM indicators.

Fuel Flow Indicator

An indicator labelled FUEL FLOW (3, Figure 1-6) presents a L and R pointer display of dry power fuel flow in kg/min to each engine.

Reheat Operation Lights

Two reheat operation lights (8, Figure 1-6) are located on the right anti-glare shield and are inoperative.
Post mod. 01670 reheat operation lights are deleted.

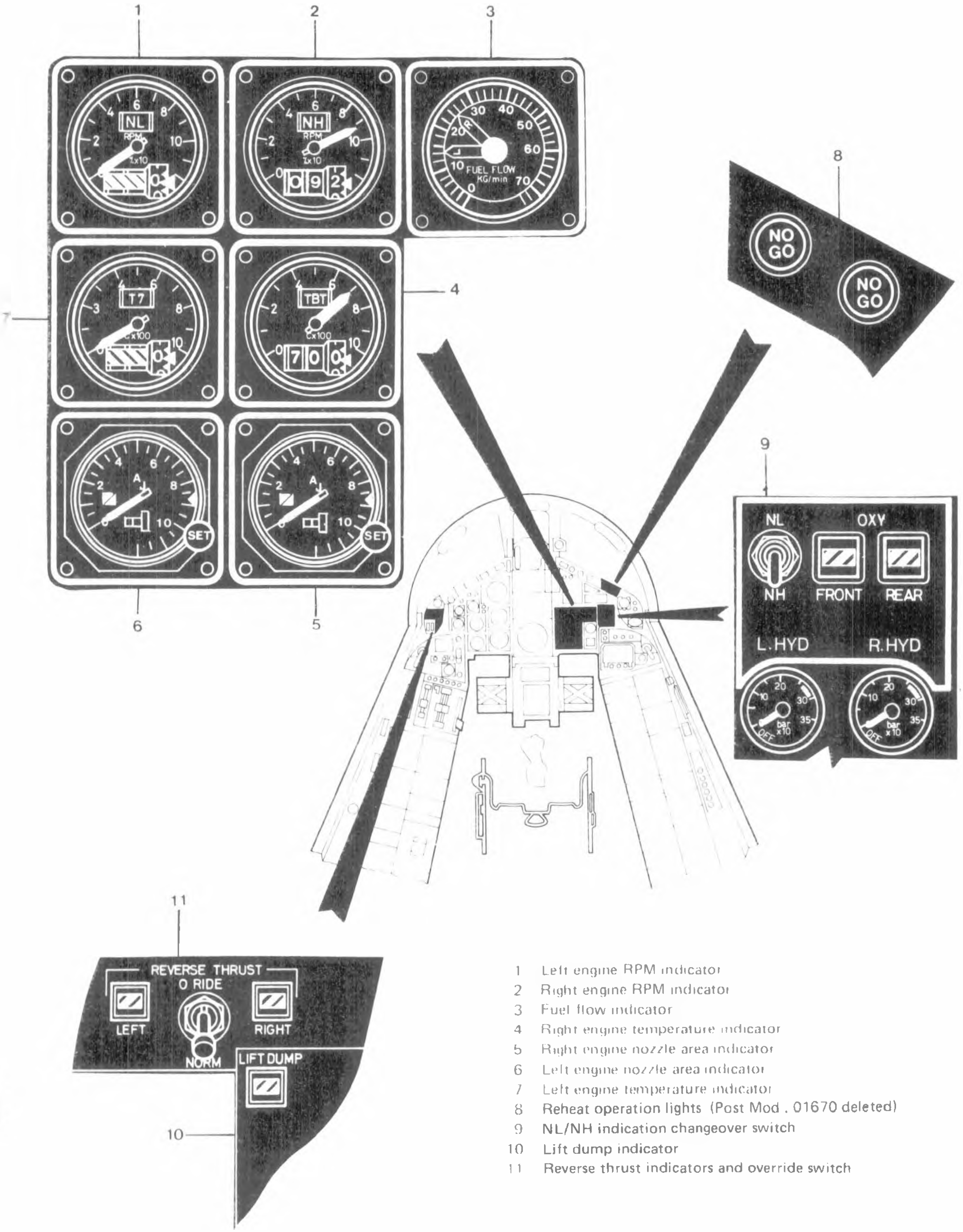
Reverse Thrust Indicators and Override Switch

REVERSE THRUST INDICATORS

The reverse thrust indicators (11, Figure 1-6) are two three-position magnetic indicators, marked LEFT and RIGHT.
They display:

Grey	Indicates thrust reverser buckets in stowed position

ENGINES CONTROL AND INDICATORS



1 Left engine RPM indicator
2 Right engine RPM indicator
3 Fuel flow indicator
4 Right engine temperature indicator
5 Right engine nozzle area indicator
6 Left engine nozzle area indicator
7 Left engine temperature indicator
8 Reheat operation lights (Post Mod . 01670 deleted)
9 NL/NH indication changeover switch
10 Lift dump indicator
11 Reverse thrust indicators and override switch

Figure 1-6

Black and white stripes	Indicates thrust reverser buckets in transit mode
REV	White REV on black background indicates thrust reverser buckets are fully deployed

OVERRIDE SWITCH

A two-position toggle switch marked O RIDE/NORM (11, Figure 1-6), permits the use of a single thrust reverser at certain failure conditions.

Lift Dump Indicator

The lift dump indicator (10, Figure 1-6) is a three-position magnetic indicator, marked LIFT DUMP, and displays:

Grey	Main landing gear strut not compressed (Post mod. 01399: white cross on grey background)
OL	Main landing gear strut compressed
LD	Lift dump in operation

WARNING

AN OL INDICATION DURING FLIGHT INDICATES A FAULT IN THE OLEO SWITCH CIRCUIT. THE REVERSE THRUST/LIFT DUMP SYSTEM SHALL NOT BE PRE-ARMED IF AN OL INDICATION IS DISPLAYED TO AVOID AN INFLIGHT THRUST REVERSER DEPLOYMENT.

Crash Panel

Pre Mod 01655 and 01663

The four ganged toggle switches on the CRASH panel (B, Figure 1-7) are operated by raising the black and yellow striped guard marked LIFT-PULL and moving it forward. The FIRE EXT – OFF/ON switch discharges the fire extinguisher into both engine compartments simultaneously. The remaining switches shut down both generators and de-energize all electrical system busbars except the battery busbar.

Post Mod 01655 and 01663

The two generator switches marked GEN L/GEN R, are removed from the crash panel and therefore when the crash bar is operated the generators will not be deenergized. An additional switch marked BATT is installed to provide a separate earth return line from the fast action device. The function of the FIRE and BATTERY switches remains as before.

WARNING

THE ENGINES SHALL BE SHUT DOWN VIA HP COCKS PRIOR TO CRASH BAR OPERATION. IF THIS SEQUENCE IS NOT FOLLOWED THE ENGINES WILL ACCELERATE UNCONTROLLED TO SELF DESTRUCTION BECAUSE ENGINE CONTROL IS LOST AND THE OVERSPEED GOVERNORS ARE NO LONGER OPERATIVE.

Rapid Take-Off Panel

The rapid take-off panel (74, Figure FO-2) includes the following engine controls:

GANGING LEVER

The RAPID TAKE-OFF panel switches can be set to the FLIGHT position either individually or by use of the rapid take-off ganging lever; the OFF position can only be selected individually.

T1 PROBE HEATERS SWITCH

A two-position toggle switch labelled T1 PROBE HEATERS controls the electrical power supply to the T1 engine intake temperature probe heaters.

IGNITION MASTER SWITCH

A two-position toggle switch labelled IGNITION which arms the engine ignition and central warning systems when set to FLIGHT.

Central Warning Panel

The central warning panel (*F 'CWP' un*) comprises the following indications for the left (L) and right (R) engine:

RED WARNINGS:

L/R FIRE	Fire or overheating in an engine compartment
L/R VIB	Engine vibration has reached level 2 (Post mod. 00859: L/R VIB deleted)
L/R REV	Thrust reverser buckets not properly deployed after selection or buckets not properly stowed
L/R TBT	Turbine cooling air overtemperature above 650 degrees C (caption(s) will latch) (Post mod. 31208: 700 degrees C)

NOTE

The caption(s) will unlatch when the left LANES TEST pushbutton is pressed and temperature is below 650 degrees C.

Post mod. 00562:

L/R OIL P	Low engine oil pressure

AMBER WARNINGS:

L/R VIB	Vibration in the turbine, or compressor area, or when pressure fluctuations in the reheat section exceed 12.6 kPa (Reheat Buzz). Post mod. 31191: Reheat buzz indication is deleted
L/R OIL P	Low engine oil pressure (Post mod. 00859: L/R OIL P deleted)
L/R OIL T	Engine oil overtemperature
L/R FUEL T	Fuel overtemperature
L/R THROT	Engine main control lane failure
REHEAT	Electronic reheat system or double lane failure (one light serves both engines)

The red L/R FIRE, L/R VIB (Post mod. 00448: L/R VIB deleted), L/R REV, L/R TBT (Post mod. 00859: L/R OIL P) captions are repeated on the rear cockpit CWP.

ENGINE OVERHEAT AND FIRE DETECTION SYSTEM

Fire or overheat conditions in the engine and APU compartments are detected by sensing element loops which are routed so that they cover the most likely potential fire zones. Each sensing element loop is connected to an individual control unit which operates a relay in the appropriate fire warning circuit. Power to all three control units is supplied from the essential DC busbar.
A fire or overheat condition in either engine compartment will illuminate the red warning lamp in the appropriate fire extinguisher button and the L or R FIRE caption on the CWP in each cockpit.
A fire or overheat condition in the APU compartment will close the APU fuel supply shut-off valve and illuminate the red APU caption on the red CWP in each cockpit.
The CWP in each cockpit carries the toggle switch marked TEST – 1/OFF/2 spring loaded to the center OFF position. Setting the switch to position 2 tests the integrity of the engine compartment fire warning system.
The APU fire warning system can be tested by the APU AUTO TEST – TEST/NORM switch on the engine test panel (54, Figure FO-2).

NOTE

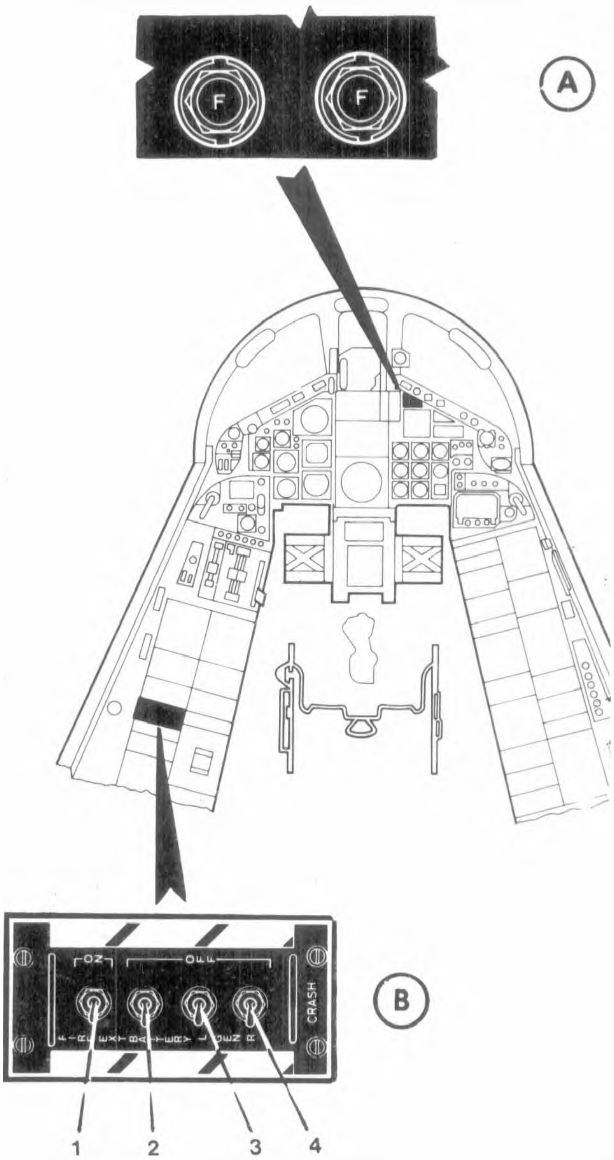
If the test is made while the APU is running, it will shut down.

ENGINE FIRE EXTINGUISHER SYSTEM

A dual-outlet fire extinguisher bottle is fitted in the right rear fuselage. Each outlet is connected to a distribution system, one for each engine bay. An electrically operated firing head at each outlet, controlled by the appropriate fire extinguisher button, enables the entire bottle contents to be discharged in the affected bay. The CRASH bar will fire both heads simultaneously when operated. The firing heads are powered by the battery busbar.
Two fused indicators, one for each firing head, are fitted in the refuel panel. They provide an indication when the appropriate firing head has been fired.

When the head is fired, the fused indicator turns red, giving a visual indication that the extinguishant has been discharged. The fire extinguisher bottle incorporates a pressure relief valve which, if pressure in the bottle exceeds a safe value, opens to discharge the entire bottle contents over board through an outlet above the right auxiliary power compartment door. The outlet has an indicator consisting of a bowl with a red inner surface covered by a white cap; if the pressure relief valve opens, the escaping extinguishant displaces the cap to expose the red interior of the bowl.
The fire extinguisher buttons (A, Figure 1-7) actuate the fire extinguisher head individually when pressed.

ENGINE FIRE EXTINGUISHER



A Fire extinguisher buttons

B Crash panel (Pre Mod. 01655/01663)
1 Fire extinguisher switch
2 Battery switch
3 Left generator crash switch
4 Right generator crash switch

Figure 1-7

ENGINE OPERATION

Although the RB 199-34 R is a 3-spool bypass engine equipped with reheat, the engine handling is straightforward. The control of the engine is electronic and different parameters are governing engine behaviour under various flight conditions. Although basically a fixed relation between throttle position and NH (N3) is fundamental, the NH idle schedule in the lower throttle range and the engine limiters in the upper throttle range influence this relationship and produce a variation of NH in flight (and hence throttle deadbands) depending on temperature, airspeed and altitude.
In the reheat range, the relation between throttle position and nozzle area is basically linear. The HP compressor total delivery pressure Pt_2 (calculated in the CUE) modifies these characteristics in such a way that at lower Pt_2 the max RH area will be reduced and the area (and hence throttle deadbands) will be seen in flight depending on airspeed and altitude.
The idle schedule, which is holding the engine at approx. 65% NH on ground operation, will increase the idle RPM as a function of Mach Number, altitude and temperature. At extreme flight conditions (supersonic), or high altitudes, max dry will be almost identical to idle. Consequently during some portions of the flight as already mentioned above, deadbands in throttle response at the idle region, at the max dry region and in the reheat region will be seen.

Ground Operation

ENGINE STARTING

The right or left engine start is initiated by selecting the ENGINE START switch to RIGHT or LEFT respectively. Engine ignition will be operative immediately and after a 5 sec delay fuel will be delivered to the starter jets. T7 will increase to approx. 250 degrees C and at approx. 21%NH the throttle lever has to be set to IDLE to open the HP SOC.
Thereafter a steady rise in T7 up to approx. 500 degrees C will be seen. Simultaneously after a short slow acceleration the engine speed will be up to the 65% NH idle speed. T7 is not imposed during starting, but when T7 indication has changed to TBT (this occurs when TBT reaches 545 degrees C

cockpit indication), an absolute limit of 675 degrees C TBT shall not be exceeded.
If a hot start occurs, the throttle should be fully closed to the HP SHUT position and the start cancel button pushed to cancel starter jet fuel and ignition. After NH has reduced to zero normally a dry cranking cycle should be carried out before the next attempt to start is made and a draining period of 30 seconds is mandatory. To achieve the dry crank, the ignition master on the Rapid T/O Panel, should be switched to OFF and the engine starter switch selected to the appropriate engine. Before the next start attempt the ignition master switch will be returned to FLIGHT.

Post mod. 00644
When the engine throttle is moved to HP SHUT, not only is the main fuel supply to the engine shut-off but the fuel supply to the engine starter jets is also cut immediately.

PRE-TAXI CHECKS

After engine start the ignition selector switch should remain in NORM position which will guarantee automatic ignition in case of a flame-out or an extreme deceleration in flight or during take-off. With the ignition selector switch in NORM position it should, however, be kept in mind that the automatic ignition circuit will be always operative if the throttle is not in the HP SHUT position and certain NH speed condition exists (see ENGINE IGNITION SYSTEM). If, for instance, one engine is shut down in flight or on the ground and the throttle is then reopened (for lift dump or reverse thrust checking), it is possible that any fuel remaining in the engine may be ignited. When both engines are running the operation of the CUE automatic control lane changeover facility should be checked with LANE 1 selected. Pressing the LANES TEST buttons will cause a light transient (max 2% NH) to occur. At the same time the L/R THROT warning on the CWP will illuminate and the TBT indicators will wind up to 925 degrees C. Pressing the left LANE TEST button will initiate an internal check of the engine temperature warning systems, and the amber L/R FUEL T, L/R OIL T in the front cockpit and the red L/R TBT warnings in both cockpits for both engines will illuminate on the CWP. Upon release, all warning lights should extinguish and TBT/T7 readings return to normal.
When Lane 2 is selected and the same test is repeated, the same warnings and indications as above will be displayed but the light transient will be seen immediately when LANE TEST is selected. In addition the nozzle will now be observed to close from 5 to 13% (Post mod. 01431: from 5 to 9%) (ENC) and the amber REHEAT caption on the CWP in the front cockpit will illuminate. To reset the nozzle to normal, the relight buttons shall be pressed. After approx. 3 seconds the engine will return to normal nozzle position and the REHEAT caption will extinguish. Thereafter the lane switches shall be reselected to Lane 1 and again the throttle warnings will illuminate for a short period.

NOTE

A lane test with Lane 2 selected will cause the REHEAT indication on the Maintenance Panel to be recorded.

Generally, Lane 1 is the preferred lane due to the auto change feature to Lane 2 in the case of a Lane 1 failure. Lane 2 will perform the same functions as Lane 1 and all operations are practically identical in both lanes. Following the lane test, a governor check shall be performed by selecting the governor test switch to NH and accelerating the throttles to MAX DRY. The NH will settle to approx. 85%. Retard the throttles to below 80% NH, and then select the governor test switch to NL. The RPM indicator NL flag will appear. Advance throttles to MAX DRY and the engine RPM indicators will settle at approx. 80% NL. This is the normal way to perform the governor check; however, if circumstances do not permit this high RPM check at the starting position of the aircraft, it may be done prior to take-off.

TAXI OPERATION

During taxi, the nozzle position may be selected to TAXI NOZZLE OPEN (100% Aj), reducing idle thrust by approx. 40%. Having selected TAXI NOZZLE OPEN, reverse thrust is inhibited while if reverse thrust is selected the selection of TAXI NOZZLE OPEN cause the retraction of the reverse thrust buckets. It should, however, be kept in mind that TAXI NOZZLE OPEN should be deselected before run-up and that a maximum of approx. 75% NH can be achieved with nozzle selected to TAXI NOZZLE OPEN due to mechanical interlock in the throttle box.

BEFORE TAKE-OFF

For the run-up before take-off select both throttles to MAX DRY and compare engine readings to placard values. TBT should be identical to placard on either phase but the TBT schedule (TBT at max dry as function of total inlet temperature TT1) may cause deviation in TBT of up to ± 15 degrees C in extreme temperature conditions. Thereafter min. reheat can be selected. Min. reheat nozzles on the ground will be at approx. 3%, then throttles should be advanced to MAX REHEAT and nozzles will indicate approx. 103%. The brakes will normally hold max reheat but if tire slippage is encountered brakes should be released and the engine indicators checked during the initial portion of the temperature take-off run. Tire slippage may occur on light weight take-offs or during very cold temperature operation. No further changes in engine parameters should occur during ground run.

AFTER LANDING

After landing, one engine may be shut down if desired, but the engine TBT should be less than 450° C.
Before the shut down of one engine, the cross-drive should be selected to AUTO to prevent loss of one hydraulic system.

Engine Handling in Flight

Dry and reheat handling in flight is straightforward and within the normal flight envelope of the aircraft no general limits should be encountered. However, extreme conditions such as high altitude, slams from IDLE to MAX REHEAT or engine operation under extreme loads, with, for example, single engine handling with cross drive engaged and simultaneous operation of wing sweep, may be encountered certain limits.

DRY OPERATION

Dry engine handling under normal conditions, i.e. at speeds above 200 kts, 1 g flight and operating both engines, is straightforward up to 40,000 ft. Acceleration rate will vary between 7% NH/sec^2 on the ground and 2 – 3% NH/sec^2 at 40,000 ft but as the idle NH is also increasing with altitude, the acceleration time to max dry is in the order of 4 sec. Certain extreme conditions, occurring singly or in combination, can cause engine surge (Figure 3-5). These conditions include:

- High AOA
- Low Airspeed
- High Altitude
- X-Drive Engaged
- Wing Sweep Operation
- Engine Slam Acceleration

Surges are characterised by loud single or successive bangs, or in the case of a locked in surge, a light rumble accompanied by stagnating or decreasing NH, increasing TBT, and no throttle response.
If a surge is encountered under any of these extreme conditions, it will normally not recover unaided. If the engine continues to surge, a reduction in AOA should clear the surge. A further possible method of clearing a surge, is to reduce the load on the engine, for instance, interrupting wing sweep operation. If the surge continues, the engine should be throttled back slightly. If the engine remains in the locked in surge condition, further retardation of the throttle to idle is recommended. If still in surge, the engine should be shut down and a normal restart made.

REHEAT OPERATION

In reheat, the throttle position demands an equivalent nozzle position, which in turn schedules the reheat fuel flow. Total temperature, altitude, HP compressor outlet pressure and turbine pressure ratio are additional parameters governing reheat operation. As a function of airspeed and altitude the min. reheat nozzle will open from the ground static condition of 32% (Post mod. 01431: 28%) to approx. 75% (Post mod. 01431: 42%) at 40,000 ft, 250 KIAS. Similarly the 100% (Pre mod. 10781: 102% on the left engine; Post mod: 01431: 98%) ground nozzle at max reheat is reduced to a minimum of 85% Aj. When MAX REHEAT is selected on the ground at max dry, approx. 3.5 sec (MK 103: 3 sec) are required to achieve max reheat.
This time will increase to a maximum of 5 sec at extreme flight conditions. The primary parameter governing these functions is HP compressor outlet pressure (PE2) calculated by the CUE.
The turbine pressure ratio is the monitoring parameter for the reheat operation which signals automatic nozzle closure to normal dry area in the case of a RH blowout. In this case the throttles shall be retarded into the dry range before attempting a reselection of reheat. When reheat is deselected, 3.5 seconds are required for the nozzle to close completely. Thrust decrease is immediate and once the nozzle passes approx. 45% Aj reheat fuel flow is shut off completely. When reheat is cancelled the reheat fuel lines are purged and will be primed again during the next selection. After RH cancel an immediate reselection is permitted, but the light up sequence will start again only after a delay of approx. 5 seconds (Post mod. 01431: 1.5 : 5 seconds) after RH fuel flow shut off to allow fuel lines purging. For repeated reheat operation within the normal flight envelope no limitations will be encountered, but on slams from IDLE to MAX REHEAT a reheat blow out and automatic nozzle closure may occur since the engine may be tran-

siently on a limiter at the moment the nozzle starts to open. It is therefore generally recommended to let the engine first come up to approx. max dry TBT's and then slam into MAX REHEAT. Good reheat light-up with this procedure is assured up to 40,000 ft within normal flying speeds. Slams from idle to max reheat will generally be accomplished without difficulty up to altitudes of 30,000 ft.

COMBAT OPERATION

No special limitations exist for selecting COMBAT and COMBAT will be easily achieved under all flight conditions where max reheat has been reached. It should be kept in mind that per sortie a maximum of 5 minutes combat may be used. A rise of approx. 15 degrees C (Post mod. 01431: 23 degrees C) in TBT will be observed when COMBAT is selected.

RELIGHTS

For detailed information and current procedures, refer to Section III, "EMERGENCY PROCEDURES, Flameout/Relighting".

SECONDARY POWER SYSTEM

The secondary power system provides facilities for starting the engines on the ground and transmits mechanical power from the engines to various accessories.
The system, mounted in front of the engines and separated from them by a bulkhead, consists of two accessory gearboxes and an auxiliary power unit (APU), which is mounted on and drives the right hand accessory gearbox. Each gearbox drives an integrated drive generator (IDG), a hydraulic pump and an engine fuel backing pump. Each gearbox may be driven by its associated engine through a freewheel clutch, or through the X-drive shaft from the other engine, or drive its associated engine for starting purposes through a torque convertor.

AUXILIARY POWER UNIT

The APU is a gas turbine using aircraft fuel supplied from the RH feed line of the engine fuel supply system via the APU shut-off valve. The APU drives the right hand gearbox. In addition to providing torque for engine starting, the APU drives the aircraft generators and hydraulic pumps, thus providing facilities for aircraft system checkout.

Gearbox lubricating oil and hydraulic oil are cooled by fuel recirculating through coolers and back to the main fuselage tanks. On the right hand side the fuel is cooled as it passes through the right hand air-cooled fuel cooler (ACFC), before its return to the tanks. An injector pump, powered by APU compressor bleed air, induces an airflow through this cooler via a bleed air valve which is controlled by the APU bleed switch on the rapid take-off panel.

APU Starting System

For starting purposes, the APU is fitted with a 28 V DC starter motor and an ignition system. The starting cycle is controlled by an automatic starting circuit. The APU may be started from an external 28 V DC ground power supply or with power derived from the aircraft's battery through the 28 V DC busbar PP4. In-flight operation of the APU is inhibited. An APU fire safety switch is located in the RH main landing gear compartment. It is used to prevent the APU from being started when work is performed on the secondary power system in the vicinity of the APU exhaust duct.
An air intake duct and shutter is installed in the RH side of the bay. When the APU starts the shutter automatically opens to admit outside air to the compressor intake. The shutter closes when the APU is shut down.
An APU fire warning system monitors the average temperatures in the vicinity of the APU. Should excessive temperatures be detected, the system will initiate visual (CWP) and audio warnings, and shut down the APU by closing the APU fuel system shut-off valve (See ENGINE OVERHEAT AND FIRE DETECTION SYSTEM for detailed information).

Cross-Drive System

The right and left hand accessory drive gearboxes can be interconnected through the cross-drive shaft and a friction clutch, which is closed by oil pressure from the right hand gearbox oil pump or by an auxiliary oil pump driven by the cross-drive mechanism.
Normally the APU is started with the X DRIVE CLUTCH switch at OPEN and will therefore drive the right hand gearbox only. However, if both gearboxes are required, the cross-drive clutch may be engaged by selecting AUTO either before or after the APU has started. The system shall not be run in this condition for long periods on the ground as

only the right ACFC has an injector pump to prevent excessive fuel temperature.

With the X-DRIVE CLUTCH switch at AUTO, either engine may be started first from the APU. The APU will automatically shut down at approximately 60% NH and the second engine can then be started from the first. The cross-drive clutch shall be opened by pressing the X-DRIVE CLUTCH/PUSH OPEN button after the second engine has reached self sustaining speed. The cross-drive clutch will not then re-engage unless a difference in engine speed in excess of 15% NH is detected; in which case the clutch will engage and the amber SHUT indicator light illuminates. The cross-drive clutch will remain engaged until manually disengaged by pressing the X-DRIVE CLUTCH SHUT-PUSH OPEN button. If the engine speed differential is still in excess of 15% NH the clutch will immediately re-engage. If the X-DRIVE CLUTCH switch is selected to OPEN the clutch will disengage and remain in this condition.

With the X-drive clutch closed, in the event of a gearbox overload condition, a speed difference between the gearboxes in excess of 4% NH lasting longer than 2.5 sec, will automatically open the X-drive clutch.

WARNING

AN ATTEMPT TO CLOSE THE CROSSDRIVE CLUTCH FOLLOWING LATCHING OPEN DUE TO AN OVERSPEED OR OVERLOAD CAN BE MADE EITHER BY PRESSING THE X-DRIVE CLUTCH LIGHT/ PUSHBUTTON WITH THE X-DRIVE CLUTCH SWITCH AT AUTO, OR BY SELECTING THE SWITCH TO OPEN AND BACK TO AUTO. THIS ACTION SHOULD ONLY BE TAKEN IN EMERGENCY.

SECONDARY POWER SYSTEM CONTROLS AND INDICATORS

The secondary power system (A, C, Figure 1-8) comprises the following controls:

APU Power Switch (Post mod. 00011)

A three-position toggle switch, located on the engine start panel, labelled APU POWER INT/EXT DC/EXT AC, selects the power source of the APU starter motor.

APU Switch

The APU switch is a three-position toggle switch, located on the engine start panel, marked APU-START/OFF, spring-loaded to the center position.

APU Run Light

On the engine start panel an amber light marked RUN illuminates when the APU is running with the APU BLEED switch in the OPEN position. The RUN light is flashing when the APU runs with the APU BLEED switch in the CLOSED position.

X-Drive Clutch Switch

The X-DRIVE CLUTCH switch is a two-position toggle switch, located on the engine start panel, marked X-DRIVE CLUTCH – AUTO/OPEN

AUTO position	Clutch engages under certain conditions, e.g. speed differential > 15%
OPEN Position	Clutch is disengaged

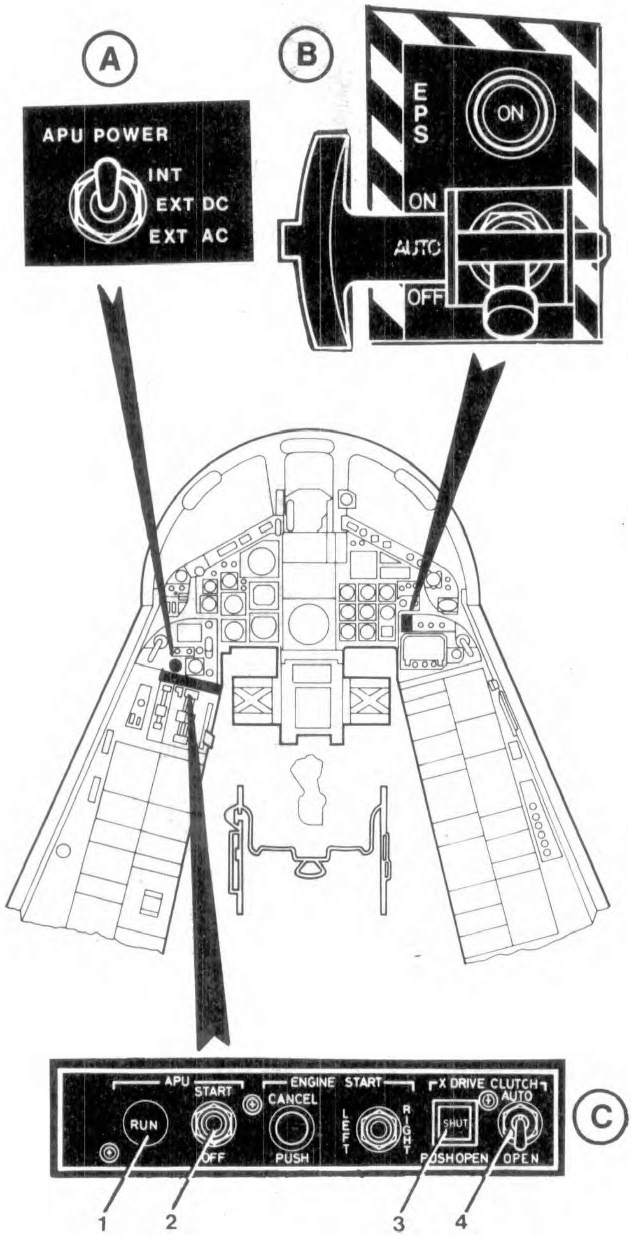
X-Drive Clutch Shut/Push Open Button

A combined amber light/push button, marked SHUT – PUSH OPEN, is located on the engine start panel. The light is steadily illuminated while the cross-drive clutch is engaged. Pressing the push button disengages an engaged cross-drive clutch if speed difference is < 15% NH.

APU Bleed Switch

The APU bleed switch is a two-position toggle switch, located on the rapid take-off panel, marked CLOSED/OPEN. The switch selects the position of the APU bleed air valve.

SECONDARY POWER SYSTEM (CONTROLS AND INDICATORS)



A APU Power Switch (Post Mod. 00011)

B Emergency Power System Switch

C Engine Start Panel

1 APU run light
2 APU switch
3 X-drive clutch SHUT/PUSH OPEN button
4 X-drive clutch switch

Figure 1-8

APU Auto Test Switch

The APU AUTO test switch is a two-position toggle switch, located on the engine test panel, marked TEST – NORM, spring-loaded to the NORM position. When TEST is selected the integrity of the APU fire warning system is tested.

NOTE

If the APU is running when the system is tested, APU shut-down occurs.

Central Warning Panel

On the CWP a red warning light APU illuminates in both cockpits when either an overheat or a fire is detected, and when the APU AUTO test switch is in the TEST position.

APU OPERATION

With 28 V DC power from the battery via battery busbar PP4 (or alternatively utilizing power from a 28 V DC external power source, connected to the aircraft), the BATT MASTER switch set to FLIGHT, the APU BLEED switch to CLOSED and momentarily depressing the APU switch to START, energizes the SPS control unit. The APU air intake shutter opens, the APU RUN light flashes, the APU main fuel valve closes. Simultaneously the starter accelerates the APU turbine assembly and the ignition circuit will be activated. When ignition occurs, the turbine, assisted by the starter, accelerates to approx. 48% of nominal speed. At this point, the starter and ignition circuit is de-energized and the turbine continues to accelerate to approx. 60% of nominal speed, and provided that a compressor pressure of 1.3 bar is achieved, the igniter fuel valve closes and the APU main fuel valve opens. Under normal conditions the time to reach maximum speed is approx. 15 sec, however, under extreme cold soak temperatures it may take up to 50 sec. If this time is exceeded, the APU will automatically shut down. The SPS control unit signals the APU clutch to engage and drive the RH gearbox. When the APU BLEED switch is selected to OPEN, the APU RUN light stops flashing but remains illuminated. If either engine is started, the APU will be shut down when that engine reaches approx. 60% NH.

NOTE

- To ensure adequate APU operation, the APU BLEED switch should remain in the CLOSED position until the APU turbine has reached nominal speed.
- If prolonged operation is required the X-drive clutch and the APU BLEED should be selected OPEN to minimize APU load and to ensure adequate cooling airflow.

Post mod. 00011

The APU starter motor power supply (internal DC, external DC or external AC) can be selected by means of the APU power switch.

X-DRIVE OPERATION

For take-off and landing and light up to 5000 ft the cross-drive switch should be selected to AUTO to maintain all hydraulic services in case of engine failure. At low altitude, power take-off capability of the engine is such that even in case of a gear box seizure the live engine will not be influenced significantly, and shear necks in the gear boxes will before the engine RPM is dragged down.

EMERGENCY POWER SUPPLY (EPS) SYSTEM

In the event of a double engine flame-out or double generator/TRU failure, an EPS system provides hydraulic power for emergency operation of the taileron actuators at limited rate and/or electrical power for a DC fuel pump. The hydraulic component of the EPS consists of a DC motor driving a variable delivery hydraulic pump (EHP), assembled as a package. The package is installed in the left secondary power bay in parallel with the engine driven hydraulic pump of the aircraft left hydraulic system.
The DC emergency fuel pump is installed in fuel cell No. 6 and supplies fuel to the right engine fuel feed line. Both pumps are driven from a silver-zinc 25 V DC one shot battery installed in the fin area. The battery sustains sufficient power to drive the EHP and the DC fuel pump for 3 minutes or the DC fuel pump alone for 7 minutes (Post mod 11019 20 minutes).

Double Engine Flame-Out Case

In the case of a double engine flame-out, with the EPS switch in the AUTO position, and the WOG switch de-actuated, as both engine RPM's fall below 59% NH, the EPS system will be activated in the following sequence:

- The contactor between the one shot battery and the EHP closes
- The left hydraulic system utility isolating valve closes to conserve hydraulic pressure for operation of the tailerons
- The X-drive clutch opens automatically
- The engine crossfeed valve opens
- The RCOV's drive to the ENG position

At RPM < 50% NH:

- The generators go off line
- The one shot battery fires and will now supply power to the EHP and the DC fuel pump. Both pumps will come on line after 1 or 2 seconds.

NOTE

With the EPS switch in the ON position the one shot battery will be activated irrespective of engine RPM and WOG position.

Normally an attempt to relight the right engine would be made first, within the engine operating envelope up to 30000 ft and a minimum RPM of 12% NH (Post mod. 01431: 14% NH). When the first engine reaches 59% NH, the X-drive clutch closes with the EPS in the AUTO position (if the EPS switch is in ON it shall be selected to AUTO). When the first engine speed exceeds 59% NH, the hydraulic pumps are pressurized, the left utility isolating valve opens and the EHP will be disconnected from the one shot battery if in AUTO. Irrespective of the EPS switch position, the DC fuel pump will run until the battery is exhausted.

Double Generator/TRU Failure case

If a double generator or a double TRU failure occurs, the DC busbars PP1 and PP2 will de-energize causing the one shot battery to fire, driving the DC fuel pump only.

EPS System Controls and Indicators Switch

A three-position toggle switch (B, Figure 1-8) marked EPS – ON/AUTO/OFF, control the EPS system.
The switch is guarded in the OFF position by a safety pin when the aircraft is on the ground. The switch positions function as follows:

ON	With power on DC busbar PP3, the one shot battery will fire immediately. The EPH and DC fuel pump will run. The fuel crossfeed valve opens, both RCOV's, will drive to the ENG position, the left hand hydraulic system isolating valve closes, and the X-drive clutch receives an open signal
AUTO	Automatic function of EPS is enabled if WOG switch is in the flight position
OFF	EPS function is disabled

NOTE

Caution should be exercised when selecting the EPS switch from OFF to AUTO. If the toggle is pulled, the switch may inadvertently enter the ON position resulting in EPS battery activation. It is not required to lift the EPS switch toggle when selecting between OFF and AUTO.

EPS System ON light

The EPS light (B, Figure 1-8) marked ON illuminates when the one-shot battery is supplying DC power, provided that the EPS switch is not in the OFF position.

FUEL SUPPLY SYSTEM

Fuel is carried in two fuselage tank groups and in the wings, external fuel tanks can be carried under the fuselage and the wings. All fuel is transferred to the fuselage tank groups before being fed to the engines, with the front group normally feeding the left engine and the rear group feeding the right engine and the APU (Figure FO-5).

The fuel transfer sequence is automatically controlled but the normal sequence can be overriden by the pilot if required.
Fuel is transferred from the external tanks by air pressure and from the wing tanks by transfer pumps.
Fuel is used as a cooling medium for hydraulic and lubricating oil, high temperature fuel being cooled by air being returned to the tanks.
Fuel can be dumped overboard from the fuselage tank groups through an outlet in the fin. All external tanks are jettisonable.
Ground refuelling is normally carried out from a single pressure refuelling point, but the aircraft can also be gravity refuelled.
Defuelling can be carried out through the pressure refuelling point or by suction through the gravity refuelling points.
For fuel quantity refer to Figure 1-9. The aircraft is equipped for in-flight refuelling. A hydraulically operated probe is fitted to the right side of the front fuselage and can be extended to receive fuel from a tanker aircraft. A floodlight is fitted to the refuel probe strut, to facilitate night refuelling.

FUEL TANKS

Fuselage Tanks

The aircraft fuselage tank system comprises a front tank group of six cells, plus a wing box tank, and a rear tank group of ten cells.
The cells are made of tear-resistant bladder material except for two cells in the front tank group which are partially self-sealing. The wing-box tank forms part of the fuselage structure.
The cells in each group are interconnected by vent and transfer connections, and flap valves permit gravity fuel flow only towards collector boxes in each tank group. Each collector box houses a double ended boost pump with integrated non-return valves.
Negative G limitations are listed in Section V "Operating Limitations".
A transfer pump in the forward cell 1 b of the front tank group starts at low fuel conditions, and transfers fuel to the front collector box to prevent front boost pump starvation during dives and rapid deceleration.
The two tank groups are independent of each other, but can be interconnected through a valve, controlled by the TANK INTER – OPEN/CLOSE switch.

Wing Tanks

The wing tanks are an integral part of the wing structure.
The fuel contained in these tanks is transferred to the fuselage tank groups by dual transfer pumps at each wing tip, the left wing supplying the front group and the right wing supplying the rear group.

External Tanks

External subsonic fuel tanks can be carried on the inboard wing pylons and on the fuselage shoulder pylons.
Fuel transfer from those tanks is achieved by pressurized air and automatically controlled by a level sensing system and transfer valves. Normally the left underwing and underfuselage tanks transfer to the front fuselage tank group and the right underwing and underfuselage tanks transfer to the rear fuselage tank group.

FUEL TRANSFER SYSTEM

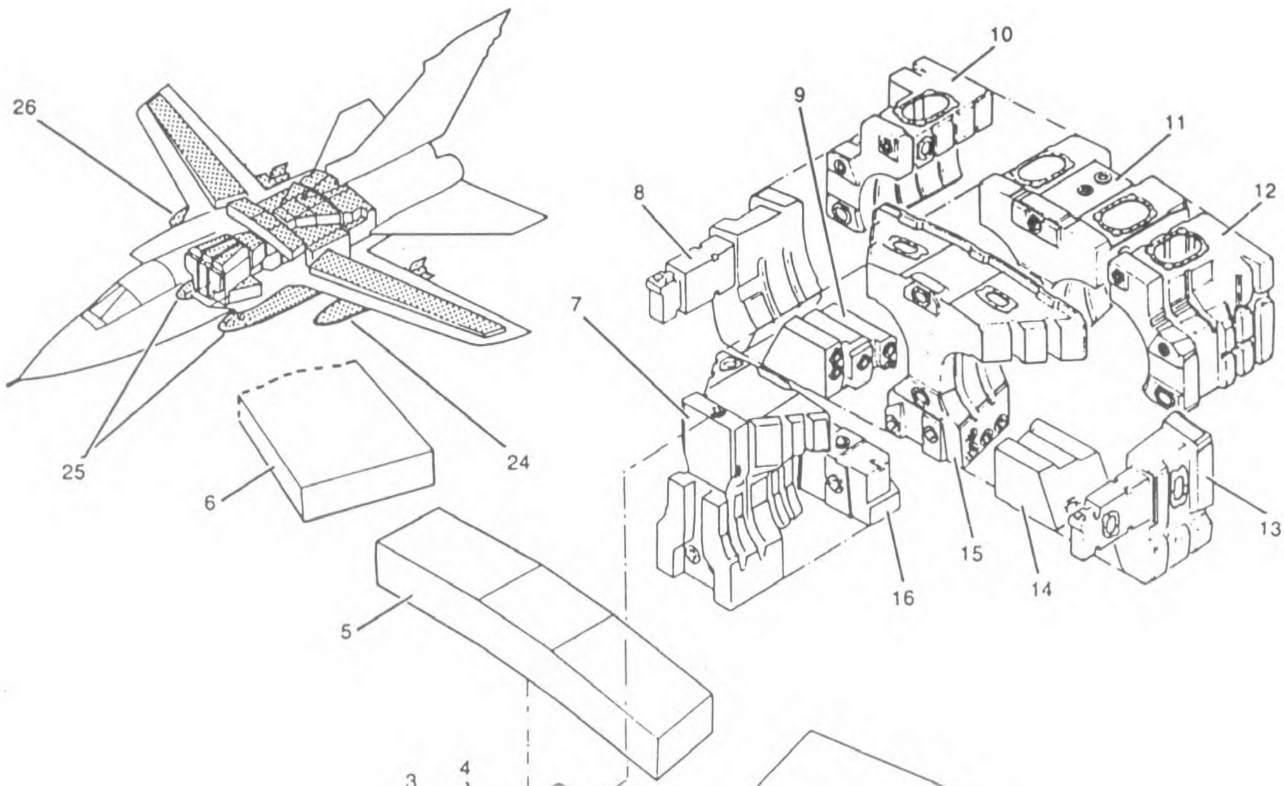
AUTOMATIC TRANSFER

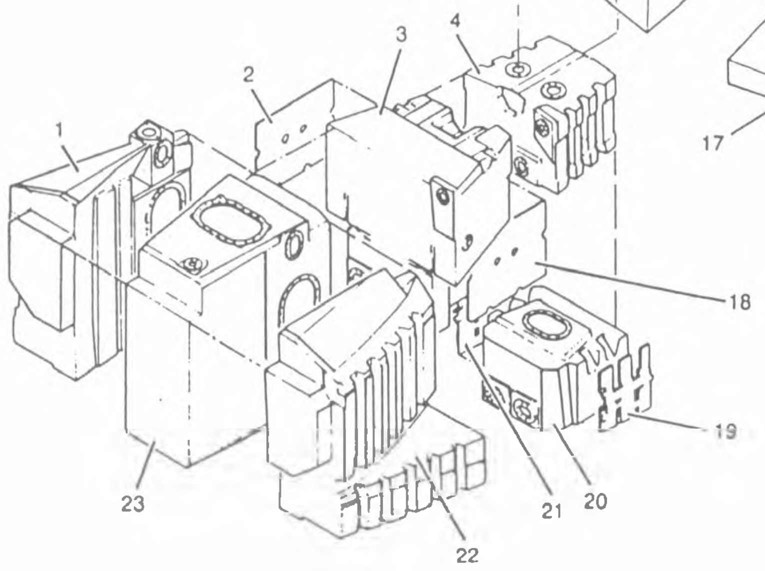
The aircraft is fitted with thermistor level sensors, which provide signals to the tank level sensing control unit. With the SEQUENCE switch on the fuel control panel (C, 12, Figure 1-10) set to NORM, fuel is transferred from the external tank in the following sequence:

- Under-wing tanks
- Under-fuselage tank(s) (for asymmetric configuration see Manual Transfer, this chapter)
- Wing tanks
- External tank transfer is achieved by pressure controlled fan bleed air.

This sequence is normally automatically controlled by level sensor in the individual tanks which selects the external tank transfer valves, and the pressure/vent valve (see "FUEL PRESSURIZATION AND VENT SYSTEM") as required.
Fuel enters the fuselage tank groups through two fuel-pressure-operated combined refuel/transfer valves, one for each group. The shutoff piston of each valve is operated by servo fuel flow which is controlled by a high level sensor in the associated

FUEL CELLS ARRANGEMENT AND FUEL CONTENTS TABLE





1 CELL 1C
2 BACKING BOARD
3 CELL 2
4 CELL 3
5 WING BOX TANK
6 WING TANK, RIGHT
7 CELL 5
8 CELL 12
9 CELL 8
10 CELL 10
11 CELL 11
12 CELL 9
13 CELL 13
14 CELL 7
15 CELL 6
16 CELL 14
17 WING TANK, LEFT
18 BACKING BOARD
19 BACKING BOARD
20 CELL 4
21 BACKING BOARD
22 CELL 1A
23 CELL 1B
24 EXTERNAL WING TANK, LEFT
25 EXTERNAL FUSELAGE TANKS
26 EXTERNAL WING TANK, RIGHT

TANK	Usable Contents – kg	
	F-34/35	F-40
FRONT TANK GROUP	2128	2008
REAR TANK GROUP	1862	1758
WING TANKS	782	738.4
AIRCRAFT TOTAL INTERNAL CONTENTS	4772	4504.4
EXTERNAL TANK (EACH)	1200	1132.5

NOTE

Fuel masses are based on the specific gravities as follows: F-34/35 0.800, F-40 0.755

Figure 1-9

tank group. Whenever a tank group is full, the servo flow is shut-off by an integral solenoid valve, de-energized by the sensor.
Indication of the position of the external tank transfer valves and the state of the wing tank transfer pumps is given by two sets of four green indicator lights, located on the fuel control panel. The appropriate lamp illuminates when the corresponding transfer valve is open or the corresponding transfer pumps are delivering pressure. If a transfer valve fails to close on completion of transfer, the associated lamp remains illuminate.
When the total fuel content is sensed at approx. 2050 ± 50 kg, the wing transfer pumps will be switched on and wing fuel will be transferred to the fuselage tank groups. The pumps will be switched off automatically when the tanks are empty provided that the SEQUENCE switch is in the NORM position.
When the contents of the forward tank group reduce to approx. 660 kg in level flight, a fuel pump in cell 1b is activated to transfer fuel to the collector box. At a fuel contents approximately of 300 kg in either tank group, a low level signal illuminates the amber FUEL caption light on the CWP in the front cockpit and opens the cross feed valve, provided that the cross feed switch on the fuel control panel is in the AUTO position.
The pump increases the inter-cell transfer rate to the front collector box, reducing the possibility of boost pump starvation due to a low fuel condition during dives and rapid deceleration.

MANUAL TRANSFER

Manual transfer is required in cases of:

- Automatic transfer failure
- Asymmetric external tank configuration
- B/B pod configuration (see B/B Refuelling Pod Operation, this chapter)

Automatic Transfer Failure

The external tank transfer valves and wing tank transfer pumps can be controlled directly by the appropriate setting of the SEQUENCE switch, which by-passes the level sensor in the selected tanks. The WG position of this switch disconnects wing tank transfer from the automatic sequence and switches on the wing transfer pumps.

NOTE

> To avoid prolonged dry running of the wing transfer pumps after wing transfer has been completed the SEQUENCE switch shall be selected to NORM position.

Selecting U/FUS or U/WG will open the respective external tank transfer valve.
An alternative transfer route through the refuel sides of the main refuel/transfer valves can be selected by using the ALTER switch. When set to ALT this switch closes the transfer side of both valves by de-energizing the integral solenoid valves and selects the refuel side of both valves. Because of the refuel valve flow restrictor the transfer rate with ALT selected will be reduced.
External and wing tank fuel from both sides can be transferred into one fuselage tank group by use of the EMERG TRANS switch.
This switch selects a motor-driven reversible non return valve to the reverse position and also closes the transfer side of the main refuel/transfer valve for the non-selected fuselage tank group.
The fuselage tank group collector boxes can be interconnected via a tank interconnecting valve, controlled by the TANK INTER switch. With OPEN selected the tank group with the higher fuel level transfers to that with the lower fuel level at low rate. To ensure that both engines continue to receive a fuel supply during pitch attitude changes the TANK INTER switch shall be returned to CLOSED when the amber FUEL caution light illuminates (C, 3, Figure 1-10).

Asymmetric Three Tank Configuration

The single U/FUS external tank may be carried on LH or RH shoulder station, which results in forward or aft tank group fuel imbalance respectively.
The following fuel management should be utilized already prior to take-off.

U/FUS TANK ON SHOULDER STATION	TANK FUEL STATE	SEQUENCE SWITCH POSITION	EMERG TRANS SWITCH POSITION
LH	FULL	U/FUS	NORM
	HALF FULL		REAR
	EMPTY	NORM	NORM
RH	FULL	U/FUS	FRONT
	HALF FULL		NORM
	EMPTY	NORM	NORM

FUEL PRESSURIZATION AND VENT SYSTEM

The fuselage fuel tanks are pressurized by LP compressor bleed air regulated to a minimum of 14 kPa, and supplemented by ram air from an intake in the leading edge of the fin.
Bleed air for external tanks transfer is taken from the LP compressor and fed to the tanks at a controlled pressure of 105 kPa. On completion of external tank fuel transfer, the bleed air supply is shut off and the external tanks are connected to the fuselage tank pressurization system.
Fuselage tank pressure is restricted to max. of 38 kPa. Excess pressure is vented to atmosphere through an outlet in the fin trailing edge. A pressure switch senses the differential between fuselage tank pressure and ambient pressure which is derived from a tapping in the fuselage spine. Should this differential reduce to 3.45 kPa the switch closes and illuminates the amber VENT warning light on the CWP in the front cockpit.

FUEL COOLING SYSTEM

Fuel is used as a cooling medium for reheat vapour core pumps, hydraulic oil, and engine and accessory gearbox lubricating oils.
The reheat vapour core pumps are cooled by reheat servo fuel which is then fed back to fuel mixing jet pumps in the engine feed lines upstream of the first stage pumps. Two fuel-cooled oil coolers are installed in each engine feed line, one combined unit upstream of the forward reheat servo flow shut-off valve to cool hydraulic and accessory gearbox oils, and one downstream of the valve to cool engine oil.

An air cooled fuel cooler (ACFC) is installed in each fuel recirculation line. Cooling air is supplied by ram air intake and under certain flight conditions augmented by air ejectors driven by engine HP compressor 6th stage air, via a combined shut-off/pressure reducing valve. This valve automatically opens when all the following conditions occur simultaneously:

- Engine speed less than 85% NH
- TR not selected
- Fuel temperature in the engine feed line is 70 degrees C or more

Excess fuel from each engine HP is normally returned to the pump inlet through a temperature-sensitive recirculation valve. When pump outlet temperature rises to 135 degrees C the valve starts to open and the excess fuel is fed back to a fuel-mixing jet pump in the appropriate tank group through an ACFC. The engine recirculation valve is fully open at 150 degrees C. A temperature sensitive switch activates the amber L or R FUEL T indication on the CWP in the front cockpit should pump outlet temperature rise to a preset limit.
An internal cooling circuit is included in each recirculation system to cater for APU and/or accessory gearbox operation when the associated engine is not running. The internal circuit operates automatically when the RCOV is driven to the INT position by the 59% NH signal as the engine runs down following HP cock closure.
Following engine start, as engine speed increases beyond 59% NH, the RCOV will be driven to the ENG position and open the normal recirculation circuit. The RCOV position ENG and INT are shown by the magnetic indicators on the ground servicing panel.
To improve fuel cooling, two air ejectors are provided on both ACFC. Each ejector is controlled through an automatic valve; it opens when the tanks fuel reach 70° C with the engines speed less than 85% NH. Opening of these ejectors is inhibited by deployement of the thrust reverser. When prolonged running of the APU is required an air flow can be induced through the right ACFC by an air jet pump which is controlled by the APU BLEED – CLOSED/OPEN switch.

ENGINE FUEL SUPPLY SYSTEM

Fuel is drawn from each fuselage collector tanks by two internal boost pumps and supplied to the engine fuel systems through fuel first stage pumps (Figure FO-6). In the event of the failure of any

boost pump an integral pressure switch activates the appropriate F or R PUMP indication on the CWP in the front cockpit and a non-return valve closes to prevent fuel feeding back through the failed pump.
Each engine feed line contains a check valve, which isolates the associated tank group in the event of leakage or damage, a first-stage pump driven by the accessory gearbox, and a forward reheat servo flow shut-off valve controlled by the appropriate LP COCKS switch.
If required the two engine feed system can be interconnected through a crossfeed shut-off valve which is selected by the CROSS-FEED – OPEN/AUTO/CLOSE switch. An amber OPEN light illuminates whenever the valve is not fully closed.
The APU is supplied by the right engine fuel feed system from a connection downstream of the first-stage pump. Fuel flow to the APU is through a shut-off valve controlled by the APU control unit.
In the event of a double engine flame-out or a double generator failure an EPS system provides electrical power for a DC fuel pump.
The DC emergency fuel pump is installed in fuel cell n° 6 and supplies fuel to the right engine fuel feed line (refer to para EMERGENCY POWER SUPPLY SYSTEM).

FUEL DUMP

Fuel can be dumped overboard from the fuselage tank groups by boost pump pressure through and outlet at the upper rear of the fin. External and wing tank fuel is transferred in the normal manner before being dumped. Fuel dumping is controlled by three shut-off valves, one for each tank group, and a master valve, each operated by an individual switch on the fuel control panel. Indicator lights on the panel show OPEN whenever the associated valve is open. Each fuselage group dump valve closes automatically when the contents of the associated group reduces to approximately 300 kg, or should pressure in the associated engine feed line reduce to approximately 1.3 bar (18.5 PSI); in both cases the valve is latched shut but, should valve closure be the result of a transient low pressure condition, dumping can be continued by selecting the appropriate switch to CLOSE then OPEN. If a low pressure condition results from a double boost pump failure, fuel from the affected group can be dumped via the serviceable group at a reduced rate by selecting TANK INTER OPEN.

GROUND REFUELLING AND DEFUELLING

Refuelling is normally carried out through a single pressure refuelling point at the lower right side of the fuselage. The aircraft can also be gravity refuelled through individual filler caps fitted to the fuselage tanks. During pressure refuelling individual tank refuel/transfer valves are selected open by switches on a ground servicing fuel panel and are automatically closed by high-level sensors when tanks are full; indicator lights show the state of the valves. Closing the access door of the ground servicing fuel panel ensures that all switches are returned to the "flight" condition. Defuelling through the pressure refuelling point can be boost/transfer pump assisted or by suction. The aircraft can also be defuelled by suction through the tank filler caps. Defuelling through the pressure refuelling points is controlled from the ground servicing panel.

IN FLIGHT REFUELLING SYSTEM

Flight refuelling can be carried out by means of a retractable probe. Flight refuelling can be selected to all tanks or to internal tank groups only. The probe is normally extended and retracted hydraulically from the right hydraulic utilities system. In the event of electrical or hydraulic failure the probe can be extended by an emergency circuit powered from the left utilities system. Once the EMERG OUT selection has been made the probe cannot be retracted in flight. The probe is retained in the retracted position by a mechanical lock and in the extended position by a hydraulic lock. Probe position is indicated by an amber U/L lamp on the fuel control panel which illuminates whenever the probe is unlocked. A floodlight is mounted on the probe strut to facilitate night refuelling. Lamp brightness is controlled by a switch in the rear cockpit, and the electrical supply to the lamp is through the OUT or EMERG OUT settings of the FLT REFUEL PROBE switch.
The green RDY lamp illuminates when the PROBE is selected to OUT or EMERG OUT, the transfer sides of both fuselage tank groups combined refuel/transfer valves are closed the pressure/vent valve is in the vent position and the depressurization valve is open. A TANKS switch selection of INT or ALL energizes the refuel sides of the fuselage tank groups combined valves and the wing refuel valves via a tank level sensing control unit which receives and amplifies signals from high and low sensors in all tanks. The refuel sides of the refuel/transfer valves are opened by fuel pressure following refuelling drogue contact. The transfer sides are de-energized and closed by PROBE se-

lection to OUT or EMERG OUT. During flight refuelling fuel is fed to the fuselage tank groups through the refuel sides of the refuel/transfer valves and to the wing tanks through wing tank refuel valves.
When the tanks are full the servo-flow controlling the valves are shut-off when the integral solenoid valves are de-energized by the tanks level sensing control unit, through signals from the high-level sensors.
The green FULL indicator, on the right anti-glare shields, illuminates when all tanks are full as detected by the high level sensors, and extinguishes when the TANKS switch is set to OFF.
Setting the PROBE to IN extinguishes the RDY indicator, closes the depressurization valve and operates the pressure/vent valve to pressurize the external tanks. Fuel transfer is then controlled by the tanks level sensing control unit. When the fuel in either fuselage tank group reduces by 50 kg the transfer side of the associated combined refuel/transfer valve will open by transfer pressure.

NOTE

- If after refuelling the TANKS switch is not selected to OFF, fuel transfer to the fuselage tank groups will occur through both sides of the combined refuel/transfer valves.
- The PROBE switch will always be set to IN following completion of refuelling.
- If after selection of PROBE switch to OUT or EMERG. OUT positions the FR VLV caption on CWP is illuminated, the transfer side of the fuselage refuelling/transfer valves are open and the refuelling shall be accomplished at a reduced pressure to avoid damages at the fuel cells.

"BUDDY-BUDDY" (B/B) REFUELLING SYSTEM

The B/B refuelling system consists of an aircraft used as a tanker, equipped with a self contained refuelling pod and a receiver aircraft, equipped with the refuelling probe, to transfer fuel by the probe-and-drogue method.

The B/B refuelling pod can be installed on the centerline station only with MWCS suspension system.
The pod has a fuel capacity of 880 kg (usable 845 kg) and is capable of pumping fuel to the receiver aircraft at a rate of 300 to 720 kg/min, depending on the configuration and the fuel level in the receiver aircraft's tanks.
Fuel can be also transferred from the tanker aircraft's fuel system through the pod to the receiver aircraft, or from the pod back to the tanker's fuel system (49, Figure FO-3).
The system main components are:

Tanker Aircraft

- B/B refuelling Pod, consisting of
  - Ram Air Turbine
  - Hydraulic Pump
  - Fuel Pump
  - Hose Reel Assembly
  - Refuelling Assembly
  - Pod Signal Lights
- Refuel Control Panel
- Switching and Indicator Elements on Fuel Control Panel
- Floodlight

Receiver Aircraft

- Refuelling Probe
- Switching and Indicator Elements on Fuel Control Panel

The B/B refuelling pod is normally pressure refuelled via the tanker's fuel system but may be gravity refuelled through a filler cap on top of the pod.
The aircraft's boost pumps are used to transfer fuel from the internal fuel system via the dump valves into the pod's fuel cell. The pod can be pressurized in a similar manner to a normal external fuel tank, to transfer the fuel back into the tanker's fuselage tank groups.
A ram air turbine on the nose of the pod (consisting of a propeller, a governing mechanism, and a solenoid operated brake) drives a hydraulic pump.

The pump provides hydraulic power to the fuel pump and the hose reel motor.
A 15 meter long fuel hose is stowed on a drum in the tail of the pod. During refuelling operations the hose will be extended from or retracted onto this drum. The hose bears white markings at certain intervals along its length. These marking indicate to the receiver pilot the amount of hose extended from the pod.
A refuelling assembly attached to the end of the fuel hose contains a reception coupling (consisting of a paradrogue of 710 mm diameter and a wind-driven generator).
During refuelling operation hose tension is maintained automatically.
In the event of a failure which precludes hose retraction, the hose can be jettisoned by a guillotine mechanism.

Pod Signal Lights

A set of three coloured lights on each side of the pod's tailcone indicate to the receiver aircraft the mode of operation existing within the pod.
The lights function in unison with the SIGNAL LIGHTS on the REFUEL control panel, as follows:

- Amber lights – The hose is extended and the pod system is ready for receiver engagement and fuel transfer.
- Green lights – Fuel is flowing from the pod to the receiver aircraft.
- Red lights
  Steady illumination; the hose is extending or retracting therefore the pod is not ready for refuelling

  Flashing
  - Signal to the receiver not to engage on the drogue
  - During refuelling, signal to break contact immediately

A REFUEL control panel (Figure 1-11) is located on the rear cockpit left hand console and will be installed, when the aircraft adopts the tanker role.

FUEL SYSTEM CONTROL AND INDICATORS

Fuel Flow Indicator

The fuel flow indicator (3, Figure 1-6) calibrated in kg/min, has two pointers, marked L and R, which indicate the dry power fuel flow to the left and right engine respectively.

Fuel Quantity Indicator/Selector Unit

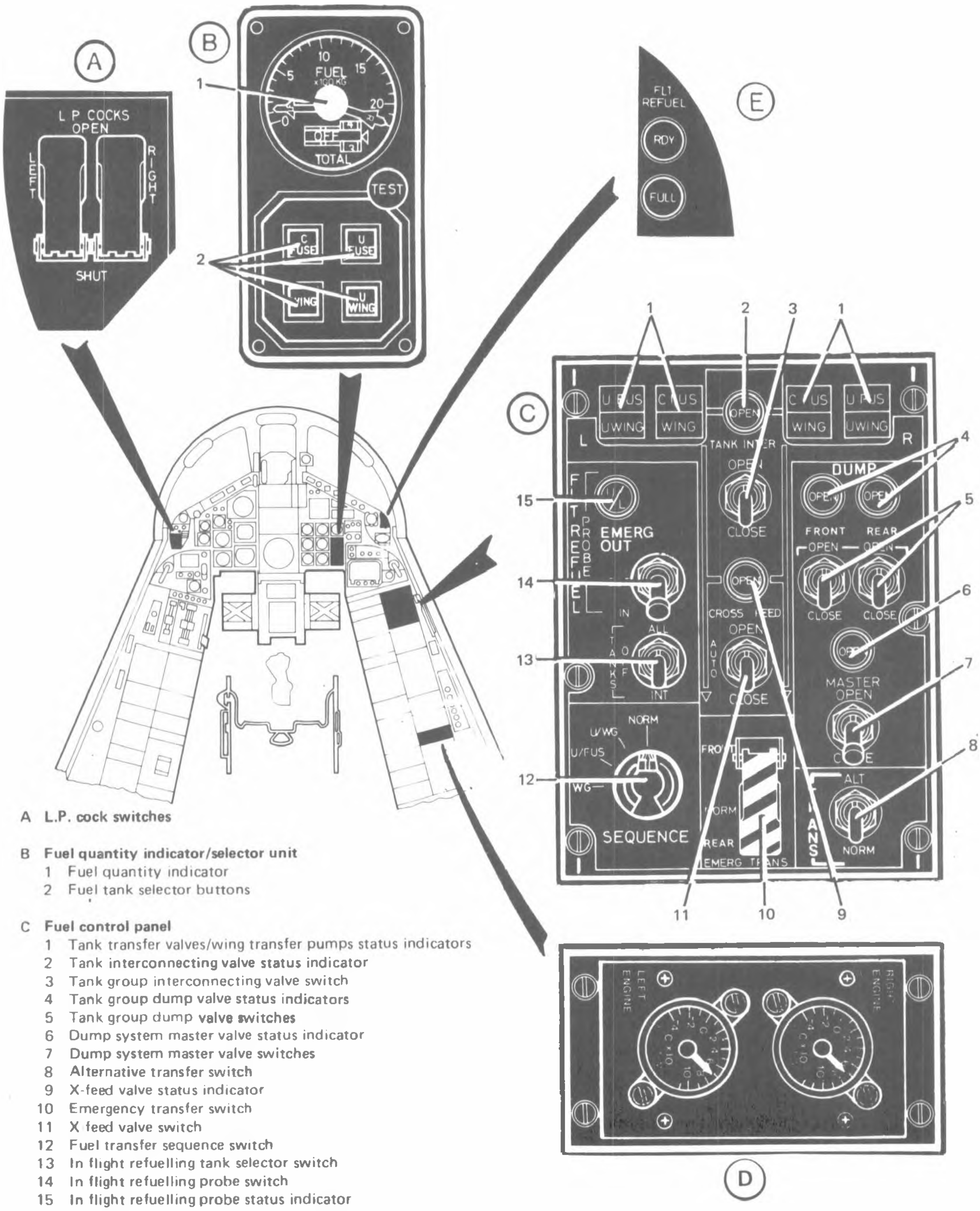
An indicator (B, Figure 1-10) has two pointers marked LF (left/front) and R (right/rear), which normally indicate fuselage tanks front and rear group fuel quantities between 0 and 2200 kg. When a button on the panel below the indicator glass is pressed the pointers indicate fuel quantity in the tank selected. The indicator incorporates a digital counter which indicates total fuel remaining in divisions of 100 kg. This digital counter is covered by an off flag when the electrical power is switched off.
A TEST button, when held pressed resets the fuel quantity indicator pointers and the digital counter to zero. Any position other than zero indicates a malfunction.
Each of the four push buttons when held pressed selects the associated tank fuel quantities to be indicated by the quantity indicator pointers. The push buttons are marked:

C/FUS	Center fuselage tank only. One pointer superimposed on the other act together as one pointer
U/FUS	Left and right under-fuselage tanks
WING	Left and right wing tanks
U/WING	Left and right under-wing tanks

Rapid Take-Off Panel

The rapid take-off panel (74, Figure FO-2) contains the following fuel system controls:
Two two-position toggle switches, marked FUEL BOOST PUMPS – FRONT/REAR, which control the operation of the front and rear fuselage tank group boost pumps.
A two-position toggle switch, marked APU BLEED – CLOSE/OPEN, which control the operation of the jet pump in the right ACFC.

FUEL SUPPLY SYSTEM



A **L.P. cock switches**

B **Fuel quantity indicator/selector unit**
1 Fuel quantity indicator
2 Fuel tank selector buttons

C **Fuel control panel**
1 Tank transfer valves/wing transfer pumps status indicators
2 Tank interconnecting valve status indicator
3 Tank group interconnecting valve switch
4 Tank group dump valve status indicators
5 Tank group dump valve switches
6 Dump system master valve status indicator
7 Dump system master valve switches
8 Alternative transfer switch
9 X-feed valve status indicator
10 Emergency transfer switch
11 X feed valve switch
12 Fuel transfer sequence switch
13 In flight refuelling tank selector switch
14 In flight refuelling probe switch
15 In flight refuelling probe status indicator

D **Tank fuel temperature indicators**

E **Flight refuelling lights**

Figure 1-10

Central Warning Panel

The CWP in the front cockpit contains the following fuel system warning indications:

- RED caption FUEL (both cockpits) indicates a low fuel contents (approx. 50 kg) in the collector box (forward group)
- AMBER captions
  - FUEL indicates that fuel quantity in either fuselage tank group is approximately 300 kg or less (both cockpit)
  - L FUEL T and R FUEL T indicate that the fuel temperature at the left and right engine fuel pump outlet exceeds 150° C
  - F PUMP and R PUMP indicate a failure of one or both boost pumps in the front and rear fuselage tank groups
  - VENT indicates a drop in fuselage tank differential pressure to below 3,5 kPa
  - FR VLV indicates, that, with the probe selected OUT or EMERG OUT, one or both fuselage tank group transfer valves are open

Fuel Control Panel

The fuel control panel (C, Figure 1-10) contains the following controls and indicators:

TANK TRANSFER VALVES / WING TRANSFER PUMPS STATUS INDICATORS

Two sets of four green lights labelled L and R and marked U FUS/C FUS/U WING/WING, indicate the state of the external tank transfer valves and the wing tank transfer pumps.

U FUS	Illuminates when left or right underfuselage tank transfer valve is open or not fully closed
C FUS	Illuminates when the centerline tank transfer valve is open or not fully closed
U WING	Illuminates when left or right underwing tank transfer valve is open or not fully closed
WING	Illuminates when left or right wing tank transfer pumps delivery pressure above 28 kPa ± 7

TANK GROUP INTERCONNECTING VALVE SWITCH

TANK INTER – OPEN/CLOSE switch is a two-position toggle switch which controls the operation of the fuselage tank group interconnecting valve.

TANK INTERCONNECTING VALVE STATUS INDICATOR

An amber OPEN indication, marked TANK INTER which illuminates whenever the fuselage tank interconnecting valve is open or not fully closed.

TANK GROUP DUMP VALVE SWITCHES

Two two-position toggle switches with positions FRONT – OPEN/CLOSE and REAR – OPEN/CLOSE, marked DUMP, which control the fuselage tank group dump valves.

TANK GROUP DUMP VALVE STATUS INDICATORS

Two amber OPEN indications, marked DUMP, which illuminate whenever the associated fuselage tank group dump valve is open or not fully closed.

DUMP SYSTEM MASTER VALVE SWITCH

A two-position latch toggle switch, marked MASTER with positions OPEN/CLOSE controls the dump system master valve.

DUMP SYSTEM MASTER VALVE STATUS INDICATOR

An amber OPEN indication, marked MASTER, illuminates to indicate that the dump system master valve is open or not fully closed.

ALTERNATIVE TRANSFER SWITCH

A two-position toggle switch, marked TRANS with positions NORM/ALT to select the refuel side of the main refuel/transfer side of the valves.

EMERGENCY TRANSFER SWITCH

A three-position toggle switch, marked EMERG TRANS with positions FRONT/NORM/REAR guarded at NORM by a black and yellow striped guard. The switch serves to select transfer of all external and wing tank fuel to one fuselage tank group.

FUEL TRANSFER SEQUENCE SWITCH

A four-position rotary switch, marked SEQUENCE, provides a manual control of the fuel transfer sequence with the following settings:

WG	Wing tank transfer pumps selected on
U/FUS	Under-fuselage tank transfer valves selected open
U/WG	Under-wing tank transfer valves selected open
NORM	External tank transfer valves controlled by low-level sensors. Auto hold wing system enabled

X – FEED VALVE SWITCH

A three-position toggle switch, marked CROSSFEED – OPEN/AUTO/CLOSE selects the mode of operation of the crossfeed valve:

OPEN	Crossfeed valve selected open
AUTO	Crossfeed valve automatically opened when fuel quantity in either fuselage tank group falls to approximately 300 kg
CLOSE	Crossfeed valve selected closed

X – FEED VALVE STATUS INDICATOR

An amber OPEN indication, marked CROSSFEED illuminates whenever the crossfeed valve is not closed.

IN – FLIGHT REFUELLING TANK SELECTOR SWITCH

A three-position toggle switch, marked TANKS – ALL/OFF/INT, to select the appropriate tank group fuel valves open for inflight refuelling.

NOTE

When selecting INT the fuselage and wing tank refuel valves open for in-flight refuelling.

IN – FLIGHT REFUELLING PROBE SWITCH

A three-position latch-toggle switch, marked FLT REFUEL PROBE – IN/OUT/EMERG OUT, controls flight refuelling boom extension and retraction.

IN	Boom selected retract
OUT	Boom selected to extend by normal hydraulic supply
EMERG OUT	Boom selected to extend by emergency hydraulic supply. After selecting EMERG OUT the boom can not be retracted when selected in

IN – FLIGHT REFUELLING PROBE STATUS INDICATOR

An amber U/L indication illuminates whenever the flight refuelling boom is not locked in.

Tank Fuel Temperature Indicators

Two indicators (D, Figure 1-10) in the front cockpit are provided to monitor the temperature of the fuel of both tanks groups.

LP Cocks Switches

The LP cocks switches (A, Figure 1-10) are two two-position toggle switches, marked LP COCKS – LEFT/RIGHT – OPEN/SHUT, guarded to the OPEN position by red covers. Each switch controls the operation of one LP valve and reheat servo shut-off valve.

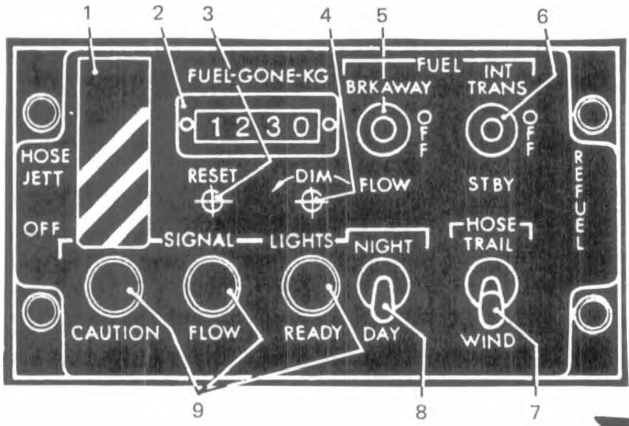
Refuel Control Panel

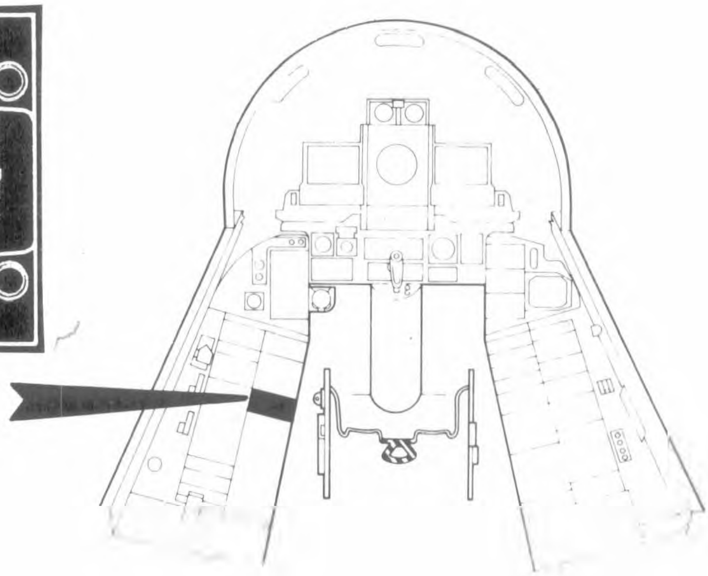
The refuel control panel (Figure 1-11) contains the following controls and indicators.

HOSE JETTISON SWITCH

A two-position toggle switch with the positions HOSE JETT/OFF and guarded in the OFF position by a black and yellow striped guard. The switch initiates emergency jettison of the fuel hose.

REFUEL CONTROL PANEL





1 HOSE JETTISON SWITCH
2 FUEL GONE INDICATOR
3 FUEL GONE INDICATOR RESET PUSHBUTTON
4 FUEL INDICATOR DIMMER CONTROL
5 FUEL FLOW SWITCH
6 FUEL MASTER SWITCH
7 HOSE OPERATING SWITCH
8 POD SIGNAL LIGHTS DIMMER SWITCH
9 SIGNAL LIGHTS

Figure 1-11

FUEL GONE INDICATOR

The indicator is marked FUEL – GONE – KG and shows the amount of fuel transferred to the receiver aircraft. The four digit readout registers in 10 kg increments.

FUEL GONE INDICATOR RESET PUSHBUTTON

Pressing the pushbutton, marked RESET, the fuel gone indicator resets to 0000.

FUEL INDICATOR DIMMER CONTROL

The brightness of the fuel gone indicator display can be adjusted by the dimmer control, marked DIM.

FUEL FLOW SWITCH

The three-position lock toggle switch, marked FUEL, with the positions BRK AWAY/OFF/FLOW, controls the operation on the fuel pump.
The toggle shall be lifted to move it from the OFF position.

BRK AWAY	CAUTION lights on the pod's tail cone and the SIGNAL LIGHTS – CAUTION on the REFUEL control panel flash and fuel pump stops regardless of mode of operation.
OFF	Fuel pump is not running
FLOW	With the fuel master switch in the STBY position, the fuel pump delivers fuel to the receiving aircraft, provided that the integral fuel flow switch circuits are energized

FUEL MASTER SWITCH

The three-position toggle switch is marked FUEL with the positions INT TRANS/OFF/STBY

INT TRANS	The pressure vent valve opens and the pod will be pressurized and used as a centerline tank
OFF	Ram air turbine blades are feathered and the hose reel drum is mechanically locked
STBY	The propeller blades of the turbine unfeather, and in flight it operates the hydraulic pump

NOTE

In the position OFF and STBY no automatic closure of the B/B pod transfer valve after automatic wing hold release will occur.

HOSE OPERATING SWITCH

A two-position lock toggle switch with the positions TRAIL/WIND, is used to unwind or retract the fuel hose. When set to TRAIL the floodlight on the tailcone illuminates.

POD SIGNAL LIGHTS DIMMER SWITCH

A two-position toggle switch is marked SIGNAL LIGHTS with the positions NIGHT/DAY and controls the pod's signal lights intensity for day or night operation.

SIGNAL LIGHTS

A red SIGNAL LIGHTS – CAUTION light illuminates while the fuel hose is extending or retracting. If the hose is fully extended, or if the drogue is stowed, the CAUTION light extinguishes.
The amber SIGNAL LIGTHS – READY light illuminates when the fuel hose is extended and the system is ready for contact. It extinguishes when contact has been made and the pump is pumping fuel to the receiver aircraft.
The green SIGNAL LIGHTS-FLOW light will be illuminated by a signal from the FUEL GONE indicator after the fuel begins to flow from the pod to the receiver aircraft.

Floodlight

A floodlight mounted on the tail cone illuminates the underside of the tanker aircraft for night refuelling operations.

Flight Refuelling Lights

The flight refuelling lights (E, Figure 1-10) comprise a green RDY indication which, with the probe selected OUT or EMERG OUT indicates that both fuselage group transfer valves are closed and the pressure vent valve is set to vent. A green FULL indication illuminates when INT is selected, and the fuselage and wing tanks are full, or ALL is selected and all fuel tanks are full.

NOTE

The absence of the ready light implies either, that the pressure/vent valve is not in the vent position, with the result that the external tanks will fill at a lower rate, or that the depressurization valve in the fin is not open, resulting in a lower internal tanks to fill rate.

Refuel Probe Light Control

The refuel probe light control is a rotary dimmer switch marked REFUEL PROBE LIGHT and is located in the rear portion of the rear cockpit right hand console (34, Figure FO-3). With the probe selected OUT or EMERG OUT it controls the intensity of the flight refuelling probe floodlight.

B/B REFUELLING POD OPERATION

Selecting the fuel master switch to STBY will unfeather the propeller of the ram air turbine. Turbine rotation drives the hydraulic pump which builds up internal system hydraulic pressure, which subsequently unlocks the drum but the drogue remains stowed. Drogue extension starts after the hose operating switch set to TRAIL.

– The drogue ejects into the airstream by the force of an ejection spring, and the hose unwinds

- Simultaneously the underside of the tanker aircraft fuselage will be illuminated by the floodlight located on the pod's tail, and
- The red CAUTION light on the pod's tailcone on the REFUEL control panel illuminate while the hose is extending

When the hose has reached the fully extended position, the SIGNAL LIGHTS – READY light illuminates and the CAUTION light extinguishes.
Power from the wind-driven generator will illuminate the four position lights on the brim of the drogue.
After the receiver aircraft has made contact, fuel flow is provided only if the fuel flow switch is in the FLOW position and the receiver aircraft has pushed the hose about 1.5 meters towards the tanker aircraft so that the integral fuel flow switch circuits will be energized.
The amber SIGNAL LIGHTS – READY extinguishes, the fuel pump runs, the fuel gone indicator registers the fuel transferred and the green SIGNAL LIGHTS – FLOW light illuminates.
During refuelling the reel is servo-controlled by hydraulic pressure which is proportional to the hose load.
An increase in hose load causes a trail signal, while a decrease in hose load causes a wind signal.
If fuel supply from the internal tank groups to the pod's fuel cell is required, the fuselage internal tank group dump switches, labelled DUMP – OPEN/CLOSE, on the fuel control panel shall be set to OPEN. The pod will then be replenished at a rate of 325 to 360 kg/min until the pod high level sensor operates (pod full).
Fuel transfer to the receiver aircraft will be terminated automatically when:

- The receiver aircraft's tank are full by closing of its internal fuel shut-off valves

NOTE

If the fuel transfer rate exceeds the rate at which the pod is replenished, it is possible that fuel transfer will be interrupted by the pod low level sensor. However transfer will recommence when the pod low level sensor is again wetted.

- A pod empty signal is sensed by the pod low level sensor
- The internal fuel flow switch circuits de-energize

To stop fuel transfer manually at a desired fuel quantity, the fuel flow switch on the REFUEL control panel shall be switched to OFF.
When the fuel pump stops running, the SIGNAL LIGHTS – FLOW light extinguishes and the SIGNAL LIGHTS – READY light illuminates.
After refuelling, the tank group dump switches shall be selected to CLOSE.
Placing the fuel flow switch to OFF and the hose operating switch to WIND will:

- Extinguish the SIGNAL LIGHTS – READY light
- Illuminate the SIGNAL LIGHTS – CAUTION light
- Extinguish the floodlight
- Rewind the hose reel drum

After retraction of the hose, the SIGNAL LIGHT – CAUTION extinguishes and the fuel master switch shall be set to OFF if fuel transfer is completed. The blades of the ram air turbine feather.

Automatic Hose Rewind

Changes in airspeed exceeding a certain amount may result in automatic hose rewind, which will not be indicated to the aircrew.

Breakaway

In an emergency case the tanker aircraft can signal the receiver aircraft pilot not to engage or to break contact, by placing the fuel flow switch to BRK AWAY causing the SIGNAL LIGHTS – CAUTION light to flash. The fuel pump is disabled regardless of the pod operation mode.

Hose Jettison

In the case of a hose rewind failure or abnormal behaviour of the hose, it can be cut by a guillotine mechanism. By lifting the cover guard and placing the hose jettison switch to HOSE JETT, the ram air turbine feathers, hydraulic pressure decays, the hose reel drum locks and a cartridge fires the hose guillotine.

CAUTION

THE GUILLOTINE CARTRIDGE WILL FIRE AT ANY TIME THE HOSE JETTISON SWITCH IS SELECTED TO HOSE JETT AND DC BUSBAR PP3 IS ENERGIZED.

Internal Transfer

Pod fuel may be utilized for the normal tanker's engine supply, with fuel transferred in the same way as a centerline tank fuel.
With the fuel master switch selected to INT TRANS the pod will be pressurized from the engine LP compressor bleed and fuel transfers to the fuselage tank groups with a rate of 63 to 150 kg/min, depending on aircraft altitude and throttle setting, if:

- Underwing tanks are empty
- Auto wing hold release point has not been reached

If during pod fuel transfer the auto wing hold release point is signalled, transfer will be interrupted but will recommence when both wing tanks are empty. On completion of pod fuel transfer (pod low level sensor signal or de-selection of INT TRANS), the LP compressor bleed air ceases and the pod remains pressurized from the normal fuselage tank pressure.

ELECTRICAL POWER SUPPLY SYSTEM

The Electrical Power is provided by two Integrated Drive Generators (IDG) that supply a three-phase, 115/200V, 400 Hz AC system. DC loads are supplied from the AC system via two Transformer-Rectifier Units (TRU) and a battery charger. A 24V, 36 AH battery provides power for independent APU starting and for the essential services in the event of failure. On the ground, the system can be supplied from an external supply unit via an AC ground power connector, and a DC ground power connector is provided for APU starting.

AC SYSTEM

The AC busbars are supplied by two generation channels normally operating in parallel. Each channel consists of an IDG and an associated Generator Control Unit (GCU) which provides control and protection facilities, monitors the system condition and controls the busbars interconnection. A three busbars system supplies the aircraft AC utilities. Two main busbars XP1 and XP2 are connected via contactors to the left (XP1) and the right (XP2) generator respectively. The third busbar (XP3) is directly connected to XP2 (Figure FO-7). Busbar XP1 is connected to XP2 by an AC Busbar Tie Contactor. This contactor is controlled by both GCUs, in normal operations it is constantly in closed position. The Busbar Tie Contactor is provided to supply the busbar of the failed generator in case of single generator failure. Refer to Figure FO-8 for the utilities powered by the AC busbars.

Integrated Drive and Generator Unit

The accessories gearbox of each engine drives an IDG consisting of a costant speed drive unit and a generator. The generator is rated continuously at 40 KVA, at 60 KVA for two hours and at 70 KVA for five minutes. Oil for constant speed drive operation and for generator cooling is taken from the associated gearbox. The generators are normally operated in parallel, though each is capable of supplying the total aircraft load. If necessary, both generators can be driven from one engine or from the APU, via the gearbox cross-drive system. The APU may shut down due to overloading if driving both gearboxes under maximum load conditions. Excitation, regulation and protection facilities for each generator are provided by the associated GCU which activates the system failure warnings when necessary, and controls a generator contactor in the line between the generator and its busbar. Each GCU monitors the condition of its associated channel: both GCUs control the AC busbar tie contactor and activate the failure warnings if a high load difference occurs during parallel channel operation.
During APU start, with the crash bar set to rear (Pre Mod. 01655) and Generator switches ON the right GCU energizes its generator contactor when the right generator reaches normal operating speed. The right generator is thus connected to the XP2 and XP3 AC busbar and the Right Fail light on the engine control panel and the CWP red AC caption go off. The GCU then closes the AC busbar Tie contactor to interconnect the XP1 and XP2 AC busbar, allowing the right generator to supply all AC loads. Since the DC supplies are derived from

ELECTRICAL POWER SYSTEM OPERATING CONDITIONS

OPERATING CONDITIONS		BOTH GENERATOR OPERATIVE	RIGHT GENERATOR FAILED	LEFT GENERATOR FAILED	XP1 FAILED	XP2 FAILED	XP3 FAILED	RIGHT GENERATOR OFF(*)	LEFT GENERATOR OFF(*)	BOTH GEN. FAILED	BOTH GEN. OFF(+)	DIFF. CURRENT FAILURE	CRASH Pre Mods 01655 01633	CRASH Post Mods 01655 01633
SWITCHES POSITIONS	crash panel	not op	not op	not op	not op	not op.	not op	not op	not op.	not op	not op	not op.	operat	operat.
	LH gen. sw.	ON	ON	ON	ON	ON	ON	ON	OFF	ON	OFF	ON	ON	ON
	RH gen. sw.	ON	ON	ON	ON	ON	ON	OFF	ON	ON	OFF	ON	ON	ON
GENERATORS	LH generator	operat.	operat	inoper.	inoper.	operat	operat	operat.	inoper	inoper.	inoper.	operat.	inoper	operat
	RH generator	operat.	inoper.	operat.	operat	inoper	inoper.	inoper.	operat	inoper	inoper	operat.	inoper	operat.
WARNING LIGHTS	AC	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	–	OFF	OFF	OFF
	GEN	OFF	ON	ON	ON	ON	ON	ON	ON	ON	–	ON	OFF	OFF
	LH gen. FAIL	OFF	OFF	ON	ON	OFF	OFF	OFF	ON	ON	–	OFF	OFF	OFF
	RH gen. FAIL	OFF	ON	OFF	OFF	ON	ON	ON	OFF	ON	–	OFF	OFF	OFF
BUSBARS SUPPLY CONDITIONS	XP1	LH & RH gen	LH gen	RH genr	isolated	LH gen	LH gen	LH gen	RH gen	not supp	ext pow	LH &RH gen	not supp	LH & RH gen
	XP2	LH & RH gen	LH gen	RH gen	RH gen	isolated	isolated	LH gen	RH gen	not supp	ext. pow	LH & RH gen	not supp	LH & RH gen
	XP3	LH & RH gen	LH gen	RH gen	RH gen	isolated	isolated	LH gen	RH gen	not supp	ext. pow	LH & RH gen	not supp	LH & RH gen

(*) on the ground only one generator operative and before connecting the second one.
(+) on the ground with external power connected and switched on.

Figure 1-12

the AC system, both TRU and the battery charger come on line and the DC warnings go off.
When the left generator reaches normal operating speed, and provided that conditions for paralleling are correct, the left GCU energizes its generator contactor to connect the left generator to the XP1 AC busbar; the Left Fail light on the engine control panel and the amber GEN caption on CWP go off. Provided that conditions for paralleling are correct, the AC bus bar tie contactor remains closed. The generators are thus operating in parallel to supply all AC busbar.
For AC electrical power system operating conditions refer to Figure 1-12

DC SYSTEM

The DC power distribution system comprises two main busbars (PP1 and PP2), which are interconnected through protective fuses, and essential busbar (PP3), a battery busbar (PP4), and a maintenance busbar (PP5). Each TRU feeds one main busbar and the essential busbar while the battery busbar is normally supplied from a battery, assisted by a battery charger. Each TRU is capable of supplying the total DC demand. The maintenance busbar PP5 is supplied from the battery busbar PP4 via the crash switch (Figure FO-7).
A DC battery contactor and its associated control circuit ensures that the DC essential busbar remains live following a double TRU failure and provides facilities for supplying the essential services before the APU is started when ground AC power is not available.
Following a double TRU failure, a fast action device consisting of a silicon controlled rectifier (SCR) and associated control circuitry, ensures the minimum power interrupt to essential equipment and causes the battery busbar contactor to close. If the SCR fires but the battery busbar contactor remains open, its closure is ensured by a battery contactor relay, which is wired in parallel with the fast action device.
Normally the battery busbar contactor is held open by a correct output from either TRU. This isolates the battery busbar from the power demands on the

ELECTRICAL POWER SYSTEM OPERATING CONDITIONS

OPERATING CONDITIONS		CORRECT DC POWER SOURCE	RH TRU OR XP2 FAILED	LH TRU OR XP1 FAILED	BATT. CHAR. OR XP3 FAILED	BOTH TRU FAILED	BOTH GENERA-TORS FAILED	CRASH Pre Mods 01655 01663	CRASH Post Mods 01655 01663
SWITCHES POSITIONS	crash panel	not oper	not oper	not oper	not oper	not oper	not oper	operated	operated
	batt. master	FLIGHT	FLIGHT	FLIGHT	FLIGHT	FLIGHT	FLIGHT	FLIGHT	FLIGHT
DC POWER SOURCE	LH TRU	operating	operating	inoperat	operating	inoperat	inoperat	inoperat	operating
	RH TRU	operating	inoperat	operating	operating	inoperat	inoperat	inoperat	operating
	batt. charger	operating	operating	operating	inoperat	operating	inoperat	inoperat	operating
	BATTERY	operating	operating	operating	operating	operating	operating	operating	operating
WARNING LIGHTS	TRU	OFF	ON	ON	OFF	ON	ON	OFF	OFF
	DC	OFF	OFF	OFF	OFF	ON	ON	OFF	OFF
BUSBARS SUPPLY CONDITIONS	PP1	LH & RH TRU	LH TRU	RH TRU	LH & RH TRU	not suppl	not suppl	not suppl	LH & RH TRU
	PP2	LH & RH TRU	LH TRU	RH TRU	LH & RH TRU	not suppl	not suppl	not suppl	LH &RH TRU
	PP3	LH & RH TRU	LH TRU	RH TRU	LH & RH TRU	BATT. & B.C.	BATTERY	not suppl	LH & RH TRU
	PP4	BATT & B.C.	BATT & B.C.	BATT & B.C	BATTERY	BATT. & B.C.	BATTERY	BATTERY	BATT & B.C
	PP5	BATT & B.C.	BATT & B.C	BATT & B.C.	BATTERY	BATT. & B.C.	BATTERY	not suppl	not suppl

Figure 1-13

rest of the system and thus the battery will be rapidly recharged.
On the ground if external AC power is not available, the DC battery contactor is closed when the BATT MSTR switch on the rapid take off panel is set to FLIGHT, and is opened automatically when the first TRU comes on line.
Refer to Figure FO-8 for the utilities powered by DC busbars and refer to Figure 1-13 for DC electrical power system operating conditions.

Transformer – Rectifier Units

Each TRU produces two electrically-isolated 28V DC output from a three-phase, 200V 400 Hz AC input. One output from each is connected directly to the DC essential busbar and the second feeds the interconnected PP1 and PP2 DC busbar. Each output is capable of supplying loads up to 150A provided that the total load on a TRU does not exceed 200A. Below these limits the outputs are maintained at a nominal 28V DC by an internal current monitor which also feeds "output correct" signals to the contactor control relay and "output incorrect" signals to the failure warnings. Each TRU is cooled by an internal fan.

Battery

A 24V, 36 AH battery is connected to the battery busbar (PP4) directly and to the Maintenance busbar (PP5) via the crash bar. It provides power for ground maintenance, independent APU starting, and for the essential DC services, whenever TRU output is not available. The battery incorporates sensors which are connected to the charger regulation circuit. The battery is ventilated by air taken from the equipment bay cooling system.

Battery Charger

The battery charger is basically a TRU which produces a DC output from a three-phase, 200V, 400Hz AC input. The output voltage level is determined by the battery sensor and the unit is capable of supplying loads up to a maximum of 45 to 55 A. The charger is supplied from the XP3 AC busbar and output is connected to the battery busbar. Internal protection circuit switches off the charger in the event of overvoltage, loss of input power, loss of output and overheating; the unit is automatically re-energised if the fault condition subsequently disappears. The battery charger is cooled by air taken from the equipment bay cooling system.

Voltmeter (Post Mod. 01662)

A voltmeter is fitted on the right consoles in the rear cockpit (Figure 1-14, FO-3, FO-4). The instrument is connected to the Battery busbar (PP4), it therefore indicates either the output voltage of the battery charger or the battery voltage when the battery charger is not operating.
The instrument is divided into four coloured sectors, namely:

Red 10V to 24V
Possible battery charger failure (if both engines are running) or battery voltage too low level (if both engines are not running).

Amber 24V to 28V
Battery voltage low level (if both engines are not running).

Green 28V to 32V
Normal operating condition

Red 32V to 35V
Excessive output of battery charger due to a failure of the battery charger control circuit or to damaged battery cells.

NOTE

When in flight, the voltmeter normally pulses between 29V to 31V.

EXTERNAL POWER SUPPLY

The external AC power receptacle is installed on the right side of the fuselage. The external supply is connected to the XP1 AC busbar by a ground power contactor, which is energized by the ground power control unit (GPCU) which first establish that neither generator is on line and that the incoming supply is correct in voltage, frequency and phase sequence before completing the circuit. The ground power supply is connected through the busbar tie contactor to all AC busbars, which in turn power the TRU's to provide DC power.
A 28V DC electrical supply can be connected to a DC ground supply point on the left side of the fuselage. The supply point is connected directly to the APU starting circuit.

ELECTRICAL SYSTEM CONTROL AND INDICATORS

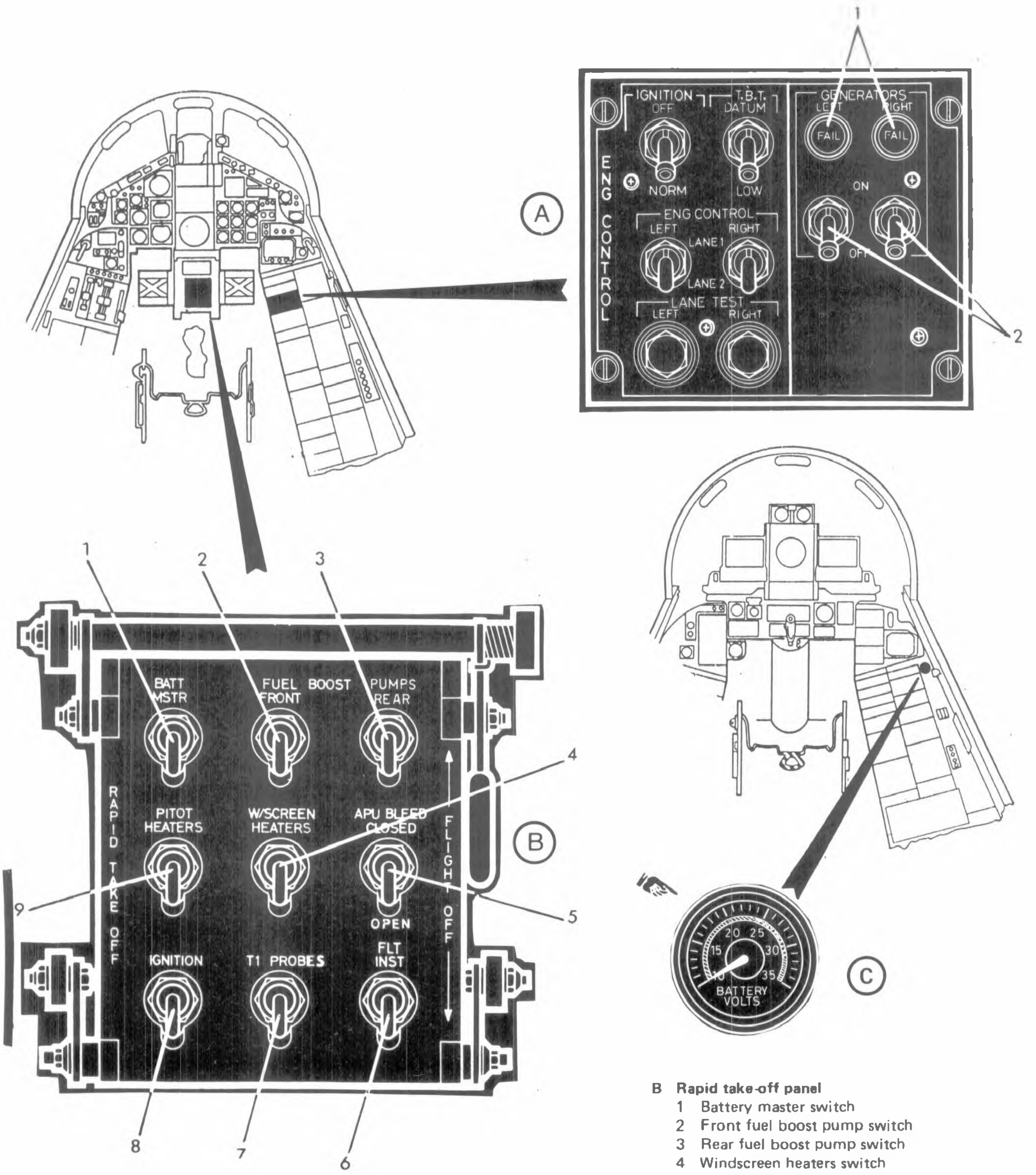
Rapid Take-Off Panel

The RAPID TAKE-OFF panel (B, Figure 1-14) is located in the lower main forward instrument panel and comprises nine two position toggle switches and a ganging lever.
Moving the ganging lever upwards sets all the switches to the FLIGHT position. However the switches can only be set to the OFF individually.
The switches in the FLIGHT position have the following functions:

BATTERY MASTER	Connects the battery busbar to the essential busbar (PP3)
FUEL BOOST PUMP	Initiates operation of the:
– FRONT	Front fuselage tank group fuel pump
– REAR	Rear fuselage tank group fuel pump
PITOT HEATERS	Connects power to incidence, pitot and total temperature probe heaters
W/SCREEN HEATERS	Connects power to the electrical wind screen heater
APU BLEED CLOSED	Closes APU bleed air valve
IGNITION	Connects power to the engine igniter
T1 PROBES	Connects power to the T1 probe heater
FLT INST	Connects power to the pilot altimeter and attitude director and its turn rate gyro-unit

With switches in the OFF position the relevant systems are de-energized and the APU BLEED switch opens the bleed air valve.

ELECTRICAL POWER SUPPLY SYSTEM (CONTROLS AND INDICATORS)



A Engine control panel
1 Generator failure lights
2 Generator control switches

B Rapid take-off panel
1 Battery master switch
2 Front fuel boost pump switch
3 Rear fuel boost pump switch
4 Windscreen heaters switch
5 APU bleed control switch
6 Flight instruments power switch
7 T1 probes heater switch
8 Engine igniters control switch
9 Pitot probe heater switch

C Voltmeter (Post Mod 01662)

Figure 1-14

Engine Control Panel

The engine control panel (A, Figure 1-14) includes the following electrical system control and indicators:
Two GENERATORS – ON/OFF toggle switches to select the generators on or off line, providing that the crash switches are in the normal flight position and the control and protection circuits permit.
Two amber GENERATORS LEFT/FAIL and RIGHT/FAIL lights illuminate when the associated generator contactor is open and the generator is off line.

Crash Panel

Pre Mod. 01655 and 01663
The crash panel (B, Figure 1-7) is marked CRASH and carries four switches which are guarded by a yellow ganging bar. It is marked with black stripes and labelled LIFT – PULL. When the bar is operated, the switches marked GEN L/GEN R and the BATT switch move to the OFF position thus opening the generator contactors and disconnecting the maintenance busbar from the battery busbar. Consequently all electrical system busbars, except the battery busbar, (PP4) will be deenergized. The FIRE EXT switch moves to the ON position and the engine fire extinguisher will discharge into both engine compartments simultaneously.
Post Mod.01655 and 01663
The two generator switches marked GEN L/GEN R are removed from the crash panel and therefore when the crash bar is operated the generators will not be deenergized.
An additional switch marked BATT is installed to provide a separate earth return line from the fast action device. The function of the FIRE and the battery switches remains as before.

WARNING

THE ENGINES SHALL BE SHUT DOWN VIA HP COCKS PRIOR TO CRASH BAR OPERATION. IF THIS SEQUENCE IS NOT FOLLOWED THE ENGINES WILL ACCELERATE UNCONTROLLED TO SELF DESTRUCTION BECAUSE ENGINE CONTROL IS LOST AND THE OVERSPEED GOVERNORS ARE NO LONGER OPERATIVE.

Central Warning Panel

The following electrical system captions are displayed on the CWP.

Red warnings (both cockpits):

AC	Both generators off line
DC	Both TRU's have failed

Amber warnings (front cockpit only):

GEN	Either or both generators off line In case of a high difference current of > 50 amps between the generators
TRU	Either or both TRU's have failed

HYDRAULIC POWER SUPPLY SYSTEM

Two separate hydraulic system (Figure FO-9) independently supply pressure from hydraulic pumps mounted one each on the engine driven accessory gearbox. Each system draws fluid from its own hydraulic reservoir. A cross-drive mechanism between the gearboxes can be selected so that the APU or either engine can supply hydraulic power for both system. Each engine normally drives its own accessory gearbox and hydraulic pump.
Each system is divided into a control and utility system, the control system being protected by an isolating valve which operates in the event of a leak to isolate the utility. If the leak lies in the utility system the remaining fluid is retained for the primary flight controls.

HYDRAULIC SYSTEM OPERATIONS

In normal operation, with the cross-drive clutch selected to AUTO, the cross-drive clutch closes when a 15% NII differential is sensed as an engine runs down, and both gearboxes are driven by the remaining engine: there is no change in the status of the hydraulic systems. In this situation, however, it is prudent to ensure that the HYDRAULICS switch of the shut-down engine is set to AUTO to guard against a subsequent gearbox failure, since in that event the hydraulic system does not depressurize with ON selected at the corresponding HYDRAULICS switch.

The hydraulic system was designed to operate with the HYDRAULICS switches both selected to AUTO in flight to allow the automatic depressurisation of either system after a gearbox run-down (eg, after an engine flames out with the cross-drive open). However, it was found that, with AUTO selected, a particular failure of the SPS control circuit could cause the depressurisation of both hydraulic systems after a single gearbox run-down, and it was essential to have either of the HYDRAULICS switches set to ON to prevent this occurring.
Post Mod. 10977, which corrects the SPS control circuit logic, the aircraft can be safely flown with AUTO selected at both switches but, during the period where there are both Pre and Post Mod. 10977 aircraft in service, the best action is to fly with the HYDRAULICS switches set to LEFT – ON, RIGHT – AUTO. In the Pre Mod. 10977 aircraft with these selections, the possibility of a double depressuration is guarded against. In Pre and Post Mod. 10977 aircraft with these selections, the right hydraulic system depressurises automatically after a right gearbox run-down but the left HYDRAULICS switch shall be set to AUTO to depressurize the left hydraulic system after a left gearbox run-down. Post Mod. 10977 after a double engine flameout (or when shutting down both engines on the ground), the left hydraulic does not depressurize unless the LEFT HYDRAULICS switch is set to OFF.

HYDRAULIC FLUID RESERVOIRS

Two reservoirs, one for each system, are located in the rear fuselage. Each reservoir has a hydraulic fluid capacity of 16.2 litres and is pressurized to approx. 8 bar. Each reservoir incorporates fluid level and temperature transmitters, a low-level switch and a pressure relief valve. Fluid level is indicated on aircraft skin gages. The low-level switch is in circuit with the system isolating valve.

HYDRAULIC PUMPS

Each constant pressure variable delivery pump incorporates a solenoid-operated depressurizing valve which is controlled by the appropriate HYDRAULICS– ON/AUTO/OFF switch and the relevant gearbox speed switch.
In the OFF position, the depressurizing valve is energized to limit system pressure to approximately 70 : 110 bar.
In the AUTO position, the depressurizing valve will be energized to reduce the accessory gearbox load while the APU is running and when the accessory gearbox speed is below 55% NH. While the engines are running down, the depressurizing valve will remain de-energized when the accessory gearbox speed in above 30% NH.
In the ON position, the depressurizing valve is de-energized to provide normal maximum discharge pressure of approximately 270 bar at zero flow and 260 bar at max. flow. In the event of a double engine flame-out, an EPS system provides hydraulic power for emergency operation of the taileron actuators. The hydraulic component of the EPS consists of a DC motor driving a variable delivery hydraulic pump (EHP), assembled as a package. The package is installed in the left secondary power bay in parallel with the engine driven hydraulic pump of the aircraft left hydraulic system (for further information refer to para EMERGENCY POWER SUPPLY SYSTEM).

HYDRAULIC ACCUMULATORS

A main accumulator in each system smooths out pressure surges from the pump and produces the flow response necessary for satisfactory operation of the flight controls. The accumulator is charged with nitrogen to 140 bar.
In addition to the main accumulator, each system has an accumulator which supplies the artificial pitch feel (charged with nitrogen to approximately 60 bar). This absorbs transient supply pressure variations to the feel system during normal operation and also ensures a slow reduction in feel jack stiffness should both utilities system fail. The left system has a canopy accumulator (charged with nitrogen to 105 bar) and a wheelbrake accumulator (charged with nitrogen to 140 bar). A fully charged wheel brake accumulator can provide a minimum of ten brake applications.
When the canopy accumulator is fully charged it can provide a minimum of three canopy operating cycles or may be used to back up the wheel brake accumulator to provide a minimum of fifteen wheel brake applications. The accumulators are charged with nitrogen and the pressures in each accumulator are indicated on skin gages.

ISOLATING VALVES

Electrically operated isolating valves, controlled either automatically by the reservoir low-level switches or manually by the UTILITIES TEST switch, divide each system into two parts. If, due to a leak in the system the fluid content of a reservoir reduces to 3.2 litres the low-level switch operates to

close the isolating valve. A pressure switch, downstream of the isolating valve closes when utility pressure falls below 130 ± 10 bar and illuminates the relevant amber UTIL indication on the CWP in the front cockpit (in addition the CSAS, PFCS and RAMP fail warnings will illuminate). All utilities in the affected system are isolated from the hydraulic pressure supply, except the taileron actuator in the left system, and the taileron and rudder actuators in the right system. This condition will continue throughout the remainder of the flight as the reservoir low-level switch can be reset only on the ground.
The UTILITIES TEST switch is operated by the pilot to test the operation of the isolating valves and the failure indications before flight.

NOTE

In the event of a double engine flameout, the left hand isolating valve will be closed by an EPS signal, to conserve EHP pressure for operation of the tailerons.

HYDRAULIC COOLING

Each system is provided with a fuel-cooled hydraulic oil cooler installed in the low pressure return line to the reservoir.

HAND PUMP

The left system has a hand pump for pressurizing the wheelbrake and canopy accumulators. The pump is located in the left accessory gearbox compartment and is operated by a detachable handle stowed on the compartment door.

PRIORITY VALVES

Two pressure-operated priority valves, one for each system, ensure that large demands made by the secondary flight control system (principally wing sweep) do not affect the hydraulic supplies to the primary flight controls. Each valve starts to close when its upstream pressure reduces to 230 bar and is fully closed at 200 bar to temporarily isolate the secondary flight control system from the hydraulic supply.

HYDRAULIC SUPPLY

The hydraulic system provides power to operate the flying controls and utilities as indicated in Figure 1-15.

HYDRAULIC SYSTEM FAILURE AND WARNINGS

Each system contains a fluid temperature sensor upstream of the hydraulic oil cooler, and is in circuit with the amber HYD T indication on the CWP in the front cockpit.
The caption illuminates if fluid temperature exceeds approx. 145 degrees C. The warning remains activated until temperature reduces to approx. 110 degrees C.
A pressure switch in each controls section is in circuit with its associated red CONTR indication on the CWP in both cockpits. The switch operates to activate the warning if the pressure falls below 130 ± 10 bar.
As described under "Isolating Valves", loss of fluid from either system will operate the low-level switch and close the respective isolating valve when the reservoir contents are reduced to 3.2 litres. With the isolating valve closed, a pressure switch downstream of the valve operates to illuminate the respective amber UTIL indication on the CWP. After activating the EPS system, the left utility system isolating valve closes and the amber L UTIL indication on the CWP illuminates.

HYDRAULIC SYSTEM CONTROLS AND INDICATORS

Hydraulic Pressure Indicators

Two gages (1, Figure 1-16), marked L HYD and R HYD having rotating indicators displaying hydraulic pressure in each system, from 0 to 350 bar. A white sector on the scale indicates normal hydraulic pressure operating range.

Reservoir Fluid Level Indicators

Two gages (6, Figure 1-16), skin-mounted one on either side of the rear fuselage, having system reservoir fluid level in litres from 3.2 to 16.2. The left gage indicates the fluid level of the left hydraulic system and the right gage that of the right system.

HYDRAULIC SUPPLY

Left System	Right System
Flight Control System	Flight Control System
Tailerons	Tailerons
	Rudder
Utility System	Utility System
Rudder	
Flaps and slats	Flaps and slats
Krueger flaps	
	Airbrakes
Inboard spoilers	Outboard spoilers
Wing sweep	Wing sweep
Left air intake ramps	Right air intake ramps
Pitch "q-feel" system	Pitch "q-feel" system
Canopy	
Wheelbrakes	
Air-to-air refuelling probe emergency extension	Air-to-air refuelling probe normal
	Landing gear
	Nosewheel steering
	Radar stabilization and scanning

Figure 1-15

Main Accumulator Pressure Indicators

Two gages (5, Figure 1-16), skin-mounted one on either side of the rear fuselage, having moving indicators displaying the respective system main accumulator pressure in bar from 0 to 350 bar. The accumulators are pressurized by the relevant left and right hydraulic systems. If hydraulic pumps are depressurized, the indicator will show approx. 140 bar.

Canopy Accumulator Pressure Indicator

A skin-mounted gage (7, Figure 1-16), on the left side of the front fuselage, having a moving indicator displaying the pressure in the canopy accumulator from 0 to 350 bar. The accumulator is pressurized by the left hydraulic system, or by use of a handpump.

Wheel Brakes Accumulator Pressure Indicators

A skin-mounted gage (8, Figure 1-16), on the left side of the front fuselage, having a moving indicator displaying the pressure in the wheelbrake accumulator from 0 to 350 bar. The accumulator is pressurized by the left hydraulic system, or by use of a handpump.

Pitch Feel Accumulator Pressure Indicators

Two gages (9, Figure 1-16), skin-mounted on the left side of the front fuselage, having moving indicators displaying the pressure in the two pitch feel accumulators from 0 to 100 bar. The accumulators are pressurized by their respective hydraulic systems.

Brake Pressure Indicator

A pressure indicator (4, Figure 1-16), marked BRAKES, having three indicator needles showing against the upper scales the pressure at each wheel brake on the normal system only, and against the lower scale the accumulator pressure available. With the electrical power off the pointers indicate OFF.

Hydraulic Pressurization Switches

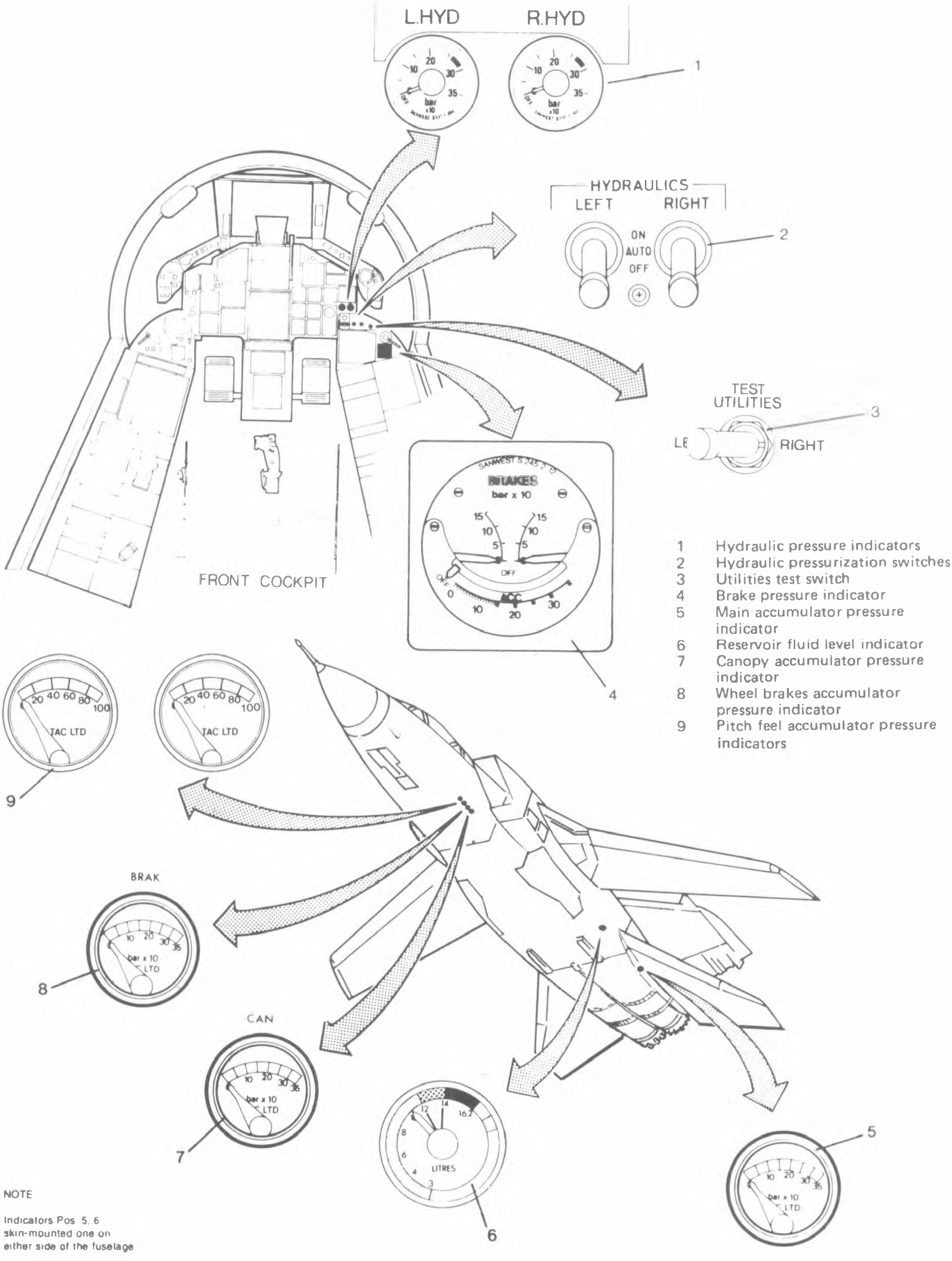
Two three-position latch-toggle switches (2, Figure 1-16), marked HYDRAULICS – LEFT/RIGHT – ON/AUTO/OFF, each controls the depressurizing valve on one hydraulic pump. The switches may be locked in each of the three positions.

ON — The depressurizing valve is closed independent of gearbox speed to provide maximum discharge pressure.

AUTO — During gearbox runup up to 55% the depressurizing valve is open to reduce gearbox load. Beyond 55% the valve closes and the hydraulic system will provide max discharge pressure. During gearbox rundown, the depressurizing valve will not open before 30% (Post mod. 10977: in the case of a double engine flameout (both gearboxes run down) the left depressurizing valve stays closed. Only the right hand hydraulic system will depressurize to reduce gearbox load).

OFF — The depressurizing valve is opened independent of gearbox speed, to limit system pressure to 70 ÷ 110 bar.

HYDRAULIC SYSTEM (CONTROLS AND INDICATORS)



1 Hydraulic pressure indicators
2 Hydraulic pressurization switches
3 Utilities test switch
4 Brake pressure indicator
5 Main accumulator pressure indicator
6 Reservoir fluid level indicator
7 Canopy accumulator pressure indicator
8 Wheel brakes accumulator pressure indicator
9 Pitch feel accumulator pressure indicators

NOTE

Indicators Pos 5, 6 skin-mounted one on either side of the fuselage

Figure 1-16

Utilities Test Switch

A three-position switch (3, Figure 1-16), spring-loaded to the center position, marked TEST UTILITIES – LEFT/RIGHT, closes the respective isolating valve when set to LEFT or RIGHT, to simulate failure of the appropriate utilities system.

Central Warning Panel

Indications on the CWP for hydraulic system failures are as follows:

Red warnings (both cockpits):

L CONTR, R CONTR	Illuminates if hydraulic pressure falls below 135 bar ± 10 in the respective system.

Amber warnings (front cockpit only):

L UTIL, R UTIL	Illuminates if utility pressure falls below 130 bar ± 10 in the respective system.
L HYD T, R HYD T	Illuminates if the fluid temperature in the respective system exceeds approx. 145 degrees C. It remains activated until temperature reduces to approx. 110 degrees C.

LANDING GEAR SYSTEM

The landing gear (LG) (Figures FO-10 and FO-11) is a tricycle-type, forward retracting and hydraulically operated. The main landing gear (MLG) consists of two oleo-pneumatic legs each having a single wheel. The arrangement of the MLG provides symmetrical gear operation. The nose landing gear (NLG) has twin wheel. Normal extension and retraction of the landing gear is electrically controlled and hydraulically operated. A nose wheel steering system forms part of the nose gear leg. An emergency lowering system is included, which is mechanically controlled and operated by nitrogen gas pressure.

MAIN LANDING GEAR

The main landing gear is retracted forward into the sides of the fuselage. Retraction is effected by hydraulic actuators powered by the right utilities system. The MLG is locked in the UP position by hydraulics latches and by self locking drag braces actuated by a lock jack in the down position. The MLG doors are operated by hydraulic actuators. The landing gear selector lever is locked in the DOWN position by a solenoid which is activated by the WOG switch when the aircraft is on the ground. The LG can be retracted on the ground by pressing the red emergency override button, which releases the solenoid lock. The lever may then be raised.

CAUTION

DO NOT USE THE EMERGENCY OVERRIDE BUTTON IN THE AIR WHEN THE LANDING GEAR SELECTOR LEVER CANNOT BE RAISED.

To prevent inadvertent DOWN selection of the landing gear, the selector lever is mechanically locked in the UP position. It can only be released by pushing forward the uplock lever on top of the landing gear handle.
Retraction and extension of the landing gear takes 5 ± 1 seconds.

NOSE LANDING GEAR

The nose landing gear (NLG) is retracted forward into a well. Retraction and extension are achieved by a hydraulic actuator, powered by the right hydraulic system. The oleo-pneumatic strut is held in the up position by means of a self-locking system as part of the drag brace. The lowered position is fixed by the same drag brake lock link, held down by springs and the pressure of the actuator. The two front doors of the landing gear well are controlled by the landing gear through a mechanical linkage. The rear gear door is fixed to the strut. The up and down locked positions of the doors are fixed by overcentering. In case of emergency, an additional nudger jack assist in overcoming the overcentering position of the door drive shaft.

LANDING GEAR EMERGENCY LOWERING SYSTEM

The emergency lowering system is supplied from a pressurized nitrogen storage bottle. The bottle is

fitted with an emergency selector valve which is operated via a cable, by pulling the LG emergency lowering handle. When the handle is pulled out, irrespective of the position of the LG selector lever, pressurized nitrogen is routed to the actuators of the NG door emergency release mechanism and leg, the MLG door locks, doors and legs. At the same time the MLG and NG dump valves will open. The LG will extend and lock down in the normal manner. While the landing gear is in transit, the red U/C caption on the CWP illuminates and the lyre bird tone sounds. When the gear is locked down, the landing gear position indicator will show three green lights, the U/C caption extinguishes and the lyre bird tone ceases. If the LG selector lever is in UP, the lever warning will continue to flash.
Subsequent to the emergency LG lowering the LG lever should be selected DOWN. This will cancel the gear-up signal which otherwise could be felt by the aircrew as an irritating "bang" during taxiing each time the nosewheel passes the centered position.

NOSEWHEEL STEERING SYSTEM

The nose wheel steering system (NWS) provides two steering modes. In the LOW mode (green LOW indication of the split legend NWS selector/indicator), used for landing and take-off, nosewheel deflection is ± 30 degrees. In the HIGH mode (green LOW and amber HIGH indication), used for taxi manoeuvres, deflection is ± 60 degrees. The NWS system will deflect the nosewheels at an approx. rate of 20 degrees/second in both steering modes.
The system is energized manually by pressing the nosewheel steering mode selector/indicator or automatically after gear lowering and successful NWS BITE.
Initial engagement of the nose wheel steering system is always into the LOW mode. In the LOW mode only, automatic yaw compensation augments normal steering demand. Directional control is obtained by either operating the rudder pedals or automatically, with max ± 6° authority, in the case of rapid directional changes. The automatic control is obtained by feeding yawing speed signals from the lateral computer into the steering control box, which computes a corrective steering signal, resulting in automatic lateral stabilization of the aircraft. When the nosewheels and either main wheels are off the ground, a "steer to center" signal is applied to the steering system and the NLG can only be retracted if the nosewheels are centered. The NWS is automatically tested within 12 seconds after the nose gear is down. Successful testing is indicated by illumination of the LOW (green) caption of the split legend nose wheel steering mode selector/indicator. In case of steering and yaw control failure, audiowarning and LOW caption out occurs, in case of yaw control failure only, audiowarning and LOW indication appears.
After touchdown of the main wheels, the LOW caption extinguished, steering is disengaged and the nose wheel is in free castor. After nose gear touchdown, the LOW caption again illuminates, an automatic engagement of the system occurs with a 1,5 sec "fade in" time. The system can be disengaged manually by pressing the ICO on the control stick. For detailed information of NWS failure refer to Section III.
The nose wheel steering mode selector/indicator can be pressed again to engage the HIGH mode, indicated by illumination of the HIGH (amber) caption of the selector/indicator.
Subsequent mode changes are effected as required by pressing the selector/indicator.
With NWS not selected the wheels are in free castor with a deflection up to 360 degrees. Shimmy damping is provided in the free castor mode.
Low and high indicators are extinguished.

NOTE

- The nose wheel steering system will deflect the nose wheels at an approx. rate of 20 degrees/second in both steering modes.
- Immediately the nose wheels and either main wheel are off the ground, a "steer to center" signal is applied to the steering system.
- A sequence switch system ensures that the nose landing gear cannot be retracted, unless the nose wheels are centered.

WHEEL BRAKE SYSTEM

Each main landing gear wheel is equipped with a hydraulically operated multiple disc brake. Pressure for operation of the brakes is supplied by the left utility hydraulic system for normal operation.
Normal braking is protected by an antiskid control system. Emergency and parking brake facilities are provided.

Normal braking operations are controlled by convertional brake pedals, connected to hydraulic foot motors with the braking module.
Emergency braking is available if the left hydraulic system fails and an initial brake pressure of 150 bar is available as for normal braking. A changeover valve supplies system pressure from the wheel brake accumulator thus providing approximately 15 brake applications, but no anti-skid facility.
Additional provisions are made for selection of the brake handle to the emergency position. The brakes are operated in the normal manner by the rudder pedals, but will be supplied from the emergency brake circuit.
Full parking brake pressure of the accumulator acts on the brakes, via the emergency brake circuit, on selection of the brake handle to the parking position.
In the event of a pressure drop in the wheel brake accumulator, further brake pressure is automatically provided from the canopy accumulator.

CAUTION

DO NOT SELECT THE PARKING BRAKE WHILE THE AIRCRAFT IS IN MOTION AS THIS WILL ABRUPTLY LOCK THE WHEELS AND CAUSE TIRE DAMAGE.

NOTE

If the left hydraulic utilities system is still functioning normally, the wheel brake accumulator will be kept full. In this case the number of brake applications is not limited.

The brake selector handle is repositioned to emergency or normal from the parking position, by reversing the actions required to select those positions.

ANTI-SKID SYSTEM

The aircraft wheel brake system is equipped with an electrically controlled anti-skid system, consisting of three basic units; a control box, servo valves, and wheel driven generator sensing unit. The units are designed to give individual wheel skid control operation.

The anti-skid control system provides the following functions:

- Anti-skid touch-down protection
- Proportional skid control
- Locked wheel protection circuit
- Anti-skid failure detection

The system is energized by the main landing gear up-lock switch, whenever the LG is extended.
Whenever either wheel begins to enter a skid, as evidenced by a rapid wheel deceleration sensed by the wheel driven generator unit and relayed to the control box, the skid control system causes the corresponding metered pressure to that brake to be reduced in proportion to the intensity of the skid by the skid control valve. As a result the wheels return to the efficient braking/rolling speed just below the skid threshold. The system also compensates automatically for changes such as runway conditions, load and pedal pressure by the pilot. Below 10 knots speed, the system is inoperative, because the wheel excursions will be too small to operate the skid detector circuits.
The wheel speed sensors are wheel driven generators, which provide an output voltage proportional to wheel speed.
The output sensor of each wheel speed sensor is applied to the appropriate three stage skid control unit.

- The first stage is a deceleration detector, which differentiates the wheel speed voltages and produces an output signal, which is therefore a measure of wheel deceleration, whether it is the slow deceleration of the braking stop or the high deceleration of an incipient skid.
- The wheel deceleration signal is routed to a skid detector circuit, which represents the second stage. This circuit is set to provide an output signal only if the wheel deceleration is 8.5 m/sec^2 or more.
- The skid detector output signals are applied to the third stage, an amplifier, whose signal is used to power the associated brake pressure servo valve, which lowers the brake pressure while simultaneously depressurizing the brake cylinders. This allows the wheel to speed up again, which causes the brake to be reapplied. Should one wheel be locked completely, the brake pressure will be held off for a period of time that depends upon the speed of the wheel just before it become locked.

Touchdown protection is provided by the touchdown protection circuit in the control box. This receives wheel speed signals from both wheels and a landing gear signal from the shock strut relay. The circuit prevents brake application unless the aircraft is on the ground and the wheels have spun up. In the event of aircraft bounce at touchdown, the brakes will be automatically held off until the aircraft touches down again. The touchdown protection is inoperative whenever the BRAKES TEST button is pressed.

Built-In Test Equipment

When the pilot momentarily presses the BRAKES TEST button on the ground to initiate a systems test, a signal representing 20 knots wheel speed is applied through the wheel drive unit to the control box. On releasing the test button a skid is simulated and the built-in test equipment (BITE) checks the system components. In flight, pressing and holding the button, the test signal overrides the touch down protection system enabling the pilot to depress the brake pedals and observe the hydraulic pressure on the brake pressure triple indicator; if a fault exists or a circuit does not respond within prescribed limits, then control circuits de-energize the system and an amber A-SKID warning light on the CWP in the front cockpit illuminates.

Normal Brake Indicating System

The normal braking pressure lines are equipped with pressure sensors, which control the left and right indicator on the triple brake pressure gage.
The triple brake pressure gage is powered by the essential DC busbar (PP3) and indicates normal brake pressure applied by the pilot when:

- The LG is UP and locked, or
- The LG is DOWN and locked and either the aircraft weight is on the wheels or the BRAKES TEST button is pressed

Normal indication is approximately 140 bar with maximum pressure exerted on the brake pedals.
The ACC (accumulator) pointer on the brake pressure indicator is controlled by a pressure sensor on the brake accumulator. This indication is available as long as the essential DC busbar (PP3) is energized. Whenever pressure indication is 140 bar or less, the brake accumulator is below min. charge pressure and emergency and parking brakes will not be available.

LANDING GEAR SYSTEM CONTROLS AND INDICATORS

Landing Gear Selector Lever

The landing gear selector lever (7, Figure 1-17), located on the left hand quarter panel, marked U/CARRIAGE – UP/DOWN comprises:

- A two position wheel-shaped lever to select the Ldg–Gear UP or DOWN. The red warning light in the LG selector lever will always flash whenever the landing gear position does not agree with that of the lever, e.g., if selected to UP until all gear legs and doors are locked up, if selected to DOWN until the LG is locked down
- Landing gear selector lever down-lock override (9, Figure 1-17) red push button, which overrides an oleo switch, permitting the landing gear to be selected UP
- Landing gear selector lever up-lock (8, Figure 1-17). Protrudes from the top of the lever handle and mechanically prevents the lever from being inadvertently selected DOWN. To release the up-lock push the landing gear lever up-lock forward

Landing Gear Position Indicator

The landing gear position indicator (2, Figure 1-17) is located on the left side of the main instrument panel in the front cockpit, and in the left hand quarter panel in the rear cockpit.
It has the following functions:

- Three red UNLOCKED warning lights, one for each landing gear illuminate when a landing gear leg or a main LG door is not locked (i.e. not locked up)
- DAY/NIGHT brightness control knob with arrows pointing to the desired selection
- Three green LOCKED DOWN indicator lights, one for each landing gear leg, illuminate when the landing gear is in the LOCKED DOWN position

All lights are extinguished when the landing gear is locked UP and the doors are locked closed.

LANDING GEAR SYSTEM

1 Emergency landing gear lowering handle
2 Landing gear position indicator
3 Nosewheel steering selector indicator
4 Brake selector handle
5 Brake pressure triple indicator
6 Brake test button
7 Landing gear selector lever
8 Landing gear selector lever up lock
9 Landing gear selector lever down lock override

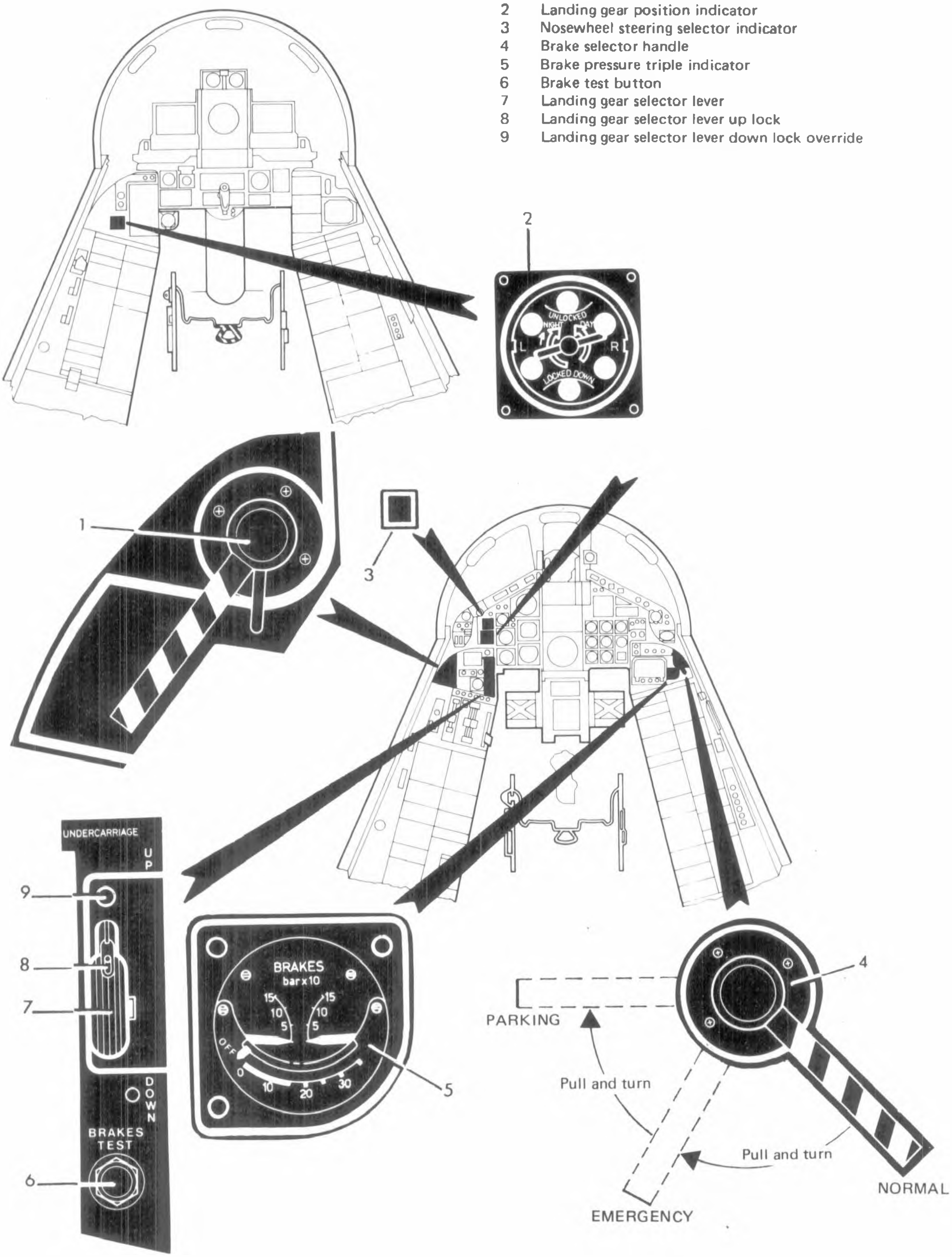


Figure 1-17

NOTE

The LG position indicator functions independently of the LG selector lever position.

Emergency Landing Gear Lowering Handle

A yellow and black striped handle (1, Figure 1-17), located on the left hand quarter panel and marked EMERG U/C, permits emergency lowering of the landing gear by pulling the handle. The handle shall be reset on the ground.

NOTE

There is a tendency to apply either a sideways force or rotation when pulling the handle and, in extreme cases, this can cause jamming. Always apply a straight pull force and avoid any rotation of the handle. The collar behind the landing gear emergency handle is for resetting purposes: crews should not attempt to move it except as a last resort if the handle fails to operate.

Nose Wheel Steering Mode Selector/Indicator

A combined selector/indicator push button, located on the left hand side of the main instrument panel (3, Figure 1-17), marked HIGH (amber) and LOW (green). The button permits initial selection of the nose wheel steering system in LOW mode and alternate selection of the HIGH wheel steering mode.

Instinctive Cut Out Switch (ICO)

A push button, located on the control stick grip under the ICO bar (9, Figure 1-20), when pressed disengages the nose wheel steering.

Brake Selector Handle

A black and yellow striped three-position handle (4, Figure 1-17), located on the right hand quarter panel, operated with a pull-out and turn action. In the fully in position, the handle selects normal braking facilities. When the handle is pulled out to the first stage and turned clockwise through approximately 80 degrees, the emergency braking facilities are selected. Pulling the handle further out to the second stage and turning it through a further 50 degrees selects parking brakes.
The brake selector handle is reselected to the emergency or normal positions by turning the handle counterclockwise to the required position and pushing it into the panel to the required stage.

Brakes Test Button

The brakes test button (6, Figure 1-17), marked BRAKES TEST, is located on the left hand quarter panel. This button is used to test the integrity of the brake system.
For details of the button functions refer to Built-In Test Equipment in this chapter.

Brake Pressure Triple Indicator

A three pointer brake hydraulic pressure gage (5, Figure 1-17), located on the right hand quarter panel, marked BRAKES/barX10, include the following indications:

- The twin pointers indicate, against the upper scales, the pressure at each wheel brake on the normal system only
- The lower pointer shows accumulator pressure available for the brakes. A red zone on the lower scale indicates that the accumulator is exhausted, and there is no sufficient pressure available for either normal, emergency or parking brake purposes.

Central Warning Panel

Indication on the CWP for landing gear system failure is provided through a red caption marked U/C.
The U/C caption will illuminate and the lyre bird tone sound when the following conditions occur simultaneously:

- Any LG leg or door are not locked in the landing configuration
- Altitude at or below 10,000 ± 1,000 feet
- Airspeed at or below 180 ± 12 knots
- Either throttle retarded to 92 ± 2% NH or below

The lyre bird tone will stop and the U/C caption extinguish whenever one of the above conditions cease to exist. The lyre bird tone may be silenced by pressing any one of the attention getters.

LANDING GEAR OPERATION

When the LG is selected to UP, the warning light in the LG selector handle flashes. After the nosewheels have centered, the NLG downlock is released, the green NLG position light will extinguish and the red light illuminates as the NLG retracts. Simultaneously the MLG downlocks are released, the corresponding green LG position lights extinguish and the red lights illuminate as the MLG retracts. After the MLG legs are up and locked the MLG doors close and lock, the red lights extinguish, and the LG selector lever stops flashing.
When the LG is selected to DOWN, the warning light in the LG selector handle flashes. The NLG, the MLG door locks and leg uplocks are released, the red LG position indicator lights illuminate and the LG is lowered. Leg down locking is indicated by the corresponding green lights on the position indicator, and the LG selector lever stops flashing.
To avoid the risk of an inadvertent gear up landing, the warning light in the LG selector flashes, the red U/C caption on the CWP illuminates and the lyre bird warning tone sounds, if the following conditions are met simultaneously:

- Any LG leg not locked down or any MLG door not in the commanded position
- Altitude at or below 10,000 ± 1,000 feet
- Airspeed at or below 180 ± 12 knots
- Either throttle retarded to 92% NH (± 2) or below

Whenever one of the above conditions ceases to exist, the lyre bird tone will stop sounding, the warning light in the LG selector lever and the U/C caption will extinguish.
The lyre bird tone may be silenced by pressing any one of the attention getters.
Emergency landing gear lowering is mechanically controlled through a yellow and black striped handle located on the front cockpit left hand quarter panel, and pneumatically operated by a nitrogen gas pressure.
Correct operation of the emergency system and indication that the landing gear is down and locked is displayed as follows:

- Three green lights illuminated on the landing gear indicator (to confirm that the three landing gear legs are down and locked)
- Selector lever warning light flashing
- U/C caption & lyre bird tone on

ARRESTING HOOK SYSTEM

The system consists of the arrester hook, a hook release combined push button and indicator marked HOOK (11, Figure FO-2; 20, Figure FO-4), a torque tube and cam assembly and an electrically operated solenoid up-lock and release unit. The green arrester hook indicator light illuminates when the solenoid up-lock and release mechanism has opened.
The arrester hook is stowed manually and retained in the retracted position by the up-lock and release unit. The hook is forced down by the combined action of the torque tube and cam assembly and its own weight.

CAUTION

- DO NOT LOWER THE ARRESTER HOOK UNTIL APPROXIMATELY 500 FEET IN FRONT OF THE ARRESTER CABLE. DAMAGE TO THE HOOK WILL BE CAUSED BY CONTACT OF THE RUNWAY.
- THE ARRESTER HOOK IS DESIGNED TO BE LOWERED ONLY WHEN THE AIRCRAFT IS ON THE RUNWAY. LOWERING THE ARRESTER HOOK WHILE AIRBORNE MAY RESULT IN SWINGING ACTION CAUSING STRUCTURAL DAMAGE.

ARRESTING HOOK SYSTEM CONTROLS AND INDICATORS

The hook release combined push button and indicator is housed in a blank and yellow striped sleeve. Pressing the button releases the arrester hook and illumination of the green light indicates that the hook is released.

CAUTION

DO NOT DEPRESS THE BUTTON FOR LONGER THAN 5 SECS, OTHERWISE DAMAGE MAY OCCUR TO THE RELEASE SOLENOID.

HIGH LIFT DEVICES

SLAT & FLAP SYSTEM

A threee sections slat is installed in the wing leading edge. Each slat section is equipped with two tracks which slide over rollers fitted to the wing leading edge. The three sections are mechanically linked to each other and moved by four screwjacks. A rubber seal if fitted to the slat lower surface to ensure slat to wing leading edge sealing when slats are retracted. A four sections, double slotted flap is fitted spanwise along the full trailing edge of each wing. Each section consists of a main vane and a leading edge vane fixed to the main vane. The actuation system comprises eight screwjacks, two for each vane.

A roller and track system gives a downward and a rearward movement when the flaps are extended.
Two independent sets of torque shafts driven by a single drive unit operate slat and flap screwjacks respectively. A telescopic shaft is provided to allow wing sweeping. The drive unit, located in the centre fuselage, is powered by four hydraulic motors, two motors driving the flap system and two motors driving the slat system. Hydraulic power is supplied by both hydraulic systems, each powering one slat and one flap motor. When a hydraulic failure occurs, the motors powered by the functioning system are able to drive both flaps and slats to their full travel, but at reduced speed.

For detailed information on system operation, refer to "SECONDARY FLIGHT CONTROL SYSTEM".

KRUEGER FLAP

The Krueger flap is a slotted aerofoil section which is hinged about three points on the nib leading edge. The flap is operated by a hydraulic jack which acts in conjunction with the slat and flap and is controlled by the high lift lever.

The Krueger flap actuators are powered by the left utility system (See "SECONDARY FLIGHT CONTROL SYSTEM").

PRIMARY FLIGHT CONTROL SYSTEM

The primary flight control system (PFCS) consists of the tailerons, the rudder and the spoilers, the command and stability augmentation system (CSAS), which functions as a signal computer, and the electrical, mechanical, hydraulic and pneumatic subsystems for control signalling and control power. The flight control system is interconnected with the pilots control stick and rudder (Figures FO-12 and FO-13). Tailerons symmetrical movement affects pitch control, taileron differential movement affects roll control. A conventional rudder is actuated via the control pedal. Spoiler operation at wing sweep less than 50 degrees supplements roll control manoeuvres.

CSAS

The CSAS is an integral part of the PFCS providing "fly-by-wire control" in two modes: full CSAS known as Manoeuvre Demand (MD) which is the normal mode of operation and Direct Link (DL) which is the electrical reversionary mode. A mechanical mode, which is normally disengaged, provides conventional hydraulic powered control via the tailerons in the event of certain multiple failures within the CSAS.

The CSAS incorporates a Mode and Failure Logic System (MFLS) which continuously monitors the triplex signal integrity and registers failures on the CSAS control panel and CWP.

Mode reversions are automatically initiated when multiple failures are detected. The pilot can also select and deselect reversionary modes for training purposes. Provision is made for a smooth changeover using faders.

FULL CSAS

The full CSAS mode is a triplex, electrically signalled control and stability system utilizing pitch and lateral computers, with the lateral computer also containing the electronic circuits for yaw control. Control demand signals to control surface hydraulic actuators are modified by air data inputs derived from the Triplex Transducer Unit (TTU), and wing sweep, flap and airbrake position signals and subsequent aircraft responses. The system produces PFCS response according to aircraft configuration and flight conditions. Rate gyros for each axis provide signals to improve short period and Dutch roll damping, thus improving overall general stability.

With the autopilot engaged, triplex control demand signals to the CSAS are generated by the autopilot and flight director system.

The pitch and roll output signals of the CSAS are routed to the taileron actuators. The electrical signal is converted into a mechanical movement, which operates the taileron power actuator servo valve. Roll output signals are also fed to the inboard and outboard spoilers provided that wing sweep is less than 50 degrees. The yaw output signal of the CSAS is transmitted to the rudder actuator loop.

The following pitch and roll deflections can be achieved:

- Symmetric taileron deflection (pitch command) is limited to + 10 degrees (nose down) and − 30 degrees (nose up).

- Differential taileron deflection (roll command) is limited to ± 10 degrees.

If full pitch command is generated, a roll command will be executed only on that side of the taileron, on which a reduction of the taileron deflection is commanded. The opposite side stays at its positive or negative maximum.

The roll/yaw crossfeed input improves rapid rolling characteristics together with turn entry and exit characteristics, especially under high load factors.

The maximum roll rate is approximately 150 degrees/sec. With mid and full flaps it is scheduled to a maximum of 40 degrees/sec.

Fin load protection is provided by the air data scheduled limiter which limits the rudder deflection to ± 30 degrees up to 244 kt, decreasing progressively to ± 10 degrees at 355 kt and above.

DIRECT LINK

If a second failure occurs, the CSAS switches to DL in the failed mode. Pilot's command signals from pitch and/or roll stick position sensors are directly feeding the taileron and spoilers actuators.

The effects with regard to the individual second failures are shown in Figure 1-21.

In pitch DL, taileron authority is reduced to + 5 degrees and − 25 degrees; flaps and/or airbrake inputs will result in a slight increase in negative taileron authority. With full roll stick applied and for flap settings above 15 degrees, ± 4 degrees of differential taileron and 39 degrees of spoiler are available. With flaps in up, the authority remains 2.1 degrees of differential taileron and 18.5 degrees of spoilers.

MECHANICAL MODE

Control reversion to mechanical mode is applicable only to the pitch and roll axes. Spoiler control may still be operating, depending on failure location. All other features of CSAS or DL are lost. Reversion to mechanical mode is achieved via a mode selector valve in each taileron actuator. Any disparity between electrical and mechanical control demands will be automatically trimmed out via a trim actuator in approximately 10 sec. During this time the pilot retains full command authority although the neutral stick position may be temporarily displaced. Control stick pitch and roll demands are mechanically routed via the pitch/roll mixer to a servo valve, directly controlling taileron position with the control stick. Pitch authority is limited to + 5 degrees and − 25 degrees. Roll authority is ± 5 degrees taileron and if spoilers are available, spoiler deflection is limited to 18.5 degrees.

In the yaw axis no mechanical back-up mode is provided. In the event of the second failure condition, the rudder will be centered and locked and the roll channel reverts to DL if the flaps are up. With flaps extended beyond 15 degrees, the roll MD channel is automatically reengaged to restore roll control authority for approach and landing.

SPOILERS

Two pairs of spoilers, inboard and outboard, are fitted to the upper surface of the wings. The inboard spoilers are powered by the left, and the outboard spoilers by the right utility system. The spoilers operate in pairs to augment roll control at wing sweep angles of less than 50 degrees. At wing sweep above 50 degrees the spoilers are inhibited. Spoilers extension is directly proportional to differential taileron demand, with a maximum extension of 50 degrees. Spoilers are controlled via the CSAS roll channel.

All four spoilers deploy when lift dump is selected. However, the lift dump facility is not a function of the CSAS.
In the event of a hydraulic system failure the associated pair of spoilers retract under aerodynamic pressure.

TAILERONS

Each taileron is controlled through a power control unit (PCU) incorporating two hydraulic linear actuators arranged in tandem with a common output shaft, and a quadruplex actuator. The PCU is normally supplied from both hydraulic systems (protected circuits), with each circuit supplying one half of the main actuator, and two of the four quadruplex actuator lanes. If either hydraulic circuit fails, the PCU continues to function but taileron response rate is reduced and only two of the four quadruplex actuator lanes are operative.
In MD and DL quadruplex demands drive the quadruplex actuator to signal the main actuator, whereas in mechanical mode, demands are routed through mechanical links direct to the main actuator.

RUDDER

The rudder PCU operates similarly to the taileron PCU. However, upon reversion, the main actuator servo valves are isolated by the mode selector valve, and a secondary servo valve, operated by a mechanical feedback, takes over and returns the actuator to the centered position at a controlled rate. The rudder is powered by the right control and left utility systems.

TRIM SYSTEM

Roll and pitch are normally commanded by the control stick grip trim button. The button controls two separate trim control lanes. This is a provision to prevent runaway trim in case of a single failure.

WARNING

MANUAL TRIM SHALL NOT BE USED WITH THE AUTOPILOT ENGAGED.
THE USE OF MANUAL TRIM WITH THE AUTOPILOT ENGAGED, RESULTS IN DANGEROUS TRANSIENT WHEN THE AUTOPILOT IS DISENGAGED. SUBSEQUENT COUNTER-ACTIONS TAKEN BY THE PILOT WILL NOT STOP THESE MOTIONS BUT LEAD TO CONSIDERABLE PILOT INDUCED OSCILLATIONS (PIO'S). SHOULD THIS SITUATION ARISE, THE PILOT SHOULD DEPRESS THE ICO, AND MOVE THE CONTROL STICK IN THE DESIRED DIRECTION AND FREEZE IT.

NOTE

- When the guard on the emergency trim switches (CSAS control panel) is lifted, the control stick grip trim control is inhibited and emergency trim is operative.
- In full CSAS no direct relationship exists between stick position and control surfaces, thus the TRIMS indicator only serves for trim positioning for take-off and to indicate the trim authority remaining in flight.

Trim positions are indicated for all three axes on the three axes trim indicator. Pilot's control deflection trim authorities and trim rates are shown in Figure 1-18.

Pitch Trim

Pitch trim is effected by a trim actuator incorporating two electric motors. When actuated, the trim actuator moves the artificial feel actuator pivot point, which in turn provides a new stick centre position in pitch. One of the trim actuator motors is controlled by the controls stick grip trim switch, the other by the emergency PITCH trim switch on

CONTROL DEFLECTIONS, TRIM AUTHORITY AND TRIM RATE

	Control Stick/ Pedal Deflections	Control Taileron/Spoiler Rudder		Trim Rate (Normal)	Emergency Trim Rate
		Control Deflection	Trim Authority		
PITCH Stick	± 13 degrees = 132 mm	+ 10 degrees to − 30 degrees mech. + 5 degrees to − 25 degrees	+ 5.2 degrees CSAS − 21.2 degrees max + 3.6 degrees DL/ − 14.6 degrees mech. mode	4.5 degrees/sec CSAS max 1.6 degrees/sec DL/ mech. mode	1/4 Trim Rate of normal operation
ROLL Stick	± 24 degrees = 91.4 mm	full CSAS ± 10 degrees diff. Tail ± 50 degrees Spoiler DL ± 2.1 degrees diff. Tail ± 18.5 degrees Spoiler mech. ± 5.0 degrees diff. Tail ± 18.5 degrees Spoiler	full CSAS ± 9.3 degrees diff. Tail ± 50 degrees Spoiler DL ± 0.81 degrees diff. Tail ± 4.1 degrees Spoiler mech. ± 1.06 degrees diff. Tail ± 4.1 degrees Spoiler	0.21 degrees Tail./sec full CSAS 0.24 degrees Tail/sec mech. mode 0.19 degrees Tail/sec DL mode	Trim Rate same as in normal mode
YAW Pedal	± 82mm	± 30 degrees max ± 5 degrees min.	± 4 degrees	via CSAS	

Figure 1-18

the CSAS control panel. The emergency trim motor operates at approximately one quarter of the normal trim rate.

Roll Trim

Roll trim is similary effected by two electric motors driving a trim actuator. One of the trim actuator electric motors is controlled by the control stick grip trim switch, the other by the emergency ROLL trim switch on the CSAS control panel. The emergency trim rate is equal to the normal trim rate.

Yaw Trim

Yaw trim is effected by operating the YAW TRIM wheel on the CSAS control panel. A potentiometer on the trim wheel supplies a trim signal to the CSAS lateral computer, thus alterning the rudder actuator control signals. Trim rate is a function of trim wheel movement. There is no provision for emergency trim in yaw.

NOTE

Do not operate the yaw trim wheel with rudder locked, as all trim commands are stored and will become active upon rudder reengagement.

PRIMARY FLIGHT CONTROL POWER SOURCES

The taileron actuators are powered by the two hydraulic systems. The inboard spoilers are powered by the left and the outboard spoilers from the right utility system. The rudder is powered by the right hydraulic system and left utility system.

ARTIFICIAL FEEL SYSTEM

Artificial feel is provided in all three axes. The artificial feel applies a centering force to stick (pitch and roll direction) and rudder pedals towards trim position. Variable pitch feel forces assist to comply with the control stick force/g requirements. The artificial pitch feel is powered by the left and right utility system.

PITCH

Pitch centering forces are generated by a pitch feel control. Normally the feel forces are generated within the pitch feel control by the hydraulic pressure from the left and right hydraulic utility systems and a mechanical spring unit. The computing elements of the feel control unit vary hydraulic pressure as a functions of dynamic pressure, wing sweep and Mach number. Duplicated pneumatic pressure signals provide the "Q-feel" signal to the computing element of the control unit. A Mach number cut off device changes the force gradient once a predetermined Mach number (M = 0.9) has been attained. A mechanical input changes the force gradient as a function of wing sweep.
Stick forces will increase with:

- Increase in dynamic pressure
- Increase in air density
- As the wings are swept forward

Transient supply pressure variations are absorbed by a hydraulic accumulator which also provides a slow decay in feel control stiffness in the event of loss of both hydraulic systems. Loss of one hydraulic system will not cause any change in feel characteristics.
In the event that both hydraulic systems are lost, the mechanical spring unit only will provide unscheduled low pitch feel and stick centering forces.

ROLL

Roll feel forces are generated by a mechanical spring unit with double slope force gradient and additional breakout forces. It provides low sensitivity for large control inputs (i.e. high altitude/low speed).

YAW

Pedal forces are generated by a spring unit with linear force characteristics.

PRIMARY FLIGHT CONTROLS AND INDICATORS

CONTROL STICK GRIP

The pilot's control stick grip (Figure 1-20) contains a trim button unit, a weapon release button (guarded), a press-to transmit (PTT) button, an autopilot engage/disengage button, an autopilot/nosewheel steering instinctive cut-out (ICO) switch, and a trigger for actuating the camera and the gun.
The trim button unit consists of a pyramid cap which houses two toggle switches.
Purpose of the trim button consists of pyramid cap which houses two toggle switches.
Purpose of the trim button is to provide trim control in the pitch and roll angles. The trim button is springloaded to the center and can be moved forward, backward, left and right.
Movement of the trim button causes roll position and pitch transducers to produce signals which are forwarded to the lateral and the pitch computers. The pyramid cap should be lifted for maintenance purposes only.

NOTE

The trim button unit in the control stick grip is inoperative when the guard on the emergency trim switches on the CSAS control panel is lifted up.

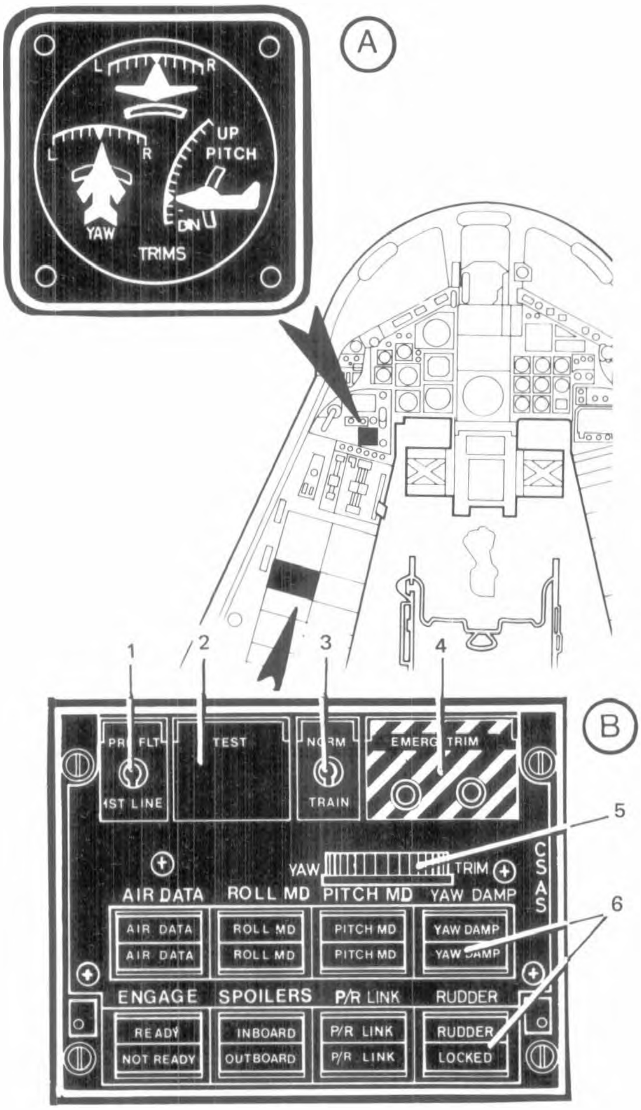
CSAS CONTROLS AND INDICATORS

The CSAS control panel (B, Figure 1-19) includes the following controls and indicators.

PREFLIGHT/1ST LINE CHECK SWITCH

A two-position toggle switch labelled PREFLT/1ST LINE guarded to PREFLT selects the required level of BITE.

PRIMARY FLIGHT CONTROL



A Three axes trim indicator

B CSAS control panel
1 Pre flight/1st line check switch
2 Test pushbutton/indicator
3 Normal/training selector switch
4 Emergency trim switches
5 Yaw trim wheel
6 CSAS selector/indicator pushbuttons

Figure 1-19

TEST PUSH BUTTON/INDICATOR

A guarded combined push button and indicator light, labelled TEST. The indicator light has three individually illuminated sections, designated as follows:

- TEST (white)
- GO (green)
- NO GO (red)

Pressing the button will initiate the BITE check. The TEST section illuminates to indicate the BITE check in progress. The test results are displayed by either the GO or NO GO lights.
BITE test procedures are detailed in Section 2 of this manual.

NORMAL/TRAINING SELECTOR SWITCH

A two-position toggle switch, labelled NORM/TRAIN guarded to NORM position. This switch selects either normal or training mode of the CSAS.
In the TRAIN position the pilot can simulate the following CSAS failures by pressing the appropriate push button/indicators.

- SPOILERS – Inboard and outboard spoilers
- PITCH MD, ROLL MD or YAW DAMP – Pitch, roll or yaw second failure i.e. reversion to direct link mode
- PITCH MD and ROLL MD simultaneously – Air data second failure mode
- P/R LINK – Reversion to mechanical mode
- RUDDER – Rudder locking

Failures will be indicated by illumination of the appropriate push button(s). Upon completion of tests the NORM/TRAIN switch shall be set to NORM and the guard shall be closed.
If the NORM/TRAIN switch is set to NORM and the failures are not cancelled, spoilers and yaw damp will be reset automatically. Sudden large signal changes occurring during a simulated failure will be fed gradually into the system over a period of approximately 10 seconds by the voter monitor faders. Pressing the P/R LINK button will extinguish this lamp and the ROLL MD lamp is the taileron is disengaged in the mechanical mode. In addition, the PITCH MD button shall be pressed to revert to full CSAS mode.

NOTE

This procedure can be performed regardless of the NORM/TRAIN switch position.

When the rudder is disengaged the roll mode reverts to direct link automatically. A complete reset can be initiated by positioning the NORM/TRAIN switch to NORM position and pressing the RUDDER and ROLL MD push buttons.

EMERGENCY TRIM SWITCHES

Two three-position toggle switches, guarded to the center (off) position. The switches are labelled PITCH – DOWN/UP and ROLL – L/R respectively. When the black and yellow hatched guard plate is lifted the control stick trim switch is inoperative and the emergency trim switches on the CSAS control panel are used to operate emergency trim.

YAW TRIM WHEEL

A thumb wheel labelled YAW TRIM. Turing the wheel will re-position the rudder actuator.

NOTE

Do not move rudder pedals when YAW TRIM is used.

CSAS SELECTOR/INDICATORS

Two rows of illuminated push button labelled and marked as shown in Figure 1-21.

THREE AXES TRIM INDICATOR

A three-pointer indicator, labelled TRIMS (A, Figure 1-19), indicating pitch, roll and yaw trim position on separate displays, is located on the left hand quarter panel. Indications are as follows:

- ROLL – L/R
- PITCH – UP/DN
- YAW – L/R

NOTE

The neutral trim positions are indicated by a triangular marker on each scale.

Rudder Pedals

The rudder pedals are used to input yaw commands. They operate conventionally and are adjustable. The rudder pedals are used for braking and nose wheel steering.

Rudder Pedal Adjustment

A ring, labelled PEDAL ADJUST (79, Figure FO-2; 67, Figure FO-4), when pulled out to its full extent allows the pilot to adjust the rudder pedals according to his own personal requirements. When released, it locks both pedals in the selected position.

CSAS FAILURES

In failure conditions, caused by unserviceable components or circuitry, the CSAS capability is preserved as long as possible by triplex/quadruplex redundancy. CSAS failures are classified as first and second failures.

First Failures

Any failure detected in the CSAS computing or actuator loop or air data source signals will not degrade the CSAS performance; the redundancy capability only is reduced. The classification is not applicable to the spoilers as a first failure in the spoiler command or actuating system will cause retraction of the affected pair of spoilers.
First failures are indicated by the amber CSAS and PFCS captions on the CWP and the relevant amber (spoilers red) caption(s) on the CSAS control panel.
First failures caused by hydraulic control circuit failure or those caused by loss of both generators or both TRUs are additionally indicated on the CWP by those captions which are shown in the relevant Emergency Procedures of Section 3.

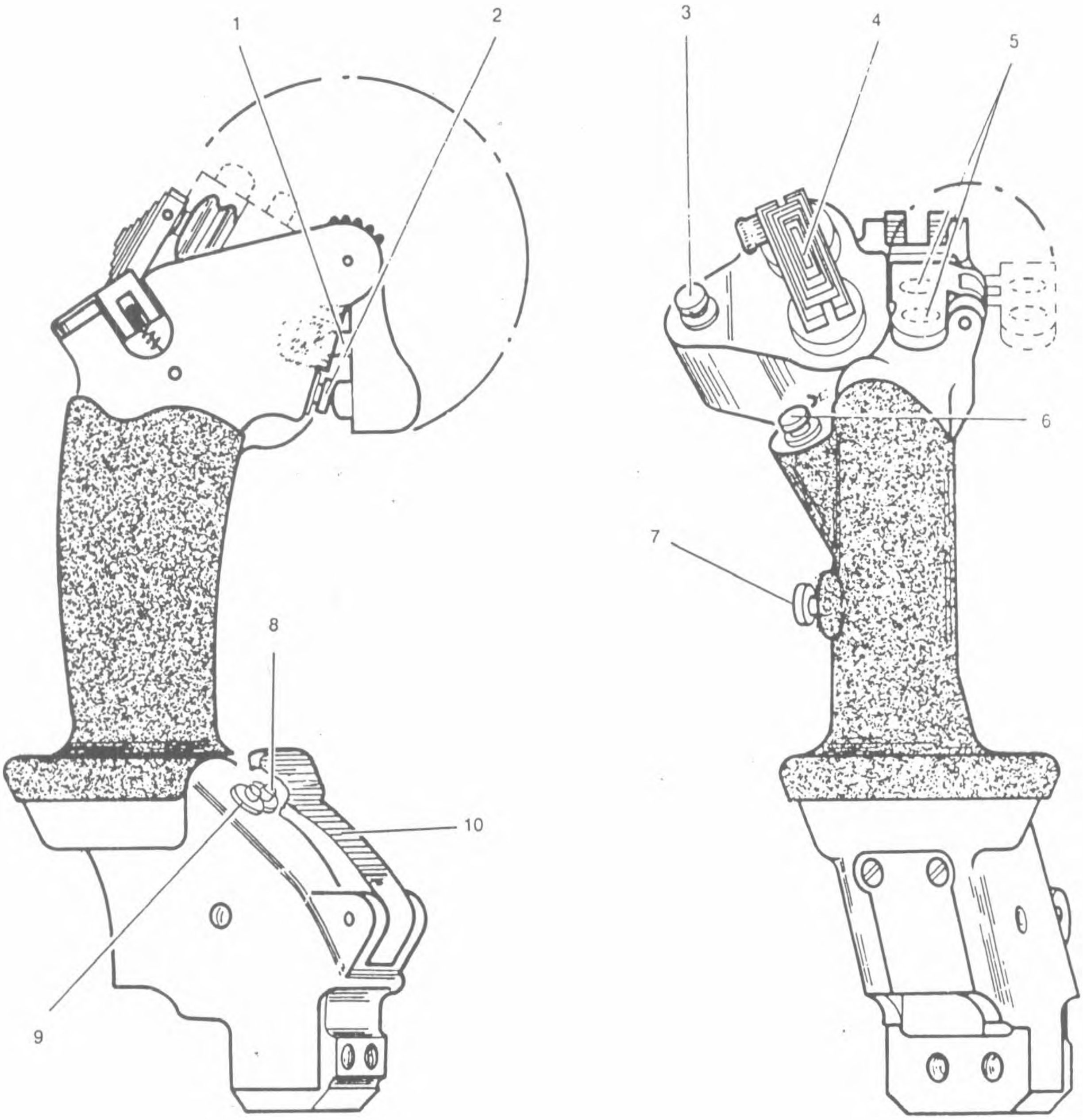
Second Failures

Second failures are subdivided into critical and significant.
Second failures are indicated by a red CSAS/CWP caption together with amber CSAS and PFCS/CWP caption with associated red push button indicator(s) on the CSAS control panel.

Significant Second Failure

A significant second failure causes reversion to DL. In the event of an air data second failures all air data scheduling is lost, and whenever the pitch and roll channels reverts to DL, the yaw channel operates on fixed gain scheduling. With flaps less than 15 degrees the schedulers are switched to high speed gain. With flaps beyond 15 degrees the schedulers are switched to zero speed gain, thus restoring full rudder authority for landing.

CONTROL STICK GRIP



1 GUN FIRING BUTTONS
2 HUD CAMERA BUTTON
3 AUTOPILOT ENGAGE/DISENGAGE BUTTON
4 TRIM BUTTON UNIT
5 WEAPON RELEASE BUTTON
6 PTT BUTTON
7 RECCE CAMERA BUTTON
8 AP INSTINCTIVE CUT-OUT SWITCH
9 NWS INSTINCTIVE CUT-OUT SWITCH
10 ICO BAR

Figure 1-20

Critical Second Failures

A critical second failure causes reversion to mechanical mode or centering and locking of the rudder.

Failure Resetting

A reset attempt may be made by pressing the relevant lit push button/indicator. In case of a second failure, then lit push buttons of the back row shall be pressed first since CSAS failure logic will not allow a reset otherwise.
If a reset is unsuccessful, the PFCS/CWP caption stays illuminated as a reminder that a failure state exists. Subsequently the central warning system is reactivated.

NOTE

For CSAS failure indications see Figure 1-21.

Central Warning Panel Captions

The CWP in the front cockpit (3, Figure 4-86) contains the following primary flight control system amber and red indications:

- Amber PFCS light up when the first "first failure" within the CSAS occurs. It comes on with the associated amber (SPOILERS – red) pushbutton indicator on the CSAS control panel. Provided it is a transient failure, both the warning can be cancelled by pressing the illuminated buttons on the CSAS control panel.

- Amber CSAS lights up whenever any failure within the CSAS occurs. It comes on in conjunction with the associated amber or red pushbutton indicator and, when the "first" failure occurs, with the amber PFCS caption on the CWP. The amber CSAS caption can be cancelled anyway by pressing the illuminated CSAS pushbutton. Subsequent failures reactivate the amber CSAS warning caption.

- Red CSAS lights up whenever either a second "significant" or "critical" failure within the CSAS occurs. It indicates a reversion to direct link in the case of a significant failure, or to mechanical mode in the case of a critical failure. It comes on in conjunction with the associated red push button indicator and the amber CSAS warning caption, besides the lyre bird tone. All these warnings can be cancelled by pressing the illuminated push button indicator on the CSAS panel. Subsequent "significant" or "critical" failures reactivate all the warning. The red CSAS caption is repeated on the CWP in the rear cockpit.

SPIN PREVENTION AND INCIDENCE LIMITING SYSTEM (SPILS)

Post mod. 00555 the Spin Prevention and Incidence Limiting System (SPILS) is introduced. The SPILS comprises a computer and a control panel. The computer receives duplex pitch rate and dynamic pressure signals from the CSAS pitch computer, duplex roll and yaw control demand signals from the CSAS lateral computer, and duplex AOA signals from the two AOA probes. The signals are processed within the SPILS computer to provide progressive triplex control demand cancel signals to the CSAS to limit the maximum AOA attainable, and to reduce control authority in roll and yaw at high AOA. Computer outputs to the CSAS are disconnected when the weight-on-ground switches are open (aircraft on the ground), if the autopilot is engaged, or if the AOA is below the threshold value.

NOTE

- Interruption/resumption of SPILS operation caused by AP engagement will not be indicated to the pilot. Any AP disengagement, e.g. at initiation of an OLPU, will cause immediate reengagement of the SPILS, provided that SPILS is in ON.

- A CSAS failure can cause illumination of the red SPILS/CWP caption which will result in SPILS disengagement.

- In the case of a SPILS disconnect in flight, a reset of the system in straight and level flight can be attempted.

FUNCTION OF CSAS BUTTONS/INDICATORS

PUSH BUTTON	INDICATION	COLOUR	REASON AND CONSEQUENCE
AIR DATA	AIR DATA	AMBER	First air data failure
	AIR DATA	RED	Second data failure Reversion to fixed gain in the yaw SAS
ROLL MD	ROLL MD	AMBER	First failure in roll MD-loop, or roll yaw crossfeed, or first air data failure. Normal roll CSAS operation. No performance reduction. Air data failures are indicated simultaneously on Roll and PITCH buttons.
	ROLL MD	RED	Significant second failure in roll MD-loop including rate gyros. A single failure within roll MD-loop and a single roll stick pick-off failure. Two failures within the cross-feed. Reversion to direct electrical link. Second air data failure, simultaneous PITCH MD (RED) indication. Reversion to fixed gain in the yaw SAS.
PITCH MD	PITCH MD	AMBER	First failure in pitch MD-loop or in the air data system. Normal pitch CSAS operation. No performance reduction. Air data failures are indicated simultaneously on PITCH and ROLL buttons.
	PITCH MD	RED	Significant second failure in MD-loop including rate gyros. A single failure in pitch stick pick-off and pitch MD-loop, if different lanes are affected. Reversion to direct electrical link. Second failure in air data system is indicated together with ROLL MD (RED). Reversion to fixed gain in yaw SAS.
YAW DAMP	YAW DAMP	AMBER	First failure in yaw SAS loop or response of one monitor. Yaw damper operating normally. No performance reduction.
	YAW DAMP	RED	Significant second failure in yaw SAS. Loss of yaw rate. Reversion to yaw direct link. No yaw damper. Reduction of roll/yaw performance.
ENGAGE	READY	GREEN	The CSAS is ready for engagement. after engagement the failure logic is reset, all failure indications are cancelled. With no failures a partial engagement is also possible by pushing the mode switches in proper sequence.
	NOT READY	RED	Power on CSAS illuminates NOT READY button. CSAS engagement with ENGAGE button not possible.
SPOILERS	INBOARD	RED	First failure in inboard spoiler servo-loop detected by roll monitor, illuminates indicator light. Inboard spoilers retracted simultaneously with the first failure detection. Reduction of roll performance.
	OUTBOARD	RED	First failure in outboard spoiler servo-loop detected by roll monitor, illuminates indicator light. Outboard spoilers retracted simultaneously with the first failure detection. Reduction of roll performance.
P/R LINK	P/R LINK	AMBER	First failure in pitch or roll direct electrical link. First failure in taileron servo-loop. Small performance reduction in pitch and roll with loss of one hydraulic system.
	P/R LINK	RED	Second critical failure in taileron systems, pitch or roll direct link paths. No more CSAS control. Large performance reduction with mechanical control.
RUDDER	RUDDER	AMBER	First failure in direct link, or rudder actuator, servo loop. Rudder system operating normally. Small performance reduction with loss of one hydraulic system.
	LOCKED	RED	Critical second failure in rudder system or yaw direct link path. Rudder centered in neutral position. No rudder control and yaw damping.

Figure 1-21

Computer Functions

PITCH AUTHORITY

Gain-scheduled taileron position and pitch rate signals from the CSAS are summed with the most-nose-up output of the AOA probes, the result being fed to a threshold detector and a level switch which engages the SPILS at 12.7 units with increasing AOA and disengages it at 10.6 units with decreasing AOA. After threshold detection the signal is gain-scheduled with dynamic pressure and, after triplex averaging, is fed via a triplex output switch to the CSAS pitch computer to reduce the taileron nose-up demand signal progressively as AOA increases. Ultimately, the AOA is limited to a maximum of between 25 and 28 units AOA depending on stores configuration and CG position.

ROLL AND YAW AUTHORITY

Roll and yaw signals from the CSAS are gain-scheduled with the most-nose-up output from the AOA probes and fed, via triplex averagers and output switches, to the CSAS lateral computer as progressive roll/yaw control demand signals thus, above the switching value of AOA, effectively reducing roll/yaw control authority in proportion to AOA. At the limiting AOA, roll and yaw control authority is limited to approximately 20% of the full CSAS control authority.

TRIPLEX AVERAGERS/FADERS

The triplex averagers generate triplex-equalized outputs from averaged duplex inputs. In the event of a full-initiated disengage signal from the failure logic, the triplex output signal is replaced by a stored signal that fades more and more rapidly to zero over a period of 10 seconds in order to avoid control transients.

FAILURE LOGIC

Inputs to the monitor in the failure logic are gated together so that any inter-lane disparity greater than the monitor trip level initiates a fault-disengage signal to the appropriate triplex averagers. When the signal has fades to zero, the triplex output switch open to disengage the switch from the CSAS. The SPILS is also disengaged via the triplex output switches if the aircraft is on the ground, when the autopilot is engaged or when the AOA is below the setting of the level switch. In the event of a fault condition or logic disengagement the attention-getters, lyre-bird audio warning, CWP red SPILS caption and the FAIL caption on the spils control panel are activated. SPILS computer information is fed to the CMP and crash recorder.

SPILS CONTROL AND INDICATORS

The controls and indicators associated with SPILS are shown in Figure 1-22. A SPILS block diagram is shown in Figure 1-23, and a simplified functional diagram at Figure 1-24.

SPILS Control Panel

The SPILS control panel (Figure 1-22) includes the following controls and indicators:

SPILS ON/OFF SWITCH

A two-position toggle switch, labelled ON/OFF is located on SPILS CP, left console, and connectors power supply to the system.

SPILS BITE/FAIL PUSH BUTTON/ INDICATOR

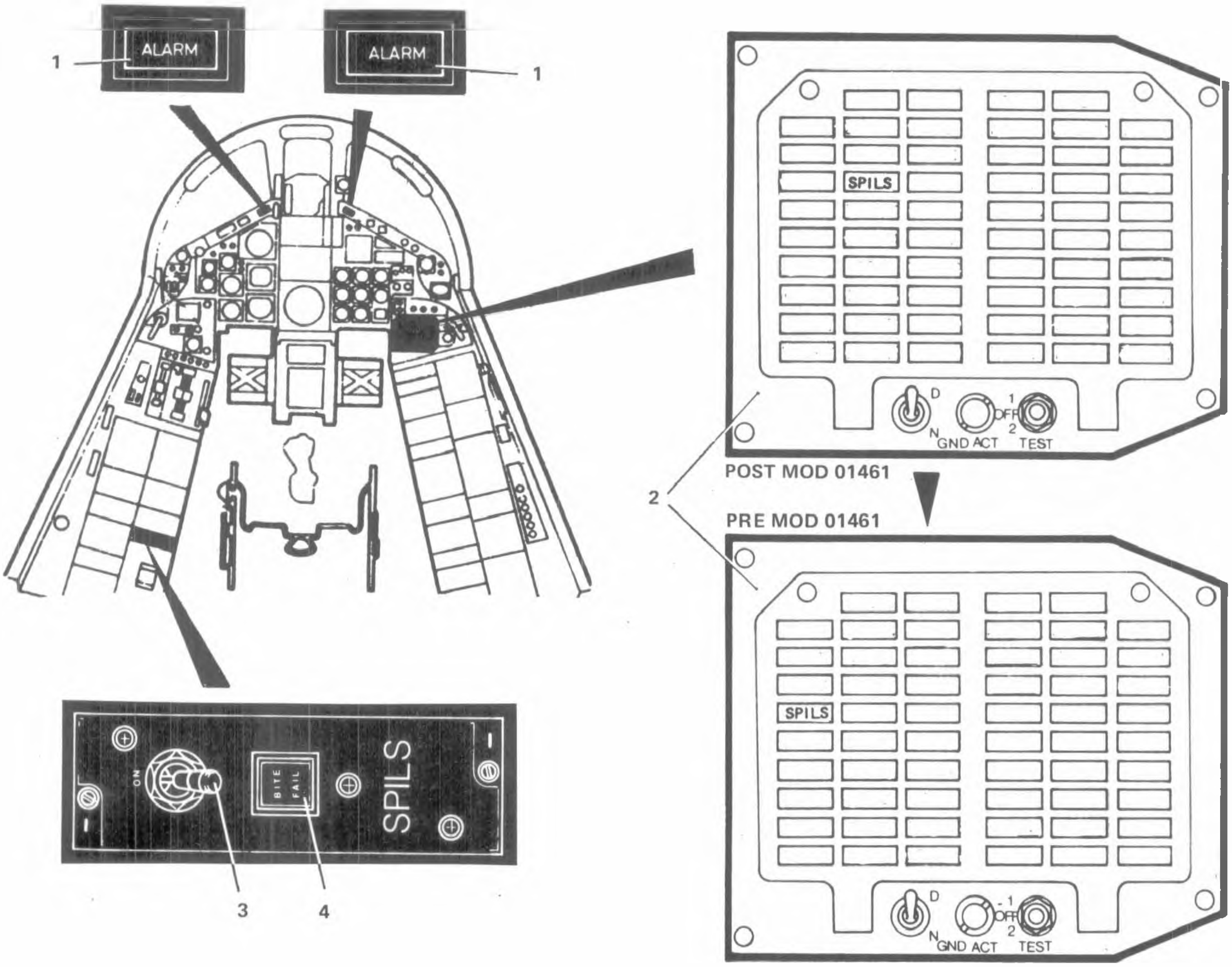
The split legend pushbutton/indicator is labelled BITE/FAIL. The upper white BITE caption flashes after a successful BITE run. The lower amber FAIL caption illuminates if power is applied to the aircraft, irrespective of SPILS ON/OFF swith position, and extinguishes after the SPILS switch is set to ON and the BITE/FAIL button is pressed. In the event of unsuccessful BITE the FAIL caption will illuminate together with the white BITE caption.
Following a SPILS failure in flight, the FAIL caption will be lit. A reset of the system can be made by pressing the pushbutton/indicator after at least 12 seconds have elapsed and providing the AOA is less than 10 units (i.e. below SPILS disengagement level).

Central Warning Panel

The CWP in the front cockpit contains the following SPILS system indication:

- On ground the red SPILS/CWP illuminates if the BITE detects a failure, or when power is initially applied to the aircraft, with the SPILS power switch in ON or OFF.
- In flight SPILS illuminates after a genuine SPILS failure.

SPILS CONTROLS AND INDICATORS



1 Attention-getters
2 Central warning panel
3 SPILS ON/OFF switch
4 SPILS BITE/FAIL pushbutton/indicator

Figure 1-22

NOTE

In flight the red SPILS/CWP caption illuminates after selecting the SPILS power switch to OFF.

ATTENTION GETTERS

The two-attention getters, located in the upper section of the left and right antiglare shields, start flashing when SPILS warning is displayed on CWP. Pressing anyone of the attention getters cancels the attention getter. CWP is unapparted by this action.

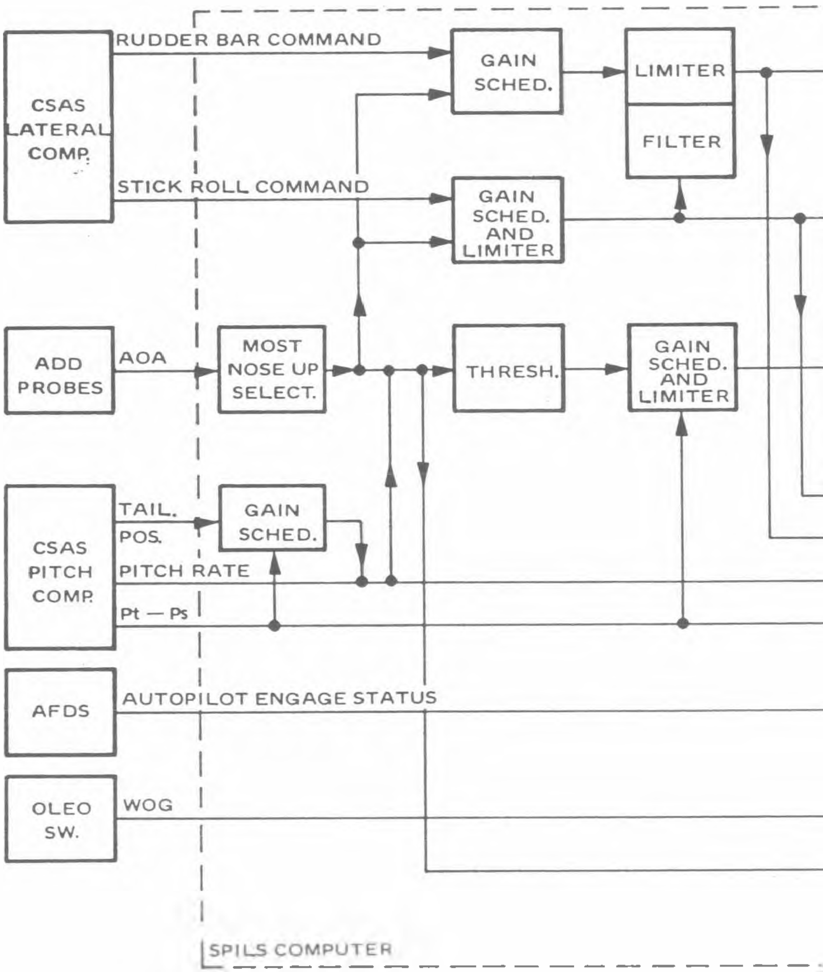
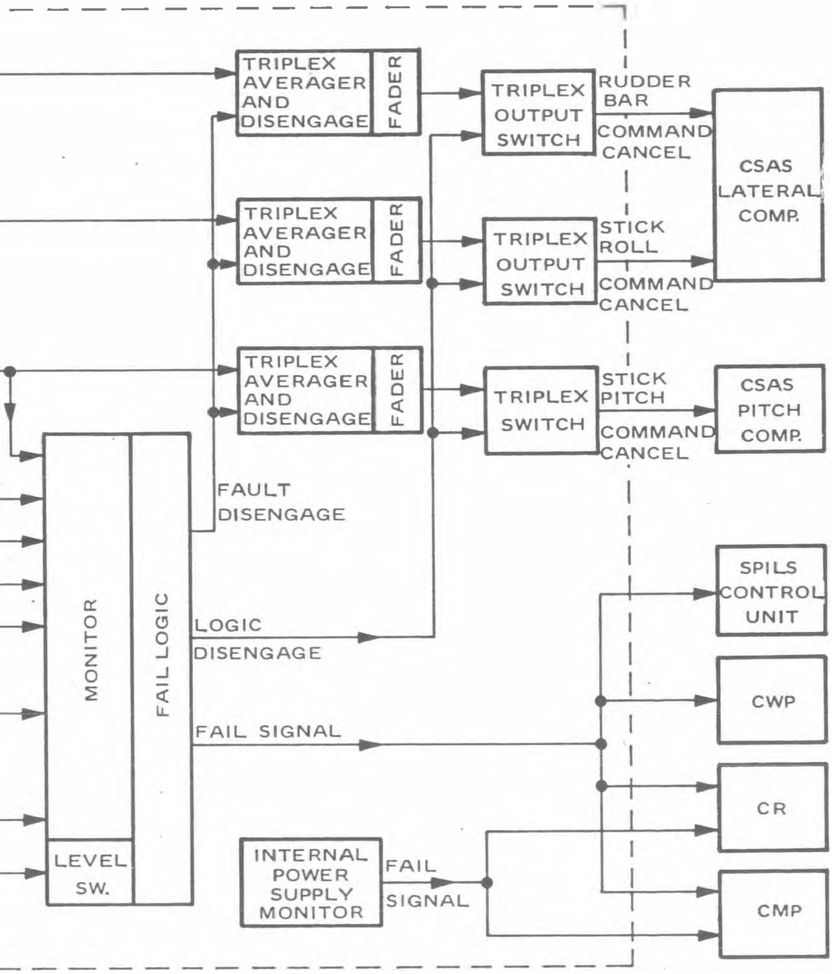

CSAS
LATERAL
COMP.
RUDDER BAR COMMAND
STICK ROLL COMMAND
GAIN
SCHED.
LIMITER
FILTER
GAIN
SCHED.
AND
LIMITER
ADD
PROBES
AOA
MOST
NOSE UP
SELECT.
THRESH.
GAIN
SCHED.
AND
LIMITER
CSAS
PITCH
COMP.
TAIL.
POS.
PITCH RATE
Pt — Ps
GAIN
SCHED.
AFDS
AUTOPILOT ENGAGE STATUS
OLEO
SW.
WOG
SPILS COMPUTER

Figure 1-23



SPILS BLOCK DIAGRAM

SPILS COMPUTER FUNCTIONS

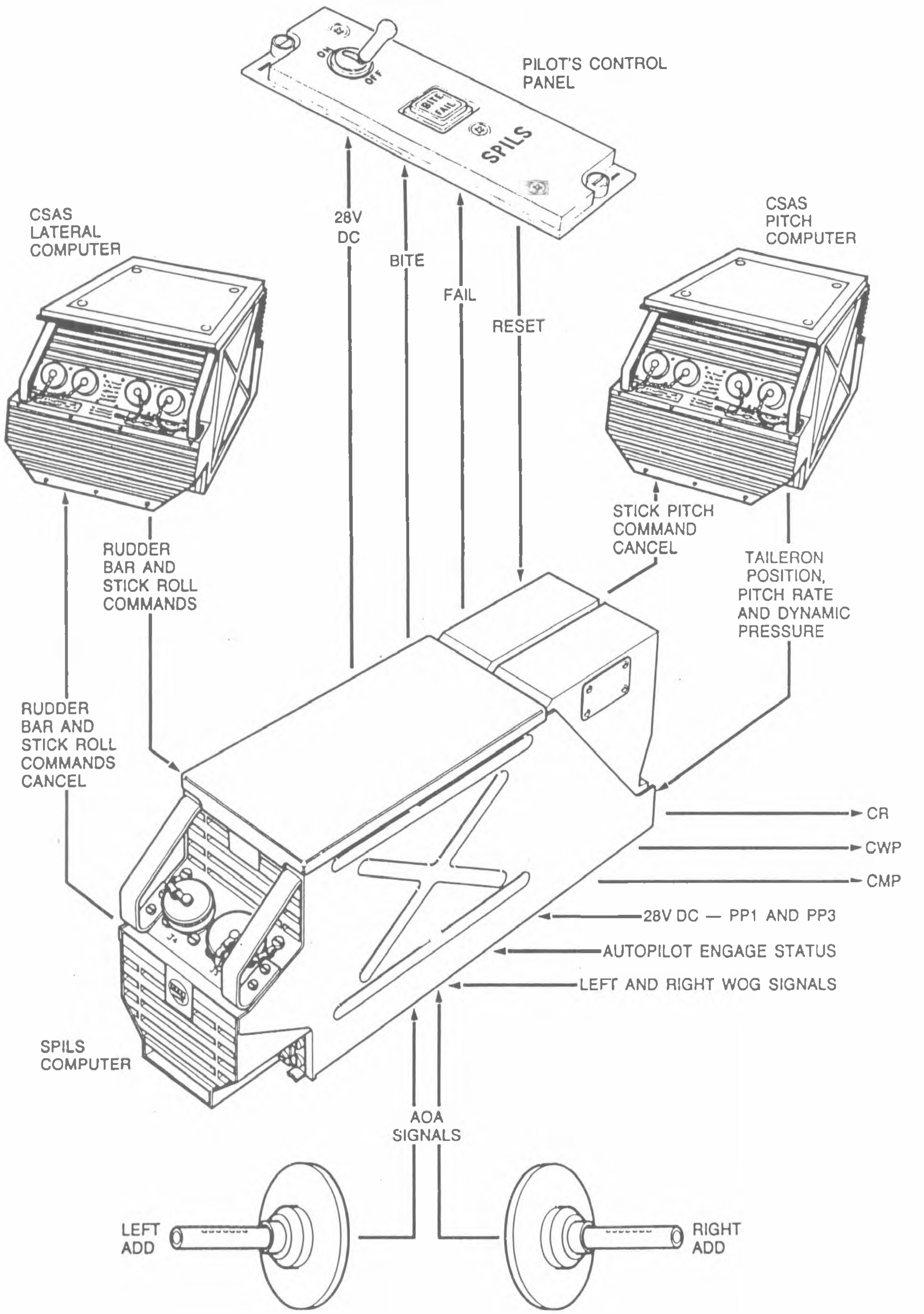


Figure 1-24

SPILS BITE

The SPILS BITE is activated on the ground in conjunction with the CSAS BITE with either PRE FLT or 1ST LINE selected. The BITE/FAIL pushbutton/indicator on the SPILS control panel shows the system status: the white BITE and amber FAIL captions come on steadily if the system fails the BITE; after a normal BITE cycle the white BITE caption flashes and it can then be extinguished by pressing the TEST/GO/NO GO pushbutton/indicator on the CSAS control panel.
The SPILS BITE function is inhibited in the air through the action of either main gears oleo switch.
The brightness of the BITE/FAIL indicator is controlled by the D/N switch on the CWP and the filaments are tested by the CONSOLES L TEST switch on the right console.

SYSTEM MALFUNCTION

After a SPILS failure (red SPILS caption on the CWP and amber FAIL caption on the SPILS control panel), an attempt to reset the system can be made by pressing the BITE/FAIL pushbutton/indicator on the SPILS control panel provided 12 seconds (fade-out time) have elapsed since the failure indication and the AOA is less than 10 units (i.e. below the SPILS disengagement level).
After a failure, the SPILS computer is automatically isolated from the CSAS. The SPILS ON/OFF switch may be selected to OFF if desired if a reset attempt is unsuccessful.
SPILS shall be regarded as failed after a CSAS second failure whether SPILS failure indication are present or not.

Electrical Supplies

The SPILS is fed with 28 V DC from PP1 and PP3 and continues to operate normally on either busbar after a power failure to one busbar. The ON/OFF switch controls the selection of power to the system; it has no logic reset function. When ON is selected the equipment is immediately operational.

SECONDARY FLIGHT CONTROL SYSTEM

The secondary flight control system (Figure FO-14) comprises wing sweep, slats, flaps, Krueger flaps, airbrakes and their control subsystems including the lift dump feature. The systems are electrically and mechanically controlled and hydro-mechanically operated by the left and/or right utility hydraulic systems.

WING SWEEP SYSTEM

The wing sweeping facility is provided for optimisation of the wing sweep angle for each flight conditions.
Each wing can rotate around pivot incorporated in the fixed section of the wing and is moved by an actuator; wing sweep is mechanically controlled and hydro-mechanically operated. Wing sweep may be varied between 25 degrees and 67 degrees. Full sweep will take approximately 7 seconds.
Moving the wing sweep lever to the rear will increase wing sweep angle and viceversa.
The wing sweep lever is mechanically interconnected with the flap lever to prevent selection of the flaps unless the wing sweep lever is fully forward, and to prevent movement of the wing sweep lever if the flap lever is not in the UP position.
The wing sweep angle is adjusted by two screw actuators, one for each wing. The left actuator is powered by the left utility system and the other by the right. To prevent asymmetric operation, the actuators are interconnected by a synchronizing shaft, which also allows one actuator to mechanically drive the other in case one utility system fails.
Wing sweep is controlled by the wing sweep lever through the high lift and wing sweep control assembly (HLWSCA). This assembly consists of two units: the high lift control unit and the wing sweep control unit. It converts the wing sweep lever position into appropriate hydraulic flow signals, driving the wing sweep actuators. Mechanical feedback shafts driven by each actuator are used to stop the flow signals, whenever the desired wing sweep angle is reached. The mechanical feedback shafts are also used to detect any symmetric operations. The asymmetry detector monitors rotation of the wing sweep actuator feedback shafts and stops both actuators by shutting off hydraulic flow, whenever an asymmetry is detected.

WING SLATS, FLAPS AND KRUEGER FLAPS

The wing slats, flaps and Krueger flaps are electrically controlled and hydro-mechanically operated. The flaps on both wings are jointly driven by screws actuators through a set of shafts and gearboxes.
The slat on both wings are jointly driven in the same manner as the flaps. Both sets of shafts incorporate telescoping sections to accommodate length variations due to wing sweep. The shafts also are

equipped with torque limiters to prevent overstressing of the drive train. The Krueger flaps are separately driven by hydraulic actuators. Slat and flap motors receive power from both utility system. The Krueger flap actuators are powered from the left utility system only.
As long as the wing are selected fully forward, the flaps lever may be moved to any of its three positions UP, MID, and DOWN, the MID position being indicated by a light mechanical detent. Each of these positions results in appropriate electrical signals, which are routed to the HLWSCA. In this unit corresponding hydraulic flow signals are initiated to drive the slats and flaps into the commanded position.

WING SWEEP	HIGH LIFT LEVER pos.	FLAP	SLAT	KRUEGER FLAP
25°	UP	0°	0°	0°
25°	MID	26°15′	24°30′	0°
25°	DOWN	50°	24°30′	116°30′

WING SWEEP	MANEUVER SWITCH pos.	FLAP	SLAT	KRUEGER FLAP
25°	UP	0°	0°	0°
25°	DOWN	7°	11°	0°
25 ÷ 45°	DOWN	0°	11°	0°
45 ÷ 68°	DOWN	0°	0°	0°

CAUTION

SELECTION OF FLAPS FROM UP TO DWN OR FROM DWN TO UP SHOULD NOT BE MADE WITHOUT A PAUSE OF APPROXIMATELY 2 OR 3 SECONDS IN THE MID POSITION. DO NOT SELECT NEW SETTING OF FLAP DURING FLAP TRAVELLING.

Mechanical feedback linkages associated with the slats and flaps actuators drive cam switches, which causes the hydraulic flow from the HLWSCA to stop whenever the appropriate slats and flaps position is reached.

The Krueger flaps extend only when the flaps lever is selected DWN and the flaps are in a position lower than MID. Retraction of the Krueger flaps will take place when the flaps lever is selected from DWN to MID. No immediate positions of the Krueger flaps are provided. Pitching moments resulting from the flap extension/retraction are largely compensated for by the CSAS.

FLAPS/SLATS ASYMMETRY PROTECTION

Flaps and slats on both wings are monitored by an electrical asymmetry detection system. The system provides asymmetry protection in the event of a failure of one drive shaft.
Flaps asymmetry: in the event of a flaps asymmetry is detected, the flaps will be locked at the position where the asymmetry occurred and remain inoperative. Locking the flaps between MID and DOWN prevent slats from retracting.

NOTE

No warning indication is available to the pilot. The emergency flap switch cannot override a flap asymmetry. The wing sweep system is then inoperative.

Slats asymmetry: in the event a slats asymmetry is detected the slats will be locked at the position where the asymmetry occurred and remain inoperative. Flaps can be operated from UP to MID, but not from MID to DWN. The DWN position can be reached in this case using the flap override switch which allows flaps to be inched DWN. Krueger flaps asymmetry will be indicated by a black and white striped display of the KRUEGER FLAPS indicator. This is not considered critical and no consequence are to be expected in the flap/slat operation.

AIRBRAKES

The airbrakes are located on the upper shoulders of the rear fuselage, on either side of the fin. Each airbrakes is operated by a hydraulic actuator supplied from the No. 2 (right) hydraulic system, and controlled by an electro-hydraulic selector valve supplied from the DC essential busbar. The actuators are mechanically connected to a synchronizing valve, which keep the airbrakes synchronized within 5 degrees.

The airbrakes are locked in the closed position by additional hydraulic locking actuators and mechanical locks.

Airbrakes selection is by operation of the combined airbrakes/manoeuvre flap/slat switch. Forward and rearward movement of the switch selects airbrakes in and out respectively. The switch is springloaded to centre (neutral). The airbrakes positioning is scheduled against mach number.

Full extension of the airbrakes will normally take approximately 4 seconds, while retraction is achieved within approximately 2 seconds.

If thrust reverse is selected in flight with airbrakes extended the airbrakes automatically retract when the WOG switches are closed, i.e. immediately after touchdown.

CAUTION

- DO NOT USE THRUST REVERSE WITH RIGHT UTILITY SYSTEM FAILURE UNLESS THE AIRBRAKES ARE LOCKED IN.

- EACH TIME AN INDICATION OF AIRBRAKES NOT LOCKED OCCURS, TR SHALL NOT BE USED.

If a failure occurs within the airbrake scheduling box automatic scheduling is lost and airbrakes extension is controlled by a redundancy switch series.

In the event the airbrakes extension exceeds the correct value, the redundancy switch series sends a signal to the "emergency IN" selector valve; this discharges supply pressure to the airbrake actuators, allowing aerodynamic drag to push the air brake in. When the correct position is reached it is automatically maintained by hydraulic lock. In this condition, when reducing aircraft speed, the airbrakes can still be further extended to the next step manually only provided the system has been resetted. To reset the system the control switch shall be moved first to the IN position, and to the OUT position.

SCHEDULED AIRBRAKES EXTENSION	
Mach No.	Airbrake Angle
< 0.82	50°
> 0.82 < 0.85	45°
> 0.85 < 0.89	40°
> 0.89 < 0.92	35°
> 0.92 < 1.15	30°
> 1.15 < 1.45	22.5°
> 1.45	15°

The amber CONFIG warning caption comes on whenever the airbrakes exceed the scheduled position.

If a second failure occurs within the T.T.U. the "emergency IN" selector valve allows the aerodynamic drag to push the airbrakes within approximately 5 degree of closed. The airbrakes extended, selecting the guarded EMERGENCY AIR BRAKE switch to IN operates the release valve, and allows the airbrakes to blow in, but they do not lock.

LIFT-DUMP SYSTEM

The lift-dump (LD) system provides for simultaneous extension of all four spoilers following touchdown. Lift-dump can be used separately or together with reverse thrust and can be pre-armed to operate automatically upon touchdown. With the throttles in the dry power range, if the left throttle alone is rocked outboard, lift-dump is selected. If the right throttle is rocket outboard, both lift-dump and thrust reverse are selected. Outboard pressure on the throttles when in the HP shut position, or in the reheat range, should not select lift dump and rectification action is necessary if such pressure does actuate the system.

Following selection, and provided the weight is on the wheels, signals are transmitted to the commutation amplifier in the CSAS lateral computer to provide simultaneous extensions of all four spoilers. The system remains engaged once activated and can only be cancelled by rocking the throttle inboard, regardless of WOG switch position.

SECONDARY FLIGHT CONTROL SYSTEM CONTROLS AND INDICATORS

Throttle Quadrant

The throttle quadrant in the front cockpit carries the following secondary flight controls:

THROTTLES

The throttle (Figure 1-25) can be rocked individually or together to an outboard position in the dry power range. Rocking the throttles out arms the lift dump and thrust reverse system. The left throttle arms/operates the lift dump system only. The right throttle arms/operates reverse thrust and since this movement is transmitted to the left throttle, lift dump will be pre-armed/operated.

MANOEUVRE AND AIRBRAKE SWITCH

A five-position pyramid type, manoeuvre and airbrake toggle switch (4, Figure 1-25) is located on the right side of the right throttle. The switch is marked MNVR UP/MNVR DOWN/CENTER/AIRBRAKE IN/AIRBRAKE OUT and spring-loaded to the center position.

NOTE

When selecting manoeuvre slats/flaps, only a momentary push of the switch is required to extend or retract. Holding the switch aft will extend the airbrakes as far as the schedule will allow, while a momentary forward push will cause the airbrakes to retract fully.

FLAPS LEVER

A lever (5, Figure 1-25), marked FLAPS – DWN/MID/UP, moving forward and aft controls the flaps and slats. In the DWN position the Krueger flaps are also extended.

WING SWEEP LEVER

A wing sweep lever (3, Figure 1-25), selects wing sweep angles between 25 degrees (lever in the fully forward position) and 67 degrees (lever in the fully aft position). The fixed scale is marked in 1 degree increments and marked in 5 degrees increments from 25 to 68 degrees.

To operate the lever, the release trigger shall be pressed for the time a selection is being made. A detend is provided in the 45 degrees position.

Secondary Control Surface Position Indicator

A four pointer secondary control surfaces position indicator (1, Figure 1-25), marked FLAP SLAT – AIR/BR – WING contains the following indicators:

- The FLAP SLAT section shows the flap position UP/MVR/MID/DWN and slat positions UP/MVR/DWN.
- The AIR/BR section shows airbrake position OUT/IN. OUT equalling 50 degrees of deflection. Center mark equals half extension. IN indicates that both airbrakes are fully retracted. Signals from switches on each locking mechanism will bring the pointer beyond the IN position, indicating that the airbrakes are locked.
- The WING section shows wing sweep angle between 25 and 70 degrees against a scale graduated in 5 degree increments and marked in 10 degree increments.

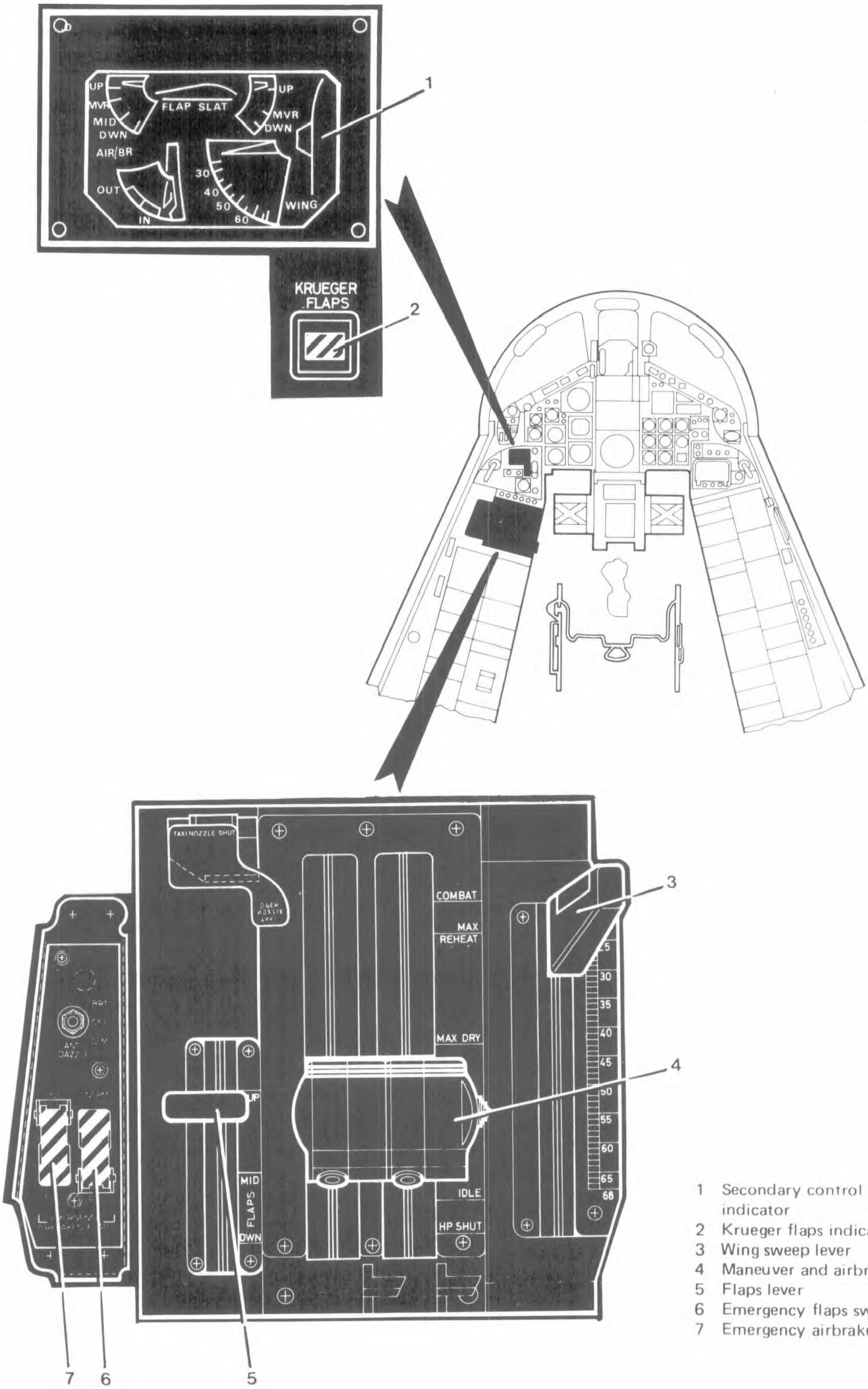
Throttle Rock Test Indicators

The throttle rock test indicators located on the engine test panel (D, 1, Figure 1-5), are two magnetic indicators, marked THROTTLE ROCK – TEST – LEFT/RIGHT, which show the result of throttle rock test on ground. A white display indicates reverse thrust and lift dump circuits are serviceable. Black and white striped display indicates a circuit malfunction.

Emergency Airbrakes and Emergency Flap Switches

A two-position toggle switch (7, Figure 1-25), marked EMERGENCY – AIRBRAKE IN/OFF, is guarded to the OFF position by a black and yellow striped cover. Selected to IN the airbrakes are released to allow aerodynamic forces to drive the airbrakes surfaces toward the retracted position.
A two-position toggle switch (6, Figure 1-25), marked EMERGENCY – FLAP NORM/ORIDE, is guarded and spring-loaded to the NORMAL position. It is used to extend flaps from MID to DOWN position in cases of slat failure.

SECONDARY FLIGHT CONTROL (CONTROLS AND INDICATORS)



1 Secondary control surface position indicator
2 Krueger flaps indicator
3 Wing sweep lever
4 Maneuver and airbrake switch
5 Flaps lever
6 Emergency flaps switch
7 Emergency airbrakes switch

Figure 1-25

Krueger Flaps Indicator

A three-position magnetic indicator (2, Figure 1-25), marked KRUEGER FLAPS, displays:

Blank-grey	Krueger flaps UP and locked
Black and white striped	Krueger flaps in transition or asymmetrically positioned or electrical power failed
DN	Krueger flaps DOWN and locked

Lift Dump Indicator

The lift dump indicator (10, Figure 1-6) is a three position magnetic indicator marked LIFT DUMP and displays:

Grey	MLG strut not compressed
(Post mod. 01399: white cross on grey background)	
OL	MLG strut compressed
LD	Lift dump in operation

CSAS Control Panel Controls

The CSAS control panel includes the following secondary flight control system controls and indicators.
A combined push button/indicator marked SPOILERS with the captions INBOARD and OUTBOARD:

- The red INBOARD caption indicates a failure in the inboard spoilers servo loop and that the inboard spoilers are locked in the retracted position

- The red OUTBOARD caption indicates a failure in the outboard spoilers servo loop and that the outboard spoilers are locked in the retracted position

Pressing the button resets the logic system if the failure is temporary and releases the spoilers from the locked position.

Central Warning Panel

The CWP in the front cockpit (3, *F 'CWP' un*) contains the following secondary flight control system red and amber indications:

- Amber CONFIG illuminates whenever either the FLAPS lever in the MID position and an airspeed of 280 knots ± 10 is exceeded, or when the flaps lever is DOWN and an airspeed of 225 knots ± 10 is exceeded, or when the airbrakes exceed the scheduled extension

- Amber SLAT illuminates whenever an asymmetry or a jam is in the slat system

AUTOPILOT AND FLIGHT DIRECTOR SYSTEM

Automatic flight control, in a variety of modes is provided by an integrated digital Autopilot and Flight Director System (AFDS).
The AFDS provides Autopilot (AP), Autothrottle and Flight Director (FD) functions which can be used separately, or in conjunction provided compatible modes are selected. An equipment interlock prevents the use incompatible modes.
The autopilot, which can only be used in full CSAS mode, is duplex but not reversionary, the second channel being used only for comparison and channel output signal averaging. The FD is reversionary, and failure in one channel automatically results in the isolation of the channel, with the FD continuing to function via the serviceable channel. In certain modes a Stick Force Cut Out (SFCO) facility provides for automatic disengagement of the autopilot by the application of stick force. In other modes, application of stick force provides an Automatic Steering Override (ASO) facility to temporarily disengage the autopilot which re-engages upon reduction of stick force below the ASO threshold.
The AFDS incorporates two similar digital computers, AFDC1 and 2, arranged in duplex. AFDC1 is powered from XP1 AC busbar, and PP1 and PP3 (Essential busbar) DC busbars. AFDC2 is powered from XP3 AC busbar, and PP2 and PP3 (Essential busbar) DC busbars. The computers receive signals from the equipment listed in the following table. Computer outputs are shown in Figure 1-26.
Attitude and heading information from the IN (primary source and SAHR (secondary source) is cross-monitored by the AFDS computers and together with signals generated by deviation from selected mode datums, is supplied to the CSAS as

triplex analogue control demands. A discrepancy of more than 1° between the IN and SAHR causes an attitude monitor trip, resulting in automatic autopilot disengagement.
The autopilot is tested at pre-flight or 1st line level, according to selection, by Built-In Test Equipment (BITE). Airborne BITE operation is inhibited through oleo switches.

AFDS AND INTERFACING SUBSYSTEMS

The AFDS incorporates or is associates with the following components, sensors and indicators.

- AFDS Computers 1 and 2
- Stick Force Sensors
- Throttle Actuators
- Auto Trim Facility
- AFDS Control Panel
- HUD, CSAS, ADC, IN, SAHR, MC, TFR, RA
- ADI
- HSI
- Instinctive Cut-Out Switch
- Approach Progress Indicator (not operative)
- Autopilot Engage/Disengage Button
- Autopilot Engage Indicator
- CWP indicator and Central Maintenance Panel
- Automatic Steering Override

COMPUTER INPUTS

DIGITAL	ANALOGUE
Inertial Navigator (IN)	Triplex Transducer Unit (TTU, via CSAS)
Secondary Attitude and Heading Reference System (SAHR)	Wing Sweep (via CSAS) CSAS rate gyro
Terrain Following Radar (TFR)	Horizontal Situation Indicator (HSI)
Air Data Computer (ADC)	Radar Altimeter
Main Computer (MC)	

AFDS CONTROLS AND INDICATORS

AFDS Control Panel

The AFDS Control panel, located on the left console (B, Figure 1-27) is used to select various AP and FD modes. A BITE TEST facility is located on the panel under a cover guard, and is used to carry out serviceability checks on the ADFS system (Figure 1-26).
The BITE test cannot be initiated in flight.
Eight push button/indicator lights are provided on the panel for mode selection. When pressed, the relevant button will illuminate on receipt of a mode acceptance signal by the AFDS computers. Pressing a button for the secondary time de-selects the mode and extinguishes the light. The following controls and indicators are installed on the AFDS control panel:

FLIGHT DIRECTOR PUSH BUTTON

A push button/indicator labelled FD. Pressed once it illuminates white, indicating that the flight director system is selected. Pressed a second time it deselects the FD system and the light is extinguished.

IAS HOLD TOGGLE SWITCH

A three-positions INC/DEC, spring-loaded to the centre position, increases or decreases the KCAS datum speed in the IAS hold mode at a rate of 1 kt/sec.

AUTOTHROTTLE PUSH BUTTON

A push button/indicator labelled THROT. Pressed once it illuminates white, indicating that the IAS hold (autothrottle) mode is engaged based on the calibrated airspeed at the time of selection. Pressed a second time the mode is disengaged and the light extinguished.

DATUM SPEED DISPLAY

A three-digit display labelled KCAS (knots calibrated airspeed). Indicates the selected datum speed in the IAS hold mode in KCAS.

APPROACH MODE PUSH BUTTON (NOT OPERATIVE)

A push button/indicator labelled APRCH. Pressed once it illuminates white, indicating that the approach mode is selected. At the same time the lights in the HDG and ALT push button illuminate. Pressed a second time it de-selects the mode and the APRCH light extinguishes. (HDG and ALT lights remain illuminated).

AUTOPILOT/FLIGHT DIRECTOR SYSTEM FUNCTIONAL DIAGRAM

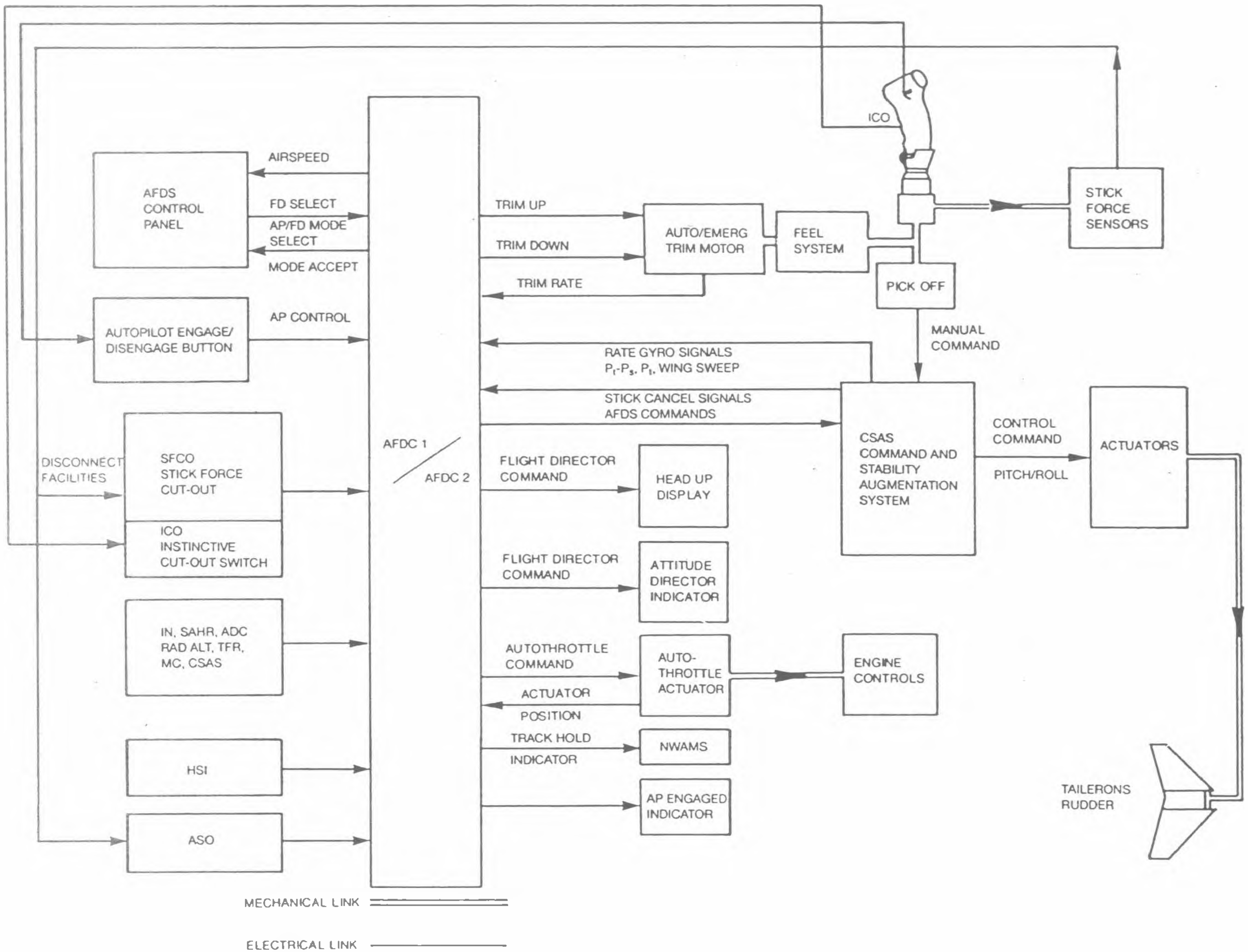


Figure 1-26

TRACK ACQUIRE MODE PUSH BUTTON

A push button/indicator labelled TRACK. Pressed once it illuminates white, indicating that the track mode is selected. With AP engaged, the aircraft will automatically acquire and maintain the track which is determined by the MC, at the time of selection. Pressed a second time the mode is de-selected and the light is extinguished.

HEADING ACQUIRE MODE PUSH BUTTON

A push button/indicator labelled HDG. Pressed once it illuminates white, indicating that the heading acquire mode is preselected. With AP engaged, the aircraft will automatically acquire and maintain the heading preset on the HSI. Pressing a second time de-selects the mode and the light is extinguished.

MACH HOLD MODE PUSH BUTTON

A push button/indicator labelled MACH. Pressed once it illuminates white, indicating that the Mach hold mode is pre-selected. With AP engaged, the aircraft will automatically maintain the Mach existing at the time of selection.

ALTITUDE HOLD MODE PUSH BUTTON

A push button/indicator labelled ALT. Pressed once it illuminates white, indicating that the barometric ALT hold mode is pre-selected. With AP engaged, the aircraft will automatically maintain the barometric height (BARO) existing at the time of engagement.

RADAR HEIGHT HOLD MODE PUSH BUTTON

A push button/indicator labelled RH. Pressed once it illuminates, indicating that the RH mode is pre-selected. With AP engaged, the aircraft will automatically maintain the radar altimeter height existing at the time of engagement.

TERRAIN FOLLOWING MODE PUSH BUTTON

A push button/indicator labelled TF (terrain following). Pressed once it illuminates white, indicating that the TF mode is selected and that AFDS is receiving commands from the TF computer. Pressed a second time the mode is de-selected and the light is extinguished.

CLEARANCE HEIGHT ROTARY SWITCH

A nine-position rotary switch, labelled CLEARANCE, preselects the clearance in the TF mode in feet over the surface. The switch position graduations are marked 200, 300, 400, 500, 750, 1000 and 1500.

TF RADAR READY LAMP

A green indicator lamp labelled READY. The lamp illuminates when the TF radar is ready for operation.

TF RIDE SELECTION SWITCH

A three-position toggle switch, labelled RIDE, with the position SOFT/MED/HARD controls the sensitivity of the TF mode.

PRE FLIGHT/FIRST LINE SWITCH

A three-position toggle switch, guarded at the centre position, with the positions PRE FLT/IST LINE. Depending on switch position, a PRE-FLT or IST LINE test is initiated, when the BITE push button is pressed. For information relevant BITE checks refer to SECTION II.

FD STATUS INDICATOR

A two-section FD status indicator labelled FD GO (green) and FD NO (red). During the self-testing sequence the FD GO light remains illuminated. On completion of self-test either the FD GO light remains illuminated or, if the FD integrity is suspect, the FD NO caption illuminates and the FD GO light is extinguished.

SELF-TEST ACTIVATING PUSH BUTTON

A push button/indicator labelled PUSH. Pressed once it illuminates white, indicating that the preselected self-test programme is activated. When the light starts flashing, it indicates that the test requires manual participation by the pilot. Cancellation of BITE is achieved by pressing the BITE push button again and the light extinguishes.

AUTOPILOT STATUS INDICATOR

A two-selection autopilot status indicator labelled AP GO (green) and AP NO (red). During the self-testing sequence the AP GO light remains illuminated. On completion of self-test either the AP/GO light remains illuminated or, if the AP integrity is suspect, the AP NO caption illuminates and the AP light is extinguished.

ATTITUDE FAIL INDICATOR

A white ATTD FAIL button/indicator which comes on if the attitude signals from the IN and from the SAHR differ by more than 1.5° in pitch and/or 3° in roll, or if a failure of the IN, SAHR or MC occurs. Pressing the button resets the attitude monitor if the fault is no longer present.

COMPUTER BITE INDICATOR

A two section indicator, labelled CMPTR 1 and CMPTR 2, illuminates white if a computer is carrying out a self-check BITE. A failed computer is indicated by an occulted computer caption.

NOTE

Pressing ICO inhibits an inflight BITE and prevents diagnosis of a failed AFDS computer.

Head-Up Display (HUD)

The HUD is an optical/electronic device which projects flight information in symbolic form, into the pilot's forward field of vision. The pilot's display unit (PDU) is installed above the center instrument panel in the front cockpit. The PDU can be used to display command signals emanating from the AFDS. With the mode selector switch on the HUD control panel selected to DIR and the FD activated, the FD symbol will appear in the PDU. If AP is engaged, the cue lines are suppressed. Thus the pilot may utilize the HUD display to monitor operation of the AFDS in all modes. In the TF mode, radar reflection objects penetrating the clearance range will result in a pitch up demand signal being displayed on the HUD. Similarly, a failure in the RH mode will display a pitch up demand signal (for detailed information refer to INTEGRATED DISPLAY UNITS, para. Head Up Display Unit).

Approach Progress Indicator (Not operative)

Attitude Director Indicator

Routes roll and pitch information to FD. The relation between the attitude director indicator (ADI) and the autopilot is described under INSTRUMENTS.

Horizontal Situation Indicator

Routes steering information to FD. The relation between the horizontal situation indicator (HSI) and the autopilot is described under INSTRUMENTS.

Autopilot Engage/Disengage Button

The autopilot engage/disengage button (3, Figure 1-20) engages the AP, consequently the AP engage indicator will illuminate. Pressing the button a second time will disengage the autopilot and the AP light will extinguish.

Autopilot Engage Indicator

The AP engage indicator (A, Figure 1-27) illuminates green when the AP is engaged.

Instinctive Cut-Out Switch

The instinctive cut-out (ICO) paddle switch (9, Figure 1-20) will immediately disengage the AP, FD, autothrottle and cancel all mode selections and preselections.

AFDS Central Warning Panel Captions

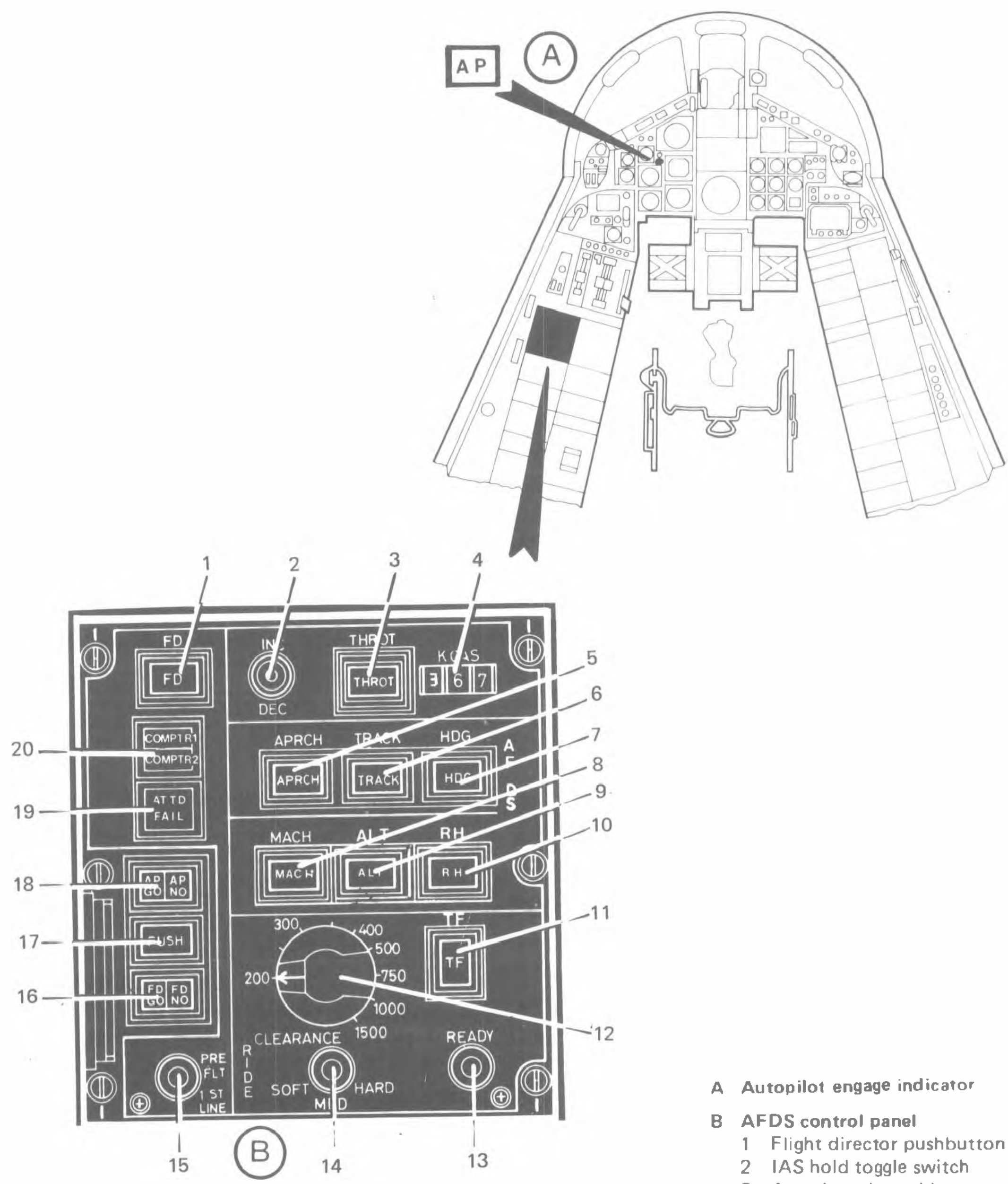
The CWP in both cockpits contains the following red and amber captions:

- Red AUTO P indicates and AP emergency disconnect either due to sensor failure or AP comparator trip.
- Red TFR indicates a terrain following radar failure, resulting in an auto pull-up and wings level in the AP mode, or in a demand signal to be followed in the FD mode.
- Amber R ALT indicates a radar altimeter failure, resulting in a wings level and pull-up in the RH hold mode.

On the front cockpit CWP only:

- Amber TF MON indicates a TF primary/secondary source data input failure or failure in source data cross monitoring.

AFDS



A **Autopilot engage indicator**

B **AFDS control panel**

1. Flight director pushbutton
2. IAS hold toggle switch
3. Autothrottle pushbutton
4. Datum speed display
5. Approach pushbutton
6. Track aquire pushbutton
7. Heading aquire pusbutton
8. Mach hold pushbutton
9. Altitude hold pushbutton
10. Radar height hold pushbutton
11. Terrain following pushbutton
12. Clearance height rotary switch
13. T.F. radar ready lamp
14. T.F. ride selection switch
15. Preflight/first line switch
16. FD status indicator
17. Self test activating pushbutton
18. Autopilot status indicator
19. Attitude fail indicator
20. Computer bite indicator

Figure 1-27

- Amber AP TRIM indicates an AP trim failure. The autotrim monitor automatically disengages autotrim.

- Amber AP MON indicates that one of the attitude sources (IN or SAHR/MC) has failed and that the primary or secondary attitude source has been selected automatically.

  Post Mod. 01464.

- Amber A THROT indicates automatic disconnection of the autothrottle mode.

On the rear cockpit CWP only:

- Amber SAHR indicates a SAHR failure.

- Amber CMPTR indicates an MC failure and a reversion to pure IN navigation mode and some loss of weapons aiming facilities.

- Amber ADC indicates the loss of one or more data computer outputs.

- Amber IN indicates inertial navigator failure.

AFDS MODE COMPATIBILITY AND PRIORITY

The AP/FD computer contain mode selection and interlock logic circuits which exclude the selection of incompatible modes.
In general, more than one speed hold mode, or two modes requiring demands in the same axis may not be selected together. The last mode selection made on the AFDS control panel takes priority and overrides any incompatible mode previously made, with the exception of the Approach or TF mode and RHH. The mode compatibilities are shown in Figure 1-28.

OPERATING MODES

The desired AP or FD mode can be selected or deselected by the AFDS panel pushbuttons. Common mode selection is provided for both AP and FD, an interlocking logic prevents conflicting modes being selected. Modes using signals from invalid equipment cannot be selected. It is possible to preselect any mode prior to engagement of AP or FD. If a red AUTO P warning caption appears on the CWP, AP disengagement is initiated and all modes will be cancelled. If the FD is engaged prior to AP, the AP engages in the same mode, and the flight conditions existing at the time of engagement of the AP become the datum for both FD and AP.
The AFDS can be operated in the following modes:

- Basic Modes:
  - Attitude Hold
  - Heading Hold
- Cruise Modes:
  - Heading Acquire
  - Track Acquire
  - Altitude Hold (BARO)
  - Mach Hold
  - Autothrottle (IAS-Hold)
- Low Level Modes:
  - Terrain Following
  - Radar Height Hold
  - Auto Approach (Not operative)

BASIC MODES

This mode is the basic mode of the AP which is operative if the engage/disengage button on the control stick is selected with no (excluding FD or THROT) preselections on the the AFDS control panel. At the moment of AP engagement, the attitude and heading information from the IN/SAHR is frozen in the AFDS computer store to provide an attitude/heading datum. Deviation from the datum generates error signals as pitch and roll demands which are fed as pitch and roll demands to the CSAS.

Attitude Hold

If the bank angle exceeds ± 7 degrees at the time of AP engagement pitch attitude and bank angle will be maintained. If pitch or bank exceed ± 60 degrees the aircraft is automatically restored to, and held at, the upper limit.

Heading Hold

If the bank angle at engagement is less than ± 7 degrees, the wings will be levelled and the AP will maintain pitch attitude and heading within an accuracy of ± 0.5 degree. A new datum for attitude/heading can be achieved by disengaging AP, applying manual correction and reengaging.

AFDS MODE COMPATIBILITY AND PRIORITY

MODE SELECTED		SUBSEQUENT MODE SELECTION: BASIC MODES		CRUISE MODES					LOW ALT MODES	
		Pitch Att. Hold	Roll Att./ Heading Hold	Altitude Hold	Track Acquire	Mach Hold	I A S Hold (Autotrottle)	Heading Acquire	T F	Radar Height Hold
BASIC MODES	Pitch Attitude	— / —	C* / —	IC / Alt Hold	C / Both Modes	IC / Mach Hold	C / Both Modes	C / Both Modes	IC / T F	IC / Radar Height Hold
BASIC MODES	Roll Att./ Heading Hold	C* / —	— / —	C / Both Modes	IC / Track Acquire	C / Both Modes	C / Both Modes	IC / Heading Acquire	C / Both Modes	C / Both Modes
CRUISE MODES	Altitude Hold	IC / Alt. Hold	C / Both Modes	— / —	C / Both Modes	IC / Mach Hold	C / Both Modes	C / Both Modes	IC / T F	IC / Radar Height Hold
CRUISE MODES	Track Acquire	C / Both Modes	IC / Track Acquire	C / Both Modes	— / —	C / Both Modes	C / Both Modes	IC / Heading Acquire	C / Both Modes	C / Both Modes
CRUISE MODES	Mach Hold	IC / Mach Hold	C / Both Modes	IC / Altitude Hold	C / Both Modes	— / —	IC / I A S Hold	C / Both Modes	IC / T F	IC / Radar Height Hold
CRUISE MODES	I A S Hold (Autotrotle)	C / Both Modes	C / Both Modes	C / Both Modes	C / Both Modes	IC / Mach Hold	— / —	C / Both Modes	C / Both Modes	C / Both Modes
CRUISE MODES	Heading Aeaquire	C / Both Modes	IC / Heading Acquire	C / Both Modes	IC / Track Acquire	C / Both Modes	C / Both Modes	— / —	C / Both Modes	C / Both Modes
LOW ALTITUDE MODE	T F	IC / T F	C / Both Modes	IC / T F	C / Both Modes	IC / T F	C / Both Modes	C / Both Modes	— / —	IC / T F
LOW ALTITUDE MODE	Radar Height Hold	IC / Radar Height Hold	C / Both Modes	IC / Radar Height Hold	C / Both Modes	IC / Radar Hoight Hold	C / Both Modes	C / Both Modes	IC / Radar Height Hold	— / —

C = Compatible Modes
IC = Incompatible Modes

* Banck Angle <7 % TF Dor AP engagement : Heading Hold
>7 % TF Dor AP engagement : Roll.Att Hold

AUTO APPROACH NOT OPERATIVE AND NOT INCLUDED IN THIS TABLE

Figure 1-28

CRUISE MODES

Heading Acquire

This mode enables the aircraft to acquire and automatically hold the preset heading datum on the HSI. True heading information from the IN or SAHR/Doppler is fed to the HSI for display. When the HDG push button/indicator on the AFDS control panel is pressed, selection is confirmed when the indicator illuminates. When the AP is engaged, it automatically turns the aircraft on to the heading set on the HSI heading index marker control, subject to a maximum bank angle of 35°, and will maintain this heading to within ± 1/2 degree. With FD only engaged, the pilot can achieve the desired heading manually. Heading changes may be made with the mode in operation, by rotation of the HSI heading index marker control. This generates a heading error signal which is fed to the AFDS to produce control demands to the CSAS. Manual deselection is accomplished by pressing the illuminated HDG push button/indicator and deselection is confirmed when the light extinguishes.

Track Acquire

In this mode the aircraft acquires and maintains the track defined by the main computer. When the TRACK push button/indicator on the AFDS control panel is pressed, it illuminates to confirm selection. When the AP is engaged, the aircraft will automatically acquire and maintain the track determined by the MC. At the same time the TRACK HOLD indicator on the WAMS panel (rear cockpit) will illuminate to indicate to the navigator that the AP is engaged in the TRACK acquire mode and that hand controller corrections inserted during fixing or attack will control the aircraft track. In the navigation phase the track is acquired using the maximum turn rate compatible with the bank angle limits (60 degrees);
The MC datum track will be held to within ± 200 feet, while in the direct steer phase (within 20 NM) the maximum track error is reduced to ± 25 feet.
With FD engaged the pilot can monitor the AP performance during maneuvers. When FD only is engaged, it enables the pilot to hold the MC track manually, subject to the bank angle limits (60 degrees). During the attack phase, the pilot can perform manual attack manouvre using information displayed on the HUD. Manual deselection is accomplished by pressing the illuminated TRACK push button/indicator and deselection is confirmed when the light extinguishes.

Altitude Hold (Barometric)

The altitude hold mode enables the aircraft to automatically maintain a constant barometric altitude. Altitude and airspeed data are continuously supplied from ADC and the CSAS/TTU altitude/airspeed monitor, to the AFDS computers. The pilot flies the aircraft to the desired altitude, using baro height information displayed on the HUD and servo-pneumatic altimeter, the ALT push button/indicator is pressed an will illuminate to confirm engagement. The barometric height existing at the time of AP engagement becomes the datum height and deviations from this will generate error signal which is fed to the CSAS as a pitch control demand. The datum altitude will be maintained to within 100 feet or ± 0,5%, whichever is the greater. If FD is engaged together with the AP in this mode, the FD provides monitoring information to the pilot about AP performance.
Manual disengagement is made by pressing the illuminated ALT push button/indicator and deselection is confirmed when the light extinguishes.

Mach Hold

This mode enables the aircraft to maintain a given Mach number using information displayed on the HUD and CSI. The selected Mach number is maintained through changes in the rate of climb and descent by pitch compensation, when the desired Mach number has been attained, the MACH push button is pressed and will illuminate confirming selection. When the AP is engaged it will maintain the Mach number existing at the time of AP engagement with an accuracy of ± 0,005 Mach. With FD engaged the pilot is able to monitor AP performance. With FD only engaged, it enables the pilot to maintain the desired Mach number manually. Manual deselection is achieved by pressing the illuminated MACH push button indicator and deselection is confirmed when the light is extinguished.

Auto Throttle

The auto throttle mode enables the aircraft to maintain a calibrated (KCAS) datum- airspeed through the use of automatic throttle control. A KCAS signal from the ADC is supplied continuously to the digital indicator (datum speed display) on the AFDS control panel, the HUD display, and the AFDS computers. Prior to auto throttle selection the aircraft is flown to the desired KCAS and

the THROT push button/indicator is pressed. Selection is confirmed when the push button illuminates.
The auto throttle actuator is installed in the throttle box assembly and responds to commands from the AP system via AFDC 2.

The KCAS value displayed at the time of engagement becomes the datum and the throttle electromagnetic clutch engages. Deviations from this datum generate an error signal which drives the throttle actuator to adjust the throttles. The datum speed will be held to an accuracy of ± 1%. Adjustment of the datum speed may be made by operating the INC/DEC switch, which has a range of ± 30 knots.

Auto throttle operates in the dry power range only, and is independent of the AP engage/disengage button. The auto throttle facility disengages automatically when the lower limit (IDLE) or the upper limit (MAX DRY) is reached. (Post mod. 01464: automatic auto-throttle disengagement will illuminate the amber A THROT/CWP caption).

The mode can be deselected manually by pressing the illuminated THROT button, or by the ICO.
The automatic throttle mechanism can be overriden manually.

LOW ALTITUDE MODES

Radar Height Hold

This mode enables the aircraft to be flown at an automatically maintained radar height. It is intended for operation over water. The altitude datum source is the radar altimeter which feeds a continuous signal to the AFDS computers. The pilot flies the aircraft to the desired altitude using the radar altitude indicator. When the RH push button/indicator is pressed, it will illuminate to confirm selection.

The radar height existing at the time of AP engagement becomes the datum height. Deviations from this datum generate an error signal which is fed to the CSAS as a pitch control demand. With AP engaged, this mode will hold the clearance height over the range 100 feet to 1500 feet, and at speeds from 300 KCAS to 0.95 Mach, with an accuracy of ± 25 feet. The climb/sink rate at engagement should not exceed 500 feet/min. The system will operate with up to ± 45 degrees angle of bank and will accomodate wave heights up to 10 feet. With FD engaged, the pilot can monitor the operation of this mode or use the FD for manual control as a reversionary mode. If a failure of the AP or radar altimeter occurs in this mode, the AP generates a pull-up signal to the CSAS, the amplitude and duration of the signal is dependent on the aircraft's attitude at the time of failure. A wings level signal is applied at the same time. These commands will be indicated in the HUD and a breakaway signal will appear in the form of a flashing cross.

Terrain Following

The terrain following (TF) mode provides the aircraft with an automatic low level flying capability. The TF radar scans the terrain ahead of the aircraft and monitors the returns above or below the preselected height threshold. This mode may be selected when the green TF READY light is illuminated and is selected in conjunction with the CLEARANCE height and RIDE switch settings as required. The CLEARANCE height rotary switch may be set from 200 feet to 1500 feet and this value, together with the RIDE setting (SOFT, MED or HARD), is transmitted to the TF computer (TFC). Request for TF mode is made by pressing the TF push button/indicator and confirmation of mode selection is indicated when the push button illuminates. When the AP is engaged, it follows commands from the TFC, but pitch rate demands are limited to 2g by the AP which provides control at speeds between 350 KCAS and 1.1 Mach. The CLEARANCE height and RIDE settings may be altered by the pilot without disengaging the AP, if the 70% low height criterium is considered.

With FD also engaged, the pilot can monitor the operation of the AP.
It is possible to adopt manual control using FD displayed commands (HUD), as a revisionary mode. If a failure occurs in the TFC or AP, the AP generates a pull-up signal to the CSAS, the amplitude and duration of the signal is dependent on the aircraft attitude and airspeed at the time of failure. A wings level signal is applied at the same time. These commands will be indicated in the HUD, the breakaway signal appearing in the form of a flashing cross. The TF mode may be manually deselected by pressing the illuminated TF push button/Indicator and deselection is confirmed when the light extinguishes.

AUTOPILOT ENGAGEMENT/MANUAL DISENGAGEMENT

The AP will engage when the autopilot engage/disengage button on the control stick (3, Figure 1-20) is pressed, provided that all pre-engagement conditions are met.

Engagement is confirmed when AP engaged indicator illuminates. Disengagement can be made by:

- Pressing the engage/disengage button again.
- Operation of the ICO.
- In all modes other than the basic mode(s), by SFCO operation.
  - In the basic mode(s), operation of the ASO will initiate temporary disengagement, the AP will re-engagement in the basic mode(s).

AUTOMATIC STEERING OVERRIDE

The automatic steering override (ASO) facility enables the pilot to temporarily the AP for maneuvering purposes. ASO will operate in the basic modes(s) only. Through the application of a stick force exceeding 38.2 N in pitch or roll, the AP will automatically disengage. (Auto throttle is not affected). When the stick force is reduced to below the ASO threshold, the AP will automatically reengage in the basic mode(s). If ASO operates when FD and AP are selected togheter, the outputs to the HUD and ADI are occulted until ASO operation ceases. The ASO has not affect on the FD when the FD is operating alone in the steering mode (i.e. AP not engaged). If, at the moment of an initial attempt to engage the AP, stick forces exceed the ASO threshold, engagement is prevented and any preselected modes are cancelled.

STICK FORCE CUT-OUT

Stick force cut-out (SFCO) operates in all modes other than the basic mode(s). When a stick force is applied exceeding 38 N in pitch or 29 N in roll, the SFCO disengages the AP and deselects all modes (including auto throttle and FD). If the FD is operating independently (i.e. with no other modes selected), SFCO has no effect.
SFCO disengagement of the AP illuminates the red caption AUTO P on the CWP. The caption will extinguish when the ICO is operated.

INSTINCTIVE CUT-OUT

The instinctive cut-out facility (ICO) enables the pilot to immediately disengage the AP, the FD system, and deselect all modes (includes the auto throttle system), by operating the ICO switch bar on the control stick. (This action also disengages the NWS).

PITOT-STATIC SYSTEM

PITOT-STATIC SYSTEM

The pitot-static system of the aircraft provides aerodynamic and environmental reference data for various subsystems. Individual intake opening serve as input sources for pitot and static pressure (Figure 1-29). The pitot intakes consist of:

P1	Pitot-static nose probe in front of the radome
P2	Pitot probe located on the right side of the fuselage below the front cockpit.
P3	Pitot probe located on the left side of the fuselage below the front cockpit.

There are seven static pressure intake sources which are located as follows:

S1	Pitot-static inside the nose probe in front of the radome.
S2 S3 S4	interconnected compensated static vents, three each on the right and three each on the left side of the nose cone
S5	on the right side of the fuselage
S6	on the right side of the fuselage
S7	on the left side of the fuselage.

PITOT AND STATIC PRESSURE DISTRIBUTION

The pitot pressure P1 and static pressure S1 are fed into the air data computer (ADC). In addition P1 is routed into the triplex transducer unit (TTU).
P2 feeds the TTU, the "Q" feel system, the right AICS and the rear cockpit combined speed indicator (CSI).
P3 feeds the TTU, the "Q" feel system, the left AICS and the front cockpit CSI.

AUTOPILOT ENGAGEMENT/MANUAL DISENGAGEMENT

The AP will engage when the autopilot engage/disengage button on the control stick (3, Figure 1-20) is pressed, provided that all pre-engagement conditions are met.

Engagement is confirmed when AP engaged indicator illuminates. Disengagement can be made by:

- Pressing the engage/disengage button again.
- Operation of the ICO.
- In all modes other than the basic mode(s), by SFCO operation.
  - In the basic mode(s), operation of the ASO will initiate temporary disengagement, the AP will re-engagement in the basic mode(s).

AUTOMATIC STEERING OVERRIDE

The automatic steering override (ASO) facility enables the pilot to temporarily the AP for maneuvering purposes. ASO will operate in the basic modes(s) only. Through the application of a stick force exceeding 38.2 N in pitch or roll, the AP will automatically disengage. (Auto throttle is not affected). When the stick force is reduced to below the ASO threshold, the AP will automatically reengage in the basic mode(s). If ASO operates when FD and AP are selected togheter, the outputs to the HUD and ADI are occulted until ASO operation ceases. The ASO has not affect on the FD when the FD is operating alone in the steering mode (i.e. AP not engaged). If, at the moment of an initial attempt to engage the AP, stick forces exceed the ASO threshold, engagement is prevented and any preselected modes are cancelled.

STICK FORCE CUT-OUT

Stick force cut-out (SFCO) operates in all modes other than the basic mode(s). When a stick force is applied exceeding 38 N in pitch or 29 N in roll, the SFCO disengages the AP and deselects all modes (including auto throttle and FD). If the FD is operating independently (i.e. with no other modes selected), SFCO has no effect.
SFCO disengagement of the AP illuminates the red caption AUTO P on the CWP. The caption will extinguish when the ICO is operated.

INSTINCTIVE CUT-OUT

The instinctive cut-out facility (ICO) enables the pilot to immediately disengage the AP, the FD system, and deselect all modes (includes the auto throttle system), by operating the ICO switch bar on the control stick. (This action also disengages the NWS).

PITOT-STATIC SYSTEM

PITOT-STATIC SYSTEM

The pitot-static system of the aircraft provides aerodynamic and environmental reference data for various subsystems. Individual intake opening serve as input sources for pitot and static pressure (Figure 1-29). The pitot intakes consist of:

P1	Pitot-static nose probe in front of the radome
P2	Pitot probe located on the right side of the fuselage below the front cockpit.
P3	Pitot probe located on the left side of the fuselage below the front cockpit.

There are seven static pressure intake sources which are located as follows:

S1	Pitot-static inside the nose probe in front of the radome.
S2 S3 S4	interconnected compensated static vents, three each on the right and three each on the left side of the nose cone
S5	on the right side of the fuselage
S6	on the right side of the fuselage
S7	on the left side of the fuselage.

PITOT AND STATIC PRESSURE DISTRIBUTION

The pitot pressure P1 and static pressure S1 are fed into the air data computer (ADC). In addition P1 is routed into the triplex transducer unit (TTU).
P2 feeds the TTU, the "Q" feel system, the right AICS and the rear cockpit combined speed indicator (CSI).
P3 feeds the TTU, the "Q" feel system, the left AICS and the front cockpit CSI.

PITOT STATIC SYSTEM

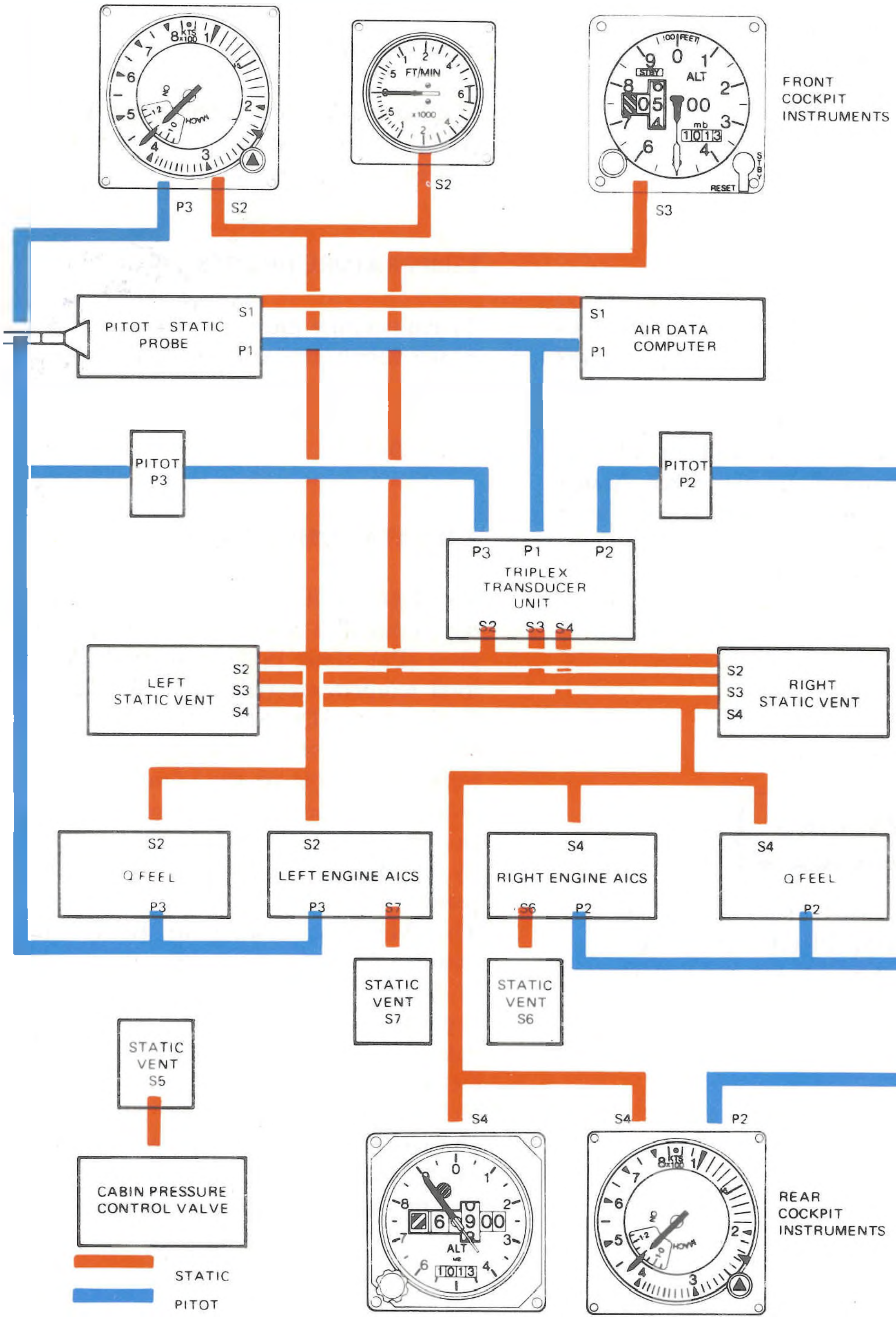


Figure 1-29

S2 feeds the TTU, the left AICS, the left "Q" feel system, the vertical speed indicator (VSI) and the front cockpit CSI.
S3 feeds the TTU and the servo-pneumatic altimeter in the front cockpit.
S4 feeds the TTU, the right AICS, the right "Q" feel system, the rear cockpit CSI and the rear cockpit altimeter.
S5 feeds the cabin pressure control valve (CPCV)
S6 feeds the right AICS
S7 feeds the left AICS.

PROBE HEATING

To prevent icing of the pilot probes the PITOT HEATERS switch on the rapid take-off panel is set to the FLIGHT position. With the PITOT HEATERS switch set to this position the pitot static probe P1 in front of the radome, both angle of attack (AOA) probes, pitot probes P2 and P3 and the total temperature probe are electrically heated. Failure or power off the P3 probe heating is indicated by an amber warning caption labelled PITOT on the CWP in the front cockpit. Probe heating is inhibited when the relevant engine speed is below 59% NH.

WARNING

THE PITOT HEATER CIRCUIT FOR THE NOSE PROBE P1, S1, P2 AND BOTH ANGLE OF ATTACH PROBES ARE NOT MONITORED BY THE PITOT CAPTION ON THE CWP.

NOTE

To provide reliable IAS information under icing conditions at AC power loss the pitot probe heater P3 is connected to the battery busbar. P3 pressure is routed to the front CSI.

AIR DATA SYSTEM

The Air Data System comprises the ADC and TTU which convert pitot and static pressures into electrical signals used, together with AOA and temperature data, for control and display.

AOA PROBES

The left AOA probe supplies the ADC and the left AICS. The right AOA probe supplies the strip AOA indicator and the right AICS.

TEMPERATURE PROBES

T1 temperature probes at the rear of each engine air intake supply the associated engine control system with intake temperature data. A second probe in the left engine air intake supplies total temperature data to the ADC.

AIR DATA COMPUTER

The digital ADC, located in the forward equipment bay, computes various air data parameters from pitot (P1), static (S1), local AOA (left probe) and total temperature (left air intake) inputs. Refer to Figure 1-30 ADC Schematic. Pitot and static pressures and electrical input signals are converted to a form compatible to the computer. The ADC requires a barometric pressure reference to be enabled to compute baro-corrected altitude. This is provided by the MB SET rotary control on the HUD control panel.
The ADC has continuous BITE circuits which monitor its performance. Should the ADC or any of its input sensors fail, the affected output and all dependent outputs are set to zero after a short time delay to cater for transients. Output signals not affected by a failure remain valid.
Reliable indication of speed, AOA and barometric altitude will still be available from the secondary pitot-static system. The altimeter in the front cockpit will automatically revert to the STBY mode.

TRIPLEX TRANDUCER UNIT

The TTU, located in the forward equipment bay, converts pressure from separate pitot and static sources into electrical signals representing indicated airspeed, altitude and Mach number. These signals

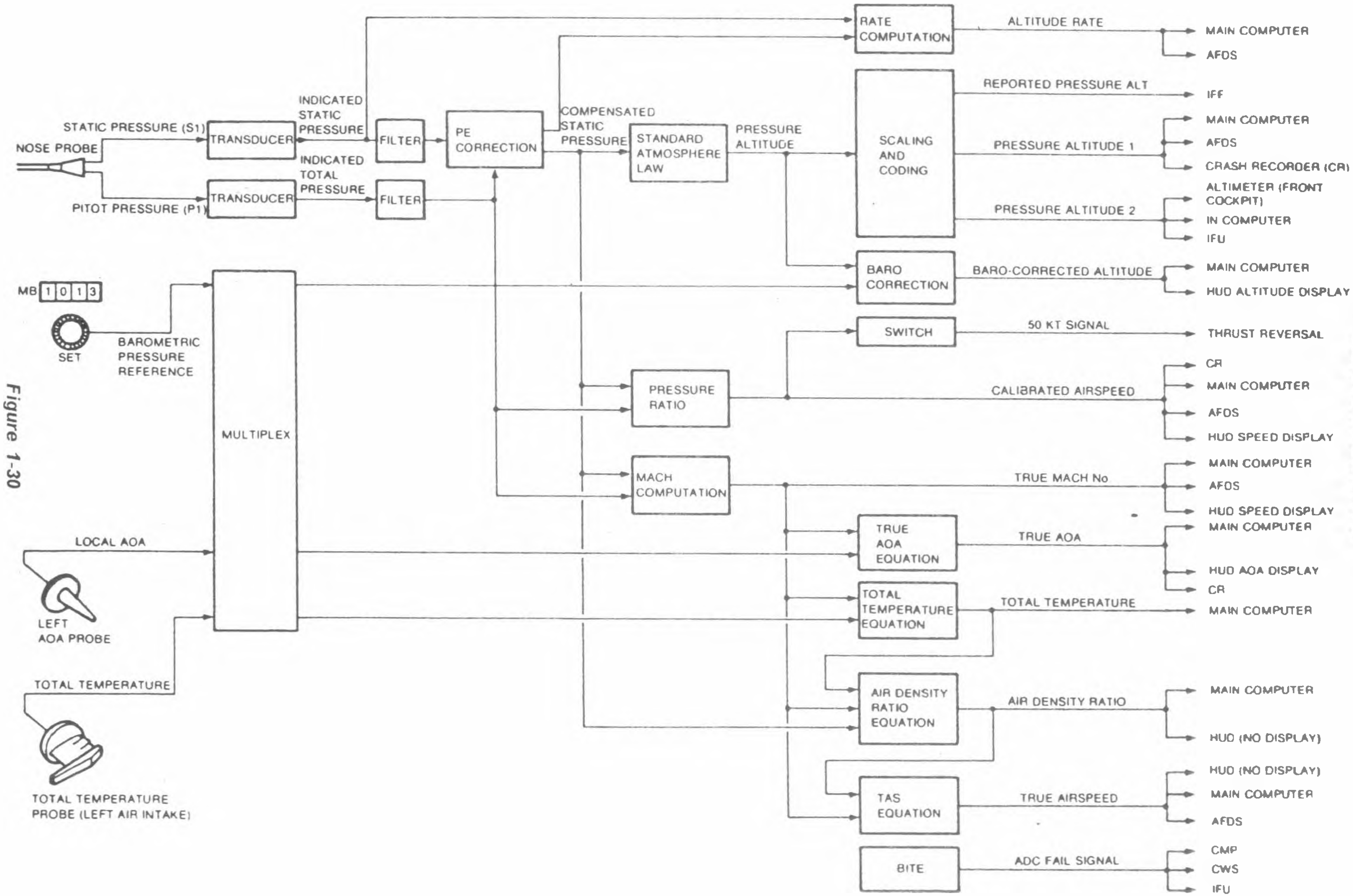


Figure 1-30 ADC SCHEMATIC

supply the CSAS and engine control systems with analogue data, and also operate a number of airspeed, altitude and Mach switches. The TTU supplies data signals for the following:

- CSAS gain scheduling
- Engine control system
- Airbrake control
- Air conditioning ejectors
- Landing gear audio alarm and flasher
- Configuration warning

CENTRAL WARNING PANEL

If the air computer fails, the amber caption ADC will illuminate on the CWP in the rear cockpit. Reliable indication of speed, AOA and barometric altitude will still be available from the secondary pitot-static system. The altimeter in the front cockpit will automatically revert to the STBY mode.

INSTRUMENTS

ACCELEROMETER

The accelerometer (B, Figure 1-31) measures positive and negative acceleration g-loads imposing on the vertical aircraft axis. A main pointer and two index tabs indicate the aircraft vertical acceleration against a dial, graduated from minus 4 g to plus 9 g in increments of 0,5 g. Instantaneous indication of g-loads is made by a self-contained mechanism assembly inside the indicator case. The main pointer moves in the direction of the g-load being applied; a negative and a positive index tab follow the main pointer to its maximum travel. The index tab remain at the maximum negative or positive g-load indication attained, whereas the main pointer drops back as soon as the g-load is reduced. The index tab can be reset back to the 1 g position by depressing the PUSH button, located on the indicator's face.

COMBINED SPEED INDICATOR (CSI)

The combined speed indicator (D, Figure 1-31) provides a combined display of airspeed from 80 to 850 KTS and Mach number from 0,5 to 2,5 M. The airspeed index marker on the outer scale can be adjusted by the control knob on the instrument bezel. The airspeed index marker on the outer scale can be adjusted by the control knob at bottom right of the instrument. The indicator in the front cockpit is supplied by the pitot pressure P3 and the static pressure S2. The indicator in the rear cockpit is supplied by the pitot pressure P2 and the static pressure S4.

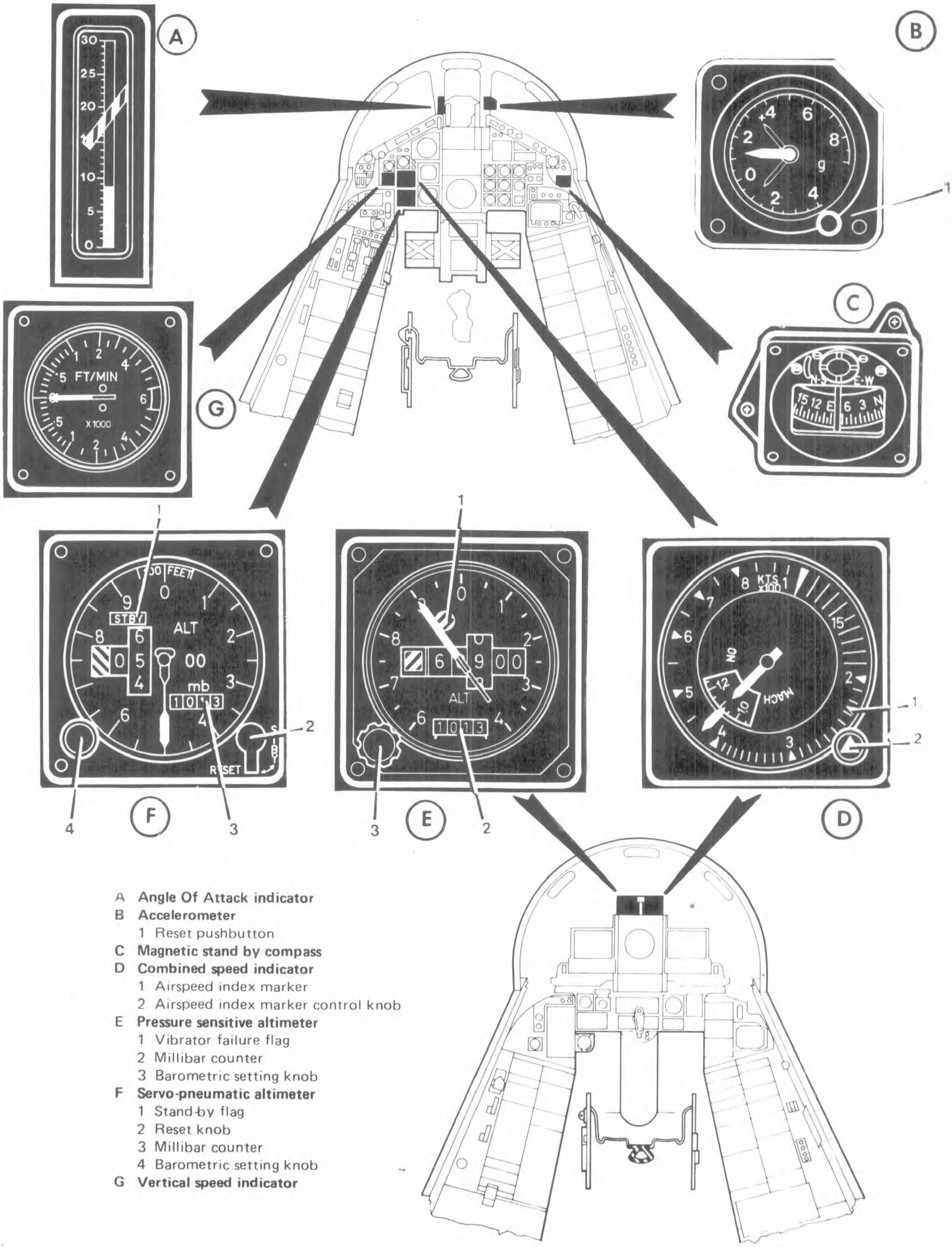
SERVO-PNEUMATIC ALTIMETER

The altimeter (F, Figure 1-31) is a servo-pneumatic instrument comprising a three drum counter indicating from − 2000 to + 80000 ft and a single needle indicating 1000 ft per revolution. At altitudes below 10000 ft, a black and white striped flag covers the left hand counter; at altitude below 0 ft this flag will be replaced by a black-and red striped flag. The altimeter operates in two different modes. Under normal condition altitude display is governed by the pneumatic input and a servo-repeater system inside the instrument, which is updated by input signal derived from ADC. In the event of power off or a difference between ADC and pneumatic input greater than 2000 feet or an ADC failure, the altimeter automatically reverts to the pneumatic standby mode. This status is indicated by STBY flag appearing in a dial cutout of the instrument. In STBY mode the altimeter operates with pneumatic pressure only, which is derived from the S3 static vents. Actuating the RESET knob on the altimeter bezel switches the instruments operating mode form STBU back to the servo mode or reverse. The RESET/STBY knob is spring-loaded to the center (neutral) position.
The servo system is powered by XP1 and PP1 provides the operating current for a vibration when in STBY mode.

NOTE

- Testing of the electrically operated servo mode of the altimeter is made with electrical power on. Adjust millibar counter to indicate 1013 and set FLT INST toggle switch on rapid take-off panel to FLIGHT position and IFU 1 toggle switch on the MC control panel to ON position. When pressing square TEST push button on the HSI mode panel the altimeter reading shall be 1250 feet. Pressing it again the test mode is deselected.

INSTRUMENTS



A Angle Of Attack indicator
B Accelerometer
  1 Reset pushbutton
C Magnetic stand by compass
D Combined speed indicator
  1 Airspeed index marker
  2 Airspeed index marker control knob
E Pressure sensitive altimeter
  1 Vibrator failure flag
  2 Millibar counter
  3 Barometric setting knob
F Servo-pneumatic altimeter
  1 Stand-by flag
  2 Reset knob
  3 Millibar counter
  4 Barometric setting knob
G Vertical speed indicator

Figure 1-31

- The test button shall be operated only when the aircraft is on the ground, otherwise the altimeter may revert to STBY mode.

- With the servo-pneumatic altimeter in STBY mode, large errors occur betwenn HUD and HDD attitude indications.

PRESSURE-SENSITIVE ALTIMETER

The altimeter (E, Figure 1-31) in the rear cockpit is a display comprising a three-drum counter indicating from - 2000 ft to 99000 ft and a single needle indicating 1000 ft per revolution. The left counter is covered by a black-and-white striped flag at altitudes below 10000 ft and by a black-and-red flag at altitude below 0 ft. The altimeter incorporates a vibrator, which reduces mechanical friction of gear trains and linkages of the mechanical assembly, If the vibrator fails, and black-and-yellow flag appears above the counter. A barometric setting knob is located on the instrument bezel to make barometric settings on the millibar counter of the altimeter.

MAGNETIC STANDBY COMPASS

A conventional magnetic standby compass (C, Figure 1-31) is installed in the front cockpit.

VERTICAL SPEED INDICATOR (VSI)

The vertical speed indicator (G, Figure 1-31) located in the front cockpit, is a standard pneumatic instrument with a range of ± 6000 feet/minute.

ANGLE OF ATTACK (AOA) INDICATOR

The AOA indicator (A, Figure 1-31) is electrically connected to the right AOA probe. Signals form the detector drive a servo-mechanism inside the instrument case. Display is made by a continuous indicating ribbon, moving against a vertical thermometer type scale graduated in units from 0 to + 30. In the event of an electrical or servo-mechanical failure a red-and-black hetched warning bar will obscure the vertical dial.

HORIZONTAL SITUATION INDICATOR (HSI)

The HSI (C, Figure 1-32) is a remotely indicating servo-instrument, displaying the aircraft's horizontal plan view depending on the mode selected on the HSI mode switch panel (B, Figure 1-32). The interface unit 1 (IFU 1) relays signal information from different input sources to the HSI. The IFU 1 is activated with the IFU toggle switch on the MC control panel. The two different operating modes which can be selected with the HSI mode switch panel are: NAV and TAC. Selected mode is indicated in the mode display window of the HSI instrument (C, 8, Figure 1-32).

NOTE

> The APP1, APP2 and DF setting on the HSI mode switch panel have no function.

In TAC mode, the relevant switches on the TACAN control panel (Figure 4-91) shall be set to obtain indications of slant range and magnetic bearing on the HSI.
In the NAV mode, true heading, track and command track is derived from the IN and MC. Function of each HSI indicator display and control element is described in Figure 1-33.
For HSI test refer to section IV Set Up, Alignment and Test of Sensor and Displays chapter, para "HSI test".

NOTE

> For all modes except NAV, the appropriate switches on the SAHR control panel (Figure 4-6) shall be selected.

ATTITUDE DIRECTOR INDICATOR (ADI)

The ADI (A, Figure 1-32) displays aircraft pitch and roll attitude, turn and slip and flight director demand.

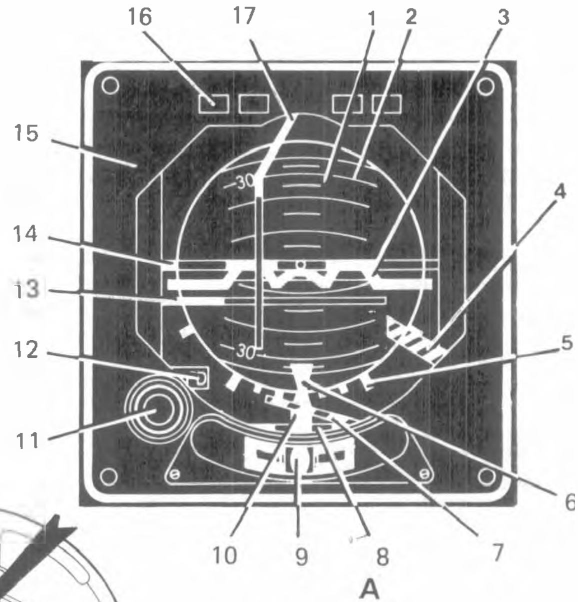
Attitude Display

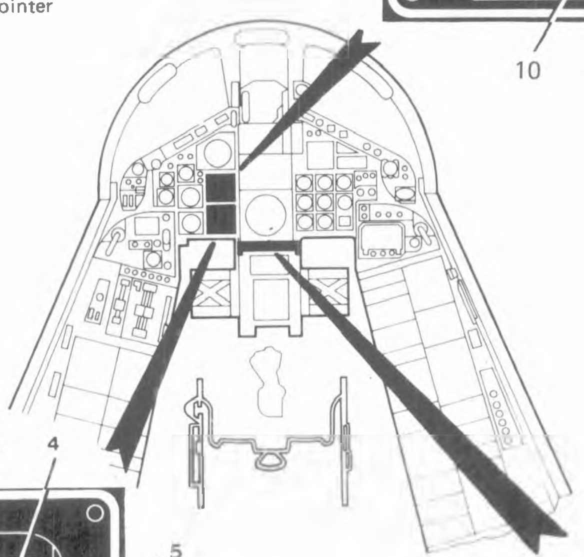
Pitch and roll attitude is displayed by the position of a spheroid relative to a fixed aircraft symbol. The spheroid is controlled by a vertical gyro and is divided by a white line representing the natural hori-

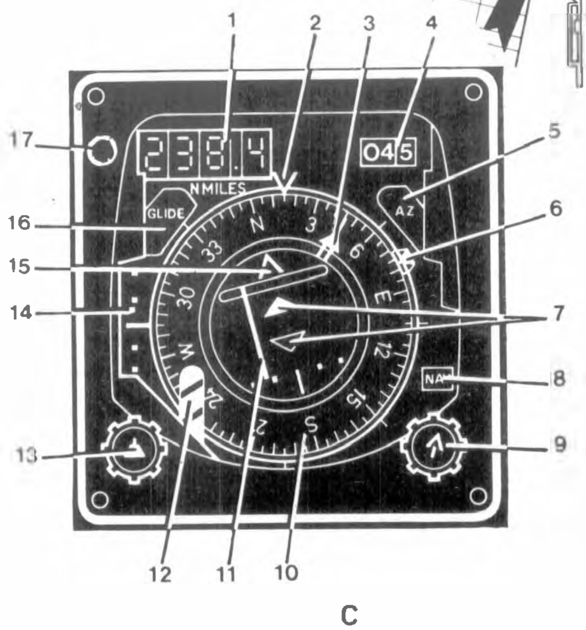
INSTRUMENTS

Attitude director indicator

1 Horizon spheroid
2 Pitch scale
3 Aircraft symbol (variable pitch datum)
4 Power failure warning flag
5 Roll scale
6 Roll pointer
7 Rate of turn failure flag
8 Rate of turn scale
9 Slip indicator
10 Rate of turn pointer
11 Gyro erecting knob
12 Flight director warning flag
13 Pitch demand pointer
14 Horizon line
15 Intrument bezel
16 Lamp assy
17 Azimuth demand pointer

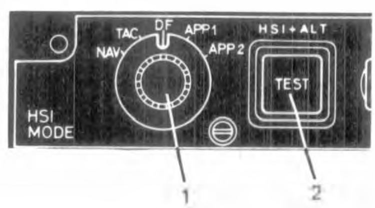






HSI mode switch panel

1 Mode selector switch
2 Test push button



HORIZONTAL SITUATION INDICATOR

1 Range distance counter
2 Fixed lubber marker
3 Actual track pointer
4 Track bearing counter
5 Azimuth flag
6 Heading index marker
7 TO/FROM indicator
8 Mode display
9 Track select control knob
10 Compass card
11 Lateral deviation bar and scale
12 Display failure flag
13 Heading index marker control knob
14 Elevation deviation bar and scale
15 Track bearing pointer
16 Elevation failure flag
17 Range counter brilliance control knob

Figure 1-32

HSI DISPLAY

MODE SETT-ING	RANGE/ DISTANCE COUNTER	LUBBER MARKER COMPASS CARD	DEMANDED TRACK/ BEARING COUNTER	HEADING INDEX MARKER	AZIMUTH FLAG	DEMANDED TRACK/ BEARING POINTER	TO/FROM INDICATOR	MODE DISPLAY
	N MILES							
NAV	Indicates range/ distance to next waypoint in NM. Used in conjunction with to/from indicator.	Indicates true heading on compass card.	Displays demanded track to selected waypoint in digital format.	Setting reference for manually selected heading. Provides output data to AFDS with FD or AP in heading acquire mode.	Azimuth signal invalid.	Indicates demanded track to selected waypoint. Direct steer within 20 NM.	Indicates whether aircraft is flying to or from the selected waypoint. Used in conjunction with range counter.	Displays selected mode NAV
TAC	Indicates slant range to selected TACAN station.	Indicates magnetic heading on the compass card.	Displays magnetic bearing to selected TACAN station in digital format.		Out of view.	Indicates magnetic bearing to selected TACAN station.	Out of view.	Displays selected mode. TAC
DF	Not operative							
APP 1	Not operative							

MODE SETT-ING	TRACK SELECT CONTROL	LATERAL DEVIATION BAR AND SCALE	HEADING INDEX MARKER CONTROL	DISPLAY FAILURE FLAG	ELEVATION DEVIATION BAR AND SCALE	ACTUAL TRACK POINTER	ELEVATION FAILURE FLAG	RANGE COUNTER DIMMER
NAV	Disengaged.	Indicates cross track error (distance) between demanded and commanded track. The spacing between the dots represents a displacement of 2000 ft.	Manual Control to set Heading Index Marker.	Signals from IFU 1, MC, IN or HSI are invalid.	Centered.	Displays the actual track of the aircraft	Out of view.	Dims 4-digit 7-segment distance counter
TAC	Disengaged.	Centered.		Signals from TACAN /SAHR IFU 1 or HSI are invalid.	Centered.		Out of view.	
DF	Not operative							
APP 1	Not operative							

Figure 1-33

zon into two sectors, grey (above horizon) and black (below horizon). A pitch scale on the spheroid is graduated above the below the horizon in 5° steps and is labelled at 30° and 60°. Zenith and nadir are represented respectively by a black and white spot. Roll angle is indicated by a pointer traversing a scale graduated in 10° steps to 30° steps to 90°. The display has full freedom in roll but is limited to 85° in pitch.

NOTE

The fast erection knob shall only be pulled in straight and level flight.

The Attitude Director Indicator is mounted on the front cockpit main instrument panel which is fitted forward by 9 degrees towards the longitudinal fuselage datum line (LFD).

The ADI only compensates for 5 degrees and show ± 0 degrees when the LFD is 4 degrees above the horizon. Therefore any ADI, mounted with a tilt angle in relation to the aircraft LFD, will show pitch error indications as a function of this tilt angle and the applied bank angle.

In conditions other than straight and level flight, the indicated pitch attitude on the ADI differs from actual aircraft pitch up to approximately minus 17 degrees at 180 degrees roll.

INDICATIONS ADI VERSUS HUD (ATTITUDE VERSUS VECTOR)

ADI (degrees)	Bank Angle (degrees)	Hud (degrees dive)
0	0	CA. 0
0	60	CA. -5
0	90	CA. -9
0	120	CA. -13
0	180	CA. -17

WARNING

AT LOW ALTITUDES, FAILURE TO CONSIDER INCREASES ACUTAL DIVE ANGLES RESULTING FORM THESE ADI ERRORS MAY PUT THE CREW INTO A CONDITION WHERE RECOVERY WILL NOT BE POSSIBLE.

Flight Director Display

The pitch and azimuth demand signals routed to the HUD from the AFDS are repeated on the ADI, and are indicated by yellow pitch and azimuth demand pointer bars which operate at right angles to each other. In response to an FD demand, the pilot flies the aircraft so that the intersection of the two pointers coincides with the center of the aircraft symbol. When power is applied to the ADI and the AP/FD system is not engaged, the pointers are parked out of view. The attitude director indicator repeats primary pitch and azimuth demand signals from the auto-pilot to head-up display. Under electrical zero signal conditions, two 90° of set pointers, the pitch demand pointer, and the bank demand pointer intersect the center of the variable pitch datum. When responding to a demand the pilot has to center the variable pitch datum over the intersection of the two pointers.

Rate of turn

Rate of turn is presented by the rate of turn pointer, which travels in linear movement over the rate of turn scale. The pointer responds to signals from a remotely located rate gyro installed in the forward equipment bay. The scale has two graduation left and right from center to indicate rate 2 (6 deg/sec) at full scale deflection.

Slip

Aircraft slip is indicated by a floating ball inside a tubular case. This slip indicator is located in the lower part of the instrument face. Slip into or out of a turn manoeuvre is indicated to a maximum of 10 degrees.

Failure Warning Flags

Three failure flags are incorporated into the instrument:

- A red flag labelled FD appears when the flight director presentation is invalid.
- In the case of a rate gyro power failure, a narrow black-and-red hatched warning flag obscures the rate of turn pointer.
- In the event a power failure or an insufficient instrument gyro speed a black-and-red hatched flag appears in the lower right display area, indicating an unreliable attitude indication.

Power Supply

The ADI gyro system is energized by setting the FLT INST toggle switch on the rapid take-off panel to FLIGHT position and 28 V DC power from DC busbar PP3 is supplied to the gyro unit in the instrument. At the same time 115 V AC power from AC busbar XP1 is supplied to the remote rate gyro unit. The ADI is illuminated integrally by 5 V AC power from the aircraft internal lighting system and controlled through a dimmer switch on the internal lights control panel in the front cockpit.

BEARING DISTANCE HEADING INDICATOR (BDHI)

The bearing distance heading indicator (B, Figure 1-34) is located in the lower left front panel of the rear cockpit. The instrument is a multiple-display servo unit which can simultaneously present the following indications:

- aircraft magnetic heading
- magnetic bearing of a selected TACAN
- distance to a station

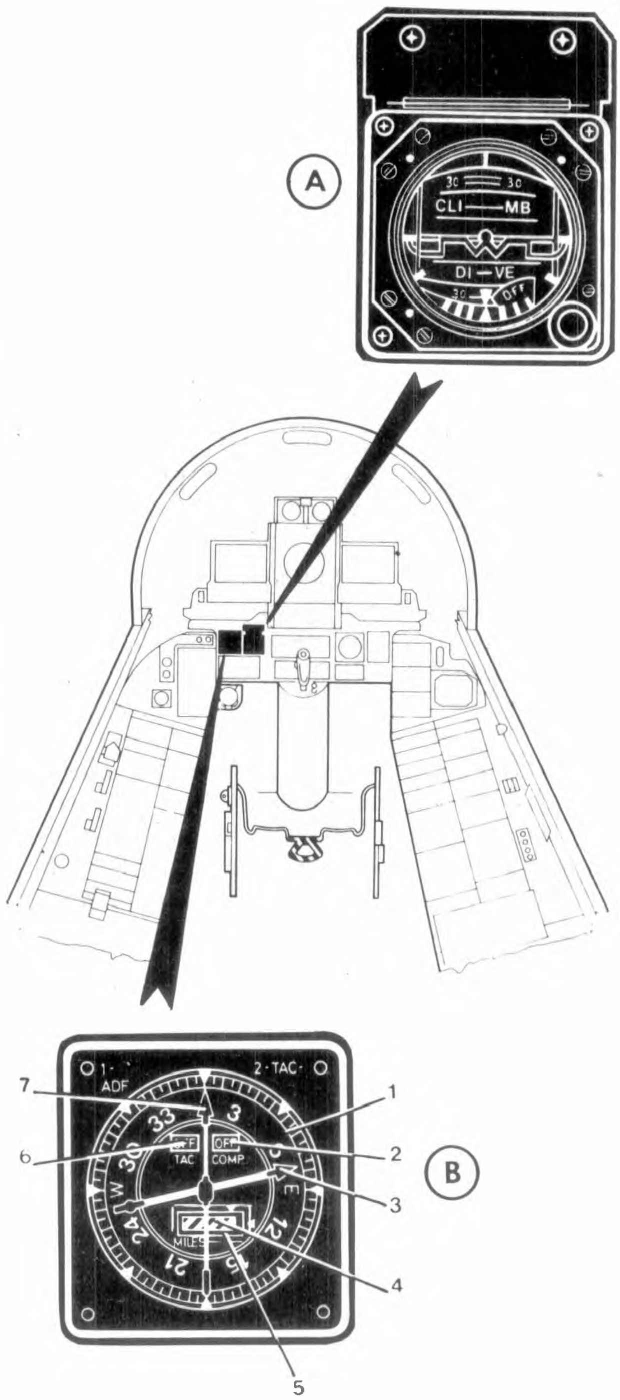
Heading

The aircraft magnetic heading is displayed by a rotating compass card, read against a fixed aircraft datum marked.

Bearing/Distance

Two servo-driven bearing needles indicate magnetic bearing to selected stations. No. 1 needle

INSTRUMENTS



A Artificial horizon
B Bearing distance heading indicator
1 Compass card
2 Compass warning flag
3 Bearing pointer NO. 1
4 Distance warning flag
5 3 digit distance counter
6 Tacan warning flag
7 Bearing pointer NO. 2

Figure 1-34

(VHF/ADF) is inoperative (Post mod. 10914: the No. 1 needle is parked above the fixed index marker). No. 2 needle receives signals from the selected TACAN station. A three digit distance counter indicates in nautical miles the slant range to the selected TACAN station.
Effect of TACAN selections on the BDHI:

OFF	No signal input to the BDHI, bearing and range warning flags are in view.
REC	Bearing information only is available. The range warning flag appears and the range counter behind the warning flag will display uncontrolled and changing random figures. If bearing fails, the bearing pointer will rotate in an anticlockwise direction, and the warning flag will appear.
T/R	Bearing and range are operating normally. If bearing fails, the bearing pointer will rotate in an anticlockwise direction, and the warning flag will appear.
A/A	Range only is operating in this mode. The bearing pointer is set to 360° and the bearing warning flag is visible.
TEST	With the BITE button depressed, the bearing pointer is set to 360° and the range counter displays 000.0.

Warning Flags

The bearing distance heading indicator is equipped with three different warning flags. The TAC warning flag in the upper left dial cut-out will indicate OFF when:

- TACAN is not operative
- TACAN information is invalid
- electrical power is disconnected from the BDHI.

The COMP warning flag in the upper right dial cut-out will indicate OFF when:

- SAHR information is invalid
- electrical power is disconnected from the BDHI.

The red and black hatched distance warning flag will obscure the 3-digit distance counter when:

- TACAN is not operative
- TACAN information is invalid
- TACAN is in the REC mode
- electrical power is disconnected from the BDHI.

The instruments servo synchro system operates on 26V, 400Hz, the warning flags solenoids and the servo amplifiers are actuated by 28 V DC and the integral instrument lighting is supplied by 5 V AC.

Rear Cockpit Artificial Horizon

The artificial horizon (A, Figure 1-34) pitch and roll attitude and roll angle display is identical to that of the ADI with the exception of an additional graduation on the roll angle scale at 180°. The instrument spheroid is controlled by an integral vertical gyro supplied direct from the No. 2 AC busbar. In the event of loss of power to the gyro, an orange OFF flag appears at the bottom right of the display. A button at the bottom right of the instrument can be pressed to erect the gyro rapidly after starting if required, or in the air if the gyro has toppled.

NOTE

The fast erection button shall not be used within 40 seconds of the application of power, and shall not be pressed continuously for longer than 60 seconds.

The artificial horizon has full freedom in roll but is limited in pitch to 80° (climb) and 82° (dive).

CANOPY

The canopy consists of two acrylic transparencies, joined by a strap to form a single assembly. It is bolted to the left and right edge members and front and rear arches. The canopy is hinged aft and opens to an angle of 35 degrees. Normal canopy operation is accomplished electro-hydraulically.
An hydraulic jack behind the rear pressure bulkhead opens and closes the canopy via a torque tube and linkage. The jack is supplied from the left hydraulic utilities system through a selector valve. An hydraulic accumulator, when fully pressurized, provides sufficient pressure for three canopy operating cycles when system pressure is not available. The nominal canopy accumulator nitrogen charge pressure is 105 bar.

NOTE

Canopy accumulator pressure should indicate 150 bar minimum. If pressure is below this value it may be achieved by use of the hydraulic hand pump.

If normal canopy opening on the ground is inhibited, it may be operated alternatively by:

- disengaging it from the normal operating mechanism by use of the jack release handle and raising it manually.

NOTE

Because of the weight of the canopy (110 kg) difficulty will be experienced in manually raising and holding it open.

- fracturing and blowing it clear by actuating the MDC
- jettisoning the canopy by operating the canopy jettison handle.

Canopy and Windscreen Sealing

A continuous inflatable rubber seal is fitted along the canopy edge members and arches to seal between the canopy and the aircraft structure. As the windscreen can be hinged forward for servicing a separate seal is fitted to the windscreen to seal between the windscreen and aircraft structure. Via a lever on the torque tube behind the pilot's seat an inflation/deflation valve will be operated by locking and unlocking the canopy. The deflation/inflation valve controls a supply of air from the environmental control system to the seals. The air supply also charges an air reservoir to supply pressure for seal inflation while the aircraft is on ground with the engines shut down.

CANOPY SYSTEM CONTROLS AND INDICATORS

Internal Canopy Operating Handle

The internal canopy operating handle (1, Figure 1-35) marked CANOPY - LOCKED/ UNLOCKED - LOWER/RAISE, is located on the right hand side of each cockpit.

The handles are mechanically interconnected, and either may be used to unlock or lock, and to raise or lower the canopy. Selecting the handle to UNLOCKED/RAISE position unlocks the hooks, withdraws the shootbolts, deflates the seals and raises the canopy fully. The canopy operating handle remains at RAISE, when released in that position. Pushing the handle fully forward before selecting RAISE will ensure the canopy unlocks cleanly. If required, the canopy may be left in any position by moving the handle to a position between RAISE and LOWER when the required canopy position is reached.
To lower and lock the canopy the operating handle has to be selected to LOWER and hold in this position. The canopy commences to lower and simultaneously the warning horn will sound. When canopy is fully lowered, the warning horn stops. The baulking device, fitted to the left hook, will be pivoted clear, allowing canopy LOCKED to be selected.
If required, the canopy can be left in any intermediate position by releasing the handle.

External Canopy Operating Handle

The external canopy operating handle (4, Figure 1-35) is located on the left hand side of the fuselage and accessible by a hinged flap.
Pushing in the flap above the external handle and pulling the handle fully causes the canopy to unlock and raise. After canopy is raised, the handle can be stowed by pushing in to fit flush with the fuselage. To lower and lock the canopy push in the flap above the external handle and pull out the handle until a stop is felt. Carry out a 15 degrees rotation in counterclockwise direction and push in handle slowly. The first 10 mm of travel will lower the canopy. After canopy is fully lowered push handle in to within 20 mm of the fuselage skin to lock the canopy. Rotate the handle in clockwise direction to align with the fuselage cutout ans push in until flush with the fuselage skin.

Internal Jack Release Handle

If the normal canopy actuating mechanism fails with the canopy fully closed, the canopy can be disengaged from the mechanism by operating the internal jack release handle, marked JACK RELEASE, on the left hand side of each cockpit (2, Figure 1-35). The canopy can be raised manually after it has been unlocked by the internal canopy operating handle.

CANOPY

1 Internal canopy operating handle
2 Internal jack release handle
3 Internal canopy jettison handle
4 External canopy operating handle
5 External jack release handle
6 External MDC initiator

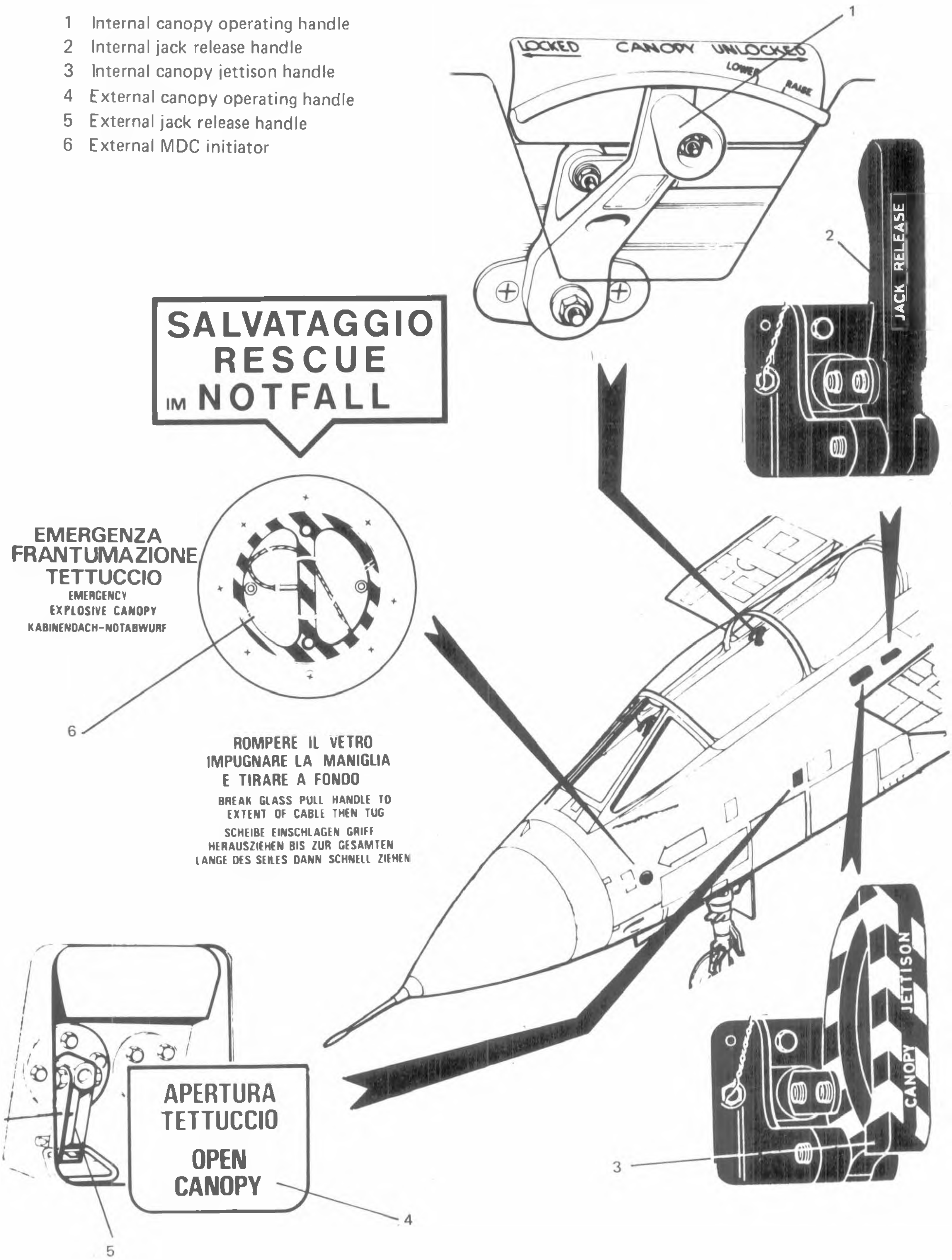


Figure 1-35

External Jack Release Handle

The canopy can be disconnected from the normal canopy mechanism by pushing in the flap above the external canopy operating handle, pulling out the handle fully to get access to the external jack release handle (5, Figure 1-35) and pulling out the handle.

NOTE

Because of the weight of the canopy (110 kg) difficulty will be experienced in manually raising and holding it open.

Internal Canopy Jettison Handle

By pulling the internal canopy jettison handle (3, Figure 1-35) marked CANOPY JETTISON, on the left side of each cockpit or any ejection seat handle the canopy will be jettisoned.

Central Warning Panel

A red CABIN caption on the central warning panel, operated by the left forward shootbolt, illuminates if either cabin altitude exceeds 26.000 feet or the canopy is unlocked.

CANOPY JETTISON OPERATION

The system consists of a canopy jettison initiator unit, two unlocking jacks situated behind the pilot's seat, a canopy jack piston unit behind the rear pressure bulkhead, and two canopy jettison rocket motors, mounted to the front end of each canopy edge member. Two cartridge are fitted in the jettison initiator unit, one is fitted in each unlocking jack, and one in each rocket motor.
A safety pin is fitted to the canopy jettison initiator unit to make the aircraft safe for parking.
The cartridges in the initiator unit are fired via cables, when the jettison handles are pulled, or by a piston operated by gases generated from the firing of the ejection seat cartridges.
Gases from the initiator unit are simultaneously piped to the canopy unlocking jacks and the canopy jack piston unit. The gases cause the firing of the cartridges in the unlocking jacks, which unlock the canopy and initiate rocket motor ignition. The jack piston unit acts on the canopy jack release to free the canopy from the normal actuating mechanism. The rocket motors force the canopy upwards until fractures occur at the hinges and the operating torque tube levers, allowing the canopy to separate from aircraft.

CANOPY MICRO DETONATING CORDS (MDC) SYSTEM

The MDC system is designed to fracture and blow clear the two parts of the canopy, thus facilitating ground rescue operations or emergency ground egress.
The system also provides a back-up facility should the canopy fail to jettison (e.g. during an ejection sequence). The system incorporates detonating cords bonded to the canopy and on initiation will fracture the canopy transparency and blow the pieces clear. For detailed information on MDCs, see Ejection Seats.

MDC INITIATOR CONTROLS

Internal MDC Firing Handle

An internal MDC firing handle (1, Figure FO-15), in a black and yellow striped housing, labelled MDC, is fitted to the left canopy rail in each cockpit. Each handle is stowed and held in the bottom of the housing by a springloaded release catch. When the catch is moved rearwards, the handle is released and pivots down. It can then be pushed forward to fire the MDC. The internal MDC firing handles, the ejector seats, and the MDC external firing handle are connected by levers and cables to the MDC initiators. Normally, on ejection, the canopy will be jettisoned immediately complete with the MDC firing mechanisms, therefore the MDCs do not detonate. However, if the canopy fails to jettison, the relevant portion of the transparency will be blown clear as each seat rises approx. 12 mm (i.e. with the command ejection selection lever in REAR, rear set movement fires only the rear transparency. The front transparency will remain in place).

NOTE

When the aircraft is on the ground with the canopy raised, both MDCs will be fired simultaneously by operating either internal MDC firing handle.

External MDC Firing Handle

An external black and yellow striped MDC firing handle (13, Figure FO-15), is received into the left forward fuselage skin and is protected by a frangible transparent panel. When the handle is broken out and extracted, it will extend on 3 m of cable, thus allowing the operator to be clear of the canopy when the MDCs denotates.

NOTE

With the canopy raised, the MDCs cannot be fired by operating the external MDC firing handle.

EJECTION SEATS

The aircraft is equipped with two Martin Baker Mk. 10 ejection seats (Figure FO-15), which provide the crew with a safe escape from the aircraft under most combinations of aircraft altitude, speed, attitude, and flight path. The seats are propelled from the aircraft by cartridge operated ejection guns on the back of the seats assisted by rocket motors on the bottom of the seats. Ejection can safely be accomplished from zero altitude to 50.000 feet and 0 to 625 knots (IAF) or Mach 2, whichever is the lowest. Operation of the ejection seat begins with actuation of the seat pan firing handle which causes the canopy to jettison and the ejection gun to fire.

NOTE

Canopy jettison malfunctions will not interfere with the seat firing sequence.

Should the canopy fail to jettison during ejection, the Micro Denotating Cord (MDC) system will fracture and blow clear the two parts of the canopy transparency.
After ejection the seat is stabilized and the forward speeds is reduced by a duplex drogue system. After automatic seat separation the personal parachute is deployed automatically.
Protection during ejection is provided by incorporation of leg restraint and arm restraint system, and head location in a shaped headrest.

Safety Features

WARNING

THE ESCAPE SYSTEM IS A POTENTIAL SOURCE OF DANGER AND INADVERTENT OPERATION MAY CAUSE FATAL INJURIES. SAFETY PINS ARE FITTED TO SECURE THE SYSTEM AND ON COMPLETION OF A FLIGHT THE CREW SHALL ENSURE THAT THE AIRCRAFT IN THE 'SAFE FOR PARKING' CONDITION.

Safety pins are provided in the escape system to prevent inadvertent initiation. Pins are fitted to:

- MDC initiator unit (4, Figure FO-15)
- Seat pan firing handle (5, Figure FO-15)
- Canopy jettison initiator unit (front cockpit only) (2, Figure FO-15)

In the front cockpit the safety pins will be inserted in stowages marked MDC, SEAT and CANOPY (12, Figure FO-15) on the right side of the cockpit during flight, and in the rear cockpit respectively, MDC, SEAT (11, Figure FO-15).

CANOPY JETTISON AND MDC

The cartridges in the canopy jettison initiator are fired during ejection by the gases generated from the ejector seat cartridges. Alternatively, the jettison initiator will be activated when a jettison handle is pulled by the pilot or navigator. The MDC system is designed to fracture and blow clear the two parts of the canopy, thus facilitating ground rescue operations, or ground emergency evacuation (emergency ground egress). The system also provides a back-up facility should the canopy fail to jettison during and ejection sequence. The MDC (3, Figure FO-15) is a detonating cord bonded to the periphery and fore and aft centre lines of each part of the canopy. The cord is routed in such a way, on detonation, it fractures each section of the canopy into two and blows the pieces clear. Guards are fitted to minimize the amount of debris blown into the cockpit following detonation.

EJECTION SEAT CONTROLS

Seat Pan Firing Handle

The black and yellow striped seat pan firing handle (5, Figure FO-15) is located in each cockpit on the front face of the seat pan. If pulled, ejection will be initiated. To prevent inadvertent operation, the handle can be secured by a safety pin.

Manual Separation Handle

The manual separation handle (9, Figure FO-15), on the right side of the seat pan, constitutes an alternative method of initiating seat/man separation and parachute deployment in the event of failure of the drogue gun and/or barometric time release unit. A thumb catch incorporated in the handle shall be depressed before the handle can be raised. The handle can be operated only after seat ejection.

WARNING

WITH ARM RESTRAINT ACTIVATED, THE MANUAL SEPARATION HANDLE MAY NOT BE REACHED IF THERE IS AN OBSTACLE (LIKE CLIP BOARD, FILLED POCKET) ON THE RIGHT TIGHT.

Pitch Control Unit

The pitch control unit (10, Figure FO-15), located behind the manual separation handle on the right side of the seat pan, is adjusted to the weight of the occupant in kg by setting a knurled knob. Rotating the knob adjusts the thrust angle of the seat rocket pack. The weight reading is displayed on an indicator drum visible through a window. The adjustment has range between 65 and 110 kg.

Post mod. 00996
The pitch control unit is deleted from the ejection seat.

Harness Go-Forward Lever

A two-position lever (8, Figure FO-15) is situated in a slotted housing on the left side of the seat pan. For normal flight conditions the lever can be selected to the forward position which allows the harness to extend but restrains rapid forward movement (e.g. during a crash landing). With the lever in the rear position, the harness straps can retract but are prevented from extending.

Command Ejection Selection Lever

A two position command ejection selection lever (30, Figure FO-3; 44, Figure FO-4), labelled COMMAND EJECTION - BOTH/REAR, is located on the right console, rear cockpit.
With the lever selected to REAR, pulling the front seat pan handle initiates canopy jettison, and sequential ejection from both cockpits (i.e. rear first). If the rear seat pan handle is pulled, it will initiate canopy jettison, and ejection from the rear cockpit only. With the lever selected to BOTH, pulling the seat pan handle in either cockpit initiates canopy jettison, and sequential ejection from both cockpits (i.e. rear first). In order to move the lever, a sleeve shall be lifted. With the sleeve lifted the lever is spring-loaded to REAR.

Seat Lower/Raise Switch

A three-position toggle switch (48, Figure FO-2), marked SEAT LOWER/RAISE, spring-loaded to the center OFF position, is located on the right console of each cockpit. In the rear cockpit the seat raise/lower switch (32, Figure FO-3; 47, Figure FO-4) is located on the lamps test panel. The switch controls the seat adjustment actuator which provides vertical adjustment of the seat pan in relation to the seat beams.

SEAT SUB-ASSEMBLIES

Ejection Gun

The ejection gun provides the initial power for seat ejection by means of one primary cartridge, percussion fired by the breech time-delay firing unit and two secondary cartridges, fired by pressure and heat from the primary cartridge.
The ejection gun time-delay firing unit for the front seat has a nominal delay of 0.75 sec. ± 0.05 and for the rear seat 0.35 sec. ± 0.05. The differing de-

lays together with the asymmetric rocket motor arrangements ensure that the seats follow divergent trajectories and will not collide during ejection.

Drogue Gun

The drogue gun is mounted on the upper left side of the main beam of the seat and is fired by a trip rod, connected to the ejection gun cross beam. The unit is triggered by seat ejection and fires a drogue piston to deploy a 22 inch diameter controller drogue 0.5 sec. ± 0.1 after ejection. The controller drogue in turn deploys the 5 feet diameter main drogue.
The gun consists of a time delay mechanism, a primary firing pin, a gas-operated firing pin, a barrel, two cartridges, and a piston connected to the drogue withdrawal line. The gas systems of the time release and manual override are connected to the gas-operated firing pin.

Rocket Motor

The thrust of the ejection gun will be sustained by the rocket motor, located under the seat pan, and is ignited as the seat leaves the aircraft. A static line, incorporated in a remore rocket firing unit mounted outboard of the left main beam below the drogue gun, is anchored to the trip rod of that unit. As the seat leaves the aircraft the static line operates the firing unit.

Pitch Control Unit

To cater for variations in seat/man combination center of gravity, the thrust angle of the rocket motor is adjusted through the pitch control unit.

Post mod. 00996 (Post OT 645)
Due to deletion of the pitch control unit, the thrust angle of the rocket motor is fixed.

Barostatic Time-Release Unit

The ejection seat is fitted with a barostatic time-release unit, located outboard of the starboard main beam, and provides the automatic release of the drogue assembly, deployment of the parachute, and seat/man separation after ejection.
A 1.5 sec. ± 0.1 time-delay mechanism is incorporated to delay the development of the parachute until the drogues have stabilized and decelerated the seat. For high altitude ejections a barostat assembly functions in conjunction with the delay mechanism to prevent operation of the time-release mechanism until seat and occupant have descended to an altitude of approximately 15.000 ft. Subject to the influence of the g-stop mechanism at ejection below an altitude of 15.000 ft. the barostat system ensures immediate deployment of the main parachute and separation of the occupant from the seat.

G Stop Mechanism

An acceleration sensitive interdictor (g-stop) incorporating a secondary barostat is fitted to the seat. The g-stop functions in conjunction with the time-delay mechanism to limit parachute opening shock loads at high speeds within the medium altitude band, below primary barostat height, by delaying parachute deployment until the seat has decelerated to below a pre-set g value. Below 6000 feet the secondary barostat prevents operation of the g-stop.

PARACHUTE AND COMBINED HARNESS

The parachute and combined harness comprises:

- a personal parachute of 5.8 m diameter
- a drogue assembly
- a combined parachute and seat harness
- a back pad.

The personal 5.8 m parachute is packed into a rigid container, located on top of the seat beam and provides head location during ejection. The parachute is packed together with a 1.5 m (5 feet) main drogue, which is connected by a second strap to a 0.56 m (22 inch) controller drogue.
The combined harness assembly is an integral part of the parachute assembly and consists of two parachute lift webs, two adjustable shoulder straps, two adjustable thigh straps, and two leg loops.
The shoulder straps have two roller brackets through which are passed the webbing straps of the harness power retraction unit. The roller brackets form the upper harness attachment points. A cross-strap between the roller prevents the shoulder straps from slipping off the occupant's shoulder.
A back pad is attached to the harness and supported by three cross-straps, passing through beckets in the back pad. Two quick-release connectors, mounted on the strap each side of the central cross-strap, provide attachment points for the personal survival pack.

Harness Power Retraction Unit

The harness power retraction unit is fitted to the front face of the ejection seat main structure. The function of the cartridge operated unit is to ensure that, regardless of the occupant's position when ejection is initiated, the harness will be retracted and mechanically locked. The occupant will be held in the correct posture before the seat moves and g forces are supplied. During normal flight operations the harness go-forward lever can be selected to the forward position, which allows the harness to extend, but retrains forward movement in the event of harness withdrawal. The harness strap can retract, but they are prevented from extending when the harness go-forward lever is in the rear position.

Harness Release Mechanism

The harness release mechanism is a mechanical assembly, operated by gas pressure from the cartridge of the barostatic time-release unit. It comprises:

- an upper harness release
- a lower harness release
- an arm restraint system release
- a leg restraint system release.

The upper harness locks are located on each end of the harness retraction unit. The straps of the harness retraction unit are passed through roller brackets on the parachute harness and lugs are locked into the top locks to provide shoulder restraint.
The lower harness release mechanism includes the two lower harness locks, the negative-g strap lock, the PEC man protection and leg restraint release mechanism and the guillotine to cut the arm restraints. The lower harness locks are located in the lower rear corner of the seat pan and house the lugs on the lower portion of the parachute harness,

Leg Restraint System

The leg restraint system is fitted to the ejection seat to draw back and restrain the occupant's legs close to the seat during ejection. The system consists of two leg restraint lines, two snubbing units, two taper plug assemblies, and four leg garters.
The lower end of each restraint line is attached to brackets in the aircraft floor by a fitting, incorporating a shear rivet. From the fitting each line is routed upwards through a snubbing unit fitted on the front face of the seat pan, forward through the D ring attached to the upper garter and then passed inboard to outboard the lower garter, and finally the end plug is fitted into the taper plug housing on the snubber unit.
Provision is made on each snubbing unit to allow the occupant to adjust the leg lines individually to give comfortable leg movement. The leg restraint line adjustment lever are located on the inboard face of each snubbing unit.

Arm Restraint System

To prevent injury to the arms due to flailing during ejection, an arm restraint system is fitted. The system consists of two restraint lines and two snubbing units each incorporating a gas-operated guillotine which cuts the arm restraint.
The guillotine is operated simultaneously with the harness release mechanism by gas pressure from the barostatic time-release unit cartridge.
The upper ends of each line are connected to the nylon tapes on the crewmembers' arm by manual connectors. The lower ends pass through snubbing units, located inboard of each thight support, on the front face of the seat pan. The snubbing units permit the lines to be drawn downward, but prevent upward movement. A boss is provided on each unit to accept a tool for adjusting the restraint line lenght.

Negative-g Restraint System

The effects of negative-g forces upon the occupant are counteracted by the fitting of a negative-g restraint strap. The fixed strap, having a lug on the lower end, which engages in a lock in the seat pan center front floor. At the upper end of the strap is a two-point quick-release fitting into which the lugs on the parachute harness shoulder straps are engaged.

Manual Separation System

In the event of a barostatic time-release failure, the manual separation system, fitted to the starboard side of the seat provides an alternative method of initiating the harness release system.
The system consist of a spade-type handle which is linked to the seat pan firing handle and shall not operated unless an ejection sequence has been initiated. The manual separation handle incorporates a locking device to prevent inadvertent operation, controlled by a button on the top of the handle.

The button shall be depressed before the handle can be raised.
Raising the handle causes the gases from the manual separation cartridge to actuate the same mechanisms as those actuated by the barostatic time-release unit in the automatic sequences. In order to cater for drogue gun failure, the gases from this cartridge are also used to fire the second cartridge in the drogue gun.

Personal Equipment Connector (PEC)

The personal equipment connector is mounted on the left hand side of the seat pan and enables the seat occupant to connect and disconnect his personal services to and from the aircraft supplies by a single action. On seat ejection all leads except the emergency oxygen are disconnected and automatically sealed off. Services supplied through the PEC are:

1. Main oxygen supply
2. Emergency oxygen supply
3. MIC/TEL
4. Anti-g suit supply (see Environmental Control System)

The PEC comprises three portions, an aircraft portion, a seat portion and a man portion. The man portion is attached to the flying clothing and released from the seat by operation or the harness release mechanism during ejection of by firmly pulling the PEC release lever. When all portions are connected all valves are opened. Should the aircraft main oxygen supply fail operation of the emergency oxygen manual control (ring grip) will activate the emergency oxygen system and select the 100% oxygen regulator.

Personal Survival Pack

The personal survival pack is a fiberglass container in which a life raft and survival aids are packed. The container is topped by a specially designed cushion, which gives support to the thighs during ejection. The pack is attached to the combined harness by a retaining strap, which passes over the raft and the seat cushion. The outer ends of the strap terminate in arrowhead connectors, which locate in quick-release connectors on the parachute harness. Pressing the thumb catches on one of the quick-release connectors allows the survival pack to be lowered on a lowering line and remain suspended approximately 15 feet below the ejectee.
The lowering line is connected by an arrowhead connector to a quick-release connector on the occupant's life preserver.
(Post mod. 01415: the PSP will be released automatically 4 seconds after seat-under separation by pirotechnical mean).
The life raft is a single-seater embodying an inflatable canopy and floor and is stowed in a zipped compartment of the fabric fiber glass container. The raft will automatically be inflated on immersion in water by means of a water-activated battery, which ignites a detonator. The gases from the detonator operate the head of a CO_2 cylinder and simultaneously withdraw the pack closure pin, allowing the life raft to emerge from the pack. The pack may be opened manually and the life raft inflated by operating a handle secured to the closure flap on the underside of the pack. The handle is attached to a firing pin which discarges the CO_2 bottle.

EJECTION SEQUENCE SYSTEM

A flow diagram of the ejection sequence system is shown in Figure 1-36.
Ejection is initiated by pulling the seat pan firing handle. The sear will be withdrawn from the firing unit and the cartridge is fired. The gases are passed to the harness retraction unit cartridge, which fires to retract the harness. The canopy jettison is initiated and, if selected, ejection of the other seat is initiated. If the canopy fails to jettison, the MDCs will detonate, As the seat rises, the drogue gun time delay and the barostatic time-release unit are activated. The electrical connections to the seat are broken, the IFF system is activated in the emergency mode, a signal is routed to the crash recorder, the aircraft portion of the PEC is disconnected, the emergency oxygen supply is activated and the leg and arm restraint system operate. As the seat nears separation from the ejection gun, the rocket motor is fired to sustain the upward thrust of the ejection gun, and after the delay mechanism (0.5 sec. + 0.1) has operated, the drogue gun is fired to pull the withdrawal line, which removes the closure pin from the flaps at the drogue parachute pack and deploys the drogues.
On removal of the barostatic time-release unit baulk and after the delay (1.5 sec. ± 0.1) has elapsed, the cartridge is fired to free the drogue shackle. The gases simultaneously operate the harness release system freeing the occupant from the seat. The drogues withdraw the main parachute, which develops and lifts the occupant and survival pack from the seat.

EJECTION SEQUENCE SYSTEM

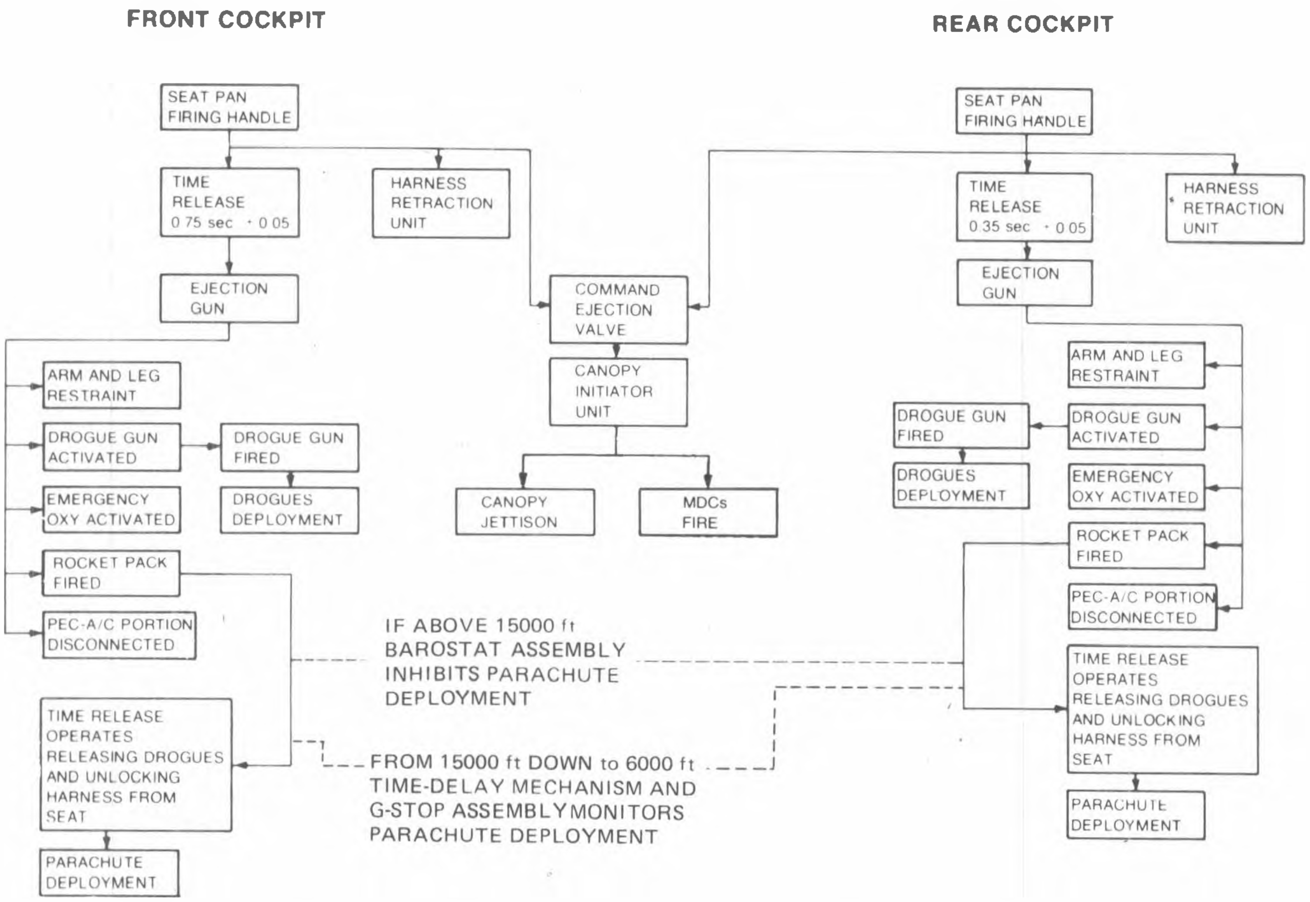


Figure 1-36

ENVIRONMENTAL CONTROL SYSTEM

The environmental control system (Figure FO-16) provides air for:

- cockpits heating/cooling
  - ventilating
  - pressurizing
- windscreen and canopy seals inflating
- windscreen rain dispersal and windscreen wash
- windscreen de-icing
- windscreen and canopy de-misting
- forward, rear, spine and radar equipment compartments, anti-g system and wing slot sealing cooling/pressurizing.

CABIN AIR CONDITIONING SYSTEM

An high pressure, high temperature air supply is bleed from the 4th stage of the high pressure compressor of each engine.
This bleed air is directed through non-return valves, and then, with the AIR SYSTEM MASTER switch on the environmental control panel (49, Figure FO-2) in the ON position and one or both engines at or above 59% NH, the air system master valve opens to allow air to enter the system.
The air is then routed through a pressure reducing valve to a primary heat exchanger, which reduces the temperature. Air flow through the heat exchanger is controlled by a by-pass temperature control valve. The air is further cooled by a cold air

unit and a secondary heat exchanger to the temperature selected by the pilot. In the event of ice forming in the cold air unit outlet, a signal from a differential pressure switch causes the temperature control valve to temporarily increase the amount of air by-passing the cold air unit and secondary heat exchanger until the ice melts. Before the air entres the equipment compartments and the cockpits, water is extracted from the air. Below certain airspeeds, ejector, located in the cooling air outlet ducts of the heat exchangers, will induce adequate cooling air flow through the heat exchangers. The primary heat exchanger ejector will operate below 190 kt and that of the secondary below 170 kt.
Overtemperature or overpressure conditions in the system result in closure of the air system master valve.

Cabin Air Distribution

The air is routed through the normally open cabin air shut-off valve controlled by the CABIN HEAT control knob on the environmental control panel (Figure FO-16) to the cabin. The air is distributed through outlets and after embodiment of mod. 00924 to the headrest of each ejection seat.

Cabin Temperature Control

Cabin temperature is controlled automatically between 5 degrees C and 30 degrees C by setting the CABIN HEAT control knob within the AUTO range between COLD and HOT, thus operating the temperature control valve. Cabin temperature between 3 degrees C and 45 degrees C may be achieved by selecting the CABIN HEAT control knob in the MAN sector between COLD and HOT. Setting the CABIN HEAT control knob to OFF closes the cabin air shut-off valve, therefore the temperature control valve runs to the "fully cold" position (2 degrees C) to ensure that cold air is supplied only to the equipment compartments.
In the event of ice forming in the cold air unit outlet, a signal from a differential pressure switch causes the temperature control valve to temporarily increase the amount of air by-passing the cold air unit and secondary heat exchanger until the ice melts. Overheat, underheat and ice protection are not provided when temperature is under manual control.

Equipment Cooling

With the engines running and the cabin air shut-off valve open, the front equipment compartment is cooled by air, discharged via the cabin pressure control valve. If the cabin air shut-off valve is closed, the air is routed to the front equipment compartment via the cabin by-pass shut-off valve. The rear and spine equipment compartments are cooled by air taken from downstream of the water separator.
The equipment compartments are cooled by cooling fans powered by XP1 which operate:

- with the AIR SYSTEM MASTER switch set to ON and both engines running at less than 60% NH.
- with the AIR SYSTEM MASTER switch to EMERG RAM AIR.

PRESSURIZATION SYSTEM

Cockpits, canopy and windscreen sealing, wing slot sealing, anti-g suits, and radar are pressurized by the pressurization system. Pressure in the cockpits is controlled by a cabin pressure control valve. When the aircraft is below 5000 feet, the valve automatically maintains an unpressurized condition in the cockpit. When the aircraft is above 5000 feet a differential pressure is maintained up to 40.000 feet. The differential pressure of 36:2 kPa (max) obtained at 40.000 feet is maintained constant at higher altitudes. The cabin altitudes corresponding to the aircraft altitudes as descripted in Figure 1-37.
A cabin pressure control valve, functioning as a safety and inward relief valve, controls the cabin pressure at a nominal 40 kPa above ambient pressure. If ambient pressure exceeds cabin pressure the safety and inward relief valve opens to allow pressure compensation.

Emergency Ram Air

An emergency ram air scoop, controlled by the AIR SYSTEM MASTER switch (11, Figure 1-38) in the EMERG RAM AIR position, will admit air into the crew compartments and avionic equipment bays in the event of loss of cooling and pressurization air.

Wing Slot Sealing

A slot is obtained on each side of the fuselage to accomodate the inner rear part of the wing, when

COCKPIT PRESSURIZATION SCHEDULE

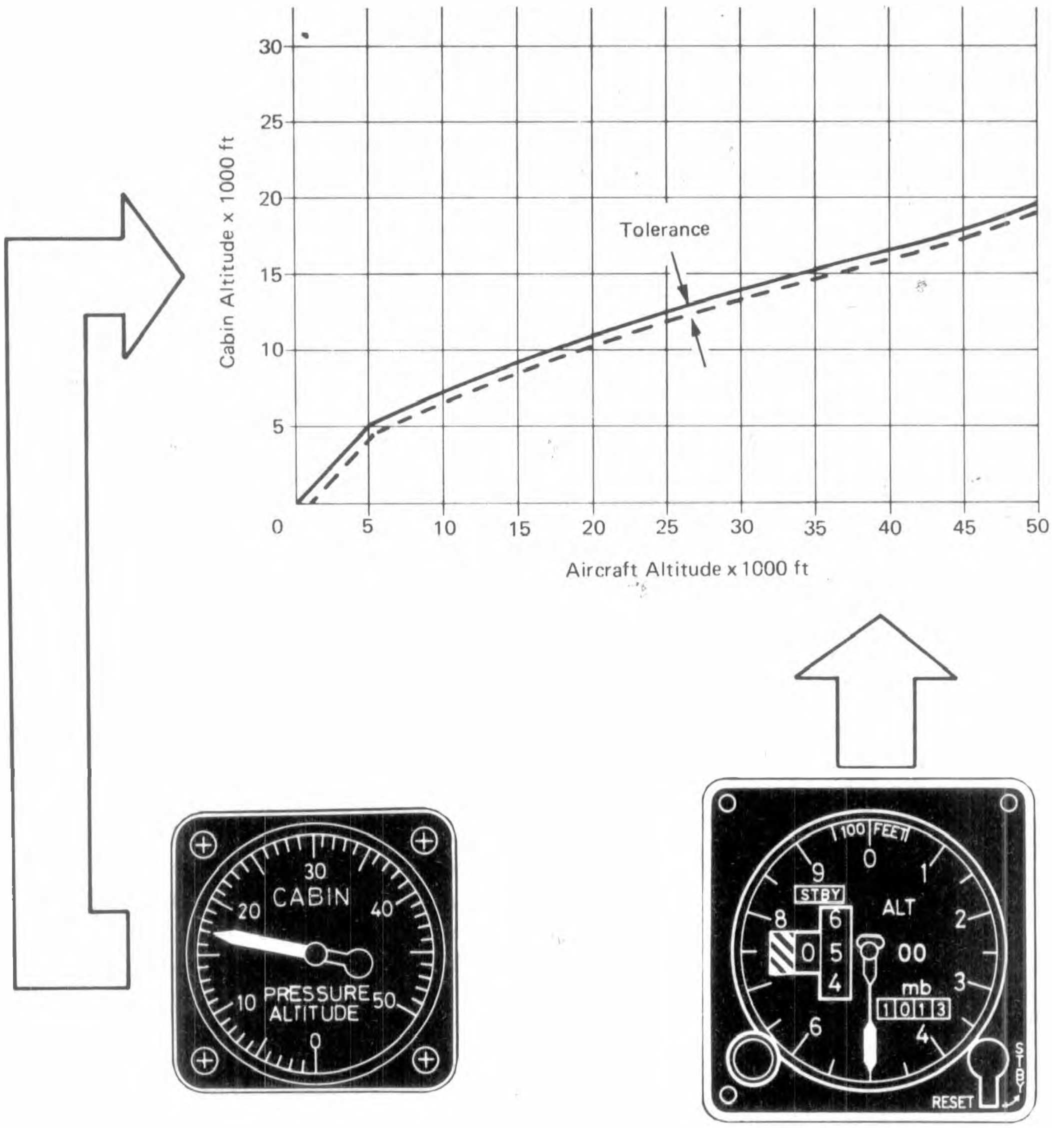


Figure 1-37

they are swept back. Aerodynamic sealing is assured by two pneumatic bags for each wing.
These bags are inflated with air pressure supplied through pressure reducing valve and automatically controlled by shut-off valves.
Each shut-off valve is controlled by a temperature sensor, which closes the valve in the event of too high air temperature (135 degrees C).

Anti-g Valves

The anti-g valves, one in each cockpit, control air delivery to the anti-g suits.
Air is tapped from upstream of the cabin temperature valve, passed through an on/off valve, an anti-g valve, and delivered to the suit via a personal equipment connector (PEC).
The on/off valve is pushed fully forward to on.
Below 2 g no air passes to the suit. Above 2 g, the anti-g valve will control the suit pressure to a maximum pressure of 82.5 kPa.
A rubber capped test button on the anti-g valve is used to test the serviceability of the valve.

Radar Pressurization

The nose radar pack is pressurized by air, tapped from the rain dispersal supply. The system incorporates a non-return valve, a combined pressure reducing/relief valve, and an air dryer.

Windscreen Rain Dispersal

Rain dispersal consists of two complementary systems, a chemical rain repellent and a system using warm air. The screen is coated with a rain repellent chemical as part of routine scheduled maintenance. The repellent is adequate above 200 knots. During low-speed flight, rain may be dispersed by warm air, directed over the outer surface of the screen. The air is tapped from upstream of the cabin temperature control valve and is supplied to the rain dispersal nozzle at the base of the windscreen, via the electrically-operated rain dispersal control valve.

Windscreen Wash

The windscreen washing system consists of a pressurized 2,5 litres bottle in the front equipment compartment, which feeds washing fluid through an electrically-operated shut-off valve to spray jets in the rain dispersal nozzle. The bottle is pressurized by air tapped from the rain dispersal supply via an air pressure reducing valve, a non-return valve and a windscreen washer bottle deflation valve, operated by the bottle filler cap.

AVIONIC EQUIPMENT COMPARTMENT COOLING

Before engine starting, with the AIR SYSTEM MASTER selected to ON or EMERG RAM AIR and with AC on line, cooling air is drawn into the equipment compartments by fans supplied from No. 1 AC busbar. The external ambient air is drawn via pressure boxes except for the rear compartment which uses a shut-off valve. To warn of a likely equipment overheat due to non-operation of the fans, a warning horn in the right landing gear bay sounds 2 minutes after an undervoltage in the AC supply to the fans is detected (AC not on line), if the DC essential busbar is live and engine bleed air pressure is below 50 kPa: Post mod. 00859, in addition to the warning horn, the ECS caption comes on immediately if AC is not on line.
When the AIR SYSTEM MASTER is selected to ON, either engine is running above 59% NH, and the air system master and cabin shut-off valves are open, the front and nose equipment compartments are supplied with cooling air discharged via the cabin pressure control valve. If the cabin shut-off valve is closed, cooling air is routed to the front and nose equipment compartments through the cabin by-pass valve. The rear and spine equipment compartments are supplied with cooling air tapped from the main supply between the water extractor and cabin shut-off valve. When both engines are below 59% NH with the AIR SYSTEM MASTER selected ON, the air system master valve automatically closes and equipment is cooled via the cooling fans in the equipment compartments. When engines are running with EMERG RAM AIR selected the equipment is cooled via the cooling fans in the equipment compartments irrespective of NH value.

ANTI-ICING AND DE-ICING SYSTEM

The engine air intakes are fitted with a de-icing system to ensure that no degradation in engine performance occurs during flight in icing conditions.
The cockpit transparencies can be kept clear in all conditions of flight by systems which include windscreen anti-icing and anti-misting, canopy anti-misting, windscreen rain dispersal and windscreen wash.

Ice Detection (Pre mod. 00629: not installed)

Ice Detection (Post mod. 00629)

The automatic ice detection system contains an ice detector sensor and an ice detection control unit. The ice detector sensor is located at the base of the fin.
In cases of icing conditions, a signal from the ice detector sensor will be routed via the ice detection control unit to the engine air intakes de-icing system (provided that the INTAKES ANTI-ICE switch on the ENVIRONMENTAL control panel (9, Figure 1-38) is in the AUTO position) and to the ICE caption on the CWP in the front cockpit.
The ice detector sensor contains excitation and pickup coils, heating elements and a thermoswitch, and is exposed to the airstream.
The excitation coils cause the sensor to oscillate at a frequency of approx, 40 kHz.
This frequency is compared to that of a crystal oscillator. Should ice accretion occur on the sensor its frequency will change. If the frequency difference between the sensor and the crystal oscillator exceeds a certain value the amber ICE caption will illuminate for 30 secs. Simultaneously the leading edge mats on both engine intakes will be heated continuously and the left hand intake internal mats will commence a heating cycle which lasts 64 secs. at the completion of which is similar heating cycle will be applied to the starboard intake internal mats. The sensor is also heated for the first 5 secs. of this period to clear the sensor of ice. The temperature of the sensor is controlled to a max. of 55 degrees C by the thermo-switch.

If ice appears on the sensor subsequent to each 5 secs. heating period another heating cycle will be initiated and so on, until no further ice accreation on the sensor occurs.

The ice detector sensor and the ice detection control unit are supplied from the DC busbar PP2.

Engine Intake De-Icing

The engine intake de-icing system includes an independent electrical control unit for each intake. With the system in operation the intake leading edges are heated continuously by heater mats, which initially de-ice, and subsequently prevent ice formation on the intake lips. The areas behind the leading edges and the wall of the rear damper fairings are de-iced by cyclically heated mats.

Windscreen Anti-Icing and De-Misting

The primary method of anti-icing and anti-misting the centre windscreen and quarter panels is by electrical gold film heaters, incorporated between the transparency laminations. Because the quarter panel heaters are intended primarily for anti-misting they are less effective and consume less power than the centre windscreen heater.

The heaters are controlled by the W/SCREEN HEATER switch on the rapid take-off panel (74, Figure FO-2) via control circuits, which automatically regulate the temperature of the outer surfaces. Two normal control circuits are installed, one for the centre windscreen and the second for both quarter panels, each being backed up by an overheat control circuit, which regulates at a higher temperature should the normal circuit fail. The centre windscreen control circuit incorporates an oleo relay, which ensures that full heater voltage is not applied on the ground, thus reducing the risk of damage due to thermal shock. A standby windscreen de-misting system is provided using warm air, tapped from the rain dispersal supply. The air supply is directed onto the inner surfaces of the windscreen and quarter panels via a shut-off valve, controlled by the STBY W/S DEMIST switch on the environmental control panel.

Canopy De-Misting

The canopy de-misting system uses warm air, tapped from upstream of the cabin temperature control valve. The air is directed onto the canopy inner surface via an electrically-operated shut-off valve. The shut-off valve is controlled by the CANOPY DEMIST - ON/AUTO/OFF switch on the environmental control panel (12, Figure 1-38).

ENVIRONMENTAL CONTROL SYSTEM CONTROLS AND INDICATORS

Environmental Control Panel

The environmental control panel, located on the right hand console of the front cockpit, contains the following controls and indicators (Figure 1-38).

CABIN HEAT CONTROL KNOB

A rotary switch, marked CABIN HEAT CONTROL, which controls the cabin temperature. The control switch rotates from the OFF position around an AUTO or MAN scale. Each scale is graduated between COLD and HOT.

CABIN PRESSURE ALTITUDE INDICATOR

A cabin pressure altitude indicator, graduate from 0 to 50.000 feet in 1000 feet stages, to indicate cabin equivalent altitude.

AIR SYSTEM MASTER SWITCH

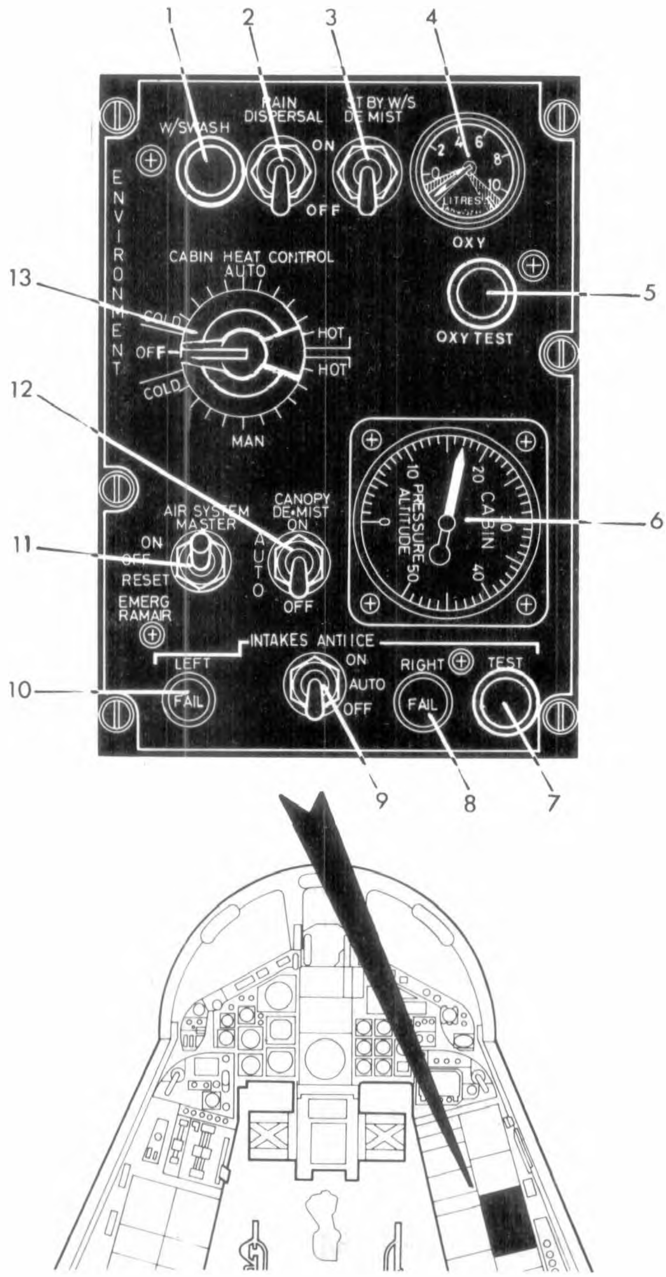
A three-position toggle switch, marked AIR SYSTEM MASTER - ON/OFF RESET/EMERG RAMAIR, controls the air supply to the systems.

ON — If both engine speeds are below 59% NH, the equipment compartment fans are switched on. If either or both engines are running at or above 59% the cooling fans are switched off and the air system master valve will open.

OFF — Electrical supply to the air system master.

RESET — Valve interrupted, i.e., valve closes. In the event of valve closure due to an overtemperature or overpressure condition, an attempt may be made to re-open the valve by setting OFF RESET, then returning the switch to ON.

ECS (CONTROLS AND INDICATORS)



1	W/screen wash pushbutton
2	W/screen rain dispersal switch
3	Standby w/screen demist switch
4	Main oxygen system contents indicator
5	Oxygen system test pushbutton
6	Cabin pressure altitude indicator
7	Intakes anti-ice pushbutton/indicator
8	Intakes anti-ice fail indicator
9	Intakes anti-ice switch
10	Intakes anti-ice fail indicator
11	Air system master switch
12	Canopy demist switch
13	Cabin heat control knob

Figure 1-38

EMERG RAM AIR — Emergency ram air valve actuated and air scoop opened with ground cooling fans activated. Air system master valve selected to close. The equipment compartment cooling fans are switched on. In this position the following services are lost:
- Wing slot sealing
- Anti-g suit supply
- Radar pressurization
- Windscreen rain dispersal and wind-screen wash
- Windscreen de-icing
- Windscreen and canopy de-misting

WINDSCREEN WASH PUSHBUTTON

A pushbutton, marked W/S WASH, controls the operation of the windscreen washing system. If the button is momentarily pressed and released, a time delay facility will supply windscreen wash for 3 secs. If the button is pressed and held, the wash operation is continuous.

RAIN DISPERSAL SWITCH

A two-position toggle switch, marked RAIN DISPERSAL – ON/OFF. When set to ON, the switch opens a shut-off valve, and hot air is delivered to the base of the windscreen via the windscreen wash nozzle assembly.

STANDBY WINDSCREEN DE-MIST SWITCH

A two-position toggle switch, marked STBY W/S DEMIST – ON/OFF. In the event of a failure of the main windscreen heating system, with the switch set to ON, hot air is supplied to the windscreen and quarter panel de-misting spray heads.

INTAKES ANTI-ICE TEST PUSHBUTTON/INDICATOR

Pre mod. 00629 – Not operative

Post mod. 00629
The anti-icing system serviceability may be tested on ground or in flight provided that the INTAKES ANTI-ICE switch is in the AUTO position. To perform a Bite test, the pushbutton/indicator labelled INTAKES ANTI ICE-TEST shall be pressed. The green indicator illuminates for approx. 3 secs. If a malfunction in the intakes anti-ice system is detected during the test period, the respective

INTAKES ANTI ICE-FAIL indicator will illuminate.

INTAKES ANTI-ICE FAIL INDICATOR

Two amber lights marked INTAKES ANTI ICE – LEFT-FAIL/RIGHT-FAIL illuminate to indicate partial failure of, or shut down of, the intakes anti-ice system (with the intakes anti-ice switch in the AUTO or ON position).

INTAKES ANTI-ICE SWITCH

The intakes anti-ice switch is a three-position toggle switch, marked INTAKES ANTI ICE – ON/AUTO/OFF. It controls the mode of operation of the intakes anti-ice system.

ON	Ice protection system for both engine intakes are initiated, provided that the oleo relay is in the "flight" position.
AUTO	Not operative. Post mod. 00629. Automatic ice detection system is enabled. The ON position shall not be used.
OFF	Ice protection circuits are switched off.

CANOPY DE-MISTING SWITCH

The canopy de-misting switch is marked CANOPY DEMIST – ON/AUTO/OFF.

ON	The canopy de-mist control valve is selected open.
AUTO	Automatic operation controlled by a de-mist temperature sensor.
OFF	The canopy de-mist control valve is selected close.

Windscreen Heater Switch

The rapid take-off panel (74, Figure FO-2) in the front cockpit carries a two-position toggle switch marked W/SCREEN HEATER and has two positions FLIGHT and OFF.

FLIGHT	Power is applied to the center windscreen and both sidescreen quarter panels heaters.
OFF	Power to the heaters is switched off.

The switches on the rapid take-off panel can be set to the FLIGHT position either individually or by use of the RAPID TAKE-OFF ganging lever; the OFF position can only be selected individually.

Central Warning Panel

The central warning panel in the front and rear cockpits contains the following environmental control system red and amber indications:

- Red CABIN, in both cockpits, indicates that cabin altitude exceeds 26000 feet or that canopy is unlocked.
- Amber ICE, in the front cockpit only (not operative).
  Post mod. 00629.
  Amber ICE, in the front cockpit indicates ice accretion on ice detector and/or ice detector sensor failure.
- Post mod. 00921.
  Amber ECS in the front cockpit only, will illuminate when one of the following conditions is not:
  1. No AC available with engines running at or below 60% NH.
  2. ECS failure with the ASM selected to ON (following selection of the ASM to EMERG, RAMAIR will extinguish the caption).
  3. Uncorrected operation of the electrical cooling fans when the ASM is in the ERA position.
  4. ASM in OFF position.

OXYGEN SYSTEM

The oxygen system consists of a main (liquid) system, located in the left side of the fuselage, and an emergency (gaseous) system on the rear of each ejection seat (Figure 1-39).

MAIN OXYGEN SYSTEM

The main oxygen system supply consists of a 10 liters liquid oxygen converter, which converts the liquid oxygen to 7600 liters of gaseous oxygen, a warming coil, which heats the gas to a temperature suitable for breathing, two connector assemblies, two shut-off valves on individual service units, and

OXYGEN SUPPLY AND DISTRIBUTION

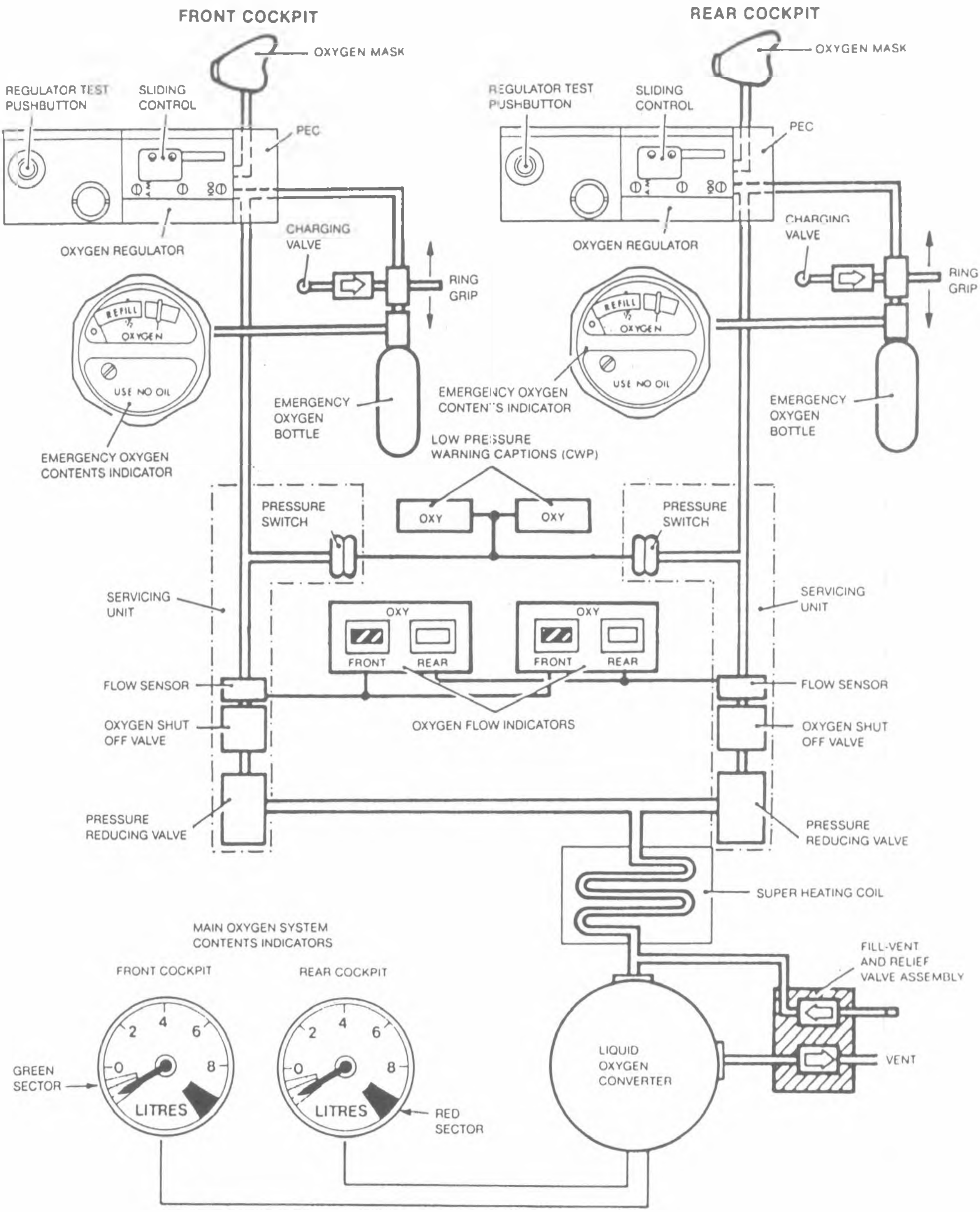


Figure 1-39

a regulator, attached to the forward face of each personal equipment connector (PEC).
From the regulator, the oxygen or the air-oxygen mixture passes back into the PEC and then through a flexible hose and mask socket to each crewmember's breathing mask.
A two-position sliding control on the regulator provides for selection of airmix or 100% oxygen supply.

In addition a two-position yellow and black striped ring grip, when pulled, selects the emergency oxygen supply and the 100% oxygen regulator. Each service unit contains a flow sensor, a pressure switch and a pressure reducing valve. A transducer between the service unit and the regulator, supplies a pressure reading to the crash recorder.

The oxygen converter may be recharged in the aircraft or replaced readily by a full unit.
Refer to Figure 1-40 for the oxygen duration chart.

EMERGENCY OXYGEN SYSTEM

The emergency oxygen system consists of two oxygen, bottles, one bottle on each seat (70 litres of gaseous oxygen), a pressure reducer and a pressure gage. The system can be activated by pulling a ring grip of the emergency oxygen selector on the left side of the seat pan. Pulling the grip selects the oxygen regulator to 100% oxygen delivery.

Automatic selection takes place as the ejection seat rises during ejection.
The emergency oxygen bottle may be recharged in situ. Each bottle provides an 3-4 minute supply of 100% oxygen.

OXYGEN SUPPLY SYSTEM CONTROLS AND INDICATOR

Oxygen Shut Off Cock

An oxygen shut off cock (9, Figure 1-41) is a two-position toggle switch, marked ON/OFF and controls the supply of oxygen to the regulator in the associated cockpit.

Oxygen Regulator

The oxygen regulator (Figure 1-39), situated on the left side of the seat pan, comprises an airmix demand-type regulator, located in a common housing, plus a pressure compensated dump valve for both regulators. A selector on top of the oxygen regulator operates a change-over valve to open the supply passage to whichever regulator is required. In cases of sudden pressure increases in the oxygen mask delivery, rapid decompression or regulator failure, the dump valve relieves to ambient. The airmix regulator delivers an oxygen/air mixture. The ratio is determined by an aneroid-operated air inlet valve and thus varies according to cabin altitude. With increasing altitude, the valve reduces the air percentage until, at 32.000 feet it is closed and 100% oxygen is delivered.

Below 15.000 feet, delivery is at ambient pressure. Between 15.000 feet and 38.000 feet, delivery is made at a slight pressure (termed safety pressure). Above this upper level, pressure breathing is introduced, with pressure increasing linearly with altitude up to 50.000 feet.

Between 0 and 38.000 the 100% O_2 regulator delivers 100% at a slight pressure (also termed safety pressure). Above this upper level, pressure breathing is introduced, with pressure increasing linearly with altitude up to 50.000 feet.
A spring-loaded push button on top of the regulator is used to test regulator delivery and confirms that the crewmember's mask is correctly fitted. For test the regulator selector shall be set to AM. The two-position sliding control, spring-loaded to both positions, marked AM/100, selects either the airmix or the 100% oxygen regulator.

Main Oxygen System Contents Indicators and Test Button

The main oxygen system contents indicators (3, Figure 1-41) are single needle indicators which are graduated in 2 liter divisions from 0 to 10 with a green sector before the 0 and a red sector beyond the 10.

Each indicator receives a signal from a contents probe located in the liquid oxygen (LOX) converter. An unserviceable probe is indicated when the indicator needle enters the red sector. A test button (4, Figure 1-41) labelled OXY TEST, when pressed, drives the needle into the green sector to prove indicator serviceability.

In addition, a filling point indicator, located on the left hand side of the LOX converter, is identical to the cockpit indicators with the exception of a yellow/gold "full" indication adjacent to the 10 liter mark.

OXYGEN DURATION

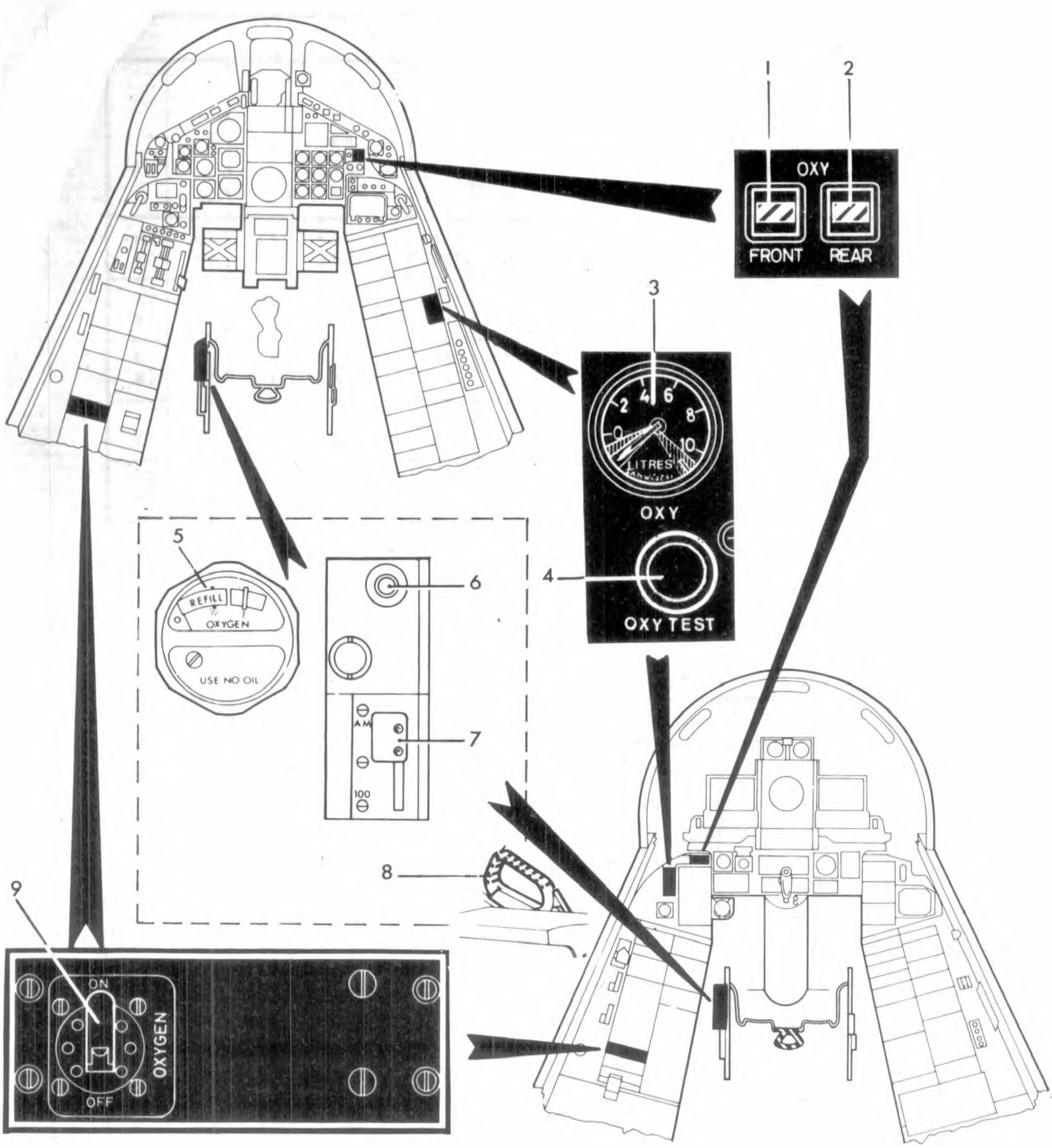
OXYGEN DURATION – HOURS										
FERRY NON-AEROBATIC FLIGHTS										
Cockpit Indicator Quantity-Litre / Cockpit Altitude-feet	10	9	8	7	6	5	4	3	2	1
35000 and above	24.6 24.6	22.1 22.1	19.7 19.7	17.2 17.2	14.8 14.8	12.3 12.3	9.8 9.8	7.4 7.4	4.9 4.9	2.4 2.4
30000	18.7 19.0	16.9 17.1	14.9 15.2	13.1 13.3	11.2 11.4	9.35 9.5	7.5 7.6	5.6 5.7	3.7 3.8	1.9 1.9
25000	14.4 15.8	12.9 14.2	11.5 12.6	10.1 11.1	8.6 9.5	7.2 7.9	5.8 6.3	4.3 4.7	2.9 3.2	1.4 1.6
20000	10.8 12.7	11.4 11.4	8.6 10.2	7.6 8.9	6.5 7.6	5.4 6.3	4.3 5.1	3.2 3.8	2.2 2.5	1.1 1.3
15000	8.8 15.8	7.9 14.2	7.0 12.6	6.2 11.1	5.3 9.5	4.4 7.9	3.5 6.3	2.6 4.7	1.7 3.2	0.9 1.6
10000	7.0 13.9	6.3 12.5	5.6 11.1	4.9 9.7	4.2 8.3	3.5 6.95	2.8 5.6	2.1 4.2	1.4 2.8	0.7 1.4
5000	5.6 11.0	4.9 9.9	4.5 8.7	3.9 7.7	3.3 6.6	2.8 5.5	2.2 4.4	1.7 3.3	1.1 2.2	0.6 1.1
Sea Level	3.5 8.9	3.2 8.0	2.8 7.1	2.4 6.2	2.1 5.3	1.75 4.45	1.4 3.6	1.1 2.7	0.7 1.78	0.4 0.9
COMBAT MISSION AND TRAINING AEROBATIC FLIGHTS										
35000 and above	13.0 13.0	11.7 11.7	10.4 10.4	9.1 9.1	7.7 7.7	6.5 6.5	5.2 5.2	3.9 3.9	2.6 2.6	1.3 1.3
30000	11.1 12.2	10.0 11.0	8.9 9.8	7.8 8.5	6.7 7.3	5.5 6.1	4.4 4.9	3.3 3.6	2.2 2.4	1.1 1.2
25000	9.5 14.2	8.5 12.8	7.6 11.4	6.6 9.9	5.7 8.5	4.7 7.1	3.8 5.7	2.9 4.2	1.9 2.8	0.9 1.4
20000	7.5 13.1	6.8 11.8	6.0 10.5	5.2 9.2	4.5 7.8	3.7 6.5	3.0 5.2	2.2 3.9	1.5 2.6	0.7 1.3
15000	6.1 12.2	5.5 11.0	4.9 9.8	4.3 8.5	3.7 7.3	3.0 6.1	2.4 4.9	1.8 3.6	1.2 2.4	0.6 1.2
10000	5.0 10.0	4.5 9.0	4.0 8.0	3.5 7.0	3.0 6.0	2.5 5.0	2.0 4.0	1.5 3.0	1.0 2.0	0.5 1.0
5000	4.2 8.4	3.8 7.6	3.4 6.7	2.9 5.9	2.5 5.0	2.1 4.2	1.7 3.4	1.2 2.7	0.8 1.7	0.4 0.8
Sea Level	3.5 7.1	3.1 6.4	2.8 5.7	2.4 5.0	2.1 4.3	1.7 3.5	1.4 2.8	1.0 2.1	0.7 1.4	0.3 0.7

NOTE

- Upper values indicate operating lever in 100% oxygen position
- Lower values indicate operating lever in AIRMIX position
- The duration time is doubled when only one crewmember is using oxygen.

Figure 1-40

OXYGEN SYSTEM (CONTROLS AND INDICATORS)



1 Front oxygen flow indicator
2 Rear oxygen flow indicator
3 Main oxigen system contents indicator
4 Oxygen system test pushbutton
5 Emergency oxygen pressure indicator
6 Regulator test button
7 Oxygen selector
8 Emergency oxygen grip
9 Oxygen shut off cock.

Figure 1-41

Oxygen Flow Indicator

Two magnetic indicators (1, 2, Figure 1-41), are marked OXY-FRONT and REAR. The indicators enable the oxygen flow to be monitored. The indicators show black and white stripes when no oxygen is flowing, and white oxygen is being drawn.

Emergency Oxygen Pressure Indicator

Located on the left side of the seat pan in each cockpit (5, Figure 1-41), a single-needle pressure indicator indicates the contents of the emergency oxygen bottle. The gage dial is divided into two sectors, one outlined in orange and marked RE-FILL, and the second outlined in green with a radial green band to indicate "full".

Central Warning Panel OXY Caption

A red OXY caption on each cockpit central warning panel illuminates when the pressure in the main oxygen system falls below 290 Pa, or when an oxygen shut-off valve is at OFF with electrical power on the aircraft.

LIGHTING SYSTEM

The lighting system is divided into external and internal lights.

EXTERNAL LIGHTING

The external lights include navigation, obstruction, formation, anti-collision, landing, and taxi lights, controlled by switches on the external lights panel (51, Figure FO-2) in the front cockpit. A ganging bar, on the external lights panel, allows the navigation, obstruction, formation, and anti-collision lights to be simultaneously switched off. A flight refuelling PROBE LIGHT is controlled by a switch on the press-to-transmit switch panel in the rear cockpit.

Navigation Lights

The navigation (position) lights consist of a red light, located on the outboard side of the left engine air intake, a green light on the outboard side of the right engine air intake, and two white lights (combine navigation/obstruction lights) one on each side of the trailing edge of the upper fin. All lights are controlled by the NAV – ON/OFF switch on the external lights panel (51, Figure FO-2). The lights can be controlled and selected to two levels of brillance, and either flashing or steady by the NORM/DIM and FLASH/STEADY switches on the same panel.

NOTE

> With navigation light ON and selected to FLASH, the fin lights do not flash if the obstruction lights are selected ON.

The navigation lights are supplied from the AC busbar 2.

Obstruction Lights

The obstruction lights consist of a red light on the left wing tip, a green light on the right wing tip and a white light (combined navigation/obstruction light) on the trailing edge of the upper fin. The obstruction lights consist of a red light on the left wing tip and a green light on the right wing tip. The lights are controlled by the OBST – ON/OFF switch and are supplied from the maintenance busbar.

Formation Lights

Two violet formation lights are installed on the upper and lower surface of each outer wing and controlled by the FORM – ON/OFF switch and supplied from the DC busbar 1.

Anti-Collision Lights

Two red anti-collision strobe lights are installed, one on the upper center fuselage and one on the lower from fuselage. Each light produces a beam, giving between 80 to 100 flashes per minute. The lights are controlled by the A/COLL-ON/OFF switch.

Landing/Taxi Lights

The landing lights are installed, one on each main landing gear door, and a single taxi light on the nose wheel strut. A three-position toggle switch (5, Figure FO-2), marked LAND/OFF/TAXI, controls the lights and ensures that the landing and taxi lights can not be selected together. The left landing light is supplied from the AC busbar 1 and the right landing light and taxi light from the AC busbar 2. Power to all three lights is only available, when the landing gear selector lever is in the DOWN position. The landing lights have a maximum operating period of 30 minutes, followed by a compulsory 15 minutes cooling period.

Flight Refuel Probe Light

A floodlight is mounted on the flight refuelling probe to facilitate inflight refuelling at night. The lamp brightness is controlled by the REFUEL PROBE LIGHT switch located on the refuel probe light control panel in the rear cockpit (34, Figure FO-3). The light can only be used, when the PROBE switch on the fuel control panel is set to OUT or EMERG OUT.

INTERNAL LIGHTING

Internal lighting of the front and rear cockpit is provided by floodlight, anti-dazzle lights, and wander lamps. Instrument and control panels are illuminated by filament lamps, pilar lamps, and electroluminescent panels. Power for instrument lamps is supplied from the XP1 and XP2 AC busbar. Power for front and rear cockpit lighting is supplied from PP2, PP3 and PP4 DC busbars.

Floodlights

Red floodlights, controlled by the FLOOD-FRONT PANEL and FLOOD CONSOLES rotary dimmer switches on the internal lights panel (55, Figure FO-2 and 36, Figure FO-3), illuminate the main instrument panels, the left and right quarter panels, and both consoles in both cockpits. The red floodlight over the rear cockpit CRPMD is controlled by the rear cockpit FLOOD-CONSOLES dimmer switch. All floodlights are supplied from the PP3 DC busbar.
A dimmer switch, labelled WAMS (16, Figure FO-2) located on the instrument dimmer switch panel controls the intensity of the indications in the pilot's WAMS control switches.

Anti-Dazzle Lights

High intensity floodlights are installed in the front and rear cockpit to illuminate the main instrument panels when required. These lights are controlled by the ANTI-DAZZLE-BRT/OFF/DIM switch, located on the miscellaneous switch panel and power is supplied from the PP2 DC busbar. The floodlights are normally used during thrunderstrom conditions or when instrument panel illumination is inadequate.

Wander Lamps

Wander lamps are fitted in the front (92, Figure FO-2) and rear cockpit (50, Figure FO-3) and are supplied with power form the battery busbar. For emergency illumination is provided a secondary mounting. The front barrel of the lamp can be rotated to any one of four positions to provide a red or white light with a spot or floodlight beam. The intensity is controlled by a knurled ring at the rear. A flasher button at the rear of each lamp provides full brilliance regardless of the position of the knurled ring.

NOTE

Pre Mod. 01445
The wander lamp in the front cockpit shall not be positioned in the forward stowage while the canopy is opening or closing.

Post Mod. 01445 This information is not applicable.

Pillar Lights

Pillar lighting for the clock in each cockpit is controlled by the relevant INTEGRAL- INSTRUMENTS rotary dimmer switch. Power is supplied from the XP1 AC busbar.

Integral and Electroluminescent Lighting

The integral lighting of the HUD control panel and the left anti-glare shield is controlled by the EL rotary dimmer switch on the instrument dimmer switch panel.
The integral lighting of the AOA indicator and the accelerometer in the front cockpit is controlled by the HEAD UP INST rotary dimmer switch on the pilot's hand controller panel.
All electroluminescent lighting together with the integral lighting of instruments and indicators of the consoles, is separately controlled by the INTEGRAL-CONSOLES dimmer switches in each

cockpit. Power to the integral and electroluminescent lighting is supplied from AC Busbar 1.

CCS Station Box Lights

The COMMS rotary dimmer/switch located on the internal lights panel controls the DC power supply and the intensity of the integral illumination of the communications control equipment station box and the IFF control unit. It also controls the lighting of the IFF control panel. Power is supplied from the PP1 DC busbar.

Lamps Test

A lamp test facility (53, Figure FO-2 and 33, Figure FO-3) is provided in each cockpit to test the filaments of all indicator lights, warning lights and integrally illuminated push buttons on the instrument panels and consoles. The FRONT PANEL switches, when set to TEST, check the lights on the main instrument panels, quarter panels and antiglare shields in the respective cockpit. The CONSOLES L and R switches (2) on the same panel, when set to TEST, check the lights on the appropriate console in the respective cockpit.

COMMUNICATION EQUIPMENT

Correlation of communication equipment is shown in Figure 1-42. Communication equipment consists of the following units:

- Communication Control System (CCS) Panel
- V/UHF Radio
- Remote Frequency/Channel Indicator (RFCI)
- UHF Emergency Radio
- HF/SSB Radio
- Pilot's Hand Controller (PHC) Panel
- Groundcrew Connector
- Telebriefing Connector
- PTT Controls
- Cockpit Voice Recorder (CVR)

CCS PANEL

The CCS panel enables correlation of audio signals produced and/or received by the aircraft. The CCS consists of two identical control panels (one in the front cockpit and the other one in the rear cockpit), a junction box, a groundcrew jack box with intercommunication connector, a telebriefing connector and three independent press-to-transmit (PTT) switches, two in the front cockpit and one in the rear cockpit. Control panel facilities are provided for each crewmember of take over control of the V/UHF communication.

A voice operated switch (VOS) is available in each cockpit. The VOS allows intercommunication (I/C) between both cockpits without operating any control elements. Speaking into the microphone automatically keys an amplifier and establishes I/C audio contact.

The groundcrew connector permits the use of a headset outside the aircraft to provide I/C between aircrew and groundcrew. By pressing his press-to-speak (PTS) button, the groundcrewman is able to communicate with the aircrew. By setting the MUTE/NORM/CALL toggle switch to CALL position either member of the aircrew is able to contact the groundcrew. The CCS operates on 28 V DC from the PP3 essential busbar.

All audio warnings produced by various aircraft systems and identification signals from radio navigation aids are routed to the aircrew headsets. Volume of radio navigation aids can be adjusted by volume controls on the relevant control panels. Aircraft system warnings are transmitted at an audio level sufficiently high enough to attract the crew's attention. Figure 1-43 lists audio signals which may be heard over the CCS.

To gain complete control of the V/UHF transceiver and UHF Communication Antenna switch from a particular cockpit, the PUSH TO CONTROL button on the CCS control panel in that cockpit shall be pressed. The PUSH TO CONTROL lamp on the CCS panel in that cockpit which has taken over control is then Operating mode and frequency or channel required can only be selected on the activated V/UHF control panel. On the non-activated V/UHF control panel the frequency display is blanked. The required antenna for UHF band communications may be selected by the UHF Antenna Selector on the CCS control panel. V/UHF volume is controlled on both CCS controls panels individually for each cockpit.

CCS Panel Controls

CCS panel controls are shown in C, Figure 1-44. Panels are identical in front and rear cockpits. Functions are as follows:

COMMUNICATION SYSTEM (CONTROLS AND INDICATORS)

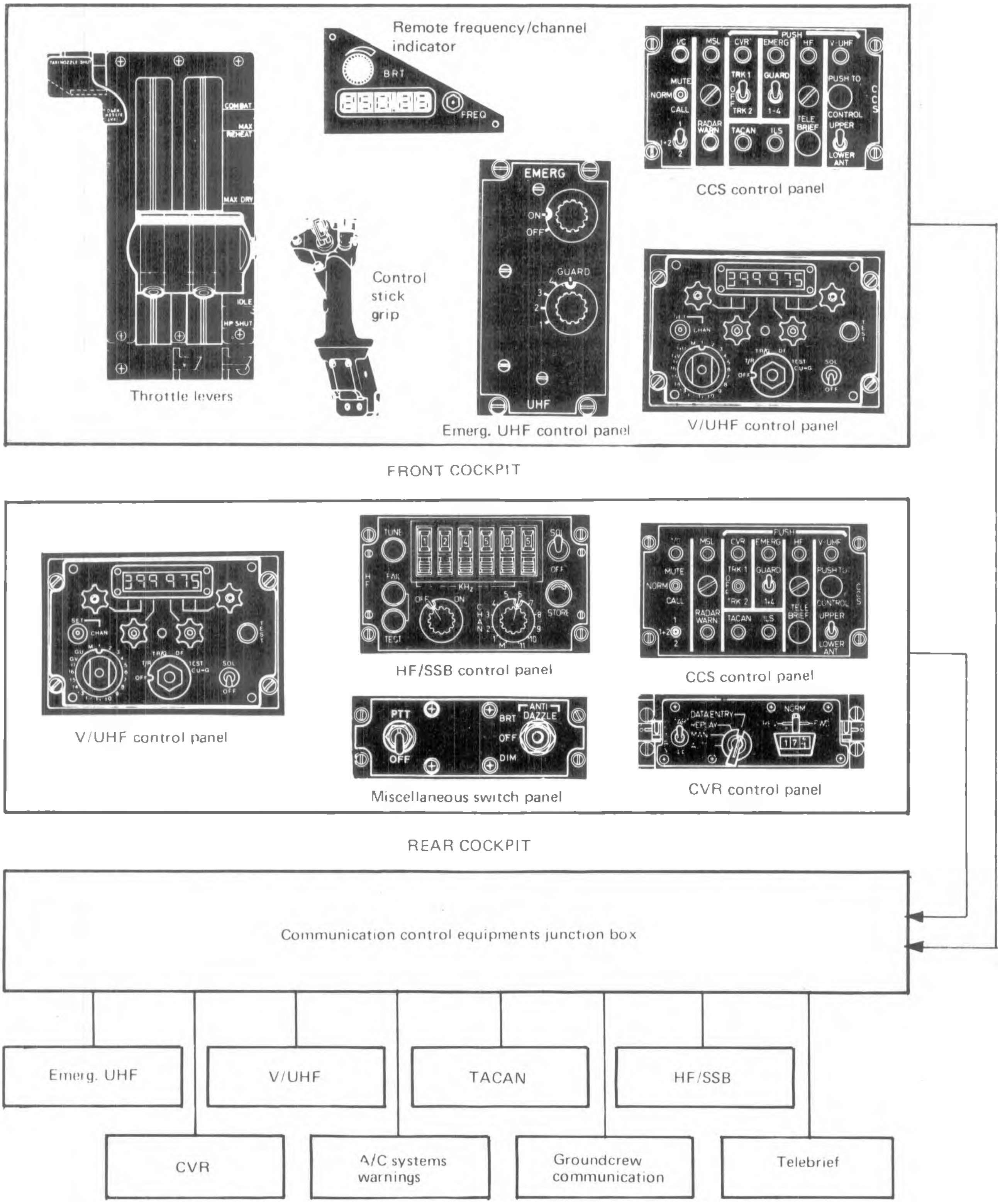


Figure 1-42

AUDIO WARNING AND IDENTIFICATION SIGNAL

WARNINGS	SIGNAL	COMMS CP VOLUME CONTROL	CANCELLABLE
Engine Fire Primary CWP Warnings Undercarriage up	"Lyre Bird" Tone	None	Press attention Getter in appropriate cockpit
Low Height Reverse Thrust Re-ingestion Manoeuvre Monitor NSAS Failure	Interrupted medium horn tone (600 Hz)		
Passive Warning Radar	— Siren Tone — Two-tone alarm	Radar Warn	Reduce to zero volume Control
Tacan	Morse coded identify	TACAN	— Reduce to zero volume Control — Select MUTE
Missile	1500 Hz	MSL	Select MUTE

Figure 1-43

INTERCOMMUNICATION VOLUME CONTROL (IC)

Pre Mod. 01742
A rotary control, adjusts the volume of intercommunication audio signals. Volume cannot be fully reduced to zero.

Post Mod. 01742
The I/C button is labelled RADIO-I/C and the I/C and MSL button positions are reversed on the CCS. The RADIO-I/C switch rotates to adjust intercom volume (volume cannot be fully reduced to zero). The switch can be set either to the up or the down position. When telebrief is connected and the RADIO-I/C switch is in up position, transmission to/from each radio is inhibited.
When the RADIO-I/C botton is pushed down the radio transmission is available using any of the normal PTT buttons.

MISSILE VOLUME CONTROL (MSL)

A rotary control which adjusts the volume of A/A missile audios. (PostMod. 01742 MSL volume control does not change its function).

COMBINED PUSHBUTTONS/ROTARY CONTROLS

Four pushbutton/rotary controls labelled PUSH: CVR, EMERG, HF, V-UHF. Operating principles for these four controls are identical. When pushed in:

CVR — CVR notebook facility will be selected.

EMERG — UHF emergency radio transmitting facility and modulation line will be selected, and equipment will be switched on, irrespective of ON/OFF switch.

HF — HF transmitting facility and modulation line will be selected.

V-UHF — V-UHF transmitting facility and modulation line will be selected.

A second press cancels all facilities, respectively disables transmitting of the UHF emergency radio. Turning the controls adjusts volume. The pushbuttons are illuminated white when pressed in, provided that the COMMS switch on the INTERNAL LIGHTS panel is on.

CHANNEL OVERRIDE SWITCH (GUARD)

A switch with two positions, GUARD and 1-4. Placing the switch in either cockpit to GUARD selects the emergency frequency on the UHF emergency transceiver and permits radio communication on GUARD only. Placing the switch to 1-4 in both cockpits allows selection of any one of four available channels, on the UHF emergency transceiver.

V/UHF CHANGEOVER PUSHBUTTON (PUSH TO CONTROL)

A pushbutton combined with a green integrated indicator lamp. Pushing the button in activates the V/UHF control and the UHF antenna selector in the relevant cockpit and the green indicator PUSH TO CONTROL illuminates to show that the V/UHF transceiver is controlled from that cockpit. Post mod 01661: pressing either PUSH TO CONTROL button transfers control to or from either cockpit. The green light is on in the cockpit which has control.

UHF ANTENNA SELECTOR (UPPER/LOWER ANT)

A two-position toggle switch. Placing the switch to UPPER connects the upper UHF antenna to the V/UHF transceiver and the lower antenna to the UHF emergency transceiver. Placing the switch to LOWER reverses the connections. Functioning of this control is dependent on the position of the V/UHF changeover pushbutton PUSH TO CONTROL.

TELEBRIEF BUTTON (TELEBRIEF)

A combined pushbutton/indicator lamp. The amber indicator illuminates when the telebrief landline is connected to the aircraft. Pressing the TELEBRIEF pushbutton keys the relevant aircrew microphone for telebrief and inhibits all transmitting functions and the groundcrew contact (Pre Mod. 01742).

ILS VOLUME CONTROL (ILS)

A rotary volume control knob (not operative).

TACAN VOLUME CONTROL (TACAN)

A rotary volume control knob, for adjustment of the TACAN audio volume. Volume cannot be reduced to zero.

RADAR WARNING VOLUME CONTROL (RADAR WARN)

A rotary volume control knob, marked RADAR WARN, which adjusts the volume of pulse repetition frequency (PRF), new threat and missile attack radar warning tones.

AMPLIFIER SELECTOR (1/1 + 2/2)

A three-position toggle switch, normally in 1 + 2 position (both amplifiers on). If one amplifier fails, back-up operation can be established by placing the switch to either position 1 or 2.

COCKPIT VOICE RECORDER TAPE TRACK SELECTOR (TRK1/OFF/TRK2)

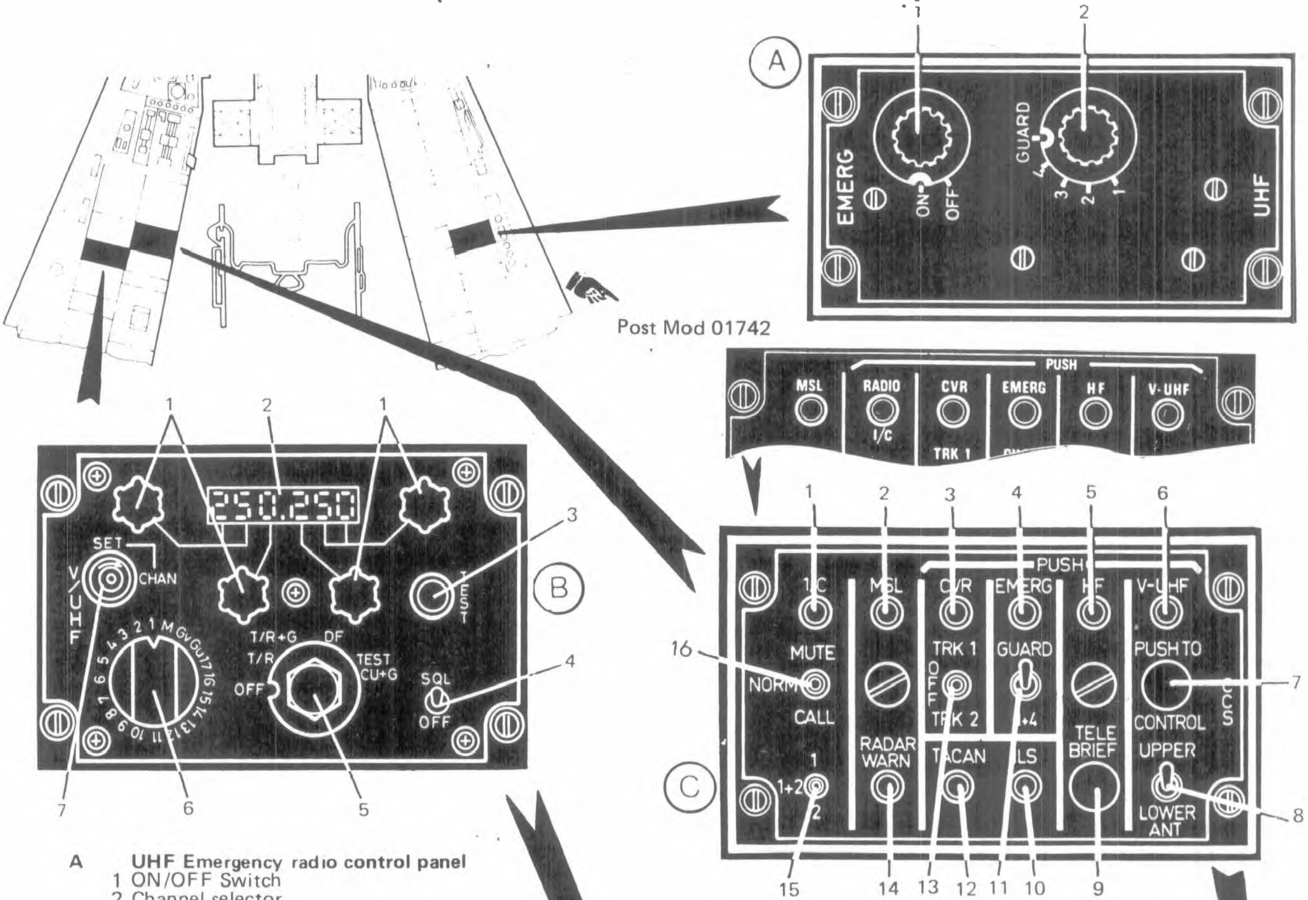
A three-position toggle switch. Placing the switch to either TRK1 or TRK2 selects the appropriate CVR tape track for replay. In OFF position the CVR replay audio in the relevant cockpit is shut off.

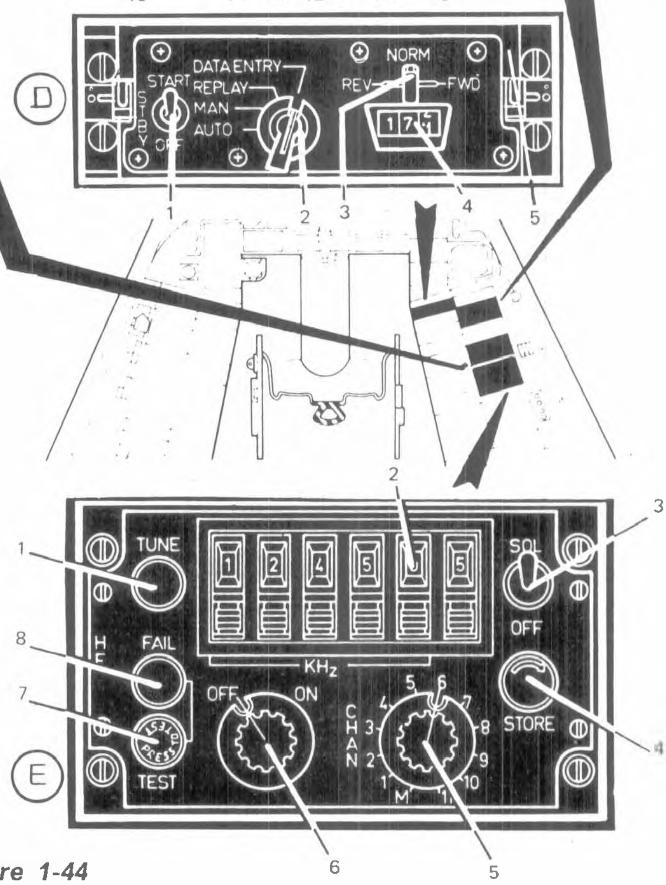
RADIO OVERRIDE SWITCH (NORM/CALL/MUTE)

A toggle switch with the positions: NORM/CALL/MUTE, spring loaded to NORM, and has the following functions:

NORM	The communications system operates normally and all audio signals are routed to both headsets. Intercom operates between cockpits with audio volume independently adjustable at CCE control panel. If the notebook facility (CVR) is in operation or any PTT button is pressed, intercom between front and rear cockpit is inhibited.
CALL	With the switch held in this position the CALL function overrides the VOS and I/C volume controls, and establishes audio contact between cockpits at max volume.
MUTE	With the switch held in this position, all audio signals to both cockpits are inhibited with the exception of V/UHF Guard and audio warnings, the switches in the front and rear cockpit operate in parallel.

COMMUNICATION SYSTEM (CONTROLS AND INDICATORS)





A **UHF Emergency radio control panel**
1 ON/OFF Switch
2 Channel selector

B **U/VHF radio control panel**
1 Frequency selector
2 Frequency display
3 Test button
4 Squelch switch
5 Mode selector
6 Channel selector
7 Channel loading switch

C **Communication control panel**
1 Intercommunication volume control
2 Missile volume control
3 Cockpit voice recorder control
4 UHF emergency control
5 HF/SSB control
6 V/UHF control
7 V/UHF changeover pushbutton
8 UHF antenna selector
9 Telebriefing control
10 ILS volume control
11 Channel override switch guard
12 TACAN volume control
13 CVR tape track selector
14 Radar warning volume control
15 Amplifier selector switch
16 Radio override switch

D **Cockpit Voice Recorder**
1 Master switch
2 Mode selector
3 Tape drive switch
4 Tape position indicator
5 Handle

E **HF/SSB control panel**
1 Tune indicator
2 Frequency selector/indicator
3 Squelch switch
4 Channel store control
5 Channel selector
6 Power switch
7 Test switch
8 Fail indicator

Figure 1-44

CCS OPERATION

Transmission may be made from either cockpit by pressing a PTT button or by activating the TRANSMIT/OFF switch on the miscellaneous switch panel in the rear cockpit.
The UHF emergency radio may be activated by pilot selection on the UHF emergency control panel or by either crewmember pressing the EMERG button on the CCS control panel. Transmit/receive facilities are available to both cockpits on the set frequency.
Recording facility are provided by the CVR. The pilot's voice is recorded on track 1 and that of the navigator on track 2. With the CVR pushbutton on the CCS control panel in the de-selected position (i.e. "out"), the CVR will record all audio signals occurring in the crewmembers headsets. Depressing the CVR pushbutton on a CCS panel inhibits intercom and during recordings from that cockpit all audio signals, except that crewmember's voice, are inhibited.
In the REPLAY mode, selected on the CVR panel, the pilot and navigator may independently select a tape track by operating the TRK1/OFF/TRK2 switch as required on the CCS control panel. Volume of the replay audio is adjusted by turning the CVR volume control on the CCS panel. Information dealing with the Rapid Data Entry facility of the CVR is described in Section IV.

V/UHF RADIO

The V/UHF transceiver is the main radio equipment which provides voice communication in the VHF band and in the UHF band also providing simultaneous monitoring of the relevant distress frequency. During UHF communications the equipment operates in combination with the UHF Communications Antenna Switch Unit: during VHF communications the radiofrequency is routed through the V/UHF Upper Antenna. Control is with the cockpit in which the CCS panel PUSH TO CONTROL lamps is illuminated, however, the receive functions are available to both cockpits.
The transmitter/transceiver, located in the rear avionics compartment, operates in the VHF frequency band and the UHF frequency band.

V/UHF Control Panel

A V/UHF control panel (B, Figure 1-44) is installed in each cockpit: controls are identical. The function of each control is as follows:

CHANNEL LOADING SWITCH

A switch labelled SET CHAN which shall be rotated clockwise and pressed to load the frequency, set by the frequency selector, into the channel seat at the channel selector.

FREQUENCY SELECTORS

Four rotary controls (six digits) used for manual selection of frequency shown on the frequency display.

FREQUENCY DISPLAY

A seven bar six digit display which shows, in MHz units, the frequency set by the frequency selectors of the frequency of the channel selected by the CHAN selector.

TEST BUTTON

A pushbutton labelled TEST to intitate the Interruptive BITE sequence appropriate to the mode selected.

SQUELCH SWITCH

A two position toggle switch labeled SQL/OFF. Selection to SQL results in a reduction of the received noise level.

MODE SELECTOR

A five position rotary switch with the following functions:

OFF	The power supplies are disconnected. This position is guarded to prevent inadvertent selection.
T/R	The Main Transmitter/Receiver of the equipment is activated.
T/R + G	The Main Transmitter/Receiver and a Guard Receiver are activated.
DF	When a VHF frequency is selected the Main Transmitter/Receiver is activated. When a UHF frequency is selected the UHF/ADF equipment and the Main Transmitter/Receiver is activated.

TEST CU+G	Enables Interruptive BITE to be carried out on the Control Unit and the Guard Receivers.

CHANNEL SELECTOR

A rotary switch labelled CHAN with the following twenty positions.

M	The Main Transmitter/Receiver is tuned to the frequency shown on the Frequency Display.
1-17	Allows 17 channels to be preset and selected as required.
Gu	The Main Transmitter/Receiver is set to the UHF distress frequency (243,0 MHz).
Gv	The Main Transmitter/Receiver is set to the VHF distress frequency (121,5 MHz).

NOTE

A stop is positioned between M and Gv to prevent the selection of either position from the other without first having completed a full rotation of the switch.

V/UHF RADIO OPERATION

V/UHF Bite

The BITE provides interruptive monitoring of V/UHF equipment. The BITE circuits are controlled by the TEST button on CU, the function selector, SENS switch , CHAN switch and a PTT switch. Circuits within a CU check that the displays on both CU and RFCI are serviceable and that the channel store within the CU is serviceable. The BITE circuits are only functional within the selected CU. Circuits within the RX/TX check the transmitter power output and modulation depth, main and guard receiver sensitivity.
To take control of the V/UHF transceiver and of the UHF Communications Antenna Switch Unit, the V/UHF changeover pushbutton on the Comms CP shall be pressed: the integral green indicator will illuminate to confirm that the control is taken in that cockpit. To switch on the V/UHF Transceiver the mode selector shall be set to any position except OFF. The required frequency is selected either, by positioning the channel selector at the corresponding channel number or by setting the channel selector to position M and using the manual frequency selectors to set the required frequency on the frequency display. When normal transmission and reception is required the mode T/R shall be selected; when, in addition, monitoring on the distress frequency is desired, the mode T/R + G shall be selected. If a UHF frequency is selected, the UHF antenna selector shall be positioned in such a way to get the best signal. The received audio level is adjusted using the V/UHF Control on the Comms CP. The Sensitivy switch on the CU should normally be used in the SQL position; the OFF position should be selected when the signal strenght falls below an acceptable level notwithstanding UHF Antenna Selector operation. During any equipment function and independently of the CU in use, the Pilot is able to check the operating frequency by using the RFCI.

Channel/Loading

To load a frequency in a channel, set the channel selector to the required channel number. Select the required frequency by using the Frequency Selector, press and turn clockwise the SET CHAN switch. To confirm that the frequency is correctly, loaded into the memory, the pilot shall press the FREQ button on the RFCI: the frequency will be appear in the Display. The display shows the number of the channel selected when the FREQ button is released.

Channel Selection

Set mode selector knob to T/R, T/R + G and rotary switch CHAN to M. In this manner the Main Transmitter/Receiver is tuned to the frequency shown on the Frequency Display and controlled by the four Frequency Selectors Knobs.

REMOTE FREQUENCY/CHANNEL INDICATOR (RFCI)

The remote frequency/channel indicator (Figure 1-42) functions in association with the V/UHF radio control panel, and enables the pilot to monitor the frequency in use, regardless if selected in front or rear cockpit. Presentation is made by a five-digit display with decimal point for frequency display, and with the prefix CH and two-digit channel number, when acting as a channel display. A rotary control marked DIM is used to control display brightness.

UHF EMERGENCY RADIO

The UHF emergency radio equipment (A, Figure 1-44) provides two away air-to-air-to ground communication and has four preset channels (1 ÷ 4), and one GUARD channel. The equipment can also be used in case of equipment failure.
Power to the UHF emergency radio is supplied from the PP3 DC busbar.

UHF Emergency Radio Control Panel

The UHF emergency radio control panel and its controls are shown in Figure 1-44. These controls function as below:

ON/OFF SWITCH KNOB (ON/OFF)

A two-position rotary switch which controls the power supply to the UHF emergency radio.

CHANNEL SELECTOR SWITCH KNOB (GUARD)

A five-position rotary switch with the following positions:

- 1-4 selects one of four pre-set channels
- GUARD selects a channel pre-set to the international emergency frequency.

UHF Emergency Radio Operation

To receive, the required channel is set with the UHF channel selector switch. In addition, the ON/OFF switch shall be set to ON, or, alternatively the EMERG pushbutton on one of the CCS control panels shall be pressed.
To transmit, the EMERG pushbutton on the CCS panel and one of the PTT buttons shall be pressed. Alternatively, UHF communication on the international emergency frequency may be established by selecting the channel override switch on either CCS control panel to GUARD, and provided that the EMERG pushbutton on one of the CCS control panels is depressed, transmission may be made through the PTT pushbuttons.

PRESS-TO-TRANSMIT CONTROLS

V/UHF and UHF emergency transmission can be initiated from one of the following PTT switches:

Front Cockpit:	Control Stick Grip	
	Throttle Lever	
Rear Cockpit:	Control Stick Grip	(only IT)
	Throttle Lever	
	Miscellaneous Switch Panel	(only IS)

An UHF antenna switching unit provides changeover switching between the upper and lower UHF antennas and the main V/UHF emergency radio. The antenna switching unit is controlled by a switch on the CCS panel. Power is supplied from the X P3 AC busbar and from the PP2 DC busbar.

TRANSMITTING

Transmissions are made by pressing one of the PTT switches in either cockpit.

RECEIVING

Reception volume can be individually controlled in each cockpit with the V-UHF control knob on the CCS control panel.

HF/SSB Radio

(Post mod. 10809)

The HF/SSB equipment provides the aircraft with a means of a long range, single channel, voice communication. The receive and transmit functions may be selected from either of the cockpits, but channel selection and other control functions can only be selected in the rear cockpit. The equipment operates in the frequency band 2,0 to 29,9999 MHz. Frequency spacing is 100 Hz, stability is ± 5 Hz and there are eleven preset frequencies available by channel selection. The equipment comprises a Receiver/Exciter (R/E), a Power Amplifier (PA), a Control Frequency Selector (CFS), an Antenna Tuning Unit (ATU) a Control Panel and a notch antenna, which is an integral part of the airframe. The HF/SSB receives a three phase 200V, 400 Hz supply from the XP1 AC busbar and a 28V DC supply from the PP2 DC busbar.

HF/SSB Control Panel

HF/SSB control panel (E, Figure 1-44) is installed in the rear cockpit; the function of each control is as follows:

TUNE INDICATOR — A white indicator labelled TUNE which is illuminated during coarse antenna tuning when transmission is inhibited.

FREQUENCY SELECTOR/ INDICATOR — Six digiswitches, each with an associated numerical indicator, which are used to select the desired frequency. The extreme left hard selector has three positions (0, 1, 2); on the other selector digits from 0 to 9 are available.

SQUELCH SWITCH — A two-position toggle switch labelled SQL/OFF. Selection to SQL results in a reduction of the received noise level.

CHANNEL STORE CONTROL — A push button switch labelled STORE which shall be rotated clockwise before it can be depressed. When released, the switch returns to its original position. It is operated to store the frequency selected by the frequency selector into the channel close at the channel selector.

CHANNEL SELECTOR — A twelve position rotary switch labelled CHAN with positions marked M and 1 to 11. It selects one of the eleven preset channel or, at position M, the frequency set by the Frequency Selector.

POWER SWITCH — A two position rotary switch labelled ON/OFF which controls the power supply to the equipment.

TEST SWITCH/ INDICATOR — A combined push button and green indicator labelled TEST. When depressed and released the equipment interruptive BITE circuits are activated and the incoporated indicators illuminates for about one second to indicate that the test has been performed.

FAIL INDICATOR — An amber indicator labelled FAIL which illuminates if the continuous or interruptive BITE check detects an equipment failure.

HF/SSB Radio Operation

WARNING

EXTREME CAUTION SHOULD BE USED WHEN OPERATING HF/SSB ON THE GROUND DUE TO THE HIGH ENERGY RADIATED.

If a frequency already stored is required, set the channel selector to the required channel and set the power switch to "ON". Reception facilities are available upon switching the equipment on. Set the communications control panel HF volume control to give the required audio level. When the antenna is tuned, the TUNE indicator goes out. If the required frequency is not stored, set the channel selector to "M" and set the required frequency via the frequency selectors and then produce as above.

CAUTION

OPERATION OF THE POWER AMPLIFIER IMPOSES CONTINUOUS OPERATING TIME LIMIT OF 10 MINUTES IN THE TRANSMIT MODE. THE DUTY CYCLE IS 10 MINUTES TRANSMIT/10 MINUTES RECEIVE.

Channel Loading

Channel loading is carried out as follows. Set the channel selector to the channel to be loaded, the TUNE indicator illuminates indicating that the antenna is being tuned to the frequency already stored. Set the frequency selector to the frequency to be stored. When the TUNE indicator extinguishes, rotate the STORE push-button clockwise; depress and then release the push-button. The TUNE indicator illuminates indicating that the antenna is being coarse tuned to the newly stored frequency.

HF/SSB Bite

A BITE check is integrated in the HF/SSB radio. The BITE is activated by depressing and then releasing the TEST switch/indicator which illuminates to indicate that a test has been performed. Failures are indicated via the FAIL indicator. In order that correct matching of the system can be checked, transmission is necessary to test the functions. Therefore operate a PTT and then the TEST push-button.

GROUNDCREW I/C CONNECTOR

Groundcrew cockpit communication is provided by a groundcrew connector. The connector is located on the right hand main landing gear compartment. Power is taken from the 28V DC busbars.

I/C Operation

After the groundcrew head set connector is connected to the I/C connector, communication from groundcrew to aircrew can be established by pressing the PTS button on the groundcrew headset. For communication from the aircrew to the groundcrew the CALL switch on the CCS panel shall be activated.

TELEBRIEFING CONNECTOR

The telebriefing connector provides landline communication between ground controller and aircrew. The connector is mounted to the right hand main landing gear strut. When a telebriefing landline is connected, the groundcrew communication is suspended and optical indication is displayed on both CCS control panels to the aircrew.
The establish contact with the ground controller each aircrew member can activate the TELEBRIEF push button on the relevant CCS control panel. During ground emergencies the telebriefing mode may be overridden by pressing the PTS-button of a groundcrew headset.

PRESS TO TRANSMIT CONTROLS

Miscellaneous Switch Panel, PTT Switch

The miscellaneous switch panel (Figure 1-42) contains a switch for activating transmissions. The panel contains a toggle switch marked TRANSMIT/OFF. When held from the springloaded OFF position to TRANSMIT the transmissions can be made on V/UHF and UHF emergency.

Control Stick PTT Button

The control stick in the front cockpit contains a PTT button for transmitting.

Throttle PTT Button

The throttle lever in the front cockpit contains a PTT button for transmitting.

RECORDERS

The following recording facilities are installed in the aircraft:

- Cockpit Voice Recorder (CVR)
- Head-up display camera (HUD)
- Head-down display recorder (HDDR)
- Crash recorder (CR)

COCKPIT VOICE RECORDER (CVR)

The CVR provides a two track data entry facility and operates as an audio flight log for the pilot and the navigator. It is installed in the rear cockpit. The rapid data entry (RDE) facility enables replay of the pre-recorded serial digital data signals, and their reconstitution into a form suitable input to the MC. When operating as a flight log, the CVR is capable of recording and replaying all audio signals. Control settings affecting these facilities are shown in Figure 1-45. A fully loaded cassette allows 20 minutes of recording time.
The CVR operates from the PP2 DC busbar.

CVR CONTROL SETTING

MODE SELECTOR	MASTER SWITCH	VOICE RECORDER SWITCH (PHC PANEL)	TAPE DRIVE SWITCH			CVR RECORD INDICATOR (PHC PANEL)	TAPE POSITION INDICATOR (REFERENCE TO NORM)
			REV	NORM	FWD		
MAN	STBY	STOP	Not selectable		Not selectable	Exstinguished	Does not move
		START		Continuous audio record with erase-before-record		Illuminated	Advances with a rate of one digit per two seconds
	START	STOP	Not selectable		Not selectable		
AUTO	STBY	STOP	Not selectable		Not selectable	Extinguished	Does not move
		START		Automatic audio record with erase-before-record		Illuminated when audio is present	Advances with a rate of one digit per two seconds
	START	STOP	Not selectable		Not selectable		
REPLAY	STBY	Inoperative	Fast rewind		Fast forward	Extinguished	Does not move
	START		Fast rewind	Continuous audio replay	Fast forward		Advances with a rate of one digit per two seconds
DATA ENTRY	STBY	Inoperative	Fast rewind		Fast forward	Extinguished	
	START		Fast rewind	Continuous data replay	Fast forward		Advances with a rate of one digit per seconds

Figure 1-45

CVR Control Panel

The cockpit voice recorder control panel and its control elements are shown in Figure 1-44. Functions are as follows:

MASTER SWITCH (START/STBY/OFF)

A three-position toggle switch with the following positions:

OFF Power supply is shut-off

STBY Power is on, tape transport is inhibited except for reverse or forward spooling.

START Power is applied for operating the recorder in all modes.

MODE SELECTOR SWITCH (DATA/ENTRY/REPLAY/MAN/AUTO)

A four position rotary switch, with the following positions:

DATA ENTRY Provides for entering pre-recorder mission data into the main computer.

REPLAY Replays previously recorded audio signals in setting MAN or AUTO.

MAN Allows continuous recording

AUTO Records automatically, when an audio signal is sensed by the voice actuated switch in the CVR.

NOTE

To select the data entry facility, the mode selector switch is pressed, then turned.

TAPE DRIVE SWITCH (REV/NORM/FWD)

A three-position slide switch, springloaded to NORM position. When in this setting tape transport speed is normal for REPLAY, MAN, or AUTO modes. In the DATA ENTRY mode transport speed is nearly twice as fast as in NORM setting. In STBY the tape remains stationary until START is selected.
When in REV, fast rewind is accomplished; in this setting MAN and AUTO is inhibited. When in FWD fast forward transport is accomplished; other functions are the same as for REV.

TAPE POSITION INDICATOR

A three-digit counter indicating from 000 to 999.

NOTE

The counter is automatically reset to zero when a cassette is removed from the recorder unit.

Voice Recorder Indicator (RUN)

An indicator illuminates green when (only in the MAN or AUTO mode) the tape is running (Figure 4-83).

Voice Recorder Switch (START/STOP)

A two-position toggle switch, enables the pilot to activate the cockpit voice recorder in the recording modes when STBY is selected on the CVR control panel (Figure 4-83).

Front Cockpit Hand Controller Panel

Integrated into the front cockpit hand controller panel (86, 87, Figure FO-2), is the cockpit voice recorder control for the pilot. Operation of the voice recorder in the front cockpit is limited to two controls on the hand controller panel.

CVR OPERATION

For recording, the toggle switch shall be set to START position. Each crewmember can select the notebook by pressing the CVR pushbutton on the CCE panel. The pilot's voice is normally recorded on tape track 1, the navigator's voice on tape track 2. The end of a cassette is indicated on the tape counter at a display of approx. 940. For replay, set the mode selector to REPLAY with the master switch set to STBY or START. Use the FWD or REV position on the tape drive switch to bring the tape to a particular position. Select TRK 1 or TRK 2 on the CCS control panel as required. Adjust the CVR volume control on the CCS control panel as required.
To enter pre-recorded data from a cassette into the MC with mission data, ensure that the master switch is set to OFF, mode selector to REPLAY and pilot's voice recorder switch on the pilot's hand controller panel to STOP.
Set up main computer and TV/TAB to accept and display rapid data entry from the cockpit voice recorder. Install pre-recorded cassette into CVR and ensure tape position indicator is at 000.
Select master switch to STBY, observe tape position indicator and hold tape drive switch to REV. When tape position indicator stops decrementing, return tape drive switch to NORM. Select mode selector to DATA ENTRY.
Select master switch to START and check that tape position indicator increments and that TV/TAB display is cleared automatically for data insertion. Observe TV/TAB display and ensure, after approximately 10 seconds, that RDE COMPLETE is displayed. Return master switch on CVR panel to STBY.
To install a cassette into the CVR proceed as follows:
Ensure that on the CVR panel the master switch is placed to OFF, and the mode selector switch is placed to REPLAY. Set VOICE RECORDER switch on the pilot's hand controller panel to STOP. Open recorder unit lid by moving handle to upright position, then move the exposed unit to the rest position. Insert cassette. Push unit home and lock handle.
To remove a cassette from the CVR proceed in reverse sequence.

CAUTION

- DO NOT ATTEMPT TO MOVE TAPE DRIVE SWITCH FROM NORM (MECHANICALLY LOCK IN) UNLESS A CASSETTE IS INSTALLED, OR DAMAGE WILL OCCUR.
- TO AVOID MAGNETIC HEAD OR TAPE CONTAMINATION:
  - KEEP THE RECORDER UNIT LID CLOSED
  - KEEP THE CASSETTE INSIDE A PLASTIC CONTAINER WHEN NOT IN USE
  - DO NOT TOUCH THE EXPOSED TAPE.

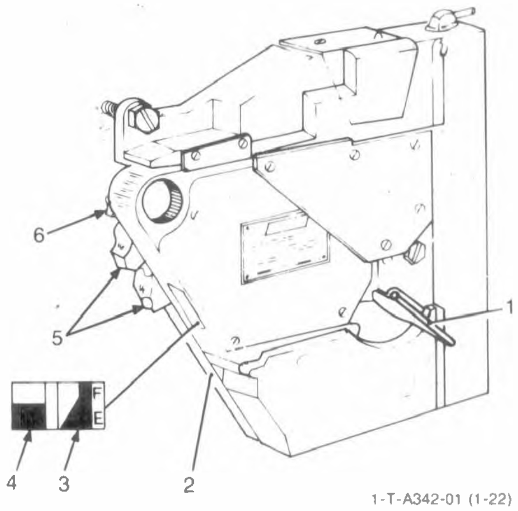
HEAP-UP DISPLAY CAMERA (HUD CAMERA)

The HUD camera records images of HUD symbology superimposed on a view of the outside world as seen by the pilot through the HUD pilot's display unit (PDU).
The HUD camera is installed on the right side of the head-up display unit in the front cockpit. The camera is controlled by settings on the camera control panel (59, Figure FO-2) and can be initiated manually through the pilot's control stick camera button, or automatically by signals form the MC. A manual single shot (SS) facility is also provided on the camera. The camera can be loaded with 16 mm standard film or with special thin film.
A standard film cassette gives a running time of 2 minutes at 16 frames per second or 1 minute at 32 frames per second. When thin film is loaded, the running times are increased to 3 minutes or 1,5 minutes respectively. Film running and film remaining and indicators are embodied into the rear side of the cassette.
The camera is supplied by the PP2 DC busbar.

HUD Camera Controls

The HUD camera controls are shown in Figure 1-46.

HUD CAMERA CONTROLS



1 Cassette locking lever
2 Cassette locked Indicator
3 Film supply indicator
4 Film running indicator
5 Frame rate selector
6 Manual single frame button

Figure 1-46

CASSETTE LOCKING LEVER

The locking lever, located on the right side of the camera, is used to lock or unlock the cassette during loading/unloading.

CASSETTE LOCKED INDICATOR

The indicator is coupled with the cassette locking lever and appears as a white bar beneath the camera body when the cassette is properly locked in position in the camera.

FILM SUPPLY INDICATOR

This is a drum type indicator captioned E (empty) and F (full), and indicates the amount of unexposed film remaining in the cassette.

FILM RUNNING INDICATOR

The running indicator is of the drum type marked with black and white segments. When the drum rotates it indicates that film is running through the camera.

FRAME RATE SELECTOR

The selector consists of two interlinked push buttons. The upper button is marked 16 and when pressed, sets the frame rate at 16 FPS. The lower button is marked 32 and sets the frame rate at 32 FPS.

MANUAL SINGLE FRAME BUTTON

This button, captioned SS (single shot), is located on the camera above the frame rate selector buttons. When pressed and released, it will expose one frame of the film.

HUD Camera Control Panel

The control panel is shown in Figure 1-47.

MASTER SWITCH

The master switch with the captions MASTER ON/OFF controls the 28V DC power supply to the camera.

OVERRUN SELECTOR SWITCH

The overrun selector switch is captioned OVERRUN (SEC), and has seven positions marked 0, 1, 2, 3, 10, 15 and 30. These positions function during manual camera operation only, and when a setting between 1 and 30 is selected, will allow the camera to run on for the set time in seconds after release of the camera button on the pilot's control stick.

PANEL LIGHTING

The legends on the control panel are illuminated by an electroluminescent panel. The intensity of the lighting can be adjusted through the cockpit dimmer system.

HUD Camera Operation

MANUAL OPERATION

Control of the camera is exercised from the control panel. With the MASTER switch set to ON, the desired frame rate selected and the OVERRUN switch set as required, the HUD camera will operate when the camera button on the pilot's control stick is depressed. On release of the camera button, the camera will continue to run for the number of seconds selected on the OVERRUN switch.

Single shot operation is achieved by depressing the SS button on the camera body.

AUTOMATIC OPERATION

With the MASTER switch set to ON, the desired frame rate selected, and the OVERRUN switch set to the O position, the camera operation will be initiated by command signals generated by the MC at:

- Selection of phase 2 during an attack with bombs
- Selection of WRB or ARB
- Selection of TOO
- Pressing of gun trigger in AGG and AAO

The camera run signal is inhibited 2 seconds after weapon release.
On receipt of a weapon release signal from the SMS, a dot is imposed on the bottom left hand corner of the relevant film frame to provide an event marker.

HUD Camera Cassette Loading

Ensure that the cassette is full by checking that the "Film Remaining" indicator is registered at the "F" mark. Hold the cassette in the right hand , position aft of the camera body (Figure 1-48).
Feed the cassette forward into the cassette aperture of the camera body so that it engages the cassette guide.
Push the cassette firmly and steadily forward as far as it will go.
Turn the cassette latching lever to the locked position (Figure 1-48).

NOTE

> The locking lever will turn only when the film cassette is positioned fully forward into its loaded position. After the film cassette is properly inserted and locked, the white indicating bar should appear.

Cassette Unloading

Turn the cassette latching lever to the unlocked position (Figure 1-48).

HUD CAMERA CONTROL PANEL

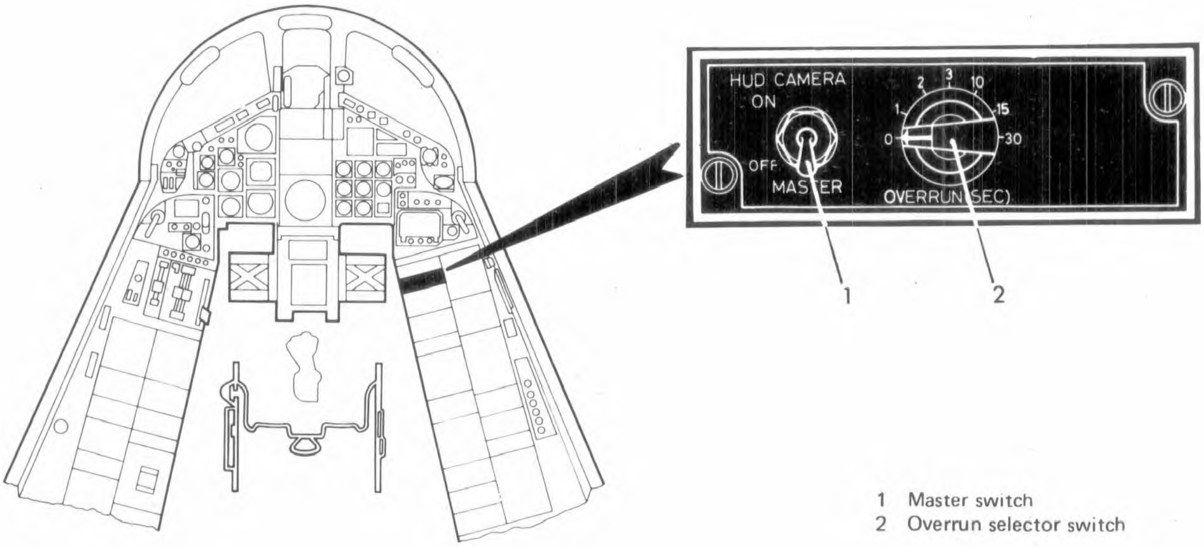
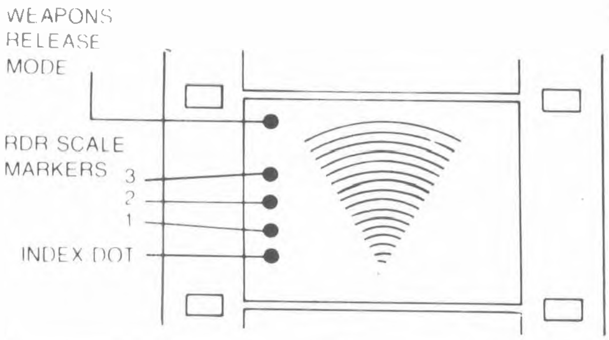


Figure 1-47

RADAR SCALE MARKERS



RADAR SCALE	2	4	10	20	40	80
INDEX MARKER	●	●	●	●	●	●
1ST MARKER	●		●		●	
2ND MARKER		●	●			●
3RD MARKER				●	●	●

Figure 1-49

Insert the right hand index finger into the lug at the top of the cassette and pull the cassette firmly aft until the resistence of the safety catch is felt.
Grip the cassette in the right hand and apply a slight downward pressure to clear the safety catch, then pull the cassette clear of the camera body.

HEAD DOWN DISPLAY RECORDER (HDDR)

The HDDR equipment provides facilities for a film record of:

- Ground Mapping Radar video and symbols from the CRPMD
- DU-1/DU-2 video display (TV/TAB 1/2)

The HDDR system consists of a camera/CRT unit, an electronics unit and a control panel.
Except for the control panel, the electronic control unit and camera/CRT unit is remotely controlled and without external setting controls.
The recording camera is loaded with a 16 mm film cassette. Running time at a frame rate of one per second is approximately 33 minutes.
The electronic unit and the camera/CRT unit operate with 115V and with 28V DC. The control panel is supplied with 28V DC. A continuous (automatic) BITE facility is incorporated into the recording system.

HUD CAMERA AND FILM CASSETTE

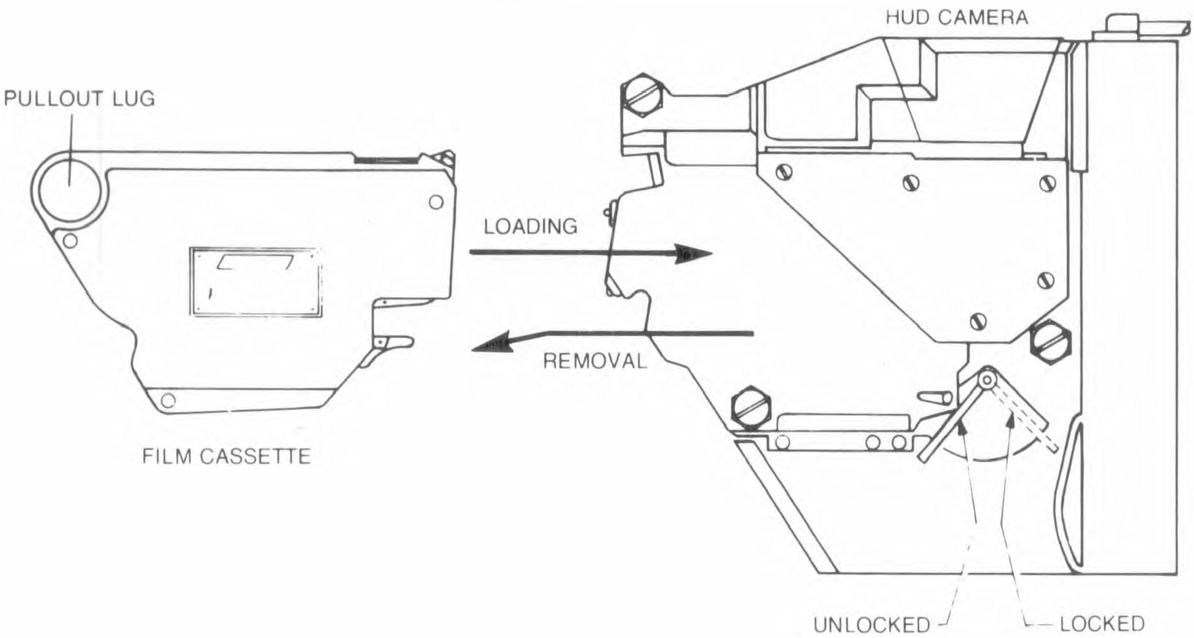


Figure 1-48

Radar Scale Marking

Three Light Emitting Diodes (LED) in the camera/CRT unit are used to indicate on the film the radar scale currently in use during radar mode operations. Each LED light emission causes a dot to be recorded on the film. A fourth LED is continuously emitting whenever the HDDR is recording in a radar mode, and provides a reference index on the film to mark radar scale position. A fifth LED, driven by a weapon release signal from the MC, records weapon release events on the film. A radar scale table is shown in Figure 1-49.

HDDR Control Panel

The HDDR control panel and its controls are shown in Figure 1-50.

FILM REMAINING INDICATOR

(Not operative)
Post mod. 10841
Film remaining indicator deleted.

FRAME RATE SELECTOR

A three-position toggle switch labelled FRPS controls the film frame rate when recording TV/TAB 1/2 information only. Position 1, 2 and 4 select frame rates of one, two and four frames per second respectively.

FAIL I/P FAIL INDICATOR

The FAIL-I/P FAIL indicator is a split amber caption indicator labelled FAIL-I/P FAIL.
The upper FAIL caption illuminates amber when the BITE function has detected a fault, in the case of film breakage, or at the end of film.
The lower I/P FAIL (Input Fail) caption illuminates amber if:

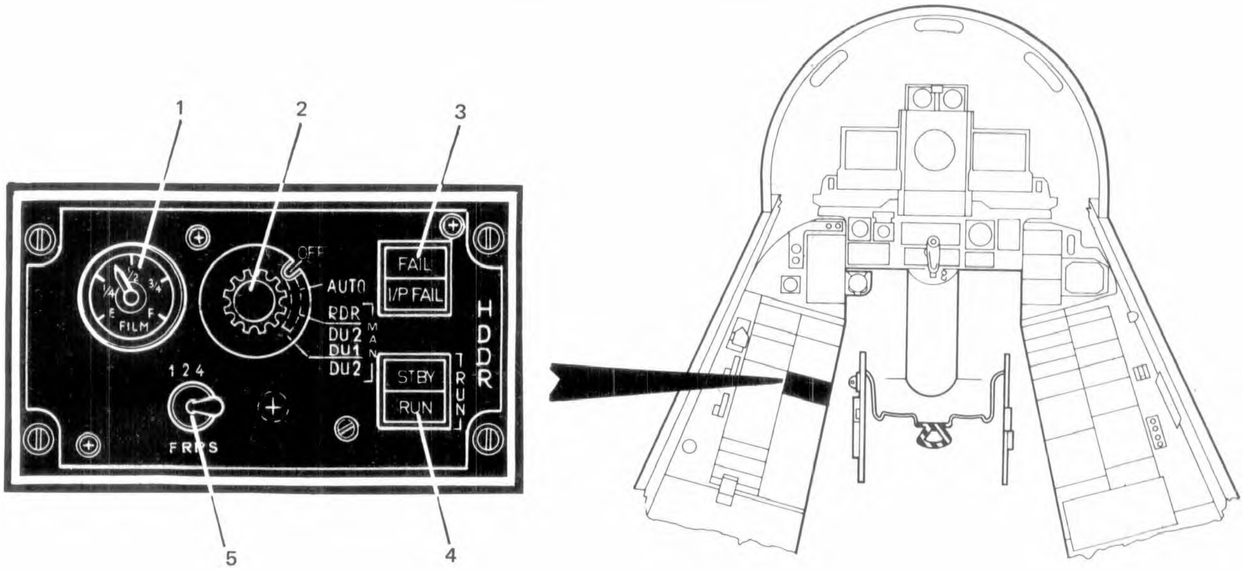
- A RDR/DU2 sequence has been selected but end-of-scan pulses fail to appear.

- A DU1/DU2 sequence has been selected but "sync" pulses fail to appear

NOTE

If a HOJ, TA, AGR, or LCK ON mode on the CRPMD is selected, since the end-of-scan pulses are absent, the HDDR will automatically generate its own pulses of 1 sec. but the I/P FAIL caption will remain illuminated.

HDDR CONTROL PANEL



1 Film remaining indicator (not operative)
Post Mod. 10841
Film remaining indicator deleted
2 Mode switch Knob
3 Fail-IP/Fail indicator
4 Run button and stby/run indicator
5 Frame rate selector

Figure 1-50

MODE SWITCH KNOB

A rotary switch which has the following positions:

- OFF
- AUTO
- RDR/DU2
- DU1/DU2

In the OFF position, all electrical power to the HDDR is disconnected.
A BITE test will be initiated whenever the mode switch is moved from the OFF position.
In the AUTO position, electrical power supplies are connected to the HDDR circuits and the manual RUN circuit is inhibited. The STBY indicator will illuminate for a 75 sec. warm-up period and will extinguish at the end of this period unless the BITE test has detected a fault. The HDDR will now operate automatically from command signals generated by the MC during certain phases in navigation and attack modes. The MC will initiate these recording sequences according to radar mode, keyboard selections and weapon selections. Three frames from each commanded source will be recorded as follows:

- During phase 1 of a planned or unplanned attack with LCK-ON or HOJ selected, radar only is recorded.
- During phase 1 or phase 2 of an unplanned attack with PLN or NAV selected on the TV/TAB, radar only is recorded.
- During phase 1 and phase 2 or a planned or unplanned attack, with F/A selected on the TV/TAB, radar and DU1 or DU2 will be recorded. LCK-ON and HOJ not selected.

In the MAN-RDR/DU2 position, the STBY indicator will illuminate and after a 75 sec. warm-up period, it will extinguish, provided that no fault has been detected by the BITE test.
Radar-DU2 sequence may then be initiated by pressing the RUN switch.
The HDDR will switch from radar recordings to DU2 recordings at three frame intervals. This sequence will continue until cancelled by second pressure on the RUN button.
In the DU1/DU2 position, the STBY indicator will illuminate and after the normal 75 sec warm-up pe-

riod it will extinguish, provided that no fault has been detected by the BITE test, DU1/DU2 recording sequences may than be initiated by pressing the RUN switch. The HDDR will switch from DU1 to DU2 recordings at three-frame intervals. This sequence will continue until cancelled by second pressure on the RUN switch.

RUN BUTTON AND STBY/RUN INDICATOR

The button/indicator is a press-to-start/press-to-stop switch incorporating the split legend STBY/RUN indication. The RUN caption will illuminate green when the switch is depressed and initiates HDDR recording operations, provided that the STBY and FAIL indications are extinguished, and the mode switch is in one of the MAN position. Second press on the button will terminate recording operations.
If, on initialing a HDDR operation, the RUN button is depressed twice in rapid succession a complete sequence from both sources will be recorded, at the completion of which the recording operation will be terminated automatically.

NOTE

The STBY caption illuminates amber when the HDDR is in the warm-up period. If, subsequent to this period it remains illuminated together with the FAIL indication, it indicates that the BITE test has detected a failure.

PANEL LIGHTING

The legends on the control panel are illuminated by an electroluminescent panel. The intensity of the lighting can be adjusted through the cockpit dimmer system.

HDDR Operation

Operation of the remotely installed HDDR is effected from the control panel. Setting the mode switch from OFF to the required recording mode activates the HDDR. The STBY indicator light on the control panel will illuminate for approx. 75 seconds after initial turn-on, then extinguishes. To record in the manual mode, the mode switch is set to either RDR/DU2 or DU1/DU2, the frame rate switch to the desired setting (1, 2, or 4 FPS), and the RUN button depressed.

To stop manual operation the RUN button is pressed again.

NOTE

After pressing the RUN button a second time to stop manual recording, the HDD recording camera will complete the current recording cycle before it terminates operation.

To record in the automatic mode, the mode switch is set to AUTO and the recording cycles will be initiated by the main computer. While taking radar frames, the frame rate will be controlled by the radar end-of-scan pulses.

HDDR Cassette Loading

To load a new cassette into the Camera/CRT Unit:
Ensure that the film indicator shows that the cassette contains the full amount of film.
Depress the catch to release the magazine cover.
Insert the cassette into the magazine, close the magazine cover.

Cassette Unloading

To unload a cassette from the Camera/CRT unit:
Depress the catch to release the magazine cover.
Withdraw the cassette and place it in a suitable container. Close the magazine cover.

CRASH RECORDER

The crash recorder (CR) system is an independent device designed to monitor, condition and record signals from certain aircraft systems. Specific parameters and events are recorded on tape in digital form. In addition a direct audio record is made from the aircraft's CCE.
The data recorded on the CR may be used for analysis following a crash or major incident.
The CR is located in the upper fuselage spine.

Crash Recorder Equipment

The system comprises the following units:

- Data Acquisition Unit (DAU)
- Accident Data Recorder (ADR)
- Normal Acceleration Unit (NAU)

The 115V, 400 Hz single-phase supply and 28V DC are routed respectively from bus-bar XP3 and bus-bar PP3.

- The DAU receives, selects and conditions the various parameters to be recorded, converts these parameters into digital format and transmit them to the ADR in the correct sequence and in the correct recording format.
- The purpose of the ADR is to make a direct record of audio signals present in the CCE and to provide a digital record of specified parameters and events occurring during flight. The audio record is of the preceding 40 minutes flying time and the digital record is of the preceding 120 minutes.
- The NAU detects aircraft accelerations in the normal (vertical) axis and provide signals to the ADR proportional to these accelerations.

Controls and Indicators

The crash recorder control comprise the following element: ENGINE START SWITCH.
The ENGINE START switch on the engine start panel will activate the CR when selected to LEFT or RIGHT.

CR Operation

The CR equipment is brought to the standby operating condition when the electrical power supply is applied to the aircraft. The equipment becomes operational when the engine start switch is set to left or right or when the weight is off the aircraft wheels.

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION II

NORMAL PROCEDURES

TABLE OF CONTENTS

Title	Page
Preparation for Flight	2-1
Pre Flight Checks	2-1
Starting Engines	2-10
Taxiing	2-18
Before Take-Off Checks	2-21
Line Up Checks	2-21
Take-off	2-23
After Take-Off/Departure Checks	2-25
Climb/Cruise	2-25
Air to Air Refuelling	2-26
Receiver Role	2-26
Tanker Role	2-27
Descent/Recovery	2-28
TF Operation	2-29
Landing	2-29
Braking Technique	2-33
Go Around	2-36
After Landing	2-36

NOTE

- It is responsibility of the aircraft commander to assure that all checklists procedures are complied with.
- For all weapon related checks, refer to the appropriate Weapons Manual.
- Mission essential information for avionic system operation, normal modes, reversionary modes etc., will be covered in Section IV.

PREPARATION FOR FLIGHT

FLIGHT RESTRICTIONS

Refer to Section V for the Operating Limitations imposed on the aircraft.

FLIGHT PLANNING

Refer to AER.1F-PA200-1A, Performance Data.

WEIGHT AND BALANCE

For maximum mass and CG limitations, refer to Section V, Operating Limitations. For detailed informations, refer to AER.1F-PA200-5.

PRE FLIGHT CHECKS

INITIAL CHECKS

Front Cockpit

1. Canopy accumulator pressure – 150 bar min
2. Ejection seat and canopy – Safe for parking

The aircraft is safe for parking when safety pins are inserted in the ejection seat firing handles, the canopy jettison initiator unit, and the canopy MDC initiator units.

3. Crash bar – Aft
4. Voice recorder – STOP
5. Flaps and wing sweep levers and probe switch – Set to actual positions
6. APU power switch – As required (Post mod. 00011)
7. Throttles – HP SHUT
8. X-drive clutch – OPEN

EXTERIOR CHECK

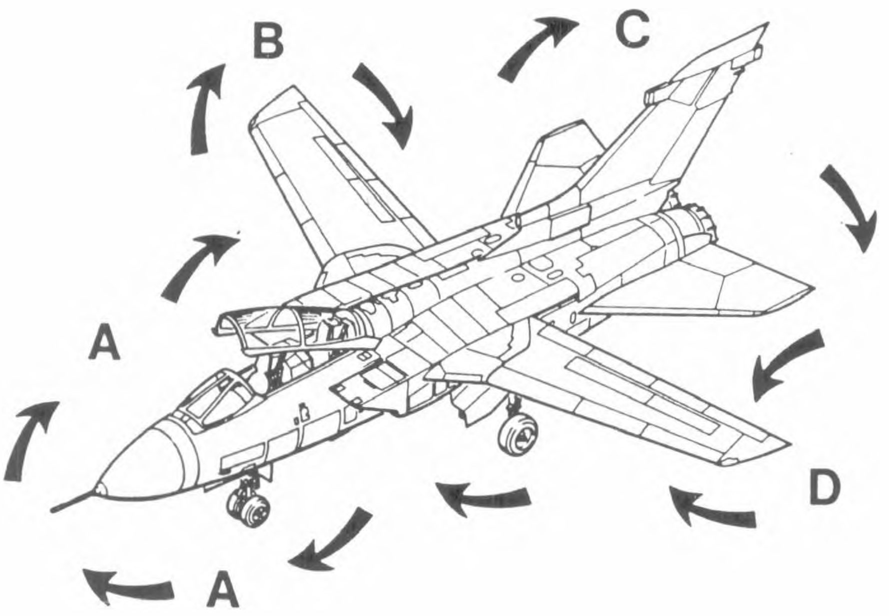


Figure 2-1

NOTE

The X-drive clutch should be in OPEN position prior to APU start for load reduction thus preventing possible APU first stage turbine disk failure.

9. Landing gear lever – DOWN
10. LP cocks – Guarded
11. MASS – LOCK SAFE, green flag, key available
12. Late arm – Guarded
13. Control column switches – Guarded
14. Hydraulics – Both AUTO
15. Brake handle – Park
16. Air system master – As required
17. TF radar – OFF
18. Rapid take-off panel – Gang bar up. W/SCREEN HEATER and PITOT HEATERS OFF

NOTE

Prior to checking relights, confirm that both throttles are in HP SHUT to avoid the risk of an engine ground fire, if the APU is running.

19. Relights – Check
20. Ignition (Engine control panel) – OFF
21. Generators – Both OFF, FAIL lights on
22. APU auto test – TEST, APU caption on CWP
23. Nav. lights – As required
24. Emerg UHF – ON, channel set
25. Connect external power or start APU (Prolonged Operation)

NOTE

AC power shall be on line as soon as possible after the battery master switch is set to FLIGHT to ensure that the ground cooling fans are operating. If AC power is not on line within two minutes of battery selection, a warning horn in the right landing gear bay sounds.

Rear Cockpit

1. Ejection seat and canopy – Safe for parking
2. Attack release – Guarded
3. WCP1 – Jettison guarded, lights out

4. TR switch (TRAINER) – FRONT
5. LP cocks (TRAINER) – Guarded
6. CRPMD – OFF
7. MC control panel – All OFF
8. INCDU – OFF
9. SAHR – OFF
10. Doppler – OFF
11. V/UHF – T/R + G
12. CCS – As required, ANT UPPER, CVR button out
13. Voltmeter (Post Mod. 01662) – Check battery voltage 25 to 27V
14. Inform pilot clear for external power or APU start

EXTERNAL CHECKS

The exterior inspections are divided into four main areas (Figure 2-1).
The entire area around the airplane as well as engine air intakes, bleed doors, ECS cooling intakes and exhausts, and afterburner ducts should be generally examined for FOD.
All surfaces should be checked for cracks, distorsion, or loose or missing fasteners. All fasteners should be flush and secure on all panels.
Attention should be directed to surfaces, lines and actuators for oil, fuel and hydraulics leaks.
All movable surfaces should be inspected for position, clearance and obvious damage.
Air intakes clear of water puddles. Ground locks and pins shall be removed.

Nose

1. WPU – Check
2. Accumulator pressure:
   Canopy – 150 bar minimum
   Brakes – 150 bar minimum
   Pitch feel (2) – 53 bar minimum
3. Canopy external controls – Secure
4. Pitot probe – Cover removed, condition
5. Static vents (3) – Plug removed
6. Nosewheel and leg assembly – Check tire, oleo and general condition
7. Nosewheel bay – c/b covers as required
8. Canopy jettison/MDC firing handle – Secure
9. AOA probe – Cover removed, condition
10. UHF/TACAN aerial – Condition
11. Upper IFF aerial – Condition
12. Hinged nose cone – Condition, locked
13. Pitot probe – Cover removed, condition
14. AOA probe – Cover removed, condition
15. Static vents (4) – Plugs removed
16. Pitot probe – Cover removed, condition
17. Intake and ramp – Fully open, condition
18. Nav. and a/coll. lights – Condition

Centre Fuselage and Wing

1. Krueger flap – Condition
2. Landing gear door safety switch – CLOSED and wire locked
3. Battery switch (Refuel panel) – ON
4. Fire bottle fuse indicators – Not red
5. RCOV – INT

CAUTION

IF THE L AND R RECIRCULATION CHANGEOVER VALVES ON THE GROUND SERVICE FUEL PANEL DO NOT SHOW INT, THE APU SHALL NOT BE STARTED.
IF ALREADY RUNNING IT SHALL BE SHUT WITHOUT DELAY TO AVOID THERMAL LOCK AND POSSIBLE FUEL FEED LINE RUPTURE.

6. APU switch – Guarded
7. Mainwheel and leg – Check tire, brake wear, oleo and general condition
8. Slats – Condition
9. Obst and form lights – Condition
10. Flaps – Condition
11. Wing slot seals – Condition

Aft Fuselage

1. Hydraulic gauge – Contents
2. Fire extinguisher pressure relief indicator – White
3. Airbrake – Condition
4. Taileron – Condition
5. Main accumulator pressure – 140 bar minimum
6. Jet pipes and thrust reversers – Condition
7. Engine bay doors – Closed
8. Lower IFF aerial – Condition
9. Fin and rudder – Condition, rudder centred
10. Arresting hook – Condition, pin removed

Left Fuselage/Wing

1. Main accumulator pressure – 140 bar minimum
2. Taileron – Condition
3. Airbrake – Condition
4. Hydraulic gauge – Contents
5. Wing slot seals – Condition
6. Flaps – Condition
7. Obst and form lights – Condition
8. Slats – Condition
9. Mainwheel and leg – Check tire, brakewear, oleo and general condition
10. Nav. and a/coll. lights – Condition
11. Krueger flap – Condition
12. Intake and ramp – Fully open, condition

EJECTION SEAT CHECKS

1. Safety pin – In
2. Manual separation handle – Secured, sear connected
3. Trip rods – Secured
4. Harness and strap – Correctly routed and secured
5. Scissor shackle – Closed, locked, laid flat.
6. Parachute pack – Closed, secured, safety ties intact.
7. Seat top latch – Flush
8. Drogue withdrawal line – Secured.
9. MDC unit – Trip rod secured
10. Emergency oxygen gauge – Contents (green mark)
11. Emergency oxygen operating handle – In position
12. PSP lowering line – Connected, sticker clip secure
13. Quick disconnect unit – Secured

STRAP IN PROCEDURE

The following procedure may be used:

WARNING

IT IS IMPERATIVE THAT THE FLIGHT SUIT LOWER LEG SIDE POCKETS ARE KEPT EMPTY SINCE ANY OBJECTS STOWED MAY DISTURB EJECTION.

1. Pitch control unit – Dial weight (Post mod. 00996: Pitch control unit is deleted)
2. Seat height – Adjust

CAUTION

CHECK QRB PROPERLY STOWED BEFORE OPERATING THE SEAT TO PREVENT DAMAGE TO THE SEAT.

3. Leg restraint lines – Fit and adjust

WARNING

THE LEG RESTRAINT LINES SHALL BE FITTED TO PREVENT LEGS FROM FLAILING DURING THE EJECTION. CHECK THAT THE LEG RESTRAINT LINES ARE ROUTED CORRECTLY THROUGH THE GARTERS AS OTHERWISE SERIOUS INJURY COULD RESULT DURING EJECTION.

4. Rudder pedals – Adjust
5. Combined harness – Fasten.
   Lock inertia reel and fit lap straps and shoulder straps. All hoses and connections routed under lap strap except for anti-g hose. Check QRB showing LOCKED

WARNING

- THE NEGATIVE G STRAP SHALL NOT BE ROUTED THROUGH THE LOWER EJECTION HANDLE.
- THE COMBINED HARNESS SHALL BE FASTENED AS TIGHTLY AS IT IS COMPATIBLE WITH SAFE AIRCRAFT OPERATION AND COMFORT.

6. Shoulder harness reel lock – Check operation
7. Arm restraint lines – Connect

WARNING

THE ARM RESTRAINT LINES SHALL BE FITTED TO PREVENT ARMS FROM FLAILING WHEN EJECTING.

8. Personal service lines – Connect:
   Main oxygen hose (oxygen supply – ON)
   Tel/mic cable
   Anti g hose

NOTE

Before closing the canopy ensure that personal equipments leads are secured. Stow jettison initiator safety pin and MDC pins.

9. PEC (man portion) – Check properly fitted
10. PSP lowering line – Connected to life vest. The lowering line shall be routed above all hoses and the lap strap

UNSTRAP PROCEDURE

1. Pilot/navigator – Ensure that seat firing handle safety pins and canopy jettison initiator unit safety pin are installed before canopy operating
2. Arm restraint lines – Disconnect and stow
3. QRB – Release
4. PSP lowering line – Disconnect
5. Leg restraint lines – Release and pull clear
6. MDC pins – Insert

INTERNAL CHECKS – FRONT COCKPIT

1. Ejection seat – Check. Strap in
2. MDC:
   Witness marks – Aligned
   Handle – Secure
   Pin – Stow
3. Canopy jettison pin – Stow
4. Oxygen – ON, 100, check MI, AM, test safety pressure, check MI, AM/100 as required

NOTE

If the aircraft has been cold soaked for a prolonged period under extreme cold temperature, refer to section VII, Cold Weather Procedures.

5. V/UHF – T/R + G
6. CCS – As required, ANT UPPER
7. APU start:
   Ground crew/navigator – Ready for APU start, fire guard posted
   A/coll lights – As required
   APU – START, RUN light flashing

CAUTION

APU OFF IF NO LIGHT UP WITHIN 15 SEC. THERE IS THE POSSIBILITY OF SERIOUS FIRE HAZARD CAUSED BY FUEL FILLING THE APU EXHAUST DUCT SUFFICIENTLY TO DRIP ONTO THE APU STARTER MOTOR.

To minimize stress and thermal load on the APU, start APU with the X-drive clutch set to open followed by 1 minute temperature stabilizing period.

NOTE

- During APU starting, with hot weather conditions (OAT higher than 25°C) and for cold weather conditions (OAT equal or below -10° C); to prevent the risk of an APU overload mantain: X-drive clutch OPEN, R Hyd. and R Gen set to ON. After first engine starting X-drive clutch shall be set to AUTO and L Hyd and L Gen will be considered.

- APU performance is limited to single gearbox operation only. The APU bleed shall be open to ensure sufficient cooling of the recirculation fuel.

- APU running with tailwind component greather than 10 kt shall not exceed 10 minutes.
- With APU running, testing of APU fire warning system will cause the APU to shut down.

After 1 minute:
X-drive clutch – AUTO
L and R hyd – 70 to 110 bar
Generators – Both ON, check each generator in turn, both ON, FAIL lights out

Ensure full serviceability of each generator by monitoring the relevant FAIL light and the GEN/CWP caption. Abort if failure is detected.

CWP – AC, DC, TRU and GEN captions out

8. If APU prolonged operation required:
   X-drive clutch – OPEN
   APU bleed – OPEN, RUN light steady
   R HYD pressure – 70 to 110 bar
9. When required to close canopy:
   Left hydraulics – ON, white sector, AUTO
   MDC/Canopy witness marks – Aligned
   Mask on, visor down
   Canopy – Closed and lock
10. Rad alt – ON
11. ESRRD:
    MODE – TEST
    TFR – NORM
12. HUD – DIR
13. TACAN – T/R
14. IFF – STBY
15. TF radar – STBY, FIXED FREQ

Left Console

1. Jack telease handle – Stowed wire intact
2. Canopy jettison handle – Stowed wire intact
3. Emergency airbrake – Guarded
4. Emergency flap – Guarded
5. Anti dazzle – OFF
6. CSAS – Guards down, READY light on
7. AFDS control panel – SCH 1500
8. AFDS BITE – Check
   ICO – Press
   Pre-flt/1st line – PRE FLT
   AFDS CP: AP GO lit
   FD GO lit

BITE pusbutton – PUSH
AFDS CP: COMPTR 1
COMPTR 2 lit.
Pushbutton flashing (after approx. 90 sec)
CWP: AUTO P
AP MON,
AP TRIM lit

Pitch SFCO – Operate, CWP lights out
AFDS CP: FD, THROT, TF lit

ICO – Press
AFDS CP: FD, THROT out
CWP: AUTO P,
AP MON,
AP TRIM lit

Roll SFCO – Operate, CWP lights out
AFDS CP: TF out

BITE pushbutton – PUSH, light out

Pre-flt/1st line – Centre and guarded
AFDS CP: COMPTR 1,
COMPTR 2,
AP GO,
FD GO out
if no go: ABORT

NOTE

- A succesful BITE check of the AP is to be carried out prior to flight. If unsuccesfull, one ferry flight, is permissible without use of AP/FD.
- ATTD FAIL lit if SAHR/IN not aligned.

9. Wander lamp – Check, stow
10. BRSL – Both LOCK, guarded
11. Throttles – Full and free (do not rock), HP SHUT

Left Quarter Panel

1. Trim gauge – Condition
2. Krueger flaps – MI indicating correct
3. Selective/emergency jettison – As required
4. Emergency landing gear lever – In
5. Flaps/slat, airbrake, wing – Indicating correct
6. Land/taxi lights – OFF

Anti-glare Shields

1. Lift dump indicator – OL
2. TR – NORM, indicators blank
3. Hook light – Out
4. AOA indicator – Flag away
5. HUD camera – Film speed, cassette latched
6. Accelerometer – Reset
7. Approach progress indicator – Blank
8. Clock – Check
9. Standby compass – Condition

Main Instrument Panel

1. Landing gear indicator – 3 greens
2. NWS lights – Out
3. Rad alt – Set bug 50 ft, PRESS TO TEST, check 100 ± 10 ft, cross-check HUD and low height warnings, set bug to zero
4. AP light – Out
5. Flight instruments – Condition ADI erect, flags away, 1013 set, altimeter RESET
6. ESRRD – Check test formats, select ES or CR as required
7. HUD – Check test formats and SBS, camera as required, select AUTO and modes as required
8. RPMD:
   Mode – T, align display, insert
   PL Test – PL1 and PL2 lights on
9. HSI modes – TEST, check altimeter 1250 ft, select TAC, deselect TEST
10. WAMS lights – Out
11. WCP2 lights – Out
12. V/UHF remote indicator – Check, set dimmer
13. RWR and STWI – Set
14. Engine instruments – Check, flags away
15. Fuel flow – Zero
16. Fuel – Check contents, TEST, zero reading. Press the contents gauge TEST button and check that both pointers indicate zero and return to normal when the button is released. Check that fuel contents are correct and that the flowmeter reads zero.

Right Quarter Panel

1. EPS – OFF, pin in, light out
2. CWP – TEST 1, TEST 2
   - TEST 1 will activate:
     - All CWP captions
     - Attention getters
     - 600 Hz audio alarm
   - TEST 2 will activate:
     - All CWP captions (and Post mod. 00629: amber ICE), except amber L/R VIB
     - Front/rear attention getters and lyre bird
     - Engine compartment fire warning system, including fire extinguisher lamps
     - LG selector lever flashing

     Indications R/C:
     - CWP captions CABIN, U/C, L/R FIRE, amber FUEL (trainer), Post mod. 10229: red FUEL
3. Brakes pressure gauge – ACC press 150 bar minimum

Right Console

1. TACAN – TEST, REC
   X/Y switch – X
   BIT button – Press GO MI, range 000.0 and bearing 360 cross check BDHI/HSI
2. HSI mode selector – As required
3. HUD camera – ON, OVERRUN set
4. TBT – DATUM
5. Eng control – Both LANE 1
6. Intake control panel – Switches guarded, FAIL lights on, RAMPS OPEN
7. Internal lights – As required
8. Throttle rock test indicators – Both white
9. Fuel control panel:
   TANKS – OFF
   Probe – OUT, if external tanks empty to depressurize the tanks and avoid transfer from pressurized fuselage tanks into empty unpressurized external tanks
   Sequence – NORM, transfer lights as appropriate
   Fuel X-feed – AUTO
   All other switches – Aft or guarded
10. IFF – NORMAL, press TEST, light on, STBY

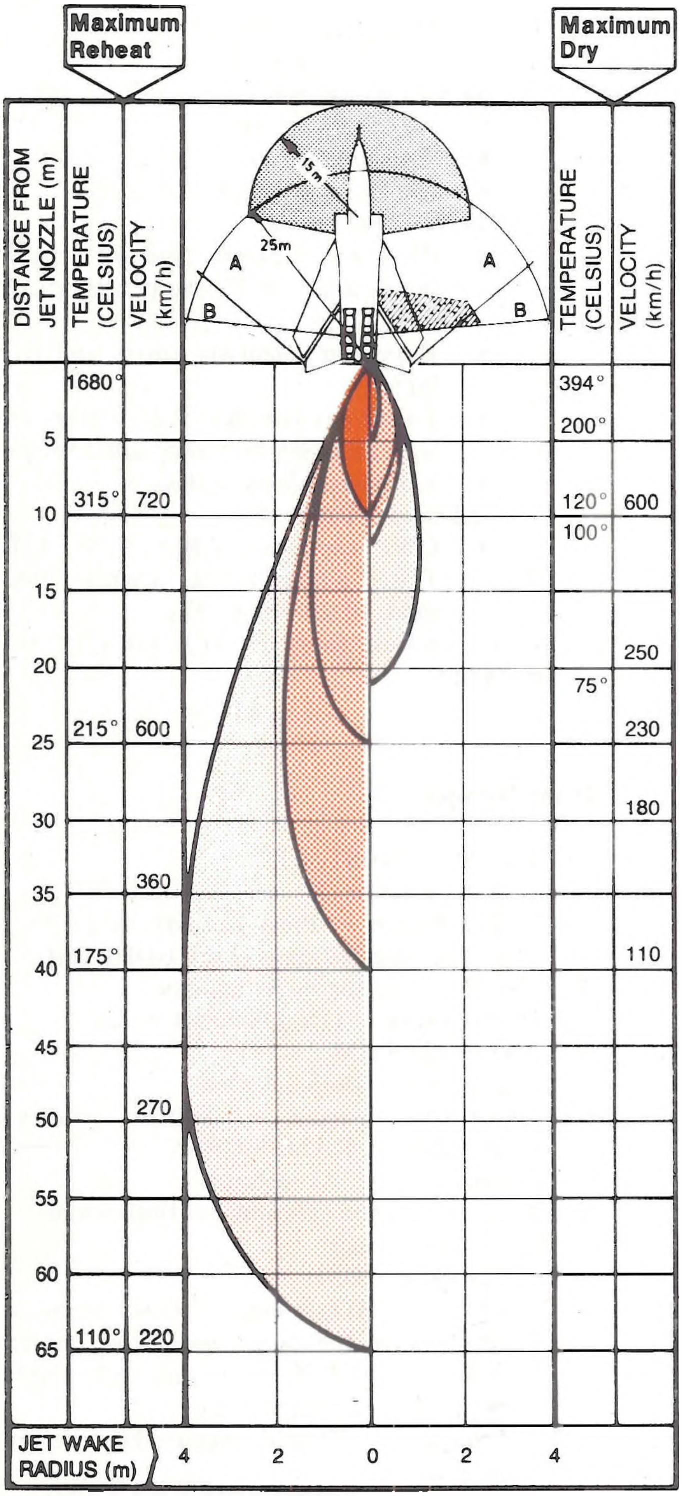
DANGER AREAS

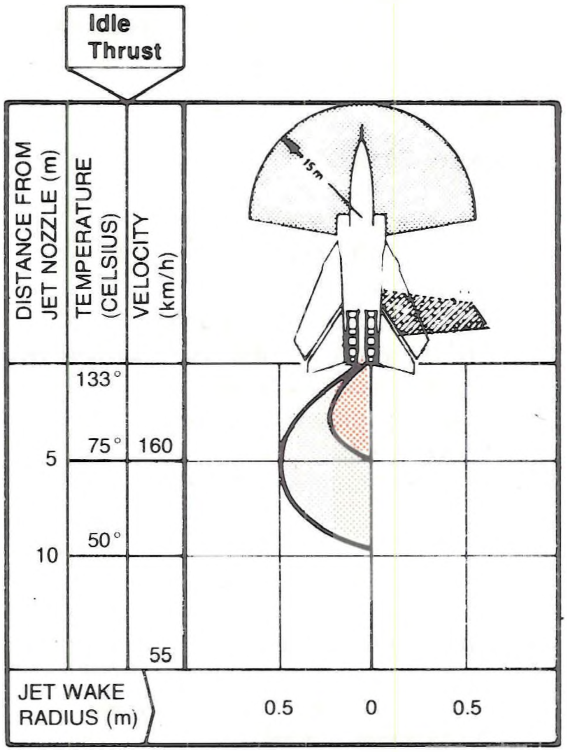
ENGINE INTAKE AND EXHAUST DANGER AREAS

Engine: RB199-34R Mk. 101

Data Basis: ESTIMATED

Date: 26 AUGUST 1977





APU Exhaust Danger Area

Intake Danger Area

WARNING

- These areas must not be entered
  A – Whilst thrust reverse is in operation
  B – During actuation of thrust reversers
- With APU or engines operating at/or above idle rpm ear protection should be worn due to high engine noise levels.

NOTE

- For clarity only one engine jet wake is shown
- Patterns are averaged. Conditions such as intermediate power settings, obstructions, reflections and weather conditions can cause the pattern to vary

Figure 2-2 (Sheet 1 of 2)

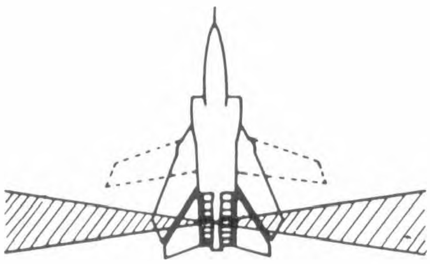
DANGER AREAS

WARNING

- Do not operate the TFR in any other mode than STBY or TEST as there is a radiation hazard to personnel within the scanning sector of 15 meters
- Do not operate the GMR in any other mode than M without INT selected when personnel are within the antenna scanning sector of 37 meters

Transmitter	Safe Distance from Antennas		
	Personnel Health Hazard	Electro Explosive Devices (EED) (installed)	Fuel
Radar	17 m		
TFR	39 m		
HF Radio	1.0 m	37.0 m	
ECM			
Doppler	1.0 m		

ROTATING PLANES OF ENGINE TURBINES AND DANGER AREAS FOR FLIGHT CONTROLS



WARNING

Do not actuate flight controls with personnel in close proximity of the horizontal stabilizers

TIRE AVOIDANCE

If landings are made which for some reason require maximum braking to stop the aircraft, avoid tire area for 30 min after aircraft has stopped. If necessary, approach from the front or rear only. If thermal release plugs have blown allowing tires to deflate, danger of explosive failure is minimal; however, danger of fire exists for at least one hour

Figure 2-2 (Sheet 2 of 2)

11. Environmental control panel:
    Rain disp. – OFF
    Stby W/S de-mist – OFF
    Oxy/test – Press, check in green zone, contents
    Cabin heat – AUTO
    Canopy de-mist – AUTO
    Cabin altimeter – Condition
    Intakes anti-icing – AUTO, FAIL lights out, press TEST, light ON

NOTE

With the intake anti-ice switch in the AUTO position and TEST pressed, the green indicator light illuminates for approx. 3 seconds. If a malfunction is detected in the system, the respective INTAKES ANTI-ICE FAIL light will illuminate.

12. Lamps – TEST, all indicators/warning lights on
13. External lights – As required

STARTING ENGINES

Refer to Figure 2-2, Danger Areas, for the extent of engine intake and exhaust hazard areas.

BEFORE STARTING ENGINES

1. Ground crew/navigator – Ready for engine start, fire guard posted
2. If APU in prolonged operation
    APU bleed – CLOSED
    X-drive clutch – AUTO

NOTE

At high OAT's (above 25° C) to avoid APU overloading, the X-drive clutch should be selected OPEN and therefore only the right engine may be started.

L hyd pressure – 70 to 110 bar
Generators – Check each generator in turn, both ON, FAIL lights out

Ensure full serviceability of each generator by monitoring the relevant FAIL light and the GEN/CWP caption. Abort if any failure is detected.

CWP – AC, DC, GEN, TRU, L/R THROT, REHEAT captions out

3. Left hydraulics – ON, white sector, AUTO

NOTE

Ascertain that canopy rails are clear of obstacles before closing the canopy.

4. Canopy – As required

STARTING FIRST ENGINE

Observe engine start limitations in Section V of this manual. With the X-drive clutch selected to AUTO, both gearboxes are driven by the APU and either engine may be started first.

NOTE

If the first engine fails to start, make a further attempt on the right engine with the x-drive clutch OPEN.

Selecting engine start switch to the appropriate engine will provide ignition and simultaneously engage the torque converter, driving the relevant engine.

1. X-drive clutch – OPEN if required
2. Engine start – Select, light on

NOTE

During the crash recorder system interruptive BITE, which is initiated by the first operation of the ENGINE START switch, a tone of approx. 1 sec lenght can be heard in the emergency UHF band.

The engine start is initiated by selecting the ENGINE START switch to RIGHT or LEFT respectively. Engine ignition will be operative immediately and after a 5 sec delay fuel will be delivered to the starter jets. T7 will increase to approx. 250°C and at approx. 21% NH the throttle lever has to be set to IDLE to open HP cock. This cause a transient decrease of T7 to about 150°C. Thereafter a steady rise in T7 up to approx. 500°C will be seen.

Simultaneously after a short slow acceleration to engine speed will wind up to the 65% NH idle speed.
T7 is not imposed during starting, but when T7 indication has changed to TBT, and absolute limit of 675°C indicated TBT shall not be exceeded.

3. Throttle – IDLE at 21% NH
4. TBT – 675°C max
5. START/CANCEL light – Out at 60% NH
6. CWP – OIL P out
7. Idle RPM – 64.5% to 68% NH
8. APU run light – Out

STARTING FAILURES

Hot Start

CAUTION

CANCEL START IN THE EVENT OF FLAME OUT, IGNITION FAILURE, ENGINE FIRE, OR ANY OTHER ABNORMALITY.

NOTE

With mod. 00644 embodied, selecting the throttle to HP SHUT will stop fuel supply to the starter jets and cancel the start cycle.

A hot start is indicated by an abnormally slow increase or stagnating NH, rapidly rising T7 followed by a switch over to TBT with rising temperature.
If it appears that TBT exceeds 675°C with NH less than 65%, throttle should be set to HP SHUT and the start/cancel button pressed to cancel starter jet fuel and ignition. Dry crank is recommended to reduce high engine temperatures subsequent to a hot start. In the event of an engine stagnation (hot start) a dry crank can be made without delay as necessary to reduce TBT.

To cancel start:

1. Throttle – HP SHUT
2. START/CANCEL button – Press

WARNING

A FURTHER START SHALL NOT BE ATTEMPTED IF TBT 675°C WAS EXCEEDED.

NOTE

T7 should be below 250°C before a further start is attempted.

Wet Start

If an engine fails to accelerate with the throttle set to IDLE at 21% NH, set the relevant throttle to HP SHUT and press the Start/Cancel button. Investigate prior to attemtping further starts.

WARNING

ALLOW 2 MINUTES BETWEEN START SELECTION; HOWEVER AN IMMEDIATE DRY CRANK MAY BE MADE TO REDUCE ENGINE TEMPERATURE, IF NECESSARY.

Dry Crank

Dry crank is recommended after wet starts.

1. Throttle – HP SHUT
2. Ignition (Rapid T/O panel) – OFF
3. CWP – Press and hold GND ACT button during start cycle

NOTE

With the ignition master switch OFF, the central warning system is deactivated. If the warning system is required during a dry crank, i.e. when dry cranking the second engine, press and hold the GND ACT button on the CWP.

4. Engine start – LEFT or RIGHT

When cycle complete, START/CANCEL light out.
5. Ignition (Rapid T/O panel) – FLIGHT

Attempt further start.

Engine fails to rotate

Set throttle to HP SHUT, press the start/cancel button and check that all switches are set correctly. No further starting attempts are allowed if they were in correct position.

Engine running inside NATO Hardened Aircraft Shelters (HAS)

To avoid damage to the aircraft structure, the limiting acoustic noise design level shall not be exceeded. Therefore following engine power limitations apply to single or double engine running:

– With the shelter doors closed, the maximum permitted engine setting is IDLE
– With the shelter door open, the setting shall not exceed 85% NH

AFTER FIRST ENGINE START

1. X-drive clutch – AUTO (if OPEN for first engine start; check GEN on)
2. RCOV – ENG

NOTE

Check with ground crew that the respective RCOV valve indication on the ground service fuel panel changes from INT to ENG as engine NH passes approx. 59%.
If ENG does not appear, shut down the affected engine as a malfunction of the RCOV circuit shall be suspected.

3. External power – Disconnect
4. L/R hyd pressure – Check white sector
5. CWP – Check L/R CONTR, L/R UTIL out
6. Utilities test – Check LEFT/RIGHT: L/R UTIL and RAMP captions on CWP
7. Wing sweep – 25 degrees
8. Flaps – Cycle, leave up
9. Manoeuvre flap/slat – Cycle, leave in
10. Airbrake – Cycle, leave locked in
11. Controls – Trim 2° nose up. Confirm tailerons full and free deflection

WARNING

PERSONNEL SHALL STAY CLEAR OF ALL CONTROL SURFACES WHEN THEY ARE IN OPERATION.

12. CSAS – Engage, check all lights out
13. Controls – Confirm full deflection of surfaces, pitch, roll and yaw
14. SPILS – ON, reset, light out

NOTE

The CSAS/SPILS BITE is required to be carried out at every seventh flight or after a max period of seven consecutive days, whichever occours first.

If CSAS BITE (pre-flight) required: the CSAS BITE comprises the automatic test and a test sequence which requires manual pilot inputs.
The lateral and pitch programs run in parallel and the automatic test is completed within 2 min, 43 sec. SPILS BITE is initiated by and runs in conjunction with the CSAS BITE. The successful completion of the automatic test is indicated by the white TEST light flashing.
A good SPILS BITE is indicated by the white flashing BITE light which will extinguish if the TEST button on the CSAS control panel is pressed. During the test cycle the FAIL light on the SPILS control panel may illuminate intermittently.

15. CSAS/SPILS BITE – Check
    NWS – Check disengaged
    Test button – Press, TEST light on
    SPILS control panel: BITE lit

WARNING

IN EMERGENCY CASES STOP BITE BY LOWERING THE BITE "TEST" BUTTON COVER GUARD.

During the initial part of the automatic BITE test period, carry out a trim check. Whereas the EMERG trim check requires only partial trim inputs, the NORM trim shall be checked over its full range to the stops. These trim checks shall be completed prior to the end of the automatic BITE period.

TRIM (P + R) – EMERG function o'ride, NORM, full range, leave fully nose down, roll neutral

NOTE

To ensure a valid CSAS BITE, the pitch trim shall remain full nose down and a LAMPS test shall not be performed during the automatic test period.

Under low temperature conditions, NO-GO status may be caused by a low hydraulic fluid temperature. The fluid temperature may be raised by exercising the primary flight controls for a min. of 1,5 min; thereafter the BITE run may be repeated.

If NO-GO:

Test button – Press
CSAS modes – Engage separately
Controls – Move for 1.5 min
BITE run – Repeat (omit Trim check, if completed)

If still NO-GO – Abort, record CMP

When the TEST light commences to flash, the manual part of the BITE should be initiated. To satisfy BITE requirements, the pitch trim shall be in neutral.

Pitch trim – Neutral
CSAS modes – Engage separately
Norm/Train switch – TRAIN
Pitch MD – Press, lights on, press out

When Pitch MD is depressed, the first time, the system goes into a second failure status, subsequently reverting to PMD normal mode when the button is pressed for a second time.

Norm/Train switch – NORM, guard down
Yaw trim – Full range, neutral

To ensure proper conduct of the test, full and deliberate control movements to each end stop shall be made, with the control being held at each stop position for a minimum of 2 sec. Pitch-up and rudder control movement demand considerable pilot effort.

Controls hold each end stop 2 sec:
Pitch nose down first, then up
Roll MD press – CSAS CP/CWP clear
Roll
Yaw

If TEST light flashes:

Repeat pitch nose up

If still flashing:

Abort
Test button – Press: TEST light out, GO light on

If NO-GO:

Repeat lateral inputs

If still NO-GO:

Abort
Test button – Press again

Confirm:

GO light out
Guard down
CSAS CP/CWP clear
SPILS CP clear

Should the system fail the BITE, the white BITE and amber FAIL caption on the SPILS control panel will illuminate steady and the red SPILS/CWP caption is lit.

NOTE

If the BITE fails, select SPILS to OFF and restrict the aircraft non SPILS AOA and manoeuvre limits.

If CSAS/SPILS not required:

16. Trim check – EMERG function and o'ride, NORM, full range, P/R/Y

In all cases:

17. Trims – Set for take-off
18. Ramps – BITE (if required)

NOTE

The ramps test is required before any planed supersonic flight.

19. TF Radar – Press TEST, NO GO light out, check E-Scope display, deselect TEST, B-risk light out

NOTE

With IN not aligned (e.g. not in NAV with STATUS 4) the red TFR/CWP caption will remain illuminated till the end of the test cycle.

STARTING SECOND ENGINE

Refer to STARTING FIRST ENGINE procedure step 2 to 7.

AFTER SECOND ENGINE START

1. RCOV – ENG check with ground crew
2. X-drive clutch – PUSH OPEN
3. CWP – TEST 2, L/R VIB

The selection of TEST 2 with running engines is necessary to confirm proper functioning of the vibration warning system. Due to low vibration levels, the L/R VIB captions may not come on at IDLE, but shall illuminate below 75% NH.

NOTE

TEST 2 should not be selected in flight except to confirm the integrity of the fire warning system following an engine fire, because the fire warning may remain on after completion of the test.

Generally, LANE 1 is the preferred lane due to the auto change feature to LANE 2 in the case of a LANE 1 failure. LANE 2 will perform the same functions as LANE 1 and all operations are pratically identical in both lanes.

4. Lanes test:
   LANE 1 – Check control
   Lanes test – Both press
   CWP: L/R TBT lit, L/R OIL T, L/R FUEL T, L/R THROT
   TBT indicators 925 ± 5°C, check REHEAT caption out

After releasing the buttons, the temperature indications return to normal and the CWP caption extinguish.

When both engines are running the operation of the CUE automatic control lane changeover facility should be checked with LANE 1 selected. Pressing and holding the LANES TEST buttons will cause a light transient (max 2% NH) to occur. NH should not exceed 75%. At the same time the L/R THROT warning on the CWP will illuminate and the TBT indicators will wind up to 925 ± 5°C. Pressing the left LANE TEST button only (in LANE 1 and 2) will initiate an internal check of the engine temperature warning systems, and the amber L/R FUEL T, L/R OIL T in the front cockpit and the red L/R TBT warnings in both cockpits for both engines will illuminate on the CWP.
Upon release, all warning lights should extinguish and TBT/T7 readings return to normal.
When LANE 2 is selected and the same test is repeated, the same warnings and indications as above will be displayed but the light transient will be seen immediately when LANES TEST is selected. In addition the nozzles close to 5 ÷ 13% (ENC) and the amber REHEAT caption on the CWP in the front cockpit will illuminate. To reset the nozzle to normal, the relight buttons shall be pressed. After approx. 3 seconds the engines will return to the normal nozzle position and the REHEAT caption will extinguish. Thereafter the lane switches shall be reselected to LANE 1 and again the throttle warning will illuminate for a short period.

WARNING

IF THE REHEAT/CWP IS LIT, ABORT. DO NOT SELECT LANE 2.

NOTE

A lanes test with LANE 2 selected will cause the REHEAT indication on the Maintenance Panel to reset.
With cold engine the appropriate TBT caption may not come on until about 2 minutes running time are reached.

Eng Control – Both LANE 2

Throttles – Check control individually to 73% NH min. no THROT/REHEAT CWP warnings
Eng control – Both LANE 1

When LANE 1 is reselected the L or R THROT indication will illuminate during the transfer and extinguish when the transfer is completed.

Taxi nozzle – Check function

Proper function can be determined by the Aj indicator showing 100% when selecting TAXI NOZZLE.

5. CRPMD/RPMD – Functional cross-check:
   RPMD – R
   CRPMD – STB, map does not move, passive MKR at center
   RPMD – STB light on, no change of display
   CRPMD – NTH UP, map north orientated, check PP and track-line
   RPMD – NTH light on, map orientated, SL, check function, PP □, check PP moves to □ marker. Check all SCALES, PP O, check PP moves to O marker
   CRPMD – NRM, map track orientated, PP at bottom of display

INTERNAL CHECKS REAR COCKPIT (STRIKE)

1. Ejection seat – Check
2. Lamps – TEST, all indicators/warning lights on
3. TV/TAB 1 and 2 – ON
4. MCCP:
   IFU 1 and 2 – Both ON
   WFG – ON
   MC – ON
5. SAHR:
   Mode – FREE, check 8888
   Variation – Set

NOTE

For shelter operation SAHR may fail and require realignment outside.

6. INCDU:
   D31/D32 – OFF
   Align – NORM
   Mode – IPI
   Status – 7/blank
   DIS – HDG/DR, check heading, enter if required, PP, enter lat/long
   Mode – ALN
   DIS – D31 and D32, insert as required
   LH status – O
   Mode – NAV
7. RDE/MDE:
   Master switch – OFF
   Mode selector – REPLAY
   Cassette – Insert
   Tape pos readout – Check 000
   Master switch – STBY
   Tape drive switch – REV, hold until counters stop
   Mode selector – DATA ENTRY
   Master switch – START until TV/TAB displays RDE COMPLETE, FAULT or FAILED, then STBY
   TV/TAB – NAV/PLN

If RDE FAULT:
   TV/TAB – Fault line in ROL, amend and ENTER

If RDE FAILED:
   CVR – Repeat RDE or manually amend

If MCCP FAIL or CWP CMPTR caption lit:
   CVR master switch – STBY
   MC – Recycle, if required
   CVR – Repeat RDE (new cassette or enter manually)

8. Fuel – Check with front cockpit
9. Ejection seat – Strapped in
10. MDC:
    Handle – Secure
    Pin – Stow
11. Oxygen – ON, 100, check MI, AM, test safety pressure, check MI, AM/100 as required
12. Jack release handle – Stowed, wire intact
13. Canopy jettison handle – Stowed, wire intact
14. HDDR – Cassette loaded
15. Wander lamp – Check and stow
16. Special weapons panel – As required
17. HDDR control panel – Set as required
18. MRCP – Set as required
    Except: Frequency – FIXED FREQ
19. Oxy test – Press, check in the green zone, contents
20. Landing gear indicator – 3 greens
21. WPU BITE – Completed
    Chan fault – Both blank

Display source – Check A and B available
weapon package – Selected

22. Artificial horizon – Erect
23. CRPMD – M, INT after 5 seconds
24. CRPMD/GMR (complete):

WARNING

EVEN WHEN THE GMR IS OPERATING ON GROUND IN M OR M + S (STANDBY) MODE, THERE MAY BE A HAZARD FROM MICROWAVE RADIATION WITHIN THE ANTENNA SCANNING SECTOR (TO A DISTANCE OF 37 METERS). THEREFORE WHEN M HAS BEEN SELECTED, INT PUSHBUTTON HAS TO BE PRESSED AFTER 5 SEC AS A SAFETY PRECAUTIONS.

Mode - M, INT after 5 seconds
Display – NRM
IND MKR map – Set
Cursors – OFF
Frz/int hold – FADE
S-S/cont inv – S-S
Fade – As required
Scale – 20/40/80
Test – MAP, PL 1 and PL 2 lights on
NHC – Cursors and marker switch up, 90 sec after M selection align test frame, insert
CRPMD test – MKR, PL 1 and PL 2 lights out, MKR test format correct, adjust THRESHOLD, OFF

25. Altimeter and CSI – Set and check
26. RWR and STWI – Set
27. NWAMS – All lights out
28. ECM control unit – Set
29. CWP – TEST 1, TEST 2 (refer to RIGHT QUARTER PANEL, step 2).
30. CVR:
    Cassette – Check loaded
    Mode selector – MAN or AUTO
    Master switch – STBY or START
31. Doppler – ON, check test velocities SEA/LAND as required. Check TEST deselected

	Vx	Vy	Vz
SEA	1192 to 1237	143 to 184	24 to 41
LAND	1173 to 1218	129 to 170	24 to 41

32. Anti dazzle – OFF
33. Command ejection – As required
34. HF – OFF
35. Refuel probe light – OFF
36. CRPMD mode – Confirm INT selected. M + S after first engine start, check all fail lights out
37. TV/TAB, CRPMD – Enter system time, check mission data
38. INCDU – Check STATUS, select NAV
39. NMCP:
    Nav modes – All available, select MAIN
    Steering mode – As required
40. TV/TAB – PP enter, check POS
41. SAHR heading – Check if FES out, slew to IN heading

After 3 minutes warm up:

42. MRCP – Test, light out after 1 minute, NO-GO out

INTERNAL CHECKS REAR COCKPIT (TRAINER)

1. Ejection seat – Check
2. Lamps – TEST, all indicators/warning lights on
3. TV/TAB – ON
4. MCCP:
    IFU 1 and 2 – Both ON
    WFG – ON
    MC – ON
5. SAHR:
    Mode – FREE, check 8888
    Variation – Set

NOTE

For shelter operation SAHR may fail and require realignement outside.

6. INCDU:
    D31/D32 – OFF
    Align – NORM
    Mode – IPI
    Status – 7/blank

Dis – HDG/DR, check heading, enter if required, PP, enter lat/long
Mode – ALN
Dis – D31 and D32, insert as required
LH status – O
Mode – NAV

7. RDE/MDE:
Master switch – OFF
Mode selector – REPLAY
Cassette – Insert
Tape pos readout – Check 000
Master switch – STBY
Tape drive switch – REV, hold until counters stop
Mode selector – DATA ENTRY
Master switch – START until TV/TAB displays RDE COMPLETE, FAULT or FAILED, then STBY
TV/TAB – NAV/PLN

If RDE FAULT:
TV/TAB – Fault line in ROL, amend and ENTER

If RDE FAILED
CVR – Repeat RDE or manually amend

If MCCP FAIL or CWP CMPRT caption lit:
CVR master switch – STBY
MC – Recycle if required
CVR – Repeat RDE (new cassette or enter manually)

8. Ejection seat – Strapped in, weight dialled
9. MDC:
Handle – Secure
Pin – Stow
10. Oxygen – ON, 100, check MI, AM, test safety pressure, check MI, AM/100 as required
11. Jack release handle – Stowed, wire intact
12. Canopy jettison handle – Stowed, wire intact
13. Anti-dazzle – OFF
14. Brakes press gauge – ACC 150 bar min
15. Wander lamp – Check and stow
16. Special weapons panel – As required
17. HDDR – Cassette loaded
18. HDDR control panel – Set as required
19. Doppler – ON, check test velocities SEA/LAND as required Check TEST deselected

	Vx	Vy	Vz
SEA	1192 to 1237	143 to 184	24 to 41
LAND	1173 to 1218	129 to 170	24 to 41

20. MRCP – Set as required
Except: Frequency – FIXED FREQ
21. Flap selector, throttles, wing sweep selector – Check position
22. Emergency landing gear lever – IN
23. Flap, slat, air/br, wing and trim indicators – Condition
24. Oxy test – Press, check in green zone, contents
25. WPU BITE – Completed
Chan fault – Both blank
Display source – Check A and B available
Weapon package – Selected
26. TR – FRONT, indicators blank
27. Lift dump indicator – OL
28. Hook light – Out
29. Flight instruments – Condition, ADI erect, flags away
30. NWS lights – Out
31. Landing gear indication – 3 greens
32. AP light – Out
33. NWAMS – All lights out
34. RWR and STWI – Set
35. CRPMD – M, INT after 5 seconds
36. CRPMD/GMR (complete):
Mode – M, INT after 5 seconds
Display – NRM
IND MKR map – Set
Cursors – OFF
Frz/int hold – FADE
S-S/cont inv – S-S
Fade – As required
Scale – 20/40/80
Test – MAP, PL 1 and PL 2 lights on
NHC – Cursors and marker switch up, 90 sec after M selection, align test frame, insert CRPMD test – MKR, PL 1 and PL 2 lights out, MKR test format correct, adjust THRESHOLD, OFF
37. AOA indicator – Flag away
38. Accelerometer – Check
39. Engine instruments – Check, flags away
40. Clock – Set
41. Total fuel indicator – Compare with TV/TAB and front cockpit
42. ECM control unit – Set
43. CWP – TEST 1, TEST 2 (Refer to RIGHT QUARTER PANEL, step 2)

44. CVR:
    Cassette – Check loaded
    Mode selector – MAN or AUTO
    Master switch – STBY or START
45. Command ejection – As required
46. HF – OFF
47. Refuel probe light – OFF
48. CRPMD mode – Confirm INT selected
    M + S after first engine start, check all fail lights out
49. TV/TAB, CRPMD – Enter System time, check mission data
50. INCDU – Check STATUS, select NAV
51. NMCP:
    Nav modes – All available, select MAIN
    Steering mode – As required
52. TV/TAB – PP enter, check POS
53. SAHR heading – Check if FES out, slew to IN heading

After 3 minutes warm up:
54. MRCP – TEST, light out after 1 minute, NO GO out

TAXIING

For "Turning Radius" during taxi operations, see Figure 2-3.
Braking during taxiing prior to takeoff shall be minimized to reduce the hazard associated with hot brakes in the landing gear bay after retraction.

WARNING

IF THE TAKE-OFF IS MADE WITH OVERHEATED BRAKES, A FIRE HAZARD CAN ARISE AFTER LANDING GEAR RETRACTION, IF A HYDRAULIC LEAK IS PRESENT.

NOTE

- If heavy or prolonged braking is used during taxiing, the brakes may have insufficient energy capacity in the event of an aborted takeoff.
- Use of thrust reverse is not permitted because the reverse thrust locking mechanism will not be inspected prior takeoff.
- For taxi distance refer to Section V of this manual.

PRE-TAXI CHECKS

1. Air system master – ON
2. Anti-g – Check
3. Confirm with ground crew:
    CMP – Reset
    Panels – Secure
4. OTF and height fix – Perform as required

NOTE

The MC may not use height fix information immediately to update height, therefore do not repeat height fixing to prevent accumulation of height errors.

5. NWS – Engage, LOW light on
6. ICO – Press, LOW light out: when pressing ICO will cancel all other inadvertent selections
7. NWS – Engage, select HIGH (re-ingest audio)
8. BRAKES – Press BRAKES TEST

When releasing the BRAKES TEST button, observe a momentary pressure drop and no A SKID CWP caption.

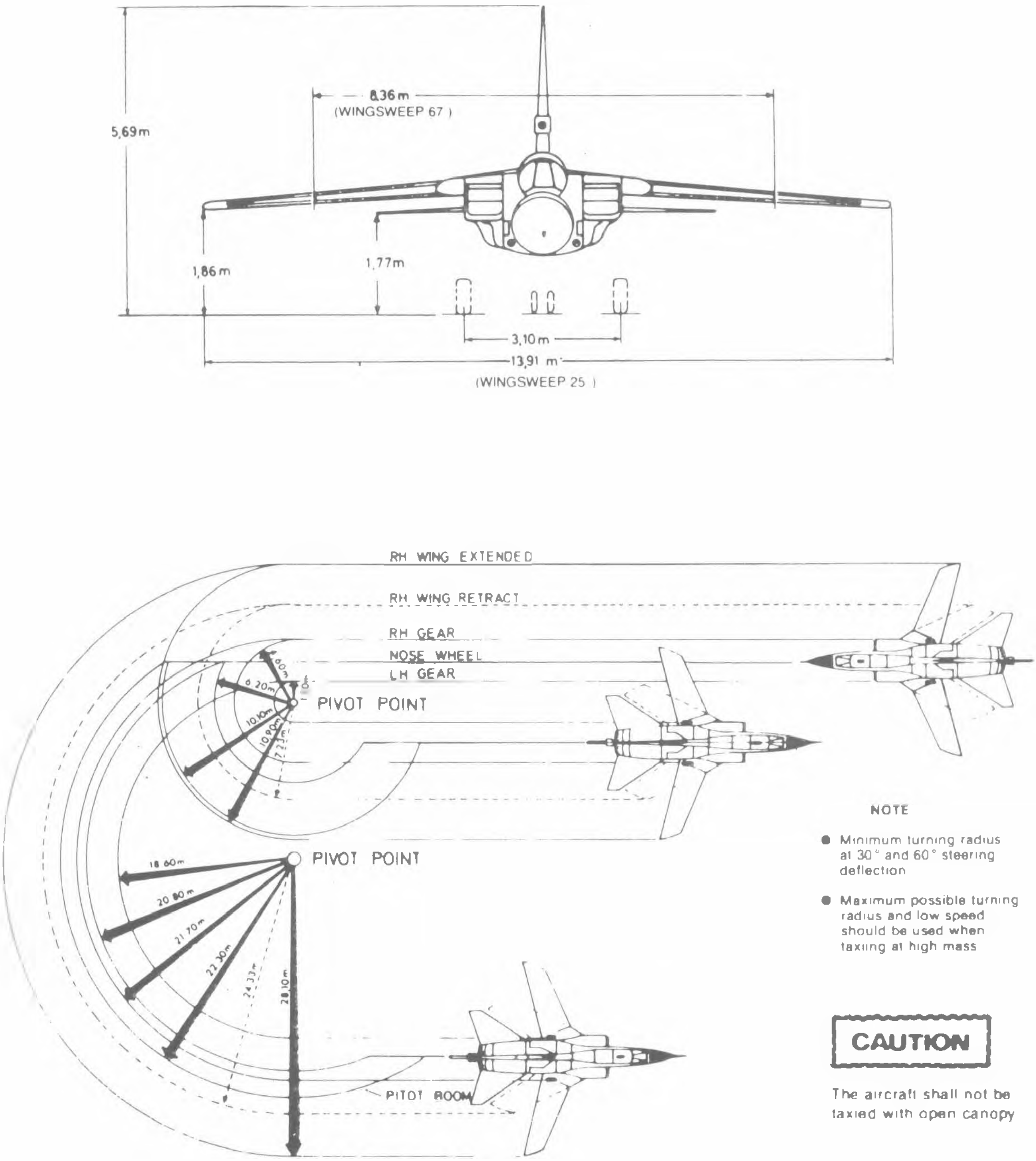
CAUTION

DO NOT PRESS THE TEST BUTTON WITHOUT CHOCKS IN POSITION OR AT HIGH POWER SETTINGS BEFORE TAKEOFF.

9. Hydraulics – Left ON, right AUTO (white sector)
10. EPS – Pin remove, AUTO, light out

The Emergency Power system control switch shall be selected to the AUTO position for all flying to protect against the consequences of a possible double engine flameout.

TURNING RADIUS



NOTE

- Minimum turning radius at 30° and 60° steering deflection
- Maximum possible turning radius and low speed should be used when taxiing at high mass

CAUTION

The aircraft shall not be taxied with open canopy

Figure 2-3

WARNING

IN CASE OF INADVERTENT SELECTION OF THE EPS TO ON, THE ONE-SHOT BATTERY HAS TO BE REPLACED BEFORE TAKE-OFF.

11. Flight refuel – Probe in, lights out (3)
12. Canopy – Closed and locked, seal inflated
13. Fuel temp – Below 70°C
14. Voltmeter (Post Mod. 01662) – Check pulsing above 28V

NOTE

For shelter operation, checks 15 to 23 should be completed outside shelter.

15. Wing sweep – As required
16. Flaps – As required
17. AFDS control panel – ATTD FAIL light, press if lit
18. Oxygen – AM
19. Seat pins – Stowed
20. Landing gear pins – Check removed
21. External/A-coll lights – As required
22. Compasses – Cross-check
23. Altimeters – Set, STBY, compare, RESET

NOTE

With the front cockpit altimeter in STBY or RESET mode the tolerance for a given QNH setting should be within ± 60 ft of the field elevation. The total difference reading between STBY and RESET mode should not exceed 100 ft.
The difference between front and rear cockpit altimeter readings should not exceed 75 ft in STBY mode.

TAXI CHECKS

1. Brakes – Check normal and emergency, reselect normal.

CAUTION

DO NOT SELECT PARKING BRAKE WHILE THE AIRCRAFT IS IN MOTION AS THIS WILL ABRUPTLY LOCK THE WHEELS, AND CAUSE TIRE DAMAGE.

NOTE

Care should be exercised when selecting the brake handle from NORMAL to EMERGENCY, as continued pulling and turning on the lever may cause it to enter the parking segment inadvertently, resulting in an abrupt locking of both main wheels. To deselect the handle from EMERGENCY to NORMAL, the lever shall be turned and pushed into position.

2. NWS – Check LOW, select HIGH

During taxi, the nozzle position may be selected to TAXI NOZZLE OPEN (100% Aj), reducing idle thrust by approx. 40%. Having selected TAXI NOZZLE OPEN, reverse thrust is inhibited and vice versa. A mechanical interlock within the throttle box will limit engine RPM to 80% NH with TAXI NOZZLE OPEN.

NOTE

With TAXI NOZZLE selected, the amber VENT caption on the CWP may illuminate due to insufficient LP Compressor bleed air pressure. Deselecting TAXI NOZZLE will extinguish the warning.

3. Left throttle – Rock outboard (LD) check differential spoilers, rock inboard
4. CRPMD – Deselct INT (in safe area)
5. GMR – Functional test, then M + S and INT
6. Flight/nav instruments – Check

BEFORE TAKE-OFF CHECKS

1. Wing sweep – 25°
2. Airbrakes – IN and locked
3. Flaps – MID
4. Trims – Set for take-off
5. X-drive clutch – AUTO, light out
6. Selective/emergency jettison – Set
7. Flight controls – Full and free
8. Hydraulics – Left ON, right AUTO (white selector)
9. EPS – AUTO, light out
10. Fuel – Quantity, balance, transfer, temperature
11. Ignition (Engine control panel) – NORM

The ignition selector switch should remain in the NORM position which will guarantee automatic ignition in case of a flame-out or an extreme deceleration in flight or during take-off. With the ignition selector switch in NORM position it should, however, be kept in mind, that the automatic ignition circuit will always be operative if the throttle is not in the HP SHUT position and certain NH speed conditions exist. If, for instance, one engine is shut down in flight or on the ground and the throttle is then reopened (for lift dump or reverse thrust checking), it is possible that any fuel remaining in the engine may be ignited.

12. Oxy – Contents, connections, flow, AM/100
13. Intakes anti-ice – As required
14. External lights – As required
15. Emerg radio – Check channel set
16. Canopy – Closed and locked, handle fully forward check seal
17. Command ejection – As briefed
18. Pins – Stowed, 4 front, 2 rear
19. Take-off emergency brief – Complete

When cleared for line up:

20. Air system master – As required
21. Rapid take-off panel – Gang bar up
22. Harnesses – Tight and locked, restraints, and PSP connected, visors down.
23. IFF – As required
24. WCP1 Chan fault – Both blank, except for uninstalled pylons/MWCA's coded Bogus
25. MASS – As required

LINE UP CHECKS

1. NWS – LOW
2. TR – Indicator blank
3. Engines check:
   GVNR TEST (if required) – NL (LANE 1) 80 ± 1%
   Throttles – MAX DRY, minimum power check if required

The NL governor check need only be carried out every 10 flying hours.
To perform the governor check with the ENG CONTROL still in LANE 1, select and hold the GVNR TEST switch to NL and advance the throttles to MAX DRY. The RPM indicators will automatically display NL speed which shall stabilizer at 80 ± 1%.
Retard the throttles to below 80% NL, thereafter release the GVNR TEST switch to OFF to avoid the risk of a surge being induced through momentary overfulling.
Refer to Minimum Power Check table, Figure 2-4, to confirm that engine values are within limits.

Throttles – MIN REHEAT, (MAX DRY for noise abatement take-off)

CAUTION

WHEN SELECTING REHEAT, ADVANCE THROTTLES STRAIGHT FORWARD. DO NOT EXERT ANY OUTBOARD PRESSURE TO AVOID SELECTING TR. SHOULD THIS ACCIDENTALLY OCCUR, CANCEL TR, REDUCE POWER AND RELEASE BRAKES TO PREVENT THE AIRCRAFT TO TIP OVER.

NOTE

If a reheat blow out occours, the nozzle will stay at the selected min reheat position.

4. CWP – All lights out
5. Brakes – Holding, check pressure

NOTE

Wheel slippage on runways with anti-skid surface shall ne avoided to prevent excessive tire wear.

MINIMUM POWER CHECK (MK 101 & MK 103 engines)

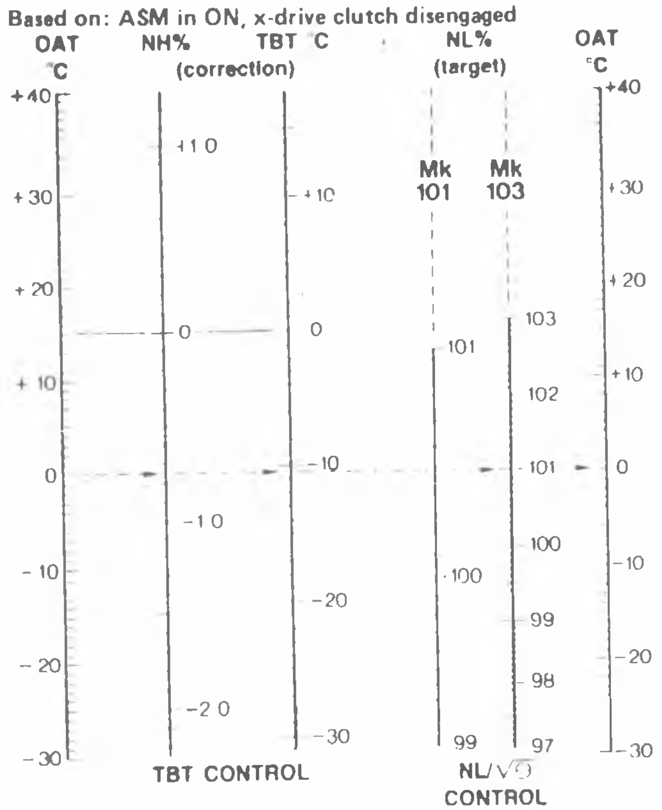


Figure 2-4

MINIMUM POWER CHECK

Values of NH and TBT relative to an OAT of 15°C are derived from engine installation ground runs. These values are displayed in the cockpit as Placard figures for each engine. Corrections to Placard figures for variations of OAT are applied as shown in Figure 2-4 to produce Target figures for each pre-take-off minimum power check.

To compare performance against target figures, set the AIR SYSTEMS MASTER switch to ON and run both engines at MAX DRY until engine parameters have stabilised. Compare NH and TBT against Target figure and check the nozzle positions. Do not fly the aircraft if either engine is out of tolerance of:

Engine	Aj	NH	TBT
Mk 101	16 ± 2.5%	± 1%	± 5°
Mk 103	12 ± 2.5%	± 1%	+ 10 − 5

If the placard NH value was defined with the ECS selected to ON and the pre take-off check is carried out in ERA, with both engines at max DRY 0.4% NH is to be added to the target figure for each engine before applying the tolerances.
If the placard NH value was defined with ERA selected and the pre take-off check is carried out with ECS selected to ON, with both engines at max DRY 0.4% NH is to be subtracted from the target figure for each engine before applying the tolerances.
During a placard check following gun and missile firing, normal Placard limitations apply. However,

TAKEOFF (TYPICAL)

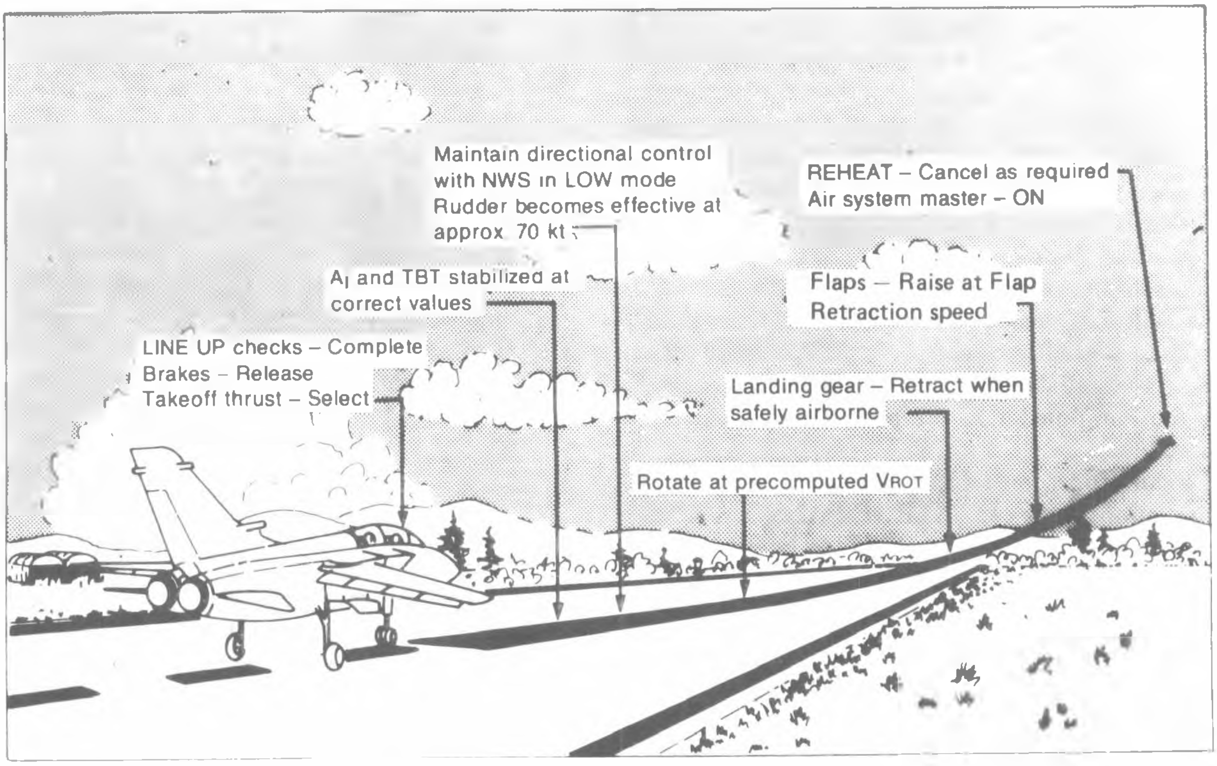


Figure 2-5

to avoid aborts, if the check is carried out immediately prior to the next flight, an additional +0.5% NH may be used for one flight only (i.e. limits of minus 1%, +1.5% NH). In this case the fact is to be reported and maintenance action taken after this flight.

If OAT <0°C, the engine may be under $NL/\sqrt{\theta}$ control indicated by NH/TBT below target. Check correct control by actual NL ± 2% of target NL.

If either engine is outside these limits do not fly the aircraft.

For Mk 103 engine only NL shall be corrected for QFE. Refer to Figure 2-4 to confirm that the engine values are within the limits.

TAKE-OFF

NORMAL TAKE-OFF

Normal take-off will be performed using MAX REHEAT thrust, flaps set to MID, and air system master selected to ON.
Directional control during the initial take-off run is easily maintained, as the nosewheel steering is very effective and NSAS will counteract any directional disturbance with immediate corrections. At approximately 70 kt rudder should be used to maintain directional control.

The aircraft will display conventional take-off characteristics. Rotate the aircraft at the computed rotation speed. It is not advisable to apply aft stick pressure prematurely since CSAS manoeuvre demand characteristics will cause full taileron deflection due to "0" rate feedback signals. This will result in increased drag and ground roll.
When rotating speed is reached, apply moderate aft stick pressure. The aircraft will become airborne with approximately 11 units AOA. At higher masses and consequently higer rotation speeds, elevator effectiveness will be greater. Therefore, back stick inputs should be smooth to match the take-off speed. Increase back stick pressure following liftoff to reach 13 units AOA. When established, the 50 ft obstacle hight will be cleared and a smooth derotation should be started to attain a convenient climb attitude of 10 to 12 degrees. This technique will ensure that the computed take-off performance data are achieved.
See Figure 2-5 for typical take-off. For take-off computation, refer to AER.1F-PA200-1A, Performance Data. If the take-off has to be continued after reheat blowout the failed nozzle (MK101: Aj above 93%, MK 103: Aj above 80%) will automatically close to DRY Area and MAX DRY thrust will be available. Asymmetric thrust will cause moderate yaw only which is easy to compensate with small rudder applications.

PERFORMANCE TAKE-OFF

Performance take-off will be performed with COMBAT thrust, flaps set to MID and air system master selected to EMERG RAM AIR. This take off is recommended in case where single engine rate of climb is insufficient for normal take-off due to high OAT/lower thrust or runway lenght available.
The technique as described under normal take-off applies except that more positive aft stick pressure is required at computed rotation speed and that after lift-off the aircraft is momentarily rotated to 15 units AOA till clear of obstacles; thereafter derotation should be started. Depending on the conditions, pitch attitudes up to 30 degrees can be expected shortly after lift-off.

NOTE

At extreme aft CG conditions, rotation should be initiated more carefully in order not to overrotate in pitch.

HEAVY MASS TAKE OFF (NOT YET CLEARED)

NOTE

The DWN flap setting for take-off is not yet cleared. In heavy mass conditions apply normal/performance take-off procedure.

Heavy mass take-off from 25000 kg and up will be performed with combat thrust, flaps set to DWN and Air System Master set to EMERG RAM AIR. The recommended trim setting is neutral.
The technique is identical to that described under Performance take-off. Due to full flaps and high masses, high rotation stick forces shall be expected, however no extreme pitch attitudes will be encountered after lift-off.

WARNING

IF AN ENGINE FAIL AFTER REFUSAL SPEED, THE TAKE-OFF SHALL BE CONTINUED AND THE AIRCRAFT ROTATED AT ROTATION SPEED TO 15 UNITS AOA. AFTER BECOMING AIRBORNE, ALL EXTERNAL STORES SHALL BE JETTISONED AND LG RETRACTED. DURING THIS PHASE THE AIRSPEED WILL INITIALLY DECREASE.

NOTE

At extreme aft CG conditions, rotation should be initiated more carefully in order not to overrotate in pitch.

CROSSWIND TAKE-OFF

Under crosswind conditions, the aircraft has a strong tendency to weather-vane into the wind. This tendency can be well controlled during take-off roll with the augmented nose wheel steering and normal use of rudder. Refer to "Crosswind Take-off and Landing Limits", Section V.

NOTE

Depending on windspeed and gusts, rotation speed should be increased by approx. 10 kt.

TAKE-OFF ON SLIPPERY RUNWAY

If tire's start to skid in MIN REHEAT, release brakes, correct any tendency to slip and select max thrust without delay.

AFTER TAKE-OFF/DEPARTURE CHECKS

1. Landing gear – UP, lights out

When the aircraft is definitely airborne, retract the landing gear. Check all UP indications safe. The landing gear and landing fear doors should be UP and locked before reaching 250 kt.

2. Flaps – UP at flap retraction speed

Landing gear retraction, flap retraction from MID to UP, and thrust reduction will cause only significant pitch changes. Normally REHEAT should be cancelled at approx. 250 to 300 kt.

3. Air system master – ON
4. SPILS – As required
5. MASS – As required

FLAP RETRACTION SPEED

The chart depicted in Figure 2-6 provides flap retraction speed versus masses with two engines operating. Adhering to the recommended speeds will results in optimum climb potential.

CLIMB/CRUISE

MAXIMUM DRY CLIMB

This climb is recommended when an optimum range climb with minimum fuel consumption is desired.
For a clean aircraft, 25 degree wing sweep, the optimum climb speed is 375 kt/0.7 M at standard day.
For detailed information refer to AER.1F-PA200-1A, Performance Data.

FLAP RETRACTION SPEED CHART

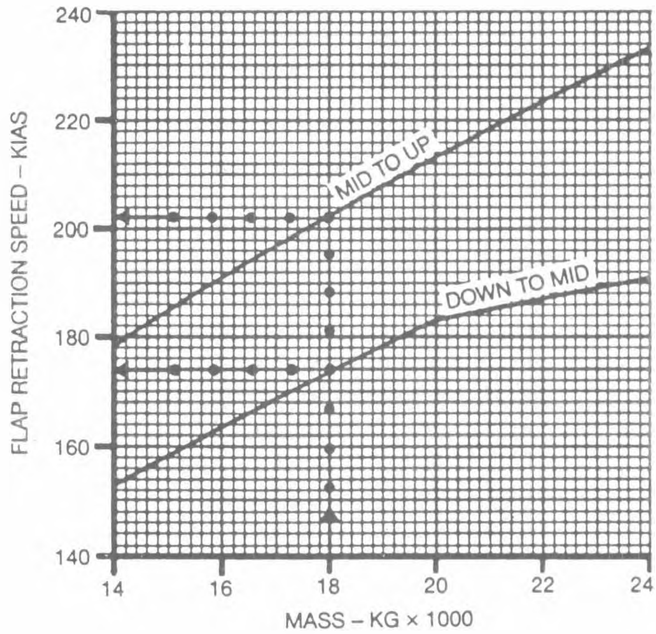


Figure 2-6

MAXIMUM REHEAT CLIMB

This climb is performed with 45 degrees wing sweep to gain maximum altitude within minimum time.
For a clean aircraft at standard day, the optimum climb speed is 0.9 M.
For detailed information refer to AER.1F-PA200-1A, Performance Data.

CRUISE

NOTE

- With a single shoulder mounted U/FUS tank plus two i/b wing mounted tanks, fuel imbalance developes because the asymmetric tank feeds into the respective fuselage group. Manual fuel management is necessary to distribute its fuel equally between the front and rear fuselage groups.

- The aircrew shall check that wing fuel is transferring at total fuel remaining of 2050 ± 50 kg. If wing fuel transfer has not started with a total fuel remaining of 1900 kg, the SEQUENCE switch shall be set from NORM to WG. Return the switch to NORM when wings are empty.

- There is no cockpit warning of an ECS shutdown at aircraft altitudes below 26000 ft. To minimize the risks of operating without cooling air to equipment the aircrew shall check frequently the status of the ECS by confirming cockpit airflow. Post mod. 00921: failure of air system pressure is indicated by illumination of the amber ECS caption on CWP.

AIR TO AIR REFUELLING

Air to Air Refuelling limitation for receiver and tanker aircraft in Section V shall be observed.

RECEIVER ROLE

Refer to Flight Refuelling in Section I of this manual.

JOINING

1. Late arm/trigger – SAFE
2. MASS – SAFE
3. Fuel – Check quantity
4. TACAN – REC
5. IFF – STBY
6. HF – OFF
7. CRPMD – M + S
8. Nav a/coll lights – As required

BEFORE CONTACT

1. Wing sweep – 25°
2. Tank inter – CLOSE
3. Fuel X-feed – CLOSE
4. Tanks – As required
5. Probe – OUT, RDY light on
6. Probe light – As required
7. Rudder trim – As required

WARNING

EXCEPT IN EMERGENCY, REFUELLING SHOULD NOT BE ATTEMPTED WITH FRVL/CWP CAPTION LIT, SINCE FUEL WILL ENTER THE TANK GROUPS THROUGH THE TRANSFER SIDE OF THE REFUEL TRANSFER VALVES AND DAMAGE TO THE CELLS MAY OCCUR IF THE TANKS ARE FILLED, BECAUSE OF CONTINUED TANKER DELIVERY PRESSURE.

NOTE

- For dry contact exercises, the TANKS switch shall be OFF.

- Refuelling may be accomplished with RDY light out, but the refuelling rate to the external tanks will be reduced due to restricted venting.

AFTER REFUELLING

After breaking contact with the drogue, the system is restored to normal and the transfer sequence restarted after selecting the TANKS switch to OFF and the PROBE switch to IN.

1. Fuel – Check quantity
2. Probe – IN, RDY and U/L lights out
3. Probe light – OFF
4. Tanks – OFF, FULL light out
5. Fuel X-feed – AUTO
6. Nav and a/coll lights – As required
7. HF, CRPMD, TACAN, IFF – As required

X-drive clutch closure may have occurred due to differential throttle operation.

8. X-drive clutch – AUTO, light out
9. Rudder trim – As required

TANKER ROLE

Refer to B/B Refuelling system in Section 1 of this manual.

NOTE

During dry training contacts, the B/B pod shall be kept full to provide better cooling for the pod's hydraulic system.

INITIAL CHECKS

1. Refuel control panel (R/C):
   Hose jett – Guarded
   Fuel switches – OFF
   Night/day – As required
   Hose/trail – Wind

With electrical power on:

2. Refuel control panel (R/C):
   Fuel gone – Lamps L TEST, check 8888, Press RESET, check 0000
   Signal lights – Out
   Fuel master – Check with groundcrew: STBY, Blades free, OFF, Blades fixed
   Fuel flow – BRKAWAY, check CAUTION light flashing, OFF, light out
3. Fuel quantity indicator/selector unit (F/C):
   C/FUS – Press, check pod quantity

BEFORE CONTACT

1. Height, airspeed configuration – Within limits
2. Refuel control panel (R/C):
   Fuel master – STBY
   Night/day – As required
   Hose/trail – TRAIL, check CAUTION light steady

If hose extended:

CAUTION light – Out
READY light – On
Fuel gone – Check zero
Fuel flow – FLOW (if wet contact required)

AFTER CONTACT

1. Refuel control panel (R/C):
   READY light – Out
   FLOW light – On
2. Fuel control panel (F/C):
   Dump switches front/rear – OPEN, lights on, fuel transfer from internal system to pod

CAUTION

DURING DRY TRAINING CONTACTS THE B/B POD SHALL BE KEPT FULL TO PROVIDE BETTER COOLING FOR THE POD'S HYDRAULIC SYSTEM.

   Dump switches front/rear – CLOSE, fuel transfer from pod
3. Refuel control panel (R/C):
   Fuel gone – Monitor fuel transfer

NOTE

During fuel transfer to the receiver aircraft the amber L/R FUEL/CWP captions may illuminate if large fuel quantities (> 3000 kg) are transferred or if an external fuel transfer valve has failed to open. In this case both DUMP switches shall be set to CLOSE to isolate the dump valves.

If transfer completed:

Fuel flow – OFF
FLOW light – Out
READY light – On
Hose trail – WIND
READY light – Out
CAUTION light – On, out after hose retraction
Fuel master – OFF

4. Fuel control panel (F/C):
   Dump switches front/rear – CLOSE

Fuel quantity indicator/selector unit (F/C):
C/FUS – Press, check pod quantity

NOTE

- Remaining fuel may be transferred from the pod to the internal system by selecting fuel master switch to INT TRANS.

- The pod may be replenished by selecting fuel master switch to STBY and subsequently dump switches front/rear to OPEN. After pod content has reached approx. 880 kg. the dump switches shall be closed.

- Close immediately both dump valves after the low level warning illuminates.

DESCENT/RECOVERY

Four types of descent may be flown as shown in Figure 2-7. Provided that CANOPY DEMIST was set to AUTO before take-off, canopy and windscreen will be anti-mist heated automatically. Should the windscreen or canopy do mist up, select STBY W/S DEMIST and/or CANOPY DEMIST to ON, on the ENVIRONMENT control panel. Selection of STBY-WS DE-MIST will be accompanied by a loud initial thump.

TYPES OF DESCENT

	RAPID	RANGE	INSTR 1	TACT
WING SWEEP	67°	25°	25°	45°
AIR BRAKES	OUT	IN	OUT	IN
THROTTLES	IDLE	IDLE	80%	80
SPEED	0.85M/ 450 kt	0.75M/ 250 kt	0.75M/ 300 kt	0.75M/ 420 kt

Figure 2-7

DESCENT/RECOVERY CHECKS

1. Instruments – Check, ADI erect, compare HUD/HDD
2. Radar Alt – Set bug as required

CAUTION

IF THE 600 HZ WARNING TONE IS TRIGGERED BY THE RAD ALT LOW HEIGHT BUG, AND SUBSEQUENTLY CANCELLED BY DEPRESSING AN ATTENTION GETTER, THE WARNING TONE IS INHIBITED, AND WILL NOT BE REACTIVATED BY ANY OF THE ASSOCIATED FAILURE CONDITIONS E.G. NWS FAILURE OR T/R REINGESTION.

Frequent checks of the HUD against HDD instruments are required since certain possible failures may affect the HUD without the appropriate warning indications. Also the front cockpit altimeter in RESET mode should be cross-checked against alternative sources as radar altimeter or rear cockpit altimeter corrected for pressure errors. All cross-checks should preferably made under steady flight conditions.

If any of the following symptoms occur while in RESET mode, the altimeter should be selected to and remain in STBY mode and the readings verified from other sources with appropriate allowance for pressure errors:

- ADC or IFU 1 warning on the rear CWP
- Occulting of HYD baro altitude
- Discrepancies between HUD and HDD baro altitude readings

NOTE

If auto reversion of the front cockpit altimeter to STBY mode occurs, the readings should again be verified from other sources.

3. TF radar – As required, set SCH
4. De-mist – As required
5. Intake anti-icing – As required
6. Wing sweep – As required
7. X-drive clutch – AUTO, light out
8. Land/taxi light – As required
9. MASS – As required
10. Trainer only: TR – FRONT

TF OPERATION

Before operating in manual or auto TF, ensure proper functioning of all applicable systems. Observe TF operating limitations in Section V of this manual.

AP CHECK

1. Height – Minimum safe
2. AP – Engage in ALT or MACH, check SFCO and ICO function, AP re-engage if required

TF CHECKS (NOT LOWER THAN 200 FT ABOVE SCH)

1. V/UHF ANTENNA – Upper
2. TACAN – OFF/REC
3. TFR – ON, check ESRRD returns and indications
4. Altimeters – Compare HUD rad alt with HDD rad alt and HDD baro. Set rad alt bug 10% below SCH

WARNING

DISCONTINUE TF IF RAD ALT NOT SERVICEABLE

5. AFDS control panel – FD, TRACK or HDG, SCH, ride, TF READY light on, TF
6. HUD – T displayed, FD command correct
7. AP – Engage, if required

NOTE

- If TFR caption on CWP or NO GO on TF RADAR CP illuminates in STBY mode, the TFR shall not be engaged.
- To avoid possible NO GO status, prior TF operation:
  - TACAN shall be switched to OFF/REC
  - No transmitter shall be made during TF flight from the lower UHF antenna.

WARNING

THE POSSIBILITY OF AP MALFUNCTION LEADING TO SUDDEN RAPID AND LARGE EXCURSIONS IN PITCH AND ROLL CANNOT BE EXCLUDED AT THE PRESENT TIME. THEREFORE, THE PILOT SHALL KEEP A HAND ON THE STICK WHENEVER THE AP IS ENGANGED AND BE PREPARED TO TAKE CONTROL IMMEDIATELY FROM THE AP IN ORDER TO REDUCE PIO'S, OVERRAPID STICK INPUTS SHALL BE AVOIDED.

RHH CHECKS

1. Altimeters – Compare HUD rad alt with HDD rad alt and HDD baro. Set rad alt bug 10% below intended height
2. AFDS control panel – RH, FD; other modes as required, engage, lights on
3. HUD – FD command correct
4. AP – Engage, if required

NOTE

If abnormal RH/AFDS behaviour is suspected, RH hold operation shall be discontinued immediately irrespective of the presence or absence of other warnings.

LANDING

Below 6 units AOA with full flaps, there is a mild proverse yaw due to roll inputs. Above 6 units AOA this changes to mild adverse yaw, therefore slight heading overswings will be encountered when rolling out of turns. The aircraft shows little roll due to rudder in the landing configuration and thus the rudder is useful for small heading adjustments.

See Figure 2-8 for a typical landing pattern. For Landing Distance Data, refer to AER.1F-PA200-1A, Performance Data.

PRE-LANDING CHECKS

1. Wing sweep – 25°
2. Airbrakes – IN and locked
3. SPILS – OFF
4. Rad. alt – Set bug to zero
5. Fuel – Balance, quantity, calculate approach speed

NOTE

- Approach speed at 14000 kg, flaps DOWN:
  - 10 units AOA, 140 kt.* plus 4 kt/1000 kg
  - 12 units AOA, 132 kt.* plus 4 kt/1000 kg
  - * Add 3 kt if krueger flap are inhibited
- Approach speed at 14000 kg, flaps MID:
  - 10 units AOA, 155 kt plus 5 kt/1000 kg
  - 12 units AOA, 146 kt plus 5 kt/1000 kg

6. Flaps – MID

WARNING

DO NOT EXTEND THE LANDING GEAR WITH LD/TR PRESELECTED AS THE SPOILERS AND/OR TR BUCKETS MAY DEPLOY.

7. Landing gear – DOWN
8. Hook light – Out
9. Harnesses – Tight and locked
10. Landing gear – 3 greens, no reds
11. Brakes – Test, A SKID out
12. NWS – LOW light on, no re-ingest audio
13. Flaps – As required

For final landing:

14. Lift dump indicator – Blank/white cross
15. Left throttle – LD preselect
16. Right throttle – TR preselect, if required

WARNING

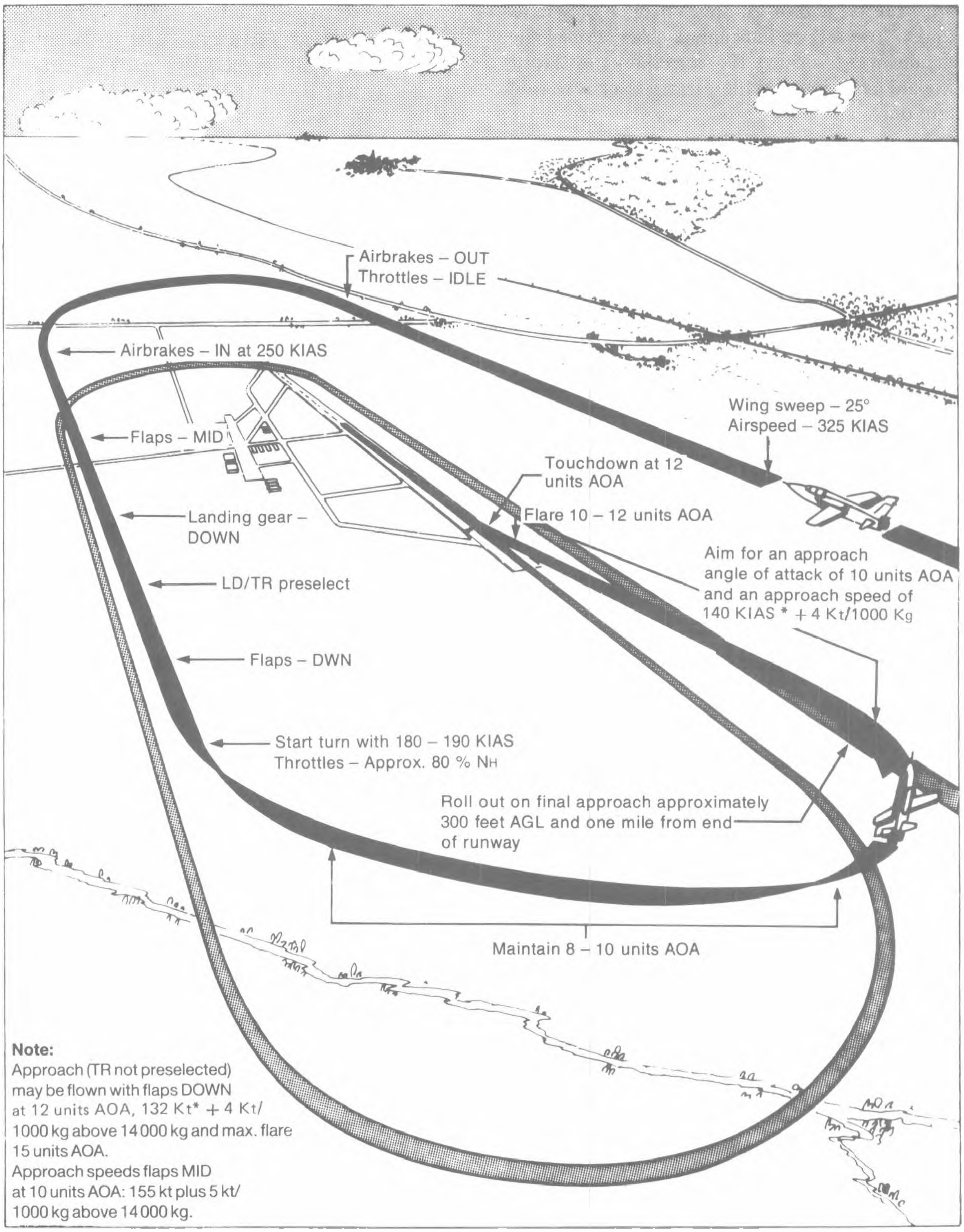
- IF OL IS INDICATED, PRESELECTION OF LIFT DUMP AND THRUST REVERSE SHALL NOT BE MADE. A FAILURE OF THE OLEO MICROSWITCH EXISTS AND MAY CAUSE AIRBORNE DEPLOYEMENT OF THE THRUST REVERSE BUCKETS AND/OR EXTENSION OF SPOILERS.
- DO NOT PRESELECT TR IF RE-INGEST AUDIO SOUNDS WHEN LANDING GEAR IS LOWERED.
- AVOID REARWARD PRESSURE AGAINST IDLE STOPS WHEN ROCKING THROTTLES TO AVOID INADVERTENT ENGINE SHUT DOWN.

CAUTION

- AIRBRAKES SHALL NOT BE USED ON THE APPROACH IN CROSSWIND > 10 KT CARRYING LARGE STORES ON U/FUS PYLONS AS SLIGHT STICK LIGHTENING OR SLIGHT PITCH-UPS MAY OCCUR ABOVE 12 UNITS AOA.
- THE AIRBRAKES SHOULD BE RETRACTED PRIOR TO TOUCHDOWN TO AVOID DAMAGE TO THE AIRBRAKES WHEN REVERSE THRUST DEPLOYS DURING THE AIRBRAKE AUTO-RETRACTION PHASE.

Lower full flaps wing level on downwind (on final for straight-in). The buffet level with full flaps is noticeably higher than flaps at MID. Crosscheck

LANDING PATTERN (TYPICAL)



* Add 3 Kt if Krueger flaps are inibited

Figure 2-8

computed final approach speed versus AOA, when on final.
For current AOA limits see Section V.
Thrust reverse and/or lift dump may be preselected after LG lowering on final approach or selected after touchdown by rocking the corresponding throttle outboard. The left throttle preselects or selects lift dump only.

For TR preselection observe thrust reverse limitations in Section V. If the LIFT DUMP magnetic indicator shows blank/white cross, preselect TR on final approach and continue to modulate thrust by throttle movement. 85% NH shall not be exceeded over the threshold and during flare.

The flare should be smooth and initiated out of ground effect just prior to touchdown. The attitude change to achieve a round-out from descent to an acceptable touchdown sinkrate is small, and changes in attitude and AOA will not result in a significant rise in drag or loss of speed. Rapid hard back stick inputs during flare should be avoided as the sinkrate will initially be increased due to the effectiveness of the taileron.

AFTER TOUCHDOWN CHECKS

At mainwheel touchdown reduce throttles to IDLE and lower the nosewheel gently onto the runway. If the NWS is engaged TR may be engaged if not preselected; when thrust reverse indicators show REV, TR may be applied. When increasing thrust above IDLE, the reversed jet airstream interfaces with the airflow ower the fin rudder proportional to the amount of thrust applied. The NSAS counters this destabilizing influence by suppressing any yaw disturbance and provides good directional control. If steering corrections are necessary, large positive pedal deflections are required to overcome NSAS authority. Improved directional stability is achieved at high thrust settings as the nose down pitching moment increases NWS. The worst stability region is experienced in the mid thrust range (approx 80% NH), where fin and rudder effectiveness is markedly reduced. Therefore, the recommended technique is to slam throttles from IDLE to MAX DRY to minimise the time in this unfavourable region. Light lateral oscillations which occur when full TR is selected may be ignored as they have no handling significance.
TR may be used down to re-ingest warning from 200 KIAS not exceeding 80% NH and/or from 165 KIAS using MAX DRY.

WARNING

ONCE ACTIVATED, LD AND TR SYSTEMS REMAINS ENGAGED BY HOLD-ON RELAYS EVEN IF THE AIRCRAFT BOUNCES AFTER TOUCH-DOWN. THE SYSTEM CAN ONLY BE CANCELLED BY ROCKING THE RESPECTIVE THROTTLE(S) INBOARD OR, IN THE TRAINER VERSION, BY SELECTING THE THRUST REVERSE SWITCH IN THE REAR COCKPIT TO OFF.

At the re-ingest warning (approximately 60 kt) retard throttles to IDLE TR and apply brake pressure. At normal taxi speed cancel TR and select TAXI NOZZLE. Prior to clearing the runway select nosewheel steering to HIGH.

NOTE

To avoid FOD cancel TR as soon as practicable.

CAUTION

- DESELECTION OF NWS VIA ICO MAY RESULT IN DIRECTIONAL CONTROL PROBLEMS WHEN IN TR. IN THIS CASE DESELECT TR IMMEDIATELY AND MAINTAIN DIRECTIONAL CONTROL BY USE OF RUDDER/ DIFFERENTIAL BRAKING.
- FOR LANDING WITH TR PRESELECTED, THE THROTTLES SHALL BE CHOPPED TO IDLE AT MAIN WHEEL TOUCHDOWN AND THE NOSEWHEEL LOWERED ONTO THE RUNWAY WITHOUT DELAY TO AVOID STRUCTURAL DAMAGE TO THE NOSEWHEEL.

- FULL TR MAY BE USED IF AIR BRAKES ARE IN AND LOCKED. IF NOT LOCKED, TR SHALL BE USED AT IDLE ONLY.

NOTE

Exercise caution when deselecting TR, since any excessive rearward pressure on the throttle release latches may result in advertent engine shutdown.

CROSSWIND LANDING

Preselect LD and fly a crabbed approach. TR may be used to the limits given in Section V of this manual. Under turbulent conditions, involving the possibility of wind shear, 10 units AOA should not be exceeded to allow for sudden changes in airspeed and to maintain normal sink rate. At high crosswinds a combination of crabbed approach and low wing method is recommended. Prior to touchdown gently kick off drift in the conventional manner to minimise the lateral loads on the landing gear but maintain a certain drift angle proportional to the existing wing. As soon as either main wheel oleo is compressed, LD will deploy and keep the aircraft firmly on the ground. Lower the nosewheel without delay to ensure early NWS operation and select TR. Full spoiler roll control will be available and any tendency for the upwind wing to rise after touchdown can be corrected by applying roll control into the wind. High TR thrust settings will increase this phenomenon but use of roll control should be avoided if possible as this will reduce LD effectiveness.
Further handling considerations as for normal landing apply.

BRAKING TECHNIQUE

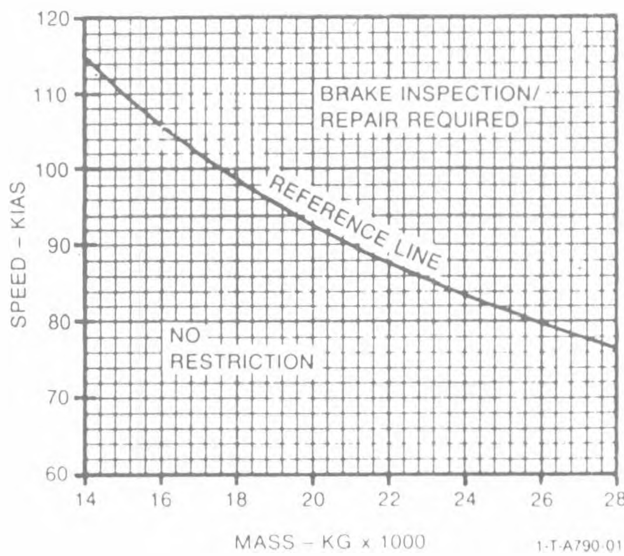
AERODYNAMIC BRAKING

Aerodynamic braking is possible regardless of flap/slat position. This technique should be applied if the thrust reverse cannot be used because a failure inhibits its operation for landing, or thrust reverse fails to deploy after touchdown, in cases of NWS failure or when landing with a known blown nosewheel tire.

When landing with a thrust reverser failure, plan to touchdown at the proper approach speed and AOA, near the front end of the runway and use its full lenght. Lift dump should be used and the aircraft's nose kept up by continuously increasing back stick pressure to maintain 18 units AOA until the airspeed has dropped to approx. 100 kt. When carriyng external stores the limit is 14 units AOA (for further informations refer to Section V of this manual). Lower the nosewheel gently onto the runway, select TAXI NOZZLE and use maximum braking technique if necessary to slow the aircraft down to taxiing speed.
If thrust reverse fails after touchdown with the nosewheel lowered onto the runway, deselect TR, if preselected. Speed and remaining runway are the dominant factors which determines whether to raise the nose and to apply the aerodynamic braking technique, or to continue the landing roll with TAXI NOZZLE selected and stick full aft. Under

BRAKE ON SPEED CHART

Based on: No TR available, Std Day, no wind.



NOTE

Below the Reference Line damage of the wheel brakes is unlikely and routine brake checks are sufficient. Above the Reference Line, brake inspection/repair is required.

Figure 2-9

normal conditions speed will be too low to use aerodynamic braking effectively if TR failed after touchdown.

To avoid major damage to the brakes, the braking energy requirements should be kept as low as possible by:

- Observing limitations in Figure 2-9
- Keeping the total brake application time as short as possible (hard but short applications).
- Using LD or TAXI NOZZLE depending on situation.

CAUTION

DURING AERODYNAMIC BRAKING, TAIL SCRAPE MAY OCCUR BEYOND 19 UNITS AOA.

OPTIMUM BRAKING

Optimum braking is achieved by using full TR together with maximum wheelbrake pedal pressure allowing the anti-skid system, which is fully adaptive, to give optimum braking and deceleration.

Wheel brakes may be applied, progressively up to full pedal pressure, 2 seconds after TR selection, and progressively applying full rearward stick pressure.

NOTE

Due to a current brake control system deficiency in the trainer version, full brake pressure will be achieved at the second brake application only.

TOUCH-AND-GO LANDING

After touchdown from normal approach maintain sufficient back stick pressure to hold the nosewheel off the ground.

Check airbrakes retracted and advance throttles smoothly to MAX DRY. At 140 KIAS minimum, rotate the aircraft to achieve 10 units AOA until the aircraft lifts off again. When safety airborne, raise the landing gear.

With the flaps selected in DWN, raise flaps to MID at calculated speed according to gross weight (155 + 5 kt per 1000 kg above 14000 kg) and after the landing gear has fully retracted.

Further raising of flaps to UP, if required, should be performed at 180 KIAS (+5 kt for each 1000 kg above 14000 kg).

WARNING

- FULL FLAP TOUCH AND GO LANDINGS WITH A KNOWN REHEAT FAILURE ON EITHER ENGINE ARE PROHIBITED.

- IN CASE OF AN ENGINE FAILURE AFTER LIFT OFF DEPENDING ON MASS, THE THRUST AVAILABLE ON ONE ENGINE IN MAX DRY MAY BE INSUFFICIENT TO CONTINUE THE CLIMB OUT, UNLESS THE PROCEDURE FOR ENGINE OR REHEAT FAILURE DURING TAKEOFF IN SECTION III OF THIS MANUAL IS APPLIED. FULL FLAPS, IF SELECTED, SHALL NOT BE RAISED BEFORE MINIMUM FLAP RETRACTION SPEED.

CAUTION

AT ROLLING SPEEDS ABOVE 80 KT, DEPENDING ON MASS, AOA AND CONFIGURATION, THE WOG SWITCHES MAY REACH THE FLIGHT CONDITION AND THE LG LEVER WILL NOT BE LOCKED DOWN, THUS THE LG LEVER COULD BE RAISED PREMATURELY.

GO-AROUND (TYPICAL)

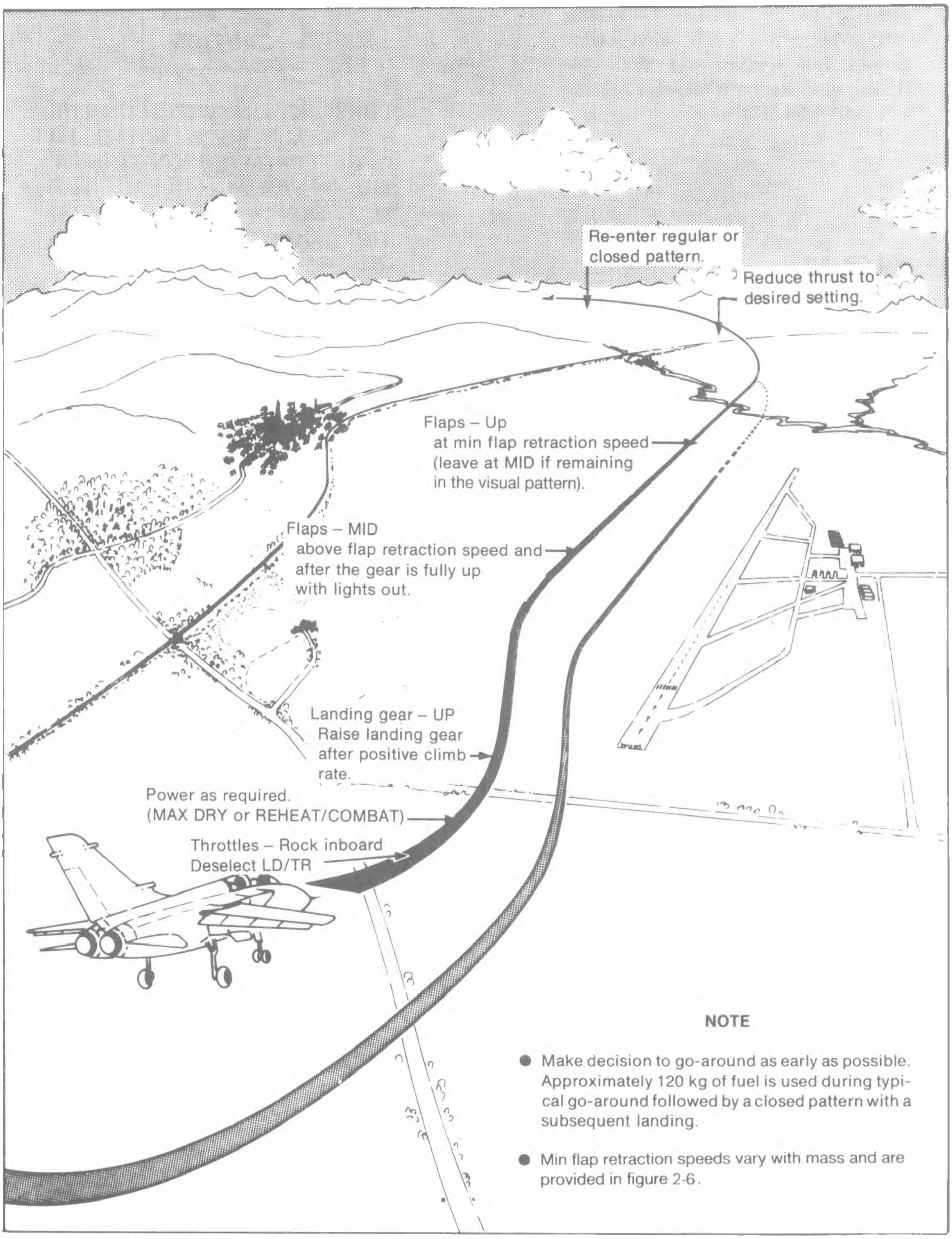


Figure 2-10

NOTE

Once the main wheel oleos are compressed and the microswitches activated, the NWS LOW light extinguishes and remains out until the landing gear has been recycled to activate NSAS BITE.

GO AROUND

The decision to go around should be made as early as possible. When the decision is made, rock the throttles inboard to deselect LD/TR, if preselected; thereafter advance throttles to required power setting. As the aircraft accelerate, rotate the nose to a climbing attitude and when altimeter and VSI indicate a positive rate of climb, continue with after take-off checks. For a typical go-around pattern refer to Figure 2-10.

WARNING

DO NOT EXTEND OR RETRACT THE LANDING GEAR WITH THE LD/TR PRESELECTED AS THE SPOILERS AND/OR THE TR BUCKETS MAY DEPLOY.

AFTER LANDING

AFTER LANDING CHECKS

1. MASS – SAFE, LOCK
2. Land/taxi lights – As required
3. IFF – OFF
4. Command ejection – REAR
5. CRPMD – M, INT
6. TFR – OFF
7. Pitot and W/screen heaters – OFF
8. Flaps – As required
9. Ignition (Engine control panel) – OFF

CAUTION

THE IGNITION SWITCH ON THE ECP SHALL BE SELECTED TO OFF TO PREVENT IGNITION OF THE RESIDUAL FUEL IN THE SHUT-DOWN ENGINE, SHOULD THE THROTTLE BE MOVED OUT OF THE HP SHUT POSITION.

10. CWP – Test 1 + 2
11. For single engine taxi:
    TAXI nozzle – SHUT
    X-drive – Ensure SHUT
    Either throttle – HP SHUT below 450°

Confirm that the X-drive is in AUTO prior to one engine shut down to maintain full electric and hydraulic service.

Either engine can be shut down if desired, but T7 should be below 450°C. After running for a period at max continuous conditions or above it is advisable that the engine should be idled for 2 minutes before shutting down to allow cooling of the rotor system.

12. Pitch trim – Fully nose down
13. Intake anti-icing – OFF
14. PSP – Disconnect

SHUT DOWN CHECKS

CAUTION

FOLLOWING HEAVY BRAKE APPLICATION, ENGINE SHUT-DOWN SHOULD BE MADE WITH THE AIRCRAFT NOSE INTO WIND, TO AVOID ENGINE FUEL SPLASHING ONTO HOT BRAKES AND IGNITING. THE MAXIMUM TAILWIND COMPONENT IS 15 kt.

Front Cockpit

1. Taxi light – OFF
2. EPS – OFF
3. Ejection seat, EPS and canopy pins – IN, confirm with nav

If entering shelter:

4. Wing sweep – 45°
5. NWS – Disengage, confirm with groundcrew
6. Brakes – Release

When stationary:

7. Brake handle – Park
8. CMP – Recorded
9. RPMD – OFF
10. Rad alt – OFF
11. ESRRD – OFF
12. HUD – OFF
13. Tacan – OFF
14. Probe – OUT (if required)

The probe shall be inspected for cracks after each AAR operation, wet or dry.

When cleared to shut down:

15. Hydraulics – Left OFF, right AUTO
16. X-drive clutch – OPEN
17. Taxy nozzle – SHUT
18. Throttle(s) – HP SHUT, RPM decreasing

WARNING

DO NOT SWITCH BATT MSTR TO OFF BEFORE THE THROTTLES OF BOTH ENGINES ARE IN HP SHUT AND RPM IS DECREASING AS OTHERWISE ENGINE CONTROL INCLUDING OVERSPEED GOVERNORS AND SHUTDOWN FACILITY ARE LOST. THE CONSEQUENCES WOULD BE THE SAME WITH A FAILED BATTERY, IF THE GENERATORS WERE SWITCHED OFF PRIOR TO ENGINE SHUTDOWN.

19. Rapid T/O panel – All OFF except BATT MSTR
20. V/UHF/emerg radio – OFF
21. CVR – STOP
22. MASS – Key removed
23. Brake handle – Normal (chocks in)

NOTE

Brake handle should be returned to NORMAL since after more 10 minutes with the brake handle in PARK, excessive distorsion of wheel brake components will occur, with subsequent brake lock.

24. HUD camera – OFF, remove cassette
25. ASM – OFF/RESET
26. External lights – OFF
27. Oxygen – OFF, check normal, emergency contents
28. Canopy – Open
29. Battery master – OFF (engines stopped)
30. MDC pin – In

Rear Cockpit

1. Ejection seat pin – IN, confirm with pilot

After CMP recorded:

2. TV/TAB – Both OFF
3. CRPMD – OFF
4. RWR – OFF
5. ECM – OFF
6. Doppler – OFF
7. IN – OFF (align if required)
8. SAHR – OFF
9. MC control panel – All OFF
10. CVR – OFF, remove cassette
11. HDDR – OFF, remove cassette
12. Inform pilot clear to shut down
13. Oxygen – OFF, check normal, emergency contents
14. V/UHF – OFF
15. MDC pin – IN

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION III

EMERGENCY PROCEDURES

TABLE OF CONTENTS

Title	Page
INTRODUCTION	3-2
GROUND EMERGENCIES	3-3
Engine Fire on the Ground	3-3
Emergency Ground Egress	3-4
TAKE-OFF EMERGENCIES	3-4
Abort	3-4
Tire Failure during Take-off Roll	3-5
Engine or Reheat Failure during Take-off	3-5
Engine Fire during Take-off Roll	3-6
Landing Gear Retraction Failure	3-7
NWS Failure	3-7
ABANDONING	3-8
Ejection	3-8
Ejection Procedure	3-11
Failure of Seat to Eject	3-12
After Ejection	3-12
Failure of Drogue Chute or Auto Separation	3-12
FIRE	3-13
Engine Fire	3-13
Rear Fuselage Fire/Hot Gas Leak	3-13
FLAMEOUT/RELIGHTING	3-14
Double Engine Flameout	3-14
Single Engine Flameout	3-15
ENGINE FAILURES	3-17
Single Engine Operation	3-17
Engine Speed Switch Failure	3-17
Engine Failure (Mechanical)	3-19
Engine Vibration	3-19
Surge	3-19
Turbine Bearing Overtemperature	3-20
Engine Oil Pressure Low	3-21
Engine Oil Overtemperature	3-21
Engine Oil and Fuel Overtemperature	3-22
ENGINE CONTROL SYSTEM FAILURES	3-22
Loss of Throttle Control	3-22
Lane Failure	3-23
Lane Failure to Reversionary	3-23
Reheat Control Failure	3-23
Reheat Blowout	3-24
Thrust Reverser Unlocked	3-25
Air Intake Ramp Failure	3-25
FUEL SYSTEM FAILURES	3-25
Fuselage Fuel Leak	3-25
Boost Pump Low Pressure	3-26
Wing or External Tank Transfer Failure	3-27
Fuel Balance	3-28
Low Collector Box Contents	3-29
Engine Fuel Overtemperature	3-29
Fuel Tank High Temperature	3-30
Vent System Pressure Low	3-30
Refuel/Transfer Valve Failure – Probe Selected In	3-30
Refuel/Transfer Valve Failure – Probe Selected Out	3-30
ELECTRICAL SYSTEM FAILURES	3-31
Double Generator Failure	3-31
Single Generator Malfunction	3-33
Single Generator Failure with AC Busbar Tie Contactor Open	3-34
Battery Charger Failure (Post Mod. 01662)	3-34
Excess Battery Charging (Post Mod. 01662)	3-35
Double TRU Failure	3-35
DC Load Reduction	3-37
Single TRU Failure	3-37
Probe Heating Failure	3-37
X-DRIVE CLUTCH/GEARBOX FAILURES	3-38
Gearbox Failure	3-38
X-Drive Clutch Does not Open	3-38
X-Drive Clutch Does not Shut	3-38
X-Drive Clutch Shuts Below 15% Diff	3-38
HYDRAULIC SYSTEM FAILURES	3-39
Failure of One Hydraulic System	3-39
Failure of One Utility System	3-40
Hydraulic Overtemperature	3-40
Brake Failure	3-40
FLIGHT CONTROL SYSTEM FAILURES	3-41
CSAS First Failure	3-41
CSAS Second Failure	3-42
Advice for Landing with Multiple CSAS Failures	3-42
SPILS FAILURE	3-43

HUD FAILURES 3-43
Loss of Symbology 3-43
Velocity Monitor Trip 3-44
Attitude Monitor Trip 3-44
TERRAIN FOLLOWING FAILURES . . . 3-46
TFR Failures 3-46
TF Monitor Warnings 3-48
AUTOPILOT/FLIGHT DIRECTOR SYSTEM FAILURE 3-49
AFDS Computer Failure 3-49
Mode Sensor Failure 3-49
AP Trim Failure 3-50
MALFUNCTION OF HMERU 3-50
OUT OF CONTROL 3-50
Loss of Control 3-50
Spin Recovery 3-51
ENVIRONMENTAL CONTROL SYSTEM FAILURE 3-51
Pressurization/ECS Failure 3-51
Fumes in Cockpit 3-52
Oxygen Failures 3-52
SINGLE ENGINE EMERGENCIES 3-53
Engine Failure on Approach 3-53
Single Engine Overshoot 3-53
Single Engine Approach/Landing X-Drive Open 3-53
Single Engine Transit – X-Drive Open . 3-53
Single Engine Descent/Recovery – X-Drive Open 3-54
Single Engine Pre Landing – X Drive Open 3-54
Single Engine Final Approach – X-Drive Open 3-55
Single Engine Approach/Landing – X-Drive Shut 3-57
Single Engine Transit – X-Drive Shut . 3-57
Single Engine Descent/Recovery – X-Drive Shut 3-57
Single Engine Pre-Landing – X-Drive Shut 3-58
Single Engine Final Approach – X-Drive Shut 3-58
GEARBOX/HYDRAULIC SYSTEM FAILURES 3-58
Transit 3-59
Descent/Recovery 3-59
PreLanding 3-59
Final Approach 3-59
NWS/NSAS FAILURES 3-61
APPROACH AND LANDING EMERGENCIES 3-62
Landing with Wings Swept 3-62
Landing with Flap/Slat Failure 3-63
Landing with a Known Blown tire 3-65
Antiskid Failure 3-65
Cable Engagement 3-65
Approach-end Cable Engagement 3-67
LANDING GEAR EMERGENCY 3-67
Landing Gear Retraction Failure 3-67
Landing Gear Fails to Lower 3-68
Emergency Gear Retraction on the Ground 3-68
Landing Gear Collapsing 3-68
Landing with Gear Unsafe 3-68

INTRODUCTION

This section contains procedures to be followed in various emergencies to ensure maximum safety for the crew and/or aircraft. Through knowledge of these procedures will enable the aircraft to better cope with an emergency. The steps should be performed in the listed sequence. However, the procedures do not restrict the aircrew from taking any additional action necessary to deal with the emergency. The procedures contain items classified as critical or noncritical. The critical items are actions that shall be performed immediately to avoid aggravating the emergency and causing personal injury, loss of life or loss or damage to the aircraft. Critical items are presented in **boldface letters** and shall be committed to memory. Verbal knowledge of bold face procedures is not necessary, however, it is mandatory that all aircrews commit to memory the full intent of the actions indicate and the proper sequence of steps. Noncritical items are considered to be less urgent and shall be accomplished by direct reference to the checklist.

CWP Indications

Primary Warnings (red).
Immediate action required. Initiation of attention getters, audio alarm signals and captions on CWP.

Secondary Warnings (amber).
No immediate action required with the exception of OIL P (Post mod. 00562: amber OIL P deleted). Initiation of attention getters and captions on the CWP.

Crew Concept

As soon as the aircraft commander or navigator becomes aware that an emergency situation exists, he shall immediately alert the other crew member to the situation. Load sharing between crew members is extremely important and should be accomplished as follows: critical actions shall be executed immediately by the aicraft commander assisted by the navigator, whereas noncritical actions will be initiated by the navigator referring to the flight crew checklist and accomplished by the aircraft commander. In any emergency situation, contact should be established with a ground station as soon as possible after completing the initial corrective action. Include position, altitude, heading, speed, nature of the emergency and pilots intentions in the first transmission. Thereafter the ground station should be kept informed of the progress of the flight and of any changes or developments in the emergency. Three basic rules apply to most emergencies and should be observed by each aircrew member:

1. Maintain aircraft control
2. Analyze the situation and take proper action
3. Land as soon as possible/as soon as practicable

The meaning of "land as soon as possible" and "land as soon as practicable", as used in this section, is as follows:

Land As Soon As Possible (ASAP) – Emergency conditions are urgent and require an immediate landing at the nearest suitable airfield, considering also other factors, such as weather conditions and aircraft mass.

Land As Soon As Practicable – Emergency conditions are less urgent and in the aircrews judgement the flight may be safely continued to an airfield where more adequate facilities are available.

WARNING

- THE CANOPY SHOULD BE RETAINED DURING ALL EMERGENCIES WHICH COULD RESULT IN CRASH, FIRE, CRASH LANDING, ABORTED TAKE-OFF AND CABLE ENGAGEMENT. THE RISK OF BECOMING TRAPPED DUE TO A CANOPY MALFUNCTION OR OVER-TURNING OF THE AIRCRAFT IS OUTWEIGHED BY THE PROTECTION GIVEN TO THE AIRCREW BY THE CANOPY.
- ALL ODORS NOT IDENTIFIABLE BY THE AIRCREW SHALL BE CONSIDERED TOXIC. IMMEDIATELY GO OXYGEN 100%. PROPERLY VENT THE AIRCRAFT AND LAND ASAP. DO NOT TAKE OFF WHEN UNIDENTIFIED ODORS ARE DETECTED.

NOTE

- The emergency procedures are tri-nationally agreed and are listed in generic form in the Flight Crew Checklist. However, in the manual the procedures are listed in the following form: Ground-, Take-off-, Inflight-, and Landing Emergencies.
- The procedures detailed in this section apply to both MK101 and MK103 engines unless otherwise stated.

GROUND EMERGENCIES

ENGINE FIRE ON THE GROUND

Red

L FIRE or R FIRE

F button

Shut down engine and operate the appropriate fire extinguisher, or consider crash bar operation after both engines have been shut down.
Should an engine fire occur during engine start with the APU running, select APU switch to OFF.

1. **THROTTLES – HP SHUT**
2. **LP COCKS – SHUT**
3. **FIRE BUTTON – PRESS**
4. **APU – OFF**

EMERGENCY GROUND EGRESS

The pilot shall decide whether to abandon the aircraft through manual egress or by ejection. His intention shall be conveyed without ambiguity to the other crewmember as early as possible. This decision will depend upon the type and severity of the emergency situation and the condition/position of the canopy. If normal opening of the canopy is not assured, confirm that it is locked closed, otherwise jettisoning will be inhibited. Consider use of the MDC facility as a last resort, since injury from canopy debris is likely and egress rendered more difficult because the canopy rails remain on the aircraft.

Serviceable Intercom

The executive order for ejection shall be given by the aircraft commander, by calling "EJECT" if circumstances permit. If the aircraft commander intends to jettison the canopy prior to the decision to abandon the aircraft, he shall inform the other crewmember by use of intercom or hand signals. If the navigator decides to eject for whatever reason, despite the aircraft commander's intention to leave the aircraft through manual egress, he shall inform the pilot, select the command ejection lever to REAR and eject with the canopy closed. At all times, the navigator should remain strapped in until he is sure that no ejection will be carried out.

Unserviceable Intercom

If the executive order for ejection cannot be given over the intercom due to a failure or operation of the crash panel, circumstances permitting, the aircraft commander should make hand signals either side of the ejection seat head-box to indicate that the intends to initiate ejection.
Both arms will be held up with the forearms vertical and fist clenched, then moving the forearms briskly up and down 3 times.
If the emergency does not necessitate ejection and manual egress is intended, the aircraft commander should, if possible, wave both hands, finger stretched either side of the head-box.

If necessary:
1. Eject

WARNING

EJECTION SHALL NOT BE ATTEMPTED UNLESS THE CANOPY IS CLOSED AND LOCKED, OR HAS BEEN JETTISONED.

Otherwise:
1. Unstrap completely
2. Canopy – Open (normal, MDC, jettison)

If time and circumstances permit:
3. Seat pins – In

WARNING

- IF NORMAL CANOPY OPENING NOT ASSURED, USE MDC/JETTISON (CANOPY SHALL BE FULLY CLOSED).
- TO PREVENT POSSIBLE INJURY DURING MDC FIRING, THE HELMET VISORS SHALL BE DOWN.
- THE MANUAL SEPARATION HANDLE SHALL NOT BE USED ON THE GROUND, SINCE THE AIRCREW MAY NOT BE SEPARATED FROM THE SEAT BUT THE DROGUE GUN WILL FIRE IF THE SEAT PIN IS OUT.

TAKE-OFF EMERGENCIES

ABORT

If an emergency other than engine failure/fire occurs during take-off, the aircrew shall decide whether to continue take-off or to abort. However, once refusal

speed is reached, take-off shall be continued since the pilot will be unable to stop the aircraft within the remaining runway length. If the decision to stop is made, retard the throttles to IDLE and rock outboard: this will deploy the lift dump and select the TR (before operation of full TR confirm REV displayed on TR indicators). Delay in selecting lift dump may lead to directional problems in crosswinds and will reduce braking capability. In crosswind conditions mantain the stick in the central position, lateral left or right inputs cause the corresponding spoilers to retract, which, increases lift on the wing therefore detriment bracking efficency; if wing lift sufficiently to operate the associated weight on ground switch, the touchdown protection system operates and disengages the brakes. Although TR is available, the use of asymmetric TR above IDLE power after an engine failure shall be performed in accordance with the limitations listed in section V of this manual, in addition the use of asymmetric TR can cause hook rotation , therefore it is recommended to concentrate on a succesful overrun cable engagement. Whenever asymmetric TR is used, select ORIDE to bypass the TR logic and reduce the engine to IDLE prior to hook deployment. This avoids turning of the hook shoe in the efflux as it lowers.
To achieve maximum braking, apply full brake pedal pressure with lift dump deployed and progressively apply full aft stick. If full brakes are applied during an abort (above about 80 kt ground speed) the brakes may not bring the aircraft to a halt but speed is reduced for the overrun cable engagement.

1. **THROTTLES – IDLE, ROCK OUTBOARD**
2. **TR – O RIDE**
3. TR indicators – Check REV
4. Throttles – As required

If cable engagement is anticipated:
5. Throttles – IDLE
6. Hook – Down, light on
7. Brakes – Release before crossing cable

When stopped:
8. NWS – HIGH before pullback
9. TR – Deselect

WARNING

DO NOT BRAKE WHILE ROLLING BACKWARDS TO AVOID TIP- OVER.

TIRE FAILURE DURING TAKE-OFF ROLL

The decision whether to continue take-off or abort will mainly depend on the speed at the time of failure, mass, remaining runway length, weather conditions and availability of an arresting system. Use thrust reverse with care. Take-off should be continued once rotation attitude is established.

If not aborting:

1. **GEAR/FLAPS – DO NOT RETRACT**

ENGINE OR REHEAT FAILURE DURING TAKE-OFF

If an engine fails before reaching minimum go speed, the take-off shall be aborted (for further information refer to Abort drill), as the thrust available is insufficient to accelerate the aircraft to take-off speed within the remaining runway.
If engine failure occurs beyond minimum go speed and before refusal speed, the take-off may either be aborted or continued. However once refusal speed is reached, take-off shall be continued since the aircraft cannot be stopped within the remaining runway length (or runway length-to-cable, considering max cable engagement speed).
If take-off is continued the following technique is recommended:

- Confirm or select COMBAT on both engines. Advancing the throttle on the serviceable engine from MAX REHEAT to COMBAT will increase TBT and thrust by about 3% (MK101) or 5% (MK103), regardless its nozzle is frozen or in dry range. The COMBAT selection will not entirely compensate for the loss of reheat thrust on the effected engine in case of reheat blowout. ASM to ERA will result in a further thrust increase of about 10%.

- Rotate at the normal V rotate, taking care not to over-rotate. Be prepared to counter any swing towards the dead engine with rudder.

- Climb away 13 units AOA, opposing yaw with rudder.

- Consider jettisoning external stores.

- When safely airborne, raise the landing gear. Maintain 13 units AOA for normal takeoff or

15 units AOA for performance take-off. Delay raising the flaps until safely clear of the ground then accelerate to the flaps-up, single engine climb speed. (Refer to AER. 1F-PA200-1A for Flaps Retraction Speed and Safe Single Engine Operating Speed charts).

– When the aircraft is stabilized at a safe speed and height, identify the failed engine and retard the relevant throttle to the HP SHUT position.

WARNING

- FOR HEAVY MASS TAKE-OFF, AFTER BECOMING AIRBORNE, ALL EXTERNAL STORES SHALL BE JETTISONED AND LG RETRACTED. DURING THIS PHASE THE AIRSPEED WILL INITIALLY DECREASE.

- FOR NORMAL AND PERFORMANCE TAKE-OFF THE SINGLE ENGINE CLIMBS RATE MAY BE REDUCED DURING GEAR RETRACTION WHICH COULD BE CRITICAL AT HIGH TAKE-OFF MASSES. THEREFORE THE RETRACTION OF THE GEAR SHOULD BE DELAYED UNTIL AT SAFE ALTITUDE.

CAUTION

WITH ANY REHEAT FAILURE CONFIRM OR SELECT COMBAT ON BOTH ENGINES. UNDER NO CIRCUMSTANCES THE THROTTLES SHOULD BE RETARDED TO ATTEMPT REHEAT RESELECTION.

If decision to stop is made:

1. **ABORT**

If take-off is continued:

1. **THROTTLES – COMBAT**

When airborne:

2. **EXTERNAL LOAD – JETTISON (if necessary)**

If an engine failure:

3. THROTTLE – HP SHUT

If a reheat failure:

3. Refer to "REHEAT CONTROL FAILURE" drill

ENGINE FIRE DURING TAKE-OFF ROLL

Red

L FIRE or **R FIRE**

F button

If during take-off an engine fire warning is indicated the take-off should be aborted if possible.
If decision to stop is made abort (for further informations refer to Abort drill), retard the relevant throttle of the failed engine to HP SHUT position, shut the LP cock and press the relevant fire button. When the aircraft is stopped retard the other throttle to HP SHUT position.
If refusal speed has been reached or exceeded, it is advisable to continue take-off with maximum thrust available. Be prepared for partial or complete loss of thrust. In this event, continue with a single engine take-off and apply the following technique:

– Move the throttles to COMBAT position

– Rotate at normal V rotate, ensuring do not to over rotate. Be prepared to counter any swing towards the dead engine with the rudder.

– Climb away 13 units AOA, opposing yaw rudder.

When safely airborne:

– Jettison external stores

– Raise the landing gear. Maintain 13 AOA for normal take-off or 15 units AOA for perfromance take-off. Delay raising flaps until safely clear of the ground, then accelerate to the flaps-up, single engine climb speed. (Refer to AER.1F-PA200-1A for Flaps Rectration Speed and Safe Single Engine Operating Speed Charts).

– When the aircraft is stabilized at a safe speed and height, identify the failed engine and retard the relevant throttle to the HP SHUT position, shut the LP cock and press the appropriate Fire button.
When the fire extinguisher bottle has been discharged and the warning lights are out, it may be assumed that the fire is extinguished since an open circuited fire warning element will continue to detect an overheat condition.

WARNING

- FOR HEAVY MASS TAKE-OFF, AFTER BECOMING AIRBORNE, ALL EXTERNAL STORES SHALL BE JETTISONED AND LG RETRACTED. DURING THIS PHASE THE AIRSPEED WILL INITIALLY DECREASE.
- FOR NORMAL AND PERFORMANCE TAKE-OFF THE SINGLE ENGINE CLIMB RATE MAY BE REDUCED DURING GEAR RETRACTION WHICH COULD BE CRITICAL AT HIGH TAKE-OFF MASSES. THEREFORE THE RETRACTION OF THE GEAR SHOULD BE DELAYED UNTIL SAFE ALTITUDE IS OBTAINED.

If decision to stop is made:

1. **ABORT**
2. **THROTTLE – HP SHUT**
3. **LP COCK – SHUT**
4. **FIRE BUTTON – PRESS**

When stopped:

5. Other throttle – HP SHUT

If take-off is continued:

1. **THROTTLES – COMBAT**

When airborne:

2. **EXTERNAL LOAD – JETTISON (if necessary)**
3. **COMPLETE ENGINE FIRE DRILL**

LANDING GEAR RETRACTION FAILURE

If the gear lever is stuck at DOWN, do not use force to move the lever UP or use the emergency override button.

If the gear lever is UP:

1. Control stick – Apply momentary push (not below 0 g)

If unsuccessful and the gear position indicators show one or more reds with or without flashing handle, all greens out, and external inspection shows gear up and doors closed, carry out a single recycle as a microswitch malfunction may be suspected.

2. Gear – Recycle once

If unsuccessful and in all other cases:

3. Gear lever – DOWN

If either main gear green remained on during up selection:

4. Emerg gear handle – PULL

In all unsuccessful cases:

5. Land as soon as practicable

NOTE

- If practicable, confirm gear down and NW centered by external inspection before landing.
- If nosewheel fails to retract, the LOW light does not come on until the nosewheel touches down.

NWS FAILURE

NSAS Failure

A NSAS failure is indicated by the green LOW light on and the 600 Hz tone sounding. NWS is not affected but TR shall be limited to IDLE.

NWS Runaway

NWS runaway take-off (or landing) is detected immediately, as the NWS will not respond to rudder control inputs. Disconnect the NWS by pressing and holding the ICO.

NWS Failure

A total NWS failure is indicated by the green LOW light occulting and the 600 Hz tone sounding. The nosewheel reverts to free castor mode. Certain failures can result in the nose gear being deflected or rotating slowly.
If significant directional swing developes, up to full differential braking may be required in addition to full rudder application, to regain directional control. When using differential braking, avoid releasing the brakes completely on either pedal. System lag due to hydraulic response time, backlash and aircraft inertia, produces a significant delay (up to 1 second) between the initial application of brake and aircraft response, thus aggravating the tendency towards overcontrol. This will lead to directional swing. If violent swing develop, release the brakes momentarily.
If aborting, reduce throttles to IDLE, and if stopping distance appears marginal, lower the hook shortly before the cable. If directional control is satisfactory, select IDLE TR.
If take-off is continued, do not retract the LG since the NG steer-to-center function may be affected. For NWS Failure/Runaway apply the following drill:

1. **ICO – PRESS AND HOLD**

If aborting:

2. Throttles – IDLE/LD
3. Use rudder/differential braking to keep straight
4. Hook – Down, light on

If directional control satisfactory:

5. Throttles – IDLE TR

If take-off is continued:

6. Gear – Do not retract if NWS runaway has occurred (refer to NWS/NSAS Failures drill for landing)

NOTE

Do not retract the landing gear following a NWS failure as nose wheel steer-to-center functional may be affected.

ABANDONING

EJECTION

The escape system is designed to function up to 625 kt or Mach 2, however, human factor studies and analysis of ejection seat escape criteria have shown that ejection, at speeds in excess of 600 knots and at supersonic speeds, becomes extremely hazardous because of excessive forces being exerted on the body. Therefore, it is recommended to reduce the airspeed prior to an ejection, if possible. For after ejection sequence refer to Figure 3-1.

Ejection Altitude

Under level flight conditions, eject at least 2000 feet above the terrain. The recommended altitude is 5000 feet AGL ideally at 250 kt. Under out of control conditions, eject at 10000 feet above the terrain whenever possible. For ejection altitude refer to Figure 3-2.

WARNING

DO NOT DELAY EJECTION BELOW 2000 FEET ABOVE THE TERRAIN IN FUTILE ATTEMPTS TO START FLAMED OUT ENGINES OR FOR OTHER REASONS THAT MAY COMMIT YOU TO AN UNSAFE EJECTION. ACCIDENT STATISTICS SHOW A PROGRESSIVE DECREASE IN SUCCESSFUL EJECTIONS AS ALTITUDE DECREASES BELOW 2000 FT ABOVE THE TERRAIN.

Crew Coordination

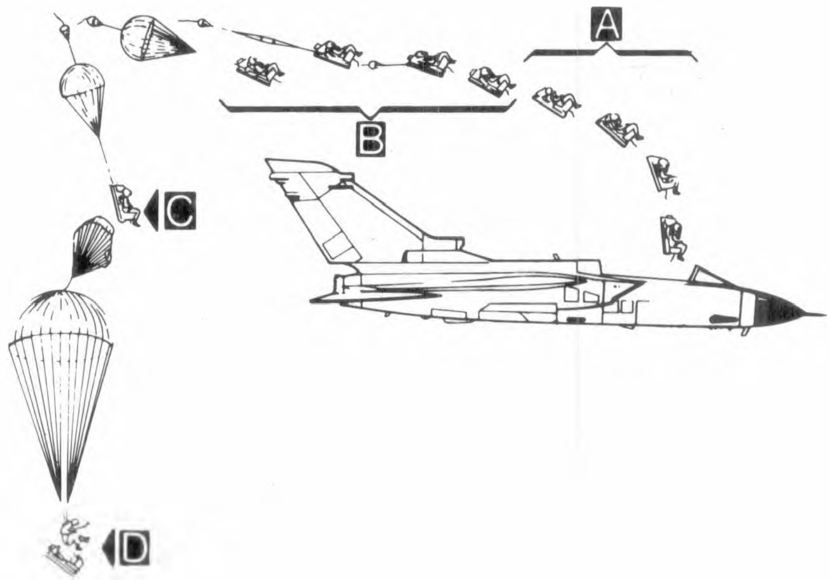
The aircraft commander shall notify the navigator, before he initiates the ejection, by one of the following methods:

Primary: Intercom, calling "EJECT" if circumstances permit

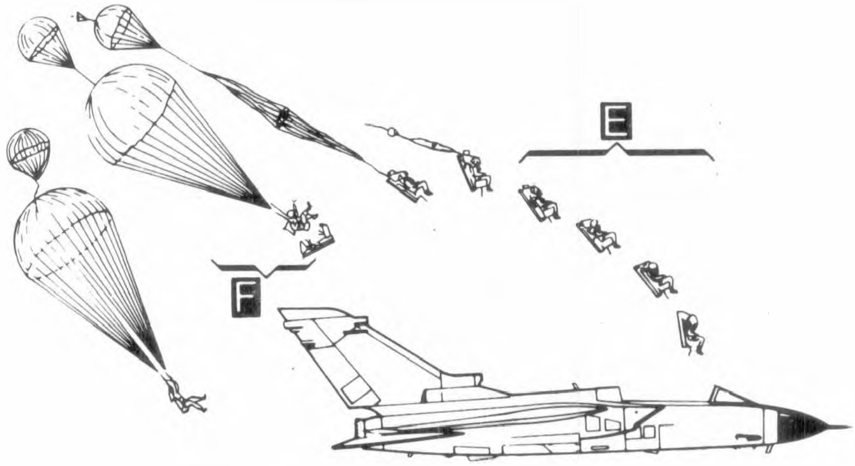
Secondary: In case of intercom failure: rapid movement of the stick from side to side to gain the navigators attention, then

AFTER EJECTION SEQUENCE

HIGH ALTITUDE EJECTION



LOW ALTITUDE EJECTION



A – Ejection seat is propelled up the guide rail, arms and legs are restrained, emergency oxygen bottle is actuated, PEC aircraft portion is disconnected, time delay mechanism and drogue gun are tripped, IFF is actuated in the emergency mode, and the seat rocket motor fired.

B – Drogue gun fires approximately 0.5 sec ± 0.1 after ejection, deploys controller drogue, which in turn, deploys the main drogue so that the seat is stabilized and decelerated.

C – Seat and occupant descent through upper atmosphere. When an altitude of approximately 5,000 mtr is reached, the barostatic time release unit actuates the release mechanism, which in turn, actuates to release the occupant's harness, arm and leg restraint lines, the PEC man-portion and restraint straps.

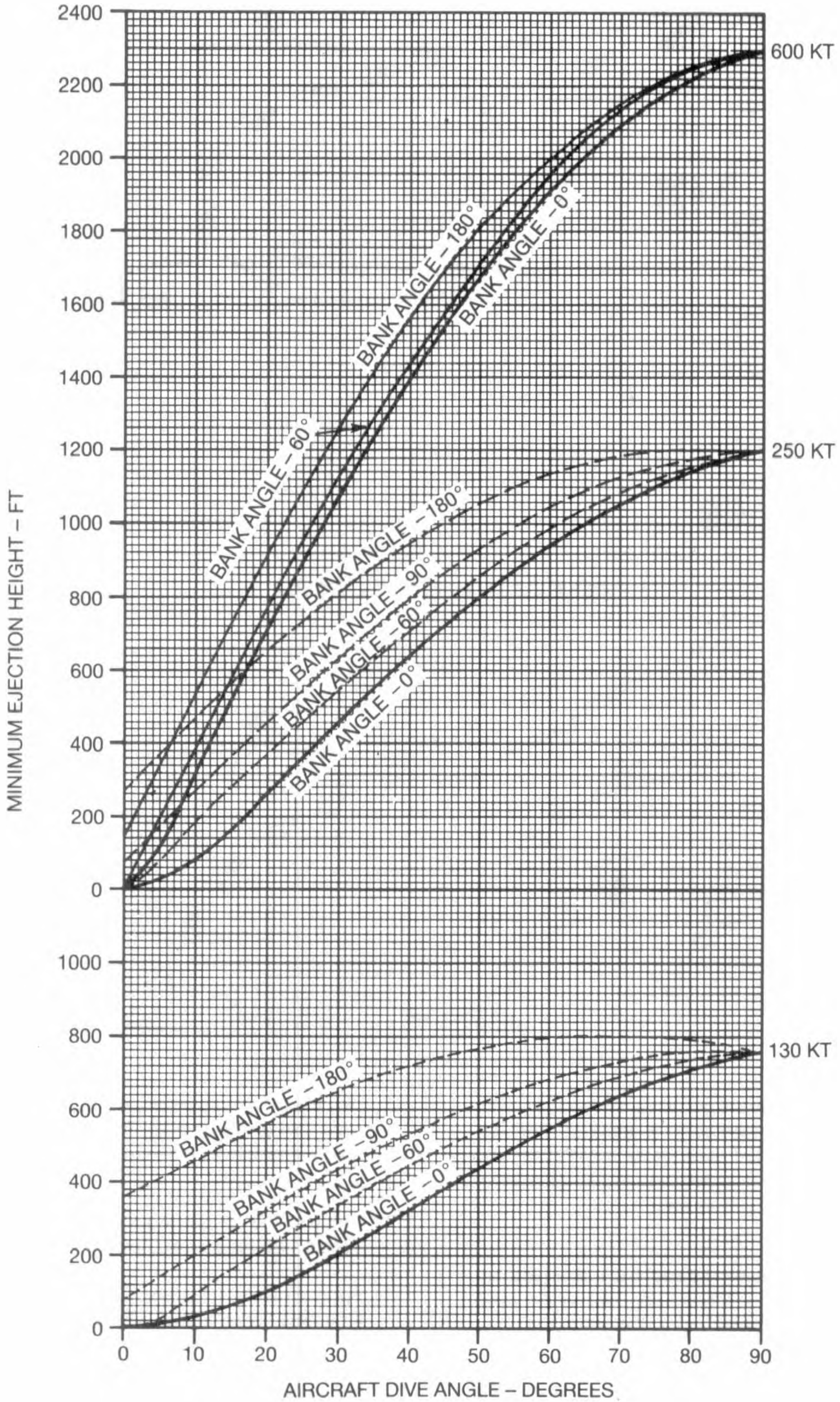
D – The main drogue pulls the parachute withdrawal line to deploy the personal parachute. The occupant is held by sticker clips until opening shock of parachute snaps the seat from him, permitting normal descent rate

E – Same as the corresponding steps A – B in the High Altitude Ejection Sequence, except:

F – Approximately 1.5 seconds after initiation of ejection the time delay mechanism actuates to release the occupant's harness, arm and leg restraint lines and PEC man portion. The g-stop functions in conjunction with the time delay mechanism and limits the parachute opening shock load at high speed within the medium altitude band and below primary barostat height down to 6000 ft MSL. The main drogue pulls the parachute withdrawal line to deploy the personal parachute. Total time required from initial pull of an ejection seat handle to full deployment of both parachutes is approximately 4 seconds, depending on speed at ejection.

Figure 3-1

MINIMUM EJECTION ALTITUDE VS. AIRSPEED, DIVE ANGLE, AND BANK ANGLE



Note: 1. Ejection on ground can be accomplished from 0 to 250 KIAS up to 60° bank.
2. Ejection can be accomplished from zero altitude to 50 000 ft and 0 to 625 KIAS or Mach 2, whichever is the lowest.
3. Computation of minimum ejection altitudes is based on the moment of initiation of the ejection gun. All heights include 1 sec reaction time for the pilot's seat and the corresponding sinkrates.
4. Data for bank angles are estimated for coordinated flight. Yaw or slip increases the height required for successful recovery.

Figure 3-2

daylight: make hand signals either side of the ejection seat head-box by holding one arm up with the forearm vertical and fist clenched then moving the forearm briskly up and down 3 times (one handed clenched fist salute)
night: signal with vertical wave of the flashlight over the left shoulder

WARNING

- IF SEQUENCED EJECTION IS INITIATED FROM EITHER COCKPIT WITHOUT FIRST ALERTING THE OTHER CREW MEMBER, INCAPACITATION FROM IMPROPER BODY POSITION DURING EJECTION COULD RESULT.
- IF THE CANOPY HAS TO BE JETTISONED OR IS LOST, THE AIRCRAFT SHOULD BE RECOVERED AS QUICKLY AS POSSIBLE TO A MAXIMUM ALTITUDE OF 15000 FT AND TO SPEED LESS THAN 250 KIAS.
- THE MDCs SHOULD NOT BE OPERATED MANUALLY DURING FLIGHT BECAUSE OF THE RISK OF INJURY TO THE CREW BY TRANSPARENCY DEBRIS.

Command Ejection

Command ejection sequences may be initiated from the front or rear cockpit. With the command ejection selection lever positioned to BOTH and the ejection initiated by the aircraft commander or navigator, the canopy will jettison immediately, the harness restraint mechanism will be activated and the sears from both front and rear ejection gun time delay firing units will be withdrawn. After a delay of 0.35 seconds the rear seat will be ejected, followed by a further delay of 0.4 seconds for the front seat. Ejections initiated by the navigator should be limited to severe emergency situations, when directed by the aircraft commander or when the aircraft commander is incapacitated. With the command ejection selection lever in the BOTH position, the sequencing system will operate if the seat firing handle in the rear cockpit is pulled. The canopy will jettison, the rear seat will eject followed by the ejection of the front seat.

Single Ejection

With the command ejection selection lever set to REAR, two ejection sequences are possible: the sequence ejection, which is initiated by the aircraft commander and described under COMMAND EJECTION, and the single ejection of the navigator, initiated from the rear cockpit. By pulling the firing handle in the rear cockpit, the canopy will be jettisoned, the harness retraction mechanism activated and the rear seat is ejected only.

Low Altitude Ejection

During any low altitude ejection, the chances of a successful ejection can be greatly increased by zooming the aircraft, speed permitting, to exchange airspeed for altitude. The zoom should not exceed a 20 degrees nose up attitude. Ejection should be initiated while the aircraft is in a positive climb. This will result in a more nearly vertical trajectory for the seat, thus affording more altitude and time for seat separation and parachute deployment.

High Altitude Ejection

Generally, high altitude ejection can be defined as ejection initiated above the seat barostatic setting.

EJECTION PROCEDURE

NOTE

If circumstances permit, it is preferable for the pilot to initiate ejection. This guarantees normal ejection sequence irrispective of the position of the command ejection lever. If the pilot is prevented from initiating ejection, the command ejection lever shall be set to BOTH before the navigator pull his seat firing handle.

If time and conditions permit:

1. Alert other crew member

2. Command ejection lever – BOTH
3. Speed – Minimum for control, ideally 250 kt
4. Height – Ideally 5000 ft AGL
5. Aircraft – Head towards unpopulated area
6. IFF – EMERG
7. Harnesses – Tight and locked
8. Oxygen masks – Tight
9. Visors – Down
10. Radio – Call as required
11. Throttles – IDLE
12. Ejection position – Assume
13. Eject

Grasp the firing handle using a two handed grip, or place one arm between legs and grasp handle (palm facility aft) and with free hand grasp opposite wrist. Pull straight up and maintain a continued pull until full travel is reached.

NOTE

- Sit erect, buttocks back, shoulders against parachute pack, head against headrest, spine straight, legs extended and tights on seat cushion.
- Normally, upon ejection, the complete canopy will be jettisoned immediately without detonation of the MDC firing mechanisms. However, if the canopy fails to jettison, the MDCs will be individually fired during the seat ejection sequence.

The crew member not initiating the ejection should be alerted and assume the proper body position with hands on the firing handle to avoid possible injury.

FAILURE OF SEAT TO EJECT

NOTE

To assure proper body position prior to ejection, it is recommended to continue holding the failed seat firing handle, if conditions permit.

1. **COMMAND EJECTION – BOTH**
2. **FIRING HANDLES – PULL AGAIN**

AFTER EJECTION

After seat/man separation perform the following procedure:

1. Parachute – Check
2. Mask – Remove
3. Survival pack lanjard – Connected
4. Survival pack – Release (Post mod. 01415: Auto release)
5. Life vests – Inflate
6. QRB – Rotate and press on touch down

NOTE

For life raft inflation the manual release handle shall be pulled.

FAILURE OF DROGUE CHUTE OR AUTO SEPARATION

In the event of a failure of the drogue gun, the ejection seat may gyrate violently. By pulling the manual separation handle, the main drogue will deploy, stabilize the seat and stop the gyrations.
If the barostatic time release unit fails to operate, i.e. if the aircrew member is still in the ejection seat below 5000 meters, actuation of the manual separation handle will release the harness, leg restraint lines, negative g restraint strap, PEC man portion and release the arm restraint lines. The main drogue then will deploy the personal parachute as in the automatic sequence.

1. **MANUAL SEPARATION HANDLE – PRESS AND PULL**

WARNING

WITH ARM RESTRAINT ACTIVATED, THE MANUAL SEPARATION HANDLE CAN ONLY BE REACHED, IF THERE IS NO OBSTACLE (LIKE CLIP BOARD, FILLED POCKET) ON THE RIGHT THIGH.

FIRE

ENGINE FIRE

Red

L FIRE	or	R FIRE

F button

Shut down the engine, shut the relevant LP COCK and operate the appropriate fire extinguisher. Reduce airspeed below 450 kt, if possible, to obtain best results from the extinguishant. When the fire extinguisher bottle has been discharged and the warning lights are out, it shall be assumed that the fire is out since even an open circuited fire warning element will continue to detect an overheat condition.
As a precautionary action, the hydraulic of the good engine shall selected to ON. This will bypass a possible failure in the SPS control unit, which could otherwise lead to hydraulic system depressurization. With an engine failure or an engine shut-down the RCOV could fail to change from the "Flight" (ENG) to the "ground" (INT) position. This restricts the flow of fuel through the fuel-cooled oil coolers of the associated gearbox and, if the LP COCK is also closed as a part of the shutdown drill, fuel is trapped in the pipeline through the coolers, between the fuel tank and the LP COCK. The trapped fuel is then thermally expanded by the heat from the coolers and fuel pipe rupture can occur after 10 minutes. The fire drill requires the LP COCK to be SHUT. In this case it is imperative that the thermal expansion of the trapped fuel is not allowed to reach the point at which the pipe could rupture. The fire drill therefore require the crossfeed valve to be opened to bleed off excess pressure and the x-drive clutch to be opened, thereby depowering the gearbox of the failed engine and removing the heat source.
Subsequently, the X-drive clutch may be closed on one or more occasions to provide essential services during the approach and landing phase, but total usage shall not be exceed 10 minutes unless Mod 01670 is incorporated. Post Mod 01670, two RCOV indicators on the glareshield in the front cockpit each show INT (green) or ENG (amber) to confirm the position of each RCOV in the associated engine fuel system. If the RCOV indicator relevant to the shut-down engine shows INT, the RCOV is in the correct position and the X-drive clutch may be left closed throughout the recovery.

1. **THROTTLE – HP SHUT**
2. **LP COCK – SHUT**
3. **FIRE BUTTON – PRESS**
4. Hydraulics – Good engine to ON, failed engine to AUTO
5. Check for further indications of fire
6. Confirmed – Eject
7. Not confirmed

If RCOV indicators fitted and the appropriate indicators show INT

8. Land – ASAP refer to Single Engine Transit X-drive Shut

If RCOV indicators not fitted or the appropriate indicators show ENG

8. Fuel X-feed – OPEN
9. X-drive clutch – OPEN
10. Land – ASAP refer to Single Engine Transit X-drive Open

REAR FUSELAGE FIRE/HOT GAS LEAK

Any unexplained combination of any of the following occurring in close sequence:

Red			Amber
CSAS	APU	CSAS	GEN
L FIRE	R FIRE	L UTIL	R UTIL
L CONTR	R CONTR	FUEL	ECS
CABIN	R/C:	IFU 1	IFU 2

Abnormal nozzle indications, other than intermittent warnings.

A duct or clamp failure can cause a hot gas leak of the ECS. The symptoms are a series of intermittent and apparently unconnected CWP warnings, including electrical, CSAS and hydraulic failures. As damage to the electrical and mechanical flight controls system can occur, the aircraft should be pulled up to safe height. The selection of the AIR SYSTEM MASTER switch to EMERG RAM AIR closes the ECS master valve, provided the leak is downstream of the shut-off valve, isolates those areas in the rear fuselage where a hot air leak would be most damaging. If the leak is upstream of the shut-off valve, the EMERG RAM AIR selection does not isolate the leak but the situation is not exacerbated. If low level, it is obviously advisable to climb to a safe height and stay VMC if possible. If IMC is unavoidable, VMC should be attained as quickly as possible and the HUD and HDD should be cross-monitored carefully while IMC. If there is any discrepancy between the HUD and the HDD instrument indications, the HDD is more likely to be correct. If at high level, it is necessary to descend below 25,000 feet to conform with oxygen and EMERG RAM AIR limitations, remaining VMC if possible. If fire is confirmed, eject: otherwise land as soon as possible. When landing is intended, the aircrew should be aware of the risk involved and be prepared for ejection, should flight control problems occur during the landing phase.

1. **AIR SYSTEM MASTER – EMERG RAM AIR**
2. Check for fire

If fire confirmed or control problems encountered:
3. Eject

If fire not confirmed:
4. Land – ASAP

WARNING

- CREW SHOULD BE ALERT FOR LOSS OF AIRCRAFT CONTROL OR FIRE AT ANY TIME.
- CREW SHOULD NOT HESITATE TO EJECT IMMEDIATELY IF CONTROL PROBLEMS ARE EXPERIENCED CLOSE TO THE GROUND, OR IF THE FUSELAGE FIRE APPEARS TO BE SERIOUS.

FLAMEOUT/RELIGHTING

DOUBLE ENGINE FLAMEOUT

With the ignition switch on the engine control panel selected to NORM, auto ignition and starting fuel is provided by the CUE following a double engine flameout. If an automatic relight has not occurred and both engines have dropped below 59% NH, the X-drive clutch and the fuel X-feed valve will open, if selected to AUTO. The left utilities isolating valve will close, to ensure that the emergency hydraulic pump (EHP) is supplying the tailerons only. When both engines have dropped to below 50% NH, the IDGs go off line and the one shot battery will fire supplying both the EHP and DC fuel pump. Normally, the one shot battery will activate automatically; however, if the EPS light is not on, the malfunction may be rectified by selecting the EPS to ON. The EPS switch shall then be returned to AUTO as otherwise the X-drive clutch will not automatically close following an engine relight.
For standardization, a common procedure is used to satisfy Pre- and Post mod. 10977 (Change to SPS Control Unit) states. With the hydraulic switches set to LEFT – ON, RIGHT – AUTO prior to flight, it is assured that in case of a single SPS control unit failure, significant degradation due to hydraulic pressure loss on both sides is prevented.
In a double engine flameout situation, consequently only the right hydraulic system will automatically depressurize at 30% NH, thus allowing an immediate relight of the right engine. As a precautionary measure, the left hydraulic switch shall be selected to OFF without delay, to cater for the possibility that the right engine cannot be relit, e.g. due to mechanical failure.
With the EPS activated, miminum hydraulic flow for operation of the flight controls only and pressurized starting fuel for relight, will be available for 3 minutes minimum. Control movements should be minimized due to limited hydraulic pump capacity and to prevent reversion to mechanical mode.
As the DC fuel pump delivers adequate starting fuel to both engines, either engine may be started first. However, due to the limited capacity of the fuel pump, only one HP cock should be opened at any one time. Press the appropriate relight button and monitor NH/TBT increase.
After successful windmilling relight of one engine, when passing 59% NH, the EPS switch shall be returned from ON to AUTO position. This ensures that, the X-drive clutch and the fuel X-feed valve will close and the EHP disconnects:

- If the right engine is relit first with the right hydraulic switch in AUTO, hydraulic pressure will be available on that side as the NH increase beyond 55%
- If the left engine is relit first with the left hydraulic switch in OFF, after EHP disconnectes (59%), the left system remains unpressurized until the left hydraulic switch is moved from the OFF position. However, provided that the EPS is in AUTO, at 59% the X-drive clutch will close, thus driving the right gearbox/hydraulic pump and pressurizing the right hydraulic system.

NOTE

After successful light-up, it may take up to 1 minute to achieve idle RPM.

When the either engine is relit, prior to selecting the left hydraulic switch to ON, ensure that the X-drive clutch is shut. Relight the other engine by applying the drill for assisted relight. When second engine is relit, check left hydraulic ON, right AUTO, reset CSAS (via train mode), SPILS. Press the relight pushbuttons in order to reset the reheat safety logic. If the reset is successful the nozzle area increases from ENC to 16% (MK101 engine) or to 10.5% (MK103 engine), check that the AJ indicate normal reading for dry thrust and the REHEAT/CWP caption extinguishes. Land as soon as possible.
If the red L CONTR/CWP caption is illuminated before a relight is achieved and the aircraft does not respond to control inputs, eject.

WARNING

- IF THE EPS LIGHT DOES NOT ILLUMINATE WHEN SET TO ON, PREPARE TO EJECT AS LOSS OF AIRCRAFT CONTROL IS IMMINENT.
- DO NOT DELAY EJECTION AS AIRCRAFT CONTROL WILL BE LOST, IF THE EPS BATTERY IS DEPLETED (AFTER 3 MINUTES).
- EPS BATTERY SUPPLY FOR 3 MINUTES MINIMUM. THIS TIME SHALL BE TAKEN AS THE LIMITING FACTOR AND NOT THE INTENSITY OF THE EPS LIGHT.
- EPS LIGHT WILL REMAIN ON AFTER THE ONE SHOOT BATTERY HAS EXPIRED.

1. **EPS – ON**
2. **LEFT HYDRAULIC – OFF**

If no auto-relight:

3. **THROTTLES – HP SHUT**
4. **EITHER THROTTLE (preferably the right) – IDLE, PRESS RELIGHT**

When either engine is relit:

5. EPS – AUTO
6. X-drive clutch – Ensure SHUT
7. Left hydraulic – ON
8. Other engine – Assisted relight

When second engine is relit:

9. Hydraulics – Check left ON, right AUTO
10. Reset – CSAS (via train mode), SPILS and ENC
11. Land ASAP

SINGLE ENGINE FLAMEOUT

The assisted relight and the windmill relight are provided to restart a failed or shut down engine. Either procedure may be initiated below 30000 ft.

NOTE

- Any relight attempt, resulting in a rapid increase in TBT with little or no corresponding rise in NH or an increase beyond 675° C with an NH of less than 65%, shall be cancelled.
- A relight should not be attempted if the engine failure or flameout was accompanied by engine explosion, fire, vibration, seizure or other abnormal behaviour.

The assisted relight method constitutes the primary method of starting an engine in flight and should be initiated when flying at low altitude and airspeed (with heavy mass).
The pre-requisites for a successful assisted relight are a serviceable X-drive clutch and gearboxes.
The windmill relight can be used whenever the minimum RPM of 12% NH (MK101) or 14% NH (MK103) can be reached and constitutes the only possible method in cases where the flameout is accompanied by gearbox or X-drive clutch failure.

Assisted Relight

Prior to attempting an assisted relight, select the throttle of the affected engine to HP SHUT and confirm that the dead engine is windmilling. Check the X-drive clutch engaged.
When within the relight envelope (Figure 3-3), advance the throttle of the affected engine to IDLE and set the dead engine to ENGINE START. Observe rise in NH and T7. If relight is not obtained or TBT exceeds 675°C when NH is less than 65%

shut the engine down and attempt further relights at lower altitude/higher airspeed. If relight is succesful the engine should accelerate to idle speed within 30 seconds, thereafter the left hydraulic system should be selected to ON and the right to AUTO; the X-drive clutch should be opened. If relight is unsuccesfull; land as soon as practicable and apply the drill for single engine transit, X-drive shut.

1. Throttle – HP SHUT
2. X-drive clutch – AUTO (light on)
3. Throttle – IDLE, within envelope
4. Engine start – LEFT or RIGHT

If light up is not obtained or TBT exceeds 675° C when NH is less than 65%:

5. Throttle – HP SHUT
6. Further attempts at lower altitude/higher airspeed – Carry out

If relight successful:

5. Hydraulics – Check left ON, right AUTO
6. X-drive clutch – Push OPEN

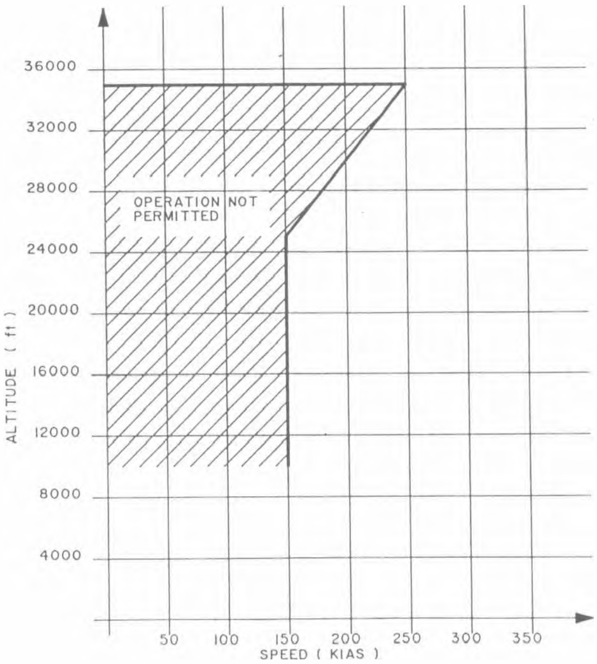
If relight unsuccessful:

7. Land – As soon practicable, refer to Single Engine Transit X-drive Shut drill.

Windmill Relight

Following a flameout, the CUE initiates auto ignition and starting fuel supply, provided that the ignition on the ENG CONTROL PANEL is in NORM.
As precautionary action, the hydraulic of the good engine shall be selected to ON. This will bypass a possible failure in the SPS control unit, which could otherwise lead to hydraulic system depressurization. The hydraulic on the failed side should be in AUTO to reduce the load on the engine and improve the windmill relight conditions.
If auto relight is unsuccessful, the relight button should be pressed to cater for a possible auto ignition circuit failure.
If unsuccessful, select the throttle of the affected engine to HP SHUT for at least 10 seconds.
With the X-drive in AUTO, the clutch will engage upon engine rundown of the flamed out engine thus preventing loss of electrical and hydraulic services on that side.
The minimum required RPM is: 12% NH (MK101) or 14% NH (MK103), at a maximim altitude of 30.000 ft (Figure 3-4).
If the flame out is accompanied by a X-drive clutch open malfunction, a slightly higher airspeed is required to reach the minimum RPM to achieve a successful relight.

ASSISTED RELIGHT ENVELOPE



NOTE

Max altitude with F-44 fuel is 25000 ft.

Figure 3-3

Prior to relighting the engine, confirm within the relight envelope. Select the appropriate hydraulic to AUTO to depressurize the hydraulic system and reduce the load on the affected engine.
Advance the throttle of the affected engine from HP SHUT to IDLE and press the relight button momentarily. Observe a slow initial rise in NH and T7 after approx. 2 to 3 seconds, thereafter the engine will accelerate to idle speed within 40 to 70 seconds, or if TBT exceeds 675° C, when the NH is less/then 65%, cancel the attempt to relight and carry-out further attemps at lower altitude/higher airspeed.
If relight is unsuccesful land as soon as practicable and apply the drill for Single Engine Transit x-drive shut.

1. Hydraulics – Good engine to ON, failed engine to AUTO

If no auto relight:
2. Throttle – HP SHUT
3. Throttle – IDLE, press relight

When engine relit:
4. Hydraulics – Left ON, right AUTO
5. X-drive clutch – Push OPEN

If light up is not obtained or TBT exceeds 675° C when NH is less than 65%:
6. Throttle – HP SHUT
7. Further attempts at lower altitude/higher airspeed – Carry out

If relight unsuccessful
8. Land – As soon as practicable, refer to Single Engine Transit, x-drive shut

WINDMILL RELIGHT ENVELOPE

ENGINE	MAX ALTITUDE	MIN NH
MK101	30000	12
MK103	30000	14

NOTE

MAX altitude with F-44 fuel is 25000 ft.

Figure 3-4

ENGINE FAILURES

SINGLE ENGINE OPERATION

The X-drive clutch should remain in AUTO for all single engine cases except for engine fire, gearbox overload or seizure, or mechanical engine failure, to ensure full service of the electric, hydraulic and flight control systems. Asymmetric effects associated with single engine operation are very small, however, flying for a prolonged period may cause center of gravity problems and require fuel balancing. Should a RCOV failure occur after engine failure or shutdown, the fuel flow through the fuel cooled oil cooler of the associated gearbox is restricted if the LP cock of the affected engine is closed. Thermal expansion of the fuel by the heat from the cooler may cause fuel line rupture. Therefore, for cases of fire, the fuel X-feed valve shall be opened to bleed off excess of pressure. Additionally, opening the X-drive clutch will cause the first stage pump to run at a reduced rate and de-power the gearbox of the failed engine, thus reducing further heat transfer to the fuel feed line. Subsequently, the X-drive clutch may be re-engaged for maximum of 10 minutes cumulative total to provide essential services during the approach and landing phase.
If during the subsequent landing LD and/or TR has to be operated, the relevant throttle shall be out of HP SHUT position. Unless the IGNITION switch on the engine control panel is selected to OFF, auto ignition and starting fuel will be actuated as soon as the throttle of the dead engine is moved out of the HP SHUT position.

ENGINE SPEED SWITCH FAILURE

Symptoms after RIGHT engine shut down/LEFT speed switch failed:

Red	Amber	Amber
R CONTR	L UTIL	R UTIL
	R OIL P	CSAS
	GEN	PFCS
		RAMP

Engine control panel R GEN FAIL Light
Multiple CSAS Failure

Symptoms after LEFT engine shut down/RIGHT speed switch failed:

Red	Amber	Amber
L CONTR	CSAS	L OIL P
	GEN	RAMP
	PFCS	L UTIL

Engine Control Panel L GEN FAIL Light Multiple CSAS Failures

If an engine speed switch relay is faulty and giving an erroneous signal, the SPS/EPS logic can assume

that an engine which is running normally, is below 60% NH, i.e., shut down or sub-idle. This fault remains dormant while both engines are running but, if the other engine is shut down in an emergency or for training purposes, the logic then reacts as if both engines are below 60% NH.
In this situation with the EPS switch in AUTO position, the single-shot battery does not fire because both TRU are still on line but the following double flameout symptoms do occur:

- The cross-drive clutch is selected and latched open, which induces gearbox failure on the side associated with the shut down engine.

- The left Utilities isolating valve closes, giving a L UTIL amber caption (if not already on). If the right engine is shut down and the left NH speed switch is faulty, the only hydraulic power available is provided by the left gearbox-driven pump supplying pressure solely to the taileron circuit. If the left engine is shut down and the right NH speed switch is faulty, the right hydraulic Utilities and Controls circuits are normal and the left Utilities are depressurised by the logic. The left control circuit may be partly pressurised by the left gearbox-driven pump if the left engine is windmilling.

NOTE

If the HYDRAULICS switch of the shut-down engine is at ON, a repeated nuisance audio warnings will occur as the windmilling engine tries to drive its associated hydraulic system, causing intermittent L or R CONTR red captions. These warnings can be prevented by setting the HYDRAULICS switch of the shut-down engine to AUTO to depressurise the associated hydraulic pump.

- In the case where the right engine is shut down or sub-idle, the right gearbox is not running and the left Utilities are isolated this induces the following failure:

  - Inboard and outboard spoilers
  - Rudder locked
  - DL in roll
  - Pitch MD
  - P/R LINK first failure
  - Wing sweep, flaps, slats and normal landing gear lowering

In this situation, taileron roll authority is reduced to 2.1° differential with flaps above 15° down (4° differential below 15° down), and there may not be sufficient authority to opposite the rolling moment if full reheat is used on an overshoot. Going through TRAIN to mechanical mode increases roll authority to 5° differential, but degrades the pitch handling characteristics.

- In a less serious situation where the left engine is shut down and the left gearbox is not running, the inboard spoilers are locked and P/R LINK and RUDDER first failures are indicated on the CSAS control panel. Control authority is normal except for the loss of inboard spoilers.

- If the fuel cross-feed switch is set to AUTO, crossfeed cock opens and the amber X-FEED caption on the fuel control panel comes on.

Malfunction of the NH speed switch, which is fundamental of this failure situation, can be detected on start-up by observing the ENGINE START – CANCEL LIGHT, which should go out as NH accelerates through 60%. A speed switch failure after start can be detected on the ground or in the air, eg, prior to shutting down the other engine for training or air test purposes, by briefly selecting the ENGINE START switch to LEFT or RIGHT. While the switch is held to LEFT or RIGHT the CANCEL light stays on and, if the speed switch is serviceable, the light goes out immediately after the switch is released. If the light remains on after being released, that speed switch is defective: press the CANCEL light to stop the start cycle and do not shut down the other engine.
If the speed switch failure has not been previously detected and the symptoms listed above occur with only one engine below 60% NH, the situation can be remedied by placing the EPS switch to OFF. If a faulty speed switch is responsible, the systems reverts to normal for a single-engine shut-down: the cross-drive clutch closes (with AUTO selected) restoring the lost gearbox, the left Utilities isolating valve returns to normal and the CSAS failure can be reset (by TRAIN mode). The crossfeed cock closes with AUTO selected.
If selecting the EPS switch to OFF does not cure the symptoms, the failure is not a speed switch failure and the EPS switch should be returned to AUTO to preserve the protection given by the EPS.

ENGINE FAILURE (MECHANICAL)

Mechanical malfunction of an engine is usually accompanied by engine vibrations, loud noises, explosions, surges or engine seizures. If any of the foregoing symptoms occur, shut the appropriate engine down. Check the windmill RPM of the failed engine and the status of the X-drive clutch. If the X-drive clutch engages and remains shut, indicating no gearbox failure, leave the X-drive clutch in AUTO. If it has disengaged, do not engage. Land as soon as practicable. If a gearbox failure is suspected, select the X-drive clutch to OPEN and refer to Gearbox Failure drill.

1. **THROTTLE – HP SHUT**

If gearbox failure is suspected refer to Gearbox Failure drill.

NOTE

If X-drive clutch has not shut, do not try to engage.

ENGINE VIBRATION

Amber

L VIB or R VIB

Illumination of the caption indicates that a certain vibration level in the turbine or compressor sections, sensed by two vibration transducers, has been exceeded. It may also indicate that there are excessive pressure fluctuations in the reheat section of the jet pipe. If the caption illuminates with reheat thrust selected, reheat buzz and/or an out-of-balance running engine shall be assumed.

1. Throttle – IDLE

If warning goes out:

2. Throttle – Leave at IDLE

If warning remains on:

3. Throttle – HP SHUT
4. Land – ASAP, refer to Single Engine Transit X-drive Shut drill

If warning remains on at windmilling speed:

5. Engine – Relight
6. Throttle – Leave at IDLE
7. Land – As soon as practicable

SURGE

A surge is an aerodynamic distruption of airflow through the compressor, caused by subjecting the compressor to a pressure ratio above its capabilities at the existing conditions. Normal surges are accompanied by loud single or successive bangs occasionally accompanied by the momentary appearance of an amber THROT on the CWP. If the surge is self clearing, no immediate action is required. If surge is not self clearing and it is difficult to determinate which engine is surging, reduce both throttles rapidly to IDLE and decrease AOA. If the surge is locked in, indicated by a light rumble accompanied by stagnating or decreasing NH, high TBT and no throttle response, increase airspeed by reducing altitude. If the surge remains locked in, shut down the faulty engine. If damage is suspected or if single engine land as soon as possible and apply the drill for Single Engine Transit X-drive Shut. If damage is not suspected, relight the affected engine and land as soon as practicable. If both engines are affected by locked in surge, shut down the engine with the highest TBT and the lowest NH first and relight.

1. **THROTTLES – IDLE**
2. **AOA – DECREASE**

If surge locked in:

3. Descend and increase airspeed
4. Positively identify faulty engine by:
   - High TBT
   - No throttle response
   - Low NH (possibly sub-idle)
5. Faulty engine – HP SHUT

If damage suspected or if single engine:

6. Land – ASAP refer to Single Engine X-drive Shut drill

If no damage suspected:

7. Engine – Relight
8. Land – As soon as practicable

NOTE

An engine surge caused by a bird strike may be self clearing. However, if the VIB caption on the CWP illuminates, carry out the relevant procedure.

Potential Lock-In Surge Region

The region to the left of and above hatched line shown in Figure 3-5, passing linearly through 200 kt/30000 ft and 300 kt/40000 ft, indicates where lock-in surge may occur. This area should therefore be avoided, but, if entered, to avoid lock-in surge, AOA should not exceed 15 units and engine load should be normal. Refer to Section V, "Engine Operation in Flight".

TURBINE BEARING OVERTEMPERATURE

Red

L TBT	or	R TBT

Turbine bearing cooling air overtemperature is indicated on the CWP as TBT which will latch if a preset temperature limit within the HP turbine bearing chamber is exceeded.
Even momentary temperature peaks resulting from chopped throttle reductions at high indicated airspeed/low altitude may trigger the warning(s) but do not necessarily imply a genuine failure.
A permanent overtemperature condition may cause failure of the carbon seals, deterioration of bearing lubrication, followed by vibration until complete bearing failure and engine seizure.
If TBT warning appears on the CWP, reduce the throttle of the affected engine to IDLE and operate the good engine below MAX DRY.
Confirm that the left lanes test switch is in LANE 1. After 15 seconds but within 30 seconds (to avoid possible major engine damage) press and release the left lanes test button momentarily.
If the warning remains on, indicating a permanent failure, shut down the engine land as soon as practicable and apply the drill for Single Engine Transit X-drive shut.
If the TBT/CWP caption extinguishes, continue the flight and OPEN X-drive clutch.

1. **THROTTLE — IDLE**
2. **Other engine — Max 90% NH**

After 15 seconds but within 30 seconds:
3. **LEFT lanes test — Press momentarily (lane 1)**

POTENTIAL LOCK IN SURGE REGION

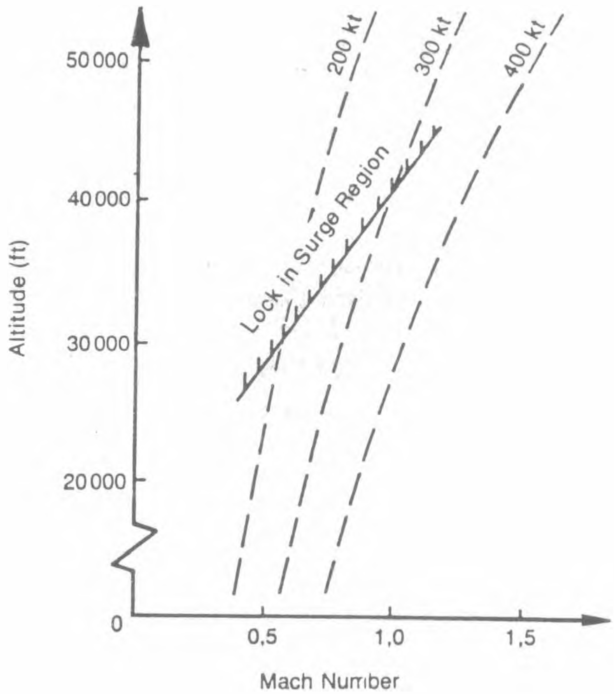


Figure 3-5

NOTE

- The L and/or R TBT CWP captions can be cancelled by pressing the left lanes test button. However, as the high temperature may exist up to 15 seconds, the TBT/CWP may not unlatch immediately. Therefore the attempt to clear the CWP should be made 15 seconds after the TBT/CWP caption appeared.
- If the engine is good and TBT is limited, the throttle should be retarded until NH is observed to drop, to ensure that the engine is NH controlled. Pressing the left lanes test button disables the TBT limiter, the TBT indicator winds up to 925° C, and engine control reverts to lane 2.

If warning remains on:
4. **Affected engine — HP SHUT**
5. Land — As soon as practicable, refer to Single Engine Transit x-drive shut drill.

If warning goes out:

4. Continue flight
5. X-drive clutch – PUSH OPEN

In unlikely event of a double genuine turbine bearing overtemperature warning, retard throttles to minimum practicable and reduce airspeed to approx. 250 KIAS. Apply drill for single TBT failure.

If one caption remains lit, shut down the affected engine and land as soon as practicable. Refer to Single Engine Transit x-drive shut drill.

If both warnings remain on, maintain minimum practicable power settings and land ASAP from a precautionary pattern.

WARNING

IF ENGINE SEIZURE OCCURS, THE AIRCREW SHALL DECIDE WHETHER TO CONTINUE OR EJECT.

NOTE

Notify to ground personnel of any illumination of the TBT caption(s).

ENGINE OIL PRESSURE LOW

Red	Amber
L OIL P or R OIL P	L OIL P or R OIL P

(Post mod. 00859)

Illumination of the caption on the CWP signifies insufficient oil pressure which may be caused by loss of engine oil, malfunction in the oil system or by maintaining the aircraft for a prolonged period in an abnormal attitude where the oil supply is interrupted.

For negative g flight, the limitations in Section V, under Engine Operation, shall be observed with particular respect to engine and modification (time delays) standards.

Recovering the aircraft to 1 g flight and retarding the throttle to IDLE may rectify the malfunction allowing the flight to be continued. However, if the caption remains on for more than 10 seconds after the aircraft has attained level flight, the engine shall be shut down to avoid bearing failure or engine seizure.

The point at which a bearing may fail, subsequent to an oil pressure failure, is unpredictable.

1. **THROTTLE – IDLE**
2. **RECOVER TO 1 G FLIGHT**

If after 10 sec warning persists:

3. **THROTTLE – HP SHUT**
4. Land – As soon as practicable

ENGINE OIL OVERTEMPERATURE

Amber

L OIL T or R OIL T

Engine oil is cooled by the fuel cooled oil cooler, the degree of cooling achieved depends on fuel temperature and volume of fuel passing through the cooler. Prolonged operation with degraded lubrication may result in bearing failure or complete loss of an engine. If the malfunction occurs, retard the respective throttle to IDLE and increase fuel flow by reducing altitude. However, if the warning remains on for more than 5 minutes after the aircraft has been recovered to level flight, shut down the affected engine and land as soon as practicable.

CAUTION

IN HOT WEATHER OPERATION, IF L/R OIL T WARNING LIGHT COMES ON FIXED, WAIT TWO MINUTES BEFORE EFFECTING THE FOLLOWING PROCEDURE.

NOTE

If accompained by FUEL T caption refer engine oil and fuel overtemperature drill.

1. **THROTTLE – IDLE**
2. Recover to 1 g flight

If warning persists for more than 5 minutes:

3. Throttle – HP SHUT
4. Land – As soon as practicable, refer to Single Engine Transit x-drive shut drill

NOTE

The engine may be relit for landing provided the warning caption is out and the other parameters for starting are normal.

ENGINE OIL AND FUEL OVERTEMPERATURE

Amber

L OIL T	or	R OIL T
L FUEL T	or	R FUEL T

Sequential or simultaneous illumination of the amber OIL T and FUEL T/CWP captions on one side indicates a high oil temperature in the oil feed line and a high fuel temperature in the burner feed line. This failure could be caused by RCOV moving to INT due to the absence of the 59% NH signal, or the valve itself malfunctioning. Similarly the fault may lie with a malfunctioning engine fuel recirculation valve.

Retard the respective throttle to IDLE and recover the aircraft to 1 g.

Switch off the relevant generator to reduce the oil temperature in the fuel-cooled oil cooler.

If temperature is more than 70° C descend below 10000 ft to increase the cooling effect of the surrounding air.

If warnings persist for more than 5 minutes or temperature is more than 70° C and continues to rise, the relevant engine shall be shut down to prevent further temperature increasing.

Set the x-drive clutch to open and land as soon as practicable using the drill for Single Engine Transit, x-drive open.

CAUTION

IN HOT WEATHER OPERATION, IF L/R OIL T OR L/R FUEL T WARNING LIGHT COMES ON FIXED, WAIT TWO MINUTES BEFORE EFFECTING THE FOLLOWING PROCEDURE.

1. **Throttle – IDLE**
2. Recover to 1 g flight
3. Generator – OFF (if practicable)
4. Fuel temperature indicator – Check

If more than 70°C:

5. Altitude – Below 10000 ft

If warnings persist for more than 5 mins or temperature is more than 70° C and continuing to rise:

6. Throttle – HP SHUT
7. X-drive clutch – OPEN
8. Land – As soon as practicable refer to Single Engine Transit x-drive open drill

NOTE

- Engine may be relit for landing if both captions are out.
- If X-drive clutch was opened, it may be returned to AUTO for landing.

ENGINE CONTROL SYSTEM FAILURES

LOSS OF THROTTLE CONTROL

Engine control will be lost if all lanes and reversionary channels have failed. The emergency overspeed governor prevents overspeeding the engine by spilling surplus fuel from the burner lines back to the HP pump inlet. If throttle authority cannot be restored, by selecting the other lane and the affected engine controlled within the operating limits, it shall be shut down immediately.

1. Eng control – Select other lane

If adequate control is not regained:

2. Throttle – HP SHUT
3. Land – As soon as practicable, refer to Single Engine Transit x-drive shut drill

NOTE

Expect momentary loss of throttle control when switching from lane 2 reversionary to lane 1 reversionary.

LANE FAILURE

Amber

L THROT or R THROT

The mandatory lane for normal operation is lane 1. If lane 1 failure is detected, control will be transferred automatically to lane 2. Switching to lane 2 will extinguish the warning on the CWP. Land as soon as practicable if the warning on CWP persists.

1. Eng control – LANE 2

NOTE

Continue sortie provided that throttle response is given when LANE 2 is selected with the warning on the CWP out.

LANE FAILURE TO REVERSIONARY

Amber

L THROT or R THROT

REHEAT

Illumination of the THROT and REHEAT captions on the CWP indicate that both main lanes and the reheat lane of the appropriate CUE have failed. Engine control has accordingly reverted to the reversionary mode of the selected lane and reheat will be frozen if it had previously been selected. Attempt an ENC reset by pressing the appropriate relight button. If REHEAT extinguishes and L or R THROT remains, select LANE 2, otherwise remain in LANE 1. Land as soon as practicable.

The remote possibility exists that REHEAT malfunction originates from one engine, and THROT warning from the other engine. To determine to which engine the REHEAT caption refers, proceed as follows:

– If in reheat, modulate the throttles in sequence and observe nozzle response. A frozen nozzle indicates the affected engine. If in dry range, select min reheat on the engine not affected by THROT warning. If reheat thrust is available the REHEAT caption refers to the other engine. Carry out the appropriate drills for Reheat Failure or Lane Failure.

NOTE

If a simultaneous failure of both engine control systems to LANE 2 occurs, land ASAP.

1. Reheat – Cancel
2. TBT, NH – Check, control below limits
3. Eng control – LANE 1
4. Relight button – Attempt ENC reset

If REHEAT extinguishes and L or R THROT remains:

5. Eng control – LANE 2

If ENC reset unsuccessful:

6. Throttle – Handle with caution
7. Land – As soon as practicable

REHEAT CONTROL FAILURE

Amber

REHEAT

with

Frozen Aj or ENC

A reheat control system failure results in frozen Aj or ENC and is indicated by illumination of the REHEAT caption on CWP.
Take-off is not affected and reheat should be maintained until no longer required. After reheat cancellation, the nozzle will drive to ENC. Press the relevant relight button to attempt ENC reset. If successful, the Aj indicates normal reading for dry thrust and the REHEAT/CWP caption extinguishes.

If frozen Aj:

1. REHEAT – Maintain as required

If ENC:

2. Throttle – Dry range
3. Relight button – Attempt ENC reset

NOTE

- Reheat not available if no ENC reset.
- If nozzle asymmetric, use TR with caution.

REHEAT BLOWOUT

In case of reheat blowout if the working line limiter (WLL) signal reversion to max dry, reheat fuel is cut off and the Aj will indicate the normal dry thrust reading (i.e. MK101, 16%; MK103, 12%). This auto-reversion will occur if the selected reheat Aj is, for MK101 >93% for all altitudes; MK103 >80% at sea level, but increasing with altitude. Core engine continues to operate normally.
If the selected reheat rating (Aj) is below those values previously mentioned and reheat blows out or fails to light up, then the nozzle will remain at the selected value. Reheat should be manually cancelled by retarding the throttle to dry range.
If reheat blowout occurs in flight, select the relevant throttle to dry range and select REHEAT (except for take-off where both throttles shall be selected to COMBAT). Due to the fuel system purge requirement expect a delay of 5 sec for MK101, or 1.5 to 5 sec for MK103 before reheat light up occurs (Refer to Figure 3-6 and Figure 3-7).

AREA OF WLL OPERATION – MK101

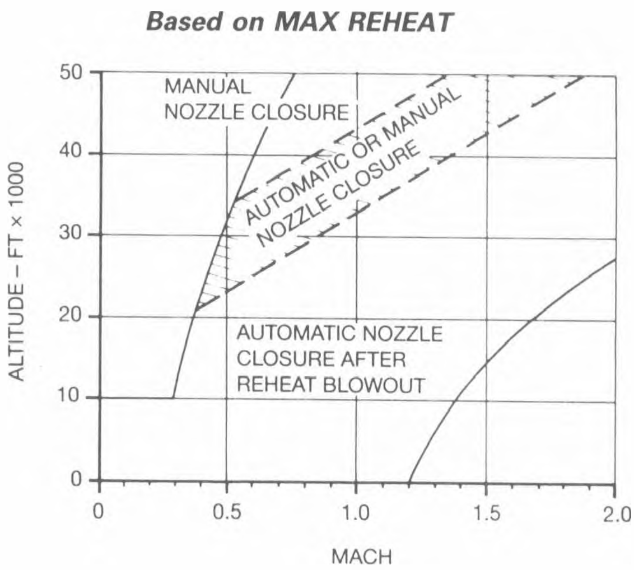


Figure 3-6

AREA OF WLL OPERATION – MK103

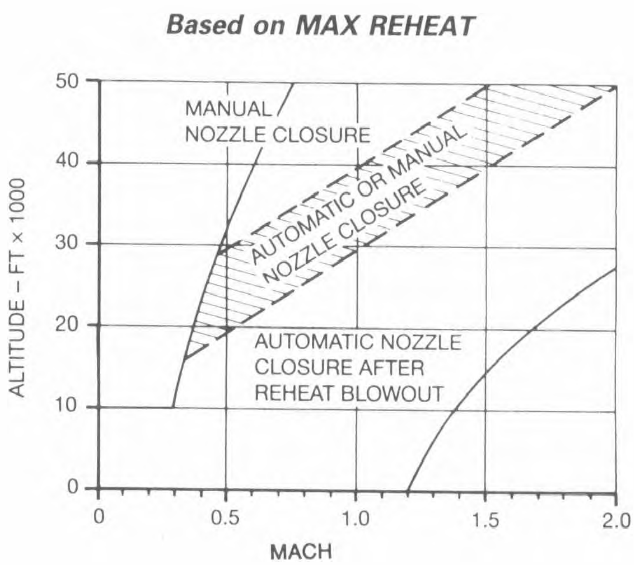


Figure 3-7

THRUST REVERSER UNLOCKED

Red

L REV	or	R REV

and/or
Magnetic Indicator REV or X-hatched

Deployment of the thrust reverser will be felt immediately, as the aircraft will yaw and decelerate and force the aircrew sideways and forward, depending on airspeed and position of the thrust reverser buckets into the jetstream.
To avoid possible structural damage, corrective action shall be taken without delay such as selecting the throttle to IDLE.
If bucket deployment is not confirmed and there are no handling difficulties, reduce speed to below 300 kt and land as soon as practicable.
In both cases refer to Single Engine Transit x-drive shut drill.
Should a TR failure occur after touchdown, select thrust reverse to ORIDE.

1. **THROTTLE – IDLE**

If deployment confirmed and/or handling difficulties:

2. Throttle – HP SHUT
3. Land – As soon as practicable, refer to Single Engine Transit x-drive shut drill

If deployment not confirmed or no handling difficulties:

2. Speed – 300 kt or below
3. Land – As soon as practicable, refer to Single Engine Transit x-drive shut drill

AIR INTAKE RAMP FAILURE

Amber

RAMP

INTAKE Control Panel L or R FAIL

Failure of the Automatic Control Unit (ACU) or loss of AC and DC electrical power will lock the ramps in the position in which they were at the time of failure. Since the ramp setting may not match the existing flight condition at airspeeds above 1.3 Mach, rapid throttle movement may result in engine surge or flameout. On pressing the FAIL button on the AICS panel, the system will resume normal operation, if the failure was only temporary. If unsuccessful, select and and leave ramp in ORIDE position, then reduce throttles slowly to MIN REHEAT until airspeed is reduced below 1.3 M.
Selecting ORIDE with hydraulics and DC power available will cause the ramps to drive at a constant rate to the fully OPEN position. When hydraulics are lost with ORIDE selected, the airstream might then push the ramp towards the OPEN position. As there is no indication of the ramp position, degraded engine performance should be anticipated and engine should be handled with care. Do not exceed 1.3 M for the remainder of flight.

1. Mach/altitude – Maintain
2. Fail button – Press

If unsuccessful:

3. Ramp – ORIDE
4. Throttles – Min REHEAT until below 1.3 M
5. If ramp remains X-hatched – Handle engine with care
6. Speed – Below 1.3 M

FUEL SYSTEM FAILURES

FUSELAGE FUEL LEAK

Fuselage group asymmetry not associated with unequal engine demand or transfer failure indicates a leak within a group or in the associated engine feed line. In extreme cases, the amber FUEL caption illuminates on the CWP. Cancel reheat on both engines if in use, close the fuel x-feed valve to prevent further transfer to and subsequent loss from the defective side and check the tank inter switch is set to close. Select EMERG TRANS to the good group to transfer fuel to the good group only. Select SEQUENCE as required, as its position determines the sequence and source of fuel supply to the selected group. Fuel in a leaking tank should be used before it is lost. Set the SEQUENCE switch to the affected tank group and when the failed tank is empty, return the switch to NORM to restore the transfer sequence. Land as soon as possible.

If flameout is imminent, as precautionary action, the hydraulic of the good engine shall be selected to ON. This will by pass a possible failure in SPS control unit, which could otherwise lead to hydraulic system depressurization. Open X-drive clutch to prevent major damage to the associated gearbox and IDG due to lack of cooling fuel.

If a flameout occurs shut the relevant engine down, land as soon as possible and apply the drill for Single Engine Transit X-drive open

1. Fuel X-feed – CLOSE
2. Tank inter – Check CLOSE
3. Emerg trans – Select to good group
4. Sequence switch – As required
5. Land – ASAP

NOTE

- Be prepared for loss of engine associated with failed group. Associated F/R PUMP caption should be ignored.

- In all configuration an acceptable fuel asymmetry is:
  - Front heavy – No limit
  - Rear heavy – 600 kg

If flameout imminent:

6. Hydraulics – Good engine to ON (ensure white sector). Failed engine to AUTO
7. X-drive clutch – OPEN

If flameout occurs:

8. Throttle – HP SHUT
9. Land – ASAP, refer to Single Engine Transit X-drive Open

WARNING

- IF THERE IS NO FUEL IN THE COOLING CIRCUITS; DO NOT CLOSE X-DRIVE FOR MORE THAN 2 MINS. CUMULATIVE TOTAL.

- IF IT IS DESIRED TO RETAIN WING TANK FUEL TO GIVE EXTRA RESERVES STOP FUEL TRANSFER BY SELECTING SEQUENCE SWITCH TO AN EMPTY FUEL STATION.

BOOST PUMP LOW PRESSURE

Amber

F PUMP or R PUMP

Illumination of the respective caption on the CWP may be an indication of a single or double boost pump failure.
Abort take-off if possible. If take-off is continued and double boost pump failure has occurred, flameout of the affected engine shall be expected.
In this case apply the "Engine failure during take-off" procedures, selecting maximum thrust and considering reducing mass.
When airborne, investigate and attempt a relight. If in flight the amber F/R PUMP caption appears on CWP and the engine behaves abnormally or flameout occurs, a double boost pump failure should be suspected.
If F-40 fuel is used both engine shall be handled with caution. If boost pump failure is confirmed, avoid negative g and cancel reheat if selected.
Open the fuel X-feed valve and land as soon as practicable, ASAP with F-40 fuel, using gentle throttle movements and avoiding high power demands.
In flight, a single or double pump failure can be determined by attempting to dump fuel from the affected tank group.
Fuel balancing may be required to avoid CG problems, if flying for a prolonged period is necessary.

1. Negative G – Avoid

WARNING

USE OF REHEAT MAY CAUSE DOUBLE ENGINE FLAME OUT.

If engines behaves abnormally:

2. Fuel X-feed – OPEN

If flameout occours:

3. Failed engine – Relight
4. Land – As soon as practicable (ASAP with F-40 fuel)

NOTE

A brief F or R PUMP/CWP caption may come on under zero or negative g. If a warning fails to go out immediately upon applying positive g a booster pump failure has occurred.

WING OR EXTERNAL TANK TRANSFER FAILURE

Incorrect Fuel Transfer on FCP and/or Asymmetric Tank Contents and/or Amber FUEL

External Tanks

If an external fuel transfer valve fails to open, the relevant caption on the fuel control panel will not illuminate, indicating that fuel will not transfer from the respective tank.
A pressurization failure or proportioner malfunction shall be suspected if the relevant valve caption on the fuel control panel is illuminated but fuel is not transferred.
This can be confirmed by the fuel contents decreasing at a greater rate from the affected fuselage tank group and if the fuselage front group feeds prematurely, the amber FUEL caption comes on when contents reduce sufficiently.

NOTE

With the amber FUEL caption on and the X-FEED switch set to AUTO, the crossfeed cock opens. If the boost pumps output pressure from one group is significantly mismatched with the other, rapid fuel asymmetry can occur. Selective switching of the boost pumps allows rectification of the imbalance and maintains the aircraft within the CG limits. In situations where switching off one pair of boost pumps is imprudent, setting the X-FEED switch to CLOSE prevents increasing asymmetry.

Ensure the PROBE switch is selected IN and the FLT REFUEL switches are to OFF. Set the SEQUENCE switch to the tank group failing to transfer. If this action is successful, reselect NORM when the affected tank is emptied and ensure that the next tank in the sequence is transferring. Should this tank also fail to transfer, the sequence shall then be manually controlled by use of the SEQUENCE switch.
A malfunctioning fuselage transfer valve may be by-passed by selecting ALTER TRANS switch to ALT.

NOTE

The refuel/transfer valves open but the rate of transfer is reduced.

In case of a fuel transfer failure leading to one I/B tank full and the other empty, the FWD and AFT fuel contents shall be observed closely and balance maintained following standard fuel management procedures.
Unfavorable longitudinal CG conditions may be encountered especially in case of a transfer valve failure of the left U/WG tank, because fuel is transferred to the rear tank group only.

In order to improve lateral control authority, the wing should be set to 25° WS, 10 units AOA should not be exceeded and gentle manoeuvring only should be executed.
If necessary to land in this situation, AOA shall not exceed 10 units during approach and 12 units for flare.
Lateral control authority with some CSAS failure (spoiler failure, RDL, P/R 2nd failure) will be further degraded and landing could be hazardous.
Internal wing fuel should be held as long as possible, otherwise the maximum carriage speed in 25° WS of 250 KIAS/0.7 Mach needs to be observed.

Wing Tanks

With the SEQUENCE set to NORMAL, the wing tank transfer pumps are actuated and will deliver fuel pressure, which will be confirmed by illumination of the relevant WING caption on the fuel control panel.

If, in spite of this indication, a fuselage fuel transfer failure is indicated by premature depletion of a failed group, press WING on the fuel quantity indicator unit to determine wing fuel state.

Wing fuel transfer may be achieved by selecting ALTER TRANS to ALT, which will open the fuselage refuel valves.

NOTE

With the TRANS switch set to ALT, the rate of transfer is reduced.

1. Probe switch – IN
2. Flt refuel switch – Check OFF
3. Sequence – Failed tank

If unsuccessful:

4. Trans – ALT

If one underwing tank remains full:

5. Wing sweep – Forward to 25°

For landing with full underwing tank:

6. Flaps – MID
7. AOA – 10 units approach, 12 units flare

NOTE

Crosswind limit with asymmetric stores 10 kt.

FUEL BALANCE

WARNING

IF FUEL LEAK IS SUSPECTED, FUEL X-FEED TO REMAIN TO CLOSE.

In cases of major imbalance, confirm that the fuel X-feed is in AUTO and the associated indicator light is out. Select EMERG TRANS to the low group and SEQUENCE as required, as its position determines the sequence and source of fuel supply to the selected group.

NOTE

In all configurations an acceptable fuel asymmetry is:
– Front heavy - no limit
Rear heavy - 600 kg

1. Fuel X-feed – Check AUTO, light out
2. Emerg trans – Select to low group
3. Sequence switch – As required

If imbalance persists:

4. Trans – ALT

If unsuccessful:

5. Emerg trans, sequence, trans – NORM

If imbalance persists (rear group heavy only):

6. Tank inter – OPEN

With the tank interconnect switch selected to OPEN, fuel will transfer from the rear to the front group only, at a rate of approx. 0.8 kg/sec.
If imbalance still persists, fuel balancing may be achieved (with one or both engines running) by switching OFF the booster pump of the low fuel group.
Check that the tank interconnect is CLOSED and the fuel x-feed is OPEN (confirm light on).
One fuel booster pump switch shall be selected to flight at all times.
When balanced, switch the boost pumps to FLIGHT and the fuel x-feed to AUTO.

If imbalance still persists:

7. Throttles – If two engines, cancel reheat
8. Tank inter – CLOSE
9. Fuel X-feed – OPEN, light on
10. Boost pumps (low fuel group) – OFF

WARNING

- BEFORE SWITCHING THE LOW GROUP BOOST PUMP OFF, ENSURE THAT FUEL X-FEED VALVE IS INDICATED OPEN, OTHERWISE THE REMAINING ENGINE WILL FLAMEOUT.
- USE OF REHEAT MAY CAUSE DOUBLE ENGINE FLAMEOUT.

When balanced:

11. Boost pumps – ON
12. Fuel X-feed – AUTO, light out

If imbalance still persists:

13. Boost pumps – ON
14. Fuel from heavy group – Dump (if required)

The fuel dump rates depend on engine power settings.
Dumping from a single tank group gives a dump rates at sea level of 6.8 kg/sec for single or double engine operation in dry range. The dump rate decrease with increasing altitude.

WARNING

- IF A FUEL LEAK IS SUSPECTED, FUEL X-FEED TO REMAIN CLOSE.
- WITH BOTH ENGINES RUNNING ON A SINGLE BOOST PUMP GROUP, USE OF REHEAT MAY CAUSE A DOUBLE ENGINE FLAMEOUT.

LOW COLLECTOR BOX CONTENTS

Red

FUEL

The fuel low level warning on the CWP may be activated if the aircraft is manoeuvring at low g at high power settings.

Throttles shall be retarded without delay and the aircraft recovered immediately to level flight to avoid flameout.

The fuel X-feed valve opens automatically when the warning appears and closes when the caption extinguishes. Maintain 1 g flight at a reduced power setting for a minimum of 1 minute to restore the fuel contents in the forward collector box.

1. Recover to 1 G flight
2. Fuel contents/transfer – Check
3. Maintain level flight for 1 minute after warning is out

ENGINE FUEL OVERTEMPERATURE

Amber

L FUEL T or R FUEL T

NOTE

If accompained by OIL T caption refer to Engine Oil and Fuel overtemperature.

If an engine fuel overtemperature is indicated, conditions permitting, switch off the relevant generator to reduce the oil temperature at the fuel cooled oil cooler. Since fuel is used as a cooling medium for hydraulic oil and engine gearbox lubricating oil, fuel circulation within the system should be increased. If the fuel temperature reads below 70° C, advance the throttle of the affected side to MAX DRY. If above 70° C, reduce the RPM of the respective engine to below 84% NH and descend below 10000 ft to increase the cooling effect of the surrounding air.

CAUTION

IN HOT WEATHER OPERATION, IF L/R FUEL T WARNING LIGHT COMES ON FIXED, WAIT TWO MINUTES BEFORE EFFECTING THE FOLLOWING PROCEDURE.

1. Generator – OFF (if practicable)
2. Fuel temp indicator – Check

If less than 70° C:

3. Throttle – Increase fuel flow/MAX DRY

If more than 70° C:

4. Throttle – Below 84% NH
5. Altitude – Below 10000 ft

If warning persists for more than 5 mins or temperature is more than 70° C and continuing to rise:

6. Throttle – HP SHUT
7. X-drive clutch – OPEN
8. Land – As soon as practicable, refer to Single Engine Transit x-drive open drill

NOTE

- Engine may be relit for landing if FUEL T warning is out.
- If FUEL T caption remains on, the X-drive clutch may be returned to AUTO for operation of essential services and for landing.

FUEL TANK HIGH TEMPERATURE

Fuel Temperature Indicator more than 70° C

At high ambient air temperature and particularly low fuel states, the fuel tank temperature may exceed its operating limits. The problem may be overcome by switching the relevant generator off, retarding throttle to below 84% NH and descending below 10000 ft.

Temperature indicator more than 70° C:

1. Generator – OFF (if practicable)
2. Throttle – Below 84% NH
3. Altitude – Below 10000 ft
4. Land – As soon as practicable

If temperature rising rapidly or above 80° C:

5. Land – ASAP

If after landing the temperature has risen above 90° C:

6. Both throttles – HP SHUT when stationary

VENT SYSTEM PRESSURE LOW

Amber

VENT

Illumination of the caption on the CWP signifies a low fuselage fuel tank pressure. Avoid high power demands and rapid descents, as fuel cells may collapse. If possible, reduce the descent rate to less than 6000 ft/min at a speed below 1.1 Mach with at least one engine at not less than 80% NH. If the CWP caption extinguishes, flight may be continued.

1. Descent rate – Less than 6000 ft/min
2. Speed – Below 1.1 M
3. Throttles – At least one engine above 80% NH

REFUEL/TRANSFER VALVE FAILURE – PROBE SELECTED IN

A refuel valve stuck open failure will result in fuel venting from main fuel vent following AAR. Excessive fuel consumption from one external fuel tank.

NOTE

If it is desired to retain wing tank fuel to give extra reserves stop fuel transfer by selecting SEQUENCE switch to an empty fuel station.

1. Keep failed fuselage group less than full

A transfer valve stuck open failure can occur at any time during flight following fuel transfer from external tanks, or after AAR. It may be evidenced by fuel venting from the main fuel vent outlet in the fin, or excessive consumption from a wing or external tank. Fuel shall be transferred manually by applying the Fuel Balance drill. Fuselage group fuel should be kept less than full to avoid overfilling and subsequent loss of fuel through the vent system.

REFUEL/TRANSFER VALVE FAILURE – PROBE SELECTED OUT

A transfer valve stuck open failure can occur at any time during flight following fuel transfer from external tanks, or after AAR.

It may be evidenced by fuel venting from the main fuel vent outlet in the fin, or excessive consumption from an external tank. If the AAR probe is OUT, the failure will be accompanied by an amber FR VLV/CWP caption.

Amber

FR VLV

1. Attempt wet refuel

If FR VLV caption goes out:

2. Continue refuelling normally

If FR VLV caption stays on:

2. Wet refuel – Discontinue except in emergency

WARNING

IF REFUEL IS CONTINUED IN AN EMERGENCY, DO NOT COMPLETELY FILL ANY FUSELAGE TANK TO AVOID TANK DAMAGE.

NOTE

If dry contact is made with FR VLV caption lit, fuel can enter fuselage group even with flight refuel switches OFF.

ELECTRICAL SYSTEM FAILURES

DOUBLE GENERATOR FAILURE

Red		Amber	
AC and DC		GEN	TRU
		F PUMP	R PUMP
		RAMP	CSAS
		PFCS	REHEAT
			R ALT

ENGINE and INTAKE Control Panels L and R GEN FAIL Lights

A double generator failure will result in loss of all boost pumps, thus fuel supply to the engines will be critical. If in reheat thrust, throttles should be retarded to MAX DRY range without delay to avoid possible engine flameout.

Repeated recycling of both generator switches may bring one or both generators back on line. Following the failure maintain speed control using airbrakes, start stop watch, to check the remaining time from the one shot battery expiration and if required select Floodlights to ON; turn towards the nearest suitable airfield for an ASAP landing. If successful, reset CSAS and SPILS.

Press the relight pushbuttons in order to reset the reheat safety logic. If reset is successful the nozzle area increase from ENC to 16% (MK101 engine) or to 10,5% (MK103 engine), check that Aj indicates normal readings for dry thrust and the REHEAT/CWP caption extinguishes. Land as soon as possible.

If reset attempts fail to bring at least one generator back on line, leave the generator switches in ON to allow an automatic reset should the fault condition subsequently disappear. With EPS selected to AUTO, and the light on, the one-shot battery has fired, delivering current to the DC fuel pump. Should the EPS light be out, select the EPS to ON, then AUTO. The electro-hydraulic pump will be deactivated and only the DC fuel pump will have power supplied for approx. 7 minutes (Post Mod.

DOUBLE GENERATOR FAILURE SERVICES LOST

FLIGHT INSTRUMENTS HUD Altimeter (RESET) Rad alt Alt vibrator (rear cockpit) HSI Turn rate gyro AOA indicator Artificial horizon (rear) **NAVIGATION** MC, IN Doppler, ADC SAHR, IFU 1/2 TACAN V/UHF (Main) Radar ESRRD TV/Tabs CRPMD **WARNINGS** VIB CONFIG OIL T, OIL P, FUEL T **HEATERS** Windscreen T1, P1, P2 and AOA probes **LIGHTING** Integral Instrument All external (except obstruction lights)	**ENGINE** Reheat Nozzle indicator Engine de-icing VIB warnings **FUEL** Transfer pumps Flow meters Boost pumps, except EPS Fuel Dump **AIR FRAME** Flaps/slats (frozen) and indicators (parked off) Ramps (ORIDE avail.) LD and TR Refuel probe (normal) Ice detector CSAS 1st failure **MISC** Battery charger Seat height adjust Windscreen wash Cabin temp control Cabin air and bypass control Canopy demist control Windscreen heat control

Figure 3-8

DOUBLE GENERATOR FAILURE ITEMS AVAILABLE

Engine and governors control (MECU)	Antiskid
	Normal gear lowering
HP cocks	NWS
LP cocks	Hook
Ignition	Canopy operation
Wing sweep (stiff to operate)	ADI
Airbrakes (no indication)	IFF
Emergency UHF	Console flood lights

Figure 3-9

11019, 20 minutes) delivering fuel to the right engine for operation within the dry range.

NOTE

Once activated, the one-shot battery cannot be switched off by the EPS switch.

The fuel X-feed valve shall be closed to ensure that the total pressurized fuel from the DC fuel pump is fed to the right engine thus single engine operation up to MAX DRY thrust is possible. With the right engine failed, the fuel X-feed shall be opened to allow delivery of pressurized fuel from the DC pump to the left engine.
Depending on fuel type used, the throttle of the relevant engine shall be handeled in accordance with procedures given below.
F-40 fuel constitutes the most restrictive fuel in the double generator failure case. With the mechanical first stage pump still running but the boost pump inoperative due to AC lost, the 1st stage pump inlet requirement will not be satisfied with increasing altitude and/or decreasing engine RPM. These circumstances will lead to cavitation and finally result in engine flameout.
Prior to EPS light out (fading light), depending on the fuel type and temperature, the minimum power versus altitude envelope should be observed to avoid engine flameout.
DC current from the aircraft battery may be available for approximately 20 minutes. Additionally, load reduction will assist in prolonged battery life. Should control problems arise due to battery depletion or sudden loss of battery power, **eject.**
Plan for a no LD/TR approach and refer to Landing With Flap/Slat Failure drill as the flaps/slats remain in the position attained at the moment of failure.

NOTE

If the slats are extended at the time of failure, do not sweep the wings beyond 45° because the slats cannot retract.

Consider departure cable engagement. When stopped, the running engine shall be shut down without delay to prevent uncontrolled engine runaway, before the battery supply has depleted.
For services lost in case of double generator failure refer to Figure 3-8 and for item available refer to Figure 3-9.

1. **Throttles – MAX DRY**

NOTE

Switching OFF intakes anti-ice may increase the chances of succesfull generator recycling.

2. **Generators – Recycle**
3. Use airbrake for speed control, start stop watch
4. Floodlights – ON if required
5. Land – ASAP

NOTE

Allow second generator up to 1 min to reset.

If successful:

3. Reset CSAS (P/R LINK and RUDDER via TRAIN), SPILS and ENC
4. Land – ASAP

If unsuccessful:

3. EPS – Light on, if not select ON, then AUTO
4. Fuel X-feed – CLOSE (OPEN if right engine failed)
5. Throttles (F-34/F-35/F-44) – Handle with caution, min. 75% above 10000 ft

5. Throttles (F-40):
   - Left – Maintain MAX DRY
   - Right – Handle with extreme caution maintaining max practicable RPM

For F-40 fuel refer to NOTE below.

6. Emerg UHF – Select
7. Battery load – Reduce

WARNING

- EPS BATTERY SUPPLY FOR 7 MIN MINIMUM.
- AOA INDICATION FROZEN.
- NO FUEL DUMP, LIMITED INSTRUMENTS, NO LD/TR, NO REHEAT

8. Approach and landing – No LD/TR, no flaps expect departure-end cable engagement use airbrakes for speed control, if required, land with airbrakes out.

On touchdown:

9. Airbrakes – Out
10. Hook – Down, min 500 ft before cable

When stopped:

11. ICO – Press, no braking
12. Both throttles – HP SHUT

WARNING

- AIRCRAFT BATTERY SUPPLY FOR APPROX. 20 MIN, THEREAFTER ENGINE SHUTDOWN IS IMPOSSIBLE AND UNCONTROLLED ENGINE RUNAWAY WILL OCCUR.
- EPS LIGHT WILL REMAIN ON AFTER THE ONE SHOT BATTERY HAS EXPIRED.
- WITH EPS EXHAUSTED AND FUEL TEMP ABOVE 40° C, BE PREPARED FOR LOSS OF BOTH ENGINES.

NOTE

With F-40 fuel after 7 mins (Post mod. 11019: 20 mins) engine handling is more critical. Set:

- Right throttle: MAX DRY above 6000 ft, Min 90% below 6000 ft, Min 85% below 3000 ft
- Left throttle to max practicable. Shut down left engine if rundown occurs.

SINGLE GENERATOR MALFUNCTION

Amber

GEN

GEN FAIL light (ENG CP)

There is only one amber GEN caption on the left side of the CWP, serving both generators. Its illumination could be misinterpreted as a 'left' generator failure. It is therefore important to identify which generator has failed by confirming the status of the GEN FAIL light on the engine control panel. One generator is sufficient to support the entire electrical load under all operating conditions.

The failed generator should be recycled and left ON to allow for a possible automatic reset. If the generator cannot be reset, ensure that X-drive is in AUTO as a precautionary measure to ensure continuous electrical power supply in case of an engine failure.

1. Check GEN FAIL lights (Eng. c.p.)

If GEN FAIL light on (single gen. failure):

NOTE

Switching OFF intakes anti-ice may increase the chances of succesful generator recycling.

2. Generator – Recycle (reset may take up 1 minute)

If unsuccessful:

3. X-drive clutch – Check AUTO
4. Land – As soon as practicable

If in addition to a generator failure, a single hydraulic system failure occurs on the same side, gearbox failure shall be suspected.

NOTE

The inboard spoilers may fail but can be reset.

The amber GEN caption on the CWP wihout the respective FAIL light on the engine control panel, implies a high differential current condition in excess of 50 A, signifying that the generator is operating at a reduced output, thus absorbing current from the serviceable generator. Do not attempt to reset the generators, as the faulty side cannot be identified. If the serviceable generator is switched off, the faulty or fully generator remains on line, resulting in a double generator failure situation. Furthermore the chanches of resetting the serviceable generator are remote and depend entirely on the status of the failed generator.

If GEN FAIL lights out (high difference current):

2. Do not recycle generators
3. Land – As soon as practicable

SINGLE GENERATOR FAILURE WITH AC BUSBAR TIE CONTACTOR OPEN

Amber

F PUMP	and	R PUMP
GEN		RAMP
TRU		REHEAT

Engine control panel L or R GEN FAIL
Intake control panel L or R FAIL
ECS panel, possible Intakes ANTI-ICE L or R FAIL. Left or right Aj indicator frozen at last position plus fail flag

The amber GEN caption on CWP associated with the captions relevant to the systems supplied by the failed generator (indicated by the GEN FAIL caption on the Engine Control panel) indicates a single generator failure when the AC tie busbar contactor is open. This implies that only the busbar connected to the operating generator is supplied. Avoid negative g as the fuel boost pumps associated with the failed generator are inoperative and an engine flame out may occur. The failed generator should be recycled and left to ON to allow a possible automatic reset. If the generator cannot be reset, ensure that the X-drive is in AUTO as a precautionary measure to ensure continuous electrical power supply in case of an engine flame out.

1. Negative G – Avoid

NOTE

Switching OFF intakes anti-ice may increase the chances of succesful generator recycling.

2. Generator – Recycle (reset may take up to 1 minute)

If unsuccessful:

3. X-drive clutch – Check AUTO
4. Land – As soon as practicable

NOTE

For failure analysis refer to Figure 3-10.

BATTERY CHARGER FAILURE (POST MOD. 01662)

After a battery charger failure, the voltmeter indication remains 27 V or below and may be reset to normal operation if a temporary fault condition occurred.
If the battery charger fails and the battery is below its full capacity but the generators and TRUs remain on line, the aircraft operations are not affected. Nevertheless it should be considered that, after a battery failure, the subsequent loss of both generators causes a total electric failure and an immediate and uncontrollable acceleration that leads to destruction of the engines. For this reason, crews are advised to land as soon as practicable after a battery charger failure.
Voltmeter indication 27 V or below

1. Land – As soon as practicable

SINGLE GENERATOR FAILURE WITH BUSBAR TIE CONTACTOR OPEN – SERVICES LOST

Left Generator failed	Right Generator failed
FLIGHT INSTRUMENTS HUD Servo altimeter HSI Turn rate gyro **NAVIGATION** TACAN CRPMD/RPMD LEFT TV/TAB GMR **WARNINGS** CONFIG **ENGINE** Left reheat Left nozzle indicator Left engine deicing **FUEL** No. 1 boost pumps (F and R) No. 1 wing transfer pumps Cell 1b transfer pump **AIRFRAME** Left ramp (o'ride available) Left T1 probe heater Left windscreeen quarter panel heat P2 probe heater **LIGHTING** Instrument and integral front Left landing lamp **ARMAMENT** Chaff/Flare	**FLIGHT INSTRUMENTS** Rear artifical horizon/BDHI **NAVIGATION** MC, IN, SAHR, Doppler ADC ESRRD Both TV/TAB's Main V/UHF **WARNINGS** CONFIG **ENGINE** Right reheat Right nozzle indicator Right engine deicing **FUEL** No. 2 boost pumps (F and R) No. 2 wing transfer pumps Flowmeters **AIRFRAME** Right ramp (o'ride available) Right T1, P1 and L and R AOA probe heaters Right quarter and centre windscreen panel heaters Battery charger **LIGHTING** Instrument and integral rear Right landing lamp, Taxi lamp Navigation lights **ARMAMENT** Radar warning Chaff/flare

Figure 3-10

EXCESS BATTERY CHARGING (POST MOD. 01662)

If the voltmeter indicates 31 V steadily or less, with no pulse after the sufficient recharging time, a malfunction of some significance has occurred. Either the battery charger control circuit has failed or the battery had a cell failure.

Wathever the reason is, the battery is receiving an excess charge which may cause it to overheat and to suffer a possible thermal runaway. This would cause permanent damage for the battery. For this reason crews are advised to land ASAP after this malfunction.
High voltmeter reading without pulsing

1. Land – ASAP

DOUBLE TRU FAILURE

Red	Amber	
DC	TRU	CSAS
	F PUMP	R PUMP
	PFCS	RAMP
		R ALT

This failure has certain similarities to the Double Generator Failure case since all boost pumps are lost. Engine behaviour depends largely on the type of fuel used.
The F-40 fuel constitutes the most restrictive fuel in the double TRU failure case.
If in reheat thrust the throttles should be set to MAX DRY without delay to reduce engine demand and avoid flameout.
With the EPS selected to AUTO, since both TRUs have failed, the one-shot battery will fire (light on) and drive the DC fuel pump only.

NOTE

Once activated, the one-shot battery cannot be switched off by the EPS switch.

Use airbrakes for speed control, start stop watch to check the remaining time until the one shoot battery is depleted. The fuel X-feed valve shall be closed to ensure that the total pressurized fuel from the DC fuel pump is fed to the right engine thus single engine operation up to MAX DRY thrust is possible. With the right engine failed, the fuel X-feed shall be opened to allow delivery of pressurized fuel from the DC pump to the left engine.
Turn towards the nearest suitable airfield for an ASAP landing.
The one-shot battery will drive the DC fuel pump for a minimum of 7 minutes (Post mod. 11019: 20 minutes). This time is the criteria governing battery capacity and not the brightness of the EPS light.

Depending of fuel type used, the throttles of the relevant engine shall be handled in accordance with the procedures given below.
When the EPS is exhausted, only the 1st stage pumps are running and pump inlet requirements will not be satisfied. With increasing altitude and/or decreasing engine RPM, these circumstances will lead to cavitation and finally result in engine flameout. Therefore, the minimum power settings versus altitude given in the drill should be observed.
The time criterion for the aircraft battery capacity is not critical because the battery is supported by the battery charger. However, load reduction will further prolong battery life (refer to Figure 3-12).
Plan for a no LD/TR approach and refer to Landing With Flap/Slat Failure drills as the flaps/slats remain in the position attained at the moment of the failure.

NOTE

If the slats are extended at the time of failure, do not sweep the wings beyond 45° because the slats cannot retract.

Consider departure cable engagement. When stopped, shut down the engines(s) without delay.
For services lost in case of double TRU failure refer to Figure 3-11.

1. **Throttles – MAX DRY**
2. EPS – Light on, if not, select ON, then AUTO
3. Use airbrakes for speed control, start stop watch
4. Fuel X-feed – CLOSE (OPEN if right engine failed)
5. LAND – ASAP
6. Throttles (F-34/F-35/F-44): – Handle with caution, min. 75% above 10000 ft
5. Throttles (F-40):
   - Left – Maintain MAX DRY
   - Right – Handle with extreme caution mantaining max. practicable RPM

For F-40 fuel see note below.

7. Emerg UHF – Select

DOUBLE TRU FAILURE – SERVICES LOST

FLIGHT INSTRUMENTS HUD Rad Alt Alt vibrator (rear cockpit) AOA indicator **NAVIGATION** IN Tacan V/UHF (Main) Radar TV/TABs CRPMD **WARNINGS** CONFIG OIL T, OIL P, FUEL T **HEATERS** P1 and P2 probes **LIGHTING** Instrument All external except land/taxi and nav	**FUEL** Boost pumps, except EPS Fuel dump **AIRFRAME** Flaps/slats (frozen) and indicators Ramps (ORIDE avail.) LD and TR Wing sweep lock release (stiff to operate) Refuel probe (normal) Ice detector CSAS 1st failure **MISC** Windscreen wash Cabin temp control Cabin air and bypass control Canopy demist control Windscreen heat control

Figure 3-11

8. Battery load – Reduce to minimum (Figure 3-12)

WARNING

- EPS BATTERY SUPPLY FOR 7 MIN MINIMUM.
- AOA INDICATION FROZEN.
- NO FUEL DUMP NO LD/TR
- EPS LIGHT WILL REMAIN ON AFTER THE ONE SHOT BATTERY HAS EXPIRED.

9. Approach and landing – NO LD/TR, no flaps, expect departure end cable engagement, use airbrakes for speed control if required, land with airbrakes out.

On touchdown:

10. Airbrakes – Out
11. Hook – Down, min 500 ft before cable
12. ICO – Press, no braking

WARNING

WITH EPS EXHAUSTED AND FUEL TEMP ABOVE 40° C, BE PREPARED FOR LOSS OF ENGINE.

NOTE

With F-40 fuel after 7 mins (Post mod. 11019: 20 mins) engine handling is more critical. Set:
- Right throttle: MAX DRY above 6000 ft, Min 90% below 6000 ft, Min 85% below 3000 ft
- Left throttle to max practicable. Shut down left engine if rundown occurs.

DC LOAD REDUCTION

The following services may be switched off following a double generator or double TRU failure.

LOAD

EQUIPMENT	LOAD (AMPS)
Front Cockpit	
Pitot Heaters	10.0 A
IFF	4.3 A
Console floodlights	1.5 A
Obstruction lights	2.0 A
Emergency UHF	
Transmit	1.3 A
Receive	0.7 A
Rain dispersal	1.2 A
Standby W/S demist	1.2 A
Instr. panel floodlights	0.7 A
Wander lamp	0.2 A
Rear Cockpit	
IN	10.0A
Console floodlights	1.5 A
Emergency UHF	
Transmit	1.3 A
Instr. panel floodlights	0.7 A
Wander lamp	0.2 A

NOTE

Battery life may be increased up to 2 minutes by reducing DC load immediately upon detection of failure.

Figure 3-12

SINGLE TRU FAILURE

Amber

TRU

An amber TRU caption on the CWP indicates a single TRU failure. One transformer rectifier unit can carry the entire electrical load. No corrective action is possible.

1. Land – As soon as practicable

PROBE HEATING FAILURE

Amber

PITOT

An amber PITOT caption on the CWP signifies a malfunctioning probe heater. Flying in areas where freezing moisture is present, shall be avoided.

X-DRIVE CLUTCH/GEARBOX FAILURES

GEARBOX FAILURE

Red		Amber	
L CONTR or R CONTR		L UTIL or R UTIL	
			GEN
			CSAS
			PFCS
			RAMP

ENGINE Control Panel L or R GEN FAIL

In the event of a gearbox overload, causing a speed differential greater than 15%, the X-drive clutch will attempt to close.
However, if the clutch continues to slip as a result of an overload condition, the clutch will open automatically, e.g. speed differential between gearboxes in excess of 4% NH for longer than 2.5 seconds. Only one attempt to re-engage the X-drive clutch should be made.
Should a gearbox seizure occur, the PTO shaft shearneck in the associated gearbox will break thus preventing the engine from being dragged down.
Thereafter electric and hydraulic services on one side including 1st stage fuel pump operation will be lost.
Monitor the hydraulic system for the remainder of flight and land ASAP. Refer to Gearbox/Hydraulic System Failure.

1. X-drive clutch switch – OPEN
2. For services lost see Figure 3-13
3. Land – ASAP. Refer to Gearbox/Hydraulic System Failure drill

X-DRIVE CLUTCH DOES NOT OPEN

Failure of the X-drive clutch in the closed position is indicated by the X-drive clutch SHUT light remaining on after PUSH OPEN button was pressed, with the X-drive clutch switch set to AUTO and engine speed differential less than 15% RPM.
In this case select the X-drive clutch switch to OPEN. If the SHUT light remains on, the engine with the higher RPM will carry both gearbox loads. Avoid load hunting by setting a NH differential of more than 1% and stay within the X-drive envelope to avoid possible engine surge.

1. X-drive clutch switch – OPEN

If unsuccessful:
2. Throttles – Set NH differential

X-DRIVE CLUTCH DOES NOT SHUT

X-drive clutch failed in the open position is indicated by the X-drive clutch SHUT light remaining out when engine speed exceeds 15% NH differential with the X-drive clutch switch set to AUTO.
The system may be reset by pressing the SHUT light button. If unsuccessful, select the x-drive clutch switch to OPEN and back to AUTO.

1. SHUT light – Press to reset

If unsuccessful
2. X-drive clutch switch – Re-cycle

WARNING

DO NOT ATTEMPT TO RESET/SHUT THE X-DRIVE CLUTCH IF THERE ARE ANY SYMPTOMS OF GEARBOX FAILURE.

X-DRIVE CLUTCH SHUTS BELOW 15% DIFF

If the X-drive clutch SHUT light illuminates with the engines within the 15% NH differential and the X-drive clutch in AUTO, a PTO shaft failure or a gearbox control unit failure shall be assumed. To identify the failure, pushing the X-drive SHUT light button will open the X-drive clutch momentarily and extinguish the light.
If a PTO shaft is sheared, the affected gearbox will immediately run down, producing the 15% NH differential signal which will close the X-drive clutch again, and the light will reappear.
To avoid major damage, select the X-drive clutch to OPEN. Refer to Gearbox Failure drill.

1. SHUT light – Press to reset

If light recurs:

2. X-drive clutch switch – OPEN
3. For gearbox failure refer to Gearbox Failure

HYDRAULIC SYSTEM FAILURES

FAILURE OF ONE HYDRAULIC SYSTEM

Red		Amber	
L CONTR or R CONTR		L UTIL or R UTIL	
			RAMP
			CSAS
			PFCS

Illumination of the captions on the CWP may indicate a hydraulic leak, line rupture or hydraulic pump failure.
If the malfunction occurs within the utility system, the remaining fluid is retained for operation of the primary flight controls, since the isolation valve protects the flight control system.
Set both hydraulic switches to ON thus isolating a possible malfunction in the gearbox control unit.
The use of hydraulics shall be minimized and a degraded handling performance shall be expected, i.e. slight change in pitch fell characteristics and slower control capabilities at low airspeeds.
At high airspeeds special attention should be given to inoperative air intake ramp and the relevant engine should be handled with care.
With the X-drive clutch in AUTO the risk of a complete hydraulic/utility failure is reduced, should the engine, which is driving the serviceable hydraulic pump, fail.
Monitor the hydraulic system for the remainder of the flight and land ASAP.
If the left system has failed, only the emergency brakes are available (no anti-skid); do not check the brakes before landing and minimize the use of brakes.
If right system has failed the landing gear shall be lowered using the emergency system. Do not preselect lift dump and use IDLE TR only. NWS is not available, but the nosewheel can be assumed to be centered.

NOTE

Intermittent illumination of the GMR caption in straight and level flight may be an indication of an impending right hydraulic utility system failure.

1. Hydraulics – ON

WARNING

IF LEFT SYSTEM FAILED AND KRUEGER FLAP EXTENDED, DO NOT SELECT FLAPS TO UP.

If system not restored:

2. X-drive clutch – Recheck AUTO
3. For service lost see Figure 3-13
4. Land – ASAP. Refer to Gearbox/Hydraulic System failures drill

SERVICES LOST

L CONTR and L UTIL	R CONTR and R UTIL
Left controls (protected) circuit comprising: – 2 channels of taileron actuators	Right controls (protected) circuit comprising: – 2 channels of taileron and rudder actuators
L UTIL	**R UTIL**
Left utilities circuit comprising: – Wheel brakes (normal) – 2 channels of rudder actuator – Inboard spoilers – One HLWSCA supply – Left intake ramp – Refuel probe (emergency) – Krueger flaps – Antiskid – Canopy (normal)	Right utilities circuit comprising: – Landing gear (normal) – Nosewheel steering – Outboard spoilers – Airbrakes – One HLWSCA supply – Right intake ramp – Refuel probe (normal) – Radar drive

Figure 3-13

FAILURE OF ONE UTILITY SYSTEM

Amber

L UTIL	or	R UTIL
		RAMP
		CSAS
		PFCS

Illumination of the captions on CWP indicates a leak in the utility system.

Minimizing the use of hydraulics and ensure that the X-drive clutch is in AUTO will protect against a possible double utility system failure, should the engine which is driving the serviceable hydraulic pump fail.

Monitor the utility system for the remainder of flight and land ASAP.

1. X-drive clutch — Recheck AUTO
2. For services lost see Figure 3-13
3. Land — ASAP. Refer to Gearbox/Hydraulic System Failures drill

HYDRAULIC OVERTEMPERATURE

Amber

L HYD T	or	R HYD T

Illumination of the caption on the CWP indicates a hydraulic fluid overtemperature condition, caused by a malfunction within a hydraulic component.
If accompanied by illumination of the corresponding L or R FUEL T, the failure implies a high fuel temperature and may be corrected by increasing fuel flow within dry range and minimizing the use of hydraulics.
An excessively high temperature within the hydraulic system will result in damage to hydraulic components and seals.
The load of the system should be reduced by switching the respective hydraulic system to OFF if the warning persists for more than five minutes.
Before selecting the affected hydraulic to OFF, the hydraulic switch of the good side shall be selected to ON, to protect against a possible hydraulic depressurization.
The X-drive clutch in AUTO will guard against the possibility of a total loss of hydraulics resulting from a subsequent engine failure on the side where the hydraulic is set to ON.
Land ASAP, refer to Gearbox/Hydraulic System Failures.

1. Fuel flow — Increase

If warning persists for more than 5 minutes:

2. Hydraulics — Good system ON. Affected system OFF
3. For service lost see Figure 3-13
4. Land — ASAP. Refer to Gearbox/Hydraulic System Failures drill

NOTE

Minimize use of hydraulics. Hydraulics may be returned to left ON, right AUTO for landing if warning disappears.

BRAKE FAILURE

Amber

A SKID

Zero Brake Pressure

A brake failure is detected by zero reading on the brake pressure indicator followed by an A SKID/CWP caption after a fault is detected during brakes test.
Select emergency brakes and fly a normal landing using LD/TR. Refer also to Antiskid Failure drill. Minimize use of brakes to avoid a possible blown tire.

1. Emergency brake — Select

NOTE

- NO anti-skid
- Consider approach-end cable engagement for short field operation.

FLIGHT CONTROL SYSTEM FAILURES

CSAS FIRST FAILURE

Amber

CSAS

PFCS

Relevant warnings on CSAS control panel.

Amber

ROLL MD | PITCH MD

YAW DAMP

PR LINK | RUDDER

A first failure is indicated by amber CSAS/PFCS captions on the CWP accompanied by failure indications on the CSAS control panel. With the exception of spoilers, first failures do not degrade CSAS performance but system redundancy will be reduced and the flight envelope restricted by the imposition of flight limitations.
Inboard or outboard spoiler failure results in reduced roll control. With outboard spoilers failed, the nose-down pitching moment associated with selection of reverse thrust is increased. For this reason IDLE thrust reverse shall be used above 110 KIAS with the nosewheel firmly on the ground. Below 110 kt full TR is allowed.
In case of a first failure, disconnect the autopilot and recover the aircraft to level flight above 500 ft AGL and below 500 kt to allow for possible pitch transient or random spike inputs in the roll channel during reset. Pressing the lit button(s) on the CSAS control panel will reset the failed modes and extinguish the amber CSAS/CWP caption. The amber PFCS/CWP caption will remain lit if the failed mode on the CSAS control panel cannot be reset. If unsuccessful, observe limitations in Figure 3-14 and Figure 3-15.

CSAS FIRST FAILURE LIMITATIONS

CAPTION	LIMITATIONS
I/B SPOILERS	Use rudder with caution
O/B SPOILERS	Use rudder with caution No LD preselect IDLE TR only above 110 kt

Figure 3-14

1. Recover to level flight above 500 ft AGL and below 500 kt
2. CSAS control panel – Press lit buttons, CSAS caption out on CWP
3. Reset unsuccessful – No rapid rolling, do not engage AP. Refer to additional limitation in following Figure 3-14.

NOTE

TRAIN is not to be used to attempt a reset except when a P/R LINK and RUDDER first failure have been caused by a temporary hydraulic system depressurization or AC failure.

Crosswind Limits for First Failures

All first failures as for normal operation

Except:

I/B or O/B spoiler .... 15 kt
I/B and O/B spoiler .... 10 kt

NOTE

Observe overriding crosswind limits in Section V, Max Crosswinds – Symmetric TR.

CSAS SECOND FAILURE

Red

CSAS

Amber

CSAS

PFCS

Relevant warnings on CSAS control panel

Red

ROLL MD | PITCH MD

YAW DAMP

P/R LINK | LOCKED

A second failure is indicated by the red CSAS and amber CSAS/PFCS captions on the CWP accompanied by failure indications on the CSAS control panel.
A second failure causes disconnection of the affected monitoring loop, resulting in a degraded operational mode, e.g. direct link or mechanical mode/rudder centered. For detailed information refer to Section I, Primary Flight Control System.
Prior to resetting a second failure, observe the limitations in Figure 3-15. Recover the aircraft to level flight above 500 ft AGL and below 500 kt, reset the failed modes on the CSAS control panel by pressing the lit button(s) starting with the back row first, since CSAS failure logic will not allow a reset otherwise. Although pitch and roll transients are insignificant, reset attempts should be made at the defined airspeeds and altitudes.
If reset is successful the flight may be continued. If reset is unsuccessful, no rapid rolling, AP or airbrakes should not be used. Land as soon as practicable and remain within the established limitations.

1. Recover to level flight above 500 ft AGL and below 500 kt
2. CSAS control panel — Press lit button back row first. CSAS captions out on CWP
3. Reset unsuccessful — No rapid rolling, do not use airbrakes, do not engage AP. Refer to Flight Limitations for (Figure 3-15)

NOTE

- TRAIN mode is not be used to attempt a reset except when a P/R LINK and RUDDER first failure have been caused by a temporary hydraulic system depressurization or AC failure.
- Roll MD may reset with selection of MID flap.

Crosswind Limits for Second Failures

All single second failures .... 20 kt

Except:
RUDDER LOCKED .... 10 kt
Any combination of second
failures listed in table below .... 10 kt

NOTE

Observe overriding crosswind limits in Section V, Chapters: Crosswind and Approach and Landing (TR para).

ADVICE FOR LANDING WITH MULTIPLE CSAS FAILURES

Lateral CSAS failures indicated by any of the following CSAS control panel indications: **ROLL MD, P/R LINK, YAW DAMP, RUDDER/LOCKED, INBOARD/OUTBOARD** (spoilers), will result in very poor lateral/directional handling, especially if the flaps are DOWN and large U/FUS stores are carried.

WARNING

DO NOT LAND WITH HEAVY U/FUS STORES AND FLAPS IN DWN. JETTISON STORES IF CONTROL PROBLEMS ARE ENCOUNTERED.

Any combination of: – ROLL MD – RUDDER LOCKED – YAW DAMP – INBOARD/ OUTBOARD spoilers	1. If no U/FUS stores (except CBLS): Perform controllability check in MID flap and land in this configuration 2. If U/FUS stores: Perform controllability check in MVR flap and land in this config. if aircraft control is acceptable. If not, jettison U/FUS stores, refer to step 1

NOTE

Additional revision of CSAS to P/R LINK or PITCH DL will aggravate the situation.

CSAS SECOND FAILURE LIMITATIONS

CAPTION	LIMITATIONS	
	With stores	Without stores
PITCH MD or PR LINK	0.75 M for 25 WS with U/WING stores 500 kt for 45/67 WS with external stores	No limit
YAW DAMP	IDLE TR only without preselection	
	For 45/67 WS 500 kt	1.55 M
RUDDER	IDLE TR only if NSAS inoperative	
	For 45/67 WS 500 kt	1.55M

Figure 3-15

SPILS FAILURE

Red

SPILS

A failure is indicated by a red SPILS/CWP caption in conjunction with an amber FAIL on the SPILS control panel and will result in automatic disconnection of the SPILS computer.

Reduce AOA below the SPILS disengagement level and wait for at least 12 seconds until the fade-out time has elapsed before pressing the BITE/FAIL button, to effect a system reset.
If the reset is unsuccessful, switching SPILS to OFF will not cancel the warning.

1. AOA – Reduce below 10 units
2. Wait for at least 12 seconds
3. SPILS control panel – Press BITE/FAIL button

NOTE

If SPILS does not reset, select SPILS to OFF and restrict AOA to non-SPILS limits.

HUD FAILURES

LOSS OF SYMBOLOGY

Complete loss of symbology signifies a serious internal HUD fault.
Recycle the MODE selector switch through the OFF position and try other modes.
Use HDD as primary flight instruments. Selected AFDS mode will continue to function normally, however low altitude modes should not be flown.
Reversionary attacks in both Air-to-Ground and Air-to-Air modes can be carried out by using SBS, since it is supplied from an alternative power source.
If a fault is detected in the incoming data, only the associated symbol is occulted unless alternative data are available from the primary sensors.
Refer to Section IV, HUD Operation – DIRECT (Primary Sensors). For further detailed information of partial failures refer to Section IV, Equipment Failures Affecting the HUD.

1. HUD – Recycle. Try other modes and Standby Sight

NOTE.

If HDD speed indication is used for approach and landing, increase calculated approach speed by 10 kt.

VELOCITY MONITOR TRIP

HUD aircraft symbol, horizon, climb/dive bars flash for 30 sec, then flash 2 sec every 60 sec and if in TF:

Amber

TF MON

HT FAIL on TFR Control Panel

Fly straight and level; if in TF maintain terrain clearance visually or climb to minimum safe altitude.
If the trip is accompanied by an ADC/CWP warning, select the HUD to AUTO or NAV and carefully monitor against HDD indications.
Some degradation of IN performance shall be expected. If significant error develop, select DP + SR on the NMCP. If the warning persists for more than 10 seconds and is not accompanied by an ADC/CWP warning, select DIR on the HUD, check the IN inputs to HUD and if they are not correct, select DP + SR on the NMCP and AUTO or NAV on the HUD control panel. Use HDD as primary flight instruments.
If the IN is correct, select DIR on the HUD control panel for navigation and AUTO for fixing and weapon aiming, but Doppler shall be in OFF and no reliance placed on the HUD climb/dive bars, VSI or VV data.

In this case VV channel (BARO IN) is not available:
1. Aircraft – Fly straight and level

If in TF:
2. Terrain clearance – Maintain visually or climb to minimum safe altitude

If monitor trip accompanied by ADC warning:
3. HUD – AUTO/NAV, monitor carefully against HDD, expect IN degradation

When significant errors develop:
4. NMCP – DP + SR

If warning persists for 10 seconds and not accompanied by ADC warning:
3. HUD – DIR, check IN

If IN not correct:
4. NMCP – DP + SR
5. HUD – AUTO/NAV (use HDD as primary flight instruments)

If IN correct:
6. HUD – DIR for navigation. AUTO for fixing/weapon aiming, but Doppler shall be OFF and no reliance should be placed on HUD climb/dive, VSI and VV data

NOTE

- In DIR mode intermittent loss of radar altitude on HUD (lasting for 6 to 10 seconds every 15 to 20 min) may occur. During this time the indications of Rad Alt and TV/TAB are present and valid.
- Transient monitor trips will occur during pullout from steep dives and in the transonic region (approx 0.85 to 1.15 M)
- If HDD speed indication is used for approach and landing, increase calculated approach speed by 10 kt.
- Vertical Velocity monitoring does not function beyond 47° bank angle and 22.5° in pitch, and or/if Doppler transient is detected.

ATTITUDE MONITOR TRIP

An attitude monitor trip is indicated by occulting of HUD aircraft symbol, horizon bars, climb/dive bars and vertical speed scale (due to the difference between the IN and SAHR dynamic behaviour around the vertical, above 70° climb angle during looping manoeuvres).
Fly straight and level using HDD.

WARNING

IN CONDITIONS OTHER THAN STRAIGHT AND LEVEL FLIGHT, THE INDICATED PITCH ATTITUDE ON ADI DIFFERS FROM ACTUAL AIRCRAFT PITCH UP TO APPROXIMATELY 17 DEGREES (DIVE) AT 180 DEGREES ROLL. THEREFORE AT LOW ALTITUDES, FAILURE TO CONSIDER INCREASES ACTUAL DIVE ANGLES RESULTING FROM THESE ADI ERRORS MAY PUT THE CREW INTO A CONDITION WHERE RECOVERY WILL NOT BE POSSIBLE. USE ADI INFORMATION WITH EXTREME CAUTION.

To identify a BITE undetected failure and to determine faulty equipment, select DIR/LOCKED on the HUD control panel.

Compare the climb/dive bars, VV and bank indications with those of the HDD.
Select the HUD DIR/VV and compare the aircraft symbols against Doppler drift, and for proper positioning.

Attempt to determine if the IN indications are incorrect and if this is the case, treat the HUD indications with extreme caution.

If the IN is incorrect, select DP + SR on the NMCP, and the HUD to AUTO, and use HDD as primary instruments.

If the IN is correct, select SAHR to OFF, then FREE/SLAVE. Maintain straight and level flight until the FES light is out.

After SAHR re-erection, press the ATTD FAIL button on the AFDS control panel and confirm that the light goes out. Select the HUD to AUTO.

If, however, the IN is correct but the SAHR will not re-erect, select COMP on the SAHR control panel and update the variation.

1. Aircraft – Fly straight and level HDD

To determine faulty equipment:

2. HUD – DIR/LOCKED
3. HUD climb/dive, VSI and bank – Compare with HDD
4. HUD – DIR/VV
5. HUD aircraft symbol – Compare against doppler drift, check proper positioning

Try to determine if the IN indications are in error and if so the HUD information shall be treated with extreme caution.

If IN not correct:

6. NMCP – DP + SR
7. HUD – AUTO (use HDD as primary flight instruments)

If IN correct:

6. SAHR – OFF, then FREE/SLAVE (straight and level unaccelerated flight until FES light out)

After re-erection:

7. ATTD FAIL – Press, out
8. HUD – AUTO

If IN is correct, but the SAHR cannot be re-erected, with the selection of COMP the display uses unmonitored IN data which shall be threated with caution.

If SAHR error persists:

9. SAHR – COMP, update variation
10. HUD – AUTO

NOTE

- If HDD speed indication is used for approach and landing increase calculated approach speed by 10 kt.
- If SAHR still fails after a MC restart (prior to selecting MAIN mode), the attitude monitor remains active.

TERRAIN FOLLOWING FAILURES

TFR FAILURES

Red	Amber
TFR	CSAS
AUTO P	PFCS
CSAS	

(BITE Detected Failures)

CRAM intrusion, amber M with AP engaged or FD satisfied, LHW (Performance Monitor Warnings)

OLPU and/or flashing HUD breakaway cross. ADI bars parked.

A TF failure is indicated to both crewmembers by the red TFR/CWP caption and a flashing breakaway cross on the HUD with FD selected.
TF data-good signal is removed from the AFDS which generates a 2 sec closed loop pull-up command.

NOTE

- All abnormal behaviour shall be reported in the TF/AFDS Crew Debrifing form.
- During OLPU autothrottle drop-out may occur leading to considerable speed excursion.
- If any of the following symptoms are observed, it should be assumed that the TF behaviour is abnormal, the TF system shall then be disengaged and the aircraft climbed to safe altitude cruise:
  - Loss of ZCL or CRAM line from the ESRRD display
  - Any abrupt change of shape or location of ZCL or CRAM line
  - Break-up of either ZCL or CRAM line into separate non-overlapping short lines
  - Noticeable jitter of either ZCL or CRAM line anywhere except at the extremities
  - Terrain returns not visible on the ESRRD out to 2 NM, allowing for the effects of radar shadowing and the effects of overflying peaks
  - Terrain returns obscured by weather returns anywhere out to 2 NM
  - Terrain returns reach the CRAM line
  - Lyre bird audio, and/or flashing attention getters, and/or manoeuvre monitor audio
  - Excessive climb or dive angle (in normal TF operation the climb/dive angle should be within the range +20° to −10°)
  - Radar altimeter height read out less than selected Set Clearance Height for protracted periods
  - Excessive positive or negative normal acceleration.

1. **AIRCRAFT – ENSURE WINGS LEVEL 3 TO 4 G PULL UP TO SAFE HEIGHT**
2. **ICO – PRESS, BEFORE TAKING MANUAL CONTROL**

If persistent warning exists:

3. Fault analysis – Complete at safe altitude (Figure 3-16)

If no persistent warning exists and TF ready light is on:

3. TF operation – Continue

If CMPTR 1/2 light lit after AP engaged:

4. FD operation only

WARNING

- A CSAS 2ND FAILURE IN PITCH MD OR A REVERSION TO MECH MODE WILL NOT INITIATE AN OLPU.
- WITH A CSAS 2ND FAILURE IN ROLL MD, THE WINGS WILL BE LEVELLED WITH REDUCED PERFORMANCE DURING THE OLPU.
- DURING CLPU OR OLPU THE ICO SHALL BE PRESSED BEFORE TAKING CONTROL OF THE AIRCRAFT OTHERWISE PIO MAY OCCUR.

NOTE

If TFR NO GO is combined with GMR failure, refer to Section IV, GMR failure.

With AP engaged, on removal of TF data-good, the AFDS generates an automatic wing level, 3-4 g closed loop pull-up command. If data-good are restored during pull-up, the AFDS responds to regain the selected clearance height. If the TF failure persists for longer than 2 sec, the CLPU is followed by an automatic AFDS disengagement and a faded 16 sec open loop pull-up command. The pilot is able to monitor the automatically executed pull-up command on the HUD FD indication to take over manually if necessary to climb to safe height.

WARNING

THE WINGS LEVELLING MECHANISATION OF THE OPEN LOOP PULL UP DURING A TURN IS UNRELIABLE AND IMPRECISE.
THE AIRCRAFT MAY BE LEFT WITH A RESIDUAL BANK ANGLE AND/OR A ROLL RATE WHICH CAN BE IN EITHER DIRECTION.
PILOTS SHALL MONITOR THE AIRCRAFT ATTITUDE AND FLIGHT PATH DURING OPEN LOOP PULL UPS (OLPUS). DEPENDING ON ATTITUDE AT THE MOMENT OF OCCURRENCE OF THE OLPU (I.E. PUSH-OVER, LET DOWNS, ETC.) A DEFINITE NOSE-UP ATTITUDE AFTER THE PULL-UP CANNOT BE GUARANTEED.
MANUAL CONTROL SHOULD BE TAKEN USING THE ICO AS SOON AS PRACTICABLE AVOIDING SNATCH-PULLS WHICH MAY LEAD TO PIOS.

With FD only engaged, on removal of TF data-good the AFDS generates a closed loop flight director pull-up command, indicated on the HUD and ADI.
If data-good is restored during 2 sec, the AFDS generates a FD demand to regain the selected clearance height.
If the TF failure persists for longer than 2 sec, the CLPU command is followed by a breakaway cross on the HUD and parking of the ADI director bars. The pilot shall satisfy the FD demand manually, discontinue TF and climb to safe height.
During any TF flying phase the pilot should compare the E-scope indications with those on the HUD and confirm the proper behaviour of the aircraft, and only when confident of the aircraft's TF performance may the pilot continue with the TF operation.

TF FAULT ANALYSIS

Warning/indication after ICO activation		Meaning	Actions
F/C	R/C		
TFR NO GO	TFR	TFR failure	1 TFR recycle If warning goes out 2 TF continue
TFR ATTD FAIL	TFR	Attitude monitor failure	TF discontinue
PLUS			
HT FAIL	IN, CMPTR SAHR or IN, SAHR or IN, DPPLR	Both attitude sources failed	TF discontinue
TF MON AP MON ATTD FAIL HT FAIL	IN or no caption	IN primary attitude failure or Vv monitor trip	TF discontinue
TF MON AP MON ATTD FAIL	SAHR or SAHR CMPTR	Secondary attitude source failure	1 Attempt reset secondary sensor If no reset 2 TF discontinue
OR			
TF MON	DPPLR		
TF MON TURN FAIL	–	Drift/turn rate comparison failure	Ensure visual terrain clearance or climb to minimum safe height
R ALT	R ALT	Rad alt failure	TF discontinue
CRAM selected, line not displayed	–	CRAM failure	TF discontinue

Figure 3-16

TF MONITOR WARNINGS

If TF MON warning accompanied by Velocity Monitor Trip, indicated on HUD by flashing bars, see HUD FAILURES, Velocity monitor Trip.

Drift or Turn Rate Comparison Trip

Amber

TF MON

TURN FAIL on TFR CP. If primary and secondary drift and turn rate from IN and MC exceed the cross comparison threshold; amber TF MON caption on the CWP and TURN FAIL on the TFR control panel are indicated.

1. TF operation – Ensure visual terrain clearance or climb to minimum safe altitude

Primary Data Input Failure

F/C

Amber

TF MON

AP MON

R/C

Amber

TF MON

(trainer)

IN

ATTD FAIL on AFDS CP
HT FAIL on TFR CP

A failure in the IN as primary source of attitude and velocity data for the TFR is indicated by amber TF MON and AP MON on the front CWP, amber IN on the rear CWP, HT FAIL on the TFR control panel, and ATTD FAIL on the AFDS control panel.
The TFR continues to operate, using the secondary source data (DOPPLER, SAHR, MC) but without cross monitoring. Therefore:

1. TF operation – Discontinue

Secondary Data Input Failure

F/C

Amber

TF MON

AP MON

R/C

Amber

TF MON

(trainer)

CMPTR

SAHR

DPPLR

ATTD FAIL on AFDS CP

A failure in the secondary source (MC and SAHR) is indicated by amber TF MON and AP MON captions on the front CWP, and depending on the nature of the failure, amber CMPTR, SAHR, or DPPLR on the rear CWP, and ATTD FAIL on the AFDS CP. The TFR continues to operate, using primary source data but without cross monitoring. Therefore:

1. TF operation – Ensure visual terrain clearance or climb to minimum safe altitude
2. Reset – Attempt

If it does not reset:
3. TF operation – Discontinue

AUTOPILOT/FLIGHT DIRECTOR SYSTEM FAILURE

For AFDS Failures during TF operation, refer to TERRAIN FOLLOWING FAILURES.

Red		Amber
AUTO P	and/or	AP MON

CMPTR 1/2
ATTD FAIL

NOTE

Do not engage AP with CSAS first or second failure

AFDS COMPUTER FAILURE

An AFDS computer failure disengages the autopilot (if selected) and activates the amber CMPTR 1 and/or CMPTR 2 captions on the AFDS CP after termination of an inflight BITE, lasting 5 to 6 seconds.
If both CMPTR captions are lit, the fault was transient and AP re-engagement should be attempted. If one computer only is unserviceable, the relevant caption is extinguished. In this case an autoreversion to the serviceable computer takes place and flight director operation only is available. Press the ICO to clear the AUTO P and CMPTR 1 and/or 2 captions. If no persistent warnings exist, AP operation may be continued; otherwise operation is restricted to FD only.

MODE SENSOR FAILURE

A sensor failure will result in an automatic AP disconnect with the red AUTO P/CWP caption. On the AFDS control panel all selected modes will be disconnected. If operating in manual mode, only FD is disconnected. In low level modes an automatic wings level 3-4 g pull-up occurs before AP disconnect.
Press ICO before taking manual control. Attempts to isolate the relevant failed sensor and continue operation without that mode.

ATTD FAIL without AP MON

If there is a drift between the IN and SAHR attitude thresholds without IN or SAHR failure, the ATTD FAIL light on the AFDS CP will illuminate, the autopilot will disengage with the red AUTO P/CWP caption illuminating. When operating in low level modes, an OLPU or a flashing breakaway cross is generated.
No autoreversion to single source operation is available because the AFDS cannot determine which attitude source is invalid. Before taking manual control, press ICO.
If the FAIL light remains unlit with the ATTD FAIL button been pressed after AP disengagement, the drift has returned within the threshold limits. AP and FD can be re-engaged. If the fault remains, the pilot may attempt to locate and isolate the defective sensors, then resume AP/FD operation on single source, if cleared.

ATTD FAIL with AP MON

The amber AP MON/CWP caption is always accompanied by the ATTD FAIL light on the AFDS control panel, indicating an IN or SAHR attitude source or input data transmission failure. No attitude crossmonitoring takes place.
In cruise mode, the red AUTO P/CWP caption will illuminate in addition and AP and FD will automatically be deselected. In low level modes, AP remains engaged and continues to function on single source only with AP MON caption illuminated, indicating this reversion.
In either case press ICO before taking manual control. A reset attempt can be made by pressing the lit ATTD FAIL button momentarily. If AP MON caption and ATTD FAIL light extinguish, both attitude sources are available and AP operation may be resumed. If the warnings persist, FD may be selected. AP may function on single source only, provided the valid attitude source is detectable and the relevant failed source can be isolated.

In case of an AP disconnect:
1. ICO – PRESS

If persistent warning exist:
2. Fault analysis — Complete at safe height (see Figure 3-17)

If no persistent warning:
2. AP operation — Continue

If CMPTR 1/2 light lit after AP engaged:
2. FD operation only

NOTE

With the CSAS first or second failure do not engage AP.

AFDS FAULT ANALYSIS

Warning/ Indication	Meaning	Action/mode of operation
AP MON ATTD FAIL	Source or input data transmission failure	FD (AP may function on single source)
ATTD FAIL	Attitude IN/SAHR deviation	ATTD FAIL press SAHR realign If successful: continue operation
AUTO P on selection of any mode	Sensor failure	Selected mode inoperative

Figure 3-17

AP TRIM FAILURE

F/C

Amber

AP TRIM

An autopilot trim failure can occur only with AP engaged. If the AP trim monitor detects a failure it will disengage the auto trim system and illuminate the amber AP TRIM/CWP caption. Disengage the autopilot and trim out any residual forces. Rer-engage the autopilot if required. If the AP TRIM caption remains or recurs, discontinue the AP operation.

WARNING

BE PREPARED FOR POSSIBLE TRIM TRANSIENT ON DISENGAGEMENT.

1. AP — Disengage
2. Stick forces — Trim out any residual forces
3. AP — Re-engage

If AP TRIM caption remains on or recurs:
4. AP operation — Discontinue

MALFUNCTION OF HMERU

HMERU wedges may disengage allowing the inboard wing fuel tank to swing laterally. Tank movement due to disengagement of the wedges in flight can be seen and felt by the aircrew. This condition does not present an immediate hazard, however violent and abrupt manoeuvres with an insecure tank may damage suspension lugs, leading to subsequent failure.
If this malfunction occurs, proceed as follows:

- Avoid abrupt manoeuvres, high load factors and minimize wingsweep operation
- Maximum airspeed 300 KIAS
- Due to the possibility of fuel venting overboard from the tank/pylon interface, consider the consequences of fuel loss/imbalance
- Land as soon as practicable.

OUT OF CONTROL

LOSS OF CONTROL

The recovery procedure is applicable to all aircraft configurations with respect to wing sweep and external stores. Recovery from most out of control situations can be effected quickly with the controls held centralized. As the AOA is reduced by the recovery action the aircraft may continue rolling slowly. Verify that sufficient altitude is available to accomplish a safe recovery. The airbrakes shall be in as the aircraft will not recover otherwise. Throttles should be retarded to IDLE to reduce the possibility of engine flameout unless at low altitude, where the probability of flameout is reduced. Should a double engine flameout occur, the EPS will be activated if in AUTO, providing minimum hydraulic pressure for flight control operation and pressurized starting fuel for relight.

1. CONTROLS – CENTRALIZE AND HOLD
2. HEIGHT – MONITOR
3. AIRBRAKES – IN
4. THROTTLES – IDLE

SPIN RECOVERY

If recovery at loss of control has not been initiated immediately after departure, the aircraft may enter a fully developed spin. Prior to application of full in-spin roll control, determine direction of spin by use of the turn needle.

If spinning below 180 kt with AOA off scale:
5. STICK – FULLY AFT AND INTO SPIN

When oscillatory motion stops:
6. CONTROLS – CENTRALIZE

If still rotating above 180 kt with AOA on scale:
7. STICK – EASE AFT

Engines shall be closely monitored at high AOA manoeuvres. If an engine surge is suspected, the AOA should be reduced immediately below the normal engine operating limits to prevent overtemperature. When recovering to a low AOA with a suspected surge, retard throttles to IDLE and monitor TBT. If TBT rises above 775°C (limit 800°C) at IDLE power, the engine shall be shut down and then relit after recovering.

If control not regained by 10000 ft AGL:
8. Eject

ENVIRONMENTAL CONTROL SYSTEM FAILURE

PRESSURIZATION/ECS FAILURE

Red		Amber
CABIN	and/or	ECS

and/or no conditioning airflow

If above 26000 ft, illumination of the CABIN/CWP caption indicates an air system failure or an unsafe canopy locking mechanism.

Post mod. 00921: An air system failure is indicated if the amber ECS/CWP caption illuminates, followed approx. 30 sec later by illumination of the red CABIN/CWP caption.

If the cockpit pressurization has failed, failure of equipment cooling bay may be also assumed. Compare aircraft and cabin altitude and check cockpit airflow. If no air conditioning flow, select oxygen to 100% and descend below 25000 ft. Attempt to reset the air system master by switching from ON to OFF/RESET and back to ON.
If airflow is restored and the CABIN/CWP caption is out, flight may be continued but airflow and avionic performance shall be monitored frequently.
Post mod. 00921: If CABIN and ECS/CWP captions are out, the air system is restored.

If the cockpit pressurization cannot be restored, select the air system master to OFF/RESET to allow for a slow depressurization (up to 2 minutes). Thereafter select the air system master to EMERG RAM AIR to restore equipment cooling bay pressurization and observe airspeed limitation. When selecting the air system master to EMERG RAM AIR, cockpit heating will be lost.
If below 26000 ft:

- No air conditioning flow (Post mod. 00921: and/or ECS/CWP caption) indicates an air system failure. Apply the procedure given below.
- Illumination of red CABIN/CWP caption indicates an unsafe canopy locking mechanism.

Recover the aircraft to 1 g flight and reduce airspeed to below 250 kt in order to maintain rear cockpit habitability should the canopy be lost. Lower visors, tighten oxygen masks and lower the seats. Land as soon as practicable.

1. Cabin altitude/cockpit airflow – Check

If abnormal:
2. Oxygen – 100%, mask tighten
3. Altitude – Descend below 25000 ft
4. Air system master – OFF RESET/ON
5. Cockpit air – Confirm flow (demist, anti-g, body spray)

If flow restored and warnings out:
6. Airflow and avionics performance – Monitor

Otherwise, or if repeated failures occur:
7. Air system master – EMERG RAM AIR below 400 kt 0.8 M (250 kt max cont)

If any other unexplained failure occurs:
8. Refer to Rear Fuselage Fire/Hot gas leak drill

FUMES IN COCKPIT

Smoke and fumes in cockpit may be first indication of an electrical fire or a possible bearing failure of an engine. If the fault is suspected being in the electronic or electric systems, select oxygen 100% and switch all non-essential equipment off. Be alert for a possible deterioration of the situation and maintain safe ejection altitude until the situation is under control.
Fumes caused by hot oil being emitted from the engine compressor due to bearing failure may enter the cockpit through the air conditioning system. Select 100% oxygen, switch cabin heat control to OFF and start a descent to below 25000 ft.
Selecting the ASM to EMERG RAM AIR will shut off the engine bleed air supply to the air conditioning system.. Smoke and fumes will dissipate quickly with EMERG RAM AIR selected. Avoid prolonged operation above 250 KTS to prevent possible cooling fans damage.

1. **OXYGEN – 100%**
2. Mask – Tighten
3. Suspect equipment – Switch off

If fumes appear to come from the air conditioning system:

4. Cabin heat control – OFF
5. Altitude – Below 25000 ft
6. Air system master – EMERG RAM AIR below 400 kt 0.8 M (250 kt max cont)
7. Land – ASAP

OXYGEN FAILURES

Red

OXY

MI steady
Suspected hypoxia
Resistance to breathing
Suspected contamination (refer to Fumes in Cockpit)

Activate the emergency bottles in both cockpits and recheck mask seals, connections and contents if any of the above described warning or symptoms are encountered.
Recheck that the oxygen supply levers in both cockpits are switched ON, since they may have been switched OFF unintentionally.

If the emergency oxygen bottle on either seat is activated, the sliding control on the regulator moves to the 100 position and the occupant receives 100% oxygen irrespective of the main system contents; however, with the main system operating normally and the oxygen supply lever in ON due to higher main system delivery pressure, oxygen will continue to flow to the masks from the main system. Only when the main system is switched OFF (in case of suspected contamination) or depleted, will 100% oxygen be supplied from the emergency oxygen bottle.
As the contents of each emergency bottle are sufficient to supply each crew member with 100% oxygen for approximately 5 minutes, sufficient time is left to analyse the situation and take corrective action.

1. **EMERGENCY OXYGEN – PULL**
2. **MASK SEAL, CONNECTIONS – CHECK**
3. Main oxygen – ON, check contents. If contamination suspected, select OFF

If oxygen supply not restored:

4. Altitude – Descend below 10000 ft cabin altitude
5. Mask hose – Disconnect
6. Land – As soon as practicable

If oxygen supply is restored:

4. Emergency oxygen contents – Monitor

If emergency oxygen contents decreasing:

5. Altitude – Descend below 10000 ft cabin altitude
6. Land – As soon as practicable

When emergency oxygen bottle empty:

7. Mask hose – Disconnect

NOTE

With AM selected, cabin air is induced into the regulator mixing chamber via a check valve by oxygen ejector pump effect, consequently airmix function is totally dependent on oxygen supply. As a result, with both main and an emergency oxygen supply systems deactivated or exhausted, the check valve remains closed, therefore breathing through the face masks is not possible.

SINGLE ENGINE EMERGENCIES

ENGINE FAILURE ON APPROACH

At the first indication of an engine failure, rock throttles inboard to deselect LD/TR, if preselected, and simultaneously advance throttles to COMBAT to obtain maximum thrust. Expect a slight directional yaw off which can easily be corrected. Upon engine failure AOA may be increased to 14 units to compensate for height loss. When re-established on glidepath at 10 units AOA, the flaps may be raised to MID to reduce drag and improve overshoot performance.
When landing is assured, lowering flaps to DWN will reduce the landing speed and shorten the landing roll. After touchdown LD only may be engaged. Only if the right gearbox is running, TR should be selected to O RIDE to by-pass TR logic and allow TR operation. Engaging TR will illuminating the REV/CWP caption corresponding to the failed engine. IDLE TR may be used below 140 kt. After engagement, throttles may be advanced up to MAX DRY.
If right gearbox is not running, due to the absence of the NWS. LD only is permitted.

1. **THROTTLES – ROCK INBOARD, COMBAT**
2. Fly 14 units AOA to regain glidepath, thereafter 10 units AOA

If height permits:
3. Flaps – MID
4. TR – O RIDE

When landing assured:
5. Flaps – As required

After touchdown:
6. LD – Engage

WARNING

DO NOT USE TR IF RIGHT GEARBOX IS NOT RUNNING.

SINGLE ENGINE OVERSHOOT

The decision whether to continue the approach or overshoot should be made as early as possible. Advance throttle of the good engine to COMBAT and confirm that the flaps are set to MID. Retract the landing gear only if the right utility hydraulic system is available to improve climb performance. If emergency lowering system has been used, or if X-drive clutch closure limitations are likely to be exceeded for the subsequent lowering do not retract the landing gear. Climb away 10 units AOA and if LP cock is closed OPEN the X-drive clutch.

1. **THROTTLE – COMBAT**
2. FLAPS – MID
3. Landing gear (if required) – UP if right utility system available
4. Climb away 10 units AOA

If LP cock closed:
5. X-drive clutch – OPEN

SINGLE ENGINE APPROACH/LANDING X-DRIVE OPEN

The drill has been set up in a chronological order which reflects the individual terminal phases of flight, namely:

– Transit, Descent/Recovery, Pre Landing, Final Approach

For the safe conduct of flight during approach and landing, it is essential, always to apply the recommended sequence of checks starting with Transit, even if the failure occurs at a later stage e.g. Pre Landing, as repetition of essential checks is not foreseen.
The aim of this consolidated drill is to avoid cross-references to other drills, except where absolutely necessary, and thus avoid distracting the crew.

SINGLE ENGINE TRANSIT – X-DRIVE OPEN

As precautionary measure mantain minimum 500 ft and fly below 500 kt. Autopilot operations are not allowed. Pressing any lit botton on the CSAS control panel, will extinguish the CSAS/CWP caption only, the PFCS/CWP caption will remain lit, indicating that the CSAS is not in full status. If right engine is shut down, switch the CRPMD to M position and the TFR to the OFF position, because radar stabilization and scanning will be lost. Open the fuel X-feed valve and ensure that the relevant light is on. If fuel balancing is required, the procedures for Fuel Balance drill should be followed. Refer to Single Engine Approach Chart to determine mass (Figure 3-19). Consider dumping fuel or jettisoning stores to reduce mass and improve conditions for an approach within the dry power range.

1. Fly above 500 ft AGL and below 500 kt.
2. Controls — Gentle manoeuvres only. Do not use autopilot. Minimize use of flaps, slats and wing sweep. Use rudder with caution.
3. CSAS — Press any button, CSAS/CWP caption out

NOTE

If landing with the X-drive clutch open, crosswind limit is 15 kt. An approach-end cable engagement should be considered, if right engine failed. See Aircraft Arresting System Limits.

4. CRPMD/TFR-M/OFF if right engine shut down
5. Fuel X-feed — Open light on
6. Mass — Reduce if required (refer to Figure 3-19). Monitor fuel quantity and balance

NOTE

- In all configurations an acceptable fuel asymmetry is:
  Front heavy - No limit — Rear heavy - 600 kg
- Range and endurance refer to Figure 3-18.

SINGLE ENGINE DESCENT/RECOVERY — X-DRIVE OPEN

To prevent initiation of the auto ignition system on the dead engine, with the throttle out of the HP SHUT position, the IGNITION on the engine control panel shall be switched OFF. Select intake anti-icing as required.
To operate TR with either engine lost, select TR ORIDE to by-pass the TR logic circuits (ensure FRONT selected in rear cockpit in the trainer variant).

1. Wing sweep — 25°
2. Instruments — Check ADI erect, compare HUD/HDD Rad alt to zero stop
3. Ignition (Engine control panel) — OFF
4. MASS — As required
5. TFR — OFF

RANGE AND ENDURANCE - 1 ENGINE WINDMILLING, 25° SWEEP

BEST RANGE NM/100 kg	kg/ min	SPEED/ MACH	ALTITUDE FT	ST BEST ENDURANCE	
				SPEED MACH	kg/ min
Mass 16000 Kg, Drag index 0					
17.9	25.9	0.42	SL	0.30	22.1
19.2	28.8	0.44	5000	0.34	21.9
20.9	25.4	0.50	10000	0.33	21.7
22.3	25.2	0.54	15000	0.42	22.4
Mass 20000 Kg, Drag index 0					
16.0	31.7	0.46	SL	0.34	27.4
16.9	31.9	0.50	5000	0.38	27.6
18.2	31.5	0.54	10000	0.42	27.9
Mass 20000 Kg, Drag index 40					
14.2	34.0	0.44	SL	0.34	29.5
14.9	33.5	0.46	5000	0.36	30.0
15.4	31.8	0.46	10000	0.40	30.8
Mass 20000 kg, Drag Index 60					
13.5	35.5	0.43	SL	0.35	30.5
14.4	35.5	0.47	5 000	0.38	30.6
Mass 22000 kg, Drag Index 60					
12.8	37.9	0.44	SL	0.37	33.9
13.5	37.6	0.47	5 000	0.41	34.5
Mass 20000 kg, Drag Index 80					
12.9	35.1	0.41	SL	0.35	31.6
13.7	37.7	0.46	5 000	0.38	31.9
Mass 24000 kg, Drag Index 80					
11.5	43.0	0.45	SL	0.38	38.5

Figure 3-18

6. Demist — As required
7. Intake anti-icing — As required
8. Landing light — ON
9. TR — ORIDE (Trainer: FRONT)

SINGLE ENGINE PRE LANDING — X DRIVE OPEN

Check fuel contents and calculate approach speed. Check that airbrakes are IN and SPILS is OFF. Ensure that the harnesses are thight and locked. The approach should normally be flown out of a straight-in with flaps in MID and 10 units AOA. Be aware that by switching the air system master from ON to EMERG RAM AIR, approx 10% thrust increase is achieved on the serviceable engine,

but this gain is already incorporated in the single engine approach chart.
If emergency drill required the LP COCK of the inoperative engine to be selected SHUT (e.g., after an engine fire) the X-drive clutch is selected OPEN to prevent fuel overheating. In this situation the X-drive clutch may be engaged by selecting AUTO to operate essential services (do not exceed the limits listed in the note below) during the approach and landing phase.

NOTE

For operation of essential services during approach and landing the X-drive clutch may be engaged for:
- 2 mins cumulative total with empty fuselage fuel group
- 10 mins cumulative total with LP COCK SHUT

1. Fuel – Calculate approach speed

NOTE

Approach speed 14000 kg at 10 units AOA:
- 155 kt plus 5 kt/1000 kg flaps MID
- 140 kt.* plus 4 kt/1000 kg flaps DWN

* Add 3 kt if krueger flaps are inhibited

2. Airbrakes – IN (emerg IN if required)
3. SPILS – OFF
4. Harnesses – Tight and locked
5. Flaps – MID
6. Air system master – EMERG RAM AIR
7. X-drive clutch – If no gearbox failure suspected: AUTO, check shut

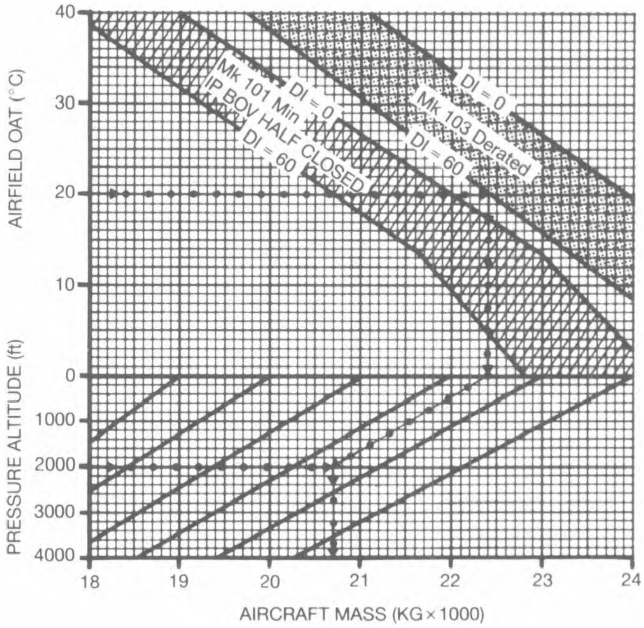
If X-drive fails to shut – **Left** engine shut down, refer to Final Approach, x-drive OPEN drill for left engine out.
Right engine shut down, refer to Final Approach, x-drive OPEN drill for right engine out.
If X-drive is shut – Refer to Final Approach, x-drive Shut drill

The behaviour of the x-drive clutch determines the procedure (x-drive open or x-drive shut) that has to be followed for the final approach and landing phase. Unless a gearbox failure is suspected, the x-drive clutch should always be shut. If the clutch engages when selected to AUTO the Final Approach, X-drive Shut drill should be applied; otherwise the relevant Final Approach, x-drive OPEN drill for Left or Right Engine Shut Down shall be used.

SINGLE ENGINE APPROACH

SINGLE ENGINE APPROACH –

DATE:	CONFIG.:	CONDITION:	FUEL GRADE:
1 November 1985	Gear DOWN	Max Dry	F-34, F-35,
DATA BASIS:	Flaps MID	One engine	F-40
Estimated		windmilling	
		10 units AOA	
		2.5° slope	



NOTE: Enter with airfield OAT and pressure altitude to determine that the aircraft mass is low enough to make a dry power approach with EMERG RAM AIR; if greater than the determined mass, consider use of REHEAT, dumping fuel or stores jettison.

Figure 3-19

SINGLE ENGINE FINAL APPROACH – X-DRIVE OPEN

With the left engine shut down and the x-drive clutch open, normal brakes and antiskid are lost however LD and limited TR operation will decelerate the aircraft sufficiently.

NOTE

If the brake handle is selected either to the emergency or park position, there is no indication of applied wheelbrake pressure on the gauge.

If the right throttle is at HP SHUT, the right throttle shall be selected to IDLE before TR can be selected. If the left throttle is at HP SHUT, to obtain TR and LD at idle power, the left throttle shall be moved to IDLE to remove the physical obstruction caused by the left throttle when at HP SHUT. Ensure that the TR override switch is set to O RIDE (and FRONT is selected in trainer aircraft). Do not pre-select LD or TR. After touchdown reduce power to IDLE and rock the left throttle outboard to obtain lift dump. Rock the right throttle outboard to obtain TR at 140 knots, increasing power up to MAX DRY at 100 knots (on dry runways only) provided the crosswind component does not exceed 10 knots.
Do not operate the brakes unless speed is reduced (earliest 80 kt). If speed is not reduced, tire skid and burst is likely to occure because of the loss of the anti-skid system.

If left engine is shut-down:
1. Landing gear – Normal lowering check 3 greens
2. Brakes – Do not check prelanding. Emergency brakes only. No antiskid. Minimize brake applications.
3. Flaps – As required

After touchdown:
4. Left throttle – IDLE
5. LD – Engage

Below 140 kt:
6. Throttles – IDLE TR (CWP REV)

Below 100 kt
7. Throttles – Up to MAX DRY (dry runway only)
8. Anticipate departure-end cable engagement

WARNING

DO NOT TAXI WITH LEFT GEARBOX NOT RUNNING.

CAUTION

DO NOT SELECT FLAPS TO UP WITHOUT LEFT UTILITY HYDRAULIC PRESSURE.

With the right engine failed and crossdrive open, the landing gear shall be selected down using the emergency system and subsequently cannot be raised if an overshoot is attempted. The nose wheel steering system is also lost, for this reason, to avoid directional problems do not use TR. Use of approach-end cable engagement is recommended provided that the limitation shown in the Aircraft/Arresting system limits table (see Figure 3-22) are not exceeded. Otherwise apply the drill which stands for a no cable situation (refer "If approach-end cable not available suitable" drill)

If right engine is shut down:
1. Landing gear – Gear lever down speed (200 kt). Emerg. gear handle pull (3 greens) – NO NWS
2. Do not preselect LD
3. Do not use TR

If approach-end cable is available/suitable:
4. Hook – Down, light on
5. Approach AOA – 10 units, flare max 12
6. Flaps – As required
7. Touchdown – At least 500 ft before cable

After touchdown:
8. LD – Engage
9. ICO – Press and hold (do not brake)
10. Lower nosewheel onto runway before cable

WARNING

- CABLE ENGAGEMENT WITH NOSEWHEEL OFF GROUND MAY CAUSE STRUCTURAL DAMAGE.
- NO BRAKING WHILE ROLLING BACKWARDS TO AVOID TIP-OVER.
- WITH RIGHT GEARBOX NOT RUNNING, TAXI ONLY IF MANDATORY TO CLEAR RUNWAY (NO NWS).

NOTE

Avoid rapid derotation to prevent NW bounce. A flat approach is preferable.

If approach-end cable not aivailable/suitable:
4. Brakes – Test, A SKID out
5. Flaps – As required

After touchdown:
6. LD – Engage
7. Use aerodynamic braking to 100 kt 18 AOA Max (14 AOA max with stores)
8. ICO – Press and hold before NW touchdown until stopped
9. Taxi nozzle – As required

WARNING

WITH RIGHT GEARBOX NOT RUNNING, TAXI ONLY IF MANDATORY TO CLEAR RUNWAY (NO NWS).

SINGLE ENGINE APPROACH/LANDING – X-DRIVE SHUT

This drill caters for the approach and landing phase and has been established to recover the aircraft safely after an engine has failed or had to be shut down, with the x-drive clutch remaining shut. Therefore, contrary to the Single Engine, X-drive Open drill, all services remain available for the remainder of flight. Only certain speed restrictions for TR operation and cross wind limits have to be observed.
Furthermore, the final part of the drill, namely Single Engine Final Approach, X-drive Shut, shall be used whenever the x-drive clutch has been shut prior to final approach in the Single Engine, X-drive Open drill.
The drill has been set up in a chronological order which reflects the individual terminal phases of flight, namely:

– Transit, Descent/Recovery, Pre-Landing, Final Approach.

For the safe conduct of flight during approach and landing, it is essential, always to apply the recommended sequence of checks starting with Transit, even if the failure occurs at a later stage e.g. Pre Landing, as repetition of essential checks is not foreseen.

SINGLE ENGINE TRANSIT – X-DRIVE SHUT

Refer to Single Engine Approach Chart to determine mass (Figure 3-19). If fuel balancing is required, the procedures for Fuel Balance drill should be followed. Consider dumping fuel or jettisoning stores to reduce mass to improve conditions for an approach within the dry power range.

1. Fuel X-feed – Open light on

NOTE

- If X-drive clutch fails to shut, refer to Single Engine Transit X-drive Open.
- If landing is attempted with X-drive closed X-wind limit is 20 kt (NO TR if X-wind is more than 10 kt).

2. Balance fuel by use of emergency fuel transfer and/or selective boost pump switching (refer to Fuel Balance drill). In all configurations an acceptance fuel asymmetry is:
   – Front heavy - No limit
   – Rear Heavy - 600 kg
3. Range and Endurance see Figure 3-18
4. Mass for landing see Figure 3-19

SINGLE ENGINE DESCENT/RECOVERY – X-DRIVE SHUT

To prevent initiation of the auto ignition system on the dead engine, with the throttle out of the HP SHUT position, the IGNITION on the engine control panel shall be switched OFF.
Select intake anti-ice as required.
To operate TR with either engine lost, select TR ORIDE to by-pass the TR logic circuits.

1. Wing sweep – 25°
2. Instruments – Check ADI erect, compare HUD and HDD Rad alt to zero stop.
3. Ingnition (Eng. c.p.) – OFF
4. MASS – As required
5. TFR – OFF
6. Demist – As required
7. Intake anti-icing – As required
8. Landing light – On
9. TR – ORIDE (Trainer: FRONT)

SINGLE ENGINE PRE-LANDING – X-DRIVE SHUT

Check fuel contents and calculate approach speed. Check that airbrakes are IN and SPILS is OFF. Ensure that the harnesses are tight and locked.
The approach should normally be flown out of a straight-in with flaps in MID and 10 units AOA. Be aware that by switching the air system master from ON to EMERG RAM AIR, approx. 10% thrust increase is achieved on the serviceable engine, but this gain is already incorporated in the single engine approach chart.

1. Fuel – Calculate approach speed

NOTE

> Approach speed 14000 kg at 10 units AOA:
> – 155 kt plus 5 kt/1000 kg flaps MID
> – 140 kt.* plus 4 kt/1000 kg flaps DWN
> * Add 3 kt if krueger flaps are inhibited

2. Airbrakes – IN (emerg IN if required)
3. SPILS – OFF
4. Harnesses – Tight and locked
5. Flaps – MID
6. Air systěm master – EMERG RAM AIR

SINGLE ENGINE FINAL APPROACH – X-DRIVE SHUT

At the start of the descent lower the landing gear normally and ensure the 3 green lights illuminate. If the right throttle is at HP SHUT, the right throttle shall be selected to IDLE before TR can be selected. If the left throttle is at HP SHUT, to obtain TR and LD at idle power, the left throttle shall be moved to IDLE to remove the physical obstruction caused by the left throttle when at HP SHUT. Ensure that the TR override switch is set to O RIDE (and FRONT is selected in trainer aircraft). Do not pre-select LD or TR. After touchdown reduce power to IDLE and rock the left throttle outboard to obtain lift dump. Rock the right throttle outboard to obtain TR at 140 Knots, increasing power up to MAX DRY at 100 knots (on dry runways only) provided the crosswind component does not exceed 10 knots.

1. Landing gear – Down, check 3 greens
2. Brakes – Test, A SKID out
3. NWS – LOW light on, no re-ingest warning
4. Spoilers – Reset if necessary

When landing assured:
5. Flaps – As required

After touchdown:
6. Throttle failed engine – IDLE
7. LD – Engage

Below 140 kt
8. Throttles – IDLE TR (CWP REV)

Below 100 kt:
9. Throttles – Up to MAX DRY (dry runway only)

WARNING

> IF X-DRIVE SHALL BE OPENED AFTER LANDING DUE TO TIME LIMITS:
> – DO NOT TAXI WITH LEFT GEARBOX NOT RUNNING
> – IF RIGHT GEARBOX NOT RUNNING, TAXI ONLY IF MANDATORY TO CLEAR THE RUNWAY (NO NWS).

GEARBOX/HYDRAULIC SYSTEM FAILURES

This follow-on drill caters for the approach and landing phase and has been established to recover the aircraft safely after a gerabox or hydraulic system failure or a hydraulic overtemperature have occurred. The following cases are affected:

- Gearbox Failure
- Failure of One Hydraulic System
- Failure of One Utility System
- Hydraulic Overtemperature

The drill has been set up in a chronological order which reflects the individual terminal phases of flight, namely:

- Transit, Descent/Recovery, Pre Landing, Final Approach.

For the safe conduct of flight during approach and landing, it is essential, always to apply the recommended sequence of checks starting with Transit, even if the failure occurs at a later stage e.g. Pre

Landing, as repetition of essential checks is not foreseen.
Regardless which side has failed, common procedures are available for Transit, Descent/Recovery and Pre Landing. For Final Approach, different procedures are available which cater specially for a left or right gearbox/hydraulic system failure.
In case of Hydraulic Overtemperature the procedures to be applied for Final Approach depend on the status of the UTIL/CWP caption. If the light is still on, the drill for gearbox/hydraulic system failures applies. Should the warning caption be out, the affected utility hydraulic may be pressurized again and a normal landing be made.

TRANSIT

As precautionary measure maintain minumum 500 ft and fly below 500 kt. Autopilot operations are not allowed. Pressing any lit button on the CSAS control panel will extinguish the CSAS/CWP caption only, the PFCS/CWP caption will remain lit, indicating that the CSAS is not in full status.
If the right gearbox fails, switch the CRPMD to M position and the TFR to the OFF position, because radar stabilization and scanning will be lost.
Consider dumping fuel or jettisoning stores to reduce mass and improve conditions for the approach.

1. Fly above 500 ft AGL and below 500 kt
2. Controls – Gentle maneuvers only. Do not use autopilot. Minimize use of flaps, slats and wing sweep.
3. CSAS – Press any lit button, CSAS/CWP caption out
4. CRPMD/TFR – M/OFF if right system failed
5. MASS – Reduce if required. For right system failures see Figure 3-22 for Aircraft Arresting System Limits

DESCENT/RECOVERY

1. Wing sweep – 25°
2. Instruments – Check ADI erect, compare HUD and HDD. Radar alt to zero stop.
3. MASS – As required
4. TFR – OFF
5. Demist – As required
6. Intake anti-icing – As required
7. Landing light – On
8. TR – ORIDE (Trainer: Front)

PRELANDING

Check fuel contents and calculate the approach speed. Check that airbrakes are IN and SPILS is OFF. Ensure that harnesses are tight and looked. The approach should normally be flown out of a straight-in with flaps in MID and 10 units of AOA.

1. Fuel – Calculate approach speed

NOTE

Approach speed 14000 kg at 10 units AOA:
- 155 kt plus 5 kt/1000 kg flap MID
- 140 kt.* plus 4 kt/1000 kg flaps DWN

* Add 3 kt if krueger flaps are inhibited

2. Airbrakes – In (emerg IN if required)
3. SPILS – OFF
4. Harnesses – Tight and locked
5. Flaps – MID

FINAL APPROACH

If left system failed: when left system has failed, normal brakes and anit-skid are lost, however full use of TR will decelerate the aircraft sufficiently. Brake application at this time should be avoided as well as use of TR above 80%, coupled with inboard spoilers failed, will unload the main gear causing tire skid even with light braking. After cancellation of TR only light to moderate braking is allowed due to failure of the anti-skid. It should be remembered that the number of brake applications is limited.

1. Landing gear – Normal lowering check 3 greens
2. Do not preselect TR
3. Brakes – Do not check prelanding. Emergency brakes only. No antiskid. Minimize brake applications.
4. Flaps – As required

WARNING

- IF KRUEGER FLAP EXTENDED DO NOT SELECT FLAPS TO UP

- DO NOT TAXI WITH LEFT GEARBOX/HYDRAULICS FAILED.

If right system failed: if right system has failed the landing gear shall be lowered by using the emergency system and cannot subsequently be raised if an overshoot is attempted. LD preselection is not recommended with o/b spoilers failed as deployment of i/b spoilers would cause a nose down pitching moment at touchdown. NWS is lost but nose gear can be assumed to be centered. Only IDLE TR is permitted.
Use of approach-end cable engagement is recommended provided that the limitation shown in the Aircraft/Arresting System limits table (Figure 3-22) are not exceeded.
Otherwise apply the drill for a no cable situation (refer to "If approach-end cable not available/suitable" drill).

1. Landing gear – Gear lever down. Speed (200 kt). Emerg gear handle pull (3 greens)
   NO NWS
2. Do not preselect LD or TR

If landing into an approach-end cable is intended, apply the relevant drill with the exception that after touchdown, before NW lowering, the ICO should be pressed and held during the engagement until full stop.

If approach-end cable available/suitable:
3. Hook – Down light on
4. Approach AOA – 10 units, flare max. 12
5. Flaps – DWN
6. Touchdown – At least 500 ft before cable

After thouchdown:
7. LD – Engage
8. ICO – Press and hold (do not brake)
9. Lower nosewheel onto runway before cable

WARNING

- CABLE ENGAGEMENT WITH NOSEWHEEL OFF GROUND MAY CAUSE STRUCTURAL DAMAGE.
- NO BRAKING WHILE ROLLING BACKWARDS TO AVOID TIP-OVER.

- DO NOT TAXI WITH A HYDRAULIC FAILURE.
- WITH RIGHT GEARBOX FAILED, TAXI ONLY IF MANDATORY TO CLEAR RUNWAY (NO NWS).

NOTE

Avoid rapid derotation to prevent NW bounce. A flat approach is preferable.

In case where an approach-end cable is not available/suitable consider the following:
- With left system failed, full use of TR will decelerate the aircraft sufficiently and braking should be avoided as well as use of TR above 80% NH will unload the main gear causing the tires to skid even with light braking. After cancellation of TR light, moderate braking is allowed.

If approach-end cable not available/suitable
3. Brakes – Test, A SKID out
4. Flaps – DWN

After touchdown:
5. LD – Engage
6. Use aerodynamic braking to 100 kt 18 AOA max (14 AOA max with stores)
7. ICO – Press and hold before NW touchdown until stopped
8. Keep straight using rudder/differential braking
10. Idle TR/taxi nozzle – As required

If directional oscillation occurs:
11. TR – Cancel
12. Brakes – Release, re-apply symmetrically

WARNING

- DO NOT TAXI WITH A HYDRAULIC FAILURE.
- WITH RIGHT GEARBOX NOT RUNNING, TAXI ONLY IF MANDATORY TO CLEAR RUNWAY (NO NWS).

NWS/NSAS FAILURES

Before landing with any NWS/NSAS problem, consider runway overrun, side area condition and crosswind.

NWS Failure in Flight

Re-ingest audio, green LOW light out.

With a total NWS failure a 600 Hz (re-ingest audio) sounds, the green LOW light extinguishes or fails to illuminate after the NWS auto test and the nose gear reverts to free caster. However, certain failures may result in the nosegear being deflected or rotating slowly. Landing under these conditions will result in directional swing or nose wheel burst.
If the failure occurs after touchdown a marked directional swing may be experienced before the failure warnings are noticed.

1. Gear — Do not recycle

Nosewheel "Steer-to-centre" function may be affected and airframe damage may occur when or after the gear is retracted.

2. If practicable, obtain visual inspection to establish position of nosewheels

NOTE

Nosegear may be pivoting slowly; therefore a prolonged inspection may be necessary.

3. Mass — Reduce if possible
4. Normal approach — TR not preselected

If x-wind exceeds 15 kt and nose gear centered and not pivoting:

5. Land into approach-end cable if available/suitable

If nose gear is cocked, pivoting or no visual inspection/ **no cable available/suitable**, do not make an approach-end cable engagement or trample the cable with the nosewheel lowered, as a severe swing could lead to a dangerous off-center engagement. In these circumstances, or if no approach-end cable is available, continue the procedure below:

In all other cases up to 15 kt crosswind:

5. Use aerodynamic braking to 100 kt 18 AOA max (14 AOA max with stores)
6. ICO — Press and hold before NW touchdown until stopped
7. Be prepared for directional swing on nosewheel touchdown
8. Keep straight using rudder/differential braking as described under NWS failure/runway after landing
9. IDLE TR/Taxi nozzle — As required

If directional oscillation occurs:

10. TR — Cancel
11. Brakes — Release, re-apply symmetrically

WARNING

- IF NOSE GEAR IS COCKED, AVOID TRAMPLING CABLE WITH NOSE LOWERED.
- CABLE ENGAGEMENT WITH NOSEWHEELS OFF GROUND MAY CAUSE STRUCTURAL DAMAGE.

NWS Fails to Enter BITE

Green LOW light without re-ingest audio after gear extension

Failure of the nosegear down signal to the NWS results in absence of both LOW light and re-ingest audio due to no BITE initiation.

NOTE

No LOW light and re-ingest audio is the normal state after a take-off or touchdown and go. Therefore, if the gear has not been cycled for any reason, the absence of a LOW light does not necessarily indicate a NWS failure.

1. Normal approach — TR not preselect
2. Use aerodynamic braking to 100 kt if practicable 18 AOA (14 AOA max with stores)
3. After nosewheel touchdown — Check NWS LOW light

If LOW light on:

4. Continue normal landing

If LOW light out:

4. Keep straight using rudder/differential braking as described under NWS Failure/Runway after landing
5. IDLE TR/taxi nozzle – As required

If directional oscillation occurs:

6. TR – Cancel
7. Brakes – Release, re-apply symmetrically

NWS Failure/Runaway After Landing

If a NWS failure or an unexpected directional swing occurs with the TR engaged above IDLE, immediately rock the throttles inboard and select IDLE, to eliminate the destabilizing effect of high power TR. If directional control is not immediately regained and a NWS failure is evident, press the ICO and use rudder and/or differential braking to reestablish control. In the case of large swing, full differential braking may be required in addition to rudder application. With rudder pedals deflected, avoid inadvertent application of the opposite brake. Below approx. 100 kt rudder effectiveness reduces rapidly, while the brakes become increasingly effective.

When applying differential brake control avoid releasing the pressure totally on either pedal. System lag due to backlash/hydraulic response time combined with aircraft inertia causes a significant delay between the initial application of brakes and the aircraft's response.

Therefore the pedal pressure should not be completely released to minimum response lag. This technique is recommended as otherwise the response lag can lead the overcontrolling, resulting in directional oscillations. If lateral PIO's develop, cancel TR, if engaged, and release the brakes momentarily; reapply symmetrically before commencing differential braking. If the stopping distance becomes marginal, prepare for cable engagement.

NOTE

ICO shall be pressed where a swing is caused by other factors, e.g. burst tire, brake failure, or slippery runways as NWS will aid recovery.

1. **THROTTLES – CANCEL TR, IDLE**

If failure causes directional swing:

2. **ICO – PRESS AND HOLD**
3. Keep straight using rudder/differential braking
4. IDLE TR/taxi nozzle – As required

If directional oscillation occurs:

5. TR – Cancel
6. Brakes – Release, re-apply symmetrically

NSAS Failure

A NSAS failure exists if the 600 Hz tone sounds (re-ingest audio) with the green LOW light remaining on; however, basic nosewheel steering is not affected. Do not pre-arm TR and use IDLE only. If failure occurs during landing, reduce TR to IDLE without delay.

1. TR – Do not prearm, use IDLE TR only

APPROACH AND LANDING EMERGENCIES

LANDING WITH WINGS SWEPT

If the wing sweep has failed, flap and slat availability depend on the failed wing position. Depending on aircraft mass, relatively high AOAs and associated speeds may be encountered during approach and flare. Stores shall be released in cases where the tire limit speed of 240 kt will be exceeded or stores will touch the runway surface. When stores are retained, considerations should be given to runway length and condition, barrier type, weather and crosswind. Investigations have shown, that for some heavy configurations with chaff/flare dispenser and 1000 kg fuel remaining, certain stores, if carried on the rear shoulder (stations 11 and 12), have to be released (see Figure 3-20). All other stores can be retained for landing.

To reduce the final approach speed, excess fuel should be burned or dumped. LD only should be preselected. Establish a straight flat approach and be aware that minimum round out authority is available, especially in the 67° wing sweep case.

If possible, the aircraft should be flown at higher altitude in the landing configuration to familiarize the crew with the aircraft handling characteristics. Raise the seat to obtain sufficient forward visibility for the higher approach AOA, readjust the rudder pedals, so that during landing full rudder travel and simultaneous braking can be easily achieved. Assure that the flight controls can be used to the full extent with the seat raised into a position above normal. Reduce mass to about 1000 kg of fuel to keep the final approach speed low and improve ground roll distance. Underfuselage tanks and bombs should be jettisoned because of insufficient ground clear-

WING SWEEP FAILURE

WING SWEEP	FLAP	SLAT	APPROACH		MAX FLARE	STORES TO BE JETTISONED (Rear SHLDR)
			AOA	KT		
45°	UP	UP	13	192	15	MW-1, BL755
45°	UP	MVR	15	181	17	MW-1, BL755 MK82, MK83, tanks
67°	UP	UP	16	201	17	

Figure 3-20

ance during flare. Do not exceed the recommended AOA for approach and during flare. Anticipate sluggish roll control at relatively high power settings and slight directional control problems at touchdown, especially when crosswind conditions exist.

Although LD will deploy after touchdown, the nose-up tendency of the aircraft should be counteracted by pushing the stick half-way forward and holding it in this position. Engage TR at IDLE and when the speed decrease to 165 kt move the throttle to MAX DRY. When the re-ingest audio comes on retard the throttle to IDLE and be prepared for overrun the cable.

NOTE

- Crosswind limit 10 kt fly straight, flat approach.
- Max mass for landing is 19000 kg.

1. Mass – Reduce (front group heavy if possible)
2. U/FUS stores – Jettison as required (Figure 3-20)
3. SPILS – OFF below 12 units AOA
4. Wing sweep lever – To indicate wing position
5. Perform controllability check to approach AOA (see Figure 3-20)
6. LD (45° W/S only) – Preselect

After main wheels touchdown:

7. Throttles – IDLE
8. Nosewheel – LOWER
9. Stick – Push half way forward

Below 200 kt

10. TR – Engage at IDLE

NOTE

TR power may be steadly increased until desired retardation is achieved. If diretional stability becomes affected, cancel TR, select IDLE and then re-engage TR.

11. Throttles – MAX DRY at 165 kt, IDLE at re-ingest audio.
12. Prepare for overrun cable engagement

NOTE

- Add 7 kt per 1000 kg above 14000 kg.
- Do not taxi if wing sweep is greater than 45° or if rear group fuel exceeds front fuel group.

LANDING WITH FLAP/SLAT FAILURE

Flap/Slat Feedback Shaft Failure

If a slat feedback shaft failure occurs, indicated by an amber SLAT caption on the CWP, the slats move to their mechanical end stops in the selected direction. However, flap extension is restricted to the MID position. If flap operation from MID to DWN is required, they shall be operated by selecting and holding the emergency flap switch in ORIDE, with the flap lever set to DOWN. Retraction of flaps via MID to UP is normal.

If a flap feedback shaft failure occurs between MID and UP, the flaps move to their mechanical end stops. Slat operation is normal. However, if a feedback shaft failure occurs between DWN and MID, the slats stay in DWN.

NOTE

EMERGENCY FLAP–ORIDE should not be used to lower flaps to DWN unless the slats are at or beyond MVR.

Both failure cases can be confirmed on the secondary control surfaces indicator by checking the slat/flap pointers which have travelled outside the scale.

Failure of Flaps to Extend

If flaps have failed at UP or MVR, roll gain is not optimized for landing. If in 25 degree wing sweep, roll control is degraded if the slats are extended without the corresponding flap condition, as spoiler effectiveness is reduced. This tendency will be aggravated if outboard and/or heavy underwing or underfuselage stores, or wing fuel are carried. The flap UP/slat DWN configuration with underwing stores constitutes the worst condition and its therefore very PIO prone (see Warning). Lateral PIO is also possible in the flap UP/slat MVR or flap MVR/slat DWN configuration if underwing stores are carried.
If a failure results in a PIO prone configuration (see Figure 3-21), attempt to obtain a more favourable flap/slat combination. If unsuccessful, jettison stores as required (see below). If unable to jettison, be prepared for lateral PIO on approach. Avoid tight control of bank angle or rapid roll corrections. If overcontrol is encountered, freezing the stick momentarily in roll or releasing it will dampen the oscillation within one cycle. In severe conditions of crosswind and turbulence there is a high risk of loss of control and controlled abandonment may be preferable.

Failure of Slats to Extend

Extension of flaps without slats will reduce the AOA at which stalling or wing drop occurs. The maximum flare AOA are given in Figure 3-21 and lie 2 to 4 units below the handling limit.
Approach with flap DWN/slat UP is not recommended because of very low AOA limit. Select flaps to MID if possible.

If flaps failed:
1. Flaps/slats – Attempt to obtain MID/DWN, MVR/MVR or UP/UP

If slats failed:
1. Flaps – Select MID

NOTE

MVR slat may be obtained using throttle MVR switch.

FLAP/SLAT FAILURE

FLAPS	SLATS	APPROACH AOA	APPROACH SPEED KT (14000 KG)	MAX FLARE AOA	HANDLING NOTES
UP	UP	12	180	14	–
	MVR	14	169	16	PIO-PRONE WITH STORES
	DWN	14	175	16	VERY PIO-PRONE WITH STORES, SEE WARNING
MVR	UP	12	165	14	–
	MVR	12	166	14	–
	DWN	12	176	14	PIO-PRONE WITH STORES
MID	UP	10	150	13	–
	MVR	12	145	15	–
	DWN	12	146	15	–
DWN	UP	6	148*	9	SEE WARNING
	MVR	10	138*	13	–

Add 5 kt per 1000 kg above 14000 kg to approach speed
* Add 3 kt if krueger flaps are inhibited

Figure 3-21

Before landing:
2. Flap lever – Leave at selection closest to actual flap position
3. Stores – Jettison as required (below)
4. Excess fuel – Dump or burn. Ensure wing and U/wing tanks empty
5. Perform controllability check to approach AOA (see Figure 3-21)
6. Land – Use straight approach with minimum roll corrections, X-wind limit 10 kt

Jettison Requirements:
PIO prone configuration
(UP/MVR, UP/DWN, MVR/DWN):
U/wing stores
except CBLS/Sidewinder
Heavy U/fus stores
All cases: As necessary for mass reduction

WARNING

- IF STUCK IN FLAPS UP/SLATS DWN CONFIGURATION WITH STORES, IN CONDITIONS OF SEVERE CROSSWIND AND TURBULENCE CONSIDER CONTROLLED ABANDONMENT.
- APPROACH WITH FLAPS DWN/SLAT UP IS NOT RECOMMENDED. SELECT FLAPS TO MID IF POSSIBLE.
- MAX FLARE AOA GIVES A 2 TO 4 AOA MARGIN FROM STALL/WING DROP.

NOTE

If HDD speed indication is used, increase calculated approach speed by 10 kt.

LANDING WITH A KNOWN BLOWN TIRE

Reduce mass if possible fly normal approach. TR not preselected. A known blown nose tire will present no problem during landing. Do not delay lowering the nose below 110 kt as it may drop sharply onto the runway and increase damage. IDLE TR and light braking may be used to decelerate the aircraft with nosewheel lowered onto the runway and NWS engaged.
When landing with a known blown main tire, carry out approach-end cable engagement. If cable engagement not possible or unsuccessful or if a main tire failure occurs at touchdown or during the early landing roll, lower the nosewheel and minimize braking.
Directional control during the ground roll with any blown tire is good. A blocked wheel, however, will cause a flat spot on the wheel and therefore heavy vibration shall be expected. After NWS engagement use IDLE TR and consider lowering the hook if cable engagement is necessary.
Before landing, consider:

- Runway and overrun, length and condition
- Crosswind

1. Mass – Reduce if possible
2. Normal approach – TR not pre-selected

If nose tire is blown:

3. Use aerodynamic braking 18 AOA max 14 AOA max with stores
4. At approx. 110 kt – Lower nose
5. After NWS engagement – Use IDLE TR and light braking only

If main tire is blown:

6. Carry out approach-end cable engagement

If cable engagement not suitable or unsuccessful:

7. Nosewheel – Lower ASAP
8. After NWS engagement – Use IDLE TR

ANTISKID FAILURE

If an A SKID/CWP caption remains on during a BRAKES TEST on the ground, pressing TEST 2 momentarily may rectify the situation. If the failure remains, the anti skid system is unserviceable.
An anti skid failure occurring in flight involves the possibility of tire burst on landing. Therefore utilize full runway length and decelerate the aircraft by TR application. If TR operation is inhibited, use aerodynamic braking followed by light braking to stop.

NOTE

As the possibility of tire burst exists, use brakes with caution.

CABLE ENGAGEMENT

Cable engagements should be considered during aborted take-offs and whenever the malfunction of a system or adverse weather conditions present a threat to directional control during the landing phase. The touchdown point should be selected taking into account environmental factors such as cable arrestment location, runway condition, crosswind, nature of emergency and difficulty in high speed directional control. Consideration should also be given to the engaging speed limits to avoid structural failure of the hook or of the cable.
Before engaging the cable, the nosewheel shall be on the ground and the wheel brakes released and throttle(s) shall be reduced to IDLE or IDLE TR if selected, to assure positive cable engagement. The throttles may be advanced inadvertently should de-

celeration force cause the pilot's hand to be thrown forward on the throttles.

Immediately after the aircraft has stopped, press ICO to deactivate NSAS and release the pedals to straighten the nosewheel. The aircraft will roll straight back to the position which it had at full stop without significant deviation.

Braking is not permitted but power may be used to counteract the pull-back after deselecting TR.

Off center engagement at higher speeds and masses should be avoided as the risk of the aircraft leaving the runway increases during pullback.

For airfield arresting system limits refer to Figure 3-23.

WARNING

NO BRAKING WHILE ROLLING BACKWARDS TO AVOID TIP OVER, INSTEAD USE POWER TO COUNTERACT PULL-BACK.

CAUTION

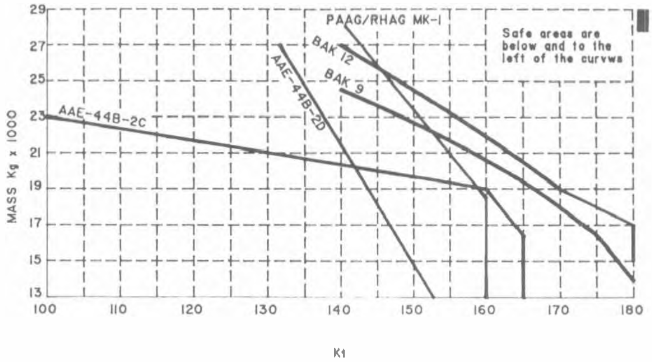
IF SINGLE TR IS USED ON LANDING AND CABLE ENGAGEMENT ANTICIPATED, TR SHALL BE REDUCED TO IDLE BEFORE HOOK LOWERING TO AVOID MISSED ENGAGEMENT DUE TO HOOK ARM SIDE SWING.

NOTE

- The shoulder harness should be locked prior to the cable engagement, as the seat will not provide automatic locking during deceleration and the aircraft will be thrown forward upon engagement.

- The nosewheel shall be on the ground and the wheel brakes released cable engagement.

AIRFIELD ARRESTING SYSTEM



WARNING

- The above figure represents a combination of arresting systems limitations and aircraft/hook structure limitations. Exceeding these limitations will cause arresting system failures and/or structural aircraft hook damage including fracture or arresting hook arm.

- Barrier PAAG shall be used for emergency case onlu; use RHAG – MK1 arrester characteristic.

Figure 3-22

Departure-end Cable Engagement

Lowering of the hook should be delayed until the last moment possible (500 ft from the cable), to avoid excessive damage to the hook caused by contact with the runway. Avoid lowering the hook on central runway lights or markings. Check that the hook indicator light is on, indicating its down position.

WARNING

NO BRAKING WHILE ROLLING BACKWARDS, TO AVOID TIP-OVER.

1. Throttles – IDLE, rock outboard
2. Hook – Down, light on
3. Brakes – Release before crossing cable

NOTE

Hook should ideally be lowered between 3000 and 500 ft before the cable.

When stopped:
4. NWS – HIGH before pull back
5. TR – Deselect
6. Throttles – IDLE
7. Nosewheel – Lower before cable
8. Brakes – Do not apply

When stopped:
9. NWS – Select HIGH (if possible) before pull back

APPROACH-END CABLE ENGAGEMENT

Establish normal landing configuration and reduce mass to minimum practicable.
Depending on type of cable, consideration should be given to engagement speed limits to prevent structural failure of the cable or the aircraft.
Aim for a flat approach not to exceed 10 units AOA with LD preselected, only if two engines. Flare AOA shall not exceed 12 units. Touchdown at least 500 feet short of cable, reduce throttles to IDLE and engage at a 90 degree angle. Lower the nosewheel without delay; however, avoid rapid derotation to prevent nosewheel bounce. If left engine is operative, select LD upon touchdown.

WARNING

- CABLE ENGAGEMENT WITH NOSEWHEELS OFF-GROUND MAY CAUSE STRUCTURAL DAMAGE.
- NO BRAKING WHILE ROLLING BACKWARDS TO AVOID TIPOVER.

NOTE

Avoid rapid derotation to prevent NW bounce.

1. Mass – Reduce to min practicable (for cable limits see Figure 3-22)
2. Hook – Down below 250 kt, light on
3. Approach – 10 units AOA
4. TR – Do not use

After touchdown
5. ICO – Press and hold if NWS failure

LANDING GEAR EMERGENCY

LANDING GEAR RETRACTION FAILURE

NOTE

Do not exceed the LG speed limitation.

If the gear lever is stuck DOWN, neither use force to move the lever up nor use the emergency override button.

If gear lever is UP:

1. Control stick – Apply momentary push (not below zero g). If unsuccessful and the gear position indicators show one or more reds with or without flashing handle, all greens out and the external inspection indicates gear up and door closed, carry out a single recycle as a microswitch malfunction may be suspected
2. Gear – Recycle once

If unsuccessful, and in all other cases:

3. Gear lever – DOWN

If either main gear green remained on during up selection:

4. Emergency gear handle – PULL

In all unsuccessful cases:

5. Land – As soon as possible

NOTE

- If practicable, confirm gear down and NW centered by external inspection before landing.
- If NW fails to retract, the LOW light does not come on until the NW touches down.

LANDING GEAR FAILS TO LOWER

Red

U/C

One or more gear indicator lights are red or out after lowering. If the landing gear fails to lower or the doors do not adopt the normal full open position with the right utility hydraulic system operative, make one attempt to lower the gear by recycling. Pulling the emergency gear handle will unlock the doors and blow the landing gear into a locked down position within approximately 5 seconds, regardless of the gear handle and existing main gear doors position. Selecting the landing gear handle to DOWN will cancel the gear-up signal. Once the emergency system has been actuated, it is impossible to retract the landing gear. The landing gear indicator will show 3 green.

One attempt to recycle is allowed.

If recycle is unsuccessful:

1. Gear level – Leave DOWN
2. Speed – 200 kt
3. Emerg gear handle – Pull (3 green)

NOTE

- The emergency gear system can be operated even if the gear lever is stuck.
- If it is suspected that a lamp in the landing gear position indicator is defective, it may be tested through the LAMPS FRONT PANEL TEST switch.

EMERGENCY GEAR RETRACTION ON THE GROUND

If an emergency dictates retraction of the gear on the ground, press the landing gear override button and select the gear level to UP, and apply Landing Gear Collapsing drill.

LANDING GEAR COLLAPSING

Should the main landing gear collapse or if emergency gear retraction on the ground becomes necessary, select EPS to off; otherwise the one-shot battery may fire and activate the DC fuel pump and EHP as the engine run down after the HP cocks are closed and the generators go off line.

1. **EPS – OFF**
2. **THROTTLES – HP SHUT**
3. **LP COCKS – SHUT**
4. **CRASH BAR – LIFT AND PULL**

WARNING

DO NOT OPERATE THE CRASH BAR BEFORE BOTH THROTTLES ARE IN HP SHUT AND NH IS DECREASING AS OTHERWISE ENGINE CONTROL, INCLUDING OVERSPEED GOVERNORS AND SHUT DOWN FACILITIES ARE LOST.

LANDING WITH GEAR UNSAFE

Before attempting landing, consider:

- Configuration (Figure 3-23)
- Jettison requirements (below)
- Runway, overrun, side areas condition
- Crosswind
- Arresting gear limitation (Figure 3-22)
- Runway foam

If condition are unfavourable: EJECT

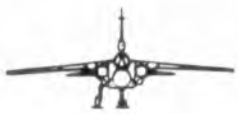
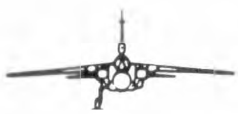
Jettison requirements:

1. Jettison the following – All live stores (except Sidewinder), asymmetric stores (including tanks), centerline stores, tanks with fuel.
2. Other stores and pylons – Retain

WARNING

IF JETTISON UNSUCCESSFUL, DO NOT ATTEMPT LANDING IF EITHER OR BOTH MAIN GEAR NOT LOCKED DOWN OR WITH ANY LIVE STORE ON FORWARD SHOULDER STATIONS WITH NOSE GEAR NOT LOCKED DOWN.

LANDING CONFIGURATIONS

FINAL GEAR CONFIGURATION	RECOMMENDED ACTIONS
 All gear up or partially up	• Avoid cable – land beyond or have removed • Fly flat approach 8AOA, full flap, minimize flare – use power to touchdown with low sink rate in flat attitude • After touchdown – Close HP/LP cocks – Operate crash bar
 Nose leg up or partially up with both mains down	• Normal approach – preselect LD only • Avoid crossing cable with nose lowered – consider removal • Keep nose up to 110 kts then lower slowly • After nose lowered use IDLE TR and light braking
 Nose leg down with both mains up or partially up	• Lower hook on approach • Normal approach to take approach end cable • After touchdown – Close HP/LP cocks – Operate crash bar
 One main leg up or partially down	• Lower hook on approach • Normal apprach to take approach end cable • After touchdown – Close HP/LP cocks – Operate crash bar
 Nose leg up and one main leg up or partially up	• Attempt retraction • If unable to obtain one of the above con figurations – EJECT

NOTE

If gear is indicating unsafe, the above drills must be followed even if the gear appears down from external check. Only close HP/LP cocks and operate crash bar if gear collapses. Have LG cocks fitted before taxying.

Figure 3-23

Before Landing:

1. Landing recommendations (Figure 3-23)
2. Excess fuel – Dump or burn
3. Pre-landing checks – Complete as applicable
4. EPS – OFF on short finals

Jettison all live stores (except Sidewinder), asymmetric stores (including tanks), centerline stores and tanks with fuel. Retain all other stores and pylons. Before landing, refer to recommended actions, appropriate to the final gear configuration (table below). Burn or dump excess fuel. Complete the applicable Pre Landing Checks. On short final, select EPS to OFF to prevent firing of the one shot battery, when both generators go off line and the WOG switches are sensing the flight condition.

WARNING

IF JETTISON IS UNSUCCESSFUL, DO NOT ATTEMPT LANDING IF EITHER OR BOTH MAIN GEAR NOT LOCKED DOWN OR WITH ANY LIVE STORE ON FORWARD SHOULDER STATIONS WITH NOSE GEAR NOT LOCKED DOWN.

SECTION IV

INTEGRATED NAVIGATION AND WEAPON AIMING SYSTEM

TABLE OF CONTENTS

Title	Page
INTRODUCTION	4-1
Software Standard Program	4-1
Sensing	4-1
Processing	4-2
Displays and Controls	4-2
SENSING	4-3
Inertial Navigator (IN)	4-3
Secondary Attitude and Heading Reference System (SAHR)	4-13
Air Data Computer (ADC)	4-18
Ground Mapping Radar (GMR)	4-18
Combined Radar and Projected Map Display (CRPMD)	4-21
Repeater Projected Map Display (RPMD)	4-22
Terrain Following Radar (TFR)	4-44
Doppler Navigation Radar (DOPPLER)	4-62
Radar Altimeter (RA)	4-66
PROCESSING	4-69
Main Computer System	4-69
Navigation Facilities	4-77
Navigation Modes and Operation	4-79
Steering Modes and Operation	4-83
INTEGRATED DISPLAYS AND CONTROLS	4-88
Television/Tabulator Display System (TV/TAB)	4-88
Head-Up Display Unit (HUD)	4-114
Navigation Weapon System Controls	4-132
MC SOFTWARE STANDARD OFP T-P-SW-X107-01-P DIFFERENCES	4-139
Ground Mapping Radar (GMR)	4-139
Main Computer (MC)	4-139
Head Up Display (HUD)	4-139
ARMAMENT SYSTEM	4-139
Releasing and Launching Equipment	4-139
Armament System Controls and Indicators	4-140
STORES COVERAGE	4-144
EMERGENCY EQUIPMENT	4-145
WARNING EQUIPMENT	4-145
Central Warning System (CWS)	4-145
Visual and Audio Warnings	4-145
Central Warning Panel	4-145
Attention Getters	4-145
Supplementary Warnings	4-145
Audio Warning Alarms	4-151
Landing Gear Selector Lever Warning	4-151
Fire Warning System	4-151
Test of Warning Lamps	4-151
Testing of Central Warning System	4-152
NAVIGATIONAL AIDS	4-153
TACAN Equipment	4-153
SUPPORT EQUIPMENT	4-156
Photographic Equipment (Recce Pod)	4-156
IFF Equipment	4-156
ON BOARD CHECKOUT AND MONITORING SUBSYSTEM (OCAMS)	4-160
Equipment Status-Go/No Go	4-160
Central Maintenance Panel (CMP)	4-161
Software System Check	4-164
Main Computer Selft Test (MCST)	4-164
Ground Test Facility (GFT)	4-165
SERVICING DIAGRAM	4-165
TRAINER VARIANT	4-165
The Aircraft	4-165
CREW DUTIES	4-171
Crew Coordination	4-171
Avionic System Operation	4-172
MISSION DATA INSERTION	4-172
Rapid Data Entry	4-172
Manual Data Entry	4-174
Data Insertion Using Map Slew or Computer Marker Facilities	4-178
Mission Data Check	4-179
SET-UP, ALIGNMENT AND TEST OF SENSOR AND DISPLAYS	4-179
Computer Engagement	4-180
SAHR System Alignment	4-180
IN System set up and Alignment	4-180
CRPMD/RPMD and GMR Set Up and Test	4-182
Doppler Test	4-183
Radar Alt Test	4-183
ESRRD Test	4-183

HUD Set Up 4-183
HUD Sensors 4-185
HSI Test 4-185
TFR Set Up and Test 4-185
NAVIGATION MODING AND STEERING 4-185
Navigation Mode Selection 4-185
Steering Mode Set Up 4-185
Steering Mode Selection 4-185
NAVIGATION UPDATING 4-188
Planned Fixing 4-188
OTF and Tacan Fixing 4-189
Unplanned Fixing 4-189
INTEGRATED SYSTEM REVERSIONARY MODES 4-190
MC Failure 4-190
IFU 1 Failure 4-192
IFU 2 Failure 4-192
IN Fault – No IN CWP Warning ... 4-193
IN Failure 4-193
SAHR Failure 4-194
ADC Failure 4-195
CRPMD Failure 4-195
RPMD Failure 4-195
GMR Failure 4-196
Doppler Failure 4-196
TV/TAB Failure 4-197
RAD ALT Failure 4-197

INTRODUCTION

The integrated navigation and weapon aiming system enables the aircraft to be flown at high speed and low level in all weathers to deliver a variety of weapons. This chapter describes the equipment installed in the aircraft and their functions.
The various equipment in the navigation system perform one or more of the following functions: Sensing, Processing and Display.
The navigation and weapon aiming system is designed to increase mission effectiveness by using the information of the various equipment for steering the aircraft and for displaying and monitoring navigation and weapon aiming data.
The system consist of navigation sensor and display, which are controlled via the main computer. Refer to Figure FO-17.

SOFTWARE STANDARD PROGRAM

Due to embodiment of hardware (equipment) modification and software (OFP load) updating, differences exist in build standard and functions between certain aircraft. These functions are determined by a specific software standard within the Software Series.
This software description given here covers software standard, OFP T-P-SW-X108-01-P, the latest load update in SS7 for 64K and 128K computers and constitutes a summary on software information directed to the aircrews.

Software Queries to SW-X108

- NORM selected on CRPMD selection of marker causes the active marker to be displayed at a range along track and not ground stabilized. However if the aircraft changes track, the marker remains on the old track.
- INT points cannot be entered or displayed in UTM.
- NFX in unplanned attacks will cause errors in range to the target.
- PP on CRPMD reverses at target-overfly (marker).
- MKR selection from F/A on Reversionary KBD does not display the active marker on the CRPMD.
- DOPPLER data on the TV/TAB are frozen at AD + SR mode initial selection with Doppler healthy.

SENSING

Navigation sensors which deliver data for processing are divided into: Autonomous, Forward and Downward Looking Sensors.

Autonomous Sensors

INERTIAL NAVIGATOR (IN)

The IN is the prime source of velocity, attitude, heading and position data and organizes navigation information for display on the Inertial Navigation Control and Display Unit (INCDU). It is the primary data source for the KALMAN FILTER, TFR and AFDS.

SECONDARY ATTITUDE AND HEADING REFERENCE (SAHR)

The SAHR as a gyroscopic platform provides aircraft heading and attitude data for reversionary navigation and attitude data for TFR and AFDS.

AIR DATA COMPUTER (ADC)

The ADC provides horizontal and height data to the avionic system which are derived from the pitot/static sensors, local angle of incidence, total temperature and barometric pressure reference inputs.

Forward Looking Sensors

GROUND MAPPING RADAR (GMR)

The GMR scans the terrain ahead of the aircraft for display of the resultant image on the Combined Radar Projected Map Display (CRPMD) and E-Scope Radar Repeater Display (ESRRD). In addition to ground mapping, the GMR includes modes for height finding, terrain avoidance, air-to-ground ranging, air-to-air track and lock-on. The GMR may be used to interrogate remote beacons.

TERRAIN FOLLOWING RADAR (TRF)

The TFR scan along the aircraft projected track and enables a preselected terrain clearance height to be accurately maintained. The elevation commands are supplied to the Flight Director (FD) and/or to the Autopilot (AP) and the terrain return is displayed on the E-Scope.

Downward Looking Sensors

DOPPLER NAVIGATION RADAR (DPLR)

The DPLR provides digital three axes velocity data by measuring the doppler shift of three radar beams reflecting off the ground. These velocity outputs are supplied to the MC.

RADAR ALTIMETER (RA)

The RA provides a precise height read-out from ground level to 5000 feet AGL. Height information is fed to the AFDS, MC, HUD, and TFR.

PROCESSING

Main Computer (MC)

The MC system is the control center of the navigation and weapon aiming system. It processes incoming navigation sensor signals and refines certain inputs to provide optimal data management. These data are automatically presented on head-down and head-up display to enable the crew to monitor automatic system performance or to fly the aircraft manually.
An Operational Flight Program (OFP) is loaded into the MC from an external Ground Loader Unit (GLU-1) or via the RDE facility of the Cockpit Voice Recorder (CVR).

DISPLAYS AND CONTROLS

The results of MC processing and calculation and direct navigation system data are presented to both crewmembers via their respective cockpit displays. The parameters available depend on the selection made by each crewmember to initiate certain functions and modes of the navigation and weapon aiming system.

Front Cockpit

HEAD-UP DISPLAY (HUD)

The HUD displays navigation and weapon aiming information in symbolic and digital form to the pilot, enabling him to navigate and carry out attacks. The HUD superimposes symbols onto the pilot's forward view of the outside world.

REPEATER PROJECTED MAP DISPLAY (RPMD)

The RPMD displays projected map data which can be selected by the pilot or as a repeat of the CRPMD to assist the pilot in navigation, re-orientation and situation assessment.

E-SCOPE AND RADAR REPEATER DISPLAY (ESRRD)

The ESRRD is a dual format display that comprises a TF E-Scope display and a repeat of the navigator's radar display. The E-Scope function gives a general indication of TFR performance by showing a profile of the terrain ahead as seen by the TFR. The radar repeater display presents a duplicate image of that which is currently displayed on the navigator's GMR display.

HORIZONTAL SITUATION INDICATOR (HSI)

The HSI provides the pilot with a display of the aircraft's horizontal situation. It gives data on heading, track, and distance to go to the next destination.

PILOT'S HAND CONTROLLER (PHC)

The PHC controls the ranging reticle on the HUD during Phase 2 and 3 of sensor fixing and weapon aiming. During rapid HUD alignment of the IN, it assists with bearing information and also provides a slewing facility for the RPMD.

PILOT'S WAMS CONTROL PANEL (PWAMS)

The PWAMS enables the pilot to select Air-to-Air Guns (AAG) and Target of Opportunity (TOO) weapon aiming functions and to "insert" position data into the MC.

PILOT'S WAMS INDICATOR PANEL

The pilot's WAMS indicator panel provides indication of attack mode selection and missile ready status.

Rear Cockpit

TV/TABULAR DISPLAYS (TV/TABs)

The two TV/TAB units are computer terminals capable of displaying data in pictorial or tabular form. The tabulator keyboards enable the navigator to insert into, exstract from, or change data in the computer or to programme a mission.

COMBINED RADAR AND PROJECTED MAP DISPLAY (CRPMD)

The CRPMD provides facilities for navigation/target acquisition and navigation/attack data insertion. It presents GMR video, which may be optically combined with a projected topographical map together with selectable electronically generated symbols.
Digital read-outs of range, aircraft track, accross track distance and antenna tilt angle are also displayed.

INERTIAL NAVIGATION CONTROL AND DISPLAY UNIT (INCDU)

The INCDU shows all navigation data directly sensed by the IN and processed by its own computer. Associated with the display is a keyboard, which enables navigation data to be inserted or changes as required.

NAVIGATION MODE CONTROL PANEL (NMCP)

The NMCP provides switching inputs via IFU 2 to the MC to select the required navigation and steering modes.

MAIN COMPUTER CONTROL PANEL (MCCP)

The MCCP provides power supply switching facilities to the MC, IFU 1, IFU 2 and Waveform Generator (WFG). It also gives an indication of program loading in process and of BITE failure detection.

NAVIGATOR'S WAMS CONTROL PANEL (NWAMS)

The NWAMS enables the navigator to select various weapon aiming functions.

NAVIGATOR'S HAND CONTROLLER (NHC)

The NHC enables navigational data to be inserted into the MC by changing map and computer marker position. It carries controls affecting GMR operation.

SENSING

INERTIAL NAVIGATOR (IN)

The IN is a self-contained navigation equipment providing the primary source of velocity, attitude, actual rack and heading data to the Avionic System. The equipment is also primary source of attitude data for the AFDS, GMR and TFR and in case of MC failure, the IN data are used directly by the HUD and HSI as indicated in Figure 4-1.
The IN can store the coordinates of two destination and produce, on demand, steering information to either one.
The IN equipment comprises two units:

- Inertial Navigator Unit (INU) located in the forward equipment bay
- Inertial Navigator Control and Display Unit (INCDU)

Before the IN can be used, the intertial platform shall be aligned to the required vertical and azimuth datums. Four alignment methods are provided:

INERTIAL NAVIGATOR — BLOCK DIAGRAM

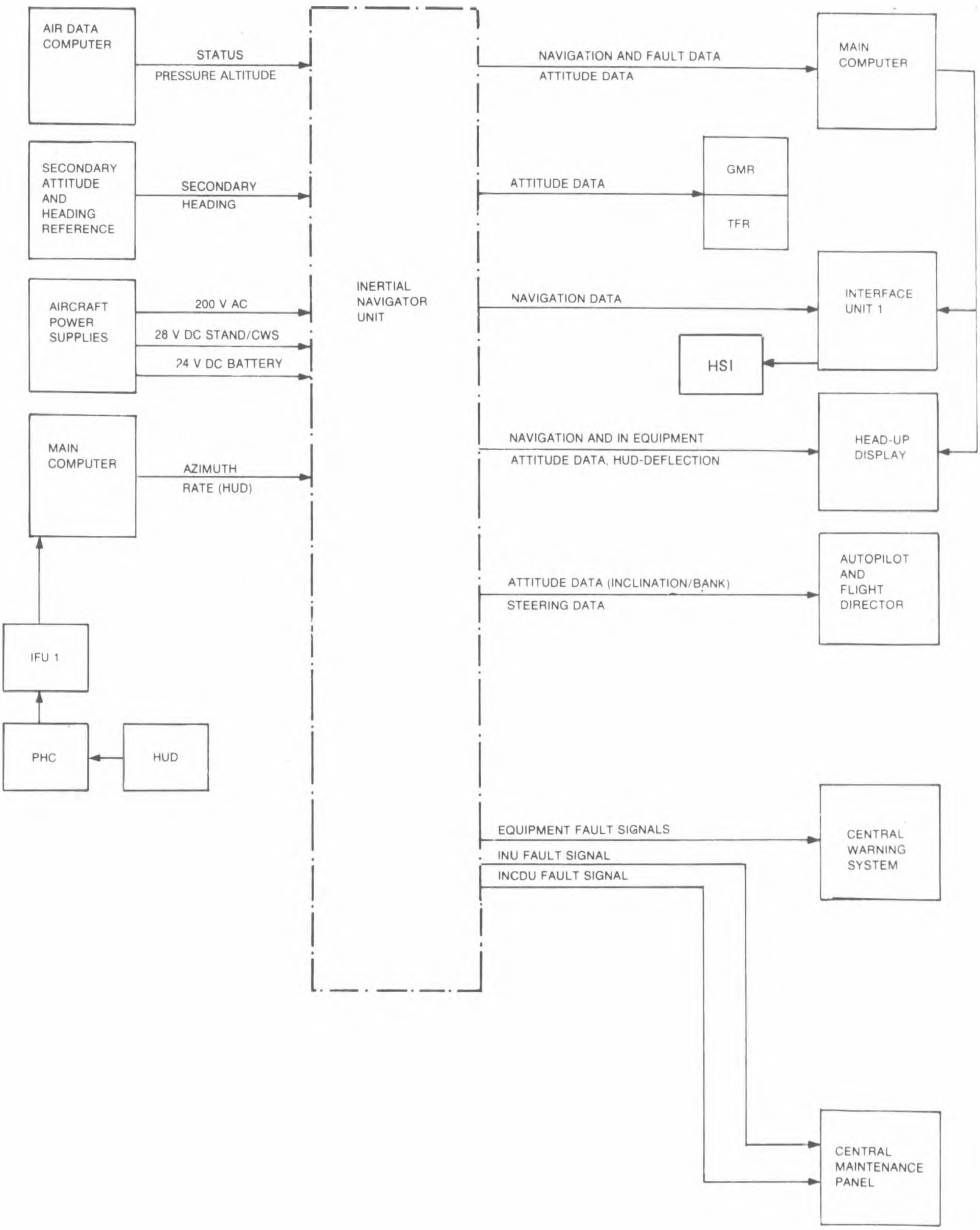


Figure 4-1

normal, rapid inertial, rapid HUD and memorized heading. The method employed and subsequent accuracy obtained is dictated by the time available and other operating restrictions. When aligned, the IN equipment senses and processes changes of attitude and acceleration. The calculations necessary to derive useful data are carried out by a digital computer within the equipment. The INU transmits data to other equipment within the aircraft. A continuous and an interruptive BITE are provided.

Power Supplies

The system is supplied with three phase 115 V, 400 Hz, AC power from AC busbar 2 (XP2) and with 28 V DC from DC busbar 1 (PP1), the BATT busbar (PP4), and ESS DC busbar (PP3). Voltage interrupt protection for the INU computer storage is provided by an integral 3.4 V battery. In case of any primary power failure the IN is connected directly to the battery busbar for approximately 2 minutes. After that time IN will be automatically switched off.

Limitations

RANGE

The equipment is capable of operating satisfactorily throughout the flight envelope between latitude 87.5° N and 87.5° S, and with degraded performance between latitude 87.5° to 89.5° N and S.

ALTITUDE

Altitude from − 2000 ft to + 70000 ft when the input of pressure altitude from the Air Data System is continuously present. A lack of ADC input causes slight degradation of performance.

Inertial Navigator Unit (INU)

The INU contains the inertial platform which is gimbal supported and gyro-stabilized. The IN platform is referenced to true north and the local vertical axis, and senses accelerations measured by three accelerometers. They are mounted such that two acceletometers respond to N-S, E-W accelerations in the horizontal plane and the third detects vertical accelerations. Synchros mounted on the gimbal axes provide attitude signals in inclination, roll and heading. This attitude position information is integrated with velocity signals and then fed to the MC for navigation and weapon aiming calculations.

Inertial platform data are processed by the IN computer for horizontal and vertical channel calculations which are passed as navigation information for display on the INCDU. These processed data are also the prime source for the MC, AFDS, GMR, TFR, HUD and HSI (Figure 4-1).
In addition, the IN computer processes the information required for HUD alignment of the platform and has the capability of storing the coordinates of two reversionary destinations (D31 and D32) and producing on demand steering information to the selected destination.

Inertial Navigator Control and Display Unit (INCDU)

The INCDU provides various controls and display for manual selection of the operating modes and various types of alignment and display. Refer to Figure 4-2.

STANDBY INDICATOR LAMP

The amber STBY lamp is constantly illuminated when STBY mode is selected and platform cluster temperature is above + 5° C. Below + 5° C the lamp flashes at a rate of approximately once every second.

STATUS INDICATOR

The two digit STATUS alpha/numerical indicator shows ALN and FIX, TEST, IPI status (LH digit), and fault status (RH digit). The LH STATUS flashes in the IPI and ALN mode when the platform temperature is below + 5° C. For status indication interpretation refer to Figure 4-3.

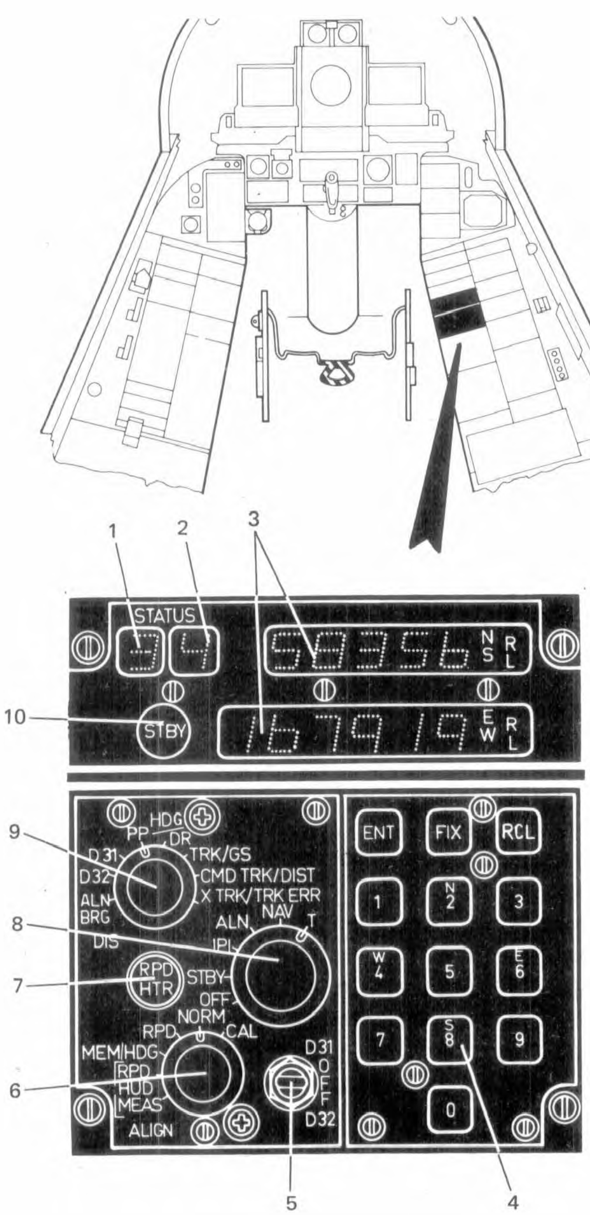
NAVIGATION DISPLAY

The navigation display consists of two digital displays for stored or computed data. The upper display numerical has a five digit read-out with N, S, R or L, the lower panel a six digit read-out E, W, R or L direction indicators. Displayed data are selected by the display selector switch. Refer to Figure 4-4.

KEYBOARD

The ten digit pushbutton keyboard with associated FIX, Recall (RCL), and Enter (ENT) buttons for data insertion is used in conjunction with the display selector switch and the navigation display. Even numbered buttons have direction annotation N, W, E and S in addition to numbers.

INERTIAL NAVIGATOR CONTROL AND DISPLAY UNIT (INCDU)



1 LH (alignment) status indicator
2 RH (fault) status indicator
3 Navigation display
4 Keyboard
5 Destination selector switch
6 Align selector knob
7 Rapid heaters indicator
8 Mode selector knob
9 Display knob
10 Standby lamp

Figure 4-2

DESTINATION SELECTOR SWITCH

The three position OFF/D31/D32 toggle switch is used to derive IN steering information.
Positions D31 and D32 permit steering information relating to alternative destinations to be displayed on the navigation display when CMD TRK/DIST or TRK/TRK ERR is selected in IPI, ALN or NAV mode. Outputs are fed to the HSI and HUD for display in the case of MC failure.
In the OFF position alternative information is de-selected.

ALIGN SELECTOR KNOB

The six-position rotary ALIGN knob is used to select the following IN alignment methods or functions:

CAL — For calibration purpose by ground crew only.

NORM — Normal alignment.

RPD — Rapid inertial alignment.

MEM HDG — Memorized heading alignment.

RPD HUD — Rapid HUD bearing alignment by reference to the stored data from HUD MEAS.

HUD MEANS — HUD measurement and storage of bearing.

RAPID HEATERS INDICATOR LAMP

The RPD HTR indicator illuminates steadily while rapid heating is in progress.

MODE SELECTOR KNOB

The six position rotary knob is used for selection of the following modes:

OFF — All power supplies are disconnected from the IN circuits.

STBY — Power is supplied to the fine heaters to maintain the IN platform at its operating temperature of +55° C for at least 4 hours.

IPI — Initial Position Insertion: power is supplied to the complete IN equip-

IN STATUS FAIL/ALIGN INDICATION

MODE	INDICATOR		INTERPRETATION	
	LEFT	RIGHT		
FIX	9			
TEST	8			
IPI	7	U	Fault — ADC fault	
		9	Fault — Internal power supply	
		8	Fault — IN computer	
		7	Fault — Data stores	
		6	Fault — Input/output circuits	
		5	Fault — INCDU	
		4	Fault — Attitude	
		blank	Fault — External power supply	
			BITE successful	
			All faults, recycle mode OFF/IPI	
			ALN may not select with fault indicated	
ALN	6		Coarse alignment in progress	
	5		Fine alignment in progress	
	4		Very poor alignment	(6 nm)**
	3		Poor alignment*	(3 nm)**
	2		Fair alignment*	(1.5 nm)**
	1		Good alignment*	(1 nm)**
	0		Very good alignment*	(<1 nm)**
		U	ADC fault or vertical channel out of limits	
			If U disappears by status 0, system OK	
			If U still present at status 0, monitor behaviour at NAV selection	
		9, 8, 6	As above. Attempt re-align	
		5, 1	As above. Attempt re-align	
		4	Fault — Attitude, may not coarse align	
		3	Fault — Platform interface. IN will function but vertical channel degraded	
		2	Fault — Platform services. Bad coarse align, may auto switch off	
			If 2 disappears, system probably OK	
NAV	blank		System OK	
	not blank		NAV selection rejected, aircraft shall not be moved	
		U	ADC fault. If U disappears at NAV selection then vertical channel is out of limits. Confirm on HUD	
			RE-ALIGN	
		9, 8, 6	As above. No confidence in IN data	
		5, 4, 2, 1	As above. No confidence in IN data	

* Applies to NRM/RPD inertial alignments only

** Average values for NRM alignment after 1 hour of flight

Figure 4-3

DISPLAYED DATA

DISPLAY SELECTOR POSITION		DATA DISPLAYED	LEAST SIGNIFICANT DIGIT	DATA INSERTED OR UPDATED
P.P.	U	Latitude Co-ordinates of Present Position	0.1 minutes	Can be inserted or updated only in the IPI mode or the NAV mode when FIX button is pressed
	L	Longitude Co-ordinates of Present	0.1 minutes	
D31	U	Latitude Co-ordinates of Destination 31	0.1 minutes	Can be inserted or changed during any mode of operation except OFF and STBY
	L	Longitude Co-ordinated of Destination 31	0.1 minutes	
D32	U	Latitude Co-ordinates of Destination 32	0.1 minutes	Can be inserted or changed during any mode of operation except OFF and STBY
	L	Longitude Co-ordinated of Destination 32	0.1 minutes	
HDG/DR	U	True Heading	0.1 degrees	Can be inserted only during IPI mode
	L	Drift Angle (zero if IN GS less than 50 kt, blank if MEM/HDG selected	0.1 degrees	Cannot be inserted or updated
TRK/GS	U	Present Track Angle	0.1 degrees	Cannot be inserted or updated
	L	Ground Speed	0.1 knots	
CMD TRK/ DIST	U	Command Track to selected destination	0.1 degrees	Displayed data is referenced to D31/D32 If D31/OFF/D32 switch is OFF, display is blank. Cannot be inserted or updated
	L	Distance To Go to selected destination	0.1 naut. miles	
X TRK/ TRF ERR	U	Across Track Distance	0.1 naut. miles	
	L	Track Angle Error	0.1 degrees	
ALN BRG	U	Align Bearing (Stored Bearing for Rapid HUD Alignments)	0.1 degrees	Can be inserted or updated only when in ALN Mode with RPD HUD Alignment selected
	L	Blank	N/A	

NOTE

"U" indicated data displayed on five digit (Upper) panel.
"L" indicates data displayed on six digit (Lower) panel.

Figure 4-4

ment and interruptive BITE is initiated.

ALN — Used in conjunction with the ALIGN selector knob to establish the vertical and azimuth datums. The alignment procedure is automatically inhibited until the platform temperature is above + 5° C.

NAV — Normal in-flight operating mode on completion of alignment, before the aircraft is moved.

T — Test mode used only by ground personnel in conjunction with the CAL position of the ALIGN selector knob.

The knob position NAV and T are detend to prevent inadvertent operation.

DISPLAY SELECTOR KNOB

The eight position rotary knob labelled DIS controls the navigation displays as follows:

ALN BRG — Stored bearing for HUD alignment is displayed on the five digit indicator.

D31 — Latitude and longitude data of the first destination can be displayed when inserted or changed.

D32 — Identical to D31 but used for the second destination.

PP — Present Position (PP) in lat/long is displayed as inserted in IPI or computed in NAV mode.

HDG/DR — In IPI mode, reference heading for alignment is displayed. During NORM and RPD alignment the sensed heading is diplayed. In NAV mode true heading is displayed on the upper and drift angle above 50 kts GS is displayed on the lower display.

TRK/GS — Actual track is displayed on the upper, ground-speed on the lower display.

CMD TRK/DIS — Track (on the upper) and distance (on the lower display) to the destination D31/D32 are displayed.

X TRK/TRK ERR — Across track distance (on the upper) and track angle error (on the lower display) to the commanded track are displayed.

For details of the display, refer to Figure 4-4.

Central Warning Panel

IN CAPTION

Illumination of the amber IN caption on the rear CWP indicates a failure in the IN equipment or that the system is switched off.

IN OPERATION

The IN equipment is switched on by selecting the mode selector knob either to IPI, ALN or NAV. In STBY position, the heaters are powered and maintain the platform at its correct operating temperature. IPI, ALN and NAV are three operating modes, with IPI selected, insertion of initial present position is provided and BITE is initiated.

Alignments

Four methods of alignment are available:

- Normal alignment
- Rapid inertial alignment
- Memorized heading alignment
- Rapid HUD alignment

The alignments require different set ups, have certain temperature restrictions and result in different IN performance. In the NAV phase, the IN functions are always the same; the gyros then run at a rate of approx. 22000 rpm, and the operating temperature is + 55° C. This temperature is achieved by RPD heating, at a rate of 15° C per min, and is initially sustained by normal heating. All temperatures mentioned here are IN-cluster temperatures and there is no direct indication of them.
Throughout all type of alignments the RH STATUS indication should be blank, only STATUS 1 may be accepted. For other RH indications realignment should be tried after cycling the Mode selector switch through OFF. Once ALN has been selected the gyros need about 5 min run-down time after switch-off. Although ALN can be reselected before this time has elapsed, alignment will not start. This is indicated by a LH STATUS 7.

NOTE

- During all alignments the aircraft shall not be moved.
- Destination selector switch shall be in OFF.

In gusty conditions or at other times when the airframe may be disturbed during alignment, STATUS 0 may not be achieved. In such condition the status number may vary. Selection of NAV should be made when the lowest number of STATUS is indicated.
For all methods of alignment the IN has to be provided with present position coordinates and actual true heading of the aircraft in the IPI mode.

PRESENT POSITION INSERTION

When the DISplay selector is set to PP, check and if required insert the latitude and longitude coordinates via the INCDU keyboard. Data inserted are displayed on the navigation display. To insert latitude, N or S as required is pressed and the coordinates are keyed in, starting with the most significant digit and ignoring initial zeroes. The legend N or S now flashes until the ENT key is pressed and the data are accepted. To insert longitude, E or W as required is pressed and the coordinates are keyed in starting with the most significant digit, ignoring initial zeroes; the legend E or W now flashes until the ENT key is pressed and the data are accepted.
Pressing RCL prior ENT recalls the previously inserted data which can be overwritten in toto for data correction.

TRUE HEADING INSERTION

The IN requires a heading input to an accuracy of ± 19° for coarse alignment before successful azimuth alignment can be ensured. When the DIS selector is set to HDG/DR, Best Available True Heading (BATH) from the SAHR is automatically fed to the IN. If SAHR is not available or the output of BATH is outside the limit of ± 19°, a heading shall be inserted manually.

NORMAL ALIGNMENT

This method of alignment provides optimum navigation accuracy and takes approximately 15 minutes. The ALIGN selector is set to NORM and mode selector to IPI. D31/D32 is set to OFF.
Power is now supplied to the complete IN equipment, interruptive BITE is initiated and LH STATUS 7 is indicated. Rapid heating is initiated if temperature is below + 55° C and indicated by the steadily illuminated RPD HTR lamp.
Present position may be inserted by selecting PP on the DIS selector and keying in the required data via the keyboard. Heading can be checked and inserted after selecting HDG/DR.
15 sec after setting the mode selector switch to ALN, the LH STATUS 6 coarse alignment indication runs down to STATUS 5 for approximately 20 sec. Gyros run up to full speed when rapid heating is completed. Heading error measurement follows. Progress of the alignment can be monitored by checking the status number. After approximately 8 min of alignment NAV selection is possible with a LH STATUS 4 or less.
For normal operation NAV is selected after 15 min of alignment with LH STATUS 0 steadily indicated. D31/D32 may be inserted during the alignment.

RAPID ALIGNMENTS

Three types of rapid alignment are available and require approx. 2 minutes alignment time from a start temperature above + 5° C, an advantage where minimum reaction time is required.

RAPID INERTIAL ALIGNMENT. This method of alignment is intended for use when the time factor is critical and a reduced alignment accuracy is acceptable. It is the least accurate of all alignment methods and should only be used if the platform temperature is above + 5 degrees C.
With the ALIGN selector switch set to RPD then mode selector to IPI, power is supplied to the complete IN equipment and interruptive BITE is initiated. HDG and PP can be checked and keyed in, if required. LH STATUS 7 is indicated.
The mode selector switch is set to ALN. After the coarse alignment gyros run up to about 1/3 of normal speed, fine alignment is indicated by LH STATUS 5 for approximately 50 seconds. Heading error measure follows. Heading correction is indicated by change of LH STATUS 4 to 0 as the mode progresses. NAV selection is possible with a LH STATUS indication of 4 or less.
For normal operation NAV is selected with LH STATUS 0 indicated. This occurs approximately 2 min after ALIGN selection.
During the rapid inertial alignment no rapid heating takes place. This occurs after NAV selection. When operating temperature of + 55° C is reached, the gyros run up to full speed.

NOTE

- Do not RPD ALN if:
  STBY light flashes (temperature is below + 5° C).
  Status indicator flashes.
  RPD HTR's applied within last 10 min.
- Below 15° C, Rapid Inertial Alignment should not be used, due to degraded performance, for the first alignment of the day.

MEMORIZED HEADING ALIGNMENT. This method of alignment is intended for use when the aircraft has not been moved since the equipment was last switched off. The accuracy of the memorized heading alignments is based on the accuracy of the heading wich has been stored in memory before the IN was switched off. Therefore, to give optimum performance, the IN should be realigned prior to this switch off.

NOTE

The ALIGN selector should not be set to MEM HDG before the Mode selector is set to OFF.

When DIS selector is set to HDG/DR a cross check with SAHR heading can be made to detect movement of the aircraft after last IN switch-off. If required select PP and key in latitude and longitude. The mode switch is selected to ALN.
When cluster temperature is below + 5° C (indicated by a flashing LH STATUS 7 and flashing STBY light), RPD heating starts until this temperature is reached. Above + 5° C no RPD heating is applied in the ALN mode and LH STATUS 5 is indicated. Gyros run up to 1/3 of their speed and the platform is aligned to the IN computer stored true heading and the local vertical. This takes about 2 min and LH STATUS 5 changes direct to 0, indicating the completion of this function.
The mode selector is set to NAV: RPD heating is then applied until the platform temperature reaches + 55° C, at which point the gyros run up to full speed.

RAPID HUD ALIGNMENT. This alignment method is intended for use when the movement of the aircraft invalidates the use of the memorized heading alignment method. The rapid HUD alignment makes use of the HUD to transfer the bearing of a distant object into the IN-equipment.

The alignment consists of two phases: the measurement phase and the alignment phase.

NOTE

The measurement phase is not required if the bearing to a distant object is known.

1. MEASUREMENT PHASE. The aircraft shall be parked at a marked position in such a way that a distant object (at least 1000 m away) is clearly visible through the HUD. The ALIGN selector is set to HUD MEAS and the Mode selector is set to ALN. A normal gyro compass alignment takes place. With the HUD mode selected to AUTO, the ranging reticle is moved by the PHC to overlay the distant object and inserted. PHC output signals are processed by the IN computer into true bearing of the object with respect to the platform and relative bearing with reference to the aircraft. The measured bearing is displayed on the INCDU navigation display by setting DIS selector to ALN BRG. The navigator may note the stored bearing for later manual input. Measurement is now completed.
   The equipment can be switched off and the aircraft be moved if required. ALIGN selector shall remain in HUD MEAS position.

2. ALIGNMENT PHASE. Before flight, the aircraft is returned to that position and heading (inbetween ± 5° of HUD field of view) at which the measurement phase was carried out. RPD HUD is set with the ALIGN selector and IPI selected by the MODE switch. LH STATUS 7 is indicated. The MODE selector is set to ALN. With the DIS selector set to ALN BRG the bearing measured during the measurement phase should be checked and inserted if required. LH STATUS 5 is indicated, the gyros run up to 1/3 of full speed and fine levelling takes place if cluster temperature is above + 5° C. If not, rapid heating starts with LH STATUS 7 still indicating, until + 5° C has been reached.
   During the alignment phase with HUD set to AUTO the pilot overlays the previously measured object with the ranging reticle and inserts. After approx. 2 min the end of fine alignment is indicated by the direct change of LH STATUS 5 to 0 and NAV can be selected. The platform will be automatically aligned to the

bearing which has been established and stored during the measurement phase.

Rapid heating is applied until operating temperature is reached and gyros run up to full speed.

IN UPDATING

Accuracy of IN present position calculation may be checked and updated when overflying an identified ground feature whose geographical coordinates are available.

At the instant of overflying, the FIX button on the INCDU keyboard is pressed, LH STATUS 9 is then indicated.

Displayed latitude and longidute are frozen and can be compared with the actual coordinates. If the update is not required, FIX is pressed again. LH STATUS 9 extinguishes, and the dynamic display is restored.

If the update is required the fixpoint coordinates are inserted via the INCDU keyboard, pressing ENTER once after insertion of latitude and once after longitude.

After the second ENTER, LH STATUS 9 extinguishes.

This action restores the dynamic display which is updated by fixing and by the IN computer from the time FIX has been pressed up to the moment actual fixpoint coordinates have been entered.

NOTE

IN updating is not recommended when MAIN or IN mode is selected since the will corrupt Kalman Filter or IN mode calculations.

IN STEERING FACILITY

If the MC is not operating, selection of the destinations D31 or D32 provides HUD steering indications to previously inserted destinations automatically, or can be used as required to fly a route by inserting waypoint coordinates one by one via the INCDU keyboard.

The inserted coordinates are displayed with the mode selector switch in IPI, ALN or NAV and can be checked or corrected.

In NAV with the DIS selector switch in CMD TRK/DIST, the actual track and distance between IN present position and the selected destination are displayed in the navigation display windows. While the distance continously changes in relation to aircraft movement, the command track is only computed at the instant of D31/32 selection. For updating CMD TRK information recycling is necessary.

With the DIS selector switch set to X-TRK/TRK ERR, the perpendicular offset in NM left or right from the initially computed track to D31/D32 is displayed, while the track error in degrees to the left or right between the computed and the actual track is indicated.

Bite

INTERRUPTIVE BITE

During the first 5 seconds (approximately) of IPI selection, interruptive BITE sequence is started. On successful completion of the test, alignment STATUS indicator shows 7 and the fault STATUS indicator should be blank. A fault detected during BITE is displayed at the RH fault STATUS indicator (Figure 4-3).

CONTINUOUS BITE

Continuous BITE is initiated in IPI, ALN, NAV and Test mode, and faults will be indicated on the fault STATUS indicator.

The quality of the vertical channel datum is monitored and the appeaarance of a U symbol in the status indicator is an indication that a satisfactory datum has not yet been achieved.

When NORMAL or HUD MEAS alignment is selected the U symbol is presented if the measured vertical velocity (VV) is greater than 3 ft/sec in the align status 3 or less. When Rapid align mode is selected (RPD, RPD HUD or MEM HDG) the U symbol will be presented if the measured VV is greater than 24 ft/sec. When the U symbol is presented during alignment, the time should be extended until the symbol is removed. The U symbol will be presented at any time in the presence of an ADC fault.

For further fault indications see Figure 4-3.

IN Malfunction

ADC FAILURE

In NAV the IN system receives pressure altitude data from the Air Data Computer to correct the internally sensed movement along the vertical axes. Loss of this data significantly degrades the IN computer outputs of vertical velocity and incidence to the HUD and TFR. These errors increase with time.

This failure is indicated by RH STATUS U and ADC fail caption on the CWP and by the status identifier 31/32/34/35/36 or 30/37 on the TV/TAB. Realignment of IN during flight is not possible.

CAUTION

FOR 5 MINUTES, AFTER THE INU IS SWITCHED OFF, THE AIRCRAFT SHOULD NOT BE HEAVILY MANEUVERED BECAUSE OF GYRO RUN-DOWN.

IN Failure

In case of failure which can cause platform damage (i.e. servo failure) the equipment will shut down automatically (IN fault). In this case no fault location is indicated.
IN failure is indicated on the rear CWP by the illumination of the amber IN caption. In this case there will be no outputs to the MC and the MC selects the best available NAV MODE. MAIN and IN captions on the NMCP are extinguished and the I symbol on the TV/TAB is occulted.
Other equipment affected by an IN failure are:

TFR	TF MON caption illuminated on the front CWP and HT FAIL lamp illuminated on the TFR CP.
AFDS	ATTD FAIL lamp illuminated on the AFDS CP and amber AP MON on the front CWP.
HUD	Loss of attitude, vertical velocity and cross track error displays in the DIR mode.
HSI	True heading, track and across track error displays are lost.

SECONDARY ATTITUDE AND HEADING REFERENCE SYSTEM (SAHR)

The SAHR is primarily used to provide attitude monitoring in terrain following. Its secondary function (in conjunction with the Doppler and the MC) is to provide attitude and heading data for reversionary navigation and weapon aiming in the event of an IN failure. The system supplies magnetic and true heading with the local magnetic variation set on the control and remote compensator unit.
The SAHR supplies true heading and attitude information to the MC and AFDS. Attitude data only are supplied to the GMR and the TFR. The IN (for initial IPI selection) and the HUD are supplied with true heading, but additional magnetic variation is supplied only to the HUD. Magnetic heading is supplied via the IFU 1, to the HSI in certain modes (Figure 4-5).
The SAHR contains continuous and interruptive BITE. The interruptive BITE is activated when the MODE knob is set to TEST. Fault are indicated on the SAHR control panel and on the rear CWP.
The system comprises the Control and Remote Compensator Unit (CRCU) the Gyro and Electronics Unit (GEU) and the Magnetic Detector Unit (MDU).

Power Supplies

The system is supplied with 115 V/400 Hz 3-phase AC from the AC busbar 3 (XP3) and 28 V DC from the essential DC busbar (PP3), 115 V/400 Hz 1-phase AC is supplied from the cockpit lighting system controlled by the CONSOLES INTEGRAL dimmer switch on the rear internal lights control panel.

Limitations

RANGE

The SAHR equipment is capable of operating between latitude 80° N and 80° S.

ALTITUDES

The SAHR operates at altitude from −1000 ft to 70000 ft MLS.

Gyro and Electronics Unit (GEU)

The GEU provides, referenced to the local vertical, pich and roll information and heading. The GEU contains electronic circuits for processing and a 4-gimbal, gyro stabilized platform from which the attitude and heading information is derived. Pitch, roll, and heading correction signals (compensation terms) derived from the MC are processed to provide the platform with earth and transport rate corrections. The compensation terms are calculated from the Doppler/SAHR/MC velocities and lati-

SAHR – BLOCK DIAGRAM

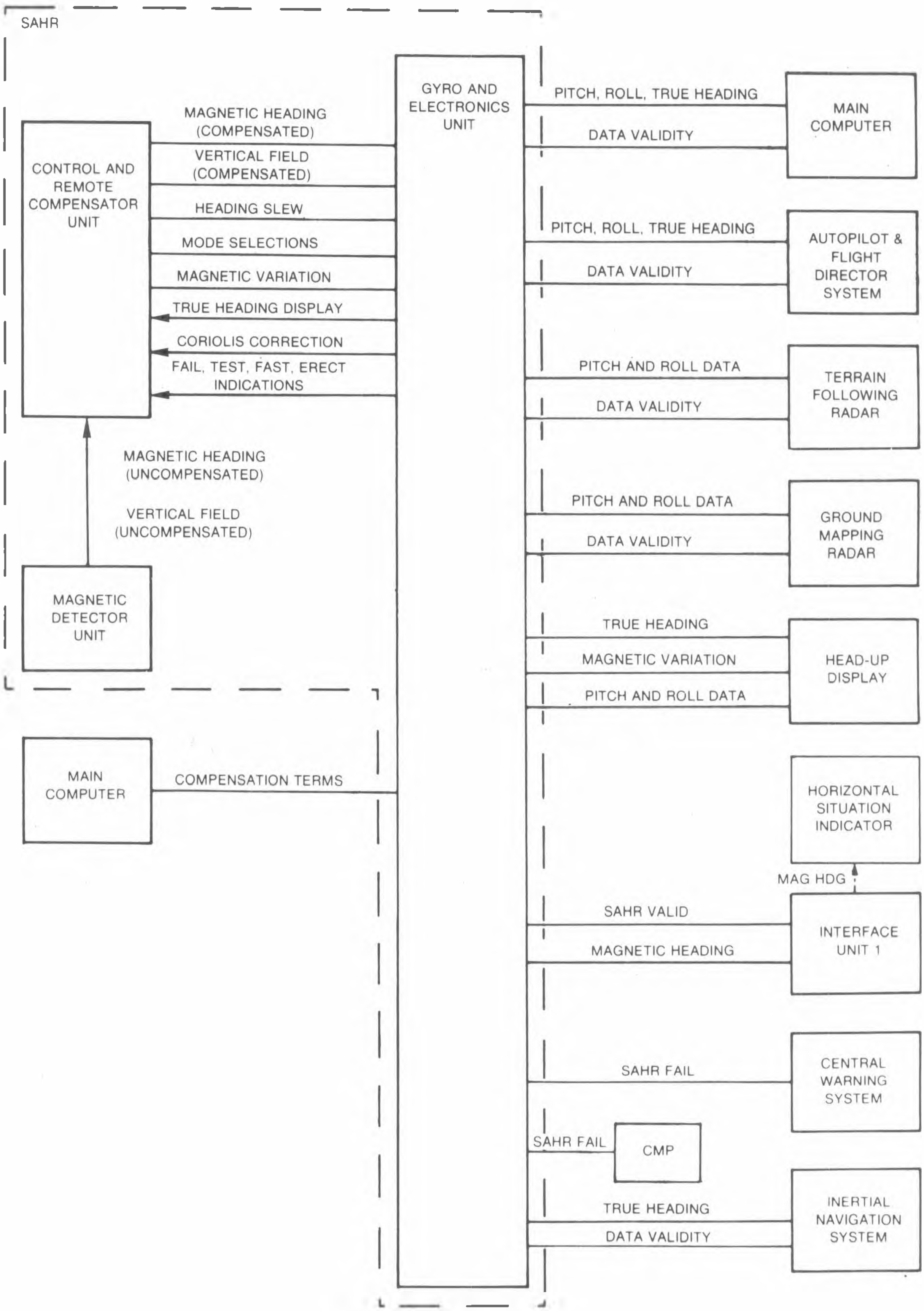


Figure 4-5

tudes and are independent of an IN failure. If the Doppler fails the compensation terms are calculated from ADC/SAHR/MC. If the MC fails, the compensation terms are lost and the COMP mode becomes the only mode available.

Magnetic Detector Unit (MDU)

The MDU at the top of the tail fin, contains detector coils which measure the earth's magnetic field. The horizontal component is used to provide compass heading information. The vertical component is used in conjunction with compensation terms from the MC, to provide compensation of detector error caused by Coriolis and centripetal acceleration effects.

SAHR Control and Remote Compensator Unit (CRCU)

The CRCU is located in the rear cockpit (Figure 4-6). The controls and indicators provide test and fail indication, heading slew control, true heading/magnetic variation read-out, indication of fast erection and synchronization, and magnetic variation setting. The remote compensator is used to correct compass system errors.

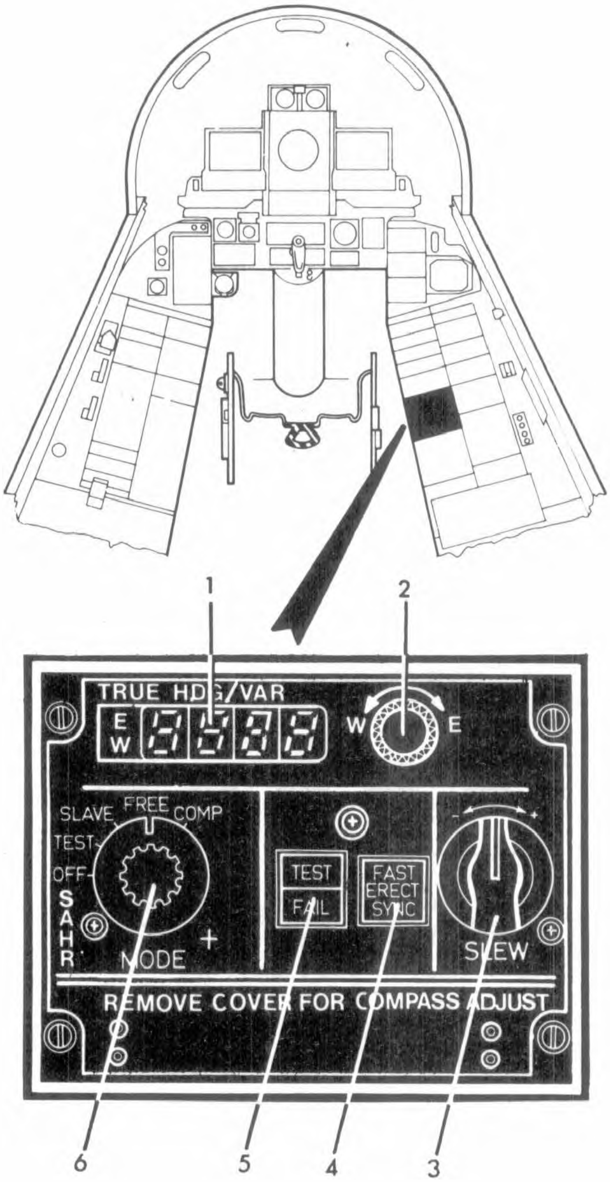
TRUE HEADING/VAR DISPLAY

The four digit TRUE HDG/VAR numerical display has two modes of operation as follows:

TRUE HDG — This is the normal display mode which is present on the digital display after alignment and Fast Erect Synchronization (FES) are completed. True heading is displayed in degrees and tenths of a degree.

VAR — The display of magnetic variation is acutated by pressing the variation control (upon releasing the control, the display returns to true heading). Magnetic variation is displayed as a four digit readout with a tenth of a degree accuracy and with the relevant indication of E (East) or W (West) illuminated.

SAHR



1 True heading/variation display
2 Variation control knob
3 Slew control knob
4 Fast erect sync indicator
5 Test/fail indicator
6 Mode selector knob

Figure 4-6

NOTE

When the CRCU receives and aircraft lamp test command, the data display indicates EW 888.8.

VARIATION CONTROL KNOB

Being pressed, the rotary W-E variation control knob sets magnetic variation for conversion of true and magnetic heading. The control setting has a range from 180 degrees W to 180 degrees E.

SLEW CONTROL KNOB

The rotary SLEW knob is spring loaded to the centre position. It shall be pressed and turned to the right to increase, and turned to the left to decrease the true heading indication, with a rate of change of 0.5°/sec.

FAST ERECT SYNCHRO INDICATOR

The amber FAST ERECT SYNC caption is illuminated during the warm-up and alignment phase in any mode other than COMP. When the caption extinguishes the equipment is ready to be used.

TEST/FAIL INDICATORS

Illumination of the upper white TEST caption indicates an interruptive BITE sequence, selected via TEST mode. The extinguishing of the TEST caption indicates successful completion of the test. The lower amber FAIL caption indicates equipment malfunction detected either during normal operation or during an interruptive BITE test.

MODE SELECTOR KNOB

The five position rotary MODE knob controls three operating modes. Knob positions are marked and function as follows:

OFF	All power supplies to the equipment are switched off.
TEST	The interruptive BITE sequence is initiated, indicated by illumination of the TEST light.
SLAVE	Platform is slaved to the earth's magnetic field and is corrected for earth rate, aircraft rate and magnetic variation, and is gyro stabilized. The slaving loop rate is 12 deg/hours.
FREE	The MDU output is disconnected from the slaving loop and platform alignment is dependent on correction for earth rate, aircraft rate and magnetic variation and is gyro stabilized. The SLEW control shall be used to set true heading according to the indication of any reliable source (true heading from the IN in flight).
COMP	True heading information is derived from the earth's magnetic field (via MDU) and corrected for magnetic variation but not gyro stabilized.

The switch movement is so arraged that, when either SLAVE or FREE is selected, it shall be pressed to select TEST or COMP. When the knob is in COMP mode, to select another mode, it is necessary to recycle the knob through the OFF position.

Central Warning Panel

SAHR CAPTION

The amber SAHR caption on the rear CWP illuminates to indicate a SAHR failure.

SAHR OPERATION

Alignment

The SAHR equipment is aligned by setting the MODE selector knob to FREE (or SLAVE); the MC shall be on and present position be inserted to provide the SAHR with accurate compensation terms. The FES caption illuminates, the equipment enters a BITE phase and the TRUE HDG/VAR readout display all 8's for approximately 4 seconds. Thereafter true heading is displayed. The local magnetic variation is checked and set if necessary by pressing the variation control, 10 seconds after the selection of SLAVE, FREE or COMP, the SAHR provides a BATH output for initial coarse alignment of the INU platform. The alignment sequence duration is between 2 and 5 minutes depending on the outside ambient tempertature. On completion of the alignment sequence, the FES caption is extinguished and the availability of AD + SR and, with Doppler engaged, DP + SR mode is indicated on the NMCP.

NOTE

For shelter operation SAHR may fail and require realignment outside.

In Flight

FREE (and SLAVE) are the normal modes of operation, with COMP as reversionary mode being selected when either the Doppler and ADC, the SAHR platform, or the MC have failed. In the COMP mode deviations of ± 2° in straight and level flight and ± 20° in turns are possible. The FREE mode does not use the MDU heading output and is therefore the preferred mode. If the FREE mode is used for longer flight periods, the TRUE HDG readout should be corrected at least every 40 minutes by slewing to IN heading.

Bite

CONTINUOUS MONITORING

A continuous BITE monitors all the SAHR main functions and gives indication of equipment malfunction by the illumination of the red FAIL caption. Power supply faults cause the SAHR to be switched off automatically.

INTERRUPTIVE BITE

A 4-second check of all GEU functions, apart from the platform, is carried out whenever the MODE knob is set to SLAVE, FREE, COMP (or TEST) from the OFF position. The TRUE HDG/VAR readout displays all 8's for approximately 4 seconds; from the fifth second true heading is displayed. The check consits of inserting test data into the pitch, roll, heading and magnetic variation channels.

TEST

When TEST is selected from OFF, the equipment goes also through its normal alignment procedure and BITE is carried out. The TEST and FAST ERECT SYNC captions illuminate. From the fifth second, instead of TH magnetic variation is displayed. After approx. 1 minute and 20 seconds the FAST ERECT SYNC caption will extinguish. The TEST mode lasts for approximately 2 minutes and the TEST caption is extinguished on completion of the test.

CAUTION

TEST MODE SELECTION INVALIDES THE SAHR OUTPUT THEREFORE THIS MODE SHALL NOT BE USED WHEN THE AIRCRAFT IS AIRBORNE.

Faults, detected during either the TEST mode or the 4 sec check sequence, are indicated by the illumination of the FAIL indicator on the CRCU and the SAHR caption on the CWP.

SAHR Malfunction

In the case of a SAHR malfunction the SAHR caption on the rear CWP, the ATTD FAIL on the AFDS CP and the FAIL lamp on the CRCU illuminate.
Further indications are given by:

- The SAHR validity indicator of the BDHI to OFF.
- The extinguishing of the DP + SR and AD + SR indicator of the NMCP.
- The ADI with FD failure flag.
- The HSI with the display failure flag in TAC, DF and APP mode.
- If the autopilot is engaged in modes other than TF or RH, it will disengage. The AP indicator extinguishes, the red AUTO P caption on both CWP's, and the amber AP MON on the front CWP will illuminate.
- If the flight director is operating in modes other than TF or RH, it will be deselected. The white FD indicator extinguishes on the AFDS control panel and the FD symbol on the HUD will disappear in this case.
- In the TF mode the amber TF MON caption on the CWP illuminates.

If the SAHR is operating in the SLAVE mode, the source of failure may be the MDU. This may be checked by setting the MODE knob to FREE (and slew to IN heading) in which case, if the MDU is at fault, the failed indication will be removed.
If the CRCU FAIL indicator remains illuminated, select the COMP mode. In this mode attitude signals from the SAHR are not available. If the FAIL indicator remains illuminated after selection of the COMP mode, the MODE knob should be set to OFF.
The SAHR may be realigned in the air but straight and level unaccelerated flight should be maintained until the FES light extinguishes (approx. 2 min).

AIR DATA COMPUTER (ADC)

The ADC, located in the forward equipment bay, is a digital computer which provides data to the MC, the IN, the HUD and AFDS.
To adjust the barometric pressure reference, an input is provided from the HUD control panel. Input data are continuously processed to solve the necessary navigation air data equation for providing calibrated airspeed, Mach number, pressure altitude, angle of attack, and true airspeed (refer to ADC system description and see *F 'ADCS' un*).

Limitations

The system performs satisfactorily within maximum operational ceiling up to 70000 ft with a temperature range of − 50 degrees C to + 160 degrees C and an AOA range of − 10° to + 25°.

Central Warning Panel

ADC CAPTION

Failures in the ADC system will be indicated by the illumination of the amber caption ADC ont he rear CWP.

ADC OPERATION

The barometric pressure (QNH) is set into the computer by the millibar setting knob, labelled MB SET, on the HUD control panel.

ADC Failure

If the ADC fails the amber caption ADC will illuminate on the CWP, also the failure will be indicated on the TV/TAB and HUD. Indication of speed, AOA, and barometric altitude will still be available from the secondary pitot-static system. The altimeter in the front cockpit will automatically revert to the STBY mode.

GROUND MAPPING RADAR (GMR)

The GMR transmits a pulsed beam of microwave energy while scanning a sector of the terrain ahead and below the aircraft. Signals return are processed and routed to a Digital Scan Converter (DSC) which produces a plan range video map, converted into a digital TV raster format and routed as synthetic video to the Combined Radar and Projected Map Display (CRPMD).
In conjunction with the IN and SAHR, the MC provides the GMR with aircraft attitude, heading and velocity (VN, VE) data which are used with antenna position data and transmission range, depending on mode selection, to calculate target angles, angle rates, range and range rates.
The equipment provides a continuous BITE, monitoring its correct functioning during all modes, and an interruptive BITE.
For GMR interface with the Navigation and Weapon Aiming System see Figure 4-7.

Power Supplies

The system is supplied with 115 V/400 Hz 3-phase AC from the AC busbar 1 (XP1) and with 28 V DC from the DC busbar 1 (PP1).

Data and Limitations

GMR:

Operating frequency	J-band
Antenna type	Four-lobe monopulse, slotted-waveguide planar array
Antenna scan coverage	60° left to 60° right
Antenna tilt range	+ 30° to − 45°
Roll gimbal limits	+ 60° to − 60°
Operating height	up to 20000 ft MSL

The GMR comprises the transmitter, the antenna/receiver, exciter/pulse compressor, radar mount/roll unit, processor/computer and the power supply. All units are located in the aircraft's nose cone.

Transmitter Unit

The transmitter unit amplifies the RF signals from the exciter/pulse compressor unit and feeds high power microwave pulses to the antenna. When TEST is selected the RF pulses are routed within the transmitter to a dummy load to dissipate the available power.

Antenna/Receiver Unit

The antenna unit contains a four lobe slotted waveguide array and is roll stabilized to a maximum of ± 55° bank. The receiver unit processes the RF

NATO RESTRICTED

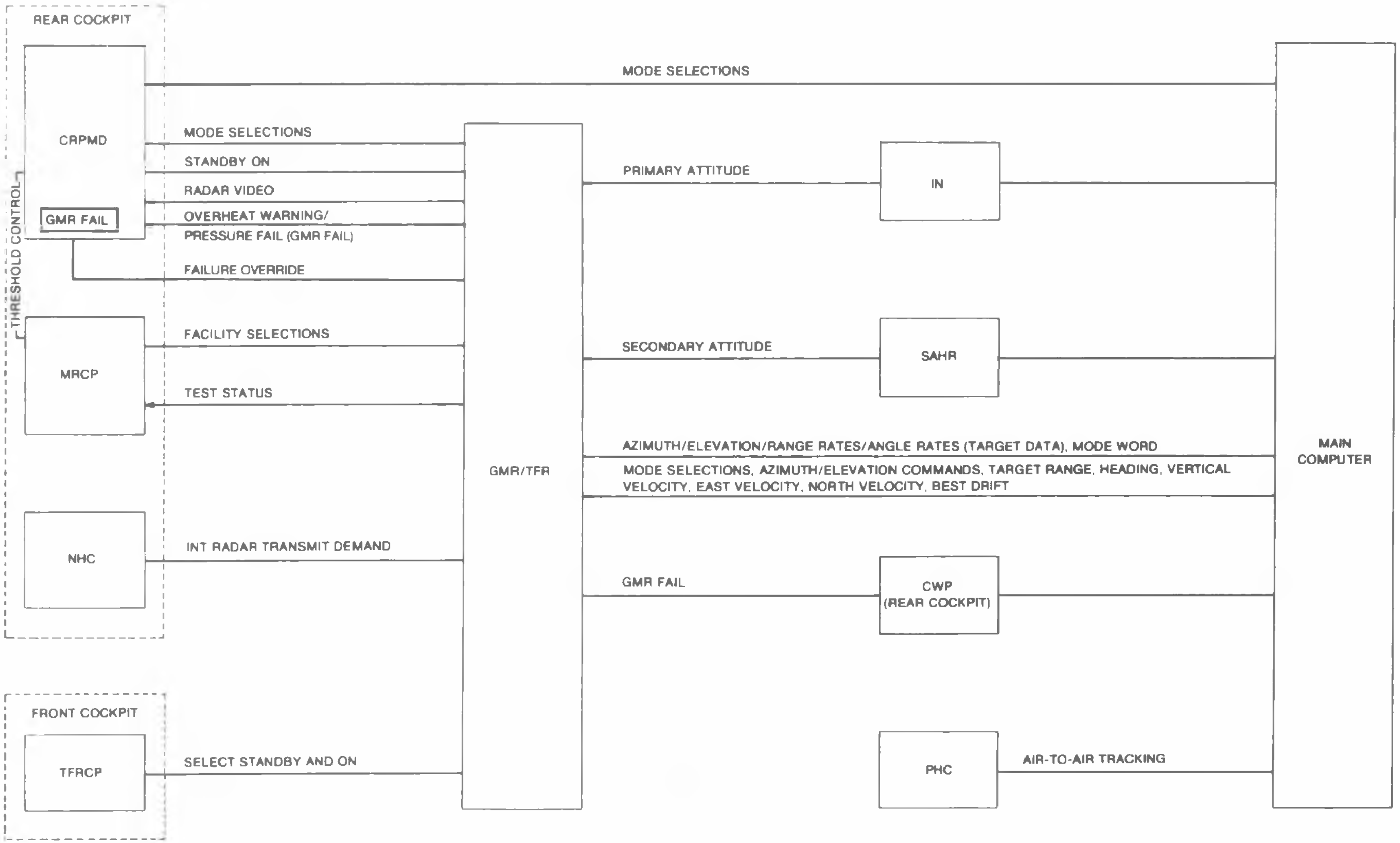


Figure 4-7 GMR BLOCK DIAGRAM

NATO RESTRICTED

energy sensed by the antenna, coverts it to an IF-frequency and feeds it to the exciter, processor/computer for target tracking or display. It contains the antenna control interface circuits which drive the azimuth and elevation gimbals to produce antenna scan patterns.

Exciter/Pulse Compressor

The exciter/pulse compressor unit provides low power RF-signals, chirped or non chirped trigger pulse for the transmitter, gate control signals for the receiver, an RF test pulse for the receiver BITE, and a pulse compression for the receiver signals.

Radar Mount/Roll Unit

The radar mount unit provides the interface between the radar system and the aircraft, and mounting for all radar units other than the antenna/receiver units. The radar roll unit provides mounting for the antenna/receiver units and contain the flexible cables, hydraulic and microwave rotary joints, required between the stationary units and the roll stabilized units.

Processor/Computer

The processor/computer unit contains the GMR computer which controls all operation by calculating target angles, angle rates, range and range rates. Also video processing is carried out, and the unit controls the antenna scan pattern, BITE operation and power distribution to other units.

Power Supply Unit

The power supply unit, which is common to both TFR and GMR, contains the low voltage DC power supplies, knobing and control circuitry.

Central Warning Panel

GMR CAPTION

The amber GMR caption on the rear CWP illuminates to indicate that the GMR equipment is either in a failed condition (e.g. input power, dynamic loop, input data) or the source data are not available. It will also illuminate when 55° angle of bank is exceeded.

Post mod. 10912: The GMR/CWP caption illuminates in TA (CMO) mode only, when AOB limit is exceeded.

GMR FAIL INDICATOR

The amber GMR FAIL indicator on the CRPMD illuminates to indicate that the GMR equipment is in a failed condition.
In addition NO GO is displayed on the MRCP if LRU BITE detects a fail condition.

GMR MODES AND OPERATION

Warm-up for the radar is provided in the following two Standby modes:

1. Operated by the ground crew:
   The Ground Standby Override Switch (5 ST) close to the CMP is operated by the ground crew and selects one of the two Ground Standby modes:

   - GROUND STANDBY. When switch is in the up (ON) position, the GMR operates in the Ground Standby mode and commences a 3-minute warm-up period at reduced power. The antenna is stowed and locked to prevent damage when the radome is opened or closed. On completion of the warm-up period, selection of M + R or R provides full operation after a time delay of 20 sec.

   - STANDBY (GROUND STANDBY OVERRIDE). When switch is in the down (OFF) position, the Ground Standby condition is overridden and the GMR operates in its normal Standby mode to simulate in-flight conditions during ground servicing. The GMR commences a 3 min warm-up period at full power, and the antenna is held at boresight. On completion of the warm-up period, TEST, or a selection of M + R or R provides full operation after a time delay of 2 sec.

2. Operated by the navigator:
   The navigator's selection of standby (M + S) starts a 3 min warm-up time. GMR modes of operation are selected on the CRPMD and on the NWAMS panel, on the throttles and PHC panel.
   Controls for the mapping radar are provided by the Mapping Radar Control Panel (MRCP).

GMR transmission and antenna azimuth positioning are controlled by the NHC, whereas the PHC controls certain functions in weapon aiming.
For set-up and mode of operation see SET-UP, ALIGNMENT AND TEST OF SENSOR AND DISPLAYS.

GMR Malfunctions

Refer to CRPMD/RPMD malfunctions.

COMBINED RADAR AND PROJECTED MAP DISPLAY (CRPMD)

The CRPMD (A, Figure 4-11) is located centrally at the top of the rear cockpit and consists of an Advanced Radar Display (ARD) and of a Projected Map Display (PMD) of which the images can be optically combined, together with electronically generated symbols.
An extension visor may be fitted to eliminate extraneous reflected light.
Radar signal returns are processed and routed to the Digital Scan Converter (DSC) which converts analogue plan range video into a digital TV raster format. Also generated electronic symbols as synthetic video are routed to the CRPMD for display. Slant-to-plan range correction is applied to provide accurate radar video (projected map registration). A micro processor provides memory, timing, symbol positioning, and controlling.
Radar and synthetic video are routed from the CRPMD to the Head Down Display Recorder (HDDR) for subsequent analysis.
The map is optically projected from a film and positioned by command of the MC. A similar moving topographical map is displayed by the Repeater Projected Map Display (RPMD) on which instead of radar and synthetic video, static symbols are represented.

Digital Scan Converter (DSC)

The DSC, located in the forward equipment compartment, converts the GMR low refresh-rate analogue radar video into a digital, high refresh-rate, 625-line, 50 Hz TV raster format for display by the CRPMD. Slant-to-plan range correction is applied to provide accurate radar video/projected map registration. The control and computing centre of the DSC is Micro Processor Unit (MPU) which provides memory, timing, control and calculates symbol positioning. A storage facility enables the radar video to be held as long as necessary. The MC provides aircraft velocity, heading and cleared height data for use in the MPU. Mode and control data is received from the CRPMD. BITE monitors operational functions of the DSC and provides fail indications and a test-mode presentation.

Advanced Radar Display

The ARD uses the DSC TV video and format control data to produce a PPI sector scan or a B scan raster display on a high-brightness, short-persistence CRT. Geometry correction is applied to the CRT drive circuits to eliminate video distortion caused by the flat screen of the CRT. Contrast and brightness controls on the face of the CRPMD modify the video characteristics to provide the required display. BITE monitors the video processing circuits and the CRT drive to provide a fail/safe indication.

Project Map Display

A coloured topographical map is optically projected from film and positioned by data from the MC. One of three 50W tungsten-halogen projection lamps illuminates a small area of the film and projects the image onto a vibrating screen. The vibrating screen improves the clarity of the picture by removing the displayed graininess of the film. A neutral density filter is placed in the projected light path when the HIGH/LOW switch on the CRPMD is set to LOW. If the in-use projection lamp fails, one of two spare lamps automatically replaces it.

COMBINED DISPLAY

The map-display image formed on the vibration screen is optically superimposed with TV video on a combining mirror. The combined image is viewed through a transfer lens via a files lens which permits a good quality image to be seen. Light reflection from the curved surface of the field lens are suppressed by a polarised screen.

DIGITAL READOUTS

Digital readouts of range, across-track distance, antenna tilt angle and aircraft track are displayed on the face of the CRPMD above the viewing port. The digital readouts are also used to indicate the results of a self-test program.

REPEATER PROJECTED MAP DISPLAY (RPMD)

The RPMD (Figure 4-14) located centrally on the front cockpit main instrument panel, displays a coloured, topographical map which is optical projected from film and controlled by data from the MC. The display (magnified 50% to compensate for the difference in cockpit viewing distance) can be a repeat of the CRPMD map or an independently positioned map, as selected. One of three 50 W tungsten-halogen projection lamps illuminates a small area of the film and projects the image onto a 3-layer viewing screen consisting of the following elements:

1. A Fresnel lens which converts the light-cone output from the projection lens into a light cylinder in the plane of the operator's eye datum.

2. A scattering screen upon which a viewable image is formed. The screen eliminates any hot spots towards the centre of the image and image degradation towards the circumference of the display screen.

3. A polarized filter which eliminates image-obscuring reflection from both inside and outside the RMPD.

For CRPMD/RPMD interfaces see Figure 4-9.

Map Coverage and Film Drive

The CRPMD and RPMD employ identical map films and film-drive mechanismis (Figure 4-8).

MAP COVERAGE

Each map consists of a minimum of 17 meters of standard 35mm perforated film containing the film title, colour resolution charts, a test pattern, rectangles of mapping and groups of slides. Mapping is positioned along the lenght of the film between the end of the test pattern and the film title at the finish of the film. The total map area is divided into rectangles at one or more of the required scales. Each rectagle is divided into lateral rows which are presented East-West along the film length. Pink-tinted boundary lines along the edges of each row indicate the limit of map coverage.

MAP STRIPES

Allowance is made for strips to overlap Noth-South and for extra mapping outside the East-West area limits to ensure that a full map display is viewed when the limits of the working area are reached.

MAP SLIDES

In addition to the rows of mapping, the film includes map slides consisting of small rectangles of mapping at a scale of 1:50 k. Provision is made in the MC software for identifying up to 15 area and 60 slides of map coverage. Data entered into the MC specified the code of the destination on the map and the slide number on which it appears. Slides are available in the stabilised mode only. NHC corrections may be applied in the normal way to move marker and lamp.

FILM DRIVE

The CRPMD receives from the MC two sets of map-film positioning coordinates to drive the CRPMD and RPMD maps independently. Each display employs three identical servomechanisms (X, Y and 0). The X and Y servos are mounted on a film-traction module which is positioned to provide across-film (North-South) drive by the Y servo and along-film (East-West) drive by the X servo. A motor, driven by the 0 servo, rotates the module to provide film orientation to match aircraft selections.

CRPMD Symbols

The DSC generates seven synthetic video symbols displayed on the CRPMD (Figure 4-10).

COMPUTER MARKER

When MKR is selected at a television/tabular (TV/TAB) display, the computer marker is active and consists of a gapped cross controlled from the NHC when the cursors/marker switch is set to marker (up). When MKR is deselected, the computer marker is passive and consists of a gapped horizontal line controlled from the MC. The active computer marker is displayed automatically in the STAB mode without selection at the TV/TAB display.

PRESENT POSITION MARKER

A small circle (NHT UP) or a small arc (NRM, STAB) indicates the aircraft PP on the projected map display. The marker is positioned at the centre of the display when NTH UP is selected and the bottom of the display when NRM is selected. When STB is selected, the PP marker may not appear initially, dependent on range to destination and

CRPMD — RPMD MAP COVERAGE AND FILM FORMAT

RECTANGLE	SCALE
1	1:1M
2	1:1M
3	1:1M
4	1:500K
5	1:500K
6	1:500K
7	1:500K
8	1:500K
9	1:500K 1:250K
10	1:1M 1:500K 1:250K

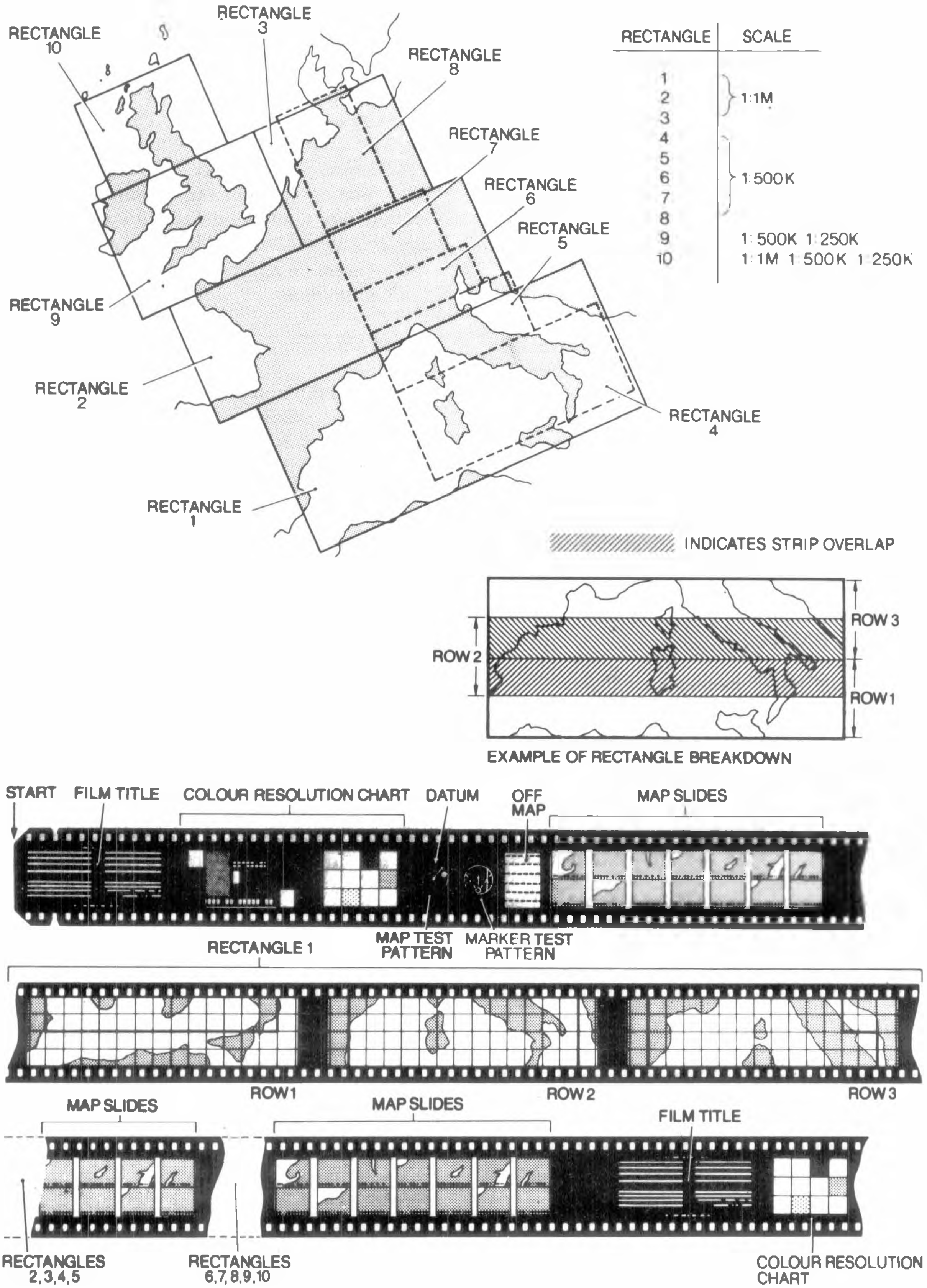


Figure 4-8

CRPMD/RPMD BLOCK DIAGRAM

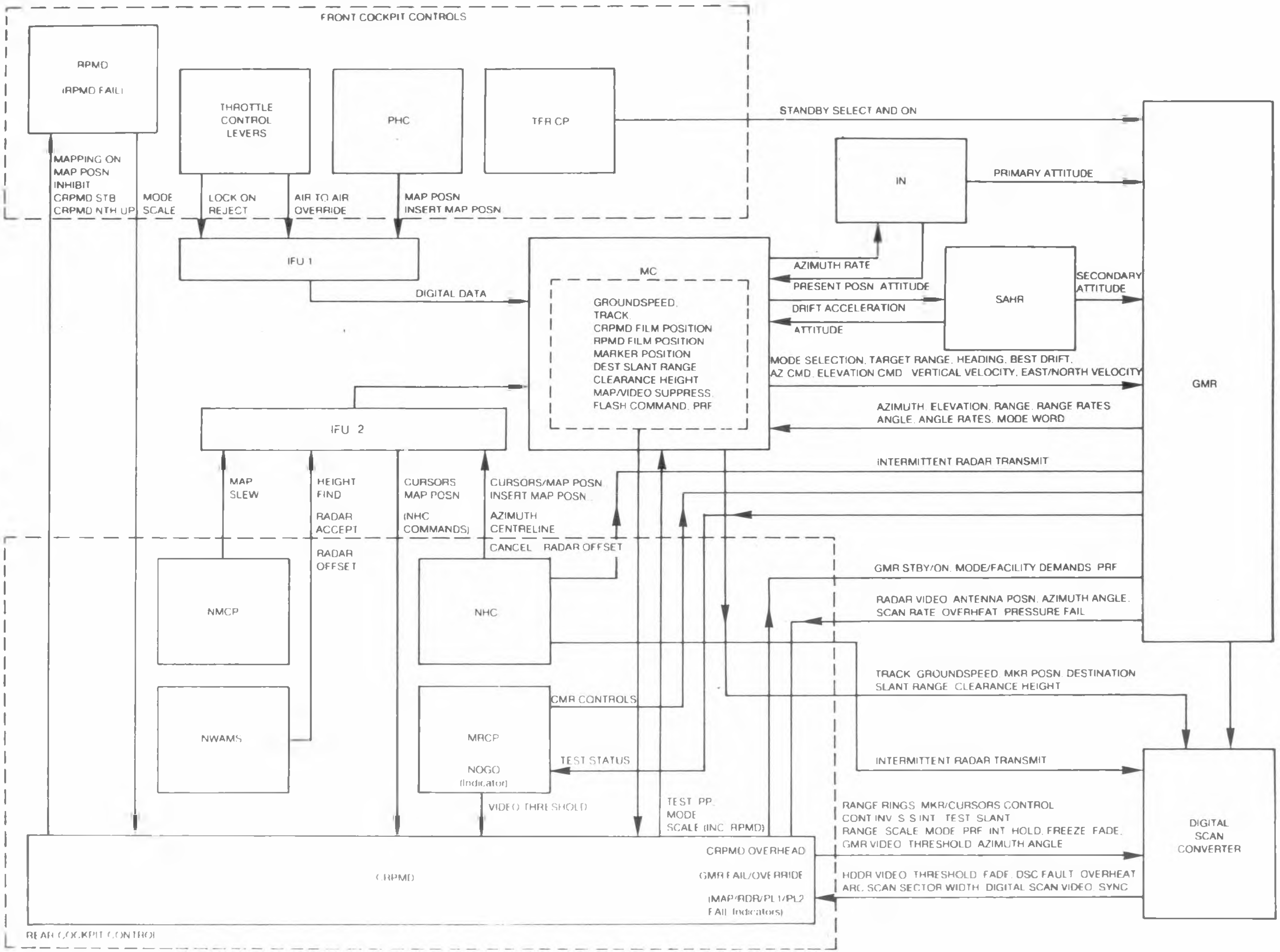


Figure 4-9

CRPMD SYMBOLS

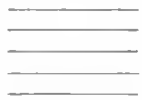
SYMBOL		COMPUTER MARKER	PRESENT POSITION	TRACK LINE MARKER	RANGE CURSOR	ACROSS TRACK CURSOR	RANGE RINGS
SECTOR SCAN FORMAT		 Active Passive	 (NRM,STB) (NTH UP)				
B SCAN FORMAT		 Active Passive	Not Displayed				
AVAILABILITY (No map with B scan) A Available NA Not available	M	A	A	A	NA	NA	NA
	M + S	A	A	A	NA	NA	NA
	M + R	A	NA	A	A	A	A
	R	A	NA	A	A	A	A
SCALES		All	All	All	Not 1/2 40 1 80	Not 1/2 40 1 80	All
DISPLAY COMPATIBILITY C Compatible NC Non compatible	NRM	C	C	C	C	C	C
	NTH UP	NC	C	C	NC	NC	NC
	STB	C	C	NC	C	C	C
	LK AHD	C	NC	C	C	C	C
SYMBOL COMPATIBILITY		Not Active and Passive together	All	All	Not with Range Rings selected	Not with Range Rings selected	All (Overrides Cursors)
DYNAMIC RANGE		Total screen area Active: Controlled from NHC. Not controllable when Cursors selected at NHC Passive. Controlled by MC	NRM: Fixed centrally 10.5 mm from screen base NTH UP: Fixed at screen centre STB: Locked to aircraft PP, moving upward on a line parallel to screen vertical bisector	NRM, LK AHD: Fixed vertically on screen centre NTH UP: Rotatable through 360° about screen centre	Zero to maximum scale range, controlled from NHC. Not controllable when Marker selected at NHC	Full screen width parallel to track line, controlled from NHC Not controllable when Marker selected at NHC	Fixed at the equivalent of 5 NM or 10 NM intervals as selected at CRPMD

Figure 4-10

the selected scale, but eventually moves up the display.

TRACK LINE

A gapped line controlled by the MC indicates the aircraft actual track for all SCAN WIDTH setting except 60. The line is stationary along the vertical bisector of the display in NRM and LK AHD, and rotates about screen centre in NTH UP. The gap in the track line allows other symbols to be identified at centre of the display and differentiates between the two lines when the across-track cursor is displayed.

CURSORS

When CURS is selected at the CRPMD, range and across-track cursor are displayed and controlled from the NHC, provided that the cursors/marker switch is set to cursor. The travel of the across-track cursors is limited to the width of the radar scan. Both types of cursor are inhibited when NTH UP, TEST, RANGE RINGS, M or M + S is selected and during scale settings or 1 80 or 1/2 40.

RANGE RINGS

When the CRPMD RANGE RINGS switch is set to 5 or 10 range markers are displayed in any display format except NHT UP. In sector-scan formats the markers are displayed as concentric areas representing intervals of 5 NM or 10 NM in plan range from the A/C PP. In B-SCAN, the markers are displayed as horizontal straight lines. Range markers are not valid with scale of 2 or 4 selected and are inhibited during the selection of M or M + S.

GMR CONTROLS AND INDICATORS

Mapping Radar Control Panel (MRCP)

The MRCP (B, Figure 4-11) is located in the rear cockpit, on the left console, and carries the following controls and indicators:

FREQUENCY PATTERN SELECTOR

The two position FREQ AGTY/FIXED FREQ switch selects the transmitter/receiver frequency pattern.
With FREQ AGTY selected, the frequency of each pulse is set to a random value within a fixed band to reduce the risk of jamming in a hostile environment.
When FIXED FREQ is selected, a fixed frequency is transmitted.

TEST PUSHBUTTON/INDICATOR

The TEST/NO GO pushbutton/indicator is pressed to initiate interruptive BITE with the white TEST and GMR/CWP caption illuminating (the TEST can be cancelled and the caption extinguished by pressing the pushbutton a second time or by selecting a higher priority mode during test). After 45 sec test sequence period the caption extinguishes.
The NO GO caption illuminates amber when a fault is detected, indicating internal or external failures of the radar. The TEST mode can be entered from M + S, M + R, or R mode on the CRPMD.

TILT SWITCH AND THUMBWHEEL

A 2-position AUTO/MAN switch selects the GMR antenna elevation tilt control mode.
In the STAB mode with AUTO and PENCIL selected, the tilt angle is controlled by MC elevation data.
With MAN selected, the tilt angle is controlled from the ELEV TILT – UP/DOWN thumbwheel to vary the elevation angle between 30° above (maximum UP setting) and 45° below (maximum DOWN setting) the radar boresight. The elevation angle is continuously displayed by the CRPMD TILT readout when M + R or R is selected at the CRPMD.
The ELEV TILT thumbwheel can be used at any time to reset the area of look of the GMR and when released, the auto function will track about the new datum.

SENSITIVITY TIME CONTROL

A 5-position STC control, with settings 1 (minimum gain) to 5 (maximum gain), adjusts the GMR receiver gain during ground mapping. This maintains a constant video amplitude for varying levels of signal returns caused by changes in range.

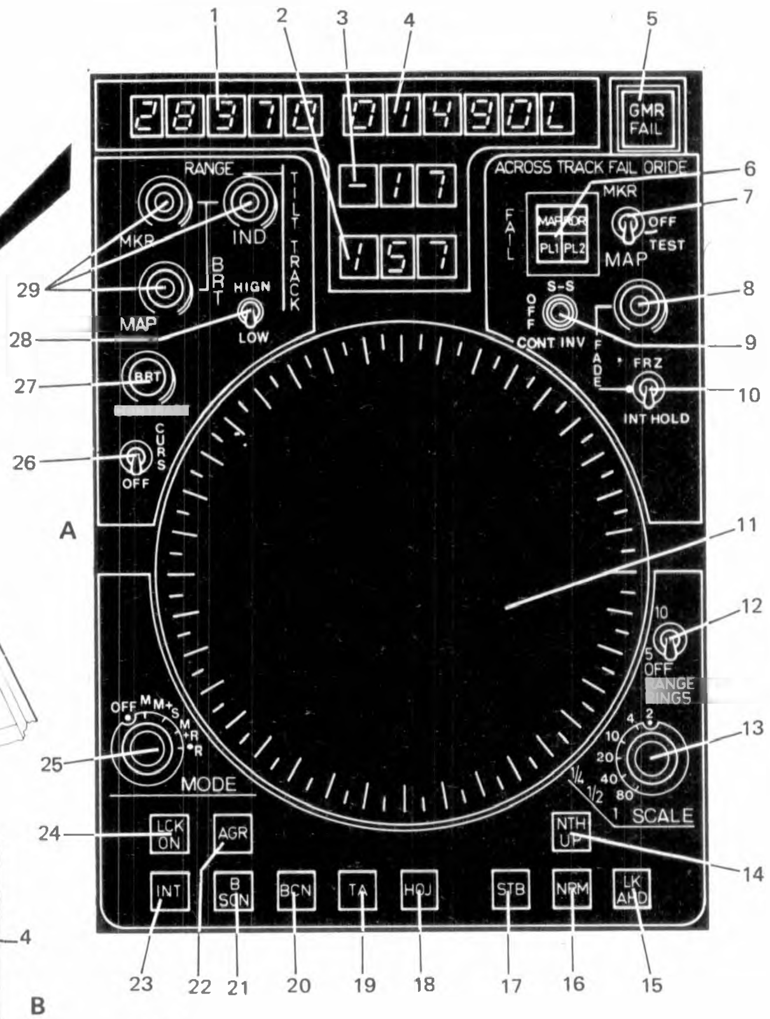
SCAN RATE SELECTOR SWITCH

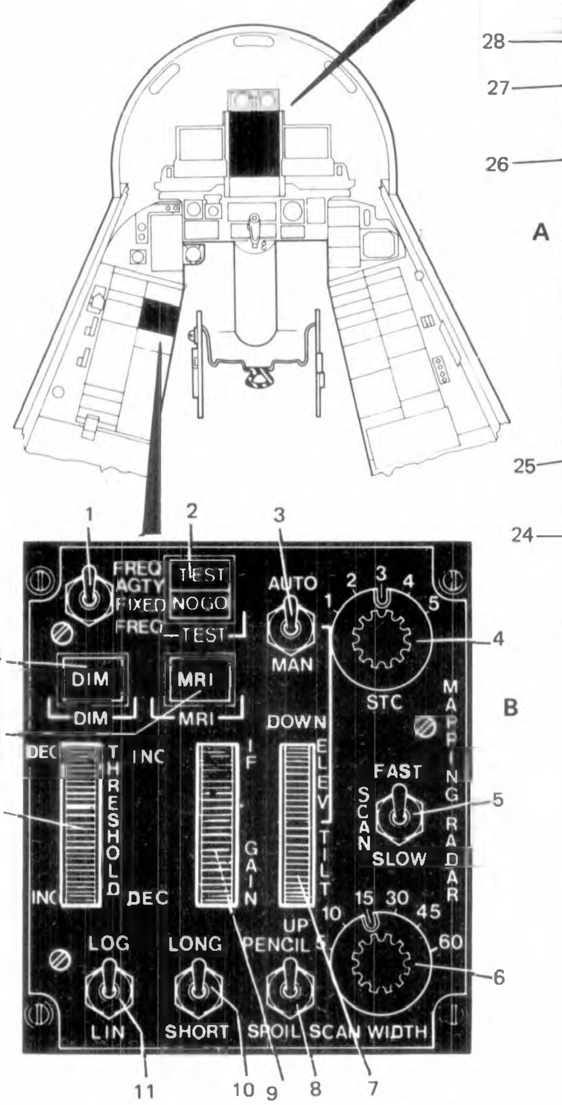
The two position FAST/SLOW SCAN toggle knob is used to select the antenna scanning rate. With the selection of FAST (only effective with 30/45/60° scan) the antenna scans at a rate of 90°/sec in azimuth and with the selection of SLOW at a rate of 30°/sec.
With TA selected the scanning rate is fixed to 90°/sec.

GMR CONTROLS & INDICATORS

A CRPMD

1 Range Cursor read-out
2 Track angle read-out
3 Tilt angle read-out
4 Across track cursor read-out
5 GMR fail light-fail/override pushbutton indicator
6 CRPMD fail- indicators
7 Test switch
8 Fade control knob
9 Scan to scan contrast inversion switch
10 Freeze/Fade/Intermittent hold selector switch
11 Display viewing port
12 Range rings display selector switch
13 Scale selector knob
14 North up mode pushbutton
15 Look ahead mode pushbutton
16 Normal mode pushbutton
17 Stabilized mode pushbutton
18 Home on jam mode pushbutton
19 Terrain aviodance mode pushbutton
20 Beacon mode pushbutton
21 B scan mode pushbutton
22 Air to ground ranging mode pushbutton
23 Intermittent mode pushbutton
24 Lock-on mode pushbutton
25 Display mode selector
26 Cursor switch
27 Contrast/brightness control knob
28 Map illumination switch
29 Map/Marker indicator brightness control knob





B **Mapping radar control panel**

1 Frequency pattern selector
2 Test pushbutton/indicator
3 Tilt switch
4 Sensitivity time control
5 Scan rate selector switch
6 Scan width control knob
7 Tilt thumbweel
8 Beam shape selector switch
9 Intermediate frequency gain control
10 Pulse widht selector switch
11 Receiver gain control switch
12 Threshold control
13 Monopulse resolution inprovement pushbutton indicator
14 Dim pushbutton/indicator

Figure 4-11

SCAN WIDTH CONTROL KNOB

The six position SCAN WIDTH rotary switch numbered 5, 10, 15, 30, 45 and 60, is used to select the required azimuth scan width angle relative to the track or to the azimuth center line as directed by the NHC switch.
The total azimuth sweep is twice the selected scan width.

NOTE

- When switching from one position to another, a pause of approx. 1 sec has to be made between to prevent a false fail indication on the CMP.
- When SCAN WIDTH 60 is selected GMR cannot be track stabilized.

BEAM SHAPE SELECTOR SWITCH

The two position PENCIL/SPOIL toggle switch is used to select one of the two radar beam shapes, depending on the operating mode. A selection of PENCIL produces a narrow beam, e.g. normally used in low level navigation updating and target acquisition.
When SPOIL is selected, the beam is changed to a shape suitable for use at medium and high flight level enroute navigation in ground mapping modes. It is optimized for 10000 Ft and 40 NM range.

INTERMEDIATE FREQUENCY GAIN CONTROL

The IF GAIN control thumbwheel (with graduations from 0 to 14 and a cut-out midposition) is used to adjust the IF amplifier gain which determines the size and definition of the displayed radar returns.

PULSE WIDTH SELECTOR SWITCH

The two position LONG/SHORT toggle switch selects the pulse width in relation to PRF. Althrough only two positions are selectable, there are actually three pulse widths available; SHORT, MEDIUM and LONG.
SHORT pulse selection allows the best resolution with minimum energy available for single target detection.
LONG pulse selection is recommended in normal mapping mode in conjunction with LIN gain and low PRF (in 40, 80 NM scale).
MEDIUM pulse (SHORT position selected) provedes a small reduction in return intensity (in 40, 80 NM scale).
MEDIUM pulse (LONG position selected) is the only pulse with sufficient energy for a target/fixpoint approach (in 20 NM scale).

	CRPMD	MRCP	RADAR OUTPUT	
MODE	RANGE SCALE (NM)	PRF	PULSE WIDTH SELECTED	PULSE WIDTH TRANSMITTED
NRM	2 – 20 2 – 20 40, 80 40, 80	HIGH HIGH LOW LOW	SHORT LONG SHORT LONG	SHORT MEDIUM MEDIUM LONG
STB	STAB RANGE TO TARGET GREATER THAN 20 NM			
	ANY POSITION	LOW LOW	LONG SHORT	LONG MEDIUM
	STAB RANGE TO TARGET LESS THAN 20 NM			
	ANY POSITION	HIGH HIGH	LONG SHORT	MEDIUM SHORT

Post mod. 10912: The PRF schedule is controlled by the GMR, i.e. the GMR automatically operates the radar with the appropriate PRF/pulsewidth selection upon manual selection of PRF/pulsewidth in accordance with the following table:

SELECTION		OPERATION		
PRF	PW	PRF	PW	CONDITION
LOW	LONG	LOW	LONG	R > 16000 FT*
LOW	LONG	LOW	MEDIUM	R > 5000 FT
LOW	LONG	LOW	SHORT	R < 5000 FT
LOW	SHORT	LOW	MEDIUM	R > 5000 FT
LOW	SHORT	LOW	SHORT	R < 5000 FT
HIGH	LONG OR SHORT	LOW	MEDIUM	R > 18 NM
HIGH	LONG OR SHORT	HIGH	MEDIUM	R > 5000 FT
HIGH	LONG OR SHORT	HIGH	SHORT	R < 5000 FT

* R is the radar estimated target range

NOTE

With the CRPMD in the STB mode, 20 NM scale selected and distance to the target approx. 18 NM, an adverse display effect is shown on upper part of the screen. This is caused by the internal BITE operation while the receiver is disabled between pulses. To prevent this effect the scale has to be reduced.

RECEIVER GAIN CONTROL SWITCH

The two position LIN/LOG toggle switch is used to alter the GMR Automatic Gain Control (AGC) function. With LOG selected (useful for distance below 10 NM), radar returns are amplified logarithmically to highlight strong signals and prevent clutter. With LIN selected (useful above 10 NM), the AGC is linear and radar returns are displayed at an amplitude proportional to their signal strenght. With SHORT (high PRF) pulse selected (final setting for target approach), LIN gain automatically is selected, regardless of switch position.

THRESHOLD CONTROL

The THRESHOLD control thumbwheel (with a graduation from 0 to 14 and a cut-out midposition) is used to determine the threshold (minimum level of signal strenght) to be displayed on the CRPMD. Radar returns above and below the set threshold are adjusted by the IF GAIN control.

MONOPULSE RESOLUTION IMPROVEMENT PUSHBUTTON/INDICATOR

The MRI pushbutton/indicator illuminates white when pressed and initiates monopulse resolution improvement of image definition in azimuth. The improvement is obtained by reducing azimuth beam errors at close range after the target has been ranged. It is deselected by a second press. This function is available in PENCIL beam only and if HT FIND is not selected.

DIM PUSHBUTTON/INDICATOR

Pressing the DIM pushbutton/indicator, the caption DIM illuminates to indicate that transmitter output power is reduced, enabling a "quieter" approach to a target. Also clutters are reduced when approaching a target at ranges between 6-8 NM (MEDIUM pulse). The function is available in GM, BCN and HOJ modes.
A second press deselects the DIM function and reverts to normal power output.

NOTE

The two pushbutton/indicators DIM and MRI are mechanically locked when pressed even if facilities are not available.

Combined Radar and Projected Map Display (CRPMD)

The following controls and indicators (A, Figure 4-11) are provided:

RANGE CURSOR DISPLAY

The five digit RANGE numeric read-out indicates, the plan range, up to 99,999 feet, between the aircraft present position (PP) and the range cursor position (slant range in reversionary).

TILT ANGLE DISPLAY

The three digit TILT numeric read-out indicates the radar antenna depression angle in degrees, together with + or − indicating upward or downward. In Auto mode it is the angle relative to radar intersected ground, in TA mode it is the angle relative to the horizontal plane.

ACROSS TRACK DISPLAY

The six digit ACROSS TRACK read-out indicates cursor position across track in feet, together with a L or R indicating left or right of track.

TRACK ANGLE DISPLAY

The three digit TRACK angle read-out indicates actual track in degrees.

GMR FAIL INDICATOR/OVERRIDE PUSHBUTTON

A FAIL ORIDE button, with an integral amber GMR FAIL light, illuminates in the event of a GMR equipment overheat/pressurization fail. If conditions dictate, the FAIL ORIDE pushbutton may be pressed within 20 seconds after illumination of GMR FAIL, to extend GMR operation for a maximum period of 2 minutes with the risk of equipment damage and degraded performance. After that time GMR shuts down automatically.

TEST SWITCH

The three position TEST toggle switch provides the following functions:

MKR — A film marker test frame is displayed in conjunction with the map test pattern.

MAP — A map test pattern is displayed which allows the symbols to be aligned via NHC and compared with the film test frame. Map alignment is completed by pressing the Insert button on the NHC.

OFF — Test frame pattern facilities are disconnected. The display is returned to the pre-mode operation.

CRPMD FAIL INDICATORS

The 4 FAIL indicators have the following functions:

MAP — The fail indicator is illuminated red to indicate a map drive fault.

RDR — The display failure indicator is illuminated red to indicate a radar display fault.

PL1 — The projection lamp indicator is illuminated green to indicate serviceability of the first spare projection lamp when pressed or MAP or TEST has been selected.

PL2 — The projection lamp indicator is illuminated green to indicate serviceability of the second spare projection lamp when pressed or MAP or TEST has been selected.

SCAN TO SCAN/CONTRAST INVERSION SWITCH

The three position toggle switch provides the following functions:

S-S — Radar returns from scintillating targets are integrated to provide a stable display.

OFF — All facilities are deselected.

CONT INV — This position provides contrast inversion of the radar display.

FADE CONTROL KNOB

The rotary potentiometer controls the function of the fade. Turning clockwise the fade rate increases to maximum. The FADE control is overriden when freeze or intermittent hold is selected.

FREEZE/FADE/INTERMITTENT HOLD SELECTOR SWITCH

A 3-position FRZ/DATE/INT HOLD switch alters the video persistence to maintain, clear or renew the display. The selected symbols operate normally with any position selected.

FRZ — When selected in any mode/facility except North-up or test, radar video is no longer updated and the last azimuth scan is displayed until the FRZ position is deselected.

FADE — When selected, the radar video is displayed and updated for as long as the NHC intermittent radar trigger is pressed. When the trigger is released, the radar video decays at a rate determined by the FADE control.

INT HOLD — When selected INT, radar video is displayed and updated for as long as the NHC intermittent radar trigger is pressed. When the trigger is released, the last azimuth scan is displayed until the trigger is pressed again or the INT HOLD position is deselected.

NOTE

With INT pressed and illuminated, the GMR transmits only when the NHC intermittent trigger is pressed. Radar video is displayed as determined by the FRZ/FADE/INT HOLD switch but the projected map and symbols remain as previously selected.

RANGE RINGS DISPLAY SELECTOR SWITCH

The three position OFF/5/10 toggle switch enables the display selection of range rings at 5 or 10 NM intervals in any radar mode display except North-Up.

SCALE SELECTOR KNOB

The six position rotary SCALE knob selects the transmitter PRF and the scale at which the projected map and radar video are displayed:

Position	Scale	Range Represented by: Display Diameter	PRF
80	1:1 M	80MN	LOW
40	1:500 K	40MN	LOW
20	1:250 K	20MN	HIGH
10	1:125 K	10MN	HIGH
4	1:50 K	4MN	HIGH
2	1:25 K	2MN	HIGH

NOTE

Scale selection of 10, 4 or 2 inhibits the map display. Map is only available in 4 (1:50 K) NM scale when STB is selected for slide use.
Post Mod. 01625 the 10 NM map scale is available.

CRPMD MODE PUSHBUTTON/INDICATORS

Four combined pushbutton/indicators are used to select modes controlling the display position of the aircraft PP and track. They illuminate when selected and are deselected by a second press or by selection of another mode.
The display presentation changes as follows:

NTH UP — Radar video is suppressed and the projected map is displayed with the aircraft present position marker at the centre of the screen and the north at the top. Aircraft track is indicated by a line with origin at the centre of the screen (PP marker) and extending to the compass rose.

STB — The radar video and the projected map are ground stabilized to display a previously selected destination, identified by the computer marker, at the centre of the screen. If F/A is not selected at the TV/TAB, the display is stabilized on the position currently at the screen centre (PP if STB is selected from NTH UP). The track is aligned parallel to the vertical bisector of the screen. If no map is available at the selected scale, the film is driven to the "off map" position. If no destination has previsiously been entered into the MC, the map is immobilised and radar video is suppressed at the moment of STB selection.

NRM — The aircraft PP and the radar scan origin are at the bottom of the screen. The track is represented by a line along the vertical bisector of the display. When only the map is displaged, aircraft PP is represented by a small arc. This is the basic mode and is displayed when selected either pressing the NRM button or cancelling any of the other three modes. The map is suppressed if B-SCAN mode or 2, 4 and 10 scale has been selected.

LK AHD — The scan origin is moved approximately one screen diameter back, to have a loof the the terrain ahead. The mode is inhibited if 80, 40 or 2 scale is selected. Any GMR facilities can be selected nut the map is suppressed when BSCN is selected.

GMR FACILITY PUSHBUTTON/INDICATORS

Seven facility pushbutton/indicators, each controlling a radar mode or facility, provide the following functions:

HOJ — The pushbutton/indicator illuminates white when selected or when entered automatically. Selection causes GMR to home-on to a source of radar jamming.

TA — The pushbutton/indicator illuminates white when selected. The facility provides obstacle warning above the horizontal plane of the aircraft (Terrain Avoidance).

BCN — The pushbutton/indicator illuminates white when selected. The radar interrogates remote surface beacons which transpond coded replies.

B SCN — The pushbutton/indicator illuminates white when selected and changes the display from PP sector scan to B scan.

AGR — The pushbutton/indicator illuminates white when selected and causes the radar to enter the Air-to-Ground Ranging mode.

INT — The pushbutton/indicator illuminates white when selected. Radar transmits only when pressing and holding the intermittent radar trigger on the NHC.

LCK ON — The pushbutton/indicator illuminates white when selected, to enter the Lock-On mode and acquire. Any previous radar video mapping is held for 5 sec and then faded. After successful lock-on a synthetic video is presented and the GMR provides outputs of range/range rate, angle/angle rate, and track bits to MC.

Successful selection is dependent on compatibility with modes or facilities already selected. Mode/Facility compatibility is shown in Figure 4-12.

DISPLAY MODE SELECTOR

The five position rotary MODE selector controls the power supply and selects CRPMD modes as follows:

OFF — Power supplies to GMR and CRPMD are disconnected. Antenna stowed and locked.

M — Power is supplied to the CRPMD, and projected map and symbols are displayed. RPMD is operable. Electrical and hydraulic power to the GMR still disconnected.

The OFF and M positions are detented to prevent inadvertent operation.
Press and turn to select these positions.

M + S — Projected map and symbols displayed as selected. Radar now on Standby, and provided with electrical and hydraulic power. Internal continuous BITE starts to run.
Post mod. 10912: AAT, AGR, and TEST modes can be entered.

M + R — Projected map and symbols displayed and the GMR is fully operative.

R — GMR is fully operative, but projected map inhibited. RPMD remains operable.

NOTE

A pause of a least 2 sec shall be made in the OFF position when recycling the GMR.

CURSORS SWITCH

A two position CURS/OFF switch selects range and across track cursors to be displayed. The cursors are controlled by the NHC if the CURS/MARKER switch is in the down position.

RADAR CONTRAST/BRIGHTNESS CONTROL KNOB

The rotary CONTRAST/BRT switch adjusts the contrast and brightness of the radar image.

GMR MODE/FACILITY COMPATIBILITY

BASIC SELECTION	OVERRIDES BASIC SELECTION	SELECTION INHIBITED	COMPATIBLE WITH BASIC SELECTION
Air to Air Track * ***	LCK-ON, HOJ, BCN, TA, GM, AGR	INT	B SCN
Lock-On	AGR, TA, HOJ, BCN, GM	INT	B SCN
Air-to-Ground Ranging *	TA, HOJ, BCN,GM	INT	B SCN
TA (CMO)	HOJ, BCN	INT	B SCN, GM
Home-on-Jam	BCN		INT, B SCN
Beacon			B SCN, GM, INT
HT Find			B SCN, BCN, GM, HOJ
Ground Mapping (GM)			AGR, LCK-ON, BCN, TA, INT, HOJ
TEST * ** ***	GM	INT	

* Operative with M + S mode (Post mod. 10912)
** Test mode is not selectable during the TF mode
*** In this mode TFR goes into STBY

Figure 4-12

MAP ILLUMINATION SWITCH

The two position HIGH/LOW toggle switch introduces a filter into the optical path when in the LOW position to improve the map colour balance by reducing brightness of the map display.

MAP BRIGHTNESS CONTROL KNOB

The rotary MAP BRT switch adjusts the brightness of the projected map display.

MARKER BRIGHTNESS CONTROL KNOB

The rotary MKR BRT switch adjusts the brightness of all symbols displayed.

INDICATORS BRIGHTNESS CONTROL KNOB

The rotary IND BRT switch adjusts the illumination intensity of the digital indicator displays.

Navigator's Hand Controller (NHC)

The NHC (B, Figure 4-82), located on the central pedestal of the rear cockpit, provides some GMR/CRPMD controls (refer to NAVIGATION AND MISSION DATA for detailed information).

Navigator's Weapon Aiming Mode Selector Panel

Two buttons on the NWAMS panel (A, Figure 4-82) are associated with the GMR (refer to

NAVIGATION AND MISSION DATA for detailed information).

Navigation Mode Control Panel

A button on the NMCP is associated with the CRPMD (refer to NAVIGATION AND MISSION DATA for detailed information).

Central Warning Panel

An amber CRPMD caption in the rear cockpit CWP illuminates to indicate an overheat condition, in conjunction with MAP or RDR fail lamps indicating overheating source.

CRPMD OPERATION

Before electrical power is supplied, CRPMD and RPMD MODE switches are set to OFF, FREQ AGTY/FIXED FREQ switch on the MRCP is set to FIXED FREQ, the ELEV TILT thumbwheel is set to the MID position, and all other controls are set as required.

WARNING

EVEN WHEN THE GMR IS OPERATING ON GROUND IN M OR M + S (STANDBY) MODE, THERE MAY BE A HAZARD FROM MICROWAVE RADIATION WITHIN THE ANTENNA SCANNING SECTOR (TO A DISTANCE OF 37 METERS). THEREFORE WHEN M HAS BEEN SELECTED, INT PUSHBUTTON SHALL BE PRESSED AFTER 5 SEC AS A SAFETY PRECAUTION.

When both generators are on line and full hydraulic pressure is available, select M, NRM and 5 sec later INT. Ensure that the GMR FAIL, MAP, and RDR indicators are extinguished.
To ensure that the equipment is operating correctly and the projected map position is accurate, the CRPMD TEST switch is set to MAP, the PL1 and PL2 indicators illuminate and the patterns are adjusted.

Check that the symbols are complete, accurate and aligned with the map film position using the NHC and press the Insert button.
With the CRPMD TEST switch set to MKR, the marker test symbols and map film test pattern are displayed as follows:

- The computer marker flashes at the display center.
- The PP marker is positioned 10mm from the bottom of the display.
- The track line is positioned vertically, coincident with the center of the display.
- The range cursor is positioned at the center of the display.
- The across-track cursor is positioned to the right of the display.
- Bright-up pulses are displayed in two straight lines diverging at ± 45° from the track line. The left line represents 2 NM intervals in slat range; the right line represents 2 NM intervals in plan range.

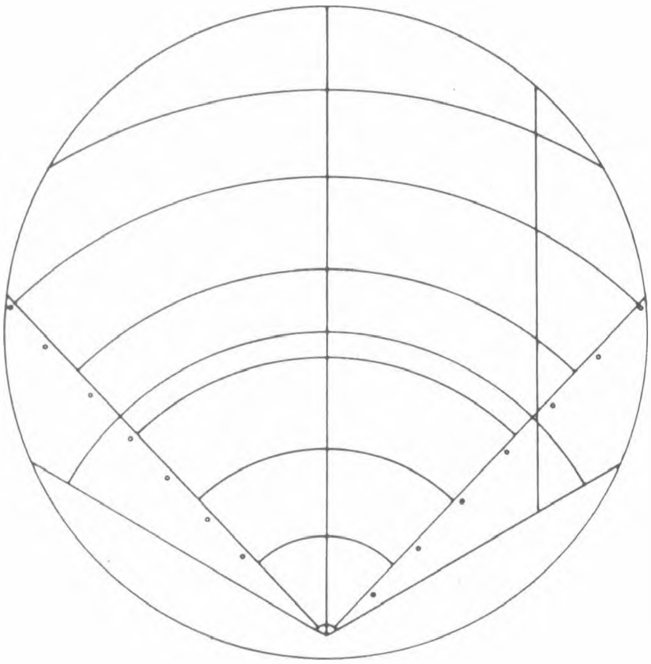
The in-use projection lamp is extinguished, and map drive inhibited. During the MKR Test, a test of the CRPMD electronics can be made by selecting the modes, scales, and facilities and observing the associated digital read-outs (Figure 4-13).
THRESHOLD has to be adjusted until seven shades of green are visible on the Test format.
The CRPMD shall be selected to M + R or R to perform the Radar Test with the following functional checks:

- CRPMD
  BRT – Turn clockwise until a raster line is just visible in the ambient lighting condition.
  CURS – ON.

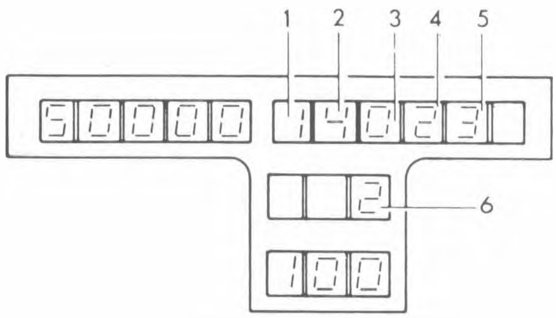
- NHC
  Set to down position, SCALE less than or equal to 20 NM. Check cursor movement change of readouts (RANGE and ACROSS TRACK).
  Set to up position.

- CRPMD
  CURS – OFF, clear of readouts (RANGE and ACROSS TRACK).
  SCALE – Select all scales in turn, confirming that PP remains constant, and leave at 40 to ensure that a good display will be seen at the next selection. RANGE RINGS –5 +10, check concentric about PP.
  B SCAN – Press, range rings concentric about PP.
  RANGE RINGS – OFF.

CRPMD MARKER TEST FORMAT



CRPMD DIGITAL READ-OUT OF MAP/MKR TEST



7-bar Indicator Location	CRPMD Controls	Switch or Button Selection	Digital Readout
1	Test Switch Facility Button	MAP/MKR AGR/AGR	1/ 3/
3	Mode Button	LK AHD NTH UP NRM STB	3 2 0 1
5	Scale Switch	1 80 1/2 40 1/4 20 10 4 2	6 5 4 3 2 1
6	Facility Button LCK ON/HOJ	HOJ LCK ON Deselected	1 2 0
7-bar Indicator Location	**RPMD Controls**	**Selection**	**Digital Readout**
2	Mode Switch	OFF or R T PP ○ SL PP □	0 2 8 1 4
4	Scale Switch	1 56 1/2 28 1/4 14	2 1 0

Figure 4-13

STB – Press, map stabilized about center of display marker by passive MKR. Track line coincident with Y axis.
NRM – Press, PP moves to bottom of display, map is track orientated.

– MRCP – Check all controls and leave in FIXED FREQ.

The CRPMD provides during the GM mode the following display mode presentation:

NORMAL MODE

The projected map will be displayed with the aircraft PP at the bottom of the display, overlaid by the PP symbol and track orientated.
Map presentation is not available in 10, 4, and 2 NM scale.
If radar in addition is selected the display is such, that the radar origin overlays the present position and the aircraft track is displayed vertically along the center line (but not in 60° B scan, where the track line represents aircraft heading).
After MKR selection on the TV/TAB, a marker is displayed 40mm above the PP symbol. With CURS/MKR switch, on the NHC, in the Up position the marker is active and is moved under NHC control.
This facility is used to call up the position of points of interest from the displayed map or from the radar picture.
If MAP SLEW is selected on the NMCP the marker is positioned at the center of the display screen (the marker is displayed even if R (Radar) has not been selected).

NORTH ORIENTATED MODE

In the NTH UP mode the projected map is displayed at the selected scale with true north at the top and with aircraft PP and symbol at the center of the display.
The track line is rotated to indicate present track against the fixed compass rose. The radar picture is suppressed and the marker, cursors, and range rings cannot be displayed.

STABILIZED MODE

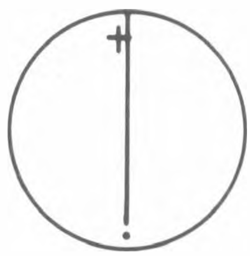
The STB mode is the primary facility for Phase 1 updating or target acquisition. It offers the possibility to stabilize the image at the center and to present it in lower scales, regardless of the distance to target. With a sector PPI radar picture displayed, a map is presented according to the scale selected such that a chosen destination (e.g. target or fix) is positioned in the center of the screen.
Demands from the NHC cause changes in position of map and marker relative to the radar echoes. The radar plot and map is track orientated and the aircraft track is represented by a line parallel to the vertical bisector of the screen.
With STB illuminated the PPO symbol represents the MC destination.

LOOK AHEAD MODE

With the CRPMD in the basic mode and with scale set to 20, 10, or 4 NM LK AHD may be selected. The look ahead range is twice as long as for the NRM mode. Therefore the radar origin is displayed backwards along the track, the amount of displacement depending on the scale currently in use. This facility enables the navigator to examine features ahead of the aircraft beyond the normal display range. Map presentation is available only in 20 NM scale, which might limit the practical usage of this display mode.
The active marker is displayed at a point 40mm above the PP.
Various radar facilities are available through the following modes:

HOME-ON-JAM MODE

The HOJ mode provides elevation and azimuth angle tracking on carrier wave type jammers operating within the radar frequency band. The mode is entered manually from the Ground Mapping mode and automatically from the Air-to-Air Tracking and LCK ON modes.
When jamming signals are detected on the display the navigator aligns the MC marker with the azimuth position of the jammer using the NHC. With the selection of the HOJ button on the CRPMD, the antenna is slewed in azimuth to the designated position.



HOME-ON-JAM VIDEO

The marker becomes passive, and mapping video is suppressed then the navigator adjusts the antenna in elevation using the ELEV TILT control until the azimuth and elevation tracking circuits are activated. An angular "lock-on" is indicated by the MC marker becoming active and the appearance on the CRPMD of synthetic video which starts at 0,5 NM from present position and runs out to maximum radar range. Tracking in azimuth and elevation is now performed and the elevation tilt input is disregarded.

The HOJ mode is entered automatically from the Air-to-Air Tracking and LCK ON modes when range track is lost and jamming is detected. The elevation and azimuth tracking circuits are activated without priorly establishing range lock-on. When the jamming signal disappears, range search is initiated, automatic lock-on is established, and normal tracking is resumed.

TERRAIN AVOIDANCE MODE/CONTOUR MAP ON BORESIGHT

NOTE

This mode is not cleared below 1000 ft AGL.

When TA is selected on the CRPMD, a contour-map-on-boresight radar display is presented, showing obstacle warning above a horizontally stabilized plane at the altitude of the aircraft. Synthetic video signals, which represent all obstacles penetrating this clearance plane, are superimposed with maximum brightness on a dimmed normal radar display. The projected map and symbols remain as preselected. The fast scan rate and ± 45° azimuth scan sector relative to the track are automatically selected during this mode. Manual antenna tilt, receiver gain controls, and ranging scales 80 and 40 are not available in this mode.

NOTE

Depending on terrain "second time around targets" may appear on the display. These, however, can be distinguished from regular targets.

BEACON MODE

NOTE

Beacon mode is not cleared for use.

When BCN is selected on the CRPMD the radar interrogates remote beacon equipment and receives replies in the form of coded pulses to be supplied to the radar display. The position of the coded replies on the radar display indicates range, azimuth bearing, and identity of the ground beacon. Ground mapping and beacon pulses are interlaced with frequency agility, selectable only for the ground mapping pulse transmissions. Beacon video with higher brightness is superimposed on the normal ground map video. LIN/LOG gain control is selectable in this mode and manual IF gain affects the GM pulse only. If the aircraft is outside the map covered area for the scale selectable, the film is driven to the off map position.

AIR-TO-GROUND RANGING

When AGR is selected on the CRPMD, acquisition, range lock, and range tracking are performed on radar targets.
The radar antenna is positioned in elevation and azimuth by the MC and is stabilized in pitch and roll. The HUD ranging reticle indicates the antenna boresight direction. AGR should not be selected when the ranging reticle is near the horizon.
Air-to-Ground Ranging is performed with automatic lock-on in range. After range lock has been achieved, the radar provides outputs of range and tracking data to the MC.

The successful lock-on condition is indicated by R positioned near the ranging reticle on the HUD. On the CRPMD radar mapping video is not available, but the range lock position is indicated by a synthetic lock-on strobe.

AGR can be employed at slant ranges below 60000 ft down to a range of 2400 ft, thereafter the HUD R symbol is occulted and integrated Vv is used for 5 seconds followed by RAD ALT (if locked on) or BARO-IN.

Post mod. 10912: AGR data are used down to a slant range of 726 ft, thereafter integrated Vv is used and the HUD symbol will occult 400 msec later.

Its use at ranges greater than 60000 ft is not recommended, as height errors are likely due to the inaccuracy inherent in pointing the antenna boresight at shallow depression angles and the tolerances of the antenna depression angle measurement.

AGR can be selected also by the pilot pressing the (AGR) Phase 2 pushbutton on his PHC panel. AGR provides slant and the depression angle of the antenna for the MC to calculate height above, and plan range to the target in Phase 2 attacks. The caption will illuminate, when radar range-lock has been achieved and accepted by the MC.

On selection of Phase 3 the ranging sensor, with GMR in AGR mode, is aimed down the HUD marker sightline to measure the relative height at the intersection of the marker sightline with the ground. This relative height line is then employed to update the along-heading range to target.
During Phase 3 the navigator can monitor the pilot's aiming and steering with the CRPMD, unless AGR mode is selected.
The CRPMD marker repeats the HUD ranging reticle ground position against the radar ground map video.

WARNING

AGAINST SEA TARGETS AGR HEIGHT SENSING IS UNRELIABLE. SIGNIFICANT HEIGHT ERRORS ABOVE TARGET CAN BE INTRODUCED IN BOMB AND GUN ATTACKS WHICH WILL INDUCE INCORRECT WEAPON AIMING AND UNSAFE HUD INDICATIONS. CROSS CHECKING AGAINST INDEPENDENT HEIGHT SENSORS IS THEREFORE ESSENTIAL.

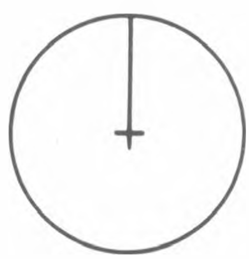
NOTE

Post mod. 10912: After selection of AGR, a change from AGR to AGR/TOO mode is achieved by pressing TOO or A/G GUNS pushbutton on the PWAMS.

AGR SYMBOL (NORM)

LOCK-ON MODE

When LCK-ON is selected on the CRPMD, automatic selection of the antenna pencil beam pattern is provided and the antenna is positioned by elevation and azimuth commands from the MC and acquisition is initiated. Range and azimuth data for acquisition are supplied by the MC. The CRPMD marker becomes passibe, stabilized on the last inserted position. As soon as elevation and azimuth pointing errors are less than ± 8 m rad, the automatic lock-on mode will start. After lock-on has been achieved the marker becomes active and the lock-on position and antenna boresight are indicated by displayed synthetic video. If lock-on is accepted, by pressing the RDR ACPT button on the NWAMS, the radar provides digital outputs of slant range, range rate, elevation and azimuth pointing angles, and elevation and azimuth rate tot he MC for use in weapon aiming calculations. An output signal is also provided (R on the HUD), indicating that lock-on has been accomplished, and a synthetic video is indicated on the CRPMD with the normal mapping mode being erased.



RADAR LOCK-ON-SYMBOL

HEIGHT FINDING MODE

(This mode is inaccurate and shall not be relied upon).
The HT FIND mode selects the GMR antenna depressing angle greater than 7 degrees for height above ground calculation in medium altitude attacks. HT FIND is selected on the NWAMS control panel. For operation see Fixing (Phase 1) in this section.

LOCK-ON/HOME-ON-JAM MODE IN PHASE 2

The pilot is able to select Phase 2, without disturbing the GMR mode, if he achieves visual acquisition of the target during Phase 1 LCK ON or HOJ attack.
This facility permits late corrections to be made towards the target, e.g., in cases where the radar may have locked onto an underised point of an elongated target.
After RDR ACPT on the NWAMS has been pressed the pilot can select Phase 2 and correct the MC target position via PHC movement with HOJ/LCK ON still available, and further the use of radar data is indicated by the illuminated RDR ACPT light. If target acquisition cannot be updated, the navigator may reselect Phase 1 allowing the MC to accept HOJ/LCK ON data again. For LCK ON mode the updating should be preceded by a new NHC insert.

B SCAN MODE

When B SCAN is selected on the CRPMD the radar display is changed from PPI sector scan to B scan. The B SCAN mode is an inverted raster scan, identical to the Normal mode raster in angular width and active scan lines, except that each scan line is horizontal rather than an arc. Two raster widths, each representing 292 azimuth memory elements, can be selected, ± 60° and ± 35°. If the scan width control setting is greater than 35°, B scan width is ± 60°; if the scan width setting is less than 35°, B scan width is ± 35°. If the azimuth centre line control is used to place a narrow scan outside the 35° limit, B scan automatically adjust to the ± 60° scan width. The projected map is suppressed and horizontal symbol elements are changed from arcs to straight lines. In the stabilized display, B scan functions exactly as for PPI sector scan but raster rotation is not provided.

INTERMITTENT RADAR OPERATION MODE

When INT is selected on the CRPMD the GMR transmits in selected mode only on command from the intermittent radar trigger on the NHC. Antenna stabilization is provided continuously and intermittent operation is available in the Ground Mapping, BCN, and manual HOJ modes, and during automatic HOJ – LCK ON mode.

Post mod. 10912: INTERMITTENT HOLD OPERATION

This facility enables the aircrew to use the GMR for navigation updating, target acquisition and measurement in a partially silent radar mode. To achieve this freeze function, INT HOLD and INT mode on the CRPMD shall be selected. In this case the computed PP, and if applicable the map, remains frozen until the intermittent radar trigger is pressed. As long as the NHC radar trigger is held, the CRPMD displays the continuously updated PP (marker), the map, and the normal radar display, all of which will be frozen again after trigger release.
With the radar now in silent condition, the frozen display may be used for updating navigation, PP, and target position. In contrast to the usual updating procedure, the active marker, overlaying the corrected pitcure, will not change its position on the display after NHC insert.
However, if GMR mode or scale is changed, the radar display requires refreshing after appropriate selection on the CRPMD or TV/TAB. Intermittent Hold operation is possible in the GMR modes BCN, STB, NRM, or LK AHD. It will not function in LCK ON, TA, AGR, HOJ, and AAT modes, despite the selection of Int Hold facility.
During Phase 2 fixing, with Intermittent Hold selected, the radar remains silent, but the MKR with the map will move in accordance with position change, and the frozen radar display disappears.
The last frozen PP and the radar display are restored with Phase 1 selection.

NOTE

- The NHC intermittent radar trigger should be pressed for the time the radar sweep moves from one side to the other, to regain an undistorted radar display of a complete sweep.

- Deselection of INT HOLD and INT shall be performed simultaneously to prevent invalid presentation.

Bite

CONTINUOUS MONITORING

Continuous monitoring of the correct functioning of circuits and equipment is carried out during all modes of operation.

INTERRUPTIVE MONITORING

To initiate the interruptive BITE checks, TEST mode shall be selected on MRCP. During the test period, the transmitter RF output is switched into the dummy load on the GMR transmitter LRU. TEST mode may be selected from the STBY, GND-STBY or GM mode positions. If TEST mode is selected from the GND-STBY position, the TEST button on the MRCP shall be pressed for at least 2 sec after a 3 min warm-up period is completed, to allow the system to stabilize. On entering TEST mode from GND-STBY the amber GMR caption on the rear cockpit CWP illuminates for approx. 5 sec and then extinguishes, while the TEST caption remains illuminated throught the entire test period of approx. 60 sec. During the test period all operational functions are automatically checked on an interruptive basis. If any failures are detected during the test, a 30 sec failure reporting period follows at the termination of the test. During this reporting period the TEST caption on the MRCP is not illuminated but the GMR FAIL indicator, and/or NO GO on MRCP illuminates, depending on the nature of the detected failure. If no failures are detected during the test period, the radar reverts immediately to the next lower priority mode selected. Selection of a higher priority mode or pressing the TEST button for a second time, terminates the TEST and/or the status reporting period.

FAIL WANING/FAIL OVERRIDE OPERATION

Detection of a waveguide pressure, and/or overtemperature malfunction of the processor/computer, the transmitter receiver, the power supply, or exciter, results in the illumination of the GMR FAIL amber warning lamp on the CRPMD.

This type of failure can be overridden, if conditions dictate, by pressing the FAIL ORIDE button on the CRPMD within 20 seconds of failure indication.

CAUTION

THIS ACTION, EXTENDING GMR OPERATION FOR APPROXIMATELY 2 MIN FROM THE INITIATION OF THE WARNING, BEARS THE RISK OF RADAR EQUIPMENT DAMAGE.

Repeater Projected Map Display (RPMD)

The following controls and indicators (Figure 4-14) are provided:

MODE/TEST INDICATOR

The indicator houses a group of four captions labelled STB, NTH, PL1 and PL2:

STB	Illuminated white when STB mode has been selected on the CRPMD.
NTH	Illuminated white when NTH UP mode has been selected on the CRPMD.
PL1	Illuminated green to indicate that Projection Lamp 1 is serviceable when PL TEST is selected.
PL2	Illuminated green to indicate that Projection Lamp 2 is serviceable when PL TEST is selected.

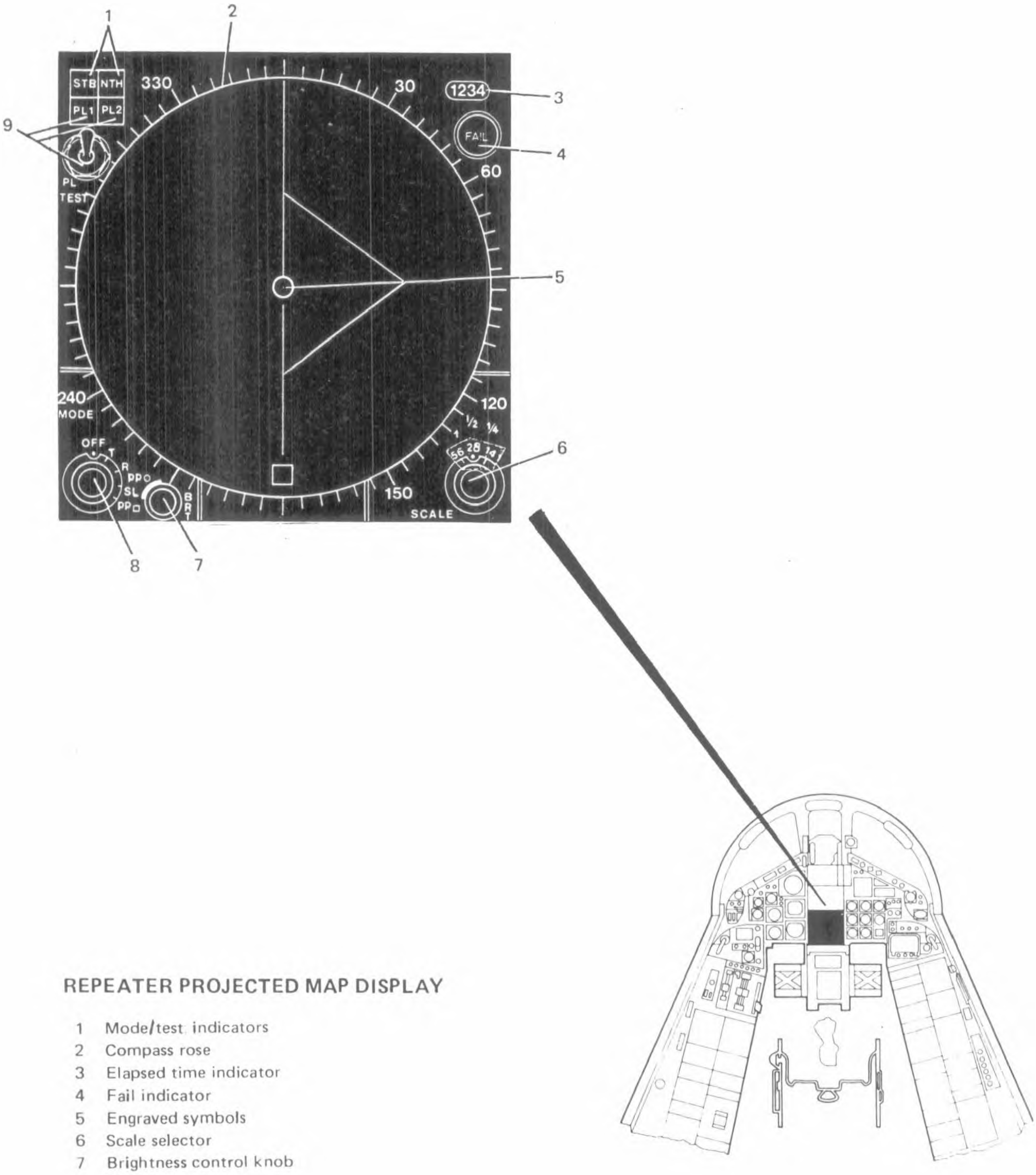
FAIL INDICATOR

The amber FAIL caption illuminates when a failure occurs in the map drive servo mechanism or the RPMD BITE detects a fault.

RPMD SCREEN

A compass rose, marked at five degrees intervals, surrounds the display screen. A circle, a square and a gapped line are engraved on the screen to provide aircraft present position and track indications, as selected by the display mode selector.

RPMD



REPEATER PROJECTED MAP DISPLAY

1. Mode/test indicators
2. Compass rose
3. Elapsed time indicator
4. Fail indicator
5. Engraved symbols
6. Scale selector
7. Brightness control knob
8. Mode selector
9. Lamp test switch

Figure 4-14

SCALE SELECTOR

A three position scale selector controls the scale of the projected map when the PP , PP or SL mode have been selected. The scale selection are listed in the table below:

Scale selection	Map scale	Range represented by display diameter
1 56	1 : 1 M	56 NM
1/2 28	1 : 500 K	28 NM
1/4 14	1 : 250 K	14 NM

NOTE

For Map scale 1 : 125 K display, the CRPMD 10 NM scale shall be selected and RPMD in Repeater (R) mode.

BRIGHTNESS CONTROL

A rotary BRT control adjusts the display brightness.

MODE SELECTOR

A six position rotary switch controls the RPMD display mode, providing the CRPMD is operating:

OFF RPMD power is disconnected.

T A test pattern is displayed, to be aligned with the engraved symbols.

R The map is a repeat of the CRPMD projected map with a reduced coverage area.
The scale selector is inhibited and the map has the same CRPMD scale.
When the CRPMD is in the LK AHD, NRM or MAP SLEW modes, the RPMD maintains the normal display with the aircraft present position indicated by the square engraved ad the bottom of the screen.
When the CRPMD is in the NTH UP mode, the engraved circle at the centre of the screen indicates the aircraft present position.
The selection is indicated by the NTH display indicator illuminating white. The map is displayed with the North at the top of the screen, the engraved gapped line representing the North direction. When stabilized mode has been selected on the CRPMD, the engraved circle at the centre of the screen indicates the MC designed destination. The selection is indicated by the STB display indicator illuminating white. The aircraft present position is not displayed.

PP Aircraft present position is indicated by the engraved circle at the centre of the screen. Aircraft track is indicated by the engraved gapped line.

SL The map can be slewed by means of the PHC to display areas outside the normal viewing area.

PP The aircraft present position is indicated by the engraved square at the bottom of the screen. The aircraft track is indicated by the engraved gapped line.

LAMP TEST SWITCH

The two position PL TEST toggle switch is spring loaded downward. When held in up position the two spare projector lamps are checked and, if the lamps are serviceable, the PL 1/2 test lamps are illuminated.

Pilot's Hand Controller (PHC)

The PHC (Figure 4-83), is located on the left console in the front cockpit. The ball control on the PHC provides RPMD map slewing.
When the data insert switch is pressed, the map position coordinates are entered into the MC (refer to NAVIGATION AND MISSION DATA for detailed information).

RPMD OPERATION

Electrical power is supplied to the RPMD by switching the MODE switch from OFF to any of the following positions:

TEST When T is selected, a Test format is displayed and the PHC becomes active. The PHC is used to align the display with the Test format, the resultant errors of alignment being stored and used to correct the drive to the RPMD.

REPEAT When R is selected, the RPMD is driven to display the same map, with the same scale and orientation as the CRPMD.

PP centered When PP is selected, PP is aligned with the etched marker in the center of the screen. The map is track orientated. Track is represented by the gapped line along the vertical bisector of the screen.

PP decentered When PP is selected, PP is moved to the etched marker near the bottom of the screen. The map is track orientated and the track is represented by the gapped line along the vertical bisector of the screen.

SLEW When SL is selected, the RPMD map is frozen (i.e. no longer driven by the map positioning outputs from the MC). Map positioning is based on PHC inputs. Coordinates taken from the map may be inserted into one of the three available working stores.

However when MAP SLEW is selected on the NMCP, this SL function is not available.
Both crewmembers should cross-check their displays for a combined function.
The CRPMD/RPMD cross-check includes the following checks:

RPMD R

CRPMD STB, map does not move, passive MKR at center.

RPMD STB light on, no change of display.

CRPMD NTH UP, map north orientated, check PP and track-line.

RPMD NTH light on, map north orientated. Select SL, check function. Select PP . Check PP moves to marker. Check all Scales. Select PP , check PP moves to marker.

CRPMD NRM, map track orientated, PP at bottom of display.

Air to Air Override Button (AAO)

A button located on the front of the left throttle enables the pilot to control the GMR. When the button is pressed, the rear cockpit GMR controls are inhibited and the GMR is slaved to the HUD ranging reticle. When the target is acquired, the GMR initiates the range search. The GMR searches within a defined range band and locks on to the nearest target. Following a successful lock on, indicated by the appearance on the HUD of the time-to-go circle, the GMR commences air-to-air tracking and provides outputs of slant range, range rate, azimuth angle/rate and elevation angle/rate for weapon-aiming calculations in the MC.
If lock on does not occur immediately, the range-search cycle repeats until lock on is achieved. If lock on is interrupted by signal fadings, the GMR continues to update tracking outputs using the last valid range and range-rate measurements. If lock on is not regained, the acquisition phase is re-entered. Air-to-air tracking cannot be overriden by any other mode and is inhibited only by selection of the CANCEL O/R button on weapon control panel 2.

LOCK-On/Reject Button

A button located on the front of the right throttle, breaks GMR lock-on when pressed. The GMR re-enters the acquisition phase.

CRPMD/RPMD Malfunctions

MAIN COMPUTER FAILURE

A failure in the MC causes the CRPMD to lose its map display, computer marker, range rings, and the STB mode (distances in slant range). Only the NRM mode and the cursors can be used. These is no automatic reversion and the rear crew member has to select NRM. The RPMD also loses its map display.

GROUND MAPPING RADAR FAILURE

If the GMR fails the CRPMD loses its radar display. The projected map display remains and can still be used as an aid to navigation and weapon aiming. Updating of the map position can only be achieved by visual fixing techniques (HUD fixing, OTF), or by TAC fixing. The RPMD is unaffected.

INTERFACE UNIT 2 FAILURE

A failure of the analogue/digital converts in IFU 2 means that the NHC cannot be used. This inhibits the use of cursors and the computer marker on the CRPMD.

TERRAIN FOLLOWING RADAR (TFR)

The TFR provides the aircraft with a low level all weather flight capability by feeding Terrain Following (TF) commands to the autopilot and/or flight director system (Figure 4-22). It scans the terrain ahead and along the aircraft's track and measures range to the terrain as a function of elevation scan angle and the produced monopulse resolution improvement (MRI) pulse. The radar altimeter measures the height above the terrain. All this data are fed to the processor/computer, which processes these inputs together with primary and secondary sources of aircraft flight data from IN, MC, SAHR (see table below) and pilot selected data (ride control, set clearance height) to generate g-command outputs.

TFR Data Sourcers

Parameters	Primary Source	Secondary Source
Attitude	IN	SAHR
Drift	IN	MC
Incidence	IN	MC
Groundspeed	IN	MC
Turnrate	MC	IN

The g-command outputs are fed to the AFDS to produce pitch demands for flight director and commands for autopilot computation. These signals shall ensure that the aircraft maintains a set clearance height above the ground. Figure 4-15 shows the terrain following control loop in simple terms.
An E-Scope display in the front cockpit is used to monitor the TFR performance. Flight director indications are presented on the Head-Up Display (HUD) and the Attitude Director Indicator (ADI) (Figure 4-23 and Figure FO-18).
Controls, on the AFDS control panel, permit the selection of clearance height and selection of hard, medium, or soft ride. The RIDE control changes the desired maximum pull-up (positive g) and push-over (negative g) command outputs and moves the zero command line up (for hard ride) or down (for soft ride) to shift the point of pull-up warning.

The operation of the TFR is continuously monitored by BITE. The primary and secondary flight data inputs are cross monitored and checked for validity. The status of the interface equipment is continuously monitored and combined with that of the TFR to provide a single TFR failure warning.
The equipment provides an interruptive BITE which isolates and monitors any fault in a single LRU. A detected failure is indicated by illumination of the NO GO caption on the TFR control panel.

Power Supplies

The system is supplied with 115 V/400 Hz 3-phase AC from the AC busbar 1 (XP1) and 28 V DC from the DC busbar 1 (PP1).
The TFR equipment comprises the transmitter unit and the antenna/receiver unit; the radar mount/roll unit, the processor/computer, and the power supply unit are common to the Ground Mapping Radar (GMR). All units are located in the aircraft nose cone.

Transmitter

The primary function of the transmitter is to generate high power Radio Frequency (RF) pulses. It also provides the generation of TFR timing pulses and a frequency analogue signal for use by the receiver automatic frequency control.

Antenna/Receiver

The antenna/receiver routes the transmitter RF output to the antenna and processes all received signals to produce the video output pulses required for TF computation. It contains the antenna control system which provides azimuth and elevation gimbal drive to produce the antenna scan pattern. During turning flight the scan pattern changes to 3-bar indication giving an azimuth coverage for a larger scan in 1 second.
The antenna/receiver is monitored by BITE.

Processor/Computer

The common TFR/GMR processor/computer unit provides TF command outputs to the AFDS for terrain clearances and provides control of all BITE functions. Data are also routed to the ESRRD which serves as a representation of the TF performance to the pilot. The processor/program

TFR — BLOCK DIAGRAM

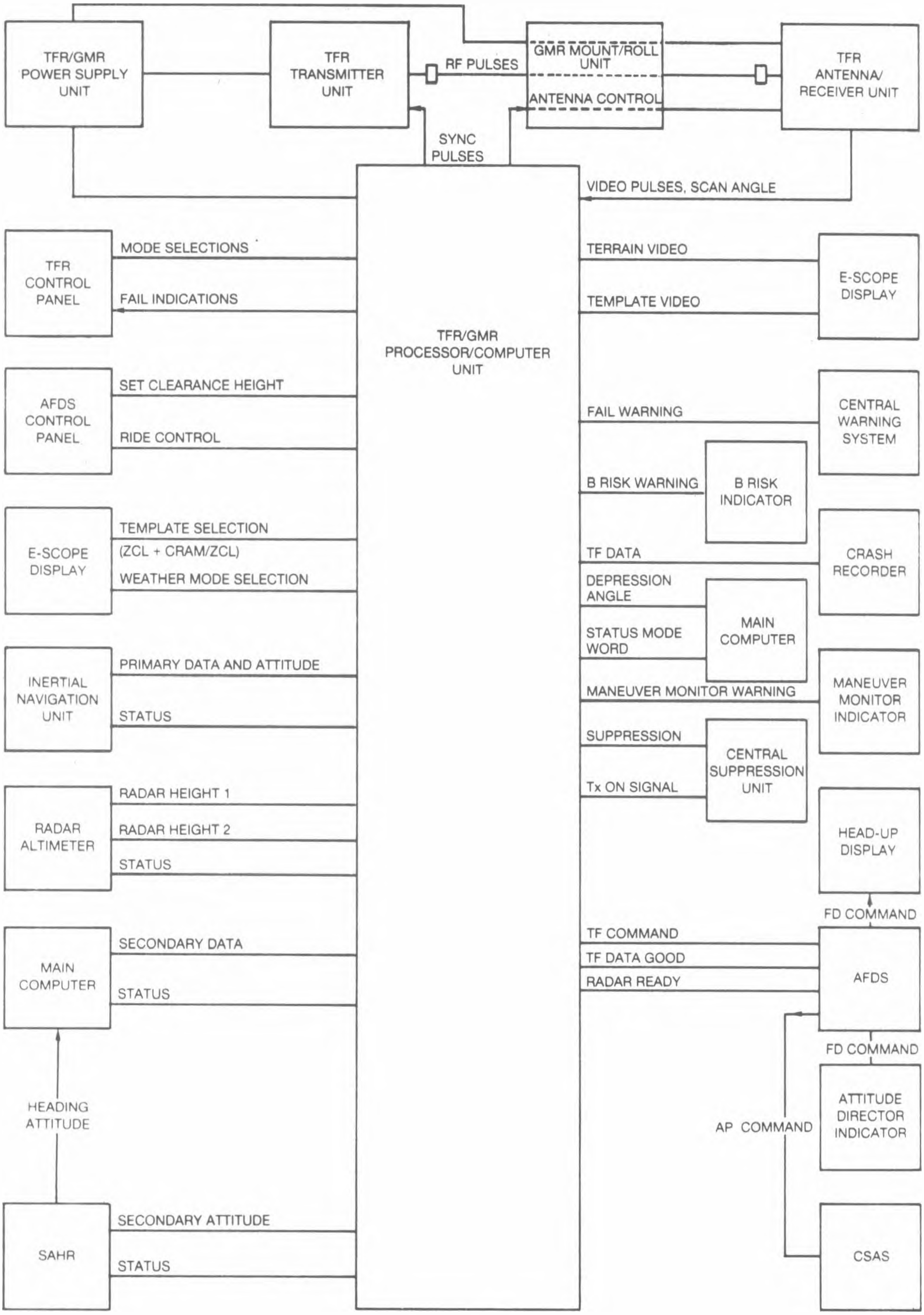


Figure 4-15

memory issues the software for controlling the nose radar as a GMR or TFR, or as a combined system.

Radar Mount/Roll Unit

The radar mount/roll unit provides the mounting interface between the radar system and the aircraft. The actual roll stabilization is performed in the GMR.

Power Supply Unit

The power supply unit, which is common to both TFR and GMR, generates low-voltage DC power from aircraft prime power and provides the power mode control interface for the radar. Additionally 115 V, 400 Hz 3-phase AC is supplied from AC busbar 2 (XP2) for the E-Scope display.

TF Radar Control Panel

The TF radar control panel (D, Figure 4-16) is located in the front cockpit and carries the following controls:

MASTER SWITCH

With the three-position Master toggle switch TF modes can be selected as follows:

OFF	All power supplies to the equipment are disconnected.
STBY	In this position power is supplied to warm up the system (3 min), dependent on the setting of the ground standby override switch.
ON	TFR is fully operative and ESRRD displays signal return. AFDS can be engaged in the TF mode, if TF READY light on AFDS control panel is illuminated.

TEST PUSHBUTTON/INDICATOR

The TEST pushbutton, with integral split legend caption TEST/NO GO, shall be pressed to initiate INTERRUPTIVE BITE. If the TEST caption, which will illuminate white during test, is not lit, press TEST button again. A second press, after test cycle is terminated, deselects TEST. NO GO caption is illuminated when a fault is detected during test or in flight when a TFR fault appears.

FREQUENCY PATTERN SWITCH

The two position FREQ AGTY-FIXED FREQ toggle switch controls the pattern of transmitter/receiver frequencies. Selection of FREQ AGTY provides a changing pattern of frequencies and the FIXED FREQ position selects random transmitter frequency fixed within in this pattern.

HEIGHT FAIL INDICATOR

The HT FAIL lamp is illuminated amber to indicate either IN is not in NAV mode or IN has failed.

TURN FAIL INDICATOR

The TURN FAIL lamp is illuminated amber when drift or turn rate monitor detects a discrepancy between primary and secondary data.

E-Scope/Radar Repeater Display (ESRRD)

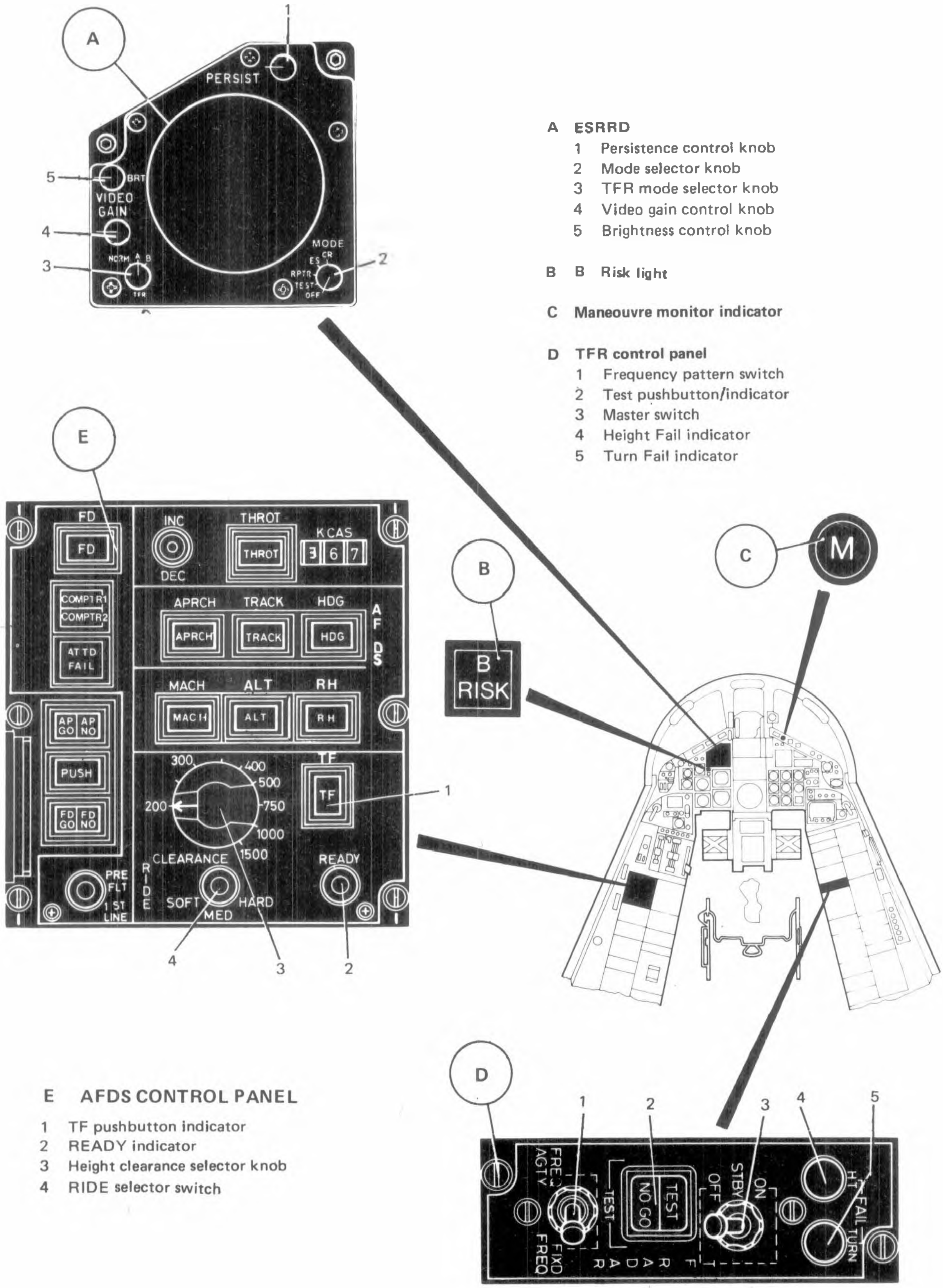
The ESRRD (A, Figure 4-16) is located on the front cockpit main instrumental panel and presents TFR video and template information in the E-Scope (ES) and in addition a CRAM line in the CRAM (CR) mode.
Also GMR information, including a Test format, can be displayed in the Repeater (RPTR) mode as a repeat of the CRPMD in the rear cockpit.
The following controls and indicators are provided:

MODE SELECTOR KNOB

The five position rotary MODE knob provides the following controls:

OFF	All power supplies to the equipment are switched off.
TEST	A display performance test pattern is selected (Figure 4-17).
RPTR	Ground mapping video is displayed.
ES	Terrain following display (E-Scope mode) is selected. ZCL and terrain video are displayed.
CR	CRAM line is selected. CRAM line, ZCL, test pulse and terrain video are displayed.

TFR CONTROLS & INDICATORS



A **ESRRD**
1 Persistence control knob
2 Mode selector knob
3 TFR mode selector knob
4 Video gain control knob
5 Brightness control knob

B **B Risk light**

C **Maneouvre monitor indicator**

D **TFR control panel**
1 Frequency pattern switch
2 Test pushbutton/indicator
3 Master switch
4 Height Fail indicator
5 Turn Fail indicator

E **AFDS CONTROL PANEL**
1 TF pushbutton indicator
2 READY indicator
3 Height clearance selector knob
4 RIDE selector switch

Figure 4-16

ESRRD TEST FORMAT

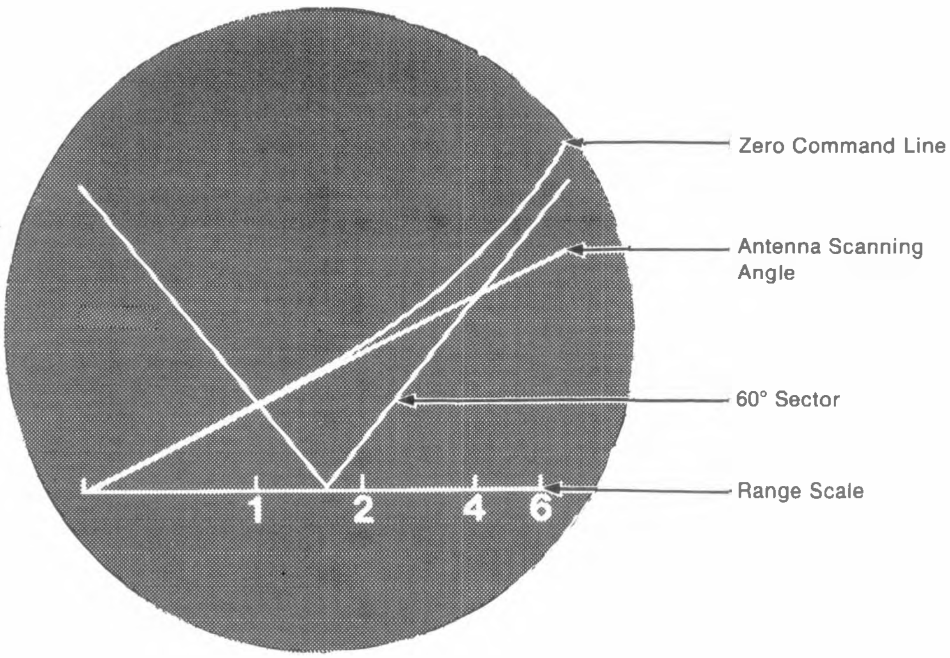


Figure 4-17

PERSISTENCE CONTROL KNOB

The direct video storage tube persistence is controlled by the rotary PERSIST knob. Turning clockwise increase the persistence.

NOTE

The PERSIST control is operative only in E-Scope modes (ES and CR).

TFR MODE SELECTOR KNOB

With the three-position rotary TFR knob, following positions can be selected (TFR and ESRRD on):

- NORM – TF operation with normal TF, receiver sensitivity.
- Weather mode A (reduced TFR receiver sensitivity) to decrease the rain effect (false pull-up command) on the TF performance.
- Weather mode B (limited TFR range and antenna scan angle) to restrict the processing region for TF command generation **(not cleared).**

BRIGHTNESS CONTROL KNOB

The rotary BRT knob is used to adjust brightness of the display. Clockwise rotation increases the brightness.

VIDEO GAIN CONTROL KNOB

The video level is varied by the rotary VIDEO GAIN knob. Contrast of the video will be reduced by turning the switch counter-clockwise. Fully counter-clockwise position gives zero video.

ESRRD OPERATION

With the ESRRD MODE set to TEST, the test format can be checked after a warm-up time of approx. 90 seconds. Then ES or CR can be selected as required.
In addition to the ESRRD test format, the ESRRD repeats the CRPMD MKR TEST display when the

MODE selector is set to RPTR, and the TF TEST format when ES/CR is selected.
Video gain and brightness functions should be checked.

TF/AFDS Control Panel

The AFDS control panel (E, Figure 4-16) carries following TFR controls:

HEIGHT CLEARANCE SELECTOR KNOB

The rotary, nine position height clearance, knob selects the intended clearance height, measured in feet vertically above ground level.

TF PUSHBUTTON/INDICATOR

The TF pushbutton/indicator illuminates white when pressed to indicate the TF mode pre-selection has been made. The mode is cancelled by pressing the pushbutton again and the caption then extinguishes.

READY INDICATOR

The READY indicator lamp illuminates green when the TFR is warmed up, the TFR switch, on the TFR control panel, has been selected to ON, and the TF data good signal is passed to the AFDS, indicating the readiness for TF engagement.

RIDE SELECTOR SWITCH

The three-position RIDE toggle switch with selections of SOFT, MED and HARD is used to select the required ride during TF by varying the pull-up/push-over command g-limits. Selection of HARD RIDE corresponds to the best terrain following performance.

RIDE Setting	Desired Maximum Push Over Command	Desired Maximum Pull up Command
HARD	+ 0.05 g	+ 3 g
MED	+ 0.25 g	+ 2 g
SOFT	+ 0.50 g	+ 1.5 g

Central Warning Panel

TFR CAPTION

The red TFR captions, located on the front and rear CWP, will illuminate under the following conditions:

- Loss of input power/power failure.
- Loss of bank stabilization from GMR.
- Bank angle exceeds ± 55°.
- Failure of IN input, together with input from either MC (Doppler) or SAHR.
- A discrepancy outside outer limits between the primary and secondary inclination and elevation incidence signals or a discrepancy outside the limits between the primary and secondary bank and ground speed signals.
- A failure detected by internal TFR BITE also produces a NO GO indication on the TRF control panel.

The amber TF MON caption, located on the front CWP, will illuminate under the following conditions:

- Primary or secondary data imput failure.
- Discrepancy between primary and secondary data in drift and/or turn rate.

MANOEUVRE MONITOR INDICATORS

The amber M lamp (C, Figure 4-16) on the anti glare shield in combination with a special 600 Hz audio illuminates by either excessive turnrate, unobeyed TF command, or Low Height Warning (LHW).

B RISK LIGHT

The amber B RISK light on the front cockpit (B, Figure 4-16) instrument panel below the E-Scope is illuminated whenever the selected CLEARANCE height is less than 350 feet and/or the aircraft speed exceeds 0.9 M with MODE-B selected on the E-Scope.
For additional warnings refer to TFR malfunctions of this section.

TFR Command Parameters

ZERO COMMAND LINE

The Zero Command Line (ZCL) is the path of TFR range scan angle combination which produce 0 g TF commands. The shape and position of the

SCHEMATIC

ZERO COMMAND LINE

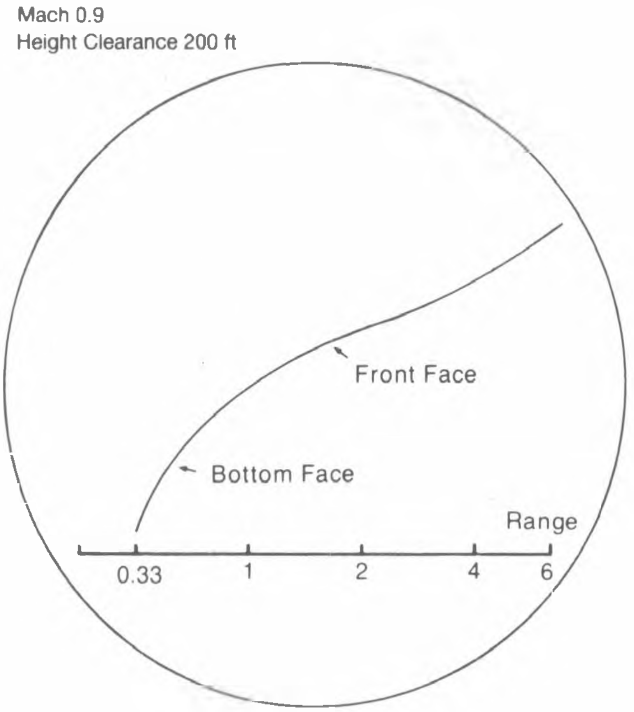


Figure A

VARIATION OF ZERO COMMAND LINE WITH SET CLEARANCE HEIGHT

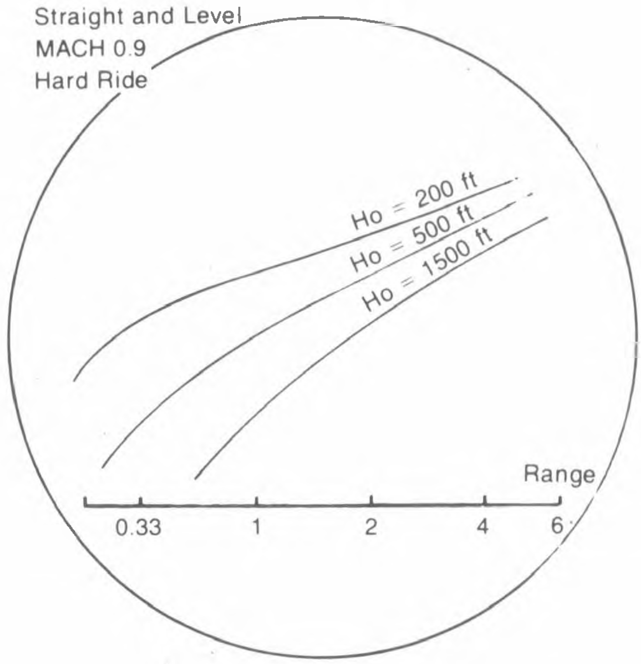


Figure C

VARIATION OF ZERO COMMAND LINE WITH VELOCITY

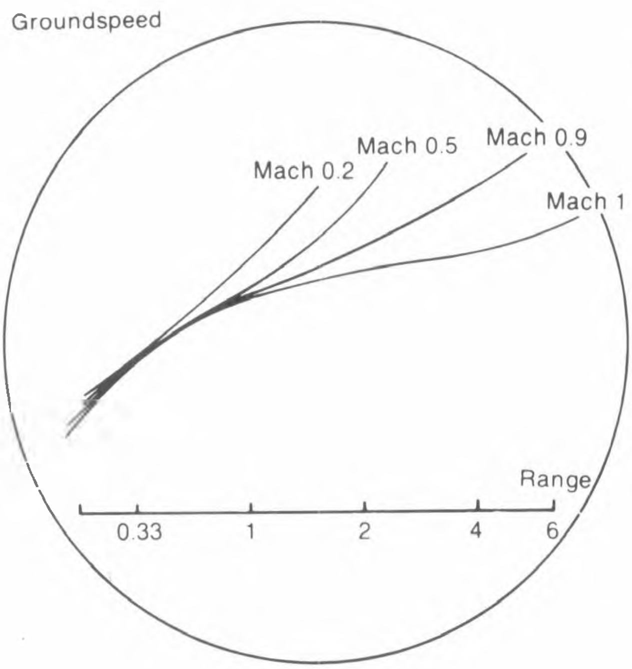


Figure B

VARIATION OF ZERO COMMAND LINE WITH RIDE SETTINGS

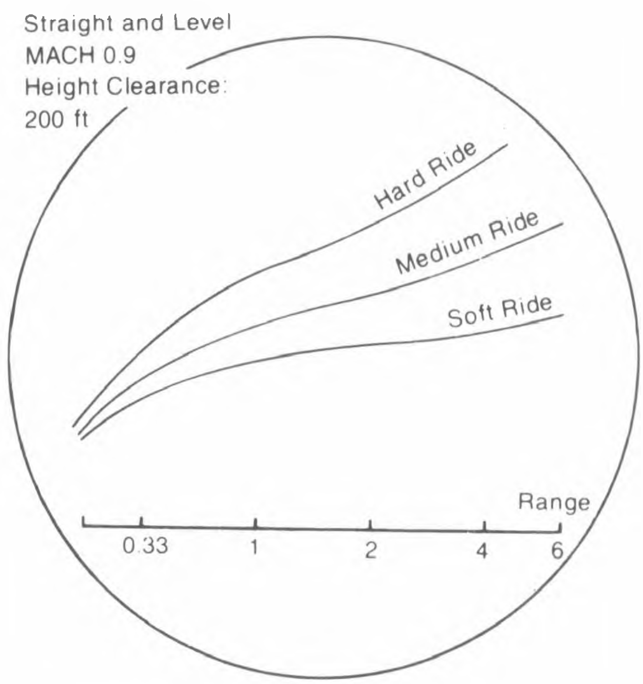


Figure D

Figure 4-18

SCHEMATIC

VARIATION OF ZERO COMMAND LINE WITH FLIGHT VECTOR

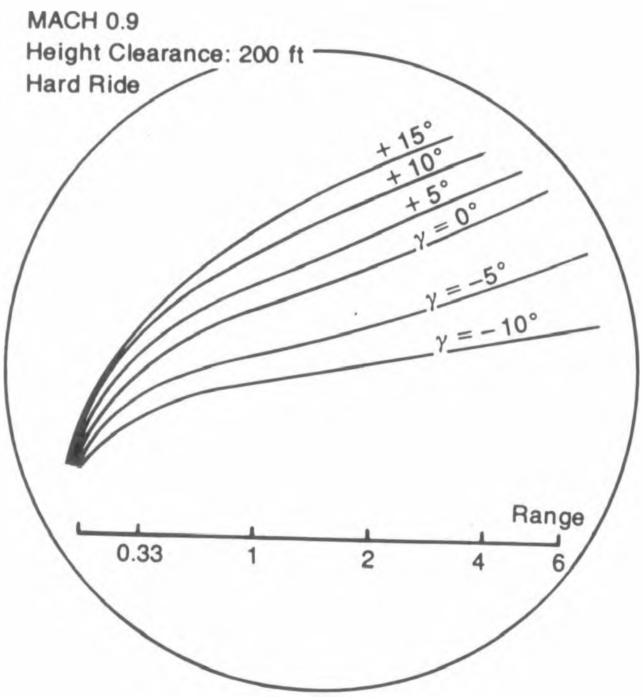


Figure A

CRAM/SPEED

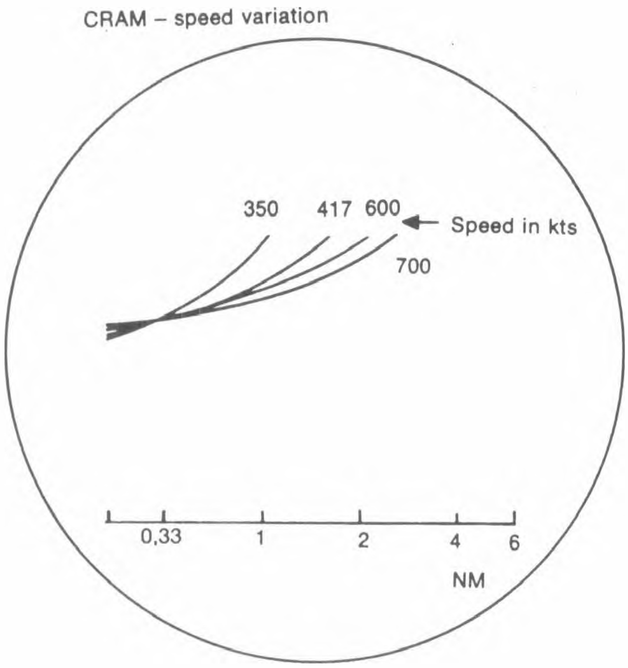


Figure B

CRAM/CLEARANCE HEIGHT

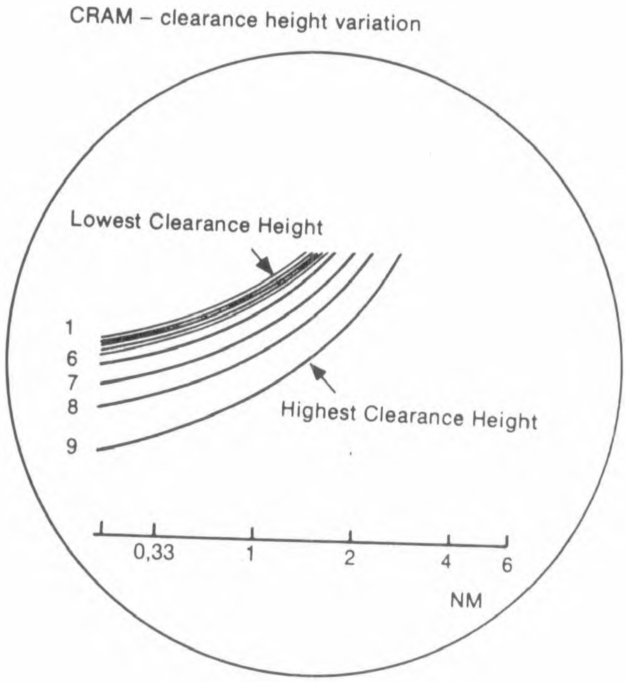


Figure C

Figure 4-19

line vary dynamically in space as a function of several parameters, i.e. speed, selected clearance height, selected ride condition and aircraft flight vector. But, regardless of its position, obstacles penetrating the line generate a pull-up command and obstacles below the line, but not touching it, generate a push-over command. The line has the shape of a "ski toe". In line with the "g" command generation the ZCL is also flight vector stabilized.

A, Figure 4-18 shows the ZCL for a horizontal flight condition as generated for M 0.9, 200 ft set clearance height, hard ride, flight case. The vertical and horizontal scaling is equal, so that the shape of the lines is shown exactly as it would appear, if it could be seen, in space ahead of the aircraft.

B, C, D, Figure 4-18 and A, Figure 4-19 shows the variation of the ZCL, relative to the position shown in A, Figure 4-18 as a function of velocity, set clearance height, ride setting and flight vector.

At high velocity the aircraft approaches an obstacle more rapidly and the radius of the pull-up maneuver is larger than at low velocity; therefore, the ZCL moves outward and downwards to provide an earlier pull-up command as velocity increase, see B, Figure 4-18.

At higher set clearance heights the ZCL is shifted downward to keep the aircraft farther from the terrain (C, Figure 4-18). Since it is not necessary to maneuver as rapidly to safely avoid the terrain at high set clearance, the ski toe is also rated downward to provide a smoother flight.

As the RIDE control is changed to give a softer ride, the pull-up command shall come earlier since the radius of the push-over maneouver is larger. Thus the "ski toe" is moved outward for softer rides as shown in D, Figure 4-18.

In Weather mode B the processed commands take account of the reduced scan angles and range limits. The flat portion of the ZCL is elongated and the curved portion flattened with softer ride setting.

As the aircraft flight vector changes, the ZCL is also rotated. In order to provide adequate warning when in a dive condition, the ZCL is rotated downward while for a climb it is moved upward (A, Figure 4-19).

The range and scan angle data defining the ZCL is sent to the E-scope where the ski toe shaped line is displayed.

CRAM LINE

A "fall-back" safety feature for the TF loop in the form of a terrain proximity warning function, called the Clearance Range Ahead Monitor (CRAM), is provided.

The CRAM equations define a template (CRAM line) which is located ahead of the aircraft and lies between the aircraft position and the space location of the TF zero command template. The output of the monitor will be sent to the TFR BITE summation circuit to indicate the presence of unsafe conditions of aircraft attitude/terrain proximity. These may have resulted from undetected failures, occurring somewhere within the TF loops, i.e. if terrain returns are detected at a range (Rt) closer to the aircraft than the CRAM template range (RCRAM).

Whenever the fail threshold is exceeded, the TF-data good signal to the AFDS will be removed and an automatic pull-up command is generated.

The CRAM line represents the 2 g incremental command line and is a function of groundspeed (B, Figure 4-19), set clearance height (C, Figure 4-19), and elevation incidence.

In case of a CRAM internal BITE detected failure the CRAM line will disappear.

WARNING

TERRAIN SHALL NEVER PENETRATE THE CRAM LINE. IF THIS OCCURS, MANUAL OVERRIDE ACTION SHALL BE TAKEN. (A FULL FLIGHT DIRECTOR PULL-UP COMMAND OR AN AUTOMATIC PULL-UP WILL BE GENERATED BY THE SYSTEM IN ADDITION TO ADVANCED INFORMATION BEING PRESENTED ON THE DISPLAY).

FLIGHT VECTOR COMMAND FROM TFR

In each alternate pulse, transmitted by the TFR, a desired flight vector is determined, based on radar range/scan angle information, selected clearance height, and attitude/velocity data from the IN, SAHR and MC. As the radar scan progresses, the most positive desired flight vector in one scan sequence is retained for use in generating the TF command.

Figure 4-20 illustrates the regions of flight vector commands for a typical evelation scan. For the segment of terrain shown, push-over commands (negative flight vector) are generated from radar returns in regions A and C. A zero command is generated in region B and at the intersection of C and D.

Pull-up commands (positive flight vector) are generated in region D with the largest pull-up command occurring at the top of region D. Thus, the

FLIGHT VECTOR COMMAND GENERATION

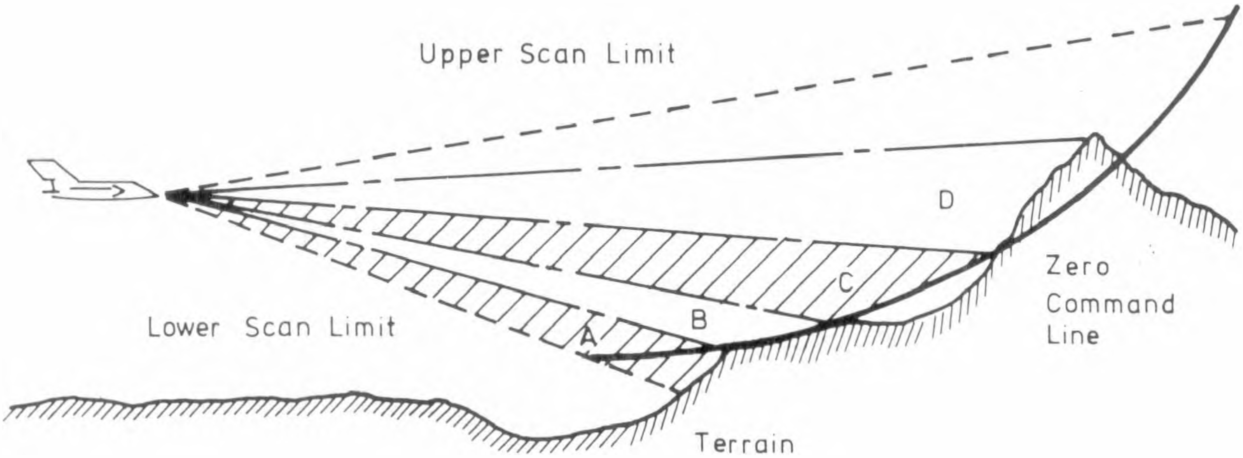


Figure 4-20

returns in region D would be retained for generating the TF command.

ALTIMETER OVERRIDE COMMAND

The radar altimeter generates the TF command when flying over water. In conditions where the terrain has very low radar reflectivity, an altimeter output is provided for adequate back up commands. Radar altimeter (override) commands tend to increase the average height at which the aircraft overflies the terrain and are inhibited automatically whenever TFR returns are adequate.

MOST POSITIVE COMMAND

With the altimeter override command functioning, the TFR most positive logic chooses the greater between the TFR command and the altimeter override command. Thus, the aircraft is always commanded with the largest climb angle demand.

DRIFT, GROUNDSPEED, ELEVATION INCIDENCE AND TURN RATEDATA

A drift signal is required in the TFR for offsetting the radar scanner when flying in crosswind. Turn rate is required for offsetting the scanner in turning flight. Groundspeed and elevation incidence signals are used to determine TF commands in the processor.

Primary and Secondary Data Monitoring

Primary and secondary input data of turnrate, drift, elevation incidence and inclination and bank are compared within the processor/computer. If a comparison threshold between primary and secondary inputs of either turn rate or drift is exceeded without a relevant detected failure, the TF MON caption on the front CWP and TURN FAIL on the TFR control panel will illuminate. This indicates the TFR is using fixed values for one or both input lines.
The comparison threshold for elevation incidence and inclination cross monitoring has an upper and

lower limit. If the lower, but no the upper, limit is exceeded and no failure in the corresponding sensor has been detected, the TFR uses that input data which produces the most nose-up TF command. If the upper limit for elevation and inclination, and/or bank and G/S cross-monitoring is exceeded, the TFR captions on both CWPs are illuminated and TF-data good signal to the AFDS is removed.

TFR MODES AND OPERATION

TFR ground operation is prohibited. The TFR control panel MASTER switch should be set to STBY with FIXED FREQ selected allowing the equipment to warm up (approx. 3 min). Additionally the TFR MODE selector on the ESRRD can be set to NORM.
Five TFR functional states affect the TFR operation:

NOTE

> The Ground Standby Override switch 5 ST is an external control switch near the CMP which is operated by the groundcrew and selects one of the two Standby modes when the aircraft is on ground.

Ground Standby — The ground standby mode (aircraft on ground and ground standby override switch in ON, STBY selected on the TF control panel) provides equipment warm-up with minimum power consumption. The transmitter is inhibited from operating and the antenna is held in a stow position by electro-magnetic brakes. Selecting TFR to OFF disconnects all power supplies immediately.

Standby — In the standby mode (aircraft airborne or ground standby override switch in OFF, on TF control panel STBY selected) all power supplies are provided, and the antenna (also the GMR antenna) is driven into aircraft boresight position.
The common processor/computer provides the TFR antenna/receiver unit with roll stabilization. After 3 minutes in the standby mode, full equipment operation (TEST or ON) is enabled within 2 seconds of selection. Selecting TFR to OFF allows the processor/computer to drive the TFR and GRM antennas to their stow position.

TEST — The test mode provides equipment operation with the transmitter power dissipating into the dummy load. The antenna scans its normal pattern and a complete check of the equipment operation is carried out by a BITE.
The interruptive TEST mode can be selected from either the ground standby or the standby mode, but not from the TF mode.

TF — In the TF mode the equipment processes all its input signals together with video returns and antenna elevation scan position information for generating TF commands.

Weather Modes A and B — The weather modes A and B selected at the ESRRD enable terrain following in precipitation without a significant increase in false pull-up commands.

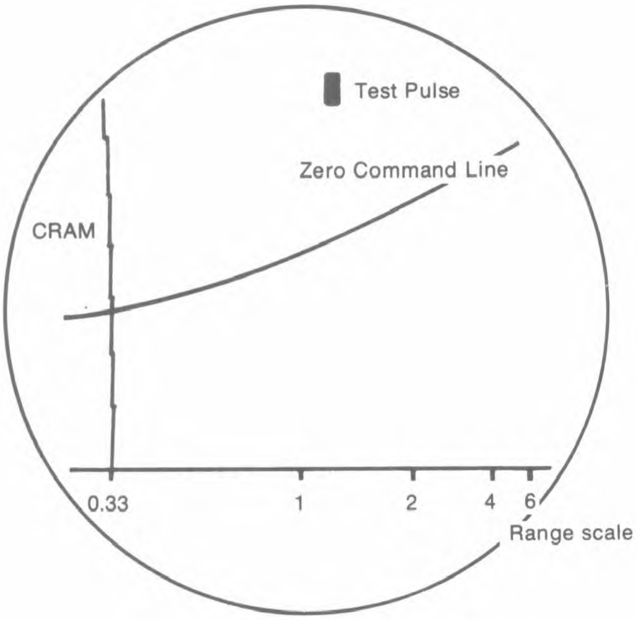
NOTE

> If recycling from ON or STBY mode a pause of a least 2 sec shall be made in the OFF position.

TFR TEST

The TEST mode can be selected from Standby and Ground Standby only after warm-up. With the TEST button on the TFR control panel pressed, the interruptive BITE program is initiated and a complete test of the equipment is carried out. The TEST-in-progress lamp should illuminate for 10 sec from Standby or 12 sec test period from Ground Standby. If the TEST lamp does not light up, wait 2 sec then press again to reset the system. The TEST mode may be cancelled thereafter, as long as the TEST lamp or the NO GO lamp is on, by pressing the TEST button twice (cancel and reset).
When the mode is entered from Ground Standby, the TFR, TF MON, and R ALT captions on the CWP, the M (Man Mon) light on the anti-glare shield, the NO GO, TURN, and HT FAIL indicator lamps on the TF RADAR control panel, and the B RISK light on the fron center panel illuminate for a 5 sec period.

TF TEST FORMAT



This pattern is shown when CR is selected.

Figure 4-21

NOTE

- If IN is not aligned (e.g. when STATUS 4 not indicated), TFR/CWP warning will illuminate till the end of TEST cycle. TFR/CWP together with a NO GO signifies a genuine TFR failure.
- To repeat the TEST on ground, a pause of 10 sec shall be made (after the white TEST caption on the TFR CP is extinguished), before initiating a new interruptive BITE.

When the mode is entered from Standby, these indicators except those on the CWP, will illuminate but for 3 sec only.

At the completion of the interruptive TEST period the TEST lamp will extinguish, the TFR will revert to Ground Standby or Standby, as selected, unless a failure was detected and indicated by the NO GO lamp.

If a failure has been detected the TFR will enter a 30 sec failure reporting period, where the appropriate lamp, indicators, and captions will be illuminated (in Ground Standby only).

This reporting period may be cancelled by pressing the TEST button twice with a 2 sec interval.

CAUTION

FAILURE TO OBEY THIS MANDATORY SEQUENCEY MAY CAUSE DAMAGE TO THE GMR ANTENNA OR LRU 1.

The interface to the ESRRD can be checked if the ESRRD MODE selector is set to ES/CR. The TF Test pattern will appear on the ESRRD. The Test format is generated for a zero ft/sec ground speed and 350 ft altitude. If CR is selected, the zero command line, test pulse, CRAM line, and range scale are displayed (Figure 4-21).

If ES is selected, only the zero command line is displayed. Video gain, brightness control and persistence functions should be checked.

DESCENDING INTO TERRAIN FOLLOWING

During the descent into TF, the aircraft's TF performance shall be checked at various heights.

Height, airspeed/wingsweep should be within limits. On the AFDS panel selection of ALT or MACH should be made with AP engaged. To check the Stick-Force-Cut-Out (SFCO), the control stick is to be pulled back. AP light will extinguish and AFDS modes be disengaged. AUTO P caption on the CWP should not illuminate. After checks completed re-engaged AP if required. RADIO shall be selected on the HUD to give an indication of radar height.

When RAD ALT lock-on has been confirmed, the radar height read out on the HUD should be compared with that on the RAD ALT (TACAN should be in OFF/REC and CCS in UPPER).

With FIXED FREQ selected on the TFR control panel, the MASTER switch shall be set to ON and NORM is selected on the ESRRD. A check on ZCL, CRAM, ground returns and test pulse can then be performed.

With the TF READY light illuminated, intended SCH, Ride and other modes selected, pressing the TF pushbutton on the AFDS control panel engages the AFDS in its TF mode. Before TF engagement

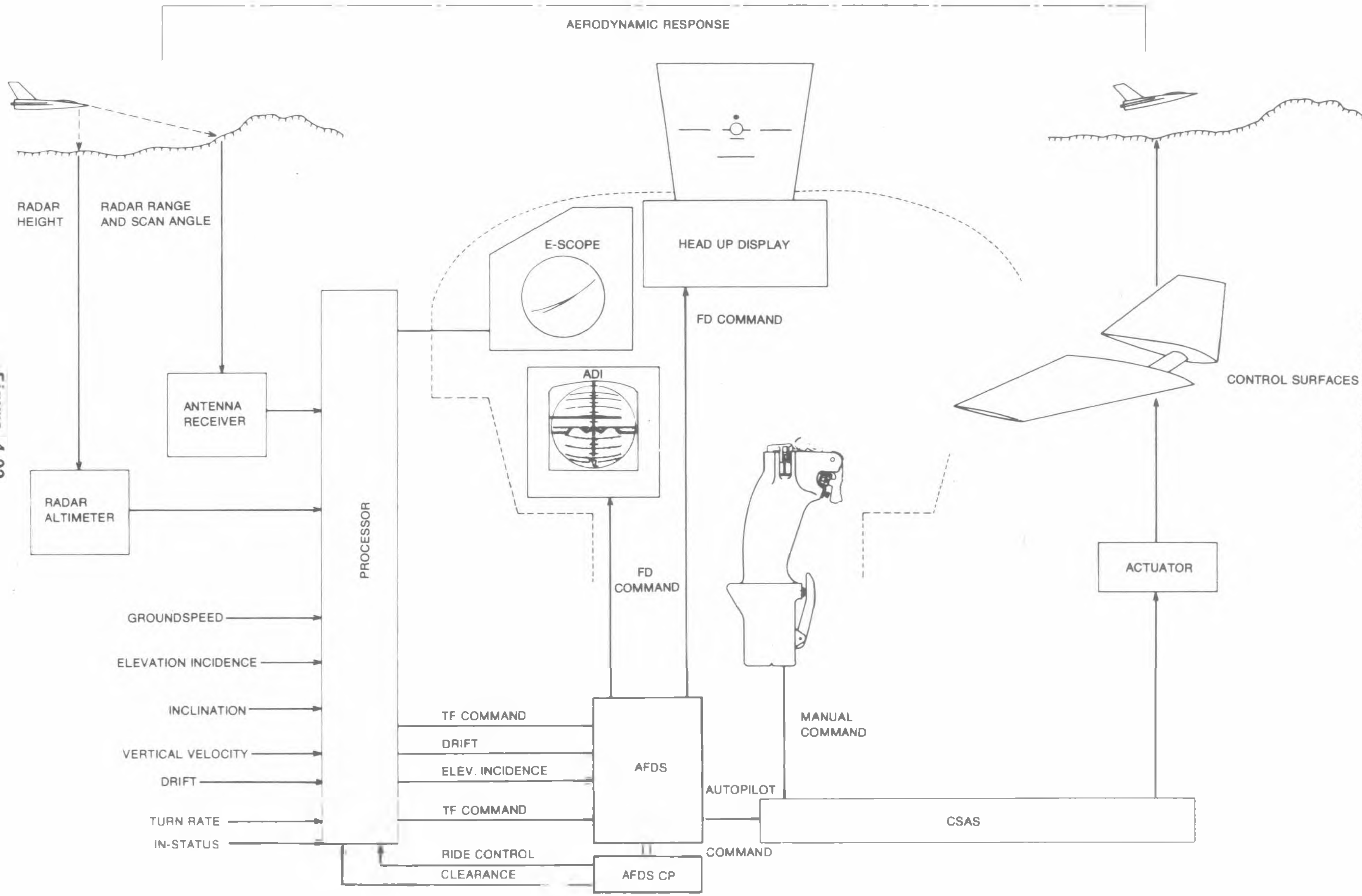


Figure 4-22 TF CONTROL LOOP

E-SCOPE, ADI AND FD INDICATIONS (TYPICAL)

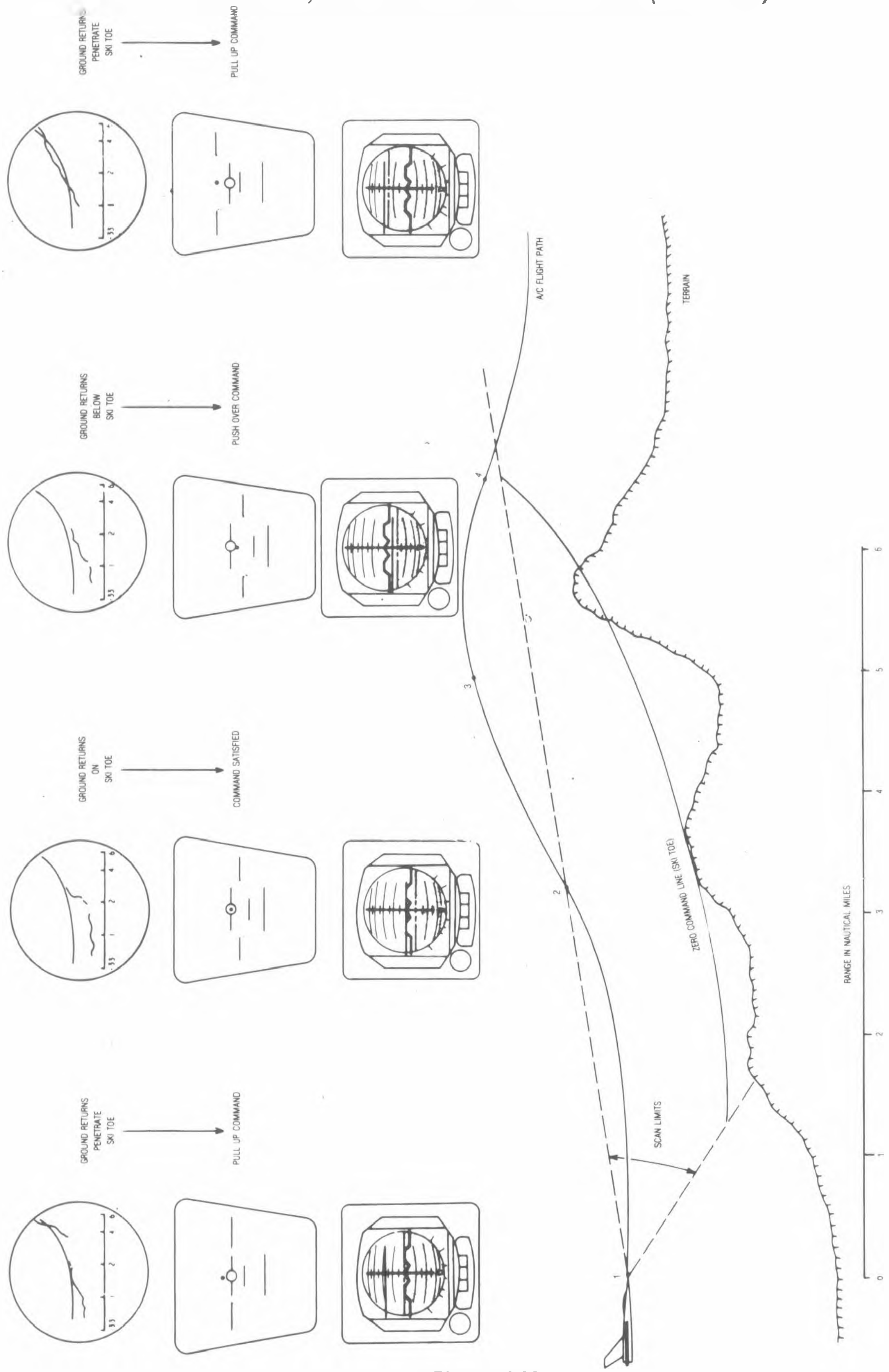


Figure 4-23

to ensure that flight director information is displayed correctly on both HUD and ADI, FD shall be selected. The displayed T on the HUD may be taken as a genuine system check.
During TF let down, the pilot should compare the E-Scope indications with those on the HUD and confirm the proper behaviour of the aircraft.
When confident of the aircraft's TF performance, descent may be made by setting the CLEARANCE control to the intended TF clearance height. The RAD ALT low height marker is set to 10% below the intended set clearance height to be flown and provides a warning of low height. Subsequent reductions in SCH and selection of RIDE condition and AFDS modes can be made as required.
(To acquire and follow a pre-planned TF route, TRACK may be selected on the AFDS control panel. A constant airspeed is maintained if THROT is selected).

CAUTION

SWITCHING ON THE TFR CONTROL PANEL FROM FIXED FREQ TO FREQ AGTY OR VICE VERSA CAUSES A SHORT (1-1.5 SEC) TF DATA GOOD REMOVAL WITH TFR NO GO AND CLPU.

NOTE

- When AAO is pressed, FD is not displayed, but TF READY light remains illuminated. Flight director information is displayed on ADI and ESRRD only.
- When Lock-On/Reject or Phase Change is pressed, TF READY light is out with TF discontinued.
- TACAN transmission from the lower antenna may have an effect on TF height keeping performance without affecting flight safety.

TFR ABNORMAL OPERATION

Under the following conditions the low height/maneuver monitor warning (audio + lamp) is activated:

- If the aircraft flies at a height lower than 70% of SCH (this is based on the height measured by the radar altimeter). In this case, TF ready light on AFDS control panel is extinguished and a closed loop pull-up command is generated.
- If the pilot did not obey the positive "g"-command. The commanded and actual aircraft flight vector differs by more than a preset limit.
- If the turn rate exceeds + 2°/sec after a variable time delay depending on the turn rate. This variable time delay can extend from 0,5 to 10 sec where a safe TF operation is still possible.

If LHW is permanent:

- With FD selected: after 2 sec HUD breakaway cross is indicated.

plus

- With AP engaged: after 2 sec AFDS disengagement followed by and 16 sec open loop pull-up command.

CAUTION

IF THE AUDIO WARNING (600 HZ) IS ACTIVATED AND THEN SUPPRESSED BY PRESSING THE ATTENTION GETTERS, THE TONE IS INHIBITED AND WILL NOT BE REACTIVATED BY ANY OTHER CONDITION AS LONG AS THE ORIGINAL FAULT CONDITION REMAINS.

Depending on which monitor has caused the warning during manual TF, the pilot has either:

- To perform a hard pull, discontinuing TF.
- To satisfy FD command.
- To reduce turnrate.

If there is a CRAM intrusion, the following occurs:

- TF-ready light on AFDS control panel is extinguished and a closed loop pull-up command is generated.

If CRAM intrusion is permanent:
- With FD selected: after 2 sec HUD breakaway cross is indicated.

plus

- With AP engaged: after 2 sec AFDS disengagement followed by an 16 sec open loop pull-up command.

The performance of the TFR may be degraded by the presence of rain, in which case weather echoes, will appear on the E-Scope display resulting in an increase of false pull-up commands. In light rain a continuous wall is presented on the display up to a range of 3 NM, where it remains. In heavier rain the wall tends to break up at 3 NM and to appear at progressively shorter ranges. By selecting either Weather mode A (or B) the TFR receiver and processor have the capability to counteract this adverse rain effect. Selecting Weather mode A has the effect that the rain cloud become less dense to the radar, whereas Weather mode B has no visual effect on rain or terrain returns on the display, but the processor compensates for the reduced scan angles and range limits. (Refer to TFR Command Parameters).

(Weather mode B only – Not cleared)
The amber B RISK lamp below the ESSRD will illuminate under the following conditions:

- the selected clearance height is less than 350 ft and/or
- the aircraft speed exceeds 0.9 M.

CAUTION

THE TF SYSTEM MAY REACT TO OTHER AIRCRAFT WITHIN THE TFR COVERAGE, E.G. OTHER AIRCRAFT APPROACHING HEAD ON AT A HIGHER LEVEL, BY PRODUCING A TF CLIMB COMMAND TOWARDS THE AIRCRAFT.

TF MALFUNCTIONS

TFR FAILURES

A TFR failure (Figures 4-24/4-25) is indicated to both crew members by the red TFR caption on CWP and a flashing breakaway cross on the HUD with FD selected.

Each TF-fail condition removes TFR data good signal from the AFDS, and the AFDS generates a wings level and pull-up command indicated on the HUD. This command has to be followed by the pilot in manual flying, whereas if autopilot is engaged, the aircraft will automatically execute the wings level and pull-up manoeuvre.

CRAM FAILURE

If status checks or cross-monitoring of CRAM input data indicate unrealiable inputs, or if internal monitoring of the integrity of CRAM indicates a failure, the CRAM is disabled (i.e. taken out of the TF-data good loop) and the CRAM line disappears from the E-Scope.

RADAR ALTIMETER FAILURE

If a fail condition is detected, indicated by the illumination of the amber R ALT caption, it will have an effect on TF flying as follows:

- Providing the TFR is receiving good ground returns, the AFDS/TF mode remains engaged with a slight increase of clearance height. If the TFR is not receiving ground returns, i.e. when flying over water or over flat ground having a low radar reflectivity, a shallow climb command (nominally 2° climb angle) is initiated. Therefore in either case TF has to be discontinued.

FAILURE OF PRIMARY SOURCE DATA INPUT

The IN is the primary source of attitude and velocity data for the TFR. A failure in this source of data is indicated by the illumination of the HT FAIL indicator on the TFR control panel. In addition, the amber TF MON on the front CWP, the amber IN caption on the rear CWP and the ATTD FAIL indicator on the AFDS panel will illuminate.
In these circumstances the TFR continues to operate, using the secondary source data (Doppler, SAHR, MC) without cross-monitoring.

FAILURE OF SECONDARY SOURCE DATA INPUT

The MC and SAHR provide the secondary source of attitude and velocity data which is used by the TFR to monitor the primary source.
A failure in the secondary source is indicated by the illumination of the amber TF MON caption on the front CWP. Depending on the nature of the failure, amber CMPTR, SAHR or DPPLR captions on the rear CWP and the ATTD FAIL indicator on the

TF-FAILURE LOOP

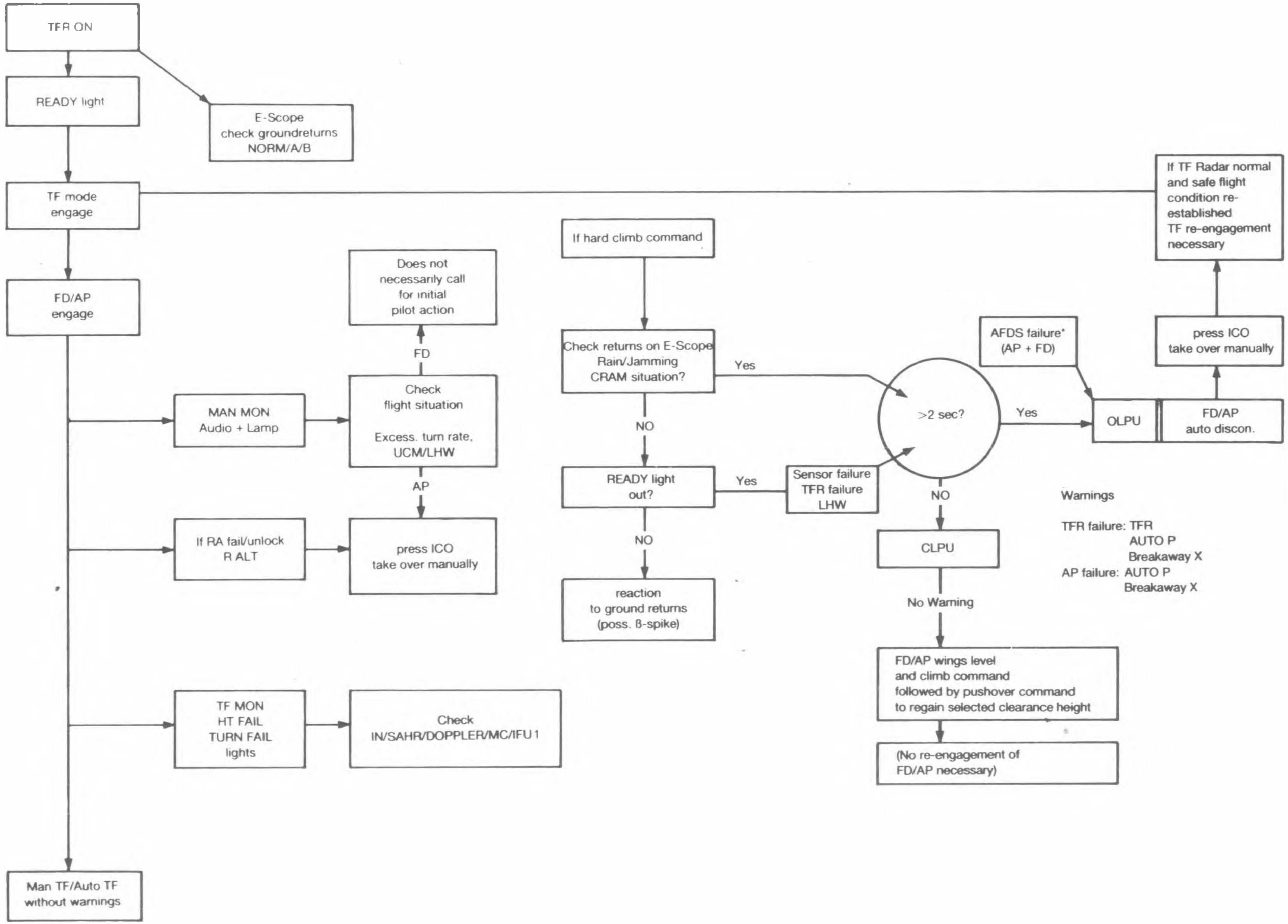


Figure 4-24

FAILURES AFFECTING TERRAIN FOLLOWING

FAILURE WARNINGS								
	CWP's			OTHER INDICATIONS				
AUDIO VIDEO	RED (P + N)	AMBER (P)	AMBER (N)	TFR CP	AFDS CP	RAD ALT	HUD ADI	FAILURE
LYRE BIRD Attention Getters	TFR						FD is suppressed on HUD, the breakaway cross is displayed the ADI bars park and the failure flag appears	Input power, bank stabilization, combined primary and secondary groundspeed and/or bank comparison, primary and secondary inclination and/or elevation incidence upper threshold comparison, CRAM
	TFR AUTO P				ATTD FAIL			Roll, attitude monitor
	TFR				NO GO			TFR internal
Attention Getters		R ALT	R ALT			Failure Flag	Occulting height on HUD Shallow climb command if TFR no good ground returns	Radar altimeter internal or input channel comparison
600 Hz Maneuver Monitor lamp						Low Height Warning Indicator Post mod. 00477 (+ Repeater Lamp)	Pull up Command	Low height less than 70% SCH (CRAM intrusion unobeyed in normal TF)
								Maneuver monitor (unobeyed command or excessive turn rate)
Attention Getters		TF MON AP MON	IN	HT FAIL	ATTD FAIL			Primary source data input
		TF MON AP MON	CMPTR SAHR or DOPPLR		ATTD FAIL			Secondary source data input
		TF MON		TURN FAIL				Primary/secondary drift and/or turn rate exceed comparison threshold
(B-RISK LAMP)								Weather Mode B limits. Low clearance height or height velocity exceeded

Figure 4-25

AFDS CP panel may also illuminate. The TFR continues to operate using primary source data without cross monitoring.

FAILURE OF DRIFT AND TURNRATE DATA INPUT

If primary and secondary drift and turnrate from IN and MC exceed the cross-comparison threshold, TURN FAIL on the TFR control panel and TF MON caption on the CWP illuminate. A reversionary mode of operation is provided in which the two fail indications still illuminate.
The table FAILURES AFFECTING TERRAIN FOLLOWING summarizes the failure warnings and their causes.

DOPPLER NAVIGATION RADAR (DOPPLER)

The Doppler provides velocities to the MC in the along Vx, across Vy, and vertical axes Vz. These veloctics are mixed with the IN velocities through the Kalman Filter, to provide best estimates of aircraft velocities for use in the navigation and weapon aiming calculations. Doppler velocities, together with SAHR inputs, are used in the MC to derive groundspeed, drift angle, and vertical velocity. These outputs monitor IN outputs during Terrain Following and constitute a reversionary mode (Figure 4-26). The equipment incorporates a continuous BITE facility which monitors signals and voltage supplies from reference sources. A detected failure is indicated by illumination of the amber DPPLR caption on the rear CWP.

Power Supplies

The system is supplied with 115 V/400 Hz AC from AC busbar XP3. 28 V DC from DC busbar PP3 is fed via a doppler equipment relay to the CWP in the rear cockpit.

Limitations

The equipment performs within a groundspeed range from 50 to 1800 kt and a drift angle of ± 30°. Maximum altitude limitation is 70000 feet.
The Doppler consists of a transmitter/receiver antenna unit, and a doppler control panel. A doppler radome assembly which is flush mounted on the underside of the forward fuselage, protects the directional antennas.

Transmitter/Receiver Antenna Unit

The transmitter/receiver unit is located in the forward equipment bay. Via a 3-beam antenna array the signals are transmitted and are received by a directional antenna array.
The signals are processed to provide digital output of velocities to the MC.

Doppler Control Panel

The Doppler control panel (Figure 4-27) is located on the right console in the rear cockpit and has the following controls:

ON/OFF SWITCH

The two position ON/OFF toggle switch controls the power supply. In the OFF position the power supply is switched off and the amber caption DPPLR is illuminated on the rear CWP. With the switch set to the ON position, the Doppler will be operative within 1 min and the DPPLR caption extinguishes.

TEST PUSHBUTTON/INDICATOR

To initiate interruptive BITE, the TEST pushbutton shall be pressed once. Pressing it a second time cancels interruptive BITE. The indicator illuminates white to indicate that TEST has been selected.

NOTE

When the aircraft is on ground, the doppler will automatically be switched into its TEST mode by a WOG signal, preventing spurious failure warnings. In this case, pressing the TEST button checks the illumination of the indicator only.

LAND/SEA SELECTOR SWITCH

The LAND position of the two position toggle switch is adopted where good ground returns are expected with the Doppler operating in normal condition. Switching to SEA, when flying over water or bad reflective surface, changes the velocity output scaling.

DOPPLER RADAR BLOCK DIAGRAM

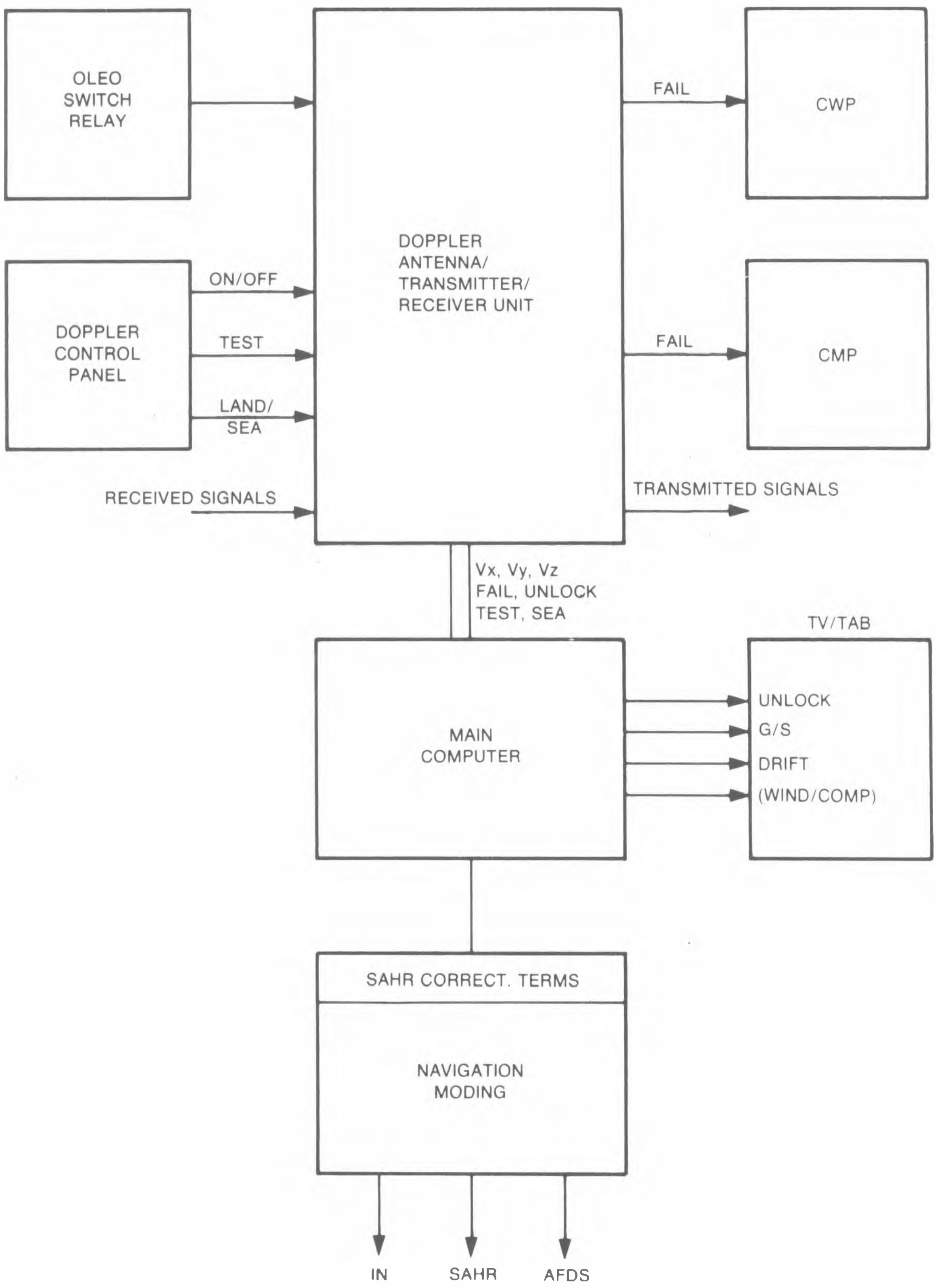
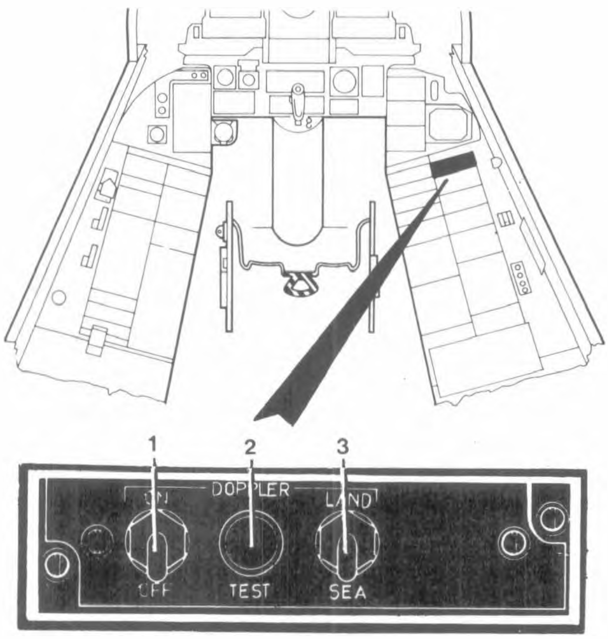


Figure 4-26

DOPPLER RADAR CONTROL PANEL



Doppler control panel
1 ON/OFF switch
2 Test pushbutton/indicator
3 Land/sea selector switch

Figure 4-27

Central Warning Panel

DOPPLER CAPTION

The amber DPPLR caption on the rear CWP illuminates to indicate either a failure in the Doppler navigation radar or when the equipment is switched off if TFR is on.

TF MON CAPTION

Loss of Doppler outputs, causing degradation of the MAIN mode and loss of Terrain Following monitoring, is indicated by the illumination of the amber TF MON caption on the CWP in the front cockpit.

DOPPLER OPERATION

The Doppler is activated by selecting the power ON position. With the TV/TAB display unit selected to the Navigation format, a contrast inverted UNLOCK indication appears for 4 sec.
By pressing the TEST button, Doppler interruptive test is performed. The time required for the test does not exceed 2 minutes and after it has been completed, the equipment goes into the operating mode. Depending on the surfaces to be overflown, the LAND/SEA switch shall be set. During flight over good reflective surfaces, the switch should be left in the LAND position. Due to differences in Doppler performance over low reflective surfaces, it is recommended that SEA is selected, as this will improve the effect of Doppler on MAIN mode performance.
Indications of actual groundspeed and drift angle are displayed on the TV/TAB by selecting NAV, or F/A and pressing the VEL key on the MFK.

Doppler Transient Monitor

The purpose of the Doppler transient monitor is to detect possible transients in the Doppler velocities (Vx, Vy, Vz), caused by the external environment, i.e. sudden changes in soil reflectivity caused by ground, calm water and rough water in alternation.

WARNING

WHEN TURNING OVER CALM WATER, DOPPLER TRANSIENTS MAY CAUSE AN OSCILLATORY PITCHING AND ROLLING MOTION WHICH E.G. COULD LEAD TO A REPEATED CYCLING BETWEEN NORMAL TF OPERATION AND CLPU WINGS LEVEL COMMAND. IF THIS OCCURS, TF SHOULD BE DISCONNECTED BY PRESSING THE ICO BUTTON.

Bite

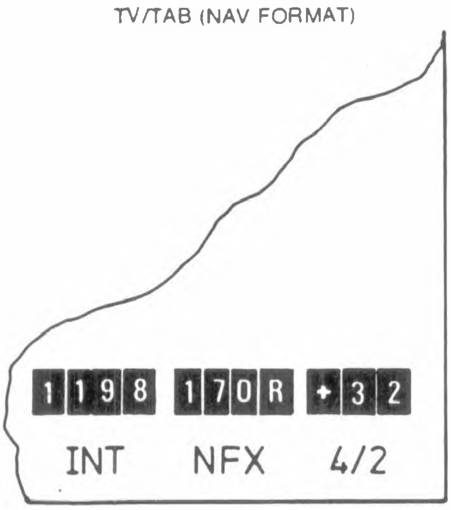
CONTINUOUS MONITORING

The Doppler BITE assesses the equipment operation on a continuous basis by monitoring certain vital parameters.

INTERRUPTIVE TEST

An interruptive test is initiated when the TEST pushbutton on the control panel is pressed to inject a test signal into the Doppler system. The TEST indicator illuminates and a valid test is indicated by

DOPPLER TEST VELOCITIES DISPLAY



	Vx	Vy	Vz
SEA	1192 to 1237	143 to 184	24 to 41
LAND	1173 to 1218	129 to 170	24 to 41

Figure 4-28

the display of test velocities on the TV/TAB (Figure 4-28). The values of the along and cross test velocities displayed depend on the setting of the LAND/SEA switch. A second press of the TEST pushbutton cancels the test and extinguishes the indicator light. The continuous monitoring BITE also operates during interruptive testing.

NOTE

- Extended periods of TEST mode operation can cause a degradation of the MAIN and DP + SR mode accuracy.
- If the TEST mode is selected in flight to confirm the status of the Doppler radar, the Doppler outputs for navigation and TF monitoring purposes are lost, therefore the TFR performance should be monitored closely.

DOPPLER Malfunctions

DOPPLER UNLOCK

A reduction in the received signal strength below a predetermined level causes the Doppler to unlock, this may e.g. occur when the aircraft is flying over and expanse of calm water or terrain with bad reflection. This condition is indicated to the navigator by the display on UNLOCK, contrast inverted, in the bottom right-hand corner of the TV/TAB in the Plan, Navigation, or Fix/Attack format.

NOTE

In DP + SR mode short-term HUD climb/dive errors may occur. Following maneuvers, e.g. where bank exceeds 47° and pitch 22.5°, Doppler may unlock/relock causing the HUD/VSI indication to jump and climb/dive bars to ladder. This effect will fade usually within 1.5 sec followed by display restabilization. Under these conditions HDD should be used as primary instruments.

When flying in this condition for extended periods, the unlock condition can cause a build-up of velocity errors more rapidly than would normally occur. If UNLOCK occurs in the DP + SR mode, the MC will use air data velocities replacing Doppler velocities and the stored wind velocity data are used to compute groundspeed.

DOPPLER Failure

Doppler failure is indicated by the illumination of the amber DPPLR caption on the rear CWP. It also is indicated by the display of UNLOCK on the TV/TAB, and the extinguishing of the white DP + SR caption on the NMCP.
Loss of Doppler outputs cause a degradation of the MAIN navigation mode and a loss of Terrain Following monitoring, indicated by the illumination of the amber TF MON caption on the front CWP. If the DP + SR mode is selected at the time of failure, the green SEL caption is extinguished and the MC automatically selects the AD + SR mode.
Equipment error or incorrect positioning of the LAND/SEA switch may be indicated by the display of a Doppler reject warning symbol "R" at the bottom right-hand side of the TV/TAB display, and is

alternately normal and contrast inverted. This warning appears irrespective of the TV/TAB format selected.

RADAR ALTIMETER (RA)

The Radar Altimeter measures height above the surface by transmitting and receiving a radio pulse and is used as a height sensor. For the height performance in TF, RA functions as a monitor, whereas in RH mode, RA becomes the basic sensor. The equipment supplies information to the AFDS, the TFR, the HUD, the MC, and the Crash Recorder, as shown in Figure 4-29.
The RA consists of a transmitter-receiver, two antennas and an indicator.

Power Supplies

The system is supplied with 28 V DC from the DC busbar PP1, 28 V DC from the DC busbar PP3 (CWS warning), and 115 V AC from the AC busbar XP1 for instrument integral illumination, controlled through the INTERNAL LIGHTS control panel in the front cockpit.

Limitations

The system provides height information up to 5000 feet within pitch and bank angles up to ± 60° over all types of terrain.

CAUTION

WHILE PITCH AND BANK ANGLES ARE EXCEEDED THE RA MAY GIVE FALSE (SLANT RANGE) HEIGHT INDICATION.

NOTE

Exceeding these limitations will cause an unlock condition.

The indicator instrument has an accuracy of ± 3 ft or ± 3% of the actual height whichever is greater for heights up to 5000 ft.

Transmitter-Receiver

The transmitter-receiver is located in the forward equipment bay. It contains a transmitter, a receiver and a range computer.
The transmitter produces pulses of high energy RF (4300 MHz) at a pulse frequency of 10 KHz. The pulses are routed to the transmitter antenna and at the same time a timer reference pulse is generated which initiates the range computer. When the return signals is received it is processed and sent to the range computer which measures the elapsed time from pulse transmission to pulse reception and converts this time to signals representing minimum height. Height is supplied in analogue and digital form to accommodate the requirements of the navigation system.
If a temporary loss of received signals occurs, the equipment reverts to a memory mode which holds the last value of height and inhibits any warning signals for a period not exceeding one second.
If the loss of signals exceeds one second, a status signal is cancelled and the indicator shows the FAIL flag.

Radar Altimeter Indicator (RAD ALT)

The RAD ALT is located in the front cockpit (B, Figure 4-30) and provides the following controls and indications:

HEIGHT POINTER

The height pointer indicates height against a circular scale which is graduated between 0 and 5000 feet.

FAIL/FT x 100 INDICATOR

The two position FAIL/FT x 100 indicator flag shows the following equipment status:

FT x 100	Displayed when the equipment is switched on and operating normally.
FAIL	A black and red striped marker is displayed when the equipment is switched off or when there is a fault condition.

LOW HEIGHT WARNING INDICATORS

The red low height warning indicator, on the indicator, illuminates if the indicated height falls below the level set by the set height marker.
A red low height repeater warning lamp (A, Figure 4-30) is located on the left hand side of the

RADAR ALTIMETER BLOCK DIAGRAM

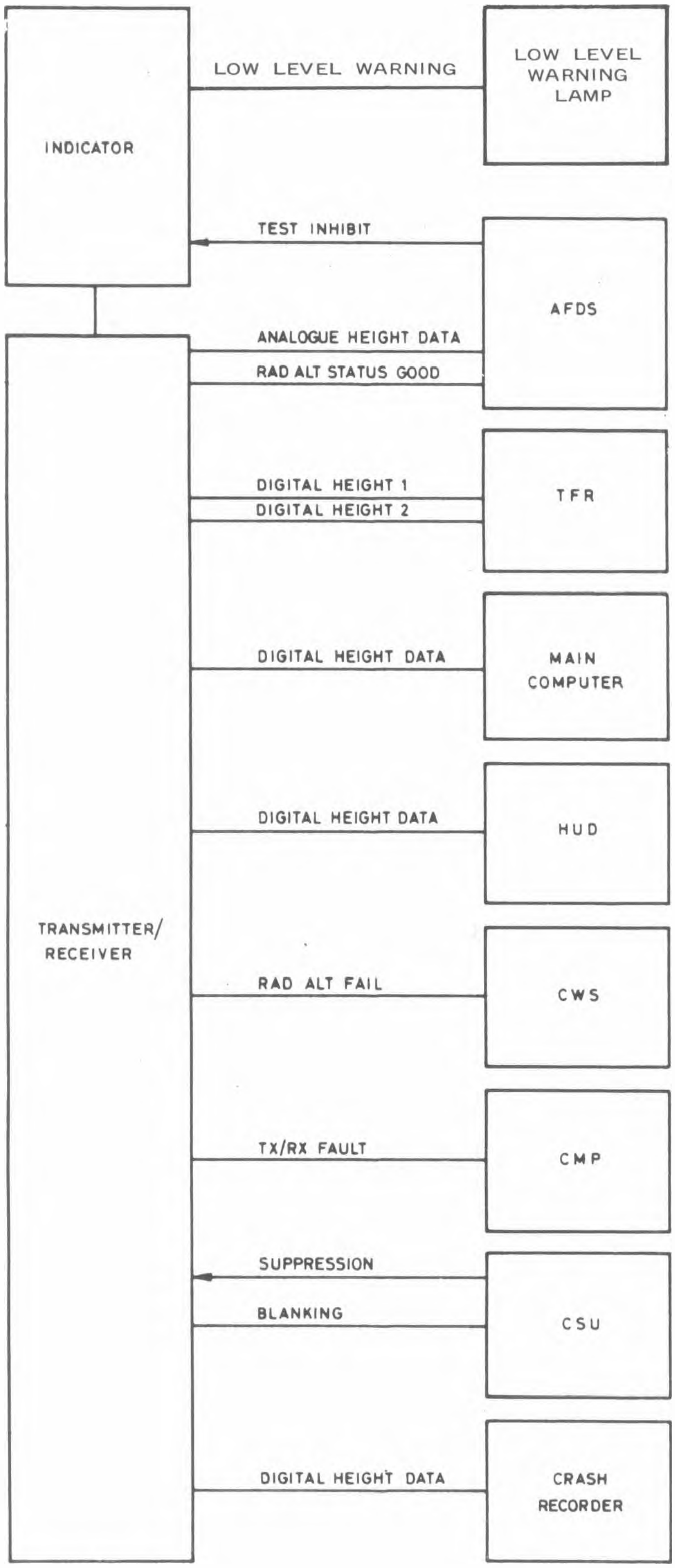
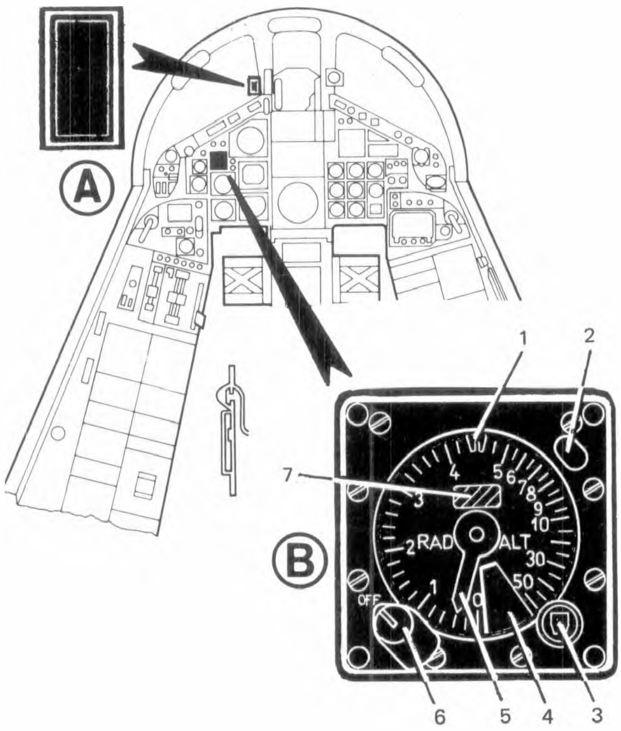


Figure 4-29

RADAR ALTIMETER INDICATORS



A Low height warning indicator

B Radar altimeter indicator
1 Set height marker
2 Low height warning indicator
3 Set height marker control knob
4 Pointer mask
5 Height pointer
6 ON-OFF/Press to test switch
7 Fail/FT x 100 indicator

Figure 4-30

AOA indicator and repeats the warning indication accompanied by a 600 Hz audio warning tone.

SET HEIGHT MARKER CONTROL KNOB/SET HEIGHT MARKER

The rotary height marker knob, labelled with the symbol of the height marker, operates a low height marker against the outer rim of the scale to manually set minimum height.

POINTER MASK

The height pointer will move behind a mask when the height exceeds 5000 ft, when there is a fault or when the equipment is switched off.

ON-OFF/PRESS-TO-TEST SWITCH

The combined two position rotary ON-OFF/PRESS TO TEST switch provides the following controls:

ON/OFF — All power supplies to the equipment are switched on or off.

PRESS TEST — Pressing and holding the switch initiates the BITE which checks the complete transmitter-receiver unit and indicator. The antennas and cables are not tested.

Central Warning Panel

R ALT CAPTION

The amber R ALT captions, on the front and rear CWPs, illuminate to indicate a failure in the RA equipment, or an unlock condition when TF mode on the AFDS has been engaged and the TFR gets no ground returns.

RA OPERATION

After ON has been selected and a warm-up period of approx. 1 min has elapsed, the height pointer will move from behind the mask position to indicate height above ground.
If there is a minimum height requirement, the height marker may be set to the desired minimum height level. Before using the low height warning facility, a confidence check may be carried out by setting the height marker to a height value above that at which the aircraft is flying, thus ensuring that the low height warning indicator, the head up repeater lamp and the warning tone are functioning.

Bite

The interruptive BITE is initiated by pressing and holding the PRESS TO TEST button. If the test is successful the indicator displays a height of 100 ± 10 feet. cross-checking with the HUD and monitoring of the low height warning should be performed.

NOTE

This test is inhibited when operating in TF or RH modes.

RA Malfunctions

If the signal is lost for more than 0.4 sec the FAIL flag is shown on the RAD ALT.

UNLOCK CONDITION

In an unlock condition, RA reverts to an internal memory search mode in which the last valid signal height will remain for 1 second. The FAIL flag will indicate the unlock condition. Only with TF mode engaged, the amber R ALT caption will illuminate. On the HUD the height will occult, but R remains. Correct height is re-displayed on receipt of RA re-validity data.

NOTE

In unlock a CWP caption may appear which will cause an erroneous CMP "fail" indication.

RA Failure

If there is a power failure inside the RA equipment, the amber R ALT captions on the CWPs will illuminate. All radar height information will disappear and selection of an alternative height sensor (e.g. BARO) is required.
When flying in RH mode with AP engaged AUTO P will illuminate to indicate the failure. In this case, AP will be disconnected after wings level and an OLPU command is established. RH is automatically disconnected.
If TF has been selected and no TFR returns are received, a shallow climb command is generated. Discontinue TF flying (especially over sea).

PROCESSING

MAIN COMPUTER SYSTEM

The MC system, when loaded with the operational flight program, performs the major role in navigation and weapon aiming. This role ranges form logical decision making (for navigation moding) to complex trigonometrical calculation (for position fixing and weapon aiming).
A continuous BITE facility is provided for the MC.

Power Supply

The MC and IFU 2 are supplied with three phase 115 V/400 Hz AC power from the AC busbar XP3. IFU 1 is supplied with the same power from the AC busbar XP1. The MCCP is supplied with 28 V DC from the essential busbar (PP3).
The system consists of the Interface Units 1 and 2 (IFU 1 and IFU 2), the Main Computer Control Panel (MCCP) and the MC itself. The computing system, including the majority of the avionic systems, is shown in Figure 4-31.

Main Computer (MC)

The MC, using signals supplied by navigation and height sensors and other various equipments, continuously calculates parameters and produces navigational data, display inputs and weapon release signals.
The MC stores these data and controls signals in the memory. Access in made via an automatic selection of data made by the MC itself and via controls/displays in both cockpits. Data are then read from the memory and continuously processed by the computer and transduced to the appropriate displays.

Interface Units (IFU 1 + IFU 2)

Equipment which receives and transmits data in digital form is directly linked to the MC. Equipment which does not possess this facility is linked to the MC via IFU 1 and IFU 2. The IFUs provide digital/analogue and digital/discrete conversion facilities.
IFU 1, in general, serves the front cockpit and IFU 2 the rear.
IFU 1/2 malfunctions such as power supply failure, input voltage out of limits or temperature overheat

COMPUTING SYSTEM DIAGRAM

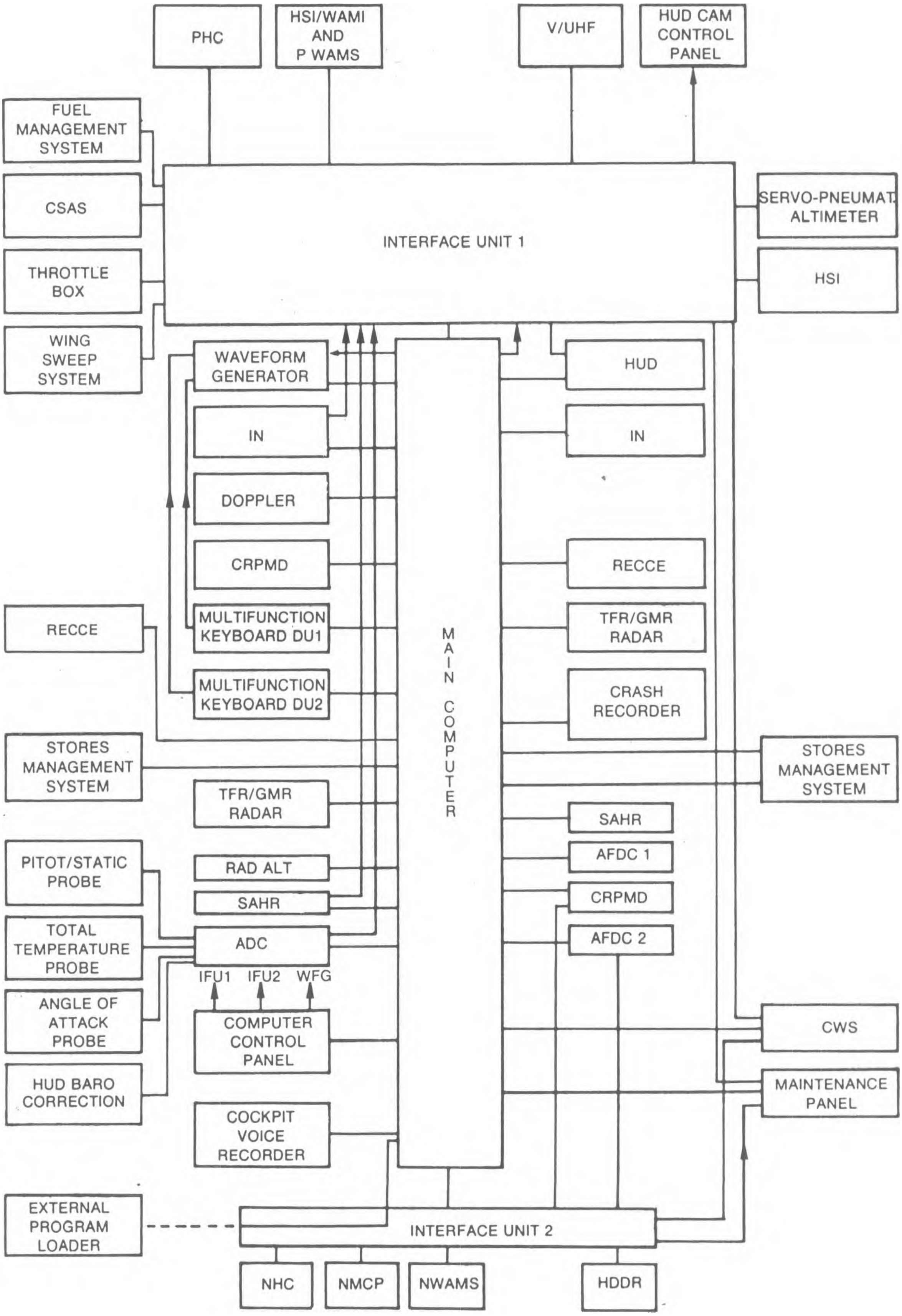


Figure 4-31

are indicated by the IFU 1/IFU 2 caption on the CWP.

Main Computer Control Panel (MCCP)

The MCCP (Figure 4-32), located in the rear cockpit, provides power supply switching facilities for the MC, IFU 1 and 2, and WFG. It also provides indications of program loading progress and faults by a LOAD-FAIL indicator.

MC POWER SWITCH

The two-position ON/OFF MC power toggle switch connects the MC power supplies. It is locked when in the ON position and shall be pulled before it can be set in the OFF position.

PROGRAM LOAD/FAIL INDICATOR

The LOAD/FAIL indicator includes the upper white caption LOAD, which illuminates during program loading, and is extinguished when loading is successfully completed, and the lower amber caption FAIL, which is illuminated when the MC detects a program loading or in flight failure.

WAVEFORM GENERATOR POWER SWITCH

The three position WFG toggle switch provides the following selections:

ON-OFF Controls WFG power supply.

TEST WFG interruptive BITE test is initiated and a Test format is displayed on the TV/TAB.

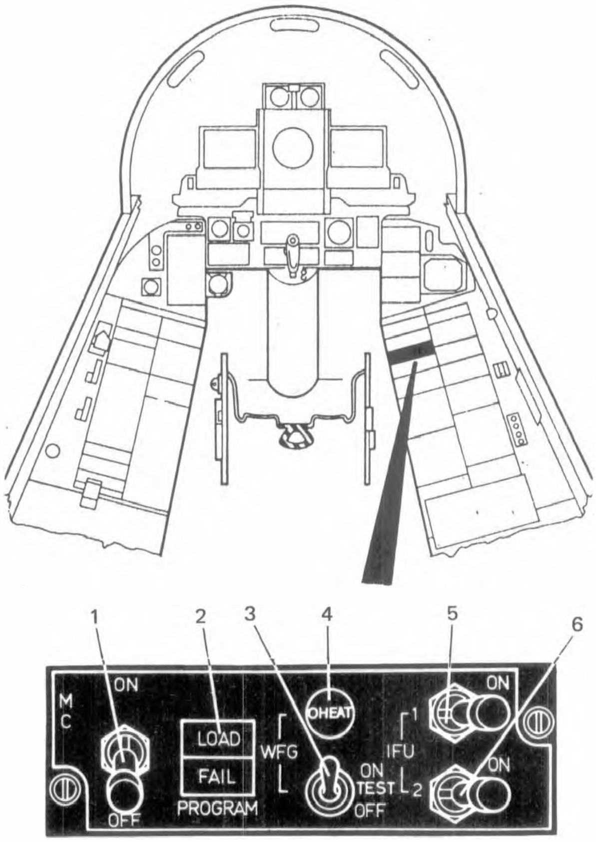
OVERHEAT INDICATOR

The OHEAT indicator illuminates amber when the WFG overheats or a failure is detected in WFG BITE operation.

IFU 1/IFU 2 POWER SWITCH

The IFU 1 power switch controls the IFU 1 and HSI power supplies.
The IFU 2 power switch controls IFU 2 power supplies.

MAIN COMPUTER CONTROL PANEL



1 MC power switch
2 Program load/fail indicator
3 Waveform generator switch
4 Waveform generator overheat indicator
5 Interface unit 1 switch
6 Interface unit 2 switch

Figure 4-32

Central Warning Panel

CMPTR CAPTION

A failure within the MC system, resulting in computer shutdown, is indicated by the illumination of the amber CMPTR caption on the rear CWP.

IFU 1/IFU 2 CAPTION

IFU malfunction as power supply failure or temperature overheat is indicated by the illumination of the amber IFU 1/IFU 2 captions.

Bite

The power supply to the MC together with the internally produced power supplies are monitored by the MC for out-of-tolerance condition.
Two temperature sensors are built into the computer. If power supply or temperature faults are detected the computer will shut down. Provided a program is loaded and the faulty parameters return to an acceptable level, the computer will automatically restart.
Principal computer functions are tested either in an interruptive or in a continuous BITE program.
An interruptive test is performed after MC switch on and during program loading. If a defect occurs, the amber CMPTR caption on the rear CWP will illuminate and system time indication will stop on the TV/TAB. If a defect occurs during program loading, a FAIL indication is shown on the MCCP.
The memory module, the central processor unit and the input/output interfaces are continuously tested.
A fault, detected by the BITE, will be indicated by the CMPTR caption on the CWP.

MC OPERATION

The MC, IFUs, WFG and TV/TABs shall be ON before a program, map film data and mission data can be loaded. Confirmation of correct system functioning is given on the CWP when the captions CMPTR, IFU 1 and IFU 2 are not illuminated.

Software Package

Any program entered into the MC memory overwrites the previously stored program. The Enhanced Ground Test Facility (EGTF) is co-resident with the Operational Flight Program (OFP) and can be selected only when the aircraft is on ground.

OPERATIONAL FLIGHT PROGRAM (OFP)

The software program is fed, via a tape, into the MC and is called the Operational Flight Program (OFP) which includes integrated navigation and weapon aiming functions. The software load is the medium which carries the program in a form acceptable to the MC.

The OFP is a software structure, based on a number of task packages. All tasks are activated in a predetermined interation rate. When load with the OFP, the MC provides the following functions:

- Processing of vertical and horizontal navigation data from the basic sensors and the incorporation of position fixing data.
- Calculation of steering demands against a stored automatic flight plan, or against a route manually called up during flight, or for attack on a target.
- Automatic and manual navigation moding and fixing sensor control.
- Calculation of pointing angles for the displays and sensors and processing of the angle, range and height data from these sensors.
- Calculation of ballistic trajectory of bombs for weapon aiming and release cues for weapon release.
- Coincident display of navigation, fixing, and weapon aiming data on the TV/TAB. CRPMD/RPMD, and HUD, to enable the crew to monitor automatic system performance, or to fly the aircraft manually.
- Calculation of Kalmar Filter (KF) error probability.
- Data status checks and inflight monitoring.

SYSTEM CHECK

A continuous/interruptive test facility is provided for the MC. Using the Enhanced Ground Test Facility, the Inflight Monitor, and the Snap Shot Data Recording, a large number of equipment are involved in the overall test configuration.

INFLIGHT MONITOR (IFM)

The IFM runs throughout the mission when the CAS of 105 kt has been passed increasing. Whenever an invalid status of a specified system parameter is recorded the IFM enters the fault data in a designated area of the computer store.
Inflight a flashing cross indicates the malfunction and by pressing PLN a failure status indication will be displayed on the TV/TAB Plan format. This information is not available on any other cockpit indication and may influence aircrew decisions relating to mission abort or change.

SNAP SHOT RECORDING (SSR)

The SSR is a programmable facility. After a PGS recorded steering tape is entered into the MC via CVR before flight, the SSR is activated in flight to record a variety of specific data.

It reacts to four different type of events; W, X, Y type recordings normally being used by maintenance personnel, and Z type recording where replay is of primary benefit to the aircrew. The Z type recording takes priority over all others. SSR storage capacity limits the recording of Z type events to a maximum of 7.
The recording of Z type events (data sets) is enabled and commences with a continuous updating by running through various monitoring/readiness stages.

In a Planned Attack with Bombs, the first stage enables the recording if the following conditions are met:

- HIGH LOFT/LOW LOFT selected on the NWAMS
  and
- Phase 2/Phase 3 selection made on the PHC for the first time
  or
- HIGH LOFT/LOW LOFT not selected
  and
- Range to Target (along track) less than 3NM

During the second stage, the data sets are recorded and continuously updated whenever Time-to-Release is less than 18 msec. All data recording is stopped at the beginning of the third stage, either by the weapon release cue of the MC or the no-release code of the SMS to the MC, thus freezing and storing the last data recording cycle.

In A/A or AGG mode, the recording will be started:

- when the trigger is squeezed

In TOO, CCIP, the recording starts:

- when the Weapon Release Button (WRB) is pressed for the first time.

When delivering a weapon package (bomb stick) with selections made via the QS and INT weapon parameter selector buttons on the WCP1, data are recorded at each individual MC release cue.

SNAP SHOT STEERING DATA

The MC is able to identify SSR steering data entered by a prerecorded cassette only if the following identification sequence is added to a set of information data prior to the closing symbology (.../+):/S – Z (Dash, Blank, Z)
Previously recorded SSR (storage) data are erased from the storage area either by a new SW loading, or by a new entry (/S), or by the aircraft passing 105 kt on the next takeoff.

ENHANCED GROUND TEST FACILITY (EGTF)

The EGTF provides a facility for the rear cockpit to inform about equipment/systems status by using the Equipment (EQM) format. It also provides a replay of recorded inflight parameters of failed system with pre-defined real-time information about serial digital MC input data by using the subsidiary IFM format, and in addition a Snap Shot Display (SSD) format for event data recording, and the Initial Data Display (IDD) format (refer to TV/TAB Formats).

OPERATIONAL FLIGHT PROGRAM LOADING

This operation is done by the ground crew. The OFP is generally supplied on magnetic tape. Two types of tape pack are currently available; a cassette used by the CVR to load programs directly into the MC and a cartridge used by the ground loading unit (GLU) to load programs via IFU 2.
OFP tapes are identified by a code, e.g. T-P-SW-1107-01-P; the first digit of the four figure group identifies the pack, i.e. 1 for a cassette and 2 for a cartridge (this digit is replaced by an X when the program code is displayed on a TV/TAB); the last three digits identify the particular program. The two figure group is always 01 for OFP tapes. Each OFP tape has a related modification number. The identify of an OFP loaded into the MC is automatically displayed on the right TV/TAB after MC and TV/TAB switch-on.

Supplementary Data

After the OFP has been loaded, supplementary data are added which are pertinent to the sortie. The data are contained on a magnetic tape in cassettes and are available for mission, map definition and for special weapons. The tapes are generally compiled on a Cassette Preparation Ground Station (CPGS) and loaded into the MC via CVR. The data can be modified during flight by crew switching actions and equipment mode information.

CRPMD MAP FILM DATA

Map film data are used to determine the constant map film strip data and to display the map film references. Three map slide along- and across-film data are displayed, followed sequentially by fifteen locations for display of the rectangular map area coordinates, scales and along film data.

CRPMD MAP FILM DATA LOADING

Map film data are loaded into the MC by using either approved RDE cassettes and/or the TV/TAB SYN key facility for manual data insertion.
For RDE six films are available at present as follows: AB. C. D. E. F. and G. (Groose Bay).

NOTE

Use the currently distributed edition of film only. The same film edition is available for the front and rear cockpit.

Using the SYN key on the Data keyboard, map data can be loaded and, after ENTER, map film reference is displayed in the ROL.

MISSION DATA

Mission data consist of the steering route and the fixing route. The steering route is a sequence of destinations to be overflown and the fixing route is a sequence of planned fixpoints. The MC can store up to 80 destinations in two sets, designated primary and secondary mission data stores, but only one set of data at a time can be used by the MC 30 destinations by Rapid Data Entry (34 by manual insertion via MFK) are used for the Automatic Flight Plan (AFP). The remaining destinations are spares and can be called up for replanning a mission during flight, or extending a mission beyond the MC flight plan capacity. The 30 destinations may comprise a combination of between 2 and 29 steering points and up to 12 fixpoints. Mission data provide the MC with the following navigation data which can be displayed by the TV/TAB when the appropriate selections are made on the MFK.

- Scaling and coordinate data associated with TV/TAB display Plan format.
- List of fixpoints, waypoints, targets and offsets, including all necessary lat/long and height AGL, range, and bearing, planned groundspeed, time over target, and CRPMD map-slide references.

NOTE

- Exchange of mission data store area of primary and secondary data can be accessed as required by pressing the MD1/MD2 MFK button.
- The exchange of mission data can only be performed prior NAV MODE selection, or with MAN-HOLD mode selected.

MISSION DATA PREPARATION

Mission data are prepared via the Cassette Preparation Ground Station (CPGS) stored by a CVR magnetic tape cassette or manually inserted via the TV/TAB keyboard. For cassette preparation a certain procedure shall be followed regarding TACAN fixpoints: in the listing of destinations the first in row following a TACAN fixpoint shall have a designator (☐ , V, R, O); otherwise when the cassette is loaded into the MC via RDE , subsequent destinations will be treated as TACAN fixpoints with TACAN PROMPT (dashes on the display positions for channel and variation).
On the TV/TAB a RDE FAULT will be indicated.

MISSION DATA LOADING

Mission data are loaded into the MC before flight by the navigator. This could be done via the RDE facility from a CVR tape cassette previously prepared or manually via the TV/TAB keyboard.

Rapid Data Entry (RDE). Mission data are normally loaded from a pre-recorded magnetic tape contained in a cassette (Figure 4-33). Before fitting the cassette into the CVR the navigator confirms that the CVR is not engaged but MC and both TV/TABs are on.
With a cassette carrying pre-recorded mission (and map) data, the following operation should be performed:

- The master switch is set to OFF, and mode selector to REPLAY. Now insert the cassette, and switch to STBY. Set the tape position 3-digital readout to 000 and start by setting the mode selector to DATA ENTRY and the master switch to START position. When the cassette starts to run, the computer carries out a parity and syntax check. The first word is a control word and is automatically checked by the MC. A correct control word causes the RDE mode to be entered, both TV/TABs to be cleared and LOAD on the MCCP to be displayed. A fault

RAPID DATA ENTRY ROUTINE

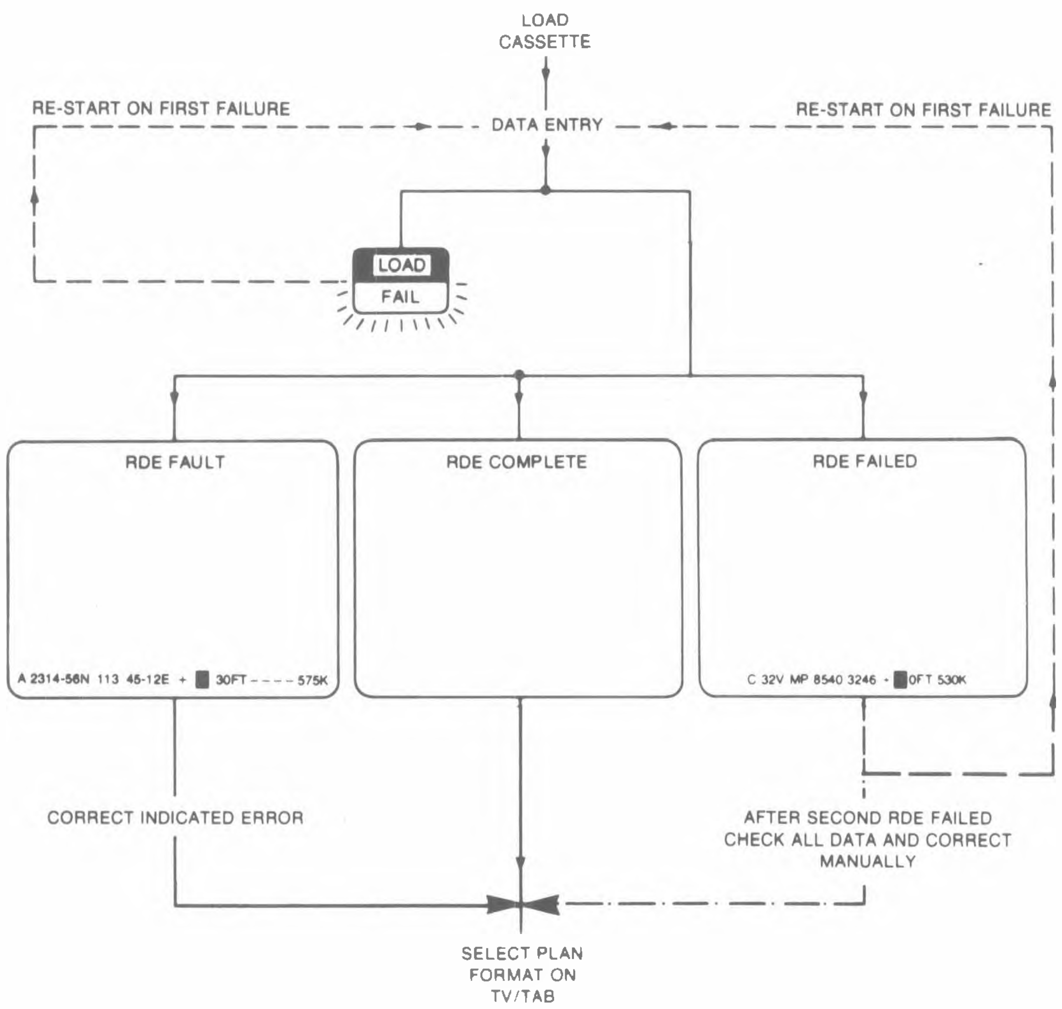


Figure 4-33

detected in the control word is indicated on the MCCP by illumination of the FAIL lamp.

- If the FAIL lamp illuminates during loading, the tape should be run in reverse until the tape position indicator stops counting and the FAIL lamp is extinguished.

- If the FAIL lamp illuminates again when the tape drive is resumed, the recorder should be switched to STBY and the cassette removed and re-inserted or changed. Recycle the MC if required.

- After approx. 10 sec, if data entry has worked properly, the word RDE COMPLETE is displayed on the TV/TAB (for RDE format, see under TV/TAB description). Then tape position counter indication can be noted as the beginning of the inflight recording and the tape should not be reversed beyond this point unless a repeat RDE is required.

Manual Data Insertion. Manual insertion of mission data and system data is performed using the MFK on the TV/TAB.
Each line of inserted navigation information from mission data is selected for display in the ROL on the TV/TAB.
When the appropriate characters of a particular ROL have been inserted, the data are entered into the MC via the ENTER key.

In addition to the data insertion via TV/TAB MFKs and RDE, data may be inserted by means of RPMD/CRPMD Slew or MKR facility. Only the plan position of waypoints can be inserted by this method. Change of destination designator and additional information, e.g. height and GS, shall be inserted again via TV/TAB MFKs.
(Refer to TV/TAB operation and to example of Mission Data Plan).

Data Storage. The following data can be stored into the MC:

- Grid data (GRID) comprises the centre of the Plan format reference coordinates and the display scale factor in NM/cm on the TV/TAB, utilizing maximum screen area.
- Present Position (PP) is designated by the symbol followed by the coordinates and height above MSL.
- Destination (DEST) is a generic term for all positional information, including all waypoints, fixpoint, targets and offsets. Up to 80 destinations can be stored in the MC, 40 in MD1 and 40 in MD2.
- Waypoints (WPT), 17 are available, each designated by a letter between A and S inclusive (omitting I and O).
- Fixpoints (FXPT) are destinations used to update the aircraft's position. Each fixpoint is designated by a number (1-9 inclusive) suffixed by a symbol (R – radar, V – visual, □ – radar and visual, O – on top, T – TACAN) denoting the type of fix.
- Targets (TGT) are each designated by one of three letters X, Y, or Z.
- Offsets (OFS) are known positions near the target which enable the aircraft's position to be accurately fixed relative to the target. Nine OFSs are available, three for each possible target. Each offset is designated by the target letter, a number (1, 2 or 3) and a symbol denoting the type of fix: R – radar, V – visual, and □ – all sensor OFSs. The designator is followed by the offset's distance in feet along northings and eastings from the target or in range and bearing (NM/degrees) and absolute height in feet.

NOTE

Northings and eastings values should be limited to a maximum resultant radial value of 64.999 feet to avoid computation errors in the MC when converting the northings and eastings into range and bearing.

- Route (RTE) comprises a list of destination codes for waypoints, fixpoints and targets in enroute sequence, followed by a list of fixpoints in order of acquisition. The route shall contain at least two steering points.
- Time-Over-Target (TOT) is the time at which the aircraft is required to arrive over the target or at one designated destination. It is displayed on the TV/TAB in hours, minutes, and seconds with two digits each and labelled with the relevant destinations.
- Intelligence Points (INT), i.e. points to be avoided, are designated 01-20, each prefixed by a pointer and a letter, denoting it's category; for example:

  A – air traffic
  B – flight safety
  C – other requirements.

  The coordinates (normal/UTM/R/B) of the point follow the designator.
- Threshold Heights as planned maximum or mimimum height in the threat area given for the passive warning radar. These heights are included in the mission data and may be displayed as two five digit read-outs on the TV/TAB.

During a sortie the navigator can alter the mission data using the MFK.
Temporary computer workstores to hold unplanned destinations are available to the pilot and navigator. The stores are designated U, V, W for the pilot to enter coordinates obtained from STORE PP and RPMD, and T for the navigator to enter coordinates obtained from the CRPMD.
In addition, planned groundspeed (GS) for each leg of the flight can be stored for time early/late calculation.
The additional destinations are spares and can be called up for replanning a mission during flight, or extending a mission beyond the 30 route stores of the MC flight plan capacity.

NAVIGATION FACILITIES

Navigation facilities are provided by computerized navigation moding, fixing, and steering systems. The navigation geometry of a sortie is controlled by the computer stored OFP, supplemented by mission data. In processing the navigation geometry parameters, the MC instructs the AFDS to apply steering commands to the Command and Stability Augmentation System (CSAS).

Navigation Processing

The terms used in the programmed navigation geometry in Figure 4-34 are defined as follows (see Figure FO-19):

Planned track. Track defined by two successive route destinations or by a present position and a destination, taking account of the aircraft turning radius.

Actual track. Angle between the tangent to the local meridian in the present position and the horizontal component of the aircraft's velocity vector.

Direct track. Instantaneous track from the present position to a define destination for the last 20 NM to go.

Command track. The computed track that commands planned track, actual track, and direct track.

Cross track distance. Distance between planned track and present position along a line perpendicular to planned track.

Track angle error. The difference between actual and planned tracks.

Track without turning circle. Initial great circle track used to determine direction of turn.

Next planned track. Great circle track between next destination and next but one destination.

Distance along planned track to next destination. Distance between next destination and the intersection of planned track with a perpendicular passing through the present position.

Distance to next destination. Distance from present position to next destination.

Required track. Track to intercept and regain planned track.

Planned turning circle. A circle to which the next planned track is tangential and the planned track is tangential at the next destination.

COORDINATE SYSTEM

Three different coordinate systems are used for velocity calculations and are: Aircraft system, Platform system and Weapon aiming system. The three systems are defined as follows:

- Aircraft system (X/Y/Z) – Axis X is in the roll axis and is parallel to the longitudinal fuselage datum (LFD). Axis Y is in the pitch axis and is perpendicular to axis X. Axis Z is in the yaw axis and is mutually perpendicular to axes X and Y.

- Platform system (N/E/V) – Axis N is in the direction of local geographical North. Axis E is in the direction of local geographical East. Axis V is in the direction of local gravity (local vertical).

- Weapon aiming system (H/D/V) – Axis H is the projection of axis X on to the horizontal plane. Axis D is the projection of axis Y on to the horizontal plane. Axis V is in the direction of local gravity (local vertical).

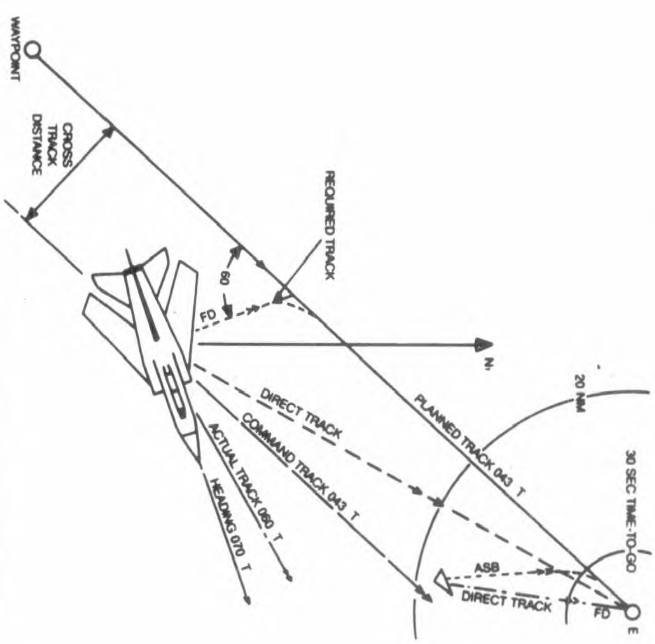
PROCESSING

Corrected navigation velocities produced by coordinate transformation are calculated by the MC:

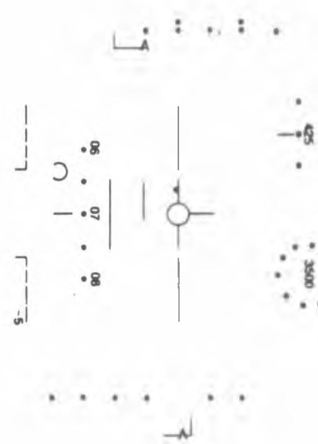
- Velocity measurement input to the KF is the average between IN and Doppler velocities in the weapon aiming axes. Velocities Vn, Ve from the IN are transformed to Vh, Vd and Doppler velocities that originate in the aircraft axes Vx, Vy, Vz are transformed to the weapon aiming axes Vh and Vd using IN bank and inclination angles. The Doppler velocity signals are smoothed to minimize fluctuating noise, but prior to the transformation process, the noise is used as a confidence check of the Doppler system operation. The KF corrected values of best Vn, Ve, Vh, Vd and best heading are used for the computation of drift angle, track, and groundspeed.

- Inputs of attitude from the SAHR, and velocities from the Doppler are used in secondary navigation calculations to provide MC outputs of incidence, ground speed, turnrate, vertical velocity, and drift angle for monitoring purposes

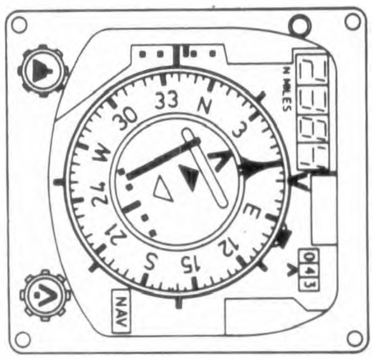
TRACK STEERING DISPLAYS



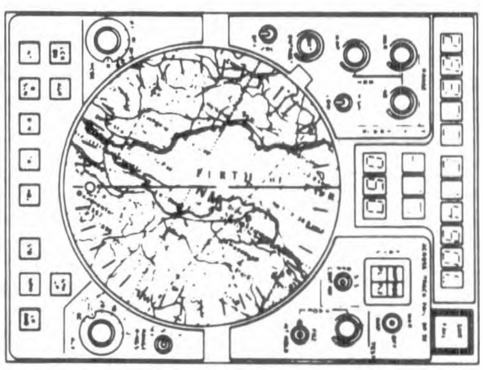
NAV DATA	DISPLAY
PLANNED DEMANDED TRACK COMMAND TRACK	HSI: TRACK POINTER AND COUNTER TV/TAB: READOUT AND TRACK PARALLELS
REQUIRED TRACK	HUD: FD COMMAND (RANGE > 20 NM) AZIMUTH STEERING BUG (>30 SEC TO GO)
DIRECT TRACK	HUD: FD COMMAND (RANGE < 20 NM) AZIMUTH STEERING BUG (<30 SEC TO GO)
ACTUAL TRACK	HSI: ACTUAL TRACK POINTER TV/TAB: CENTER LINE AND SCALE CRPMD: READOUT AND TRACK LINE
HEADING	HUD: HEADING SCALE HSI: COMPASS CARD TV/TAB: HEADING POINTER
CROSS TRACK DISTANCE ERROR	HSI: LATERAL DEVIATION BAR (MAX. 4000 FT) TV/TAB: READOUT AND TRACK PARALLELS



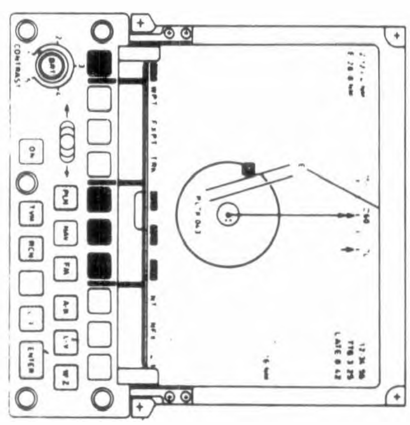
HEAD-UP DISPLAY



HORIZONTAL SITUATION INDICATOR



COMBINED RADAR AND PROJECTED MAP DISPLAY



TV/TABULAR DISPLAY

Figure 4-34

in the TFR. The monitoring outputs are derived from Doppler and SAHR independent of the IN.

- Wind data are calculated from the corrected values of VH and VD together with the True Airspeed Horizontal component (TASH) and the best value of True Heading (TH). TAS from the ADC is resolved using IN inclination to give TASH.

- Vertical navigation inputs to the MC from the IN. ADC, Doppler, and SAHR are computed to provide the parameters of best available height, vertical velocity, climb angle, and elevation incidence. Pressure altitude from ADC is converted to BARO/IN height at the IN and then processed in the MC with height fix error to produce best available height (system height). BARO IN is an optimized height parameter of pressure altitude and IN vertical acceleration, this combination giving improved short term response in maneuvering flight.

- Compensation terms for the SAHR are derived from VN, VE and latitude which are computed from Doppler velocities and SAHR output data. These compensation terms are generated and fed back to the SAHR to compensate for earth rate, transport rate, Coriolis and vertical drift.

NAVIGATION DATA

Integrated navigation system's data are presented to both crew members via their respective cockpit displays.
The displays from which a particular navigation parameter is determined are shown in Figure 4-35.

NAVIGATION MODES AND OPERATION

The moding facility provides selection and control of navigation modes which depend on the availability and condition of the sensors. The navigation sensors IN, Doppler, SAHR, and ADC deliver the basic data for navigation moding. Four navigation modes in conjunction with the MC are provided and controlled via the NAV MODE selection buttons on the NMCP: Main mode (MAIN), Inertial Navigation mode (IN), Doppler/SAHR mode (DP + SR) and Air Data/SAHR mode (AD + SR).
SR). In the event of MC failure, steering information can be derived directly from the INCDU (Pure IN).

During the rear cockpit checks each required sensor will be set up and aligned. After all necessary conditions are fulfilled, the MC causes the upper white caption of the appropriate mode on the NMCP to illuminate and indicates that particular mode is available.
Navigation moding is then initiated by pressing the required MODE button of which the appropriate lower green SEL caption indicates the selection. This serves either for automatic or for manual mode selection:

Automatic Selection. When the MAIN pushbutton is pressed, the MC automatically selects the best navigation mode available: if the MAIN mode is available this mode is selected; if the MAIN mode is not available the next degraded mode available will be selected.
If once a degraded mode is selected by the MC, the MAIN mode cannot be reselected, unless the MC is recycled. With a de-activation of the MAIN mode the upper caption of the MAIN pushbutton (availability) extinguishes.

Manual Selection. When a degraded mode is available it can be selected manually by pressing the appropriate pushbutton.
This selection will cancel the MAIN mode availability.

Manual Override Selection. With one degraded mode currently in operation, any other degraded mode available can be alternatively selected, regardless of higher or lower performance. The last remaining mode available cannot be deselected.

MAIN MODE

In the MAIN mode, the IN is the prime source of velocity, attitude, and heading information: the Doppler supplies in addition 3-axes velocity data.
The MAIN mode uses the KALMAN FILTER (KF) software routine to provide the best estimate of errors and optimum compensation of errors in sensor inputs to the MC.

Kalman Filter Software Routine. Data are refined by the KF technique, which statistically compares Doppler and IN velocity errors related to time against an internal model e.g. the KF mixes the error behaviour of the IN velocity with the error behaviour of the Doppler velocity, marking use of position fixing data. If obtains the best velocity estimates by calculating the error and correcting the outputs.
Should the compared errors exceed the calculated probability limits, a flashing R appears on the

NAVIGATION DATA/DISPLAYS

FUNCTION	DATA	DISPLAY
Position	Present position Present position error Next destination Next fixpoint Reversionary destination (D31/D32) (Track and Distance)	TV/TAB — CRPMD-INCDU-RPMD TV/TAB TV/TAB-INCDU * TV/TAB INCDU — HSI — HUD
Direction	Heading (True) Heading (Magnetic) Variation Actual track Planned track Command track Track angle error Drift angle Next planned track Track without turning circle	TV/TAB-INCDU-CRCU-HSI-HUD HSI-HUD CRCU TV/TAB-CRPMD-HSI TV/TAB-HSI TV/TAB-INCDU * INCDU TV/TAB-INCDU-HSI TV/TAB TV/TAB
Height	Barometric Radar BAA	HUD, BARO ALT TV/TAB-RAD ALT-HUD TV/TAB
Velocity	Wind Vertical	TV/TAB HUD-VSI
Speed	TAS KCAS MACH G/S	TV/TAB HUD-AFDS HUD-CSI TV/TAB-INCDU
Distance	Distance to next destination Cross track distance Distance to next fixpoint	TV/TAB-INCDU-HSI * TV/TAB TV/TAB-CRPMD-INCDU-HSI-HUD
* TO IN DESTINATIONS ONLY (D31/D32)		
Time	System time Time to go Late/Early Time over target	TV/TAB TV/TAB TV/TAB-HUD TV/TAB
Other functions	Range (measurement) Range and Bearing (to TACAN) Bearing (to beacon) Range and Command Track (to WPT/TGT) Fixing Fuel state	CRPMD HSI in TAC in TAC in NAV CRPMD-HUD TV/TAB

Figure 4-35

TV/TAB, indicating that Doppler velocities are not presently being used for Kalman Filter calculation. The MC takes all the errors into consideration when calculating the likely present position. The software routine traces the errors from the calculated PP to the destination. This back tracing of errors also enables the dynamic parameters to be corrected, thus cutting down the cumulative errors normally associated with an IN system (refer to Figure FO-20).
The error estimate is represented on the TV/TAB Navigation format by a circle with estimated PP as its centre, and has a radius such that the true PP lies inside the circle within a probability of 95%.
In an open loop process, the KF adds its estimate to the data from the sensors. This means that the output signal from each sensor is corrected and not the sensor itself. In this way, the IN remains independent form the MC, e.g. the IN platform cannot be influenced if the KF software malfunctions.

Stand Fixing. Stand fixing function in the KF software routine is provided to reduce those navigational errors which build up during the time the aircraft is stationary with MAIN mode selected.
(This is achieved by setting IN horizontally sensed velocity output values below 3 kt to 'O'. Changes of Vn, Ve and turnrate are checked every 10 sec. Stand fixing is interrupted whenever Vn, Ve is greater than 0.266 kt, or turnrate is greater than 0.11°/sec within these intervals).
Although Stand fixing is provided, OTF prior taxiing and/or takeoff is still recommended to cut down those errors which may arise during taxiing, and to update the height channel. OTF also takes care of errors which may arrive while the aircraft moves at velocities below the Stand fixing or when the IN on a static aircraft provides velocity outputs above this threshold.
The optimum of MAIN mode can be degraded by:

- Loss of Doppler velocities
- Loss of ADC data (vertical)
- Poor IN performance.

A flashing 'R' symbol displayed on the TV/TAB advises the navigator to check the Doppler and IN systems for errors in performance.
If IN is the error source, the navigator shall select the DP + SR mode immediately to avoid possible errors of climb/dive bar display on the HUD.

NOTE

If once a mode other than MAIN has been selected first, MAIN mode can only be selected after MC restart.

Reversionary Modes

All modes other than the MAIN mode are reversionary modes. In the event of equipment failure, the MC automatically selects the next most accurate mode available.
The modes in order of diminishing accuracy are:

- IN/MC
- DP + SR
- AD + SR

Each reversionary mode may be manually selected by the navigator. With a reversionary navigation mode selected, the accuracy is degraded, but fixing may increase it.

IN MODE

In the IN mode, KF processing is removed so that MC uses inputs from the IN for horizontal navigation calculations without Doppler velocity correction. It follows that this mode is a degraded mode in horizontal performance in regard to the MAIN mode, but vertical channel performance is unaltered.

NOTE

Loss of ADC data further degrade the IN mode (loss of ADC data has little effect on horizontal data, however, the vertical channel is largely effected).

DP + SR MODE

The DP + SR mode is the next best move available should the IN fail. In this case the mode is automatically selected by the MC. Doppler velocities in the aircraft axes are transformed to weapon aiming axes and geographical axes, processed with SAHR and ADC data, to provide outputs of present position, groundspeed, drift, incidence, and turn rate. During Doppler unlock periods the DP + SR mode is retained, but groundspeed is derived from stored wind data and TASH (refer to Figure FO-21).
No attitude monitoring is available if this mode is used and vertical velocity monitoring is degraded.

NOTE

- As a planned navigation mode, DP + SR may only be used in day time flight under VMC.
- Whether DP + SR is used preplanned or if demoding occurs during flight, HUD is not to be used as the primary reference (vertical speed) for instrument flying.

The mode can be degraded by:

- Doppler unlock condition (horizontal).
- Loss of ADC data (vertical).

AD + SR MODE

The AD + SR mode is automatically selected by the MC should both the IN and the Doppler fail. SAHR attitude and heading are used to determine the correct axis for TAS, the primary source of velocity information in this mode. To calculate groundspeed and drift, the stored wind data is used which can only be manually updated via the TV/TAB. All basic navigation data are available from the MC, but are significantly degraded. Vertical channel calculations for elevation incidence are derived from ADC pressure altitude rate (refer to Figure FO-22).
The following condition degrades the AD + SR mode:

- Loss of pressure altitude from ADC

PURE IN MODE

If the MC fails, only Pure IN is available (refer to Figure FO-22). This will be indicated by extinguishing of all mode indicator lights on the NMCP. Pressure altitude from the ADC is used for IN vertical calculations and ouputs of BARO IN altitude, elevation incidence, and vertical velocity are provided by the IN computer. Altitude cannot be updated because height fixing is not possible. On-top-fixing improvement to navigation is possible.
The preplanned route of the AFP stored in the computer is not available and a route is selected by inserting destination (D31/D32) into the IN, replacing each alternately as the waypoint are passed (leap-frog method).
Navigation and fixing facilities are controlled through the INCDU and data are displayed on the INCDU, the HSI, and the HUD.

Steering Computation

Main Computer planned track calculations are based on a great circle planned track between destination and a standard turning circle at each change of track.

NOTE

The maximum leg length chosen between two destinations shall not exceed 680 NM.

The first planned track is computed between the initial PP and the next destination. A standard turning circle is computed as a function of planned groundspeed and a rate of turn of 1.9 degrees/sec.
The direction of the turn is always the shortest calculated to the next track without turning circle. Without groundspeed insertion turn radius is not determined for AFP calculation.
An actual turn may also differ in geometry to the computed turn because of the AFDS steering limits, which require the maximum rate of turn 2 degrees/sec with the scheduled bank angle.
When the distance to go is greater than 20 NM and a cross track error exists, the MC calculates a steering signal to regain track, indicated by the FD.
The intercept angle between the planned and required track is 60°, and the aircraft is steered along an asymptotic curve of which the radius increases with GS to approach the planned track.
At a distance to go of less than 20 NM to the next destination, the MC calculates a new command track (direct steering) indicated by the FD while the azimuth steering bug still indicates a demand to intercept the original track at an angle of 45°. An interception angle can also be estimated by checking PP against planned route on the TV/TAB. At less than 1 NM to go the command track is frozen.

STEERING DATA

Steering signals, calculated by the MC, are fed to the AFDS which produces steering commands to acquire and maintain the command track, either automatically using the autopilot, or manually by following a flight director display.
Steering data comprising:

- Planned track
- Command track
- Actual track
- Required track
- Heading (true or magnetic)
- Cross-track distance

AFDS demands are displayed on the ADI, CRPMD, HUD, HSI and TV/TAB (Figure 4-34).

STEERING MODES AND OPERATION

Track steering is controlled from the NMCP by two pushbuttons enabling selection of AUTO/MAN and STEER/HOLD.
Two basic steering modes are available: Manual Flight Plan (MFP) steering where the aircraft is flown to a single designated destination and Automatic Flight (AFP) Plan steering where the aircraft is flown to follow a planned route through a series of destinations (Figure 4-36).

MFP STEERING

When MFP is in operation, steering signals are related to a manually constructed route; a present leg which is defined by a PP and a destination called up in the Read-Out-Line (ROL).
In this mode the planned track is a calculated tangent extending through a destination from a standard turning cicle, taking into account the actual groundspeed.
The HOLD mode is a submode of MFP steering, with no next destination being available.
When the MC is switched on, the HOLD mode is engaged as soon as a navigation mode is selected. MAN and HOLD caption will illuminate. The command track is the actual track at the instant of this first selection.
By pressing the STEER button. MFP is selected after a destination has been called up. Steering can be achieved to any destination in the TV/TAB ROL or to one called up from the Working Store (WS). With a route being present in the Plan format, a route designator can be overlaid by the writing marker and steering to that position will be provided.
If destinations are called up on both TV/TABs, or the ROL contains a steering information on one TV/TAB and the designator of the route in the other is overlaid by the writing marker, steering information is given to that destination which is indicated on the last operated TV/TAB. If no destination at all is given, pressing STEER has no effect.
If a cross-track error has built up and steering directly to a destination is required, the navigator can update the steering by repeating the MFP selection the relevant destination on the TV/TAB.
The planned track, indicated by the track parallels on the Navigation format, is continuously updated. In the Plan format the original track is retained and will not be updated unless the format the original track is retained and will not be updated unless the format is de- and subsequently reselected, or a new steering selection has been made.
To change a flight leg in the MFP, the HOLD mode is selected temporarily, then the next destination is inserted via TV/TAB and STEER is pressed for re-engage to MFP.
An automatic reversion from MFP to HOLD mode occurs when the distance to next destination along track is zero. MAN and HOLD captions will illuminate.

AFP STEERING

A route stored in the MC is required for AFP. The MC checks if a route is available and processes the first three enroute destination, including initial position, in sequence (see Figure FO-19). The first destination is set "last destination", the second "next destination", and the third "next but one destination".
Therefore the first planned track calculated is the direct line between the first and second en route destination. The next planned track, using planned ground speed, is a tangent projected through the third en route destination on to a standard turning circle. The turning circle touches the planned track and the next planned track. If no groundspeed is inserted for the next leg, computation for zero groundspeed is made, i.e. a direct line between the next and the next but one destination is the planned track.
Within 20 NM distance to the next en route WPT, direct steering si computed continuously. Whenever a flight leg is completed, the next track becomes command track and a new track is succession is calculated, and so on.
With a route stored in the MC and HOLD mode in operation for the first time, the AFP mode is selected by pressing the FLT PLN-STEER buttons. AUTO and STEER will illuminate. If no route is stored or the HOLD mode has already been in operation, pressing the buttons has no effect.
A direct change from AFP to MFP is not possible, but if AFP is in operation, HOLD can be engaged by pressing the FLT PLN button; MAN and HOLD will illuminate. An automatic reversion from AFP into MAN HOLD occurs, when the distance to the next destination along planned track is zero and no next destination en route is provided. The last command track is used continuously for steering reference in HOLD mode. Examples of automatic and manual steering selection are shown in Figure 4-37.
Whenever the MFP mode is in operation, AFP can be selected by pressing the FLT PLN button, provided the next destinations identical to any of the en-route destinations. AUTO and STEER will il-

AUTOMATIC AND MANUAL FLIGHT PLAN STEERING

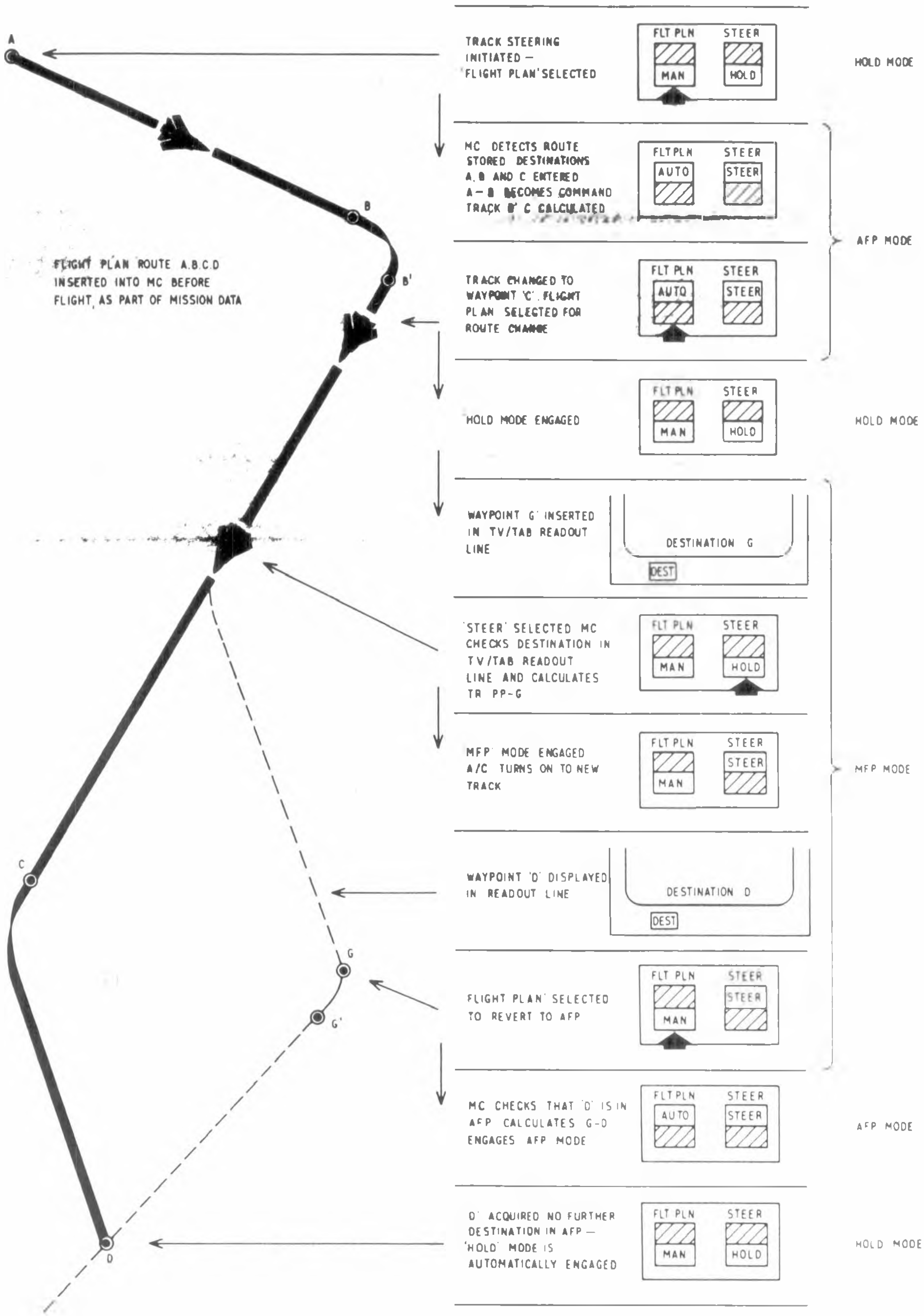


Figure 4-36

STEERING MODE TRANSITIONS

TO / FROM	MAN-STEER	AUTO-STEER
MAN-HOLD	1. Check required DEST is in TV/TAB ROL 2. Press STEER, check MAN-STEER lights on	If FLT PLN not pressed since NAV mode engagement: 1. Press FLT PLN, check AUTO-STEER lights on Otherwise: 1. Confirm DEST in TV/TAB ROL is in AFP 2. Press STEER, check MAN-STEER lights on 3. Press FLT PLN, check AUTO-STEER lights on
MAN-STEER	1. Check required DEST is in TV/TAB ROL 2. Press STEER, check MAN-HOLD lights on 3. Press STEER, check MAN-STEER lights on	1. Confirm present DEST is in AFP 2. Press FLT PLN, check AUTO-STEER lights on
AUTO-STEER	1. Check required DEST is in TV/TAB ROL 2. Press FLT PLN, check MAN-HOLD lights on 3. Press STEER, check MAN-STEER lights on	1. Toggle to required DEST in AFP on TV/TAB ROL 2. Press FLT PLN, check MAN-HOLD lights on 3. Press STEER, check MAN-STEER lights on 4. Press FLT PLN, check AUTO-STEER lights on

NOTE

Steering mode transitions have an effect on AP steering when TRK HOLD is engaged.

Figure 4-37

luminate. If rejoining the route is intended, MAP SLEW is selected and the writing marker in the TV/TAB Plan format is positioned towards the planned track to establish the lead-in point for intercept. Insertion via NHC is made. When the aircraft reaches this point, steering mode can be changed to AFP.

Navigation Updating

Navigation can be updated by either fixing or correction of existing navigation data via TV/TAB.

FIXPOINTS

Fixpoints, inserted within the route, can be used in the AFP sequence. If fixing is required with a DEST different to the one next in sequence, this DEST has to be called up in the ROL, the pressing NFX. A destination out of the displayed route in Plan format can be designated as next fixpoint by overlaying the destination with the writing marker and pressing NFX on the other TV/TAB in NAV format.

If a fix has been taken which was not part of the fixing routine, then the last fixpoint in sequence prior to NFX will be displayed after fixing.

If a fixpoint from the fixing routine has been used, the next in sequence to it is displayed after deselecting the Fix format. If a departure from and subsequent return to the route has been made, resulting in bypassing of a fixpoint, the next required FXPT shall be called up via NFX (the fixpoint required to be next shall be called up in the Nav or Plan format ROL). This will re-estabilish the fixing routine.

When TRACK HOLD is illuminated the navigator shall inform the pilot about steering mode changes, inserts during Phase 1 fixing, or when selecting TACAN on the NWAMS, because this will have an immediate effect on steering signal outputs to the AFDS.

Reversionary Operation

With a MC failure the AFP and MFP facilities are lost. Selection of the reversionary destinations D31/D32 on the INCDU provides steering data.

Fixing (Phase 1/Phase 2)

For fixing, the measuring devices are the CRPMD, the GMR, the TACAN, and the HUD. Phase 1 Stabilized, Phase 1 Marker, and Phase 2 fixes are three dimensional and require a height sensor, which may be RA, GMR, TFR, or BARO IN, for exact position computation. When F/A is selected on the TV/TAB, RDR ALT on the NWAMS is automatically selected for the height channel. It should only be used when the height of the terrain overflown is the same as that of the fixpoint, e.g. height fixing over sea. If not required, RDR ALT is deselected by another sensor selection.
With BARO IN selected, height above fixpoint is calculated from system height and stored fixpoint height, but no height updating takes place.
BAA may be utilized to call up, at any time, the Best Available Altitude for assessment. Additionally it may be selected for MC computation in preference to RDR ALT in the case where RDR ALT has been selected as a reversionary height source to BARO IN.
Without visual ground contact, Phase 1, Radar basic, Lock-on, Marker and Map matching, and TACAN fixing are possible.
In addition, under VMC, OFT and Phase 2 fixes are possible.
Results of Phase 1 fixes, except TACAN fix, can be confirmed in Phase 2.

PHASE 1

If Phase 1 fixing is performed with AP engaged and TRACK acquire selected, undesired heading changes will occur after MC insert with A displayed in the TV/TAB ROL.

PHASE 1 STABILIZED is the most common method used in fixing. The correct position and height of the fixpoint shall be inserted prior to fixing.
Phase 1 is initiated when F/A is selected on the TV/TAB. A height sensor as required is selected on the NWAMS. With the CRPMD in STB mode, the projected map and the display becomes stabilized with fixpoint and active marker at the screen centre. The navigator aligns the marker with the radar video of the fixpoint using the NHC. When the Insert button on the NHC is pressed, marker, map, and radar display are centralized on the screen and the fix error, together with an A or R, is displayed in the TV/TAB ROL. Any number of inserts can be made. If the error is neither accepted nor rejected, but Phase 2 is selected, the error is stored and will be re-displayed when Phase 1 is reselected.
The radar display calculation produces a true slant-to-plan range conversion by using RA or system height, which ever is selected, even for fixpoints, targets, or offsets above the aircraft horizon to permit fixing in Phase 1.

PHASE 1 MARKER is performed with the CRPMD in Normal (NRM) or Look Ahead (LK AHD) mode. The correct position and height of the fixpoint shall be inserted prior to fixing.
The navigator selects MKR in the Fix/Attack format. The NHC and the marker, which are initially positioned at the MC calculated fixpoint and further ground stabilized, become active and the marker is also displayed on the TV/TAB.
A height sensor (RDR ALT or BARO IN) as required is selected. Using the NHC, the marker is slewed to the fixpoint radar return. By pressing the Insert button on the NHC, the fixing error is displayed together with an A or R in the TV/TAB ROL.

PHASE 1 LOCK-ON utilizes the GMR to measure the fixpoint in plan range and height. It is initiated by Phase 1 Stabilized or Marker fix method after the marker is aligned with the radar image and inserted. LCK ON is then selected on the CRPMD where radar video is suppressed after 5 sec and the marker becomes passive. As the radar locks on the fixpoint radar return, a synthetic video bar points to the lock-on position. If the displayed lock-on position is correct, RDR ACPT is pressed on the NWAMS and the ROL is updated with an A or R displayed. Although the ROL does not change after selection of RDR ACPT, radar measurement continues as long as radar lock-on remains.
If RDR ALT is desired during LCK ON, it can be selected and used for height updating. In this case NHC insert is required additionally to the RDR ACPT selection.
If the lock-on position is not correct, LCK ON shall be deselected and the procedure can be repeated after correction of MKR/MAP and new RDR ACPT. New adjustment of the radar display may be helpful to regain a valid lock-on. Threshold should be set to minimum.

HT FIND selects the GMR depression angle for height above ground calculation in medium altitudes (around 5000 ft and above).
When STB on the CRPMD is selected and the range scale is 20 or less, PENCIL and AUTO is se-

lected on the MRCP. With HT FIND selected on the NWAMS, a height line, representing the intersection of the GMR boresight with the ground, is displayed together with the radar picture.
The ELEV TILT control on the MRCP is used to align the GMR height line with the fixpoint image, and the NHC is used to align the computer marker with the fixpoint image.
When the Insert button on the NHC is pressed, the fixpoint relative position is updated in plan range and height.

TF ELEV mode is automatically initiated, after being selected, when the slant range reduces to 2.5 NM. The TFR compares the slant range to the terrain with predicted fixpoint range input from the MC.
When the slant range passes through the value of the MC predicted range, the TFR provides the antenna depression angle measurement data as an output to the MC. This depression angle and the calculated slant range are used in calculating height above fixpoint.
When in TF mode with TF ELEV selected above 2.5 NM, RDR ALT is automatically used by the system until the slant range reduces to the required range. Then RDR ALT caption on the NWAMS is extinguished.

PHASE 1 MAP MATCHING is limited to the accuracy of CRPMD map drive and GMR resolution in relation to the selected scale (20, 40 or 80 NM). Map matching may be used whenever sharp contours are displayed by the radar.
STB on the CRPMD is selected prior F/A on the TV/TAB. The CRPMD will stabilize at the point currently under the screen centre which becomes a dummy fixpoint and the NHC is operated to slew the map until it coincides with the radar image. Pressing Insert, the fixing error is displayed on the TV/TAB ROL together with an A or R.

OTF may be carried out on the next planned fixpoint in the fixing sequence, or on an unplanned fixpoint by inserting the coordinates via the MKR or RPMD/CRPMD map slew function or via TV/TAB insertion in the ROL and selecting NFX. After confirming the fixpoint coordinates, F/A on the TV/TAB and OTF on the NMCP are selected. The OTF caption on the NMCP and the STORE PP caption on PWAMS will illuminate and the PP button shall be pressed when overhead fixpoint.
PLANNED OTF, the MC compares the actual TV/TAB PP with the calculated OTF coordinates. In addition, height updating may be made by inserting height data together with fixpoint coordinates. The NHC Insert button is pressed at overhead fixpoint.
Computed system height is then compared with fixpoint height and RA height at the moment of insert. Height fixing error is displayed in the TV/TAB ROL and may be used to update system height.

NOTE

> If BARO IN is selected or used in reversion for RDR ALT, the height fixing error is undefined and shown by dashes in the TV/TAB ROL.

After Insert, if PFX has been selected on the TV/TAB, only the plan fixing error remains in the ROL, whereas only the height fixing error remains in the ROL when HTFX has been selected.
In either case, updating takes place when ACCPT on the NMCP is selected.

UNPLANNED OTF can be performed when OTF and F/A are selected and OTF caption on the PWAMS illuminates. The STORE PP button shall be pressed when overhead fixpoint. The actual fixpoint coordinates can then be inserted via MKR or RPMD/CRPMD map slew function or if available via MFK.
At PHC or NHC insert, fixing error calculation and ROL display takes place as previously explained.
An alternative unplanned OTF may be performed by selecting OTF prior to pressing STORE PP at overhead fixpoint. Fixpoint coordinates are then inserted via TV/TAB and fixing calculation starts after selecting NFX and F/A.

TACAN FIXING is limited by its accuracy and by the fact that the MC takes the slant range measured by the TACAN as plan ground distance to the station.
The TACAN station coordinates shall agree with those in the ROL before F/A is selected on the TV/TAB. When the TAC pushbutton on the NMCP is pressed for selection, the fix error is displayed on the TV/TAB ROL.
After checking the error line the fix can either be accepted or rejected.

PHASE 2

In Phase 2, the target or fixpoint is acquired visually through the HUD, and the PHC is used to align the ranging reticle on the HUD with the actual fixpoint position.
With PHC Insert, fixing error calculation and ROL display takes place.

Phase 2 can be initiated at any time by the pilot by pressing the button on the PHC, when F/A and the correct height sensors have been previously selected. The height sensing modes available during Phase 2 include TF ELEV, RDR ALT, BARO IN and AGR.

AGR mode operates as follows: AGR is selected on the CRPMD or can also be selected by the pilot, pressing the AGR (PHASE 2) button on his PHC panel.
The caption will illuminate when radar range-lock has been achieved, accepted by the MC. The selection is inhibited outside of fixing or of an attack mode at weapon on release.
The GMR boresight is slaved to the ranging reticle on the HUD and the radar commences a range search.
The range search is carried out in a range bracket along boresight extending ± 1280 ft about the intersection of the antenna boresight and the ground.
The plan range of this intersection is initially calculated by the MC using the antenna depression angle and the height from the automatically selected height sensor.
When distributed clutter is detected simultaneously and clearly above and below boresight, the search is discontinued. With the range lock been achieved slant range so found and depression angle are continuously supplied as tracking data to the MC.
When the GMR locks in range, RDR ACPT on the NWAMS illuminates and R is displayed on the HUD.
Radar mapping is not available on the CRPMD, but synthetic video indicates the range lock position, when AGR selection has been made by the navigator.

NOTE

If AGR is selected in Phase 1, AGR establishes range lock with both the HUD and CRPMD indications as for Phase 2, but the MC cannot accept and use these AGR data. Consequently RDR ACPT is neither automatically, nor can it be manually, selected.

INTEGRATED DISPLAYS AND CONTROLS

Integrated navigation systems data as well as the results of MC processing and calculation, are presented to both crew members via their respective cockpit displays and the parameters available depend on their selection and control.

TELEVISION/TABULATOR DISPLAY SYSTEM (TV/TAB)

The TV/TAB is a computer management terminal/monitoring equipment providing all navigation and attack information in the form of alphanumeric characters and symbolic patterns displayed on a television screen.
Multi and fixed function keyboard facilities enable selection of TV/TAB operating modes and insert data for storage and updating in the MC.
In case of a waveform generator failure, a reversionary keyboard enables essential procedures.
The TV/TAB consists of one Waveform Generator (WFG) and two identical Display Units (DU). Display data are also controlled from the following facilities (Figure 4-38):

- Navigation Mode Control Panel (NMCP)
- Navigator's Weapon Aiming Mode Selector (NWAMS)
- Navigator's Hand Controller (NHC)
- Main Computer Control Panel (MCCP).

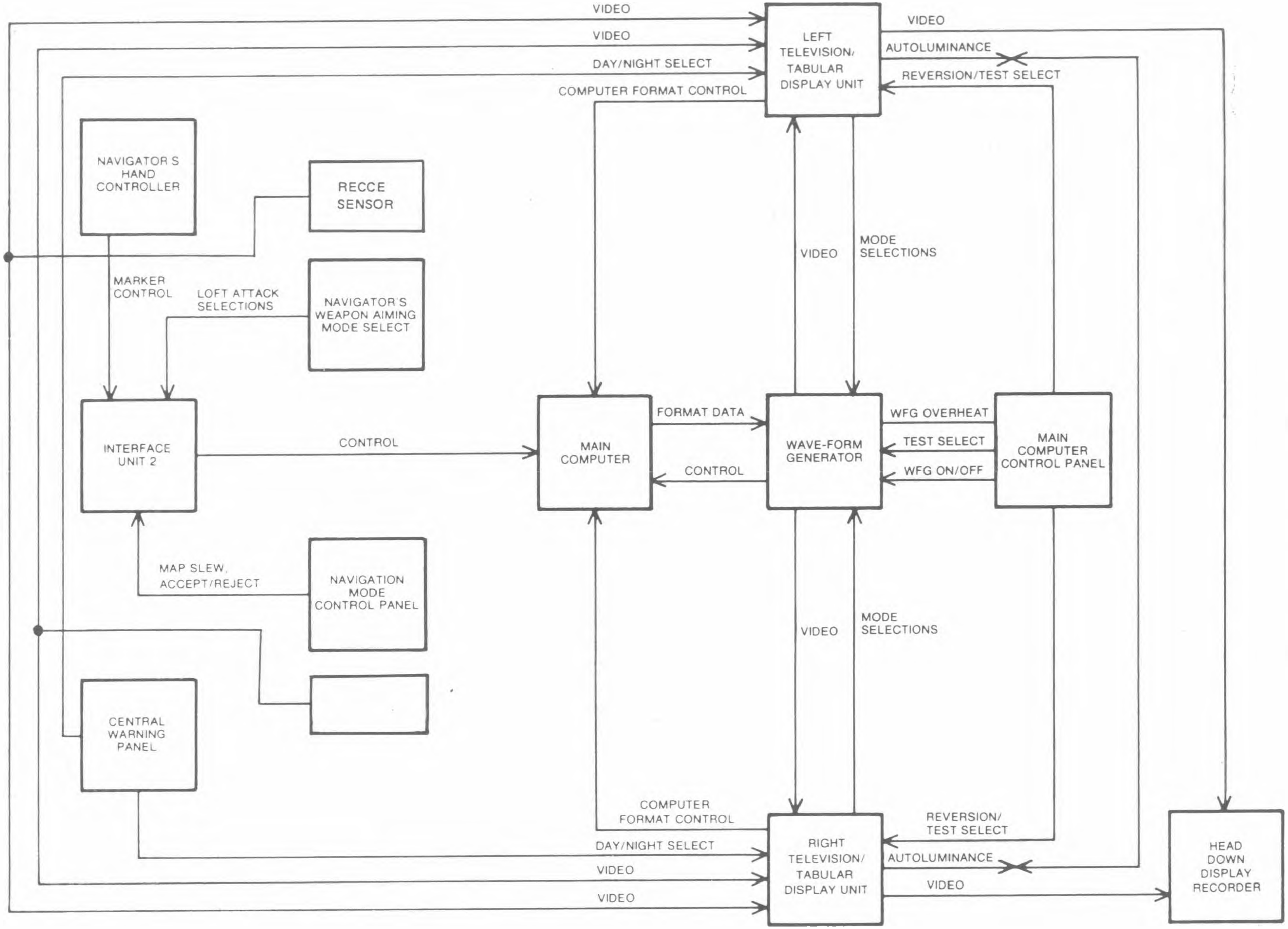
An interruptive BITE test format is generated by the waveform generator and presented on the screen when TEST is selected on the MCCP.

Power Supply

The left TV/TAB unit (DU1) is supplied from the AC busbar 1 (XP1), the right (DU2) and the WFG are supplied from the AC busbar 3 (XP3), with 200 V, 400 Hz, 3-phase AC.

Wave Form Generator (WFG)

The WFG in the rear right avionics compartment accepts display format data from the MC and mode selection data from both TV/TAB Keyboards. These data are processed and generated into video suitable for the display on the two TV/TAB screens, which may present different formats simultaneously. The WFG also generates the TEST format. The



TV/TAB BLOCK DIAGRAM

Figure 4-38

WFG control and indicator are located on the MCCP (Figure 4-32). They provide the following functions:

WFG CONTROL SWITCH

A three-position switch controls the WFG operating modes:

ON	The power supply is connected to the WFG and the TV/TAB display operates according to DU key selections.
TEST	A BITE is initiated and the WFG produces a test pattern which is displayed by either DU if the appropriate ON key is selected.
OFF	The power supply is disconnected from the WFG. The TV/TAB display operates in its reversionary mode, provided that the DU power ON key is selected.

OVERHEAT INDICATOR

The amber OHEAT indicator illuminates if the WFG overheats. It also illuminates when the WFG BITE detects a failure.

Central Warning Panel

DAY/NIGHT SWITCH

A two position D/N switch selects day or night illumination of the selected FFK keys on each DU.

TV/TAB Display Units (DU1 + DU2)

The DUs are identical and located on either side of the CRPMD in the rear cockpit, DU1 to left and DU2 to the right. Therefore two different formats can be provided for the navigator simultaneously. The DU presents waveform generator outputs in video symbolic or tabular form on a screen area of 16 x 12 cm. Generally, distinctions made between items of primary importance, such as flight and target data which are large size indicated, and those e.g. designated by the multi function Keyboard. To eliminate superfluous information when in navigation and attack situation, certain data are displayed only when selected. Key legends are written on the bottom of the display in the various tabular formats. Two autoluminance sensors on top of each DU monitor ambient lighting levels to maintain the brightness of the display at a preset level relative to the brightness of the background.
Display video is routed from each DU to a Head Down Display Recorder (HDDR) where sequences are recorded on film for subsequent analysis.
Each DU provides the following facilities (Figure 4-39):

SHIFT KEY TOGGLE

The three position shift key toggle switch, spring loaded to the centre position, is moved to the left or right to slew a writing marker along the ROL or to step through a series of destinations (after pressing WPT, position "A" is automatically in the ROL).
If a destination is selected without the selection of an alphanumeric keyboard, shifting the toggle switch to the right changes the destination continuously in alphabetical or numerical order and stops changing on release. After the last destination has been displayed it starts again from the beginning. To change only the next destination the toggle switch shall be operated momentarily. Moving the toggle switch to the left operates changes in the opposite direction.
The writing marker is displayed when an alphanumeric keyboard is selected and is identified by constrast inversion of the character overlaid.

CONTRAST-BRIGHTNESS CONTROL KNOBS

The two concentrically mounted rotary CONTRAST-BRT switches are used to adjust the contrast and brightness of all display video.

FIXED-FUNCTION KEYBOARD (FFK)

The FFK consists of twelve pushbutton keys at the centre and bottom row which, with the exception of the ON key, are illuminated white when power is supplied to the aircraft. The ON key illuminates white and bright only when it is selected and power is supplied to the equipment. The keys are used to control the power supplies, select the basic display format, determine the primary mode of the MFK, and enter the data displayed on the ROL line into the MC. Individual key functions are explained in Figure 4-40.

MULTI-FUNCTION KEYBOARD (MFK)

When the WFG is operating, the top row of ten keys forms the MFK. Key functions change with each format, and key caption markings are selectable at both the FFK and MFK.

TV/TAB DISPLAY

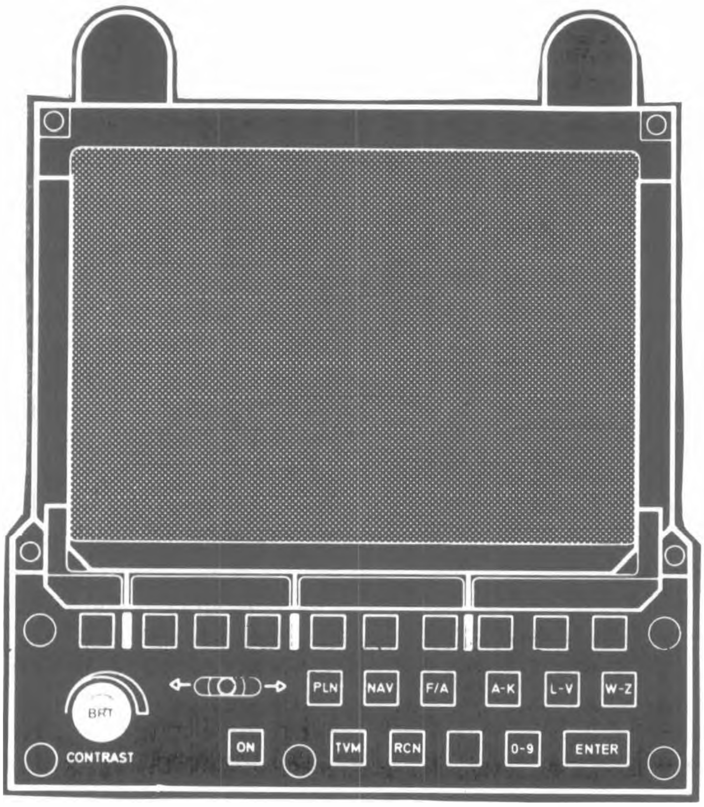


Figure 4-39

They are defined by a legend appearing immediately above them on the bottom writing line of the display. Figure 4-41 shows the table of MFK labels.

REVERSIONARY KEYBOARD (RKB)

When the WFG has failed the TV/TAB can be operated only in its reversionary mode. A sliding cover shall be raised after switching off the WFG to expose ten engraved captions which indicate the reversionary function of the MFK. The RKB enables the navigator to carry out essential procedures and actions associated with the CRPMD map. The results of the key selections are not displayed by the DU.
The functions of the reversionary keys are shown in Figure 4-42.

SECONDARY KEYBOARD

Three secondary keyboards DEST (Figure 4-43), DATA (Figure 4-44) and RTE (Figure 4-45) may be selected from the PLAN keyboard with the relevant multifunction keys. Via the DEST keyboards, destination data may be selected, corrected, or added to the MC.

The DATA keyboard allows insertion or correction of navigational data, while selection of the RTE keyboard permits the current route to be displayed for changing or modification.

TV/TAB Formats

Navigation, fixing, and attack displays are achieved by selection of the relevant format. The formats are individually selectable but the display of the Plan format is possible on one TV/TAB only at a time. In addition to the formats normally used in flight, a Test format, an Equipment (EQM) format, an Inflight Monitor (IFM) Replay format, and an RDE format are available (Figure 4-46).

TEST FORMAT

The Test format is displayed when TEST is selected at the MCCP. The two formats are identical except that the left DU displays the caption DU 1 in the top left corner and the right DU displays the caption DU 2 (Figure 4-47). An adequate number of characters are displayed to detect incorrect operation of the character processing circuits. A full complement of 20 lines is displayed; the lines at the centre

FIXED FUNCTION KEYBOARD

<table>
<tr><th>KEY</th><th>DISPLAY FORMAT</th><th>FUNCTION</th></tr>
<tr><td>ON</td><td>–</td><td>Power supplied to the display units</td></tr>
<tr><td>PLN</td><td>PLAN</td><td>Selects Plan format and PLAN keyboard on MFK</td></tr>
<tr><td>NAV</td><td>NAVIGATION</td><td>Selects Nav format and NAV keyboard on MFK</td></tr>
<tr><td>F/A</td><td>FIX/ATTACK</td><td>Selects Fix/Attack format and F/A keyboard on MFK</td></tr>
<tr><td>TVM</td><td>TV MISSILE</td><td>Changes Fix/Attack format to KORMORAN prelaunch format if KORMORAN Attack is initiated (on the RH TV/TAB only).
Pressing again reverts the display to previous selection</td></tr>
<tr><td>RCN</td><td>VIDEO FROM RECCE SENSOR</td><td>Not operating</td></tr>
<tr><td>A – K
L – V
W – Z
(3 KEYS)</td><td>PLAN, NAV

PLAN OR F/A</td><td>Selects the alpha keyboards on MFK as follows:
<table>
<tr><td>A – K</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td><td>H</td><td>J</td><td>K</td></tr>
<tr><td>L – V</td><td>L</td><td>M</td><td>N</td><td>P</td><td>Q</td><td>R</td><td>S</td><td>T</td><td>U</td><td>V</td></tr>
<tr><td>W – Z</td><td>W</td><td>X</td><td>Y</td><td>Z</td><td>O</td><td>ERAZ</td><td></td><td></td><td>+</td><td>–</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>Present Position</td><td></td><td></td><td></td><td></td><td>HYPHEN</td></tr>
</table>
Pressing again, causes keyboard to revert the previous selection</td></tr>
<tr><td>0 – 9</td><td>PLAN OR F/A</td><td>Selects the numeric keyboard on MFK, enabling numeric data to be keyed into the ROL line. When the writing marker, controlled by the shift key, reaches certain positions the keyboard captions change automatically as follows:
<table>
<tr><td>(0)</td><td>(1)
R</td><td>(2)
V</td><td>(3)
O</td><td>(4)
T</td><td>(5)
N/W</td><td>(6)
S/E</td><td>(7)</td><td>(8)
+</td><td>(9)
–</td></tr>
<tr><td>All Sensor fix</td><td>Radar fix</td><td>Visual fix</td><td>On top fix</td><td>TACAN fix</td><td>N/W coordi-nates</td><td>S/E coordi-nates</td><td></td><td>PLUS</td><td>MINUS</td></tr>
</table>
Pressing again, causes keyboard to revert to previous selection</td></tr>
<tr><td>ENTER</td><td>PLAN, NAV</td><td>Inserts data currently in the ROL into computer store.
The writing marker disappears and keyboard reverts to previous selection</td></tr>
<tr><td>SPARE</td><td>–</td><td>Provision for a further TV display format</td></tr>
</table>

Figure 4-40

MULTI-FUNCTION KEYBOARD — TABLE OF MFK LABELS

MODE	KEY NUMBER/CAPTION MARKING									
	1	2	3	4	5	6	7	8	9	10
PLN	MD1/MD2	DEST	DATA	RTE	POS	RESD	MKR	INT	PGS	IM
NAV	WS	WPT	FXPT		POS		MKR	INT	NFX	4/1
F/A	LL	ML	ATTK		POS		MKR	PFX	HTFX	4/1
DEST	WS	WPT	FXPT	TGT	OFS	RESD	MVT	R/B	UTM	IM
DATA	K	GTF	TIME	TOT	ALT	GRID	W/V	SYN	SLDE	IM
RTE		DST	DATA	RTE	DTG	RESD		DEL	INSR	FLW
GTF			–	IFM	IDD	OFP	SSD	TST	ACC	–
0 – 9	0	1	2	3	4	5	6	7	8	9
AUTO		R	V	O	T	N/W	S/E		+	–
A – K	A	B	C	D	E	F	G	H	J	K
L – V	L	M	N	P	Q	R	S	T	U	V
W – Z	W	X	Y	Z	O		ERAZ		+	–
REV	WS	WPT	FXPT	TGT	LL	ML	MKR	NFX	HTFX	FLW

Figure 4-41

REVERSIONARY KEYBOARD

NO	CAPTION MARKING	FUNCTION
1	WS	Calls up last position inserted in pilot's working store. Displayed on CRPMD by selecting MAP SLEW on NMCP
2	WPT	Calls up next WPT, FXPT or TGT, as selected. Displayed under map marker on CRPMD by selecting MAP SLEW on NMCP
3	FXPT	
4	TGT	
5	LL	Selection for "Light Load" for loft attack. If no depression made, "Heavy" load is assumed
6	ML	Selection for "Medium Load" for loft attack. If no depression made, "Heavy" load is assumed
7	MKR	Places the active computer marker on the CRPMD under control of the NHC. Pressing again, returns the marker to present position
8	NFX	Any destination called up is entered in the MC as the next unplanned fixpoint
9	HTFX	Ensure that height channel only is updated when ACCEPT is selected on the NMCP
10	FLW	Causes the CRPMD map to follow the planned route on NHC command. Pressing again reverts to MAP SLEW mode

Figure 4-42

DESTINATION KEYBOARD

NO	CAPTION MARKING	FUNCTION
1	WS	Displays the coordinates last entered into the pilot's working store in the ROL. A second press removes the data. e.g. W 48° 42.55N 011° 31.21E + ----- FT--.--.-- ---- K
2	WPT	Displays data for the next waypoint in the ROL. A second press removes the data. e.g. M 48° 32.77N 010° 50.44E + 1432 FT--.--.-- 400 K
3	FXPT	Displays data for the next fixpoint in the ROL. A second press removes the data. e.g. 1 48° 53.16N 012° 12.70E + 1092 FT--.--.-- 400 K
4	TGT	Displays data for the next target in the ROL. A second press removes the data. e.g. Y 48° 43.13N 011° 34.23E + 1202 FT--.--.-- 450 K
5	*OFS	Displays data for the next offset in the ROL (offset designator, position, and altitude). The position is indicated either – in feet northings/eastings or – in range and bearing from the target, both height in feet. A second press removes the data. e.g. Y1R 04422S 14096W + 45 FT**
6	RESD	Displays reserve destinations on the Plan format which are already inserted but not used in the currently entered route. A second press removes data.
7	MVT	Displays data of moving target (X, Y, Z) in the ROL in the same form as targets, except height is replaced by target course and speed. If no moving target is stored in the MC, another target may be displayed and can be changed to moving target by insertion of destination and speed of movement. e.g. Z 48° 31.34N 110° 41.27E 214°/20.08.40.11 1134K
8	R/B	1. Displays R/B to the selected destination from the present position. 2. PP can be overwritten by a second destination. R/B from this destination is then displayed. A second press changes the data to geographical coordinates. e.g. 1. N – O 046° 04/18.06NM + 1468 FT--.--.-- 400K 2. N – C 180° 05/25.07NM + 1468 FT--.--.-- 400K
9	UTM	Changes any displayed coordinates to Universal Transverse Mercator format. A second press restores the coordinates to latitude and longitude.
10	1M	Expands the Plan format around the destination displayed in the ROL, or the aircraft present position if no destination is displayed, to a scale of 1:1 M. A second press restores the original display.

* OFS = MSL

***NOTE**

The MC accepts offset data within a maximum radial range of 20 NM around the target only. Offset data which exceed this limit will overflow, indicated by the first character in the ROL showing contrast inverted.

Figure 4-43

DATA KEYBOARD

NO	CAPTION MARKING	FUNCTION
1	K	Displays data for harmonisation with KORMORAN missile on all four possible stations. LW P + 0.0 R + 0.0 V + 0.0 (RW/LF/RF)
2	GTF	Displays the EQM format of the Enhanced Ground Test Facility
3	TIME	Displays the system time and can be changed in the ROL. A second press removes the data
4	TOT	Displays the time over target in the ROL. A second press removes the data. e.g. TOR x 07.20.10
5	ALT	Displays the threshold height data. ALT + ----- FT + ----- FT
6	GRID	Displays the Plan format grid centre and scale data in the ROL. A second press removes the data. GRD 48° 42.24N 011° 30.40E 10 NM
7	W/V	Displays the wind direction and velocity in the ROL. Wind data can be corrected or entered manually for AD + SR mode. e.g. 270°/37
8	SYN	Displays the map reference in the ROL. Sequentional use of shift toggle switch displays three map-slide area data, followed by up to 15 map rectangular coordinates, scales, and along-film data, e.g. (Map refer. No. GSGS 5354). S1 08200.00 + 0.823 M 1 54° 30N 51° 00N 002° 30E 001° 00W 456 07213.345
9	SLIDE	Displays the map slide number. Destination data with a map-slide number are obtained by using subsequently the toggle switch to recall the destination. A second press removes the number.
10	1M	Expands the Plan format about the destination displayed in the ROL, or the aircraft present position if no destination is displayed, to a scale of 1:1 M. A second press restores the original chart and scale.

Figure 4-44

ROUTE KEYBOARD

NO	CAPTION MARKING	FUNCTION
1		Not used.
2	DEST	Selects the DEST keyboard to enable selected destination data to be checked or modified.
3	DATA	Selects the DATA keyboard to enable navigation data to be inserted or modified.
4	RTE	Displays the route data. e.g. ABCDE1XFG2Y3LA — 1X2Y3 —
5	DTG	Displays fuel flow and fuel-to-go, bearing, range, and time-to-go from the aircraft PP to a designated destination, at the current groundspeed, in the ROL. Data are obtained by marking the destination with the writing marker on the steering route ROL. If no destination is inserted, DTG is based on direct distance to the end point of current leg. A second press removes the data. e.g. 50KG/M 2130KG 270° 284 NM 0H43
6	RESD	Displays reserve destinations on the Plan format. A second press removes the data.
7		Not operation (RUNWAY TARGET XJP - - - -)
8	DEL	Deletes the character or spacing overlaid by the writing marker.
9	INSR	Inserts a spacing in front of the character overlaid by the writing marker.
10	FLW	Subsequent selection of MAP SLEW at the NMCP causes the CRPMD map to follow the planned route for the mission. The following is automatic but the speed of travel is controlled by the NHC which is effective in the Y-axis only.

Figure 4-45

DISPLAY FORMAT SELECTION AND CONTROL

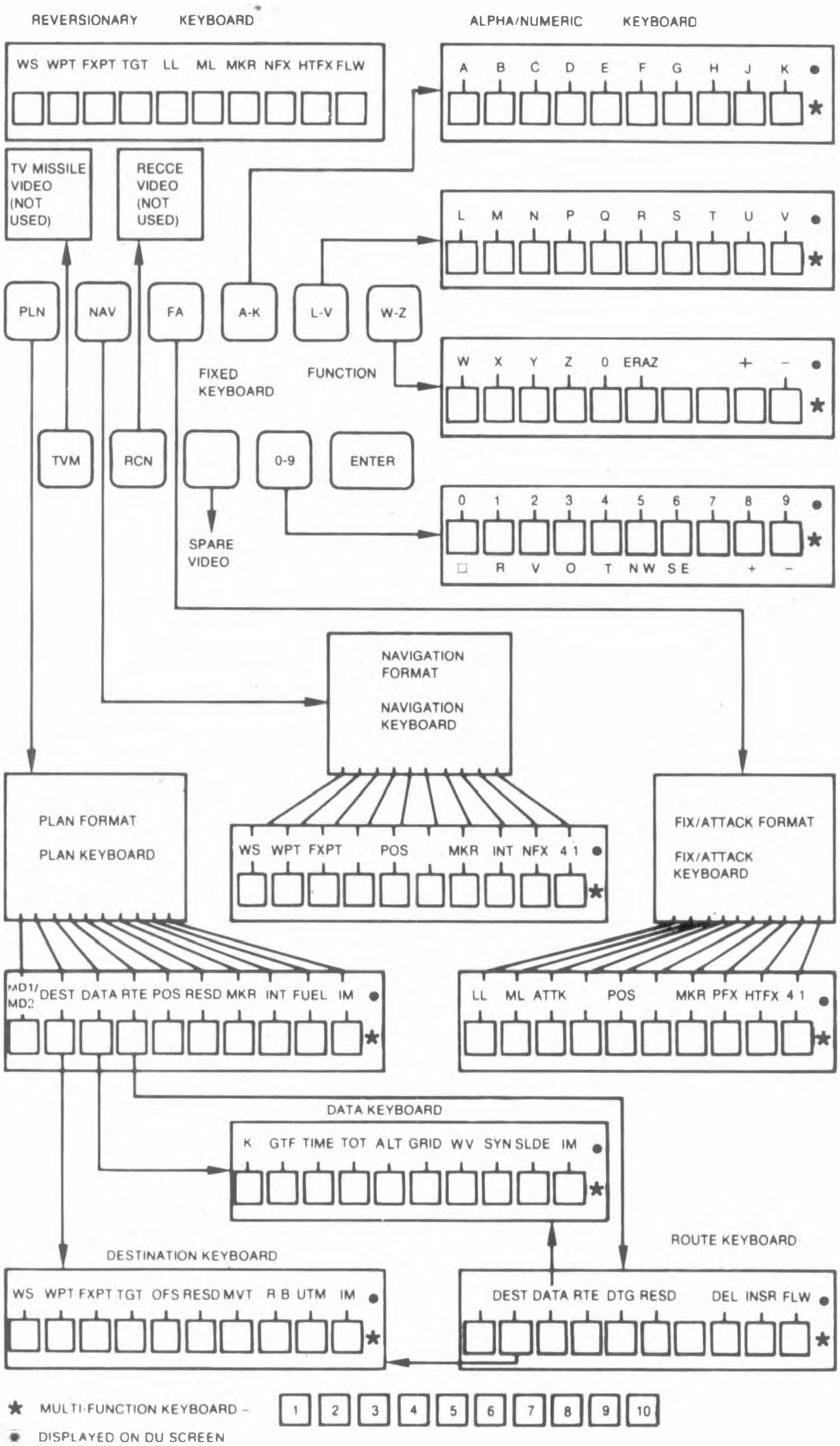


Figure 4-46

TEST FORMAT

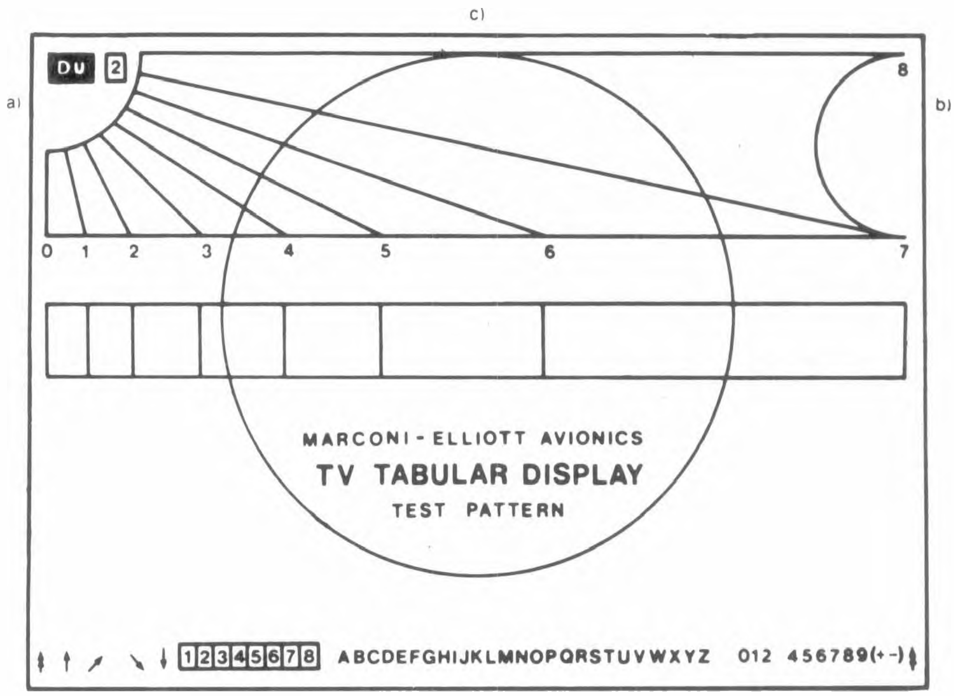


Figure 4-47

of the format are dimmed. Three circles, each testing a specific function, are displayed at once:

- The small semi-circle in the top left corner tests off-screen left and off-top conditions.
- The semi-circle on the right tests conditions and correct intersection with both horizontal and slanting lines.
- The full circle, displayed dim, tests the linearity of the display.

EQM FORMAT

To get information about the systems status before takeoff, the EQM format is selectable via PLN, DATA, GTF, L-V, TEST and ENTER. Indication of most systems and primary sensors, e.g. ADC, AFDS, CRPMD, DOPPLER, IN, GMR/TFR, IFU 1, IFU 2, TACAN, RA, SAHR and SMS, is given in alphanumerical readouts. The operator should record the contrast inverted status information for debriefing (Figure 4-48).

NOTE

When ENTER is pressed, the EQM format will appear with a delay of several seconds.

IFM REPLAY FORMAT

Whenever data input failures to the MC occur, the IFM will store this malfunction. The operator is able to call up the recorded failures on an IFM format with tabular data readouts by pressing the IFM key in the EQM format (enabled when the groundspeed passes 95 kt decreasing). For each fault the time of first occurrence, time of last transition to/from the fault state, number of occurrences, and the total time of fault are displayed. At the first recording of a fault, KCAS, IN vertical velocity, BARO height, SAHR inclination, IN bank, SAHR bank, and SAHR heading are stored and also will be displayed. The EQM format may be regained by pressing the RTN key. To revert into PLN format the OFP key shall be pressed twice (Figure 4-49).

NOTE

If MC is recycled during flight, the monitored system failure will be displayed with a contrast inverted time of first occurrence (T1).

EQM FORMAT

IN *

EQM FORMAT

ADC <–	R/A	IF1	–	HSI
AF1	SAH			PWS
AF2	SMS			TAC
CRM	SWU	IF2	–	NWS
DOP	SWG			NMP
IN	SWI			LAS
RD1	TVL	FGS	–	INI
RD2	TVR			TFM
RD3				APM

↓ ↑ . . . IFM IDD OFP SSD TST ACC . . .

* Status Change of Nav System

NOTE

If a status or mode change is detected for any equipment, the equipment abbreviation (XXX) and the corresponding legend (ACC to accept status change), are displayed contrast inverted.

<– Indicator for selected equipment mnemonic

Figure 4-48

IFM REPLAY FORMAT OF EXAMPLE

IN

IFM

IF1-MC LINK FAIL – 20

T1 – 01 45 22 10*	CAS	340
T2 – 02 33 13 00	INV	20
TT – 00 10 20 00	BAH	1400
	INI	5
	SAI	4.9
	INB	80.5
	SAB	81.0
	SAH	270.0

SIR

12	DISCRETE INPUT	00 15 23 00
13	D-A CONVERSION	00 15 23 20

. . . . . . PGE . . . . . SIR . . . . . . ACC RTN

* Contrast inverted on MC recycle

NOTE

Information is not lost if MC is recycled in flight

Figure 4-49

SNAP SHOT DATA (SSD) REPLAY FORMAT

The SSD replay format is called up on ground using the EQM format with the further selection of the SSD key. The first Snap Shot event recorded will be indicated contrast inverted on the first page displayed with the Occurrence Number shown in the top center line (each individual Snap Shot event with a complete data set is displayed separately on its corresponding page. Pressing the PGE key will call up the next page with the next recorded event in sequence, i.e. a total of seven events on seven pages can be called up).
The SSD replay format lists, among other parameters, hexadecimal data words in the ROL wich are spread into three columns. The first column contains the lines 0 to 9, as indicated, the second corresponds to 10 to 19, and the third will indicate lines 20 to 23 only (Figure 4-50).
The event word is always shown in line 0 combined with a 16-bit-readout in the bottom line. For decoding refer to Figure 4-51. The contrast inversion can be moved up or down the line column by selecting a particular parameter word which will then become contrast inverted.
In addition to the 16-bit readout each line number, when called up, will produce a decimal readout on the right side of the bottom line in one of the following terms:

- distance
- height
- velocity
- acceleration
- angle
- time

However, in case of the paired line numbers 1 + 2, 3 + 4, and 22 + 23, the individual readouts shall be added to obtain the total value (Figure 4-52).

RAPID DATA ENTRY FORMATS

When mission data are supplied via the RDE facility the MC automatically carries out a parity and sum check to ensure integrity of the inputs. The results are presented on the display units in one of three RDE formats (Figure 4-53):

- RDE COMPLETE
  This appears on both DUs to signify the successful entry of data into the MC

- RDE FAULT
  If one line of error has occurred, the words RDE FAULT appear in large size character at the top of the right-hand DU. The error character in the error line is contrast inverted. Using the MFK on the other DU to key-in the correct data into the ROL, on ENTER, the keyed-in data will be entered into the MC. When the data are correct the RDE FAULT legend and the error line is removed by selecting any format on the TV/TAB

- RDE FAILED
  If the RDE program contains more than one line of error, the words RDE FAILED are displayed. The first error line of data is displayed. Using the error line indication and a printout of RDE data as a guide, the navigator corrects the error via a re-insert of RDE or manually amends data using the MFK on the other TV/TAB. RDE FAILED legend and error line are then removed by selecting any format on the TV/TAB

NAVIGATIONAL AND ATTACK FORMATS

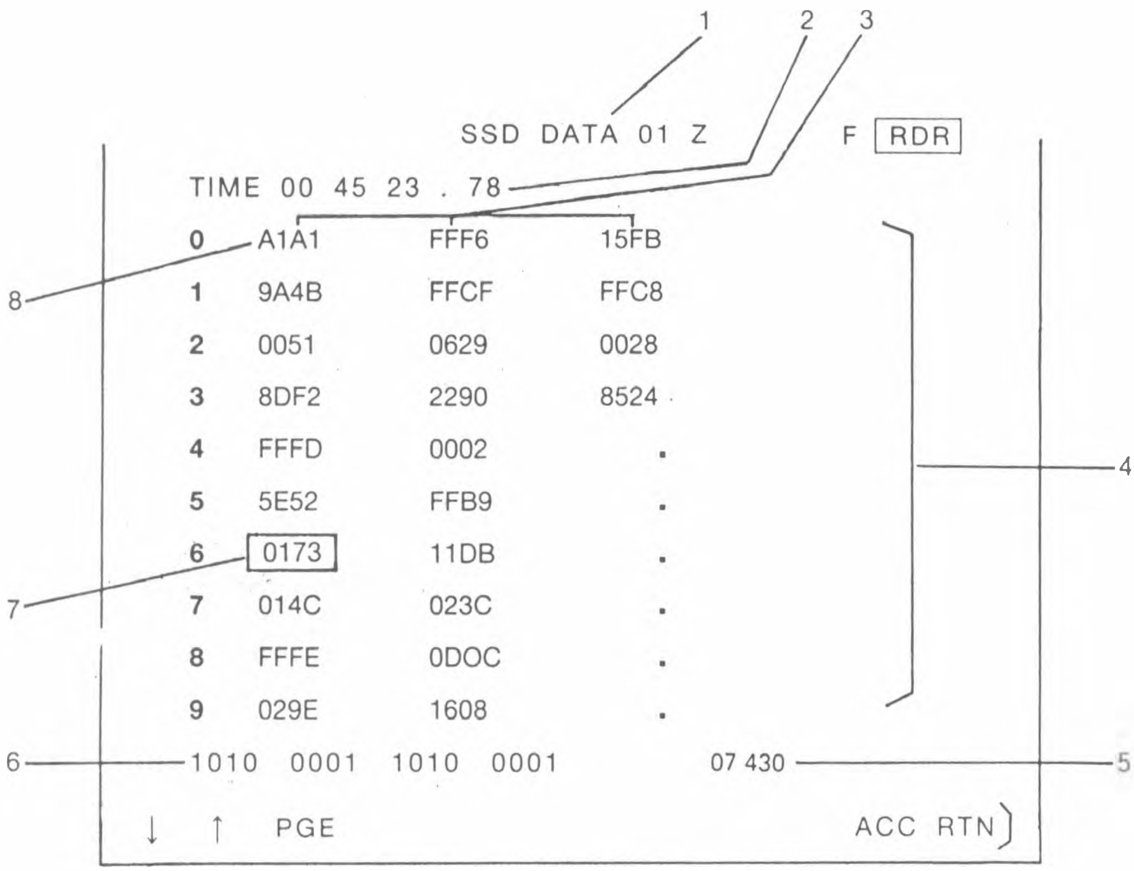
Basically three formats are individually selectable to provide different information for solution of various tasks: Plan, Navigation and Fix/Attack.
The following indications may be displayed on all types of formats, regardless of the selection:

- The word UNLOCK (contrast inverted) is displayed in the bottom right-hand corner of tne display, when no Doppler information is received by the MC.
- A flashing cross at the upper left center of the display formats indicates a system malfunction, lasting more than 500 msec.

The fault has a status identifier which is displayed at the center top of the Plan format only and is cancelled by deselecting the Plan format, to clear the display for further fail indication.

PLAN FORMAT. The basic Plan format with the PLAN keyboard appears on the display when PLN is selected on the FFK Figure 4-54. It consists of a pictorial presentation of the mission route from takeoff to landing and is shown with waypoints connected by straight lines, present position, targets, fixpoints, and system time.
Figure 4-55 shows the Plan formats (basic and extra data).
The coordinates of the point in the Plan format, corresponding to the centre of the screen together with the scale to be used, are fed into the MC during RDE as part of the mission data or manually inserted using the MFK. The MC calculates the values of the two parallels of latitude and the three meridians of longitude to an accuracy or one minute. Two variable scales are available, a normal scale dependent on the area covered by the mission plan,

SNAP SHOT DISPLAY EXAMPLE



1 EVENT OCCURENCE NUMBER OF Z-TYPE DATA
2 MISSION TIME OF EVENT OCCURENCE IN HOURS, MINUTES, SECOND, AND DECIMAL SECONDS
3 HEXADECIMAL DATA WORDS SPREAD INTO THREE COLUMNS, STARTING FROM THE LEFT
4 LINE NUMBERS CORRESPONDING TO THE ORDER OF Z-TYPE DATA IN CASE OF OTHER THAN Z-TYPE EVENT IN THE ORDER OF STEERING TAPE ENTRY
5 DECIMAL READOUT OF SELECTED DATA WORD (CONTRASTINVERTED)
6 BINARY READOUT OF SELECTED DATA/EVENT WORD
7 LINE/WORD SELECTED (CONTRAST INVERTED)
8 EVENT WORD (ONLY PRODUCING A BINARY READOUT)

Figure 4-50

EVENT WORD

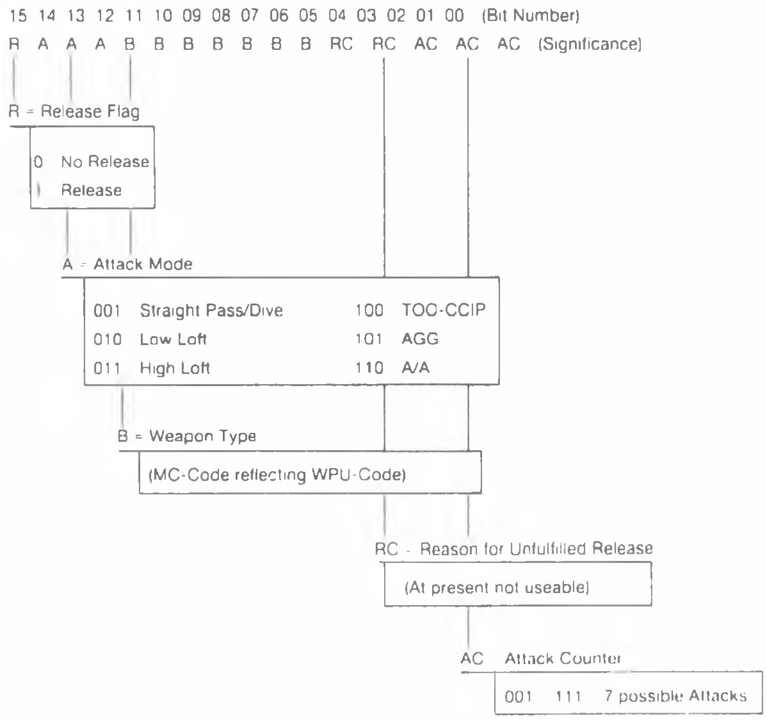


Figure 4-51

PARAMETER SIGNIFICANT

WORD NO.	PARAMETER
0	Event Word
1 + 2	Bomb Range along Heading (feet)
3 + 4	Bomb Range across Heading (feet)
5	Slant Range to Target (feet)
6	Range to Target along Heading (feet)
7	Range to Target across Heading (feet)
8	Vertical Range to Target or Fixpoint (feet)
9	Velocity of Wind along Heading (feet/second)
10	Velocity of Wind across Heading (feet/second)
11	Best Height (feet)
12	RAD Height (feet)
13	Bank Angle (degree)
14	Climb Angle (degree)
15	Vertical Acceleration (feet/second)
16	Elevation Incidence (degree)
17	Time of Flight of Bomb (second)
18	Moving Target Course/Speed (not useable at present)
19	Best Smoothed Heading (degree)
20	Best Along Heading Velocity (feet/second)
21	Best Across Heading Velocity (feet/second)
22 + 23	Best Vertical Velocity (feet/second)

Figure 4-52

RAPID DATA ENTRY ROUTINE

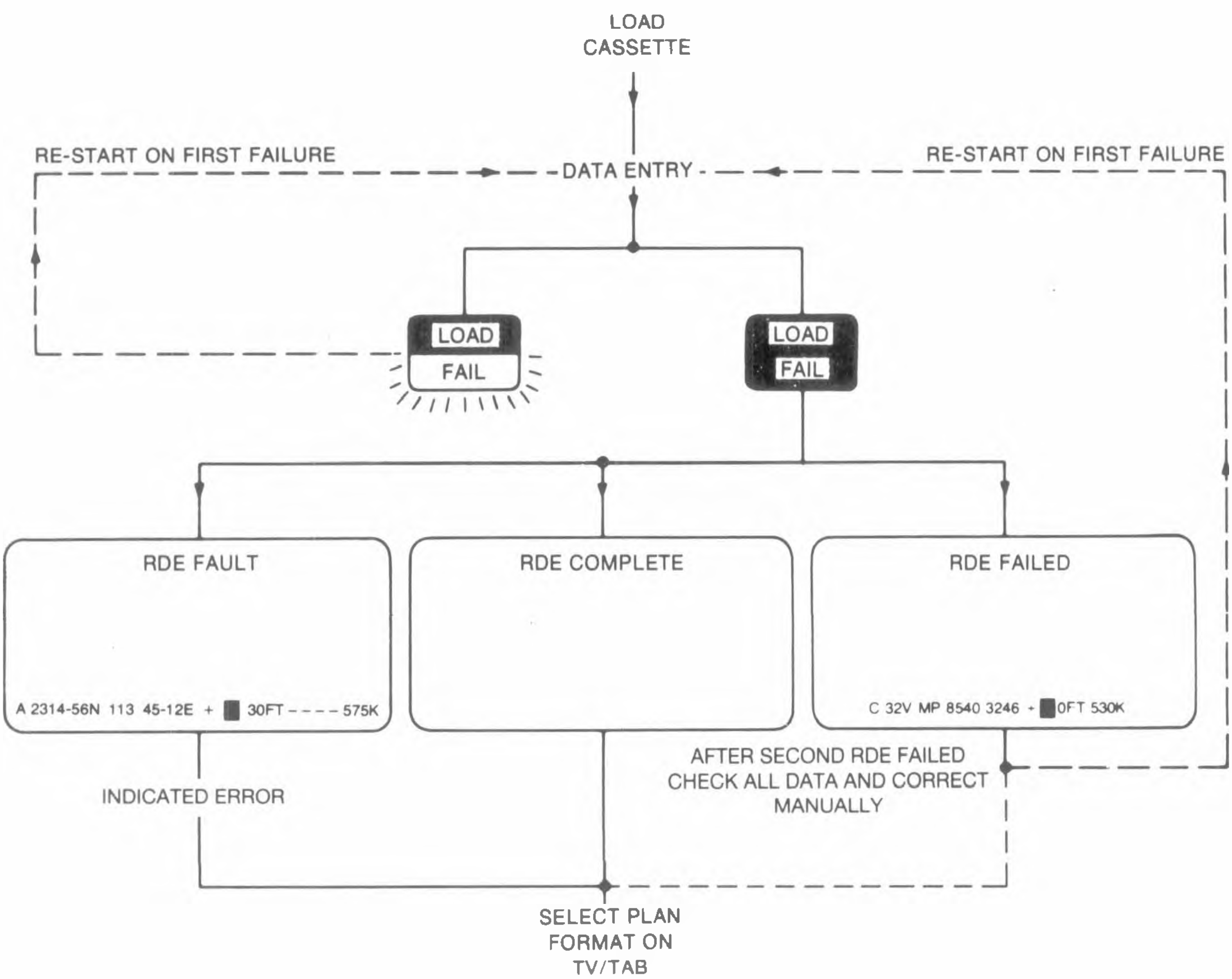


Figure 4-53

PLAN KEYBOARD

NO	CAPTION MARKING	FUNCTION
1	MD1/MD2	Selects (exchanges) Mission Data between the primary and secondary mission data store, to load and access the second set of preplanned data for extended mission.
2	DEST	Selects the DEST secondary keyboard to enable additions or corrections to selected destinations. WS/WPT/FXPT/TGT/OFS/RSD/MVT/RB/UTM/IM
3	DATA	Selects the DATA secondary keyboard to enable navigation data to be checked and insertions or corrections to be made. K/GTF/TIME/TOT/ALT/GRID/W/V/SYN/SLDE/IM
4	RTE	Selects the Route secondary keyboard. Current route appears in the ROL. / /DEST/DATA/RTE/DTG/RSD/ /DEL/INSR/FLW
5	POS	Displays present position (latitude and longitude), system time, and best available altitude in the ROL at the instant of selection with a NAV MODE selected. Pressing again removes data. e.g. O T 48° 42.65N 011° 31.82E AT 16.01.52 A + 01650 FT
6	RESD *	Displays reserve destinations on the Plan format which are already inserted but not used in the currently entered route.
7	MKR	Calls up active marker on CRPMD and places it under control of NHC also displays a marker on the TV/TAB. It can be deselected only by pressing again MKR on the indicating display unit. MKR is automatically deselect when the marker symbol is outside the display range.
8	INT **	Presents data of the first intelligence point in the ROL, other INTs can be called up by using the toggle switch. A 01 48° 43.88N 011° 49.28E
9	PGS	Enables planned ground speed (PGS) to be entered manually, loaded into the MC, and displayed on the TV/TAB. It can be changed by pressing PGS again and will be reset to its default value of 420 kt when new SW is loaded.
10	1M	Expands the Plan format around the destination displayed in the ROL, or aircraft present position if no destination is displayed, to a scale of 1:1 M. Pressing again restores original chart and scale.

* Extra Data

** 1:1 M scale only

Figure 4-54

and a 1:1 M scale selectable at the MFK. Fuel state may differ up to 288 kg from the front cockpit indication.

System time is displayed at the top righthand corner of the screen in hours, minutes, and seconds. Aircraft present position is shown by the centre of a small circle, waypoints are indicated by their letter designation, targets are shown by a triangle symbol and their letter designation, and fixpoints are shown by a plain figure contrast inverted.

Should the distance between two destinations of the route exceed 680 NM, the relevant leg destinations appear contrast inverted in the bottom left hand corner of the screen and the route shall be rearranged.

Whenever MKR is pressed the active computer marker on the CRPMD is active, a gapped cross ( ) appears on the Plan format to indicate the marker position. If MKR on the other TV/TAB has been selected priorly it will be deselected.

TOT is displayed on the lower left side of the screen in hours, minutes, and seconds with two digits each and labelled with the relevant destination.

It can be displayed in the ROL if it has been inserted via RDE or manually via MFK. Alternatively any enroute position ahead of the aircraft can be used to enter TOT by calling up the appropriate destination. This also enables time early/late calculation for any destination-route.

If no TOT has been inserted before takeoff, the takeoff time will automatically be used as TOT of takeoff point in the planned route.

Up to three intelligence data can be displayed in the 1:1 M scale, when selected via the MFK INT key. The symbols are always contrast inverted.

If a flashing cross is displayed in the left hand side of any display format, selecting PLAN will bring up the inflight display with a status information of the failed system in hexa decimal form on the top center position of the Plan format.

EXTRA DATA. Most dynamic data may be displayed as required by selection of the appropriate secondary keyboard (DEST, DATA, or RTE) using the MFK (see for DEST, DATA, RTE KEYBOARD tables).

Additional waypoints (i.e. not on selected route) may be displayed without connecting lines. Such reserve waypoints are entered via the RDE facility or manually via TV/TAB.

The position of the centre of the CRPMD is shown as a solid cross on the DU in Plan format, whenever MAP SLEW on NMCP is selected.

NAVIGATION FORMAT. The basic Navigation format in connection with the NAV keyboard is called up by pressing NAV at the FFK (Figure 4-56).

The Navigation format provides accurate steering information to the next destination. Two concentric circles appear on the screen, centred on the aircraft's PP marker with a fixed track line extending upward from the marker to a moving scale readout.

The outer circle is a range ring with N (north) indicated, representing a radius of 16 NM or 4 NM as selected; the inner circle, of variable radius, represents the zone of 95% certainty of present position as given by the Kalman filter. The current range ring radius in use is indicated at the righthand side of the display. The scales available are a normal scale of 1:1 M and an expanded scale of 1:250 K, selectable on the MFK. Planned track is displayed as two parallel lines (TRAM line) 1 NM apart, so that across track error are indicated diagrammatically against the track line. In addition, planned track is displayed in degrees within the outer circle.

Figure 4-57 shows the NAVIGATION FORMATS.

When the next destination is in display range, the track for the next leg is indicated as a dimmed line extending from the destination. The direction of the line is relative to the aircraft's current track.

When the range-to-go to the next fixpoint is less than 20 NM, the fix symbol in the top lefthand corner of the screen is alternately normal and contrast inverted. The flashing stops on selection of the Fix/Attack format. When the time-to-go to the next waypoint is less than 30 seconds, the next waypoint label at the top lefthand corner is alternately normal and contrast inverted. The flashing stops when the waypoint is overflown.

System time, time-to-go to next destination and time early/late to a destination are permanently displayed at the top righthand corner of the screen. Distance-to-go to next fixpoint is displayed at the top lefthand corner of the screen with the distance to next waypoint immediately below.

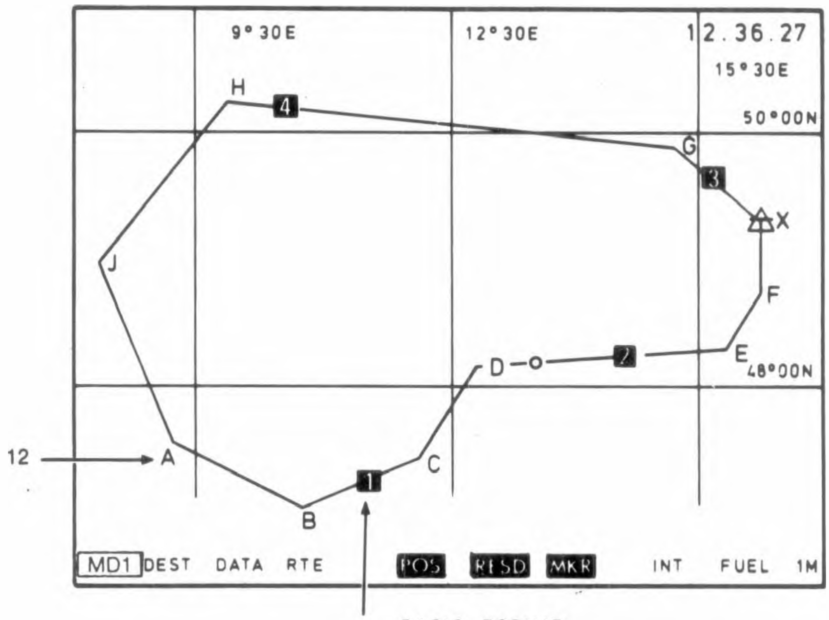
Wind, TAS, Doppler G/S, and drift data are displayed in the lower right-hand corner. Next track/cross track and RA data are displayed at the bottom left hand side.

In HOLD mode or with less thant 76 kt groundspeed (prior to takeoff), TEL displays a count-down to takeoff time. In this case the display of time-to-go is occulted until takeoff.

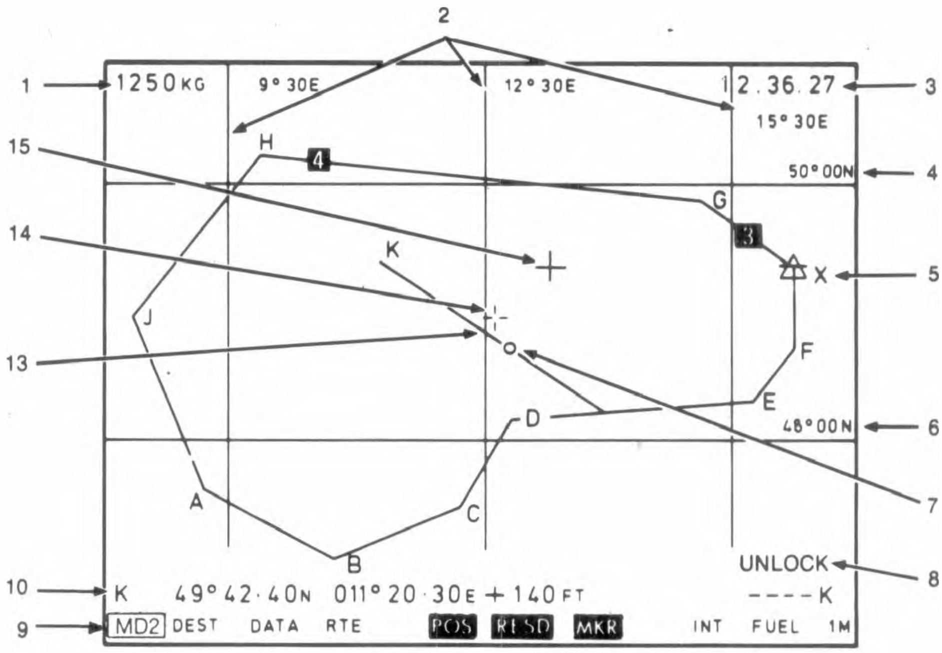
NOTE

If MFP STEER or HOLD is selected after takeoff or planned GS is not inserted, the TEL ROL is shown as undefined (0.00).

SCHEMATIC PLAN FORMATS



BASIC FORMAT



EXTRA DATA

1 FUEL STATE (FUEL SELECTED AT THE MFK)
2 LONGITUDE REFERENCE*
3 SYSTEM TIME (HOURS, MINUTES, SECONDS)*
4 LATITUDE REFERENCE*
5 TARGET
6 LATITUDE REFERENCE*
7 PRESENT POSITION*
8 DOPPLER UNLOCK INDICATION
9 MFK CURRENT FUNCTION*
10 READ-OUT LINE
11 (1, 2, 3, 4) FIXPOINTS*
12 (A–K) WAYPOINTS*
13 DEVIATION FROM PLANNED ROUTE
14 ACTIVE COMPUTER MARKER*
15 CRPMD CENTER POSITION MARKER (ONLY WHEN MAP SLEW ACTIVE)

* BASIC FORMAT

Figure 4-55

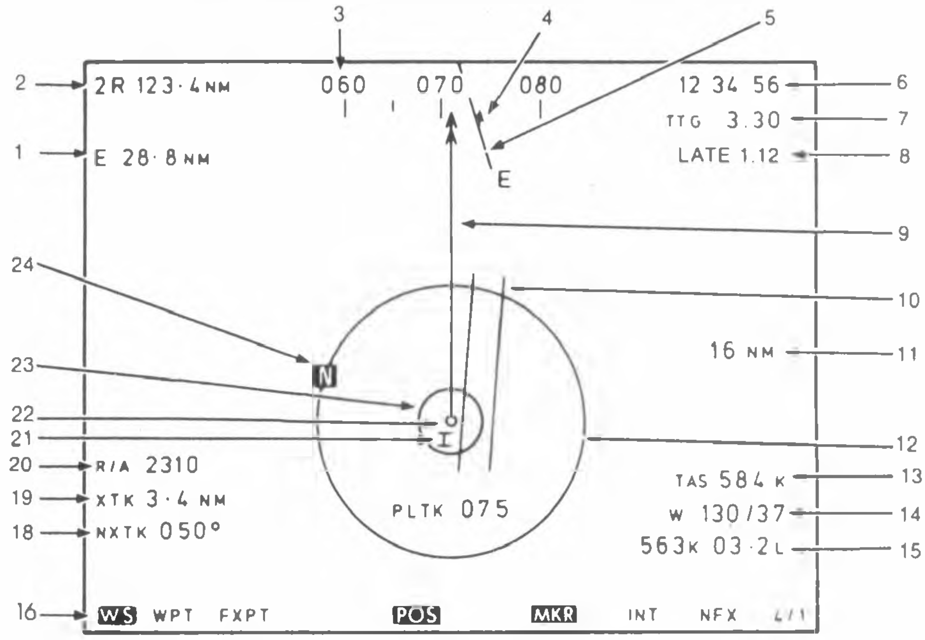
NAV KEYBOARD

NO	CAPTION MARKING	FUNCTION
1	WS	Displays the coordinates, last entered into the pilot's working store, in the ROL. Pressing again removes data. e. g. W 48° 42.55N 011° 31.21E + ----- FT --.--.-- ---- K
2	WPT	Displays data for the next waypoint in the ROL in flight-plan order. Pressing again removes data. e. g. M 48° 32.77N 010° 50.44E + 1432 FT --.--.-- 400 K
3	FXPT	Displays data for the next fixpoint in the ROL. Pressing again removes data. e. g. TAC Fix: 1T 48° 43.28N 011° 31.32E 051X 000.9
4		
5	POS *	Displays present position (latitude and longitude), system time, and best available altitude in the ROL at the instant of selection. T 48° 42.65N 011° 31.82E AT 16.35.23B +30055 FT
6		
7	MKR *	Calls up active marker on CRPMD and places it under the control of the NHC. A static marker is displayed on TV/TAB to indicate the selection made. It can be deselected only by pressing again MKR on the indicating display unit. MKR is automatically deselected when the marker symbol is outside the display range.
8	INT *	Presents data for the first intelligence point in the ROL (when within range of Nav display, corresponding INTs are indicated by change contrast inversion to normal). Pressing again removes data.
9	NFX	Displays data in the ROL entered as the next fixpoint.
10	4 : 1	Changes the display scale from 16 NM radius to 4 NM radius. Pressing again reverts the display to the former scale.

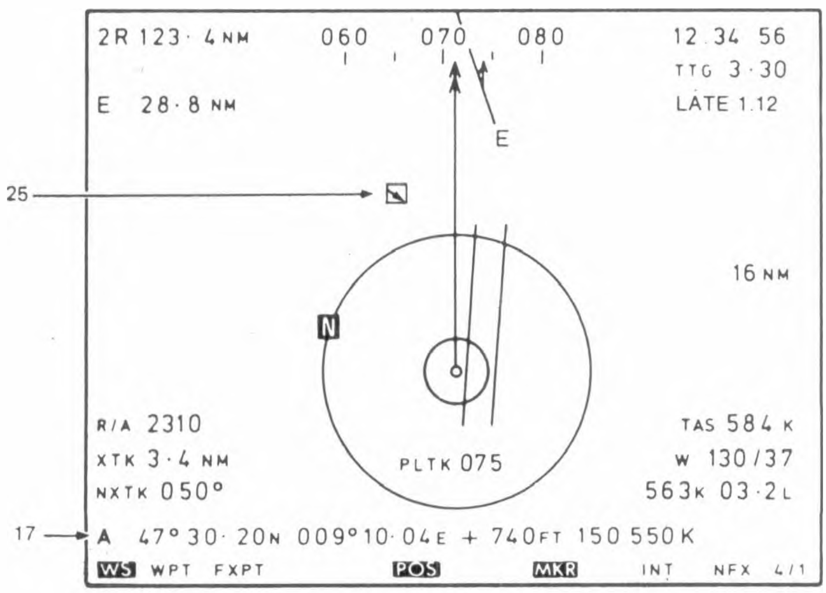
* Extra Data

Figure 4-56

SCHEMATIC NAVIGATION FORMATS



BASIC FORMAT



EXTRA DATA

1 DISTANCE TO NEXT WAYPOINT (E)
2 DISTANCE TO NEXT FIXPOINT (2) RADAR FIX
3 DEGREES OF TRACK/HEADING
4 AIRCRAFT CURRENT HEADING
5 TRACK FOR NEXT LEG
6 SYSTEM TIME (HOURS, MINUTES, SECONDS)
7 TIME-TO-GO TO NEXT DESTINATION (MINUTES, SECONDS)
8 TIME EARLY/LATE (MINUTES, SECONDS)
9 AIRCRAFT TRACK
10 PLANNED TRACK (1 NM BETWEEN LINES)
11 RADIUS OF RANGE RING
12 RANGE RING
13 TRUE AIRSPEED
14 WIND DIRECTION AND VELOCITY
15 DOPPLER GROUNDSPEED AND DRIFT
16 MFK CURRENT FUNCTIONS
17 READOUT LINE*
18 NEXT TRACK
19 CROSS-TRACK ERROR
20 RADAR ALTITUDE
21 IN POSITION INDICATOR (MAIN MODE)
22 PRESENT POSITION (MAIN COMPUTER)
23 KALMAN FILTER 95 % PROBABILITY CIRCLE
24 NORTH
25 INTELLIGENCE POINT (Example)*

* EXTRA DATA

Figure 4-57

Bearing, range, time-to-go data are measured around the total range of current route or directly to a destination which is marked with the writing marker on the steering route ROL and subsequent selection of DTG. In this case, the bearing is undefined and shown as (....°). If no destination is inserted, DTG (including bearing) is based on the direct distance to the end point of current leg.
When the contrast inverted label in the ROL is overwritten, using MFK and subsequent ENTER, this always present data based on direct distance for both on- and off-route destinations.
Intelligence points (up to two maximum) are displayed automatically when within display range, regardless whether INT has been pressed or not.
When ROL data correspond with a displayed symbol (after selection of INT and use of the shift key), both the symbol on the screen and that in the ROL change from contrast inverted to normal.
In the MAIN navigation mode, the position given by the IN is displayed relative to the Kalman filter position as a moving symbol I. If the MAIN mode is deselected (manually or automatically), the symbol is removed.
When MKR is selected a small marker as a gapped cross is displayed stationary at the RH side of the display to indicate the selection.

EXTRA DATA. The navigator can call up the following additional data by means of the MFK.
The depression of the POS key displays PP (of working store T) in the ROL with the time at which it is selected, accompanied by instantaneous readout of BAA (source and height value).
The source indication is coded by the following letters:

B = BARO
A = ADC
I = Doppler + IN
S = Doppler + SAHR

FIX/ATTACK FORMATS

On pressing the F/A key, the FIX/ATTACK keyboard appears and the display changes to the basic Fix format and is stabilized on the next fixpoint or target to provide accurate aircraft positioning and steering Figure 4-58.

FIX FORMAT. The basic Fix format (Figure 4-59) consists of a fixed vertical line passing throught the display centre and ends in a double arrow indicating actual track against a 3 digit scale at the top of the display. A PP marker moves along on the line at a speed proportional to groundspeed.
Two scales on the track line are available, 1:250 K and 1:62.5 K. The scale in use is indicated on the righthand side of the display representing 4 NM and 1 NM respectively between range markings. The next fixpoint or target appears about 3/4 of the distance up the display. Should the aircraft track change, the position of the fixpoint in bearing and distance changes accordingly.
The 95% certainty circle of the Kalman filter is centered on the computed position of the next destination (fixpoint or target). Other destinations are displayed in their correct positions relative to the next WPT, FXPT, or TGT as soon as they are within the display range. The planned track for the next leg is indicated as a line from the next destination for a distance of approximately 2.5 cm. The direction of the line is relative to the aircraft true heading.
Two sensor field of view lines diverge from the present position marker and extend upward to a length of 8 km. The field of view lines represent an angle of 12° and move up the track line with the PP marker.
System time, time-to-go, and time early late are displayed permanently at the top right of the display. Distance-to-go to the next fixpoint or target has the same form and appear in the top left position. When the time-to-go to the next destination is less than 30 seconds the next destination symbol, at the top lefthand corner, is alternately normal and contrast inverted.
Wind, TAS, Doppler G/S, and drift data which may be displayed in the lower right-hand corner by selection of the VEL key. Next track/cross track and RA data are displayed at the bottom left hand side on selection of TRF.
When MKR is selected, a marker is displayed stationary at the RH side to indicate the selection.

EXTRA FIX/ATTACK DATA. Additional information can be displayed on the Fix/Attack format when selected at the F/A keyboard.
When the INSERT button on either the NHC and/or PHC is pressed to set a fix, the computed navigation and/or height errors are displayed in the ROL.
If the KF is not operative (any other mode than MAIN engaged), A will always be displayed, unless the fix error exceeds 30 NM in any direction.
If the KF is operative the fixing data are checked for acceptability. In the TV/TAB ROL, an A for Accept or R for Reject may be displayed, together with an arrow, showing the direction of the fixing correction.
If ACCEPT on the NMCP is selected, it causes the fix coordinates to update the navigation system and the displayed fix error to be removed.

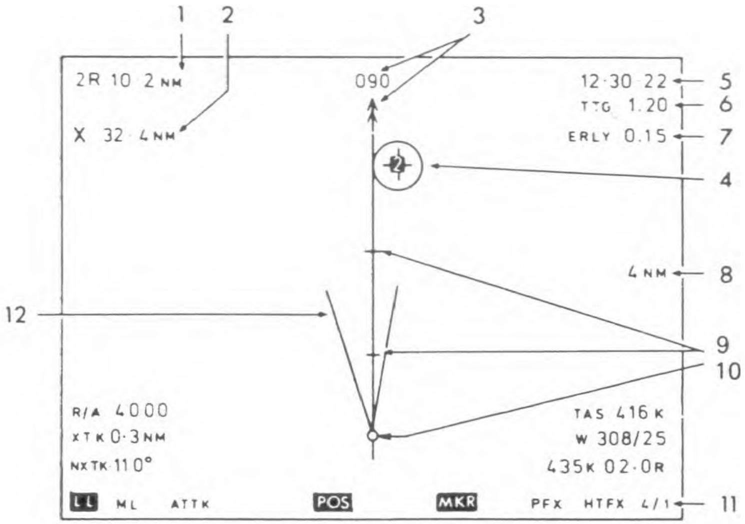
FIX/ATTACK KEYBOARD

NO	CAPTION MARKING	FUNCTION
1	LL	Computation for light weight is done during loft attack and L is displayed to the left of the CCIP line on the TV/TAB. If no selection or a second press is made, "heavy" configuration is assumed and H is displayed.
2	ML	Computation for medium weight is done during loft attack and M is displayed to the left of the CCIP line. If no selection or a second press is made, "heavy" configuration is assumed and H is displayed.
3	ATTK	Changes Fix to Attack format without attack selection made on the WAMS. Pressing again returns the Fix format.
4		
5	POS	Displays present position (latitude and longitude), system time, and best available altitude in the ROL at the instant of selection. Pressing again removes data. T 48° 42.65N 011° 31.82E AT 16.35.23 I + 01852 FT
6	VEL *	
7	MKR *	Calls up active marker on CRPMD and places it under the control of the NHC. A static marker is displayed on TV/TAB to indicate the selection. It can be deselected only by pressing again MKR on the indicating display unit. MKR is automatically deselected when the marker symbol is outside the display range.
8	PFX	Plan coordinates only are updated when ACCEPT is selected on NMCP.
9	HTFX	Height channel only is updated when ACCEPT is selected on NMCP.
10	4 : 1	Change the display scale from 16 NM radius. The gap between the distance markers change from 4 NM to 1 NM. A second press restores the former scale.

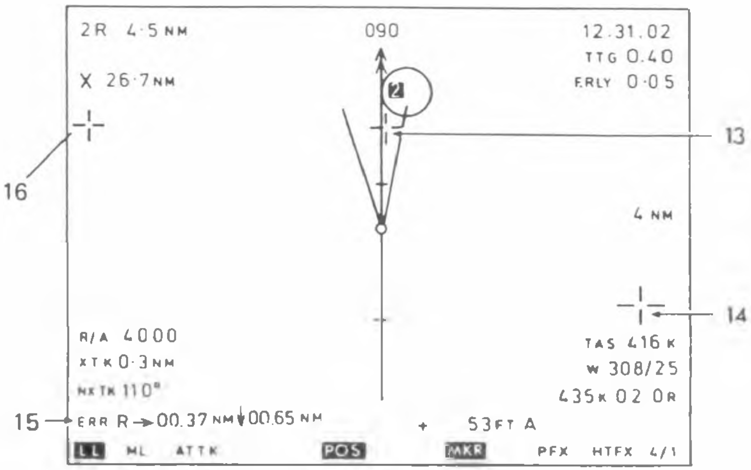
* Extra Data

Figure 4-58

SCHEMATIC FIX FORMATS



FIX FORMAT BASIC



FIX FORMAT EXTRA DATA

▯ CHARACTER CONTRAST INVERTED

1 NEXT FIXPOINT (2) RADAR
2 NEXT TARGET (X)
3 TRACKLINE AND READOUT
4 95 % KF ERROR CIRCLE WITH FIXPOINT (2) AND CENTERED MARKER
5 SYSTEM TIME
6 TIME-TO-GO TO FIXPOINT (2)
7 TIME EARLY
8 SELECTED SCALE
9 RANGE MARKERS
10 PRESENT POSITION
11 MFK CURRENT FUNCTIONS
12 (SENSOR) FIELD OF VIEW

13 COMPUTER MARKER (REPOSITIONED AFTER NHC OR PHC INSERT) * } MKR SELECTED AT MFK BOARD
14 STATIONARY MKR SYMBOL * } MKR SELECTED AT MFK BOARD
15 FIX ERROR READOUT (AFTER NHC OR PHC INSERT *
R = RADAR FIX
ACROSS TRACK ERROR } DIFFERENCE BETWEEN MEASURED AND CALCULATED POSITION OF FIX POINT
ALONG TRACK ERROR
+ 53 FT ALT HIGH
A = ERROR ACCEPTED BY MC
16 FLASHING CROSS *
(NAV/ATTACK SYSTEM MALFUNCTION)

* EXTRA DATA

Figure 4-59

If the KF rejects the fixing data, the ROL is contrast inverted when ACCEPT is selected. When REJECT is selected, the ROL is removed.

DOUBLE ACCEPT. If the fixing data are rejected by the KF, an R will appear in the ROL. First acceptance may be applied in the normal manner, causing the ROL to appear contrast inverted. However, the navigator can countermand the KF's decision as he may insert the fixing result into the MC by selecting ACCEPT a second time. At least 1 sec shall elapse between the first and second ACCEPT. The ROL will clear indicating PP is updated.
Errors are indicated up to 30 NM. If the height of the fixpoint is not known, no error can be calculated and the height error is displayed as ± ----- feet.
If the fix error exceeds 30.00 NM in either along or across track direction, it will be displayed on the screen as follows:

ERR 30.01 NM 30.01 NM + ----- FT R

ATTACK FORMAT

When either ATTK on the MFK or weapon aiming on the NWAMS is selected, the display is changed to the basic Attack format for target acquisition, provided the target is within the display range.
The following data (Figure 4-60) are added to the basic Fix format:

- Time-to-go in the top right corner of the display indicates time-to-go to release except for Phase 1 of a LOFT attack, where time-to-go to the target is indicated.

- Distance-to-go to the release point is displayed in the top left corner with distance-to-go to the target below except for Phase 1 of a LOFT attack, where both readouts show distance-to-go to the target.

- A Continuously Computed Impact Point (CCIP) marker comprising a small part of the bomb fall line, parallel to the track line and bisected by an impact line, is displayed if a WAMS mode and a weapon package containing bombs is selected. The bomb fall line is contrast inverted when the loft pull-up point is reached and remains so until weapon release.

- The direction of the course (next track) to be flown after attack relative to the current aircraft track, is indicated by a line extending from the target for a distance of about 2.5 cm.

EXTRA ATTACK DATA. With MW1 selected planned track to the target is indicated by the line extending from the target. The letter H for heavy load appears to the left of the CCIP marker when loft attack is selected on the NWAMS panel and the range to the target is below 9 NM. This load is assumed automatically by the MC without any other selection made by the MFK keys. Medium load or light load selection via the ML or LL soft keys causes the displayed H to be changed into the relevant M or L indication on the screen.
For detailed LOFT LOAD SELECTIONS refer to AER.1F-PA200-34-1.

MFK AND FFK OPERATION

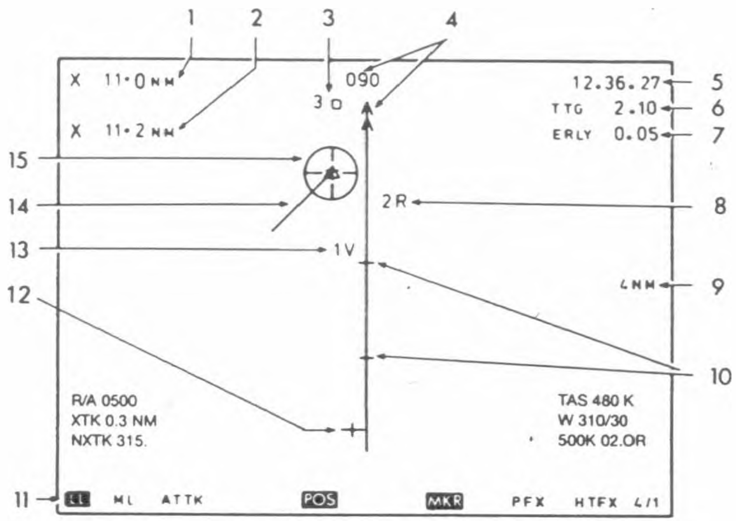
Manual insertion of mission data is performed using the MFK in conjunction with the TV/TAB display. Each line of navigation information from the mission data is selected for display in the ROL. Alpha-numeric characters in the line may be changed using the MFK, but all symbols relating to abbreviations of the units used are entered automatically. The general method of data insertion involves the selection of the appropriate keyboard, the writing of data in the ROL or the overwriting of information and finally the entering of the data into the MC. MFK selection is made via the FFK on the TV/TAB and captions of the selected keyboard are displayed immediately above the unmarked keys. Overwriting the ROL entails using the shift key to move a marker along the line in order to overlay and contrast invert the character to be replaced. The correct character is then inserted from the alpha-numeric keyboard and the marker jumps to the adjacent character.
When one or all the appropriate characters in a particular ROL have been amended, the data is entered into the MC by pressing the ENTER key on the FFK and the writing MKR disappears if the information has been accepted by the MC.
The procedures by which each navigation element of the mission data is manually entered, are given in this Section.

TV/TAB Malfunctions

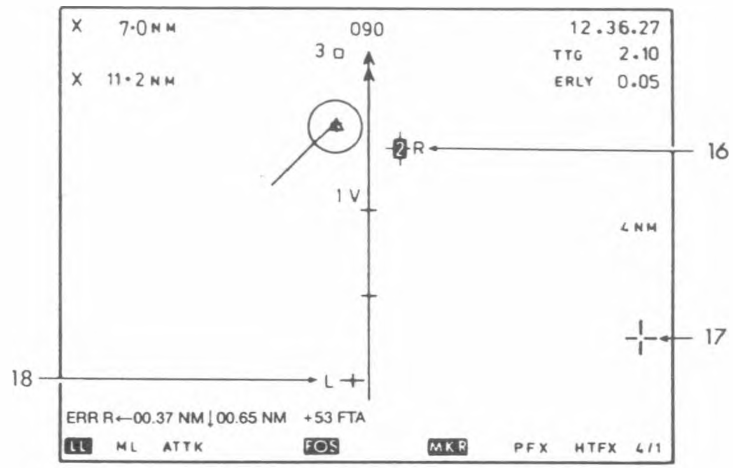
DISPLAY UNIT MALFUNCTION

If the displayed character and symbols are distorted, set the WFG switch to TEST. If the Test format is correctly shown, reselect the ON position. In other case refer to DU Failure.

SCHEMATIC ATTACK FORMATS



ATTACK FORMAT BASIC



ATTACK FORMAT EXTRA DATA

□ CHARACTER CONTRAST INVERTED

1 DISTANCE TO RELEASE POINT TARGET X
2 DISTANCE TO TARGET, WHICH MAY ALSO BE A FIXPOINT
3 OFFSET NO. 3 VISUAL AND RADAR
4 TRACK LINE AND READOUT
5 SYSTEM TIME
6 TIME-TO-GO TO TARGET
7 TIME EARLY
8 OFFSET NO. 2 RADAR ONLY
9 SELECTED SCALE
10 RANGE MARKERS
11 MFK CURRENT FUNCTIONS
12 CCIP MARKER
13 OFFSET NO. 1 VISUAL ONLY
14 NEXT TRACK (MW1 NOT SELECTED)
15 95 % KF ERROR CIRCLE WITH TARGET AND CENTERED MARKER
16 OFFSET NO. 2, DESIGNATED RADAR ONLY, SELECTED WITH THE CRPMD MARKER AND ANTENNA BORE SIGHT POINTED AT IT *
17 MKR SELECT SYMBOL *
18 CCIP MARKER LIGHT LOAD SELECTED *

* EXTRA DATA

Figure 4-60

DISPLAY UNIT FAILURE

If the character and symbol display on one DU is lost or distorted, deselected the relevant ON key and continue to operate with the remaining DU. In Plan format the selected DU will be deselected automatically and revert to Nav upon selection of PLN on the other.

WAVEFORM GENERATOR FAILURE

If the waveform generator fails, the WFG OHEAT indicator on the MCCP illuminates, and the characters and symbols on both DUs are lost or distorted.
The WFG switch should be set to OFF, but do not deselect the TV/TAB ON keys. When raising the reversionary keyboard captions cover, the RKB now provides a limited number of reversionary functions, but the result of any keying action is not shown on the display.
In general, if the TV/TAB fails, the effects on other systems are:

- Normal steering functions are available.
- Normal CRPMD functions are available to monitor destination.
- TV/TAB Shift Key can be used to toggle; MAP SLEW can be used to monitor destination on CRPMD.
- NHC and PHC Inserts can still be used to define new destinations.

HEAD-UP DISPLAY UNIT (HUD)

The HUD, in the centre instrument panel, projects information in symbolic and numeric form into the pilot's field of view.
This source of information, in one form, provides steering demands to assist the pilot to steer the aircraft manually, and in another constitutes the primary source in an attack phase.
Symbols are generated at the command of the MC by the Electronics Unit (EU) and displayed by the Pilot's Display Unit (PDU). They are presented, focussed at infinity, in the pilot's line of sight. The fixed dual combining glass with graded coatings enables the pilot to follow the display in elevation with limited head movement.
A Standby Sight (SBS) for reversionary weapon aiming is provided.
In weapon aiming and fixing sub-modes, the servo drive keeps the target bar, fixing cross, ranging reticle, and aiming pipper in the field of view of the pilot at all depression angles.
A mechanical override and a standby sight for reversionary weapon aiming are provided. Symbols are suppressed if the EU BITE detects a faulty or incorrect input. Where alternate data are available from primary equipments (IN; ADC; RAD ALT; SAHR) the HUD logic automatically selects the inputs and the display will indicate accordingly Figure 4-61.
For HUD interruptive BITE, three Test formats are displayed as determined by the MODE and MAG/TRUE switches on the HUD control panel.

Power Supplies

The unit is supplied with 200 V/400 Hz 3-phase AC from the AC busbar XP1, and with 28 V DC from the DC busbar PP2.
The SBS is supplied with 28 V DC from the DC busbar PP1.

Electronics Unit (EU)

The EU in the forward equipment compartment is a waveform generator, controlled by a high speed, on-line digital computer, and has the following functions:

- Generation of the necessary waveform for the display of the symbol repertoire.
- Selection, upon receipt of command signals, of appropriate symbols with proper priorities.
- Determination of position and motion of symbols according to data from other equipments.
- Operation of continuous in-flight internal monitoring.
- Operating of ground checkout procedures.

Pilot's Display Unit (PDU)

The PDU converts the waveforms generated by the EU into visible simbols which are displayed on a Cathode Ray Tube (CRT) and presented in the pilot's line of sight by means of a collimator and combining glass.
The PDU is positioned so that the combining glass lies in the pilot's line of sight with its outline coinciding approximately with the frame of the windscreen. The display field of view is 25°.
A solar cell in the PDU continuously monitors the brightness of the background against which the display is observed. The cell controls a circuit which automatically maintains the contrast level of the display as selected by the pilot.

HUD DIAGRAM

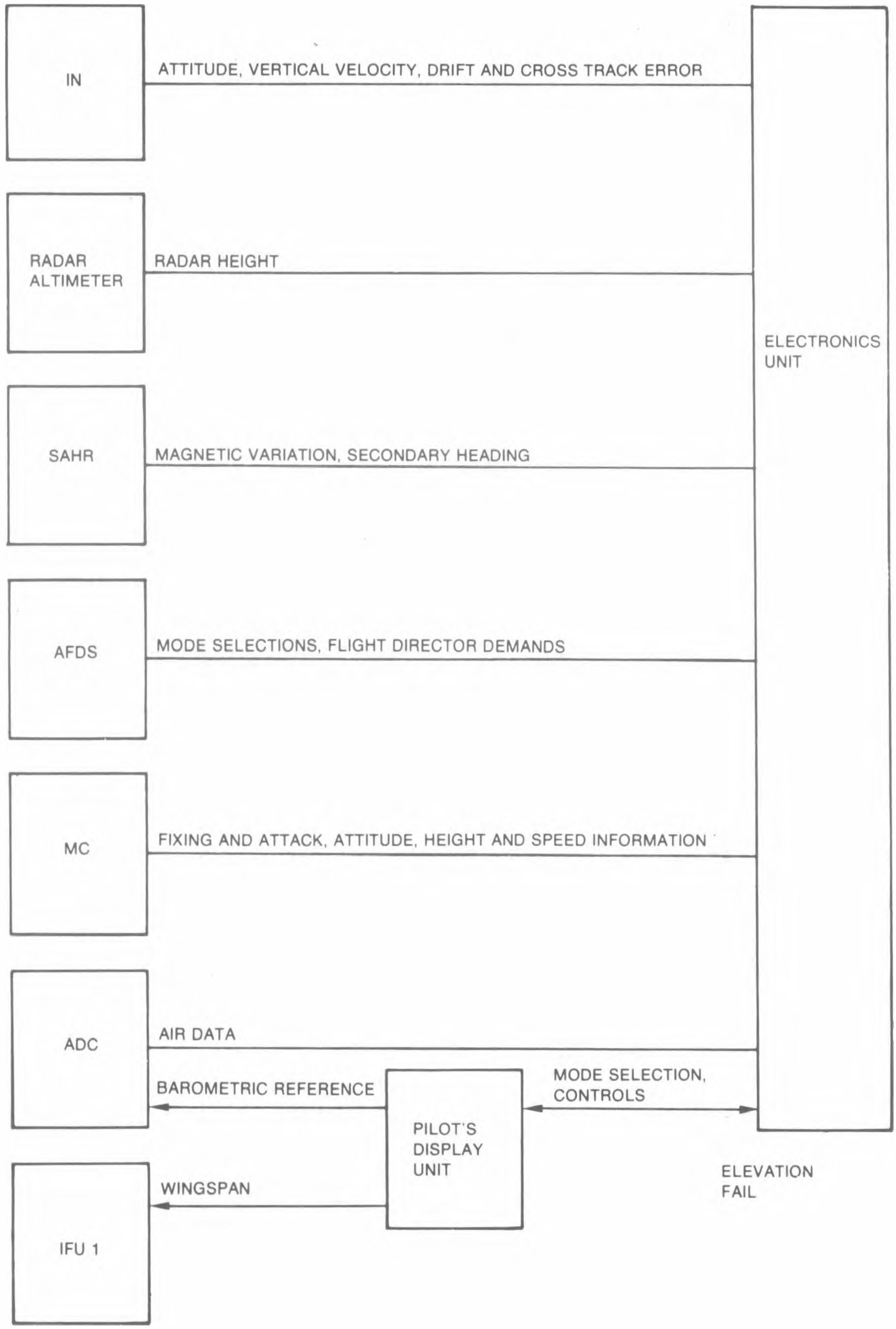


Figure 4-61

Optical Projection System

The optical projection system (Figure 4-62) comprises:

- An optical arrangement of lenses and a deflection mirror.
- A SBS optical projection facility and a collimating lens.
- A servo-controlled, symbol positioned, combining glass assembly.

COLLIMATING LENS AND DEFLECTION MIRROR

The lens and mirror system projects the display onto the combining glass. The projected image appears at a great distance ahead of the aircraft – focussed at infinity – and therefore at the location of distant objects in the pilot's view. This ensures that the pilot's eyes do not need to refocus when looking from distant objects to HUD symbols and vice versa, and also that the pilot's head movements do not introduce a parallax shift between HUD symbols and distant objects.

DUAL COMBINING GLASS

The dual combining glass is a fixed assembly which provides the symbology in a total vertical field of view with minimum head movement.

Head-Up Display Control Panel

The HUD control panels is located in the front cockpit on the main instrument panel and carries all the controls and indicators for the operation of the HUD (Figure 4-63):

HEAD UP DISPLAY UNIT (OPTICAL SCHEMATIC)

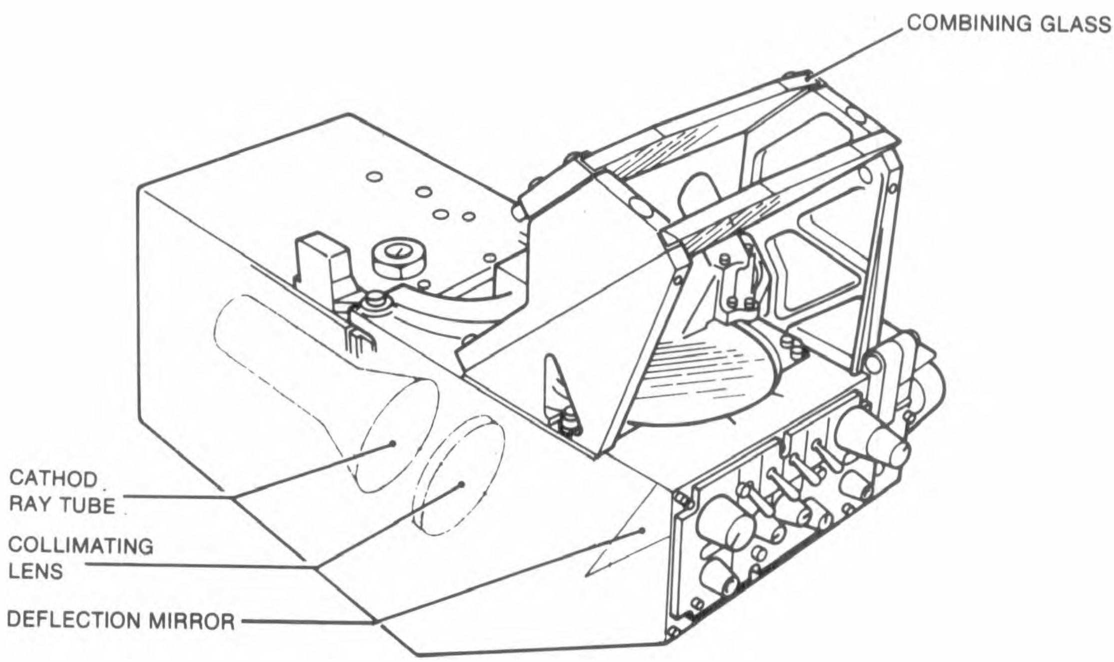


Figure 4-62

MODE SELECTOR KNOB

A six position rotary MODE switch with the following positions:

OFF — Power supplies are disconnected and the HUD is inoperative (except for SBS facility).

DIR — Attitude display, scales, and readouts are received direct from the primary navigation sensors; IN, SAHR, RA, ADC, and AFDS.

AUTO — Displayed information is received from the MC. Display format changes in accordance with commands from the MC.

NAV — The MC command is overridden to present and maintain a Navigation format, even if the navigator makes a selection, e.g. F/A, which normally would result in a changed Attack format.

T2 — BITE checkout of the Attack formats. Separate Bombs and Guns formats are selectable by the selection of the MAG/TRUE switch.

T1 — Navigation Test format is displayed during BITE checkout.

V-V/LOCKED SWITCH

The two position V-V/LOCKED toggle switch governs the position of the aircraft symbol. When V-V is selected the symbol is determined by the aircraft velocity vector, that is the flight path, in elevation and azimuth. If LOCKED is selected the symbol is locked in azimuth with respect to the LFD and adjustable in elevation by use of the VERTICAL DATUM control knob.

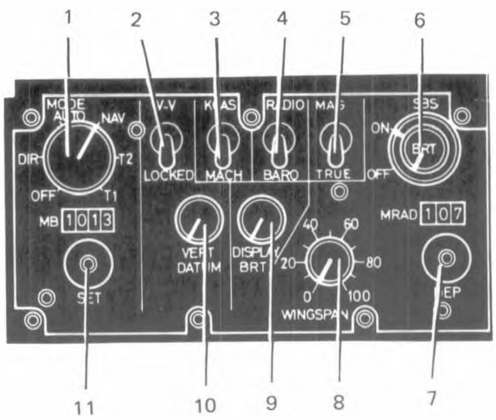
VERTICAL DATUM CONTROL KNOB

The rotary VERTICAL DATUM knob is used to adjust the HUD symbology in elevation from 0° to -10° from the LFD when the V-V/LOCKED switch is in the LOCKED position.

KCAS/MACH SWITCH

A two position toggle switch selects the ADC outputs of aircraft speed to be displayed:

HEAD UP DISPLAY CONTROLS



1 Mode selector knob
2 V-V/locked switch
3 KCAS/Mach switch
4 Radio/baro switch
5 MAG/TRUE switch
6 Standby sight control knob
7 Depression control knob and MRAD indicator
8 Wingspan control knob
9 Display BRT control knob
10 Vert datum control
11 Millibar set control knob and indicator

Figure 4-63

KCAS — Knots calibrated airspeed displayed on the PDU.

MACH — Mach number displayed on the PDU.

RADIO/BARO SWITCH

A two position toggle switch selects height to be displayed:

RADIO — Radio altimeter height, prefixed by the letter R, displayed on the PDU.

BARO — Barometric corrected height (altitude) without prefix, displayed on the PDU.

MAG/TRUE SWITCH

A two position toggle switch with the following positions:

MAG — Magnetic heading is displayed, prefixed by the letter M. During test with the MODE switch in T2, the Bomb Attack Test format is displayed.

TRUE — True heading is displayed without a prefix. In the test mode position T2, the Gun Attack Test format is displayed.

STANDBY SIGHT CONTROL KNOB

The two concentric rotary SBS switches provide the following functions:

ON/OFF — The outer ON/OFF rotary switch controls the power supply to the SBS. When selected ON, the SBS symbol for reversionary weapon aiming is displayed on the PDU.

BRT — The inner BRT potentiometer switch adjusts the brightness of the SBS symbol.

DEPRESSION CONTROL KNOB

The rotary DEP potentiometer is used to adjust the depression angle of the SBS.

MRAD INDICATOR

The three digit MRAD indicator displays the depression angle in milliradians from 0 to -260 MRAD from the LFD.

WINGSPAN CONTROL KNOB

The rotary WINGSPAN switch is used to set the known or estimated wingspan of target aircraft in air-to-air attacks, to provide a datum for the determination of range to target, using stadiametric ranging and to position range bars on the Continuously Computed Impact Line (CCIL). The control scale is calibrated from 0 to 100 ft in 20 ft increments.

DISPLAY BRIGHTNESS CONTROL KNOB

The rotary DISPLAY BRT potentiometer is used to set the level of display brightness.
The relationship to the prevailing ambient lighting condition is held constant thereafter by a solar cell on the HUD.

MILLIBAR SET CONTROL KNOB AND INDICATOR

The rotary MB SET switch sets the barometric pressure for the barometric corrected altitude in the ADC. The pressure setting is indicated in millibars on a 4 digit indicator labelled MB.

HUD Symbol Repertoire

The EU produces and updates display symbology every 20 msec. The symbols, consisting of a single element such as the aiming pipper or of several elements such as the altitude display, are grouped together in formats to display the relevant data for navigation and weapon aiming.
The symbols may be aircraft oriented, e.g. the aircraft symbol, so that their display remains aligned with the aircraft wings during rolling maneuvers, or they may be ground oriented, e.g. the target bar, which remains parallel to the horizon. The various display symbols are described as follows and their formats depend on the selection of:

- the HUD mode of operation
- the formats of the TV/TAB
- the weapon aiming mode
- the phase of attack
- the SMS selections (WCP1 and WCP2)

AIRCRAFT SYMBOL

The aircraft symbol in the form of a winged circle provides an aircraft flight path reference. Its wings remain always aligned with the actual aircraft wings. When the V-V/LOCKED switch is in LOCKED position, the symbol is locked in azimuth, indicated by a vertical tail (2, Figure 4-64), with respect to the LFD. In this case the display can be moved by the vertical datum control.
When the switch is in V-V position (1, Figure 4-64), the symbol has no vertical tail fitted and is free in elevation and azimuth but positioned by the aircraft velocity vector. In this case the horizon bars are always positioned on the horizon and drift moves the aircraft symbol to the respective side indicating the flight path.
If the symbol reaches the HUD lower limit, it is parked with a locked indication. The aircraft symbol is position-limited to ± 5° in azimuth and 0° to 15.5° in elevation. In weapon aiming mode the

aircraft symbol is positioned by the velocity vector, but may be overridden by the MC.

AIRCRAFT SYMBOL

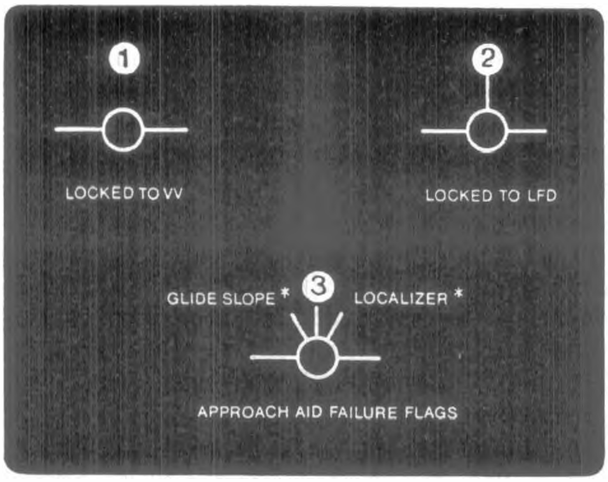


Figure 4-64

ATTITUDE SYMBOLS (FLIGHT PATH SYMBOLS)

The attitude symbols (Figure 4-65) comprise horizon bars, climb and dive bars, zenith star and nadir star. At the centre of the attitude display a pair of solid horizon bars is displayed.
Above and below the horizon bars, solid climb and dashed dive bars represent climb/dive angles between 0° and ± 90° when read against the aircraft symbol or gun cross.
During LOCKED mode only those bars, which are less than 7.5° from the reference symbol in elevation, are displayed. Therefore a maximum of three pair of attitude bars are displayed.
In V-V mode the same conditions apply, except when the aircraft symbols are depressed between −8° and −12°, where −8° becomes the new reference datum for the display of the attitude bars. The numerals are displayed in increments of 5°, those for the dive are written below and carry a negative sign, those for the climb appear above the climb bars. The short vertical legs on the climb/dive bars correspond in lenght to 1.5° of dive and are a useful indication of the glideslope and in inverted maneuvers.

The attitude pattern is displayed with its centre line always lying on the aircraft symbol or gun cross, about which the pattern rotates freely to indicate bank angle and moves upward or downward to indicate pitch. The zenith star is displayed when the aircraft climbs at the top of the attitude display to indicate a 90° nose-up attitude. The nadir star, and inverted Cross of Lorraine, is displayed at the bottom of the display to indicate a 90° nose-down attitude.

ATTITUDE DISPLAY

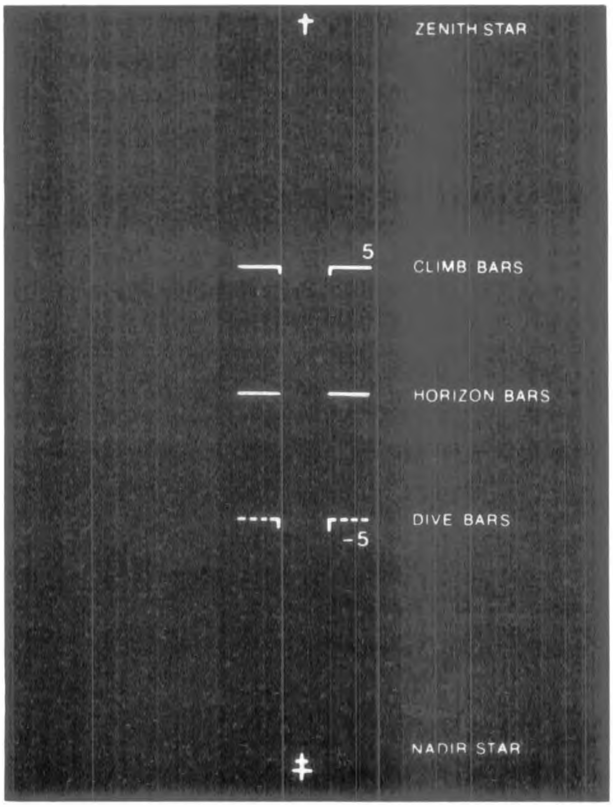


Figure 4-65

SCALES AND READ-OUTS

The HUD provides indications and numeric read-outs (Figure 4-66) of all the essential flight parameters: aircraft speed, height, vertical speed, heading, cross track error and angle of attack.

SCALES AND READ-OUTS

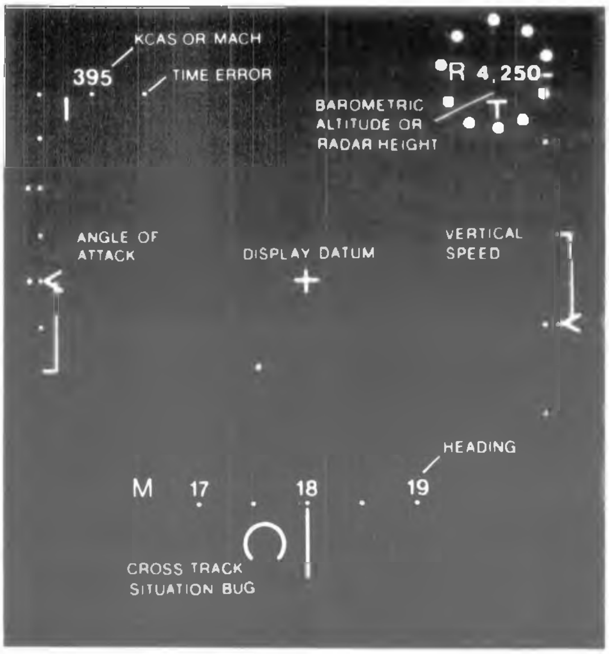


Figure 4-66

- Aircraft Speed – Aircraft speed is presented as a 3 digit readout in either KCAS or Mach number, depending on the selection of the KCAS/MACH switch.

- Time Error Scale – A time error scale indicates time early/late by means of a moving pointer against a scale of three dots. The centre dot represents "on time", the LH dot 30 sec late, and the RH dot 30 sec early, based on present groundspeed to the next waypoint (not in A/A mode and IN-HUD Alignment).

- Height – Barometric or radar heights are displayed as a five digit numerical read-out (selected by the RADIO/BARO switch on the HUD control panel), surrounded by a circular scale of 10 dots and a pointer which rotates clockwise once per 1000 feet, starting from the top mid (12 o'clock) position. When radar height is indicated, the first digit is replaced by the letter "R".
  For heights below 1000 ft, the comma is retained to introduce the possibility of a reading error, for heights below 100 ft, a "O" is displayed in the hundreds position and for negative barometric heights, a minus sign is displayed before the comma. When TF is engaged the letter T appears below the height display.

NOTE

If RADIO is selected and altitude flown is above 5000 ft, height indication is lost.

- Vertical Speed – A thermometer type pointer indicates vertical speed in the range −2000 ft/min to +1000 ft/min, against a fixed vertical scale of seven dots. The +1000 ft, and −2000 ft are indicated by twin dots for ease of scale reading. Spacing between the dots is equivalent to 500 ft/min. The pointer itself can move over a range from −3000 ft/min to +2000 ft/min.

- Heading – A horitontal 5 dot heading scale, marked every 5° with a dot and numerically annotated every 10° moves against a fixed lubber line. At least two numerical annotations are visible at one time and the heading can be either true or magnetic in all modes as selected. When magnetic heading is presented, a letter "M" is displayed to the left of the scale.

- Azimuth Steering Bug – The azimuth steering bug (ASB) is permanently displayed and provides steering information required to regain planned track with a maximum closing angle of 45°. It can be used in manual flight as the primary steering information when in weapon aiming. The ASB continues to provide information to regain planned track even when distance-to-go next steering point is less than 20 NM. A switch-over to "direct steer" is given only when time-to-go is less than 30 seconds or if the direct steering demand of the FD is greater than the ASB demand. In Weapon Aiming within 20 NM range to the target, the pilot may decide to follow the ASB to regain planned track and he will ignore the FD direct steering demand to the target.

NOTE

FD and ASB command may indicate different directions of turn, e.g. FD left turn directly to the target with ASB right turn to regain planned track.

- Angle of Attack – A thermometer type pointer displays aircraft angle of attack in the range 0°

to +25° in 5° increments against a vertical 5 dot scale. The 10° and 20° angles are indicated by twin dots for easy scale reading.

NOTE

Differences between HUD and HDD will not be signalled up to the pilot. Regular cross-checks between HUD and HDD values by the pilot are therefore essential.

FLIGHT DIRECTOR SYMBOL

The flight director symbol consists of a dot and two horizontal cue lines forming an "elastic" triangle (Figure 4-67).

FLIGHT DIRECTOR

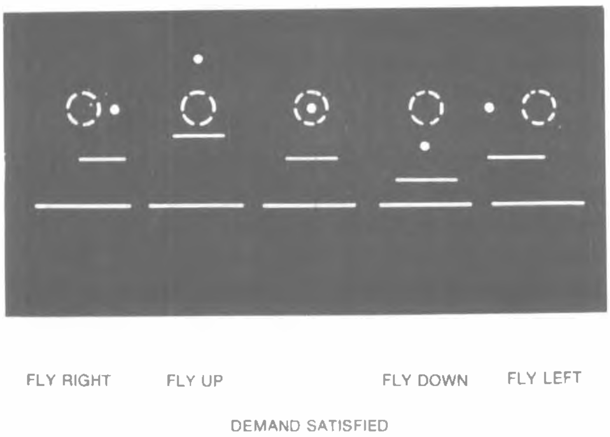


Figure 4-67

The lower line is twice the lenght of the upper and both remain parallel to the natural horizon, the dot is forming the apex of the triangle. When the flight director demand is satisfied, the dot is in the centre of the aircraft symbol. The symbol is displayed only when FD is pressed on the AFDS and the MODE selector on the HUD is switched to DIR or AUTO. If AP is engaged the horizontal lines are suppressed and only the dot remains. The pilot may utilize the display to monitor the operation of the AP in all modes. Pitch demands are indicated by the vertical displacement of the dot. The lower line maintains its position and the upper line moves in sympathy with the dot so as to maintain a position midway between dot and lower line.
Roll demands are indicated by the dot moving left or right of datum. The lower line maintains its position and the upper line moves in accordance with the dot, so that its centre lies on an imaginary line joining the dot to the centre of the lower line. When both the flight director and the autopilot are engaged the cue lines are suppressed and only the dot remains. Movement of the FD symbol in relation to the aircraft symbol is limited to ± 3° horizontally and ± 2° vertically.

NORMALIZED TIME/RANGE CIRCLE SYMBOL

The normalized time/range circle indicates time-to-go for bomb attacks or range in gun, missile, or Kormoran attacks, depending on the HUD mode of operation. The circle unwinds counterclockwise from the 12 o'clock position until only the vertical marker remains (Figure 4-68).

NORMALIZED TIME/RANGE CIRCLE

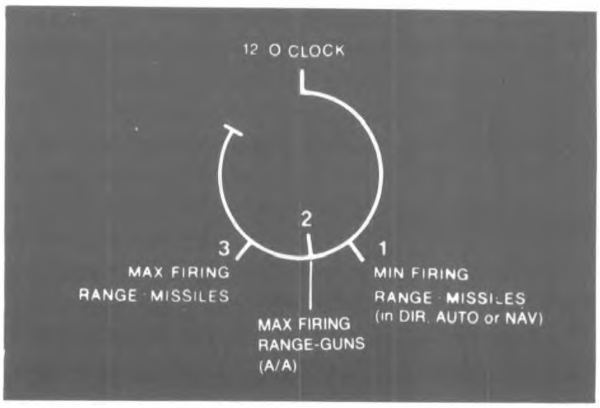


Figure 4-68

The full circle represents:

- 60 sec time-to-go to release for bomb attacks except Phase 1/2 LOFT.
- 60 sec time-to-go to pull-up for Phase 1/2 LOFT attacks.
- 4 km range for gun and A/A missile attacks.

- 36 NM range for Kormoran attacks in the radar supported modes except visual Phase 2.
- Missile READY for Kormoran TOO attacks in Phase 2.

Variable event markers, positioned on MC commands, or fixed event markers, depending on the type of attack provided as follows:

A/A guns and AIM-9
- event marker (3) variable at max. missile range
- event marker (2) variable at max. gun range
- event marker (1) variable at min. missile range

A/G guns
- event marker (3) fixed at 2500 m max. gun range
- event marker (1) variable at min. gun range

Kormoran
- event marker (3) fixed at max. missile range
- event marker (1) variable at min. missile range

Weapon Aiming Symbols-Bombs

For the symbols refer to Figure 4-69.

- Aiming Line (1) – A line extending from the V-V down through the CCIP represents the impact line of bombs, i.e. a line projected on the ground parallel to the aircraft track and offset by bomb cross trail. The top of the aiming line indicates minimum safe pass height while the moving gap represents a pass height increased by a factor of 1.5. For automatic bombing the top and the gap are related to the target bar. For TOO bombing with manual release the top of the aiming line and the moving gap (which is displayed only for free fall bombs) are related to the CCIP. The aiming line is extended from the top of the aircraft symbol by a dotted line to aid tracking.

- Moving Gap (2) – The moving gap represents the angle subtended by the safe pass height related to the distance from the target.

WEAPON AIMING SYMBOLS-BOMBS

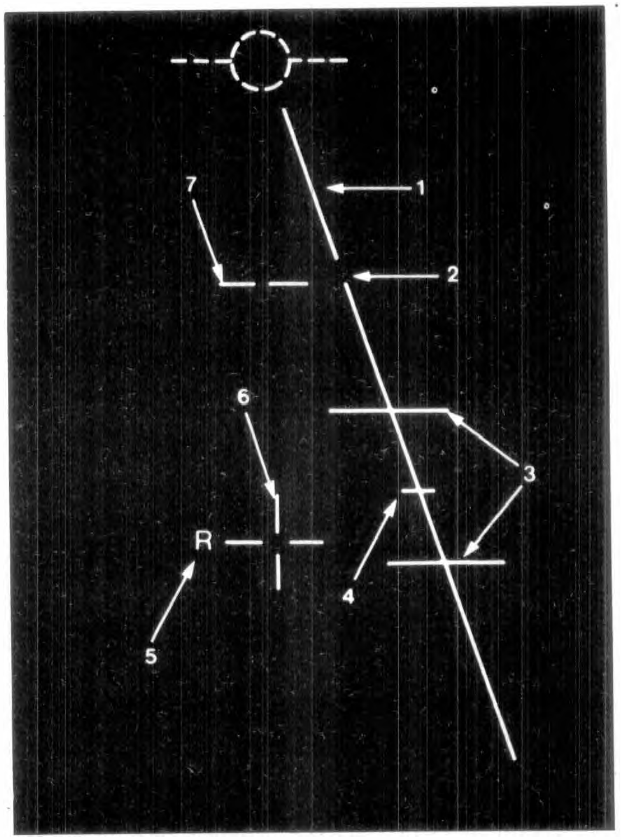


Figure 4-69

- CCIP Marker (4) – This symbol represents the calculated ground impact point of the bomb load on the aiming line. In AUTO release mode the weapons are released when the CCIP marker coincides with the target bar. In the manual release mode the aircraft shall be steered so that the intersection of the aiming line and the CCIP coincides with the target. For MW-1 attacks the CCIP marker is positioned on the aiming line to indicate the center of the ground impact pattern of the submunitions unless FIRST BOMB is selected on the NWAMS panel. If FIRST BOMB is selected, the CCIP is positioned to indicate the forward edge of the impact pattern. If the TOO CCIP attacks, the cluster lines are frozen in a memory position, the CCIP is one half carpet length ahead of the lower line or direct on it, if FIRST BOMB is selected.

- Cluster Lines (3) – Two parallel, ground stabilized cluster lines which define the along track limits of ground coverage for MW-1 submunitions, are displayed when a MW-1 weapon package is selected. They either bracket the target bar in Phase 1 attacks, Phase 2 offset attacks and Phase 3 attacks, or the ranging reticle in Phase 2 direct and TOO converted attacks. The lines slew along the aiming line in sympathy with either the target bar or ranging reticle, as these respond to MC or hand controller inputs. In TOO attacks the lines bracket the CCIP, however, to avoid the lower line being positioned below the HUD FOV in a memory position, it is limited to −14° where, if applicable, it is frozen. In this situation the CCIP is positioned one half carpet length ahead of the lower line or on it, if FIRST BOMB is selected.

– Target Bar (7) – A short horizontal line represents the computer-calculated target position.
The target bar is displayed:

- gapped in Phase 1 of direct and offset attacks where its position is updated in sympathy with the CRPMD marker by NHC inputs. When going to memory its azimuth position remains correlated to the CRPMD marker
- gapped in Phase 2 of offset attacks where its position is updated in sympathy with the ranging reticle by PHC inputs. It is not displayed in Phase 2 of an offset loft attack
- ungapped in Phase 3 of a direct attack or a converted TOO attack where its position in elevation is directly locked to the aiming line. When going to memory the target bar becomes gapped again. PHC control is lost in elevation while in azimuth it is unlocked from the aiming line and frozen to its last Phase 3 position to facilitate azimuth steering.

– Ranging Reticle (6) – The ranging reticle is a gapped cross with a centered dot displayed in Phase 2 on the target or offset position in the A/G mode. In A/A mode the centered dot is removed. The reticle position represents the boresight of the ranging sensor in use in A/A modes and computed target/offset position in A/G modes. It is controllable by the PHC during Phase 2 modes of Fix/Attack and the movement is limited to the display area. The symbol starts flashing, when driven to the horizontal display limits and is parked there but remains under PHC control.
When driven to the lower display limit while ranging on a target, memory mode is entered, i.e. the symbol is frozen 5° above the display limit and PHC control is lost. The memory mode provides azimuth steering information to the last Phase 2 position prior to leaving the HUD lower field of view.

NOTE

- If the ranging reticle inadvertently slewed to the memory position, PHC control can be regained by selecting Phase 1 and then Phase 2 again.
- While ranging on an offset, the ranging reticle driven through the lower display limit will leave the HUD lower field of view but will remain under PHC control until the target bar goes to memory. At this moment PHC control is lost and further updates are inhibited.

In Phase 3 the ranging reticle is transferred to an ungapped target bar, which in azimuth is locekd to the aiming line while elevation is controlled by the PHC. In TOO the ranging reticle is placed at a fixed angle below the aircraft symbol.

RANGE LOCK (5)

In the A/G modes, radar ranging GMR lock-on and AGR is indicated by the letter R preceding the gun cross, target bar, controlled ranging reticle or aiming pipper. R appears so the left, indicating sensor ranging with RDR selected, and that selection has been accepted by the MC.

Post Mod. 00942: For Phase 1 loft attacks GMR range lock indication preceding the target bar is displayed. In the A/A modes the R preceding the ranging reticle indicates that the GMR is in the AAT mode. Radar lock-on is indicated in the primary lead angle mode by the normalized time/range circle replacing the stadiametric ranging circle and in the secondary CCIL mode by the lock-on circle on the CCIL replacing the range bars.

Weapon Aiming Symbols – Guns and Air-to-Air Missile

For the symbols refer to Figure 4-70.

– Aiming Pipper – The aiming pipper is positioned according to the lead angle calculated by the MC and represents the aiming point for gun firing.

– Gun Cross – The gapped gun cross is fixed on the aircraft Armament Datum Line (ADL) and represents the convergence point of the guns.

WEAPON AIMING SYMBOLS – GUNS AND AIR-TO-AIR MISSILES

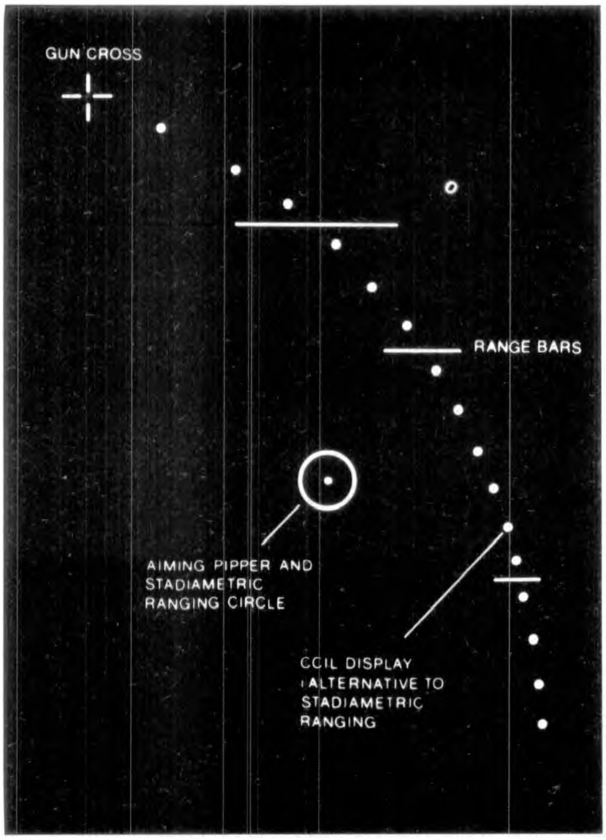


Figure 4-70

– Stadiametric Ranging Circle – A variable diameter stadiametric ranging circle centred on the aiming pipper is used to obtain range data during air-to-air attacks when radar ranging is not available. With the target's known or estimated wing span set on the HUD control panel as a datum, the ranging circle diameter is matched to the actual target wing span by the stadiametric ranging control on the front control left throttle. Circle diameter is variable from 6 to 40 MRAD.

– Continuously Computed Impact Line (CCIL) – The CCIL is a 16-dot line starting from the gun cross. Each dot represents a predicted shell impact point for each determined range, calculated by the HUD electronics unit when operating in the HUD DIRECT mode. After selecting the target wing span on the HUD control panel, range bars, representing 250, 500 (Post mod. 00942: and 1000 m) are displayed. A small 10 MRAD lock-on circle on the line indicates the shell impact point at target range when the radar has locked on. Range bars are displayed for range stimates when no radar range is available.

– Viper Diamond – For the AIM-9L the viper diamond indicates missile seeker head position of a missile. If target angles exceeds HUD limits, the diamond leaves the HUD field of view (FOV).

Post mod. 00942: If target angles exceed the HUD limits the viper diamond is frozen at the display limits and starts flashing.

FIXING CROSS AND BREAKAWAY CROSS

For the symbols refer to Figure 4-71.

FIXING CROSS AND BREAKAWAY CROSS

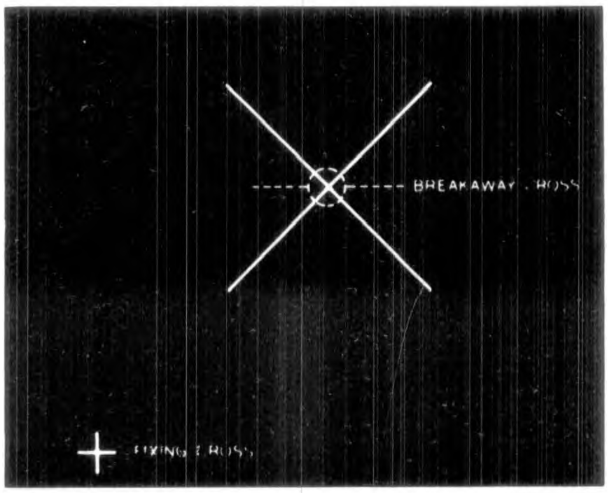


Figure 4-71

– Fixing Cross – The fixing cross as a small, solid cross indicates the calculated position of a fixpoint target or offset in Phase 1 fixing and weapon aiming. Upon selection of Phase 2 it is transferred to the rancing reticle controlled by the PHC.

– Breakway Cross – The diagonal breakway cross centred on the aircraft symbol indicates minimum safe height in gun attacks, minimum range in air-to-air attacks, a pull-up command in TF and RH modes, and also a MC failure, coupled with the HUD format changing to Direct mode.

STAND-BY SIGHT SYMBOL

For the symbols refer to Figure 4-72.

STAND-BY-SIGHT

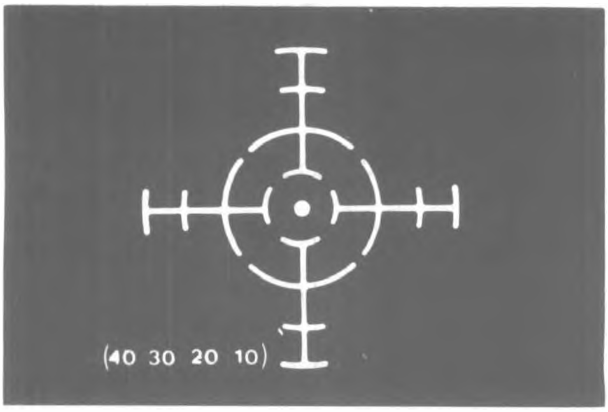


Figure 4-72

The symbol consists of two concentric circles centred on a small dot with four perpendicular lines extending outward from the inner circle, marked at 10, 20, 30 and 40 MRAD from the centre.
The SBS is used for reversionary weapon aiming when either HUD or MC has failed. The symbol is focussed at infinity and fixed in azimuth at the centre of the HUD. Depression can be manually adjusted in elevation from 0° to −15° with respect to LFD. The SBS is displayed, red coloured projected by a lamp, after selectings SBS on the HUD control panel. The lamp is supplied by 28 V DC separately from the normal HUD power supply.

HUD OPERATION

The HUD mode in use is determined by the pilot's selection via the MODE selector on the HUD control panel. Two primary modes are provided, each covering a number of sub-modes. In addition, two Test modes for checking Attack and Navigation formats are also provided.
Figure 4-73 shows the operating modes available.

DIRECT MODE

When DIR is selected, information is received directly from the primary sensors. Magnetic or true heading is displayed, depending on MAG/TRUE selection, and information is received from IN, SAHR, RA and ADC (Figure 4-74). If D31/D32 on the INCDU is not selected the azimuth steering bug is not provided. If the INCDU is not set to NAV mode, the horizon bars, climb/dive bars, vertical speed scale, and azimuth steering bus are occulted. The aircraft symbol is locked to LFD and has a tail.
In general, data may suffer some degradation in this mode since the information is received directly and is not necessarily the "best available".
Figure 4-75 shows the Direct Navigation format.

NOTE

- If DIR is selected or reverted to and a fault is detected in an input channel, the associated symbology is occulted unless alternative data are available on another direct channel.

- Intermittent loss of radar altitude on the HUD (lasting for 6 to 10 sec every 15 to 20 min) may occur in Direct mode. During this time the indications on RA and TV/TAB are present and valid.

AUTOMATIC MODE

When AUTO is selected, the HUD is driven by inputs from the MC in accordance with the relevant submode. Figure 4-76 shows the Auto Navigation format.

NOTE

When RAD ALT is "pressed-to-test", the HUD shall be in DIR for the relevant digits to be displayed. AUTO should be reselected after the test sequence to regain VV and attitude monitoring.

NAVIGATION HOLD MODE

NAV may be selected by the pilot when he wishes to retain the Navigation format display in condi-

HUD MODES OF OPERATION

MODE SELECTION	SUB-MODE	REMARKS
DIR	Navigation	Symbology driven directly from primary sensors
	Attack-Guns/Rockets (CCIL)	Air-to-Air selected on throttle
AUTO	Navigation IN Align	Symbology driven from MC
	HUD measurement	HUD MEAS selected on INCDU
	Rapid HUD Alignment	RPD HUD selected on INCDU
	Fixing	F/A selected on TV/TAB
	Attack-Bombs	LOW LOFT, HIGH LOFT, TOO/TARGET, OFFSET selected on WAMS. A/G Missile selected on WCP1 and F/A selected on TV/TAB
	Attack-Guns/Rockets (Lead Angle)	Air-to-Air selected on throttle or A/G GUNS selected on pilot's WAMS
NAV	Navigation Hold	As AUTO navigation
T2	Attack-Gun/Rockets	Attack Test format, Guns/Rockets, MAG/TRUE switch selected TRUE
T2	Attack-Bombs	Attack Test format, Bombs, MAG/TRUE switch selected MAG
T1	Navigation	Navigation Test format

Figure 4-73

HUD MODE-DIRECT (PRIMARY SENSORS)

PARAMETER	SENSOR	SYMBOL/DISPLAY
True HDG Mag HDG	IN SAHR	Heading Scale
Required Track	IN	Flight Director, Azimuth Steering Bug
Climb/Dive Roll	IN	Altitude Display
Azimuth Elevation	IN	Aircraft Symbol
Vertical Speed	IN (MAIN, IN modes) ADC (DP + SR, AD + SR modes)	Vertical Speed Scale
AOA	ADC	Angle of Attack Scale
Mach Number KCAS	ADC	Speed Readout
BARO Height RADIO Height	ADC RA	Height Readout

Figure 4-74

DIRECT NAVIGATION FORMAT

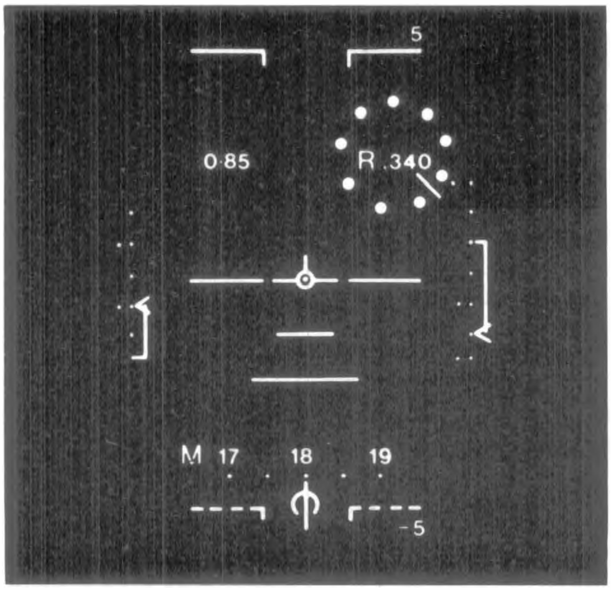


Figure 4-75

AUTOMATIC NAVIGATION FORMAT

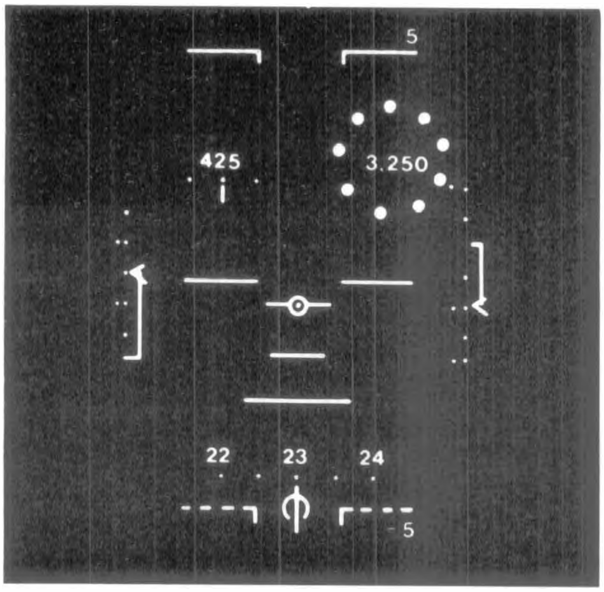


Figure 4-76

tions where the navigator's selection would result in a change of format.

Attitude Monitoring

The MC attitude monitor operates in the MAIN and IN/MC modes and compares only inclination and bank but no heading values between the IN and SAHR. In case of higher discrepancies in attitude between the two, the monitor sends a signal to the HUD which occults the FD symbol and the attitude bars on the HUD. Also the aircraft symbol will be occulted.

NOTE

If SAHR status still fails after an MC restart (prior selecting MAIN mode) the attitude monitor remains active.

Vertical Velocity Monitoring

BARO/IN ∓ Vertical channel is closely investigated by the VV monitor; a detection of a runaway VV_{BIN} and/or H_{BIN} intiates a HUD warning format.

Attitude Monitor	Navigation Modes	HUD Symbology
SAHR and IN inclination or bank exceed certain limits (but reversionary VV available)	MAIN or IN	Attitude bars, vertical speed scale and aircraft symbol occulted
VV Monitor		
VV and/or H are not best available (Monitor/BITE trip)	MAIN or IN	For the first 30 sec attitude bars and aircraft symbol flash at 1Hz then for 2 sec every 60 sec

The same warning format occurs in case of a BITE detection and in case of an ADC fault repeated to IN.

Rapid HUD Alignment

Refer to Rapid Alignment of the IN of this section (Figure 4-77).

HUD SYMBOLS IN ALIGNMENT FORMAT

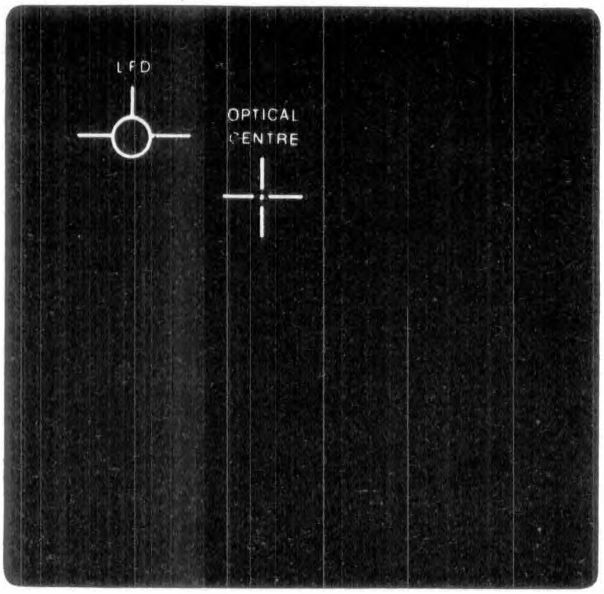


Figure 4-77

HUD Bite

Continuous monitoring tests the HUD functions in the input, central processing and output components.
To prevent faults being indicated during initial warm-up the BITE is inhibited for the first 30 sec after switching on. Interruptive monitoring uses three Test formats to display the complete symbol repertoire of the EU, Navigation, Attack-Bombs and Attack-Guns/Rockets.

NAVIGATION TEST

An interruptive BITE test of the Navigation display symbols is carried out by switching the MODE selector to the T1 position. A Test format is displayed as shown in Figure 4-78 which includes a row of input channels status figures. Digit1 represents good and 0 represents "invalid".

EXAMPLE NAVIGATION TEST FORMAT

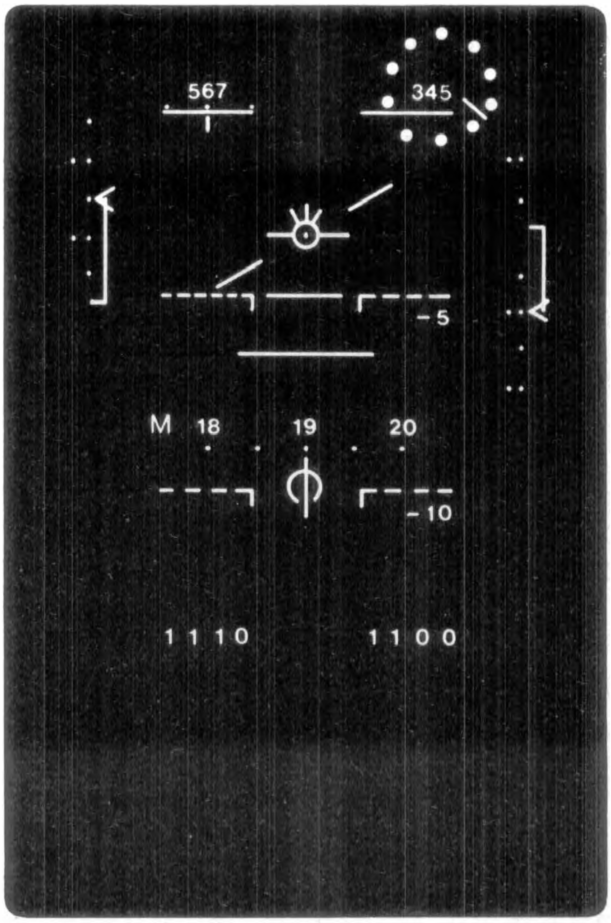


Figure 4-78

The order of channel input figures at the bottom of the format, reading from left to right, is:

- Main Computer
- Inertial Navigator Computer
- Air Data Computer
- Flight Director Computer 2
- Secondary Attitude and Heading Reference
- Radar Altimeter
- Spare
- Spare

Should any of the first six digits have changed to 0 this indicates either an input channel failure or the system is not activated. A check should be made on the navigator's CWP for equipment failure indications.

ATTACK TEST

When T2 is selected by the MODE selector, the two Attack Test formats are available depending on the position of the MAG/TRUE switch. When the MAG/TRUE switch is in the TRUE position, the Guns/Rockets format is displayed as shown in Figure 4-79. When MAG position is selected, the Bomb format is displayed as shown in Figure 4-80.

ATTACK (GUNS/ROCKETS) TEST FORMAT

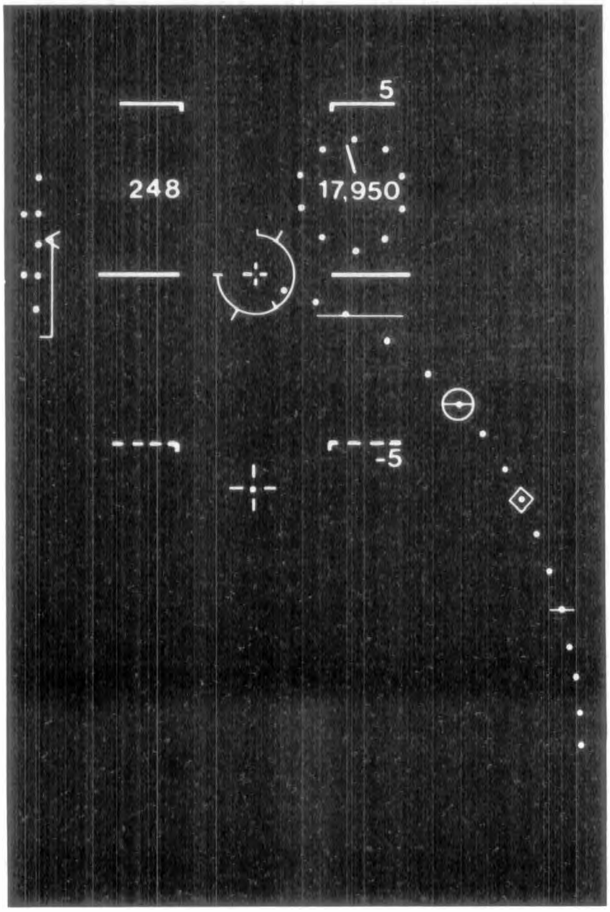


Figure 4-79

ATTACK (BOMBS) TEST FORMAT

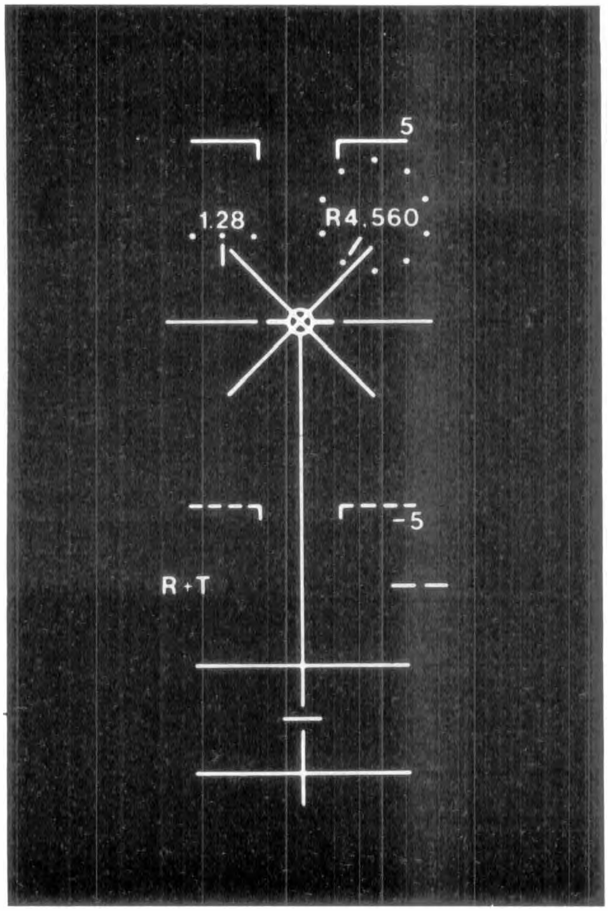


Figure 4-80

Equipment Failures Affecting the HUD

MAIN COMPUTER FAILURE

With the loss of the MC input, the HUD reverts to the Direct mode and uses inputs directly from the prime sensors. There will be no vertical velocity and attitude monitoring.
Visual attacks can be carried out by switching on the SBS and setting it to the appropriate depression angle.

IN FAILURE

If an IN failure occurs, the aircraft symbol with all attitude and vertical velocity information are occulted and no monitoring at all takes place.

SAHR FAILURE

If total SAHR failure occurs, heading scale is occulted, when MAG is selected in MAIN or IN mode or loss of vertical velocity and altitude indications when the DP + SR or AD + SR mode.

ADC FAILURE

If, due to ADC failure, the IN sets the status word invalid, the vertical speed scale, the attitude display, and the aircraft symbol are occulted (on the aircraft symbol the vertical tail flashes for 5 sec).
With BARO/IN selected, both amber ADC and IN captions on the CWP will illuminate.

RA HEIGHT FAILURE

If RA fails or unlocks, the R height readout is occulted but R remains, indicating the RADIO selection.
On receipt of RA revalidity data, correct height is redisplayed. If RA failure continues, a reversion to BARO is required. With the failure or unlock condition being removed, correct height is re-displayed.

TF/RH MODE FAILURE

In the TF mode, radar reflecting objects penetrating the clearance range will result in a pull-up command signal, a TF failure and similarly a failure in the RH mode will be displayed on the HUD by a breakaway cross. The displayed T symbol will be occulted. If AP or FD fails the T will also be occulted and MC/IN data instead of TF data will be used for display positioning. Refer to TF description for further details.

INTERFACE UNIT 1 FAILURE

If IFU 1 fails completely, the HUD loses input of attitude information. The FD will be occulted as well as the VSI, all ground stabilized symbols, and the aircraft symbol. The display is locked to the LFD but the positioning will remain on the velocity vector if V-V has been selected.
The PHC and WAMS button/indicators are inoperative and Phase 2 of planned attacks cannot be carried out. Visual attacks restricted to the use of the CCIP with manual releases. In the Air-to-Air mode, the aiming pipper and the ranging reticle are displayed co-incident in a position below the gun cross. The stadiametric circle is not displayed and the CCIL facility is unusable.
A radar lock-on can still be obtained if the aircraft is flown in that way, that the ranging reticle is superimposed over the target. If lock-on is not achieved the SBS shall be used.
The following facilities are also lost:

- Cancel visual offset
- Insert
- Lock-on reject

(For further details of partial failures of IFU 1, refer to Reversionary Operation).

HUD Malfunction

If a fault is detected in the incoming data, the associated symbol is occulted unless alternative data are available from the primary sensors. When such data are available, the HUD logic automatically selects the direct input, provided the fault persists longer than 10 milliseconds. If a detected fault is not in the input system, the display is occulted automatically.
In the PDU the system is tested for responses to test inputs and the results are examined against a narrow tolerance and a wide tolerance band. If a test response is incorrect but within the narrow (3 per cent) band tolerance, the HUD system continues to function with its accuracy degraded. If a test response is outside the narrow band limit but within the wide (10 per cent) band limit, the display is switched automatically to a Navigation format (with no weapon aiming symbols available). The display is occulted automatically if the test response is outside the wide band limit.

HUD Failure

In the event of complete HUD failure the display is occulted; manual attacks in both Air-to-Ground and Air-to-Air modes can be carried out using the SBS. (For further operation refer to Reversionary Modes).

NAVIGATION CONTROLS

Main Computer Control Panel (MCCP)

The MCCP provides power supply switching facilities for the MC, IFU 1 + 2, and WFG, and carries the following controls and indicators (Figure 4-32):

MC POWER SWITCH

The two-position ON/OFF MC power toggle switch connects the MC power supplies.

PROGRAM LOAD/FAIL INDICATOR

The LOAD/FAIL indicator includes the upper white caption LOAD, which illuminates during program loading and is extinguished when loading is successfully completed, and the lower amber caption FAIL, which is illuminated when the MC detects a program loading of inflight failure.

WAVEFORM GENERATOR POWER SWITCH/OVERHEAT INDICATOR

The three position WFG toggle switch provides the following selections:

ON-OFF Controls WFG power supply.

TEST WFG interruptive BITE test is initiated and a Test format is displayed on the TV/TAB.

The OHEAT indicator illuminates amber when the WFG overheats or a failure is detected in WFG BITE operation.

IFU 1/IFU 2 POWER SWITCH

The IFU 1 power switch controls the IFU 1 and HSI power supplies. The IFU 2 power switch controls IFU 2 power supplies.

Navigation Mode Control Panel (NMCP)

The NMCP (Figure 4-81) is used for selection and engagement of all automatic and manual navigation and steering modes and for initiation of fixing error insertion into the MC. The following controls and indicators are provided:

TACAN FIX PUSHBUTTON/INDICATOR

The TAC pushbutton/indicator is pressed to prepare the MC for a TACAN fix on a station whose coordinates are already stored in the MC. It illuminates green when pressed and is deselected by a second press.

ON TOP FIX PUSHBUTTON/INDICATOR

The OTF pushbutton/indicator is pressed to prepare the MC for an on-top fix. It illuminates green when pressed and is deselected by a second press.

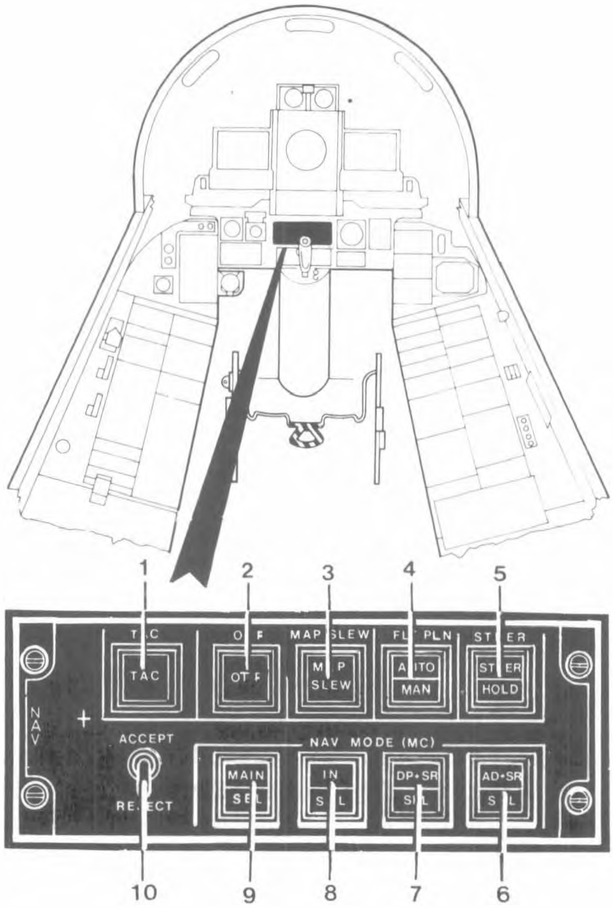
MAP SLEW PUSHBUTTON/INDICATOR

The MAP SLEW pushbutton/indicator is pressed to couple the CRPMD map drive with the NHC. It illuminates green when pressed. Pressing a second time cancels the selection. Phase change overrides the map slew function.

ACCEPT/REJECT SELECTOR SWITCH

The ACCEPT/REJECT toggle switch is springloaded to the centre position. In the ACCEPT position a fix error displayed on the TV/TAB display is accepted for navigation updating of the MC. In the REJECT position the fix error is rejected. A flashing cross at the upper left of the display indicates a Nav/Attack system malfunction.

NAVIGATION MODE CONTROL PANEL



1 TAC FIX pushbutton/indicator
2 OTF pushbutton/indicator
3 MAP SLEW pushbutton/indicator
4 FLT PLN pushbutton/indicator
5 STEER pushbutton/indicator
6 AD+SR pushbutton/indicator
7 DP+SR pushbutton/indicator
8 IN pushbutton/indicator
9 MAIN pushbutton/indicator
10 ACCEPT/REJECT switch

Figure 4-81

FLT PLN PUSHBUTTON/INDICATOR AND STEER PUSHBUTTON/INDICATOR

The two split legend pushbutton/indicators AUTO/MAN and STEER/HOLD are used to select and indicate the required steering modes:

- green AUTO and green STEER captions illuminated when pressed
  - AFP mode engaged

- green MAN and green STEER captions illuminated when pressed
  - MFP mode engaged

- green MAN and amber HOLD captions illuminated when pressed
  - HOLD mode engaged

NAV MODE (MC) PUSHBUTTON/INDICATORS

There are four split legend pushbutton/indicators for certain navigation modes. They indicate the modes available by the illumination of a white caption in the upper half of the pushbutton and similarly the mode in operation by a green caption SEL in the lower half, regardless of manual or automatic selection.
The mode buttons are:

- MAIN (Main mode)
- IN (Inertial navigator mode)
- DP + SR (Doppler + SAHR mode)
- AD + SR (Air Data + SAHR mode)

NAVIGATION WEAPON SYSTEM CONTROLS

The weapon system is controlled via the Navigator's Weapon Aiming Mode Selector (NWAMS) control panel, via the Pilot's WAMS control panel, the Navigator's Hand Controller (NHC) and the Pilot's Hand Controller (PHC), and via the WAMS indicator panel in the front cockpit.

Navigator's WAMS Control Panel (NWAMS)

The NWAMS (A, Figure 4-82) consists of 16 split legend pushbutton/indicators. The upper white caption illuminates to indicate that the MC is prepared for selection of the respective mode. The lower green caption SEL is illuminated when the mode is selected either manually by pressing or automatically. Pressing the button with SEL illuminated cancels the selection with exceptions for TARGET and OFFSET 1, 2 and 3.
The NWAMS pushbutton/indicators are:

TF ELEV

When the pushbutton is pressed, the MC uses the TFR depression angle for height finding during navigation and target acquisition fixing.

RDR ALT

When F/A is selected, RA height is automatically used if no other height sensor has been selected. If another height sensor has been selected, pressing RDR ALT will deselect the one in use and revert to RA height. In MAIN and IN/MC modes only the caption RDR ALT will extinguish, if RA fails while reverting automatically to Best Available Height.

BARO IN

When the pushbutton is pressed, the MC uses Best Available Altitude (BAA) as BARO/ADC/DOPPLER + IN or SAHR height during fixing and target positioning in preference to a valid RA height available. If subsequently, BAA (with all reversionary sources) fails, a valid RA height will be automatically reselected, indicated by RDR ALT illuminating.

HIGH LOFT

When the pushbutton is pressed the MC selects High Loft mode for release at climb angles higher than 45 degrees. It also selects TARGET, if not already been selected. The selection cancels LOW LOFT and FIRST BOMB. The selection is also indicated to the PWAMS.

LOW LOFT

When the pushbutton is pressed the MC selects Low Loft mode for release at climb angles less than 45 degrees. It also selects TARGET, if not already been selected. The selection cancels HIGH LOFT. The selection is also indicated to the PWAMS.

FIRST BOMB

The pushbutton is pressed to aim the first bomb of a stick of bombs at the target instead of centre of stick.

TOO INDICATOR

The lower caption illuminates to indicate that a target of opportunity attack mode has been initiated by the pilot pressing the TOO pushbutton on his PWAMS. The accepted selection changes F/A format to Nav format on both DUs.

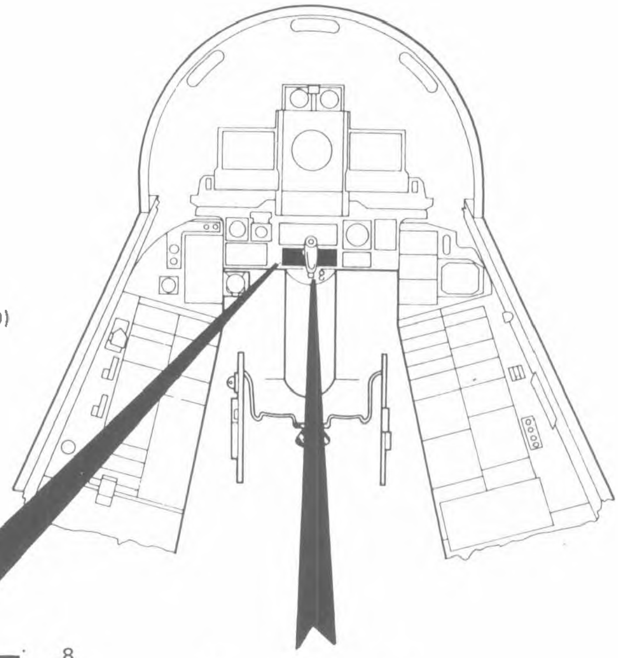
OFFSET 1, 2, 3

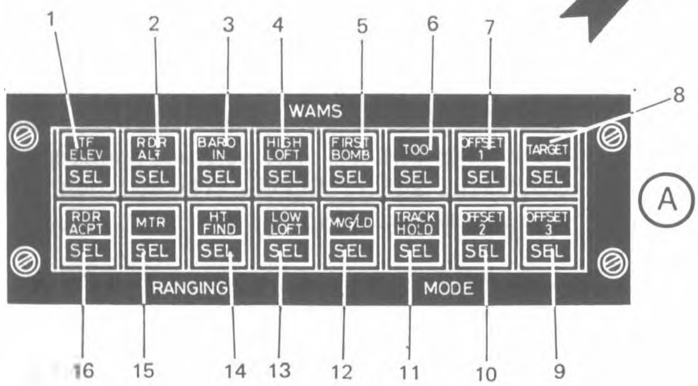
The pushbutton is pressed to aim a previously defined sensor at the selected offset. The correspond-

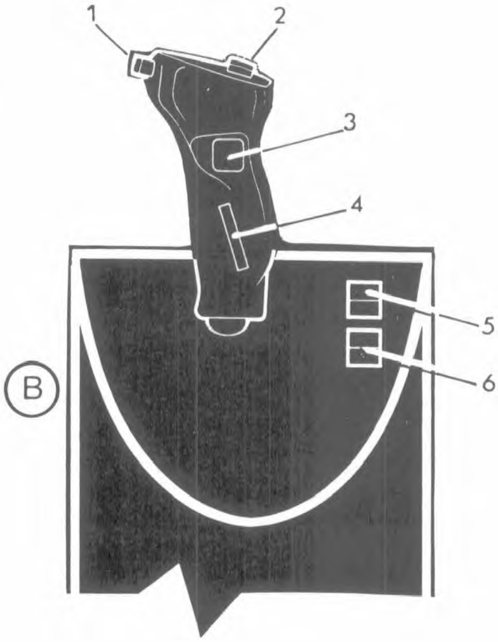
NAVIGATOR'S NAVIGATION WEAPON SYSTEM CONTROLS

A Navigator's WAMS panel

1 TF elevation pushbutton/indicator
2 Radar altimeter pushbutton/indicator
3 Baro/IN pushbutton/indicator
4 High Loft pushbutton/indicator
5 First bomb pushbutton/indicator
6 Target of oppurtunity pushbutton/indicator
7 Offset 1 pushbutton/indicator
8 Target pushbutton/indicator
9 Offset 3 pushbutton/indicator
10 Offset 2 pushbutton/indicator
11 Trackhold indicator
12 MVG/LD pushbutton/indicator (post mod. 00450)
13 Low loft pushbutton/indicator
14 Height find pushbutton/indicator
15 MTR pushbutton/indicator
16 Radar accept pushbutton/indicator







B Navigator's hand controller

1 Azimuth centre line control switch
2 Insert pushbutton
3 Cursor/marker switch
4 Intermittent radar trigger
5 Phase 1 pushbutton/indicator
6 Cancel radar offset pushbutton/indicator

Figure 4-82

ing sensors are the GMR for radar offsets, the HUD marker (ranging reticle for Phase 2 and fixing cross for Phase 1) for visual offsets, and GMR and HUD markers for all sensor offsets. When an OFFSET is selected, the NWAMS pushbutton/indicator illuminates, the offset on the F/A format becomes contrast inverted and the corresponding sensor is pointing at the computed offset position. The selection can be cancelled only by selection of TARGET or by selection of another offset which uses the same sensor.

OFFSET DESIGNATED RADAR ONLY. When a Radar Only OFFSET is selected, the GMR is directed at that offset point and any previous Radar Only OFFSET or the radar part of an All Sensor OFFSET is cancelled. In Phase 1 the active computer marker on the CRPMD indicates the offset position which can be updated with the NHC. The radar offset in Phase 1 is not indicated on the HUD. In Phase 2 the Radar Only offset position is indicated by the passive computer marker which moves in sympathy with the ranging reticle. A Radar Only OFFSET is cancelled either by selection of Cancel Radar Offset (CRO) on the NHC panel or by pressing the unlit TARGET button on the NWAMS, in which cases the computer marker is transferred to the target, or by selection of another Radar Only or an All Sensor OFFSET in which cases the computer marker is transferred to this offset point.

OFFSET DESIGNATED VISUAL ONLY. When a Visual Only OFFSET is selected, the HUD marker is directed at that offset point and any previous Visual Only OFFSET or the visual part of an All sensor OFFSET is cancelled. In Phase 1 the Visual offset position is indicated by the fixing cross. Its position is updated in sympathy with the active computer marker position. In Phase 2 the ranging reticle indicates the offset position which can be updated with the PHC. A Visual Only OFFSET is cancelled either by selection of Cancel Visual Offset (CVO) on the PHC panel in which case the ranging reticle in Phase 2 is transferred to the target, or by selection of another Visual Only or an All Sensor OFFSET in which cases the HUD marker is transferred to this offset point.

OFFSET DESIGNATED ALL SENSOR. When an All Sensor OFFSET is selected, the GMR and the HUD marker are directed at that offset point and any previous OFFSET or TARGET selection is cancelled. In Phase 1 the active computer marker and the fixing cross indicate the offset position which can be updated with the NHC. In Phase 2 the All Sensor offset position is indicated by the ranging reticle and the passive computer marker. It can be updated with the PHC. An All Sensor OFFSET can either be cancelled completely by selection of another All Sensor OFFSET or TARGET, or its radar/visual component can be individually cancelled either by selection of CRO/CVO or by selection of another Visual or Radar Only OFFSET. If TARGET is selected in Phase 1 the active computer marker is transferred to the target. If TARGET is selected in Phase 2 the ranging reticle and the passive computer marker are transferred to the target. If another All Sensor OFFSET is selected the computer marker and the fixing cross/ranging reticle are transferred to this OFFSET. If CRO or CVO is selected the corresponding sensor is directed to the target while the remaining sensor stays with the All Sensor OFFSET. If a Radar or Visual Only OFFSET is selected the corresponding sensor is directed to that offset point while the remaining sensor stays with the All Sensor OFFSET.

NOTE

- An OFFSET or a portion of an OFFSET which is cancelled by selection of TARGET or another OFFSET, can be reselected by pressing again the relevant OFFSET pushbutton/indicator.
- A Radar Only OFFSET or the radar portion of an All Sensor OFFSET which is cancelled with CRO, can be reselected by pressing CRO a second time.
- A Visual Only OFFSET or the visual portion of an All Sensor OFFSET which is cancelled with the CVO, cannot be reselected.

The WAMS logic allows two OFFSETs to be illuminated simultaneously if one has a radar designator, the other a visual. In all other cases TARGET will be illuminated in addition.

TARGET

When the pushbutton is pressed, with weapon package selected, the GMR and the computer marker of the CRPMD and the HUD ranging reticle point to the target as aiming datum for a planned direct attack initiated if F/A on the TV/TAB has been selected. Pressing the illuminated button will not cancel the selection.

TRACK HOLD INDICATOR

SEL caption illuminates when the Track Acquire mode has been selected on the AFDS control panel and AP is engaged.

MVG/LD

When the pushbutton is pressed, the MC selects the Moving Target mode for target velocity and bearing computations during HOJ with RDR ALT or best height, sufficiently accurate for use in maritime attacks (LADD (LD) not operative with conventional software). Target speed is limited to 63 kt.

Post mod. 00450: The upper white caption is labelled MVG TGT. LADD function is not incorporated.

HT FIND

When the pushbutton is pressed, HT FIND mode selects the GMR antenna depression angle for height above ground calculation. Only selectable if the GMR is in the Ground Mapping mode with STAB on the CRPMD and F/A format on the TV/TAB selected.

MTR

Not used.

RDR ACPT

When the pushbutton is pressed, the MC accepts and uses radar information from the HOJ and LCK ON radar modes. The caption SEL automatically illuminates when radar range lock is obtained in the AGR mode. In this case TF ELEV, RDR ALT, or BARO IN extinguishes.

Navigator's Hand Controller (NHC)

The NHC (B, Figure 4-82) is a (right) hand grip type which can be moved in any direction and returns to the central null position when released. Movement of the handgrip produces rate demands in X and Y axes to the MC which positions the cursors on the CRPMD, active computer marker on the CRPMD and TV/TAB, or slews the map on the CRPMD as selected.

NHC MOVEMENT	COMPUTER MARKER	CURSORS	MAP SLEW
Forward	Up	Up	Down
Back	Down	Down	Up
Left	Left	Left	Right
Right	Right	Right	Left

Four controls associated with the CRPMD and GMR are mounted on the NHC:

AZIMUTH CENTRE LINE CONTROL SWITCH

The azimuth centre line control is a 3-position rotary wheel switch which directs the centre line of the GMR antenna to the right or left of the biased centre-off position in azimuth scanning. When released it returns to the centre-off position.

INSERT PUSHBUTTON

The Insert pushbutton when pressed inserts the following position data into the MC:

- the corrected map position during CRPMD Map Test
- corrections during fixing including map radar matching
- the position of the computer marker on the CRPMD
- height data via RA for on Top fixing or height channel updating

CURSOR/MARKER SWITCH

The two-position Cursors/Marker toggle switch allows either the cursors or the marker to be moved by the NHC. The down position selects hand controller operation of the cursors when CURS is selected on the CRPMD. The up position selects active computer marker control. CURS operation is not possible in NTH-UP and tracking modes.

INTERMITTENT RADAR TRIGGER

When INT is selected on the CRPMD, pressing the trigger switch activates the GMR transmission and the radar display will be updated.

The NHC panel contains the following pushbutton/indicators:

PHASE 1 PUSHBUTTON/INDICATOR

The caption SEL illuminates green when the pushbutton PHASE 1 is pressed or when F/A is selected on the TV/TAB. It indicates PHASE 1 of fixing or weapon aiming.

CANCEL RADAR OFFSET PUSHBUTTON/INDICATOR

The caption CANCEL illuminates green, when the RADAR OFFSET pushbutton is pressed, to cancel a radar offset selection on the NWAMS panel. In this case the GMR computer marker is transferred from a radar offset point to the target. TARGET on the NWAMS panel illuminates. Any remaining OFFSET indication will show the aiming datum in use for the HUD ranging reticle. Pressing the pushbutton again transfers the CRPMD computer marker back to the offset point.

Pilot's WAMS Control Panel (PWAMS)

The PWAMS control panel (Figure 4-83) is located on the front cockpit anti-glare shield and provides three split caption pushbutton/indicators. The upper captions illuminate white when mode available, the lower captions illuminate green when selection has been made and accepted by the MC. The modes are cancelled by pressing the SEL button a second time.

TOO

When the pushbutton TOO is pressed, with weapon package being selected, it selects the Target of Opportunity mode and repeats the SEL indication on the NWAMS panel. On the HUD weapon aiming symbols (TOO Attack) are displayed if AUTO mode is selected.
By selection, the GMR in STAB mode is parked in 0 azimuth and elevation.

A/G GUNS

The pushbutton is pressed to initiate the Air-to-Ground Guns aiming functions on the HUD. The TV/TAB reverts to the Nav format if F/A is selected.

STORE PP/OTF

The STORE PP button is pressed to store the computed PP in the pilot's working store; when OTF is illuminated the button is used for On Top Fixing. The caption is extinguished when cancelling OTF on the NMCP or by selecting ACCEPT or REJECT.

Pilot's Hand Controller (PHC)

The PHC (Figure 4-83) is a fixed hand grip with four pushbutton/controls and is mounted on a panel containing the associated electronics and the PHASE 2/AGR indicator/pushbutton.

PHASE CHANGE BUTTON

The Phase Change button is pressed to select Phase 2 fixing/attacking or Phase 3 attacking, provided F/A on the TV/TAB has been selected. It also activates the reticle slew control. It is not possible to return from Phase 3 into Phase 2, but the navigator can reselect Phase 1.
The phase change button has the following different functions during bomb and air-to-air attacks:

- Bomb attacks – Pressing the Phase Change button, the first time, selects Phase 2 of weapon aiming or converts a TOO CCIP attack to a TOO converted attack. Pressing the button a second time, during Phase 2 or in a TOO converted attack, selects Phase 3 weapon aiming.

- Air-to-air attacks – Pressing the Phase Change button, while AAO is selected, causes the GMR to transmit in the Air-to-Air Tracking (AAT) mode. Subsequent presses will alternately inhibit and reactivate transmission in the AAT mode.

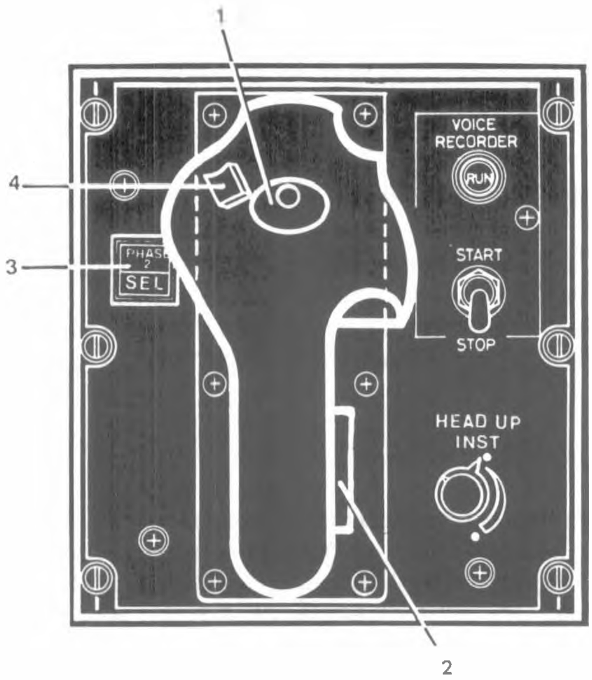
PHASE 2 (AGR) INDICATOR/PUSHBUTTON

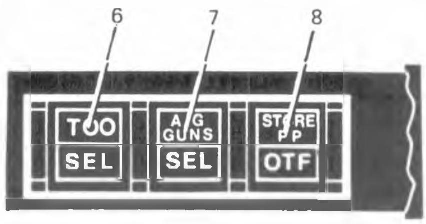
The retained Phase 2 caption illuminates white indicating AGR mode has been selected, either by the pilot pressing the (AGR) pushbutton in Phase 2, or by the navigator on the CRPMD.

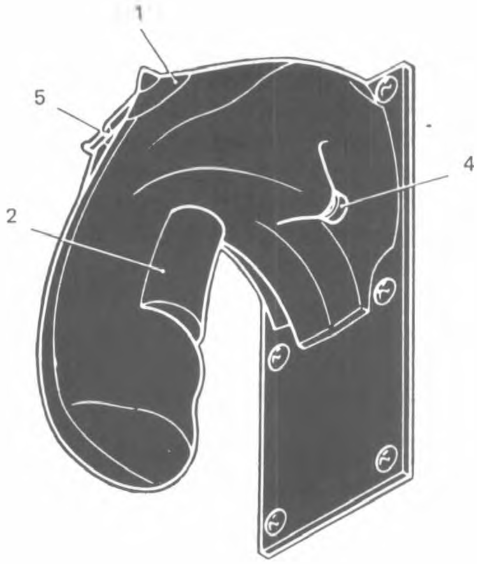
SLEW CONTROL

The slew control can be moved in any direction and is spring loaded to a central null position with a 3.25 degrees dead band to prevent unintentional output. Movement of the ball produces rate demands and sends signals to the MC.

PILOT'S NAVIGATION WEAPON SYSTEM CONTROLS







1 Ball control (selw control)
2 Insert switch
3 Phase 2 pushbutton/indicator (AGR)
4 Phase change button
5 Cancel visual offset pushbutton
6 Too pushbutton/indicator
7 A/G guns pushbutton/indicator
8 Store PP pushbutton/indicator
9 MTR caption
10 Low loft caption
11 High loft caption
12 MSL RDY caption

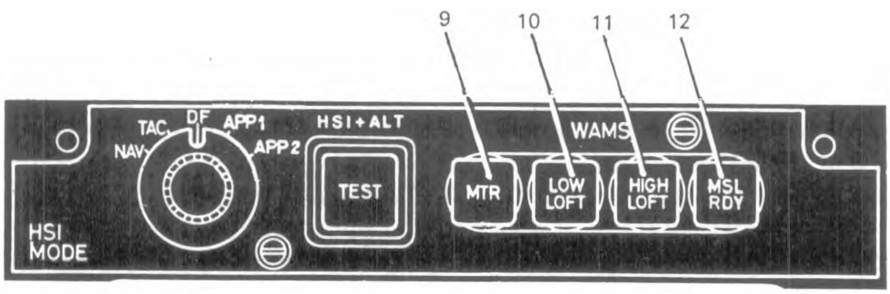


Figure 4-83

This positions a ranging reticle on the HUD in Phase 2/3, TOO, or AAO, or IN align, or slews the map (RPMD) when SL is selected and no PHASE Change has been pressed. The slew control deflections effect map slew and reticle movement as follows:

PHC SLEW CONTROL MOVEMENT	RPMD MAP SLEW	HUD RANGING RETICLE
Forward	Upward	Downward
Aft	Downward	Upward
Right	Left	Right
Left	Right	Left

NOTE

The slew control positions the ranging reticle in the X and Y-axes in Phase 2, but only in the X-axis in Phase 3.

CANCEL VISUAL OFFSET PUSHBUTTON

When the pushbutton is pressed, the selected visual offset mode is cancelled and the relevant OFFSET pushbutton/indicator on the NWAMS is deselected. The HUD ranging reticle changes from OFS to the target and TARGET on the NWAMS is illuminating. Any remaining OFFSET indication will show the aiming datum in use for the CRPMD computer marker. In addition the pushbutton provides the reselection of the auto pull-up demand during a Phase 2 direct or offset loft attack. This function is activated only when an offset is designated as combined (□) or visual (V), and Phase 2 is selected.

INSERT SWITCH

The insert trigger switch is pressed to enable marker positional information on the HUD to be used by the MC in IN Rapid alignment and in Phase 2 fixing. When RPMD SL is selected and the map is moved by the slew control, pressing the insert switch enters the geographical coordinates of the map position into the MC working store. Pressing the insert trigger during the Kormoran TOO mode uncages the gyro(s) of the selected missile(s).

Pilot's Throttle Levers

STADIAMETRIC RANGE CONTROL

The stadiametric range control thumb wheel is located on the left throttle and controls the variable-diameter stadiametric ranging circle. After the known or estimated wingspan of a target is set as datum with the wingspan control, it is used to obtain target range by matching the circle diameter with the actual target wingspan during lead angle attacks with stadiametric ranging.

AIR-TO-AIR OVERRIDE BUTTON

By pressing the AAO button, the selected Air-to-Air mode overrides any selected GMR modes in the rear cockpit.
Selection is indicated on the SMS panel in the rear cockpit and on the pilot's WCP2. The HUD enters the A/A Guns and Missile formats in the stadiametric ranging mode.

LOCK-ON REJECT BUTTON

The button is pressed to reject (deselect) radar lock-on in the AGR and Air-to-Air tracking modes.

WAMS Indicator Panel

The WAMS indicator panel (Figure 4-83) is located in the front cockpit main instrument and carries four indicators:

MTR INDICATOR

Not operative.

LOW LOFT INDICATOR

The LOW LOFT caption illuminates white when the Low Loft attack mode is selected on the NWAMS panel.

HIGH LOFT INDICATOR

The HIGH LOFT caption illuminates when the Hight Loft attack mode is selected on the NWAMS panel.

MISSILE READY INDICATOR

The MSL RDY caption illuminates white when the KORMORAN missile is ready for release.

MC SOFTWARE STANDARD OFP T-P-SW-X107-01-P DIFFERENCES

GROUND MAPPING RADAR (GMR)

10 NM Map Scale

This facility provides a 10 NM topographical map (1:125 K) to be projected and driven when the 10 NM scale is selected on the CRPMD. This will allow the application of 4 scales, i.e. 10, 20, 40 and 80 NM to any map rectangle, via RDE.
For RPMD map scale 1:125 K display, the CRPMD 10 NM scale shall be selected and the RPMD shall be in Repeater (R) mode.

MAIN COMPUTER (MC)

The SW T-P-SW-X107-01-P can be loaded into MCs of type 64 Ki and 128 KF. The software provides a method of identifying whether the Nose Radar program version is pre or post EV2 (Mod 10912) standard, i.e. the EV2 software will not interface with a pre mod hardware standard.

Double Mission Data Store

A second mission data store is available in the MC software to double the number of preplanned destinations, and can be accessed when required in flight via the MFK. A soft key MD1/MD2 is provided to exchange mission data between primary and secondary data stores to load and access the set of date in use.
The exchange of mission data can only be performed if AUTO or MAN-STEER is **not** selected.

Enhanced Ground Test Facility (EGTF)

The EGTF has the capability to display a defined equipment status and to replay recorded in flight parameters with predefined real-time information. The EGTF program starting with the EQM format can be called up via the MFKs PLAN-DATA-GTF, and inserting T, S, T and pressing ENTER.

HEAD UP DISPLAY (HUD)

Vertical Velocity (VV) in DP + SR mode is provided now by the ADC and is therefore the reliable source in attitudes.

Detailed information will be found in the Integrated Navigation System description.

ARMAMENT SYSTEM

The armament capability of the aircraft includes the delivery of conventional and nuclear weapons in various configurations. Two 27mm Mauser guns are installed in the front fuselage of the aircraft. The armament system consists of:

- Bombing and launching equipment suspension (i.e. pylons, ejector release units, launchers)
- Store management system (SMS)
- A/A missile system
- A/G missile system
- Gun system
- Special weapon system

NOTE

The description which follows is applicable to A/C MM 7006 ÷ MM 55003 and subsequent. Information applicable to aircraft prior to MM 7006 ÷ MM 55003 is contained at the end of this chapter.

RELEASING AND LAUNCHING EQUIPMENT

Releasing and launching component consists of various weapon carriers and launchers, stationary fuselage pylons, pivoting wing pylons and the stores management system.
Stores can be carried in various configurations on the seven external pylons. The four wing pylons pivot to remain streamlined with different wing positions.

ARMAMENT SYSTEM CONTROLS AND INDICATORS

Master Armament Safety Switch (MASS)

The master armament safety switch, located on front cockpit (13, Figure FO-2), is a lockable two position switch marked SAFE and LIVE.
When the switch is unlocked by the removable key and set to LIVE, fire power is supplied to the stores management system so that the jettison facilities become available immediately. In the SAFE position fire power circuits of all armament and jettison are inoperative. The key can be removed only when the switch is set to SAFE and locked. When the switch is set to SAFE a green flag is visible from outside the aircraft above the left anti-glare shield.

Later Arm Switch

The later arm switch, located on front cockpit (21, Figure FO-2), is marked LATE ARM and protected by a red guard. Lifting the guard and setting the switch to ON enables the arming, fuzing and firing circuits for bombs, rockets, air-to-ground missiles and air-to-air missiles. The late arm switch does not affect the gun firing circuits.

Weapon Release Button (WRB)

The weapon release button is located on the control stick grip. It is covered by a guard which has to be moved aside to gain access to the weapon release pushbutton. When pressed, the button operates two push-switches, one for each channel of the duplex stores management system (SMS), acting a commit switches for computer initiated weapon release switches for reversionary manual release.

Attack Release Switch

The attack release switch (1, Figure FO-3/FO-4), marked ATTACK RELEASE, is located on the left console of the rear cockpit and is protected by a metal cover. It provides a parallel functions to the weapon release button in the front cockpit.

Trigger

The trigger is located on the control stick grip and is normally stowed on top of the grip in the safe position. Before use, it is rotated forwards to the firing position so that the red position is visible to the pilot. When squeezed, the trigger first actuates the camera button to initiate HUD camera operation and subsequently two recessed gun buttons. The signal from button No. 1 is routed through the SMS and via the gun junction box to the gun electronic unit (GEU) to initiate gun firing. It also causes the SMS to generate a signal for the HUD camera to impose an event marker on the HUD camera film. The signal from button No. 2 initiates gun purging, IP and HP6 BOV (Post mod. 01332: HP6 BOV deleted) opening and engine ignition. The No. 2 signal also starts a 100 msecs delay in the gun junction box for the No. 1 signal to assure gun purging. IP and HP6 BOV (Post mod. 01332: HP6 BOV deleted) opening and engine relight prior to gun firing. The second detend operates the recessed gun firing button which enables the gun firing circuits in the selected gun electronic unit.

Air-to-Air Override Button (AAO)

The air-to-air override button is located on the front face of the left throttle lever. When pressed the first time, supplies a signal to the SMS which will:

- override and inhibit release of selections made on WCP1 except selective jettison
- prepare all air-to-air weapons for immediate release, including guns at the fast rate of fire
- illuminate the PILOT indicator on WCP1, and the CANCEL/OR lamp on WCP2
- the SMS supplies a signal to the MC (the MC automatically transfers to air-to-air mode)

The second pressure:
- enable missile lock-on

The third pressure:
- cancels missile lock-on (if MSL lock had been achieved)

Emergency Jettison Button

The emergency jettison button located on front cockpit (83, Figure FO-2) is marked EMERGENCY JETTISON. It is guarded by a black and yellow striped metal safety cover which has to be raised before the button can be pressed.
When pressed it supplies a signal to the SMS which causes all stores except A/A missiles and non weapons outboard stations to be jettisoned in sequence from the aircraft.

Selective Jettison Button

The selective jettison button located in the front cockpit (83, Figure FO-2) is marked SELECTIVE JETTISON and provides a parallel function to the selective jettison button on WCP1.

Air-to Ground Guns Button

The air-to ground guns selector button (15, Figure FO-2) is marked A/G GUNS. When SELECTED the switch sends a signal to the SMS via the main computer causing the SMS to illuminate the PILOT indicator on WCP1 and simultaneously initiating air-to-ground aiming function on the HUD.

Weapon Control Panel (WCP) 1

The WCP 1 (Figure 4-84) is located on the left console of the rear cockpit. It contains the following push-button/indicators.

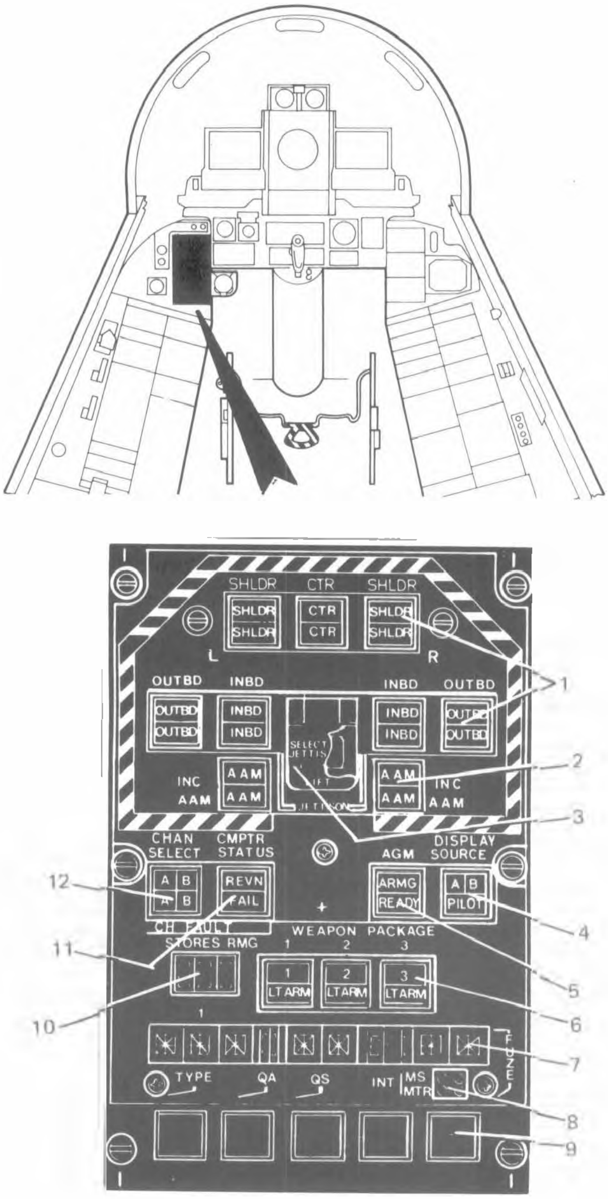
PYLON SELECTOR/INDICATOR BUTTONS

The seven pylon selector/indicator buttons are marked L SHLDR, INBD, OUTBD and R SHLDR, INBD, OUTBD and CTR. Each button has a dual caption duplicating the panel marking. The buttons are used for pylon selection during the selective jettison procedure. When a button is pressed in for pylon selection, the upper half of the indicator illuminates white. A second press deselects the pylon and extinguishes the indicator. During selective jettison the indicator extinguishes to confirm that the pylon has been cleared of stores and carries. A hangup is indicated by the lower half of the indicator illuminating amber.

AAM INCLUDE SELECTOR/INDICATOR BUTTONS

The two AAM include selector/indicator buttons are marked AAM. When pressed the upper half of the indicator illuminates white to show that the AAM has been included in the selective jettison package. A second press deselects the AAM and extinguishes the indicator. During selective jettison, the relevant indicator lamp extinguishes to show that the launcher has been cleared of stores. If the missile does not separate from the launcher, the lower half of the indicator illuminates amber.

WCP 1



1 Pylon selector/indicator buttons
2 AAM include selector/indicator buttons
3 Selective jettison button
4 Display source indicator
5 AGM arming selector/indicator button (Not operative)
6 Weapon package selector/indicator buttons
7 Weapon package parameter indicators
8 MS/MTR indicator
9 Weapon package parameter selector buttons
10 Stores remaining indicator
11 Main computer status indicator and reversionary modes selector button
12 Channel processor selector/indicator button

Figure 4-84

SELECTIVE JETTISON BUTTON

The selective jettison button is covered by a black and yellow guard marked SELECTIVE JETTISON – LIFT. The guard shall be lifted to gain access to the button.
Pressing the button initiates the jettison of stores and carries in sequence from the pylons selected by the pylon selector buttons and the AAM include buttons.

DISPLAY SOURCE INDICATOR

The PILOT indicator will illuminate after the pilot has pressed the AIR-TO-AIR OVERRIDE button and has thus taken over the command of the weapon system. The two upper indicators show which of the SMS channels supply the display. Pressing the DISPLAY SOURCE button the supplying channel will change.

AGM ARMING SELECTOR/INDICATOR BUTTON

(Not operative).

WEAPON PACKAGE SELECTOR/INDICATOR BUTTONS

The three weapon package selector/indicator buttons are marked WEAPON PACKAGE and have the dual captions 1-LTARM, 2-LTARM, and 3-LTARM. When pressed to select a weapon package, the upper half of the indicator illuminates white. The contents of a weapon package may then be selected or changed using the weapon package parameter selector buttons in conjunction with the weapon package parameter indicators. A second press of the button extinguishes the indicator and stores the weapon package information in the weapons programming unit (WPU) memory. Pressing the button for the second time illuminates the indicator and recalls the weapon package information from the processor memory. A selected weapon package indicates ready for release when the LTARM caption illuminates green after all release requirements are met. They include all required parameters of a weapon package selected, one WOG switch sensing an airborne condition and the LATE ARM switch set to up.

WEAPON PACKAGE PARAMETER INDICATORS

The five weapon package parameter indicators are associated with the five weapon package parameter selector button and show the type, quantity, interval and fuzing of weapons in the selected package. Incorrect stores loading configurations are also indicated by ERR plus a code number and the relevant station will be indicated by the lower half of the pylon selector indicator and INC/AAM indicator buttons illuminating amber.

MS/MTR INDICATOR

The MS/MTR indicator is a four lamp indicator marked MS/MTR which shows the SMS mode of the operation and indicates the INT parameters. When the SMS is in the MC mode, one lamp against MTR illuminates to show that the INT indication is in meters. When the SMS is in the reversionary mode of operation, one lamp against MS illuminates to show that the INT indication is in milliseconds.

WEAPON PACKAGE PARAMETER SELECTOR BUTTONS

The five weapon package parameter selector buttons are marked TYPE, QA, QS, INT and FUZE and are used in conjunction with the weapon package parameter indicator to select the weapon parameters required for a weapon package. Pressing a button changes the associated display one step at a time.

STORES REMAINING INDICATOR

The stores remaining indicator is marked STORES RMG. The digital indicator works in conjunction with the TYPE indicator to show the number of those weapons indicated remaining available for use. Should the electrical power supply to the system fail during flight, the PFL indication will flash in union with the REL/DEF indication on WCP2.

MAIN COMPUTER STATUS INDICATOR AND REVERSIONARY MODE SELECTOR BUTTON

The main computer status indicator and reversionary mode selector button is marked CMPTR STATUS with the dual caption REVN-FAIL. Should the main computer develop a fault, the lower half of the indicator caption FAIL illuminates amber. Pressing the button selects the reversionary mode of operation for the SMS, illuminating the upper REVN caption white.

CHANNEL PROCESSOR SELECTOR/INDICATOR BUTTON

The channel processor selector/indicator button is marked DISPLAY SOURCE and CHAN FAULT with the quadruplex caption A – B. The upper half of the caption illuminates white to show which of the two WPU processor is powering the WCP 1/2 lamps. Pressing in the switch button changes control to the other processor and changes the display from A to B or vice versa. The lower half of the indicator caption illuminates amber to indicate a fault in a processor.

Weapon Control Panel (WCP) 2

The WCP 2 (Figure 4-85) is located in the front cockpit and contains the following push-buttons/indicators.

CANCEL AIR-TO-AIR OVERRIDE SELECTOR/INDICATOR BUTTON

The cancel air-to-air override selector/indicator button is a yellow button marked CANCEL O/R. The button illuminates when the pilot selects air-to-air override. When the button is pressed the indicator extinguishes and control of the weapon system is returned to WCP1 in the rear cockpit.

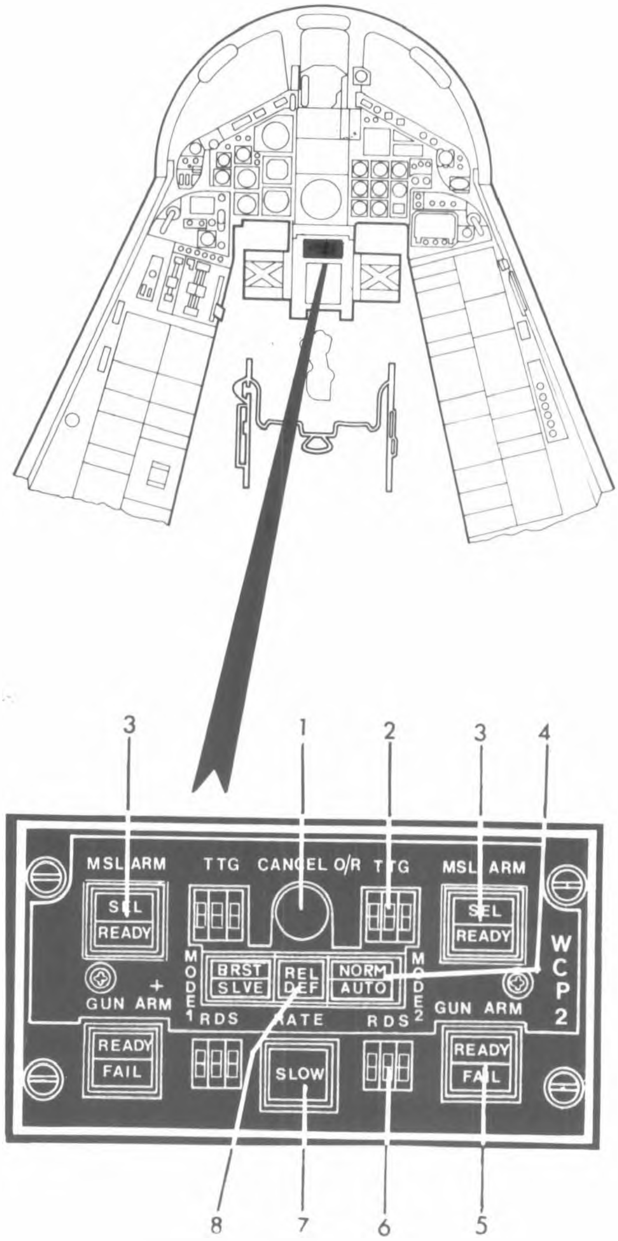
TIME-TO-GO INDICATOR

The two time-to-go indicators are marked TTG and are associated with left and right AAMs to show in digital form the time remaining that the missiles can be held in a state of readiness.
When pressed-in for missile selection, the caption SEL illuminates white to show that the relevant missile is arming. When the missile is ready for release, the caption READY illuminates green.

MISSILE MODE SELECTOR/INDICATOR BUTTONS

The two missile mode/selector indicator buttons are marked MODE 1 with the white dual captions BRST/SLVE, and MODE 2 with the dual white captions NORM/AUTO. The MODE 1 selector/indicator button pertains to the AIM9L missile only. It controls the acquisition mode. The system initializes the boresight mode and the BRST caption illuminates when AAO is selected. If the MODE 1 button is subsequently pressed the slave mode, indicated by illumination of the SLVE caption, is engaged. The missile seeker head is now slaved to the ranging reticle. Transfer back to the boresight mode is accomplished by pressing the MODE 1 button again.
The MODE 2 selector/indicator button controls the station selection mode. The system initialized the AUTO mode and the AUTO caption illuminates

WCP 2



1 Cancel air-to-air override selector/indicator button
2 Time-to-go indicator
3 Missile arming selector/indicator button
4 Missile mode selector/indicator button
5 Gun selector/indicator button
6 Rounds remaining indicator
7 Rate of fire selector/indicator button
8 Release deficiency indicator button

Figure 4-85

when AAO is selected. The missile to be fired is then determined by the AAMU, and depends upon target position and audio signal strenght. If the MODE 2 button is subsequently pressed, the normal mode engages and the NORM caption illuminates. Normally the left missile will be fired first. The sequence can be reversed manually by pressing the missile arming selector/indicator buttons. Transfer back to the auto mode is accomplished by pressing the MODE 2 button again.

GUN SELECTOR/INDICATOR BUTTONS

The two gun selector/indicator buttons are marked GUN ARM and have the dual captions READY/FAIL. Pressing either button selects and arms the relevant gun, providing the MASS is set to LIVE and one of the WOG switches on the landing gear legs indicate that the aircraft is in flight. The green READY caption illuminates to indicate that the selected gun is ready for firing. The amber FAIL caption illuminates to indicate a fault in the gun electrical system. Pressing the button a second time de-selects the gun and extinguishes the READY caption.

ROUNDS REMAINING INDICATORS

The two rounds remaining indicators are marked ROUNDS and show in digital form the number of rounds remaining available for each gun.

RATE OF FIRE SELECTOR/INDICATOR BUTTON

The rate of fire selector indicator button is marked RATE and has the caption SLOW. When pressed, the button causes the system to select the slow rate of fire for the selected guns and caption SLOW illuminates white confirming that this selection has been made. Pressing the button for the second time reverts the system to the fast rate of fire and extinguishes the SLOW caption.

RELEASE DEFICIENCY INDICATOR BUTTON

The release deficiency indicator button has the caption REL DEF. The indicator illuminates amber whenever a store hangup occurs. Pressing the button extinguishes the indicator. Should the electrical power supply to the system fail during flight, the REL/DEF indicator will flash in unison with the PFL indication in the stores remaining indicator on WCP 1.

MISSILE ARMING SELECTOR/INDICATOR

Two illuminated buttons are provided for the selection of the two guides missiles and for indicating the missile status (READY).

Bomb Release Safety Lock (BRSL) Control Panel

(Not operative).

Central Warning Panel

The rear cockpit central warning panel has four amber warning captions BUS A, BUS B, SPWA and SPWB associated with the armament system. The captions illuminate to show a fire power failure in the armament system. BUS A and BUS B are associated with the stores management system and SPWA and SPWB are associated with special weapons.

Armament System Pre Mod.

Applicable up to MM 7005 and MM 55002.

PILOT COMMAND INDICATOR (WCP1)

The pilot command indicator has the caption PILOT COMD. The indicator illuminates white when the pilot selects AAO or air-to-ground guns.

MISSILE MODE SELECTOR/INDICATOR BUTTONS (WCP2)

The two missile mode selector indicator buttons are marked MODE 1/SLVE/SCAN and MODE 2/BRST. The two buttons are used to select the mode of operation for the selected AAM. Pressing the button causes the system to change to the alternate mode, illuminating the respective caption.

STORES COVERAGE

A variety of stores can be carried on the seven external pylons of the aircraft. For stores configurations and limitations refer to section 5 this flight manual. For information on armament and ECM equipment loading and operating refer to the applicable weapons delivery manual.

EMERGENCY EQUIPMENT

NOTE

Emergency equipment is not applicable to this aircraft.

WARNING EQUIPMENT

CENTRAL WARNING SYSTEM (CWS)

The centralized warning system provides the crew with an immediate warning of the existence of an abnormal condition which could affect the safety of the aircraft. The conditions which cause a warning to be given are detected by sensors incorporated in the various aircraft systems. Outputs from the sensors are displayed on the central warning panel (CWP) in each cockpit (Figure 4-86).
Facilities are incorporated into the CWS for testing, dimming, cancelling, activating/de-activating the warnings.

VISUAL AND AUDIO WARNINGS

Primary warnings indicate abnormal conditions of primary importance and cause the appropriate red caption on the CWP to illuminate and the attention getters to flash in both cockpits, and the lyre bird audio tone to sound in both crew headsets (Figure 4-87).
Secondary warnings indicate abnormal conditions of secondary importance and cause the appropriate amber caption to illuminate and the attention getters to flash in the relevant cockpit (Figure 4-87).
Primary and/or secondary CWP captions remain lit until the fault has been removed.
Certain CWP captions are supplemented by failure/status indications on individual system control panels, which locate and categorize faults within the failed system.

CENTRAL WARNING PANEL

A central warning panel (CWP), located on the right panel of each cockpit (64, Figure FO-2 and 21, Figure FO-3), contains warning captions, which are illuminated red for primary and amber for secondary type warnings. Three controls are located at the lower panel section, they are identical in both cockpits and serve the following purposes:

- The left toggle switch, when set to "D" position, provides power for illumination of all CWP captions, attention getters, indicator light, warning lights, and illuminated buttons with full light intensity when their respective circuits re activated. With the switch set to "N" position the light intensity is dimmed.
- The pushbutton between the toggle switches labelled GND ACT is used for function testing of the central warning system together with related controls on the rapid take-off panel (5/8, Figure 4-86).
- The right toggle switch labelled 1/OFF/2/TEST is used to test the CWP captions and associated warning circuits.

ATTENTION GETTERS

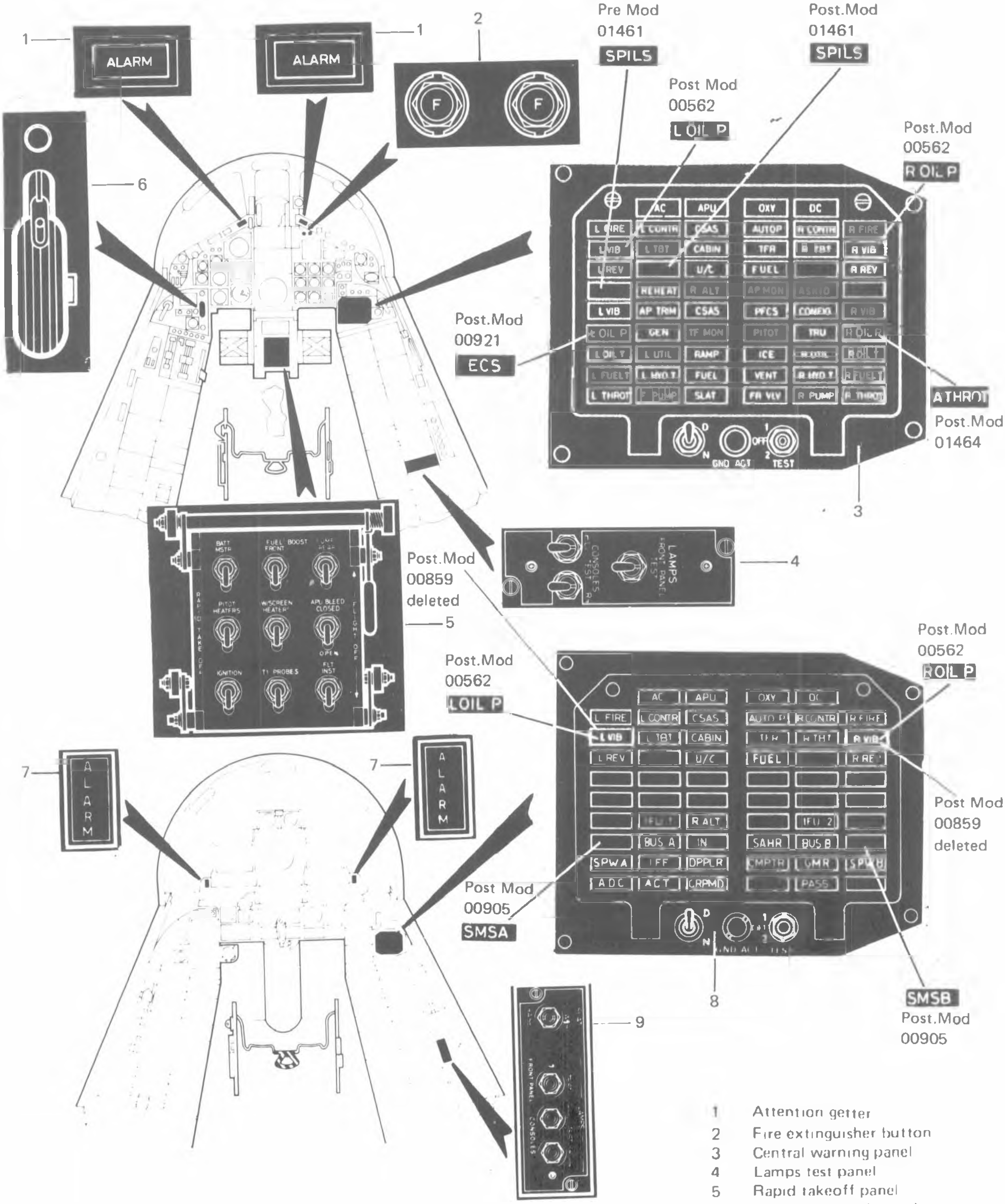
Two attention getters (1, 7, Figure 4-86) are installed in each cockpit. The two ones in the front cockpit are located in the upper section of the left and right glare-shields. The ones in the rear cockpit are positioned left and right adjacent to the TV/TAB control consoles. Whenever a warning signal is displayed on the CWP the attention getters will start flashing. Pressing anyone of the attention getters in either cockpit cancels the attention getters in that cockpit only. CWP warning captions are unaffected by this cancel action.

SUPPLEMENTARY WARNINGS

Certain CWP captions are associated with supplementary warnings external to the CWP. In these cases the CWP caption indicates the failed system and the supplementary warning indicates the type of failure or its location. CWP captions having supplementary warning are:

- Red OXY - Oxygen flow magnetic indicators
- Red and amber CSAS - CSAS control panel selector/indicators
- Red AUTO P - AFDS control panel COMPTR lights
- Red U/C - landing gear selector handle flasher
- Amber GEN - engine control panel FAIL lights
- Amber RAMP - intake control panel FAIL lights
- Amber TF MON - TF radar control panel HT FAIL and TURN FAIL lights

WARNING/INDICATOR LIGHTS (FRONT & REAR COCKPIT)



1 Attention getter
2 Fire extinguisher button
3 Central warning panel
4 Lamps test panel
5 Rapid takeoff panel
6 Landing gear selector lever
7 Attention getter
8 Central warning panel
9 Lamps test panel

Figure 4-86

CWP CAPTIONS RED CAPTIONS

CAPTION LIGHT	WARNING INDICATES	APPLICABLE IN COCKPIT
AC	Both generators off line	Front & rear
APU	Fire or overheat in APU bay	Front & rear
OXY	Pressure in the main oxygen system less than 290 kPa or cockpit shut-off valve closed	Front & rear
DC	Double TRU failure	Front & rear
L FIRE/R FIRE	Fire or overheat in left/right engine bay	Front & rear
L CONTR/R CONTR	Left, right hydraulic system pressure below 135 bar ± 10 resulting in total system loss	Front & rear
CSAS	"Significant" or "critical" second failure within the CSAS resulting in reversion to Direct Link, Mechanical mode or rudder centred and locked	Front & rear
AUTO P	Autopilot failure in the selected mode. Possible auto-disengagement preceded by wings level/pull-up command in TF mode	Front & rear
L TBT/R TBT	Overtemperature in left/right engine HP turbine bearing housing	Front & rear
CABIN	Cabin pressure above 26000 feet or canopy unlocked	Front & rear
TFR	Terrain following radar failure or inconsistency between IN/SHAR	Front & rear
L REV/R REV	Failure of left/right thrust reverser bucket to unstow with reverse thrust selected, or left/right thrust reverser bucket unstowed with "reverse thrust" not actually selected	Front & rear
Post mod. 01461 SPILS	After a genuine SPILS failure or after selecting SPILS to OFF	Front
FUEL	Low fuel contents in the collector box (forward group)	Front & rear
U/C	Any LG leg not locked down or a any MLG door not in commanded position. Altitude at or below 10000 ± 1000 ft. Airspeed at or below 180 ± 12 ft. Either throttle retarder to 92% ± 2% NH or below	Front & rear
Post mod. 00562/00859 L OIL P/R OIL P	Differential between engine oil feed pressure and scavenge pressure below 1.03 bar (left/right engine)	Front & rear

Figure 4-87 (Sheet 1 of 4)

CWP CAPTIONS AMBER CAPTIONS

CAPTION LIGHT	WARNING INDICATES	APPLICABLE IN COCKPIT
R ALT	Radar altimeter failure	Front & rear
A SKID	Wheelbrakes anti-skid failure	Front cockpit only
L VIB/R VIB	Left/right engine vibration and/or jet pipe resonance in reheat (buzz). Post mod. 31191 reheat buzz deactivated	Front cockpit only
AP TRIM	Auto pilot TRIM failure	Front cockpit only
CSAS	First failure within the CSAS resulting in reduced system redundancy.	Front cockpit only
PFCS	Failure within CSAS (caption remains lit, following an unsuccessful reset attempt)	Front cockpit only
CONFIG	Airspeed above 225 knots ± 10 with FLAPS DWN, or above 280 knots ± 10 with FLAPS MID. Airbrakes out of scheduling. TTU Failure	Front cockpit only
L OIL P/R OIL P Post mod. 00859 deleted	Differential between left/right engine oil feed pressure and scavenge pressure below 1.03 bar	Front cockpit only
GEN	One generator off line or channel load difference above 50A	Front cockpit only
TF MON	TF primary/secondary source data input failure or failure in source data cross-monitoring	Front cockpit only
PITOT	Pitot P3 probe heater failure or PITOT HEATER switch in OFF position	Front cockpit only
TRU	Single TRU failure	Front cockpit only
L OIL T/R OIL T	Left/right engine oil temperature above 165 degrees C	Front cockpit only
L UTIL/R UTIL	Left, right utilities system pressure below 130 bar ± 5 resulting in system loss	Front cockpit only
RAMP	Failure within either AICS ramp position loop or control unit. Ramp locked existing position.	Front cockpit only
ICE	Icing conditions detected or ice detection system failure	Front cockpit only

Figure 4-87 (Sheet 2 of 4)

CWP CAPTIONS AMBER CAPTIONS

CAPTION LIGHT	WARNING INDICATES	APPLICABLE IN COCKPIT
L FUEL T/R FUEL T	Left/right engine fuel pump outlet temperature above 150 degrees C	Front cockpit only
L HYD T/R HYD T	Left/right hydraulic fluid temperature above 145 degrees C ± 5 degrees C	Front cockpit only
Post mod. 01464 A THROT	Automatic autothrottle disconnect	Front cockpit only
FUEL	Contents of either fuselage fuel tank group approx. 300 kg. Crossfeed valve open automatically provided that CROSS FEED switch is in the AUTO position	Front cockpit only
ECS Post mod. 00859/00921	ECS failure or equipment cooling fan failure	Front cockpit only
VENT	Differential between fuselage fuel tank air pressure and ambient below 34.5 mbar	Front cockpit only
REHEAT	Reheat electronic system failure. Double lane failure in MECU	Front cockpit only
AP MON	IN and SAHR source data discrepancy	Front cockpit only
L THROTH/R THROT	Failure of selected left/right engine control lane	Front cockpit only
F PUMP/R PUMP	Failure of one or both booster pumps in front/rear fuselage fuel tank group	Front cockpit only
SLAT	Slat asymmetry detected. Slat locked in existing position	Front cockpit only
FR VLV	Transfer side of either or both fuselage fuel tank group refuel/transfer valves open with FLT REFUEL selected	Front cockpit only
IFU 1/IFU 2	Failure of Interface Unit 1 or Interface Unit 2 resulting in the loss of some navigation and weapon-aiming facilities	Rear cockpit only
BUS A/BUS B	MASS in LIVE position or loss of power supply channel A or B	Rear cockpit only
IN	Inertial navigator failure resulting in reversion to DP + SR navigation mode and loss of terrain following cross-monitor	Rear cockpit only

Figure 4-87 (Sheet 3 of 4)

CWP CAPTIONS AMBER CAPTIONS

CAPTION LIGHT	WARNING INDICATES	APPLICABLE IN COCKPIT
SAHR	SAHR failure resulting in loss of DP + SR and AD + SR navigation modes, and loss of terrain following cross-monitor	Rear cockpit only
DPPLR	Doppler failure resulting in loss of terrain following cross-monitor. DP + SR navigation mode not available	Rear cockpit only
CMPTR	Main computer failure resulting in reversion to Pure IN navigation mode and loss of some navigation and weapon-aiming facilities	Rear cockpit only
GMR	Mapping radar failure resulting in loss of radar display and some navigation and weapon-aiming facilities	Rear cockpit only
ADC	Loss of one or more air data computer outputs. May result in loss of AD + SR navigation mode and loss of some navigation and weapon-aiming facilities	Rear cockpit only
CRPMD	Projected map or CRT overheat resulting in loss of map and/or radar display	Rear cockpit only
SPWA/SPWB	MASS in LIVE position, or loss of power supply channel A or B	Rear cockpit only
Post mod. 00905 SMS A/SMS B	Loss of stores management system channel A or channel B	Rear cockpit only
ACT	Active ECM equipment failure	Rear cockpit only
IFF	Not operative	Rear cockpit only
PASS	Not operative	Rear cockpit only

Figure 4-87 (Sheet 4 of 4)

- Amber In - INCDU status display
- Amber ADC - TV/TAB status display.

For detailed information refer to the appropriate para.

AUDIO WARNING ALARMS

Audio warning alarms are sounded in two different tones in the crew's intercom system.

- The lyre bird tone sounds when any red caption on the CWP illuminates.

- A low-pitched (600 Hz) interrupted tone will sound when:

  - A reverse thrust/re-ingestion warning occurs. The warning will occur during engine operation in reverse thrust when the aircraft's speed falls below 60 kt.
  - A nose wheel steering system fault exists (i.e. a nose wheel steering system monitor has detected a fault).
  - The amber manoeuvre monitoring warning light illuminates in the TF manual mode (i.e. the aircraft is subjected to a turn rate in excess of 2.2°/sec or if the pilot does not obey and FD signal).
  - A low height warning occurs in the TF manual mode (i.e. the aircraft descents to an altitude which is 30% less than the set clearance height).
  - The test switch on the CWP is selected to the TEST 1 position.

NOTE

- Audio alarms can be silenced by pressing any one of the attention getters, or will be cancelled when the warning condition is rectified (i.e. successful reset).

- The 600 Hz tone, once silenced, will not reappear even if subsequently triggered by any of the preceding conditions.

LANDING GEAR SELECTOR LEVER WARNING

The warning light in the landing gear selector lever (6, Figure 4-86) will flash whenever either of the following conditions is met:

- The landing gear position does not agree with the lever position
- The aircraft is in a presumed landing condition and the landing gear is not lowered.

For detailed information see LANDING GEAR OPERATION.

FIRE WARNING SYSTEM

Integrated into two fire extinguisher buttons (2, Figure 4-86) is a red fire F warning light. In case of fire or an overheat condition the relevant (left or right) fire warning light will illuminate.
This condition in either engine compartment or in the APU is indicated in the CWP by one of the following captions: L FIRE, R FIRE, or APU respectively.
In addition the attention getters will start flashing and the lyre bird audio alarm will sound. In the event of an APU fire warning the APU fuel shut-off valve will automatically close.

NOTE

- The red captions on the CWP will remain on until the initiating cause has been remedied.

- Pressing anyone of the attention getters will silence the audio alarm.

TEST OF WARNING LAMPS

To ensure most reliability of warning system, light bulb filaments of important illuminated warning devices installed in both cockpits are function tested.
This is done the LAMPS test panel (53, Figure FO-2 and 33, Figure FO-3) in each cockpit. Individual toggle switches are provided for testing the main instrument panel, the left console and the right console warning devices independently. Arrangement of toggle switches is identical to that in the front cockpit.
Setting and holding the toggle switches will illuminate filaments of all warning lights, internally lit

pushbuttons and indicators, installed in the relevant cockpit on that circuit.
Labelling and function of toggle switches is identical for both cockpits, and are listed in the "Front and Rear Cockpit Lamps Test Facility" tables Figure 4-88.

TESTING OF CENTRAL WARNING SYSTEM

Before testing the central warning system and the integral fire warning system, the IGNITION and BATT MSTR switches on the rapid take-off panel are to be set to "FLIGHT".
Testing of the central warning system and fire warning system is to be performed in two different modes:

TEST 1
With AC power on line set 1/OFF/2/TEST toggle switch on lower right of CWP to "1". This setting will activate:

- the 600 Hz audio alarm
- the attention getters
- all warning captions on the CWP

TEST 2
Set of the 1/OFF/2/TEST toggle switch to "2" position will activate:

- all warning captions in the CWP (except for amber L VIB/R VIB with engines not running)
- the attention getters
- the lyre bird audio warning tone

FRONT COCKPIT LAMPS TEST FACILITY

SWITCH	LIGHTS TESTED
CONSOLES L	CSAS selector indicators, TEST and NO GO lights, AFDS selector indicators and indicators lights. PHASE 2 indicators and CVR RUN light; CCS station box lights; APU RUN, START CANCEL and X-DRIVE SHUT lights
FRONT PANEL	Landing gear selector handle light; nosewheel steering mode selector indicator and AP engaged indicator; landing gear position indicator lights; radar altimeter low height warning light; RPMD FAIL indicator; WAMS and WCP2 indicators, fire extinguisher button lights; CRT display and threat warning indicator lights; arrester hook selector indicator; WAMS selector indicators, reheat no-go, and FLT REFUEL RDY and FULL lights, EPS light; maneuvre monitor light; IFF caution lights; B risk light
CONSOLES R	Fuel control panel transfer indicators and indicator lights; GENERATORS FAIL lights; intake ramp FAIL lights, intakes de-icing FAIL lights; TFR panel indicator lights, environmental control panel indicator lights

REAR COCKPIT LAMPS TEST FACILITY

SWITCH	LIGHTS TESTED
CONSOLES L	HDD recorder panel indicators, MRCP indicators
FRONT PANEL	Landing gear position indicator lights and WCP1 selector indicators; CRPMD selector indicators and indicator lights; WAMS and NMCP selector indicators; CRT display, threat warning and counter-measures control panel lights; hand controller panel indicators
CONSOLES R	MC program LOAD and FAIL indicators; doppler TEST light, CCS station box lights; INCDU lights, SAHR control panel lights; HF control panel lights

Figure 4-88

– the engine compartment fire warning system (including fire extinguisher lamp)

NOTE

TEST 2 shall not be selected in flight because engine bay temperatures may be above the reset level of the fire detection system, causing the fire warnings to remain lit for the remainder of flight.

Testing procedure is identical for both, front and rear cockpit except for "Note" below.

NOTE

- When TEST 2 is performed from the front cockpit, the red CABIN, U/C, L FIRE and R FIRE and FUEL captions are illuminated on the rear CWP as well. The red light in the landing gear selector lever will flash, and both red lights in the fire extinguisher buttons will illuminate.
- When TEST 2 is performed from the rear cockpit, the red CABIN, U/C, FUEL, and the amber L HYD T, R HYD T, SLAT, FUEL, and FR VLV captions are illuminated on the front cockpit CWP, in addition to the red light in the landing gear selector lever.

NAVIGATIONAL AIDS

The aircraft is equipped with the TACAN Equipment.

TACAN EQUIPMENT

The TACAN equipment is used to obtain range and bearing information from a ground beacon or range information from a co-operating aircraft which is also equipped with TACAN. The bearing and range information is displayed on the BDHI and on the HSI.
This information is also supplied to the Navigation Sub System where it may be used for fixing. The equipment consist of a Control Panel, a Transmitter/Receiver, an Antenna Switch and two antennas.

NOTE

Function, modes of operation, and display of both HSI and BDHI are described under "INSTRUMENTS".

Transmitter/Receiver

The Transmitter/Receiver has 126 channels and operates in both the X and Y modes. These modes refer to differences of spacing of the pulse pair which constitute the interrogations and replies.
The channel frequencies separation is 1 MHz and the difference between transmitted and received frequencies is always 63 MHz (Figure 4-89).

Antenna Switch

In all modes the input/output of the Transmitter/Receiver is switched, every 5 seconds, between the upper and lower TACAN antennas by the Antenna Switch until a valid bearing or range is confirmed. Then the selected antenna remains connected until the received signal is lost or becomes too weak and antenna switching is resumed.
For antenna and electronic components location refer to Figure 4-90.

TACAN CONTROLS AND INDICATORS

TACAN Control Panel

The TACAN control panel (Figure 4-91) carries the following controls and indicators:

TRANSMISSION MODE SWITCH (X/Y)

A two position toggle switch. It is used to select either the X or the Y mode.

CHANNEL SELECTOR (CHAN)

Two concentrically mounted rotary switches labelled CHAN. The inner control is used to set the units of the channel number and outer control sets the 100s and the 10s. The channel number selected is displayed on a window integral with the controls.

VOLUME CONTROL

A rotary knob used to adjust the volume of the Morse code identity tone.

MODE SELECTOR

A four position rotary switch with the following positions:

OFF Power is disconnected.

REC Selects the Receive mode.

T/R Selects the Transmit/Receive mode.

A/A Selects the Air to Air mode.

STATUS INDICATOR

An illuminated indicator window, labelled STATUS, in which a drum is visible. The drum rotates to display GO momentarily when a BITE check is successfull.

BITE PUSHBUTTON

A pushbutton, labelled BIT, is used to initiate a BITE check.

TACAN MODES AND OPERATION

RECEIVE MODE (REC)

In the REC mode, the aircraft equipment uses the TACAN ground transmission to obtain bearing information, which is displayed on the BDHI and HSI. Morse coded beacon identification signals are supplied by the receiver to the Communication Control Equipment.

TRANSMIT/RECEIVE MODE (T/R)

In the T/R mode the Transmitter/Receiver is set to transmit as well as receive. It transmits an interrogation signal to the ground beacon and the elapsed time between the interrogation and the reception of the ground beacon's reply is used by a range computer to measure beacon range. This information is displayed on the BDHI and HSI. Bearing and beacon identification information is derived in the same manner as in the REC mode.

AIR-TO-AIR MODE (A/A)

The A/A mode is used to measure the slant range between two TACAN equipped aircraft. In this mode the TACAN acts as both an interrogator and a transponder, slant range being measured using the elapsed time between interrogation and response. Co-operating aircraft working in this mode shall be used a frequency separation of 63 MHz. If more than two aircraft are using the mode, one aircraft is chosen as reference and has a frequency separation from the remainder of 63 MHz.

TACAN System Operation

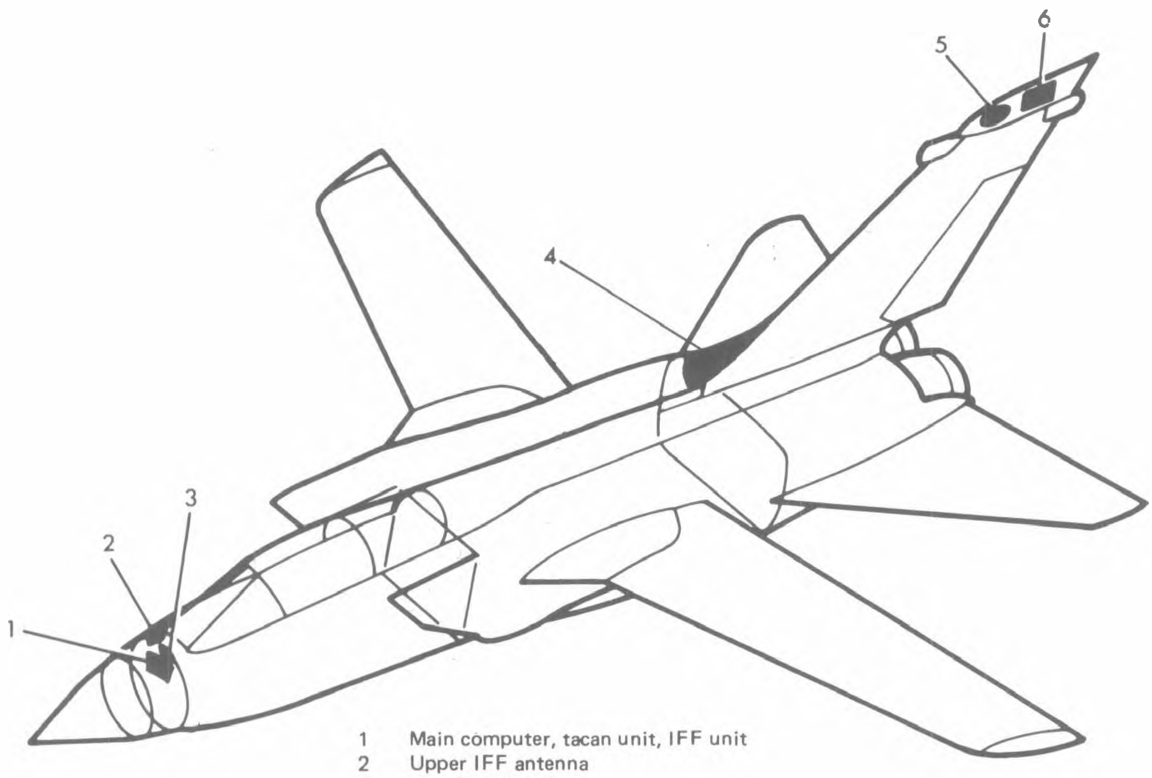
The system is switched on by setting the Mode Selector to any position except OFF. To operate the equipment, set the mode and channel required. If operation is in the REC or T/R mode identify the beacon, therefore turn the Volume Control fully clockwise and adjust the beacon identifier audio

TACAN CHANNELS AND FREQUENCIES

X/Y MODE	OP MODE	TRANSMIT CHANNELS 1-126	RECEIVE	
			CHANNELS 1-63	CHANNELS 64-126
X	REC	–	962-1024 MHz	1151-1213 MHz
X	T/R	1025-1150 MHz	962-1024 MHz	1151-1213 MHz
X	A/A	1025-1150 MHz	1028-1150 MHz	1025-1087 MHz
Y	REC	–	1088-1150 MHz	1025-1087 MHz
Y	T/R	1025-1150 MHz	1088-1150 MHz	1025-1087 MHz
Y	A/A	–	–	–

Figure 4-89

ANTENNA AND ELECTRONIC COMPONENTS — LOCATION



1 Main computer, tacan unit, IFF unit
2 Upper IFF antenna
3 Interface unit 1
4 Antenna tuning unit with notch assembly (post.mod.10809)
5 Upper tacan antenna
6 Upper V/UHF antenna
7 Lower IFF antenna
8 Interface unit 2
9 HUD electronics unit
10 Radar altimeter antennas
11 Combined lower UHF antenna and lower tacan antenna

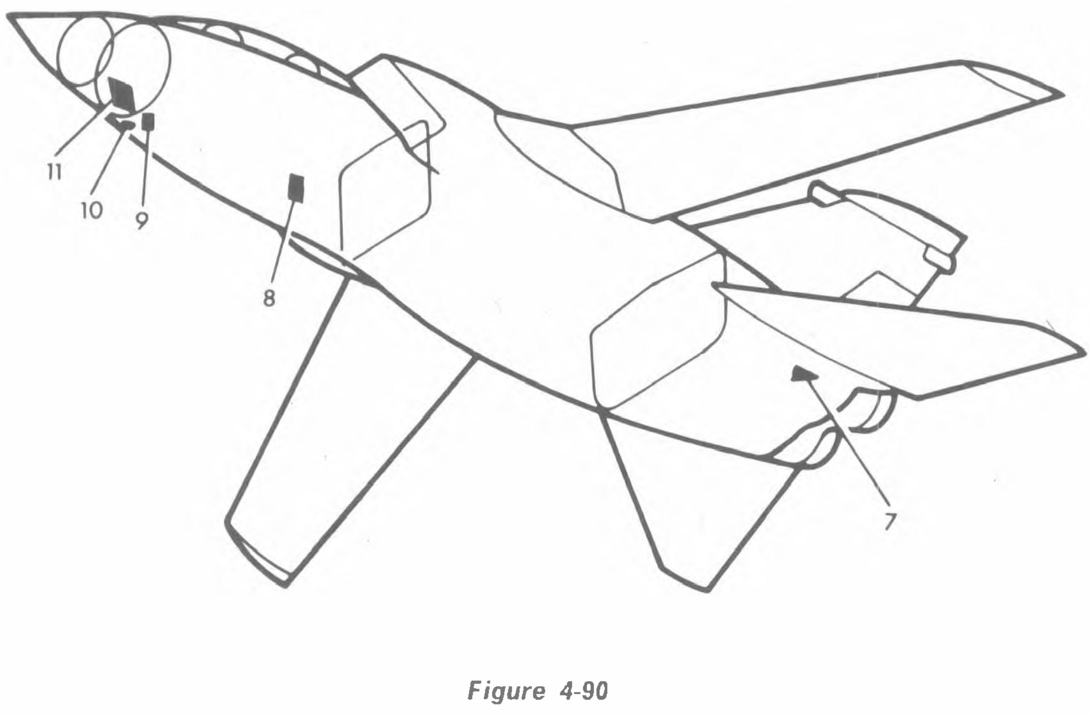
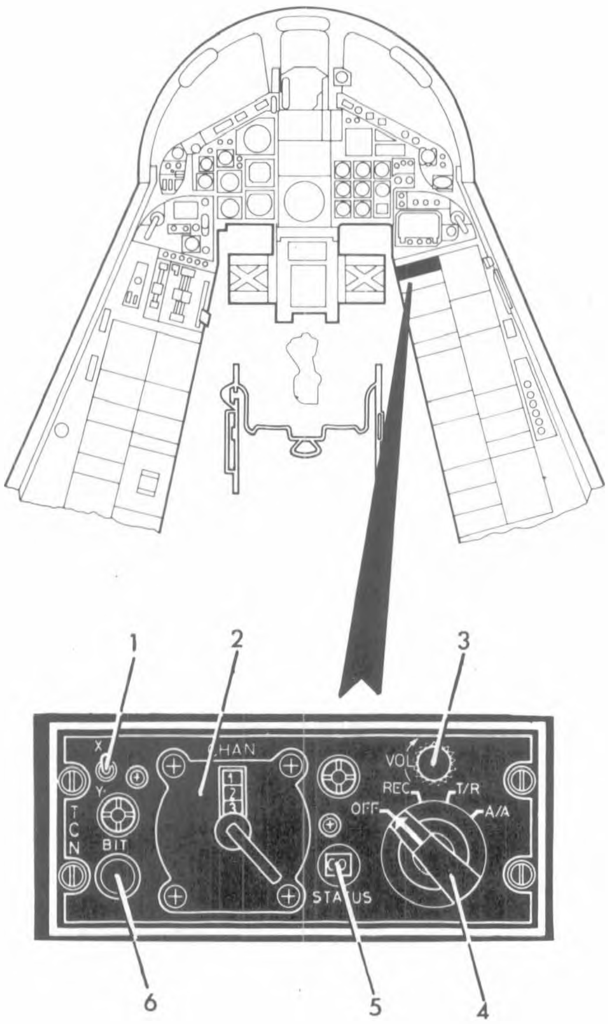


Figure 4-90

TACAN CONTROL PANEL



1 Transmission mode switch
2 Channel selector
3 Volume control knob
4 Mode selector
5 Status indicator
6 Bite pushbutton

Figure 4-91

level with the TACAN volume control on the Communication Control Panel (in this way audio identification can be performed by the Navigator).
After a warm-up period of approximately three minutes, a confidence check can be carried out using the BITE. Range and bearing information is displayed on the BHDI and on the HSI by setting the HSI Mode Switch to TAC. Fixing is initiated, provided that the ground beacon coordinates are already in the MC memory, by marking the appropriate selections on the TV/TAB Display and then depressing the TAC switch on the NHCP.
During transmission, the TACAN sends a suppression signal to CSU. At any time the TACAN may be suppressed by the CSU.

Bite

A BITE check is carried out by setting the Mode Selector to REC, T/R and A/A in turn and, in each case, depressing and releasing the BITE pushbutton. When the BITE pushbutton is operated, the word GO appears momentarily in the STATUS Indicator window and then disappears indicating that the BITE is operating correctly. If the BITE check is successful, the word GO reappears in the STATUS degrees and zero range are displayed on the HSI and BDHI.

SUPPORT EQUIPMENT

PHOTOGRAPHIC EQUIPMENT (RECCE POD)

Refer to AER.1F-PA200-34-1, Appendix B1.

IFF EQUIPMENT

The SIT-SIEMENS SIT-421 transponder system consist of a transceiver, of a control panel and of two antennas: an upper antenna located on the aircraft nose and a lower antenna located under the rear fuselage section. The receiver operates on a frequency of 1030 MHz and the transmitter operates on 1090 MHz.
The system permits automatic identification of the aircraft when interrogated by a radar system (IFF) and provides selective identification (SIF) in the different modes. The system provides a coded reply to a proper interrogation code. The correct reply to the interrogation enables the radar operator to identify the aircraft.

In case of seat ejection, with "MASTER" selector in any position (including OFF), the IFF system is automatically enabled to transmit emergency signals in the same way as when the "MASTER" selector switch is in the EMER position.
The system is supplied by the 28 V DC PP3 Essential Busbar via the relevant circuit breaker.

Receiver/Transmitter

The receiver/transmitter is a single channel equipment which produces a coded response (at a frequency of 1090 MHz) to interrogation (at a frequency of 1030 MHz) by a surface interrogator. Interrogation signals are routed from the antenna via the antenna switch and test set to the receiver section of the receiver/transmitter.
The receiver output is decoded and compared with the mode selected by the mode selection switches. If the received and selected modes are the same, a reply is encoded and trasmitted.

IFF 4 Lamp

This lamp, located in the right edge of the front cockpit glare-shield, illuminates when a failure is detected in the Mode 4 operations.

IFF Control Panel

Control elements of the IFF control panel are as follows (Figure 4-92).

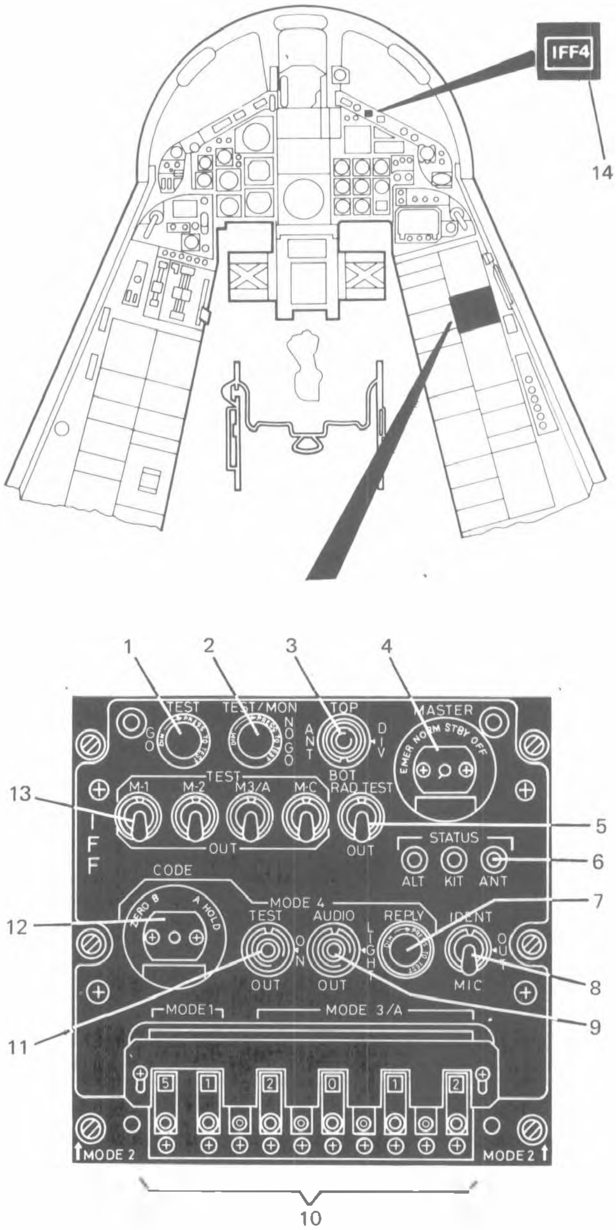
TEST-GO LIGHT

It is a press-to-test, turn to dim indicator labelled TEST-GO. It is illuminated green when the I-BITE check is successful or when the set replies correctly either to modes 1, 2, 3/A or C interrogations or to interrogation signals transmitted by an appropriate ground test equipment.

TEST/MON NO-GO LIGHT

It is a press-to-test, turn to dim indicator labelled TEST/MON NO-GO. It is illuminated amber when the I-BITE check is unsuccessful or when the set does not reply correctly either to modes 1, 2, 3/A or C interrogation or to interrogation signals transmitted by an appropriate ground test equipment.

IFF CONTROL PANEL



1 TEST go light
2 TEST-MON NO GO light
3 ANT switch
4 MASTER selector
5 RAD TEST-OUT switch
6 Status light
7 Reply light
8 IDENT-MIC switch
9 AUDIO LIGHT switch
10 MODES 1, 2 and 3/A code selectors
11 MODE 4-TEST switch
12 CODE switch
13 M1, M2, M3, and MC Mode switches
14 IFF 4 light

Figure 4-92

ANT SWITCH

It is a three-position toggle switch labelled ANT TOP/DIV/BOT. The three positions have the following functions:

TOP — The set operates through the top antenna for transmissions and through both antennas for receptions.

DIV — The system automatically selects for transmission the antenna that has received the clearest interrogation signal.

BOT — The set operates through the bottom antenna for transmission and through both antennas for transmission.

MASTER SELECTOR

It is a four positions rotary selector labeled MASTER OFF/STBY/NORM/EMER. The four positions have the following functions:

OFF — Is the de-energized position.

STBY — Power supply is connected to the equipment which is ready for immediate operation when the selector is moved to NORM or EMER.

NORM — The set operates in the mode selected.

EMER — All modes are excluded except TEST function: the set transmits emergency reply signals when interrogated.

RAD TEST-OUT SWITCH

It is a two position switch labelled RAD TEST/OUT. The two positions have the following positions:

OUT — Is the de-energized position (I-BITE is still possible).

RAD TEST — It is a momentary position and permits the reception of signals transmitted by an appropriate ground test equipment.

STATUS LIGHTS

When it illuminates amber, the three status lights labelled ALT, KIT and ANT indicate unsatisfactory operations of the set as follows:

ALT — Indicates that the ADC altitude coded data are not received by the IFF set.

KIT — Indicates that the interface with mode 4 computer is lost.

ANT — Indicates failure of one of the two antennas or that the standing wave ratio results too high.

REPLY LIGHT

It is a press-to-test, turn to dim indicator labelled MODE 4 – REPLY. It is illuminated green when mode 4 is interrogated.

IDENT – MIC SWITCH

It is a three-position switch labelled IDENT/MIC/OUT. The three positions have the following functions:

IDENT — It is a momentary position, and transmits a position identification reply for approx. 20 seconds.

MIC — Enables a special reply for approx. 20 seconds every time the transmission push-button on the engine throttle or on the control stick is pressed.

OUT — Is the de-energized position.

AUDIO LIGHT SWITCH

It is a three-position toggle switch labelled MODE 4 – AUDIO/LIGHT/OUT. The three positions have the following functions:

AUDIO — Is a signal, indicating validity of mode 4 interrogations, that illuminates the REPLY light. The acoustic signal in the head set is inoperative.

LIGHT — The REPLY light illuminates.

OUT — Is the de-energized position.

MODES 1, 2 AND 3/A CODE SELECTORS

These selectors select the reply code numbers respectively of the modes 1 (two digit), 2 (four digit) and 3/A (four digit).

NOTE

For selection of the mode 2 code numbers, the grid shall be moved up.

MODE 4 – TEST SWITCH

It is a three position toggle switch labelled MODE 4 – TEST/ON/OUT. The three positions have the following functions:

TEST — It is a momentary positions, and permits the IFF set I-BITE in mode 4.

ON — This position enables the set to reply to mode 4 interrogations.

OUT — The mode 4 is de-energized.

CODE SWITCH

It is a four positions selector labelled CODE MODE 4 – HOLD/A/B/ZERO and determines mode 4 operations. The four positions have the following functions:

HOLD — Prevents the computer from being zeroed.

A — Enables computer operations in mode 4, code A.

B — Enables computer operations in mode 4, code B.

ZERO — Erases the code from the computer.

M1, M2, M3/A AND MC MODE SWITCHES

They are four three-positions switches labelled TEST-ON/OUT – M1, M2, M3/A, MC. The three positions have the following functions:

TEST — It is a momentary position and permits IFF set I-BITE in the correspondenting mode. The mode C (MC) I-BITE is possible only if the M3/A switch is in ON position.

ON — Enables the reply capability in the corresponding mode. The reply capability of the mode C (MC) is possible only if the M3/A switch is in ON position.

OUT — Disables the reply capability in the corresponding mode.

IFF 4 LIGHT

This light indicator, labelled IFF 4, illuminates when unsatisfactory operation of the set in mode 4 is detected.

IFF OPERATION

Operation of the system is obtained by moving the MASTER selector switch to any position (except the OFF position). The STBY position is used to warm-up the system and to maintain it ready for operation.
Transmissions take place only when the MASTER selector is in the NORM or EMER position.
In case of seat ejection, the selector switch permits transmission of the emergency signals regardles of its position. By moving the MASTER selector switch to EMER, only modes 1, 2 and 3/A are enabled.
The transceiver normally operates with the MASTER selector switch in the NORM. Maximum sensitivity is automatically obtained when the selector switch is in the EMER or the seat is ejected.

OPERATION OF MODES 1, 2 AND 3/A

Modes 1, 2 and 3/A may be used independently or in combination. Mode 1 provides 32 possible code combinations, any one of which may be selected in flight by means of the two MODE 1 code selectors.
Mode 2 provides one of the 4096 possible code combinations which can be selected on the ground after sliding the control panel special grip up.
Mode 3/A provides 4096 possible code combinations which may be selected by the pilot in flight by means of the four MODE 3/A code selectors.

OPERATION OF MODE C

When Mode C is selected and correctly interrogated, the aircraft pressure altitude, expressed with four digits, is automatically reported to the air traffic controller on the ground in 100 feet increments. To provide this information, the system uses the data provided by ADC.

OPERATION OF MODE 4

Mode 4 (identification codes reserved to military use) is actually inoperative in this aircraft.

IDENTIFICATION-OF-POSITION OPERATION

When the IDENT/MIC switch is energized, the system transmits position identifying signals to all interrogating stations on Modes 1, 2 and 3/A. Transmission of the identification-of-position signal occurs in these modes even if the mode switches are in the OUT position. The two types of identification-of-position are as follows:

1. Momentarily hold the IDENT/MIC switch in the IDENT position, then release. This action causes the identification-of-position signal to be transmitted for a period of 20 seconds to all interrogating stations on Modes 1, 2 and 3/A. Repeat as required.

2. Set the IDENT/MIC switch to the MIC position. Identification-of-position signals are transmitted by pressing the push-button on the engine throttle or on the control stick grip. When the need for further identification signals has ended, return the IDENT/MIC switch to the OUT position.

EMERGENCY OPERATION

During an aircraft emergency or distress condition, the system is used to transmit specially coded signals on Modes 1, 2 and 3/A to all interrogating stations. These emergency signals are transmitted as long as the MASTER selector switch remains in the EMER position. For emergency operation, proceed as follows:

1. Pull and rotate the MASTER selector switch to the EMER position.

2. Leave the MASTER selector switch in the EMER for the duration of the emergency.

3. When the emergency has ended, return the MASTER selector switch to the NORM position.

NOTE

When seat ejection is performed, the emergency signal is automatically transmitted.

Bite

I-BITE is possible for Modes 1, 2, 3/A and C. With the MASTER selector switch in the NORM position, I-BITE is commenced by turning one of the mode switches to TEST. A signal, generated for the mode of operation selected, arrives at the set and is processed as a normal interrogation signal. Normal operation of the mode being tested is indicated by the illumination of the GO light (green light).
The RAD TEST/OUT switch provides a further method to check the system. A test special mode is obtained when the switch is momentarily moved to the RAD TEST position. The GO light illuminates when the system replies in the test mode to the interrogations issued by an external test set.
The test mode is unique and does not affect the operating modes. In the OUT position the I-BITE set monitor circuits are activated and the GO light will illuminate whenever valid replies both to external and internal interrogations are transmitted.

ON BOARD CHECKOUT AND MONITORING SUBSYSTEM (OCAMS)

The OCAMS provides an overall system test capability of avionic and non-avionic equipment and furnishes continuous monitoring and equipment interruptive testing facilities to detect and locate system defects down to line replaceable units (LRU) level. Sub-system defects and data validity status are displayed in the cockpit, LRU defects on the CMP. Defect information may appear as an overheat indication, partial or total equipment failure, or the detection of an invalid signal.
In addition, the OCAMS provides test facilities for use with external equipment, and data to the crash recorder.
Software test programmes are available for loading into the MC for ground and in flight test purposes (Figure 4-93).

EQUIPMENT STATUS-GO/NO GO

- A GO and/or NO GO status may be displayed within the cockpit on the relevant control panel or appropriate display. The GO indication or an occulted failure warning indicates no detectable failure in the equipment under test, while a NO GO or failure warning indicates a fault.

OCAMS GENERAL ARRANGEMENT SCHEMATIC

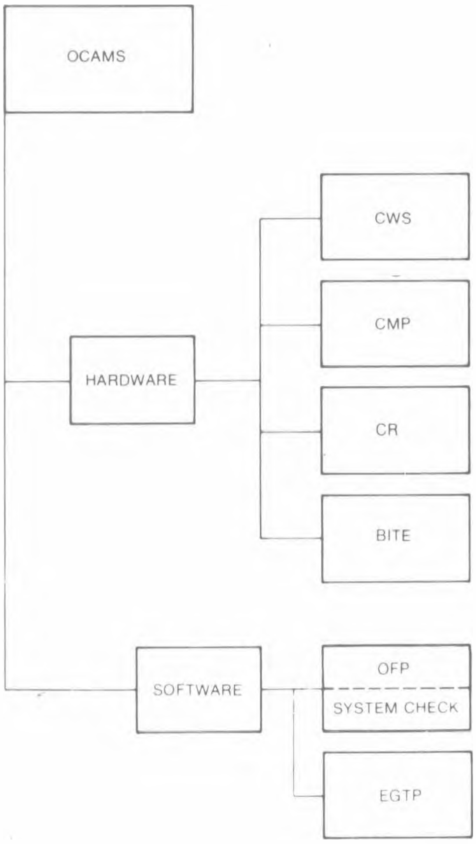


Figure 4-93

- The GO/NO GO status produces an output for automatic performance monitoring between equipments in the system, and may be used to activate the CWS.

- The NO GO status, in certain instances, produces a discrete signal from each LRU for transmission to the CMP.

CONTINUOUS MONITORING

Functions are continuously tested during equipment operation.

EQUIPMENT INTERRUPTIVE TESTING

Some equipment may be tested using a separate TEST mode. When in TEST, normal equipment operation is inhibited.
The outcome of an interruptive test may be one or both of the following:

- a status signal is generated
- test values are displayed.

CENTRAL MAINTENANCE PANEL (CMP)

The central maintenance panel (CMP) (Figure 4-94) stores information of malfunctions which occurred during aircraft operations for subsequent display on the ground. It also provides a display for the pre and post-flight checkout facility of the CSAS.
The CMP is located on the right-hand side of the aircraft, behind access panel R252. On the front panel of the CMP are 100 light-emitting diodes (LEDs), a four digit read-out unit and a three-position function switch.

CMP CONTROL AND INDICATORS

Light Emitting Diodes (LED)

Each fault LED is associated with one item of equipment and is controlled by a magnetic latch relay which changes its status and latches whenever a fault condition in that equipment is signalled.
The relay remains latched despite subsequent removal of the fault condition or interruption of the aircraft power supplies. Each LED can be identified by a letter/number code. A list of CMP card is given in Figure 4-95.
One separate LED labelled PP1-ON illuminates whenever 28 V DC busbar PP1 is supplying power to the CMP.

CMP POWER SUPPLIES

The CMP is supplied by 28 V DC from busbar PP1 via circuit breaker 11 (203VE access panel L114), PP5 via circuit breaker 350, and 5 V DC from CSAS BITE.

CENTRAL MAINTENANCE PANEL

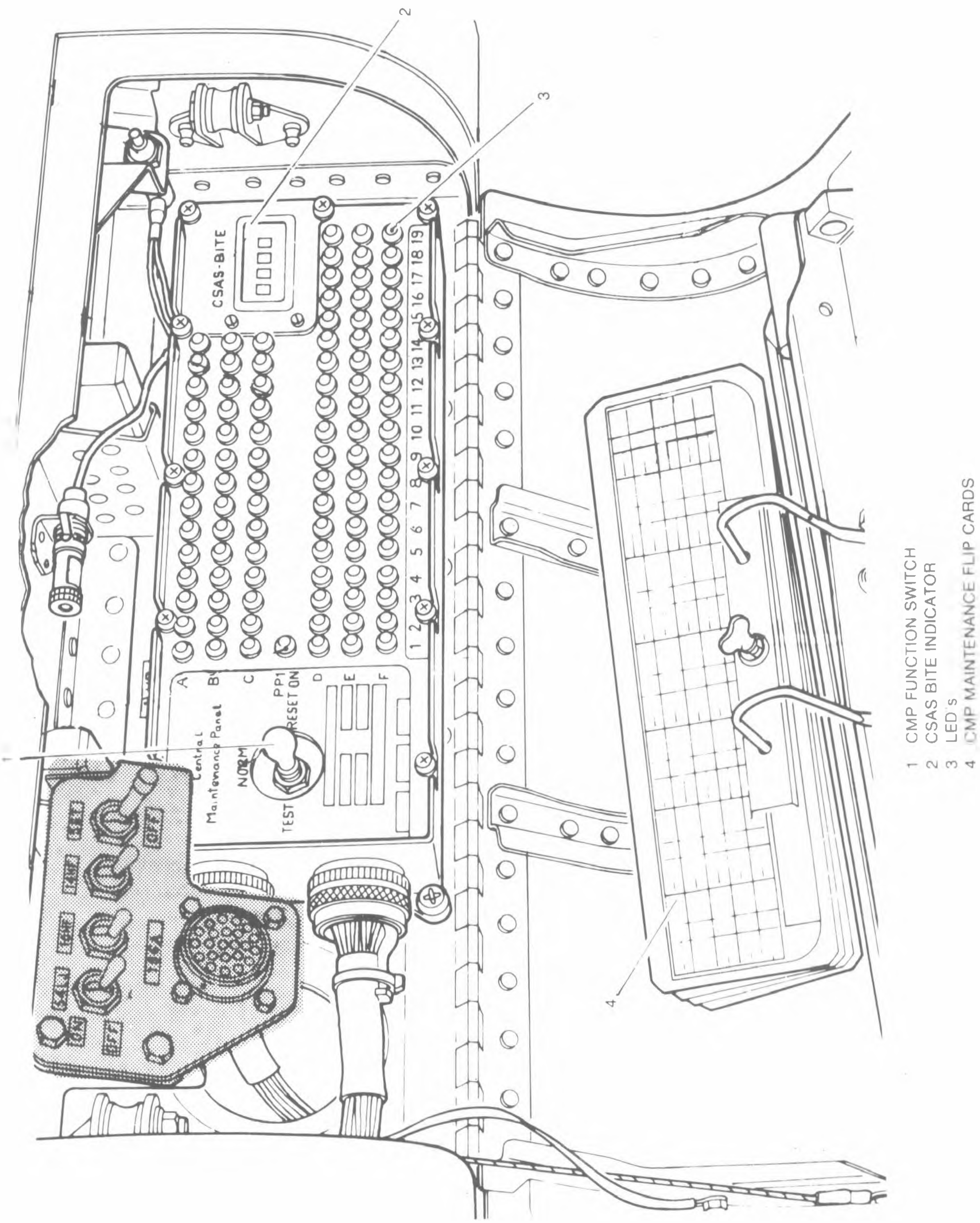


Figure 4-94

CMP INDICATIONS

	A	B	C
1	APU FAULT	AICS RAMP (LH)	HF-SS B BATT. DISCHARGED
2	ONE SHOT BATTERY	AICS RAMP (RH)	AICS CU (LH)
3	SFCS — FLAP	FUEL — CELL B	AICS CU (RH)
4	SFCS — SLAT	FUEL — WING 2	NWS — NOSE WEIGHT
5	IP-BOV (LH)	FUEL — WING 1	NWS — MAIN WEIGHT
6	IP-BOV (RH)	—	NWS — PRESSURE
7	FUEL FILTER (LH)	—	NWS — FAULT DETECT
8	FUEL FILTER (RH)	ACFC PRV/SOV (RH)	ELEC — FAD
9	—	ACFC PRV/SOV (LH)	ELEC — BATT CHARGER
10	KORMORAN DECODER	INTAKE DE-ICE (RH)	ECM — LRU 1
11	KORMORAN J.B.	INTAKE DE-ICE (LH)	ECM — LRU 2
12	—	ACQUISITION UNIT	ECM — LRU 3
13	—	ACCIDENT DATA RECORDER	ECM — LRU 4
14	RECCE	—	ECM — LRU 5

	D	E	F
1	INS — IN UNIT	MECU — DORMANT (LH)	RPMD
2	INS — IN INCDU	MECU — DORMANT (RH)	ARD — DSC
3	SAHR	MECU — REHEAT (LH)	
4	DOPPLER	MECU — REHEAT (RH)	
5	CSAS — CSAS	TTU	HDDR — EU
6	CSAS — SPILS	ECS — PRESS SW P1	HDDR — CRT
7	SMS CHAN A	ECS — TEMP SW T2	W/S HEAT — CENTRE
8	SMS CHAN B	ECS — TEMP SW T1	W/S HEAT — SIDE
9	TACAN — CU	RADAR ALT	AFDS — AFDC 1
10	—	ENG VIB (LH)	AFDS — AFDC 2
11	RADAR — PROC COMP	ENG VIB (RH)	MAINTENANCE RECORDER
12	RADAR — GMR TX	—	V/UHF — TX/RX
13	RADAR — EX PLSE COMP	MC	—
14	RADAR — GMR ANT RX	IFU 1	IFF
15	RADAR — MOUNT TOLL	IFU 2	HF/SSB — CONT PANEL
16	RADAR — POWER SUPP	ADC	HF/SSB — TX/RX
17	RADAR — TFR TX	HUD — PDU	HF/SSB — PWR AMP
18	RADAR — TFR ANT RX	HUD — EU	HF/SSB — CONT FREQ
19	RADAR — W/G PRESS	CRPMD	HF/SSB — ATU

Figure 4-95

Function Switch

Three modes of operation are controlled by the function toggle switch which has the following positions:

NORM — The switch is set to NORM for flight. When a fault is detected in the equipment, the relevant relay latches. If the access panel is opened, the relay completes a circuit to the relevant LED which illuminates red and remains lit until reset.

RESET — All LEDs extinguish if RESET is selected. This switch position has no effect on the CSAS BITE indication.

TEST — If selected, a self-test of the CMP is carried out, checking the function of all LEDs and CSAS BITE. The lit LEDs occult if RESET is selected.

CSAS BITE INDICATOR

The indicator is used for ground test purposes only and is not operative in flight. It displays a four digit readout.
The left hand digit identifies the defective channel:

- "0" stands for lateral channel
- "1" stands for pitch channel.

The three remaining digits display a number which corresponds to the test step carried out by the CSAS BITE.

SOFTWARE SYSTEM CHECK

The software system check forms part of the operational flight program (OFP).
It provides test facilities for use by both aircrew and groundcrew.
The software consists of four functional area:

- In-Flight Monitor (IFM)
- In-Flight Display (IFD)
- Main Computer Self Test (MCST)
- Ground Test Facility (GTF)

In-Flight Monitor

The IFM operates above 100 kt. It monitors and records data of invalid equipment status and specified system parameters, particularly digital links.
These data are stored in a "protected" part of the MC store for subsequent ground replay and analysis.
The IFM is inhibited when the aircraft is not in flight and the previously recorded fault data are retained in memory store for inspection using the GTF of the system check or the external ground test program (EGTP) as required. At the start of each flight the monitor memory is cleared ready for the receipt of fresh data.
A flight is defined as commencing when the calibrated airspeed from the ADC passes 100 kt increasing and terminating when the airspeed passes 100 kt decreasing.

In-Flight Display

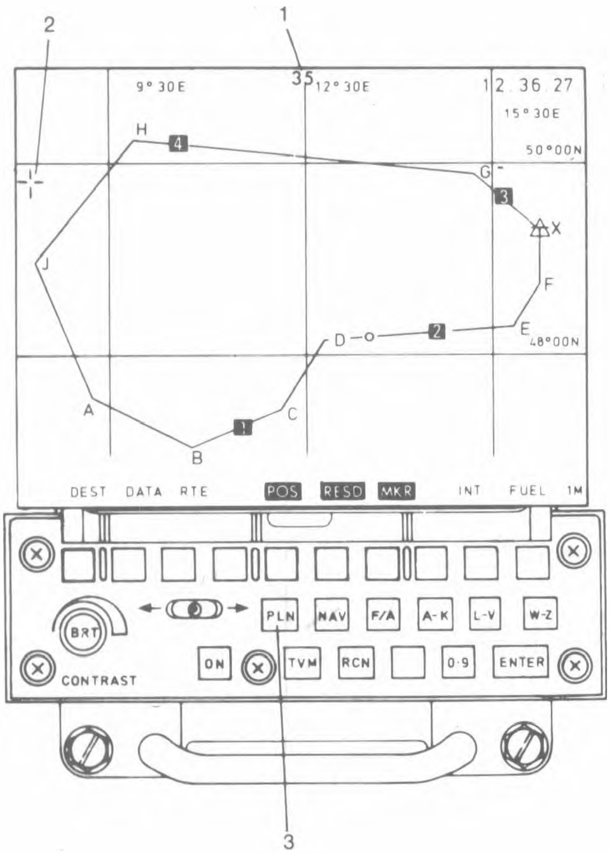
The IFD provides a display on the TV/TAB of the invalid status of various system elements not available on any other cockpit indication. If a fault exists for more than 500 msec, it will be indicated by a flashing cross in the upper left hand side of both TV/TAB displays, regardless of the format selected.
If the PLAN format is selected the status identifier is displayed at the top center of the TV/TAB (Figure 4-96).
Faults are displayed only on the first transition from a good to a bad status during any one run of the MD.
Deselecting the PLAN format cancels the fault display.
The status identifier is not redisplayed on reselection of the PLAN format, however, should further failures exist, the flashing cross will remain displayed and reselection of the PLAN format will call up and display the next status identifier.
This routine enables all the status identifiers of a multiple fault condition to be displayed in sequence.

MAIN COMPUTER SELFT TEST (MCST)

The MCST comprises interruptive and continuous tests which provide a check of the internal functioning of the MC.
The software consists of the central processing unit (CPU) BITE and a continuous input/output (I/O) test package.

- The interruptive MCST provides a comprehensive check of internal and input/output com-

TV/TAB IN-FLIGHT DISPLAY



1 STATUS IDENTIFIER
2 FLASHING CROSS
3 PLN SELECTOR BUTTON

Figure 4-96

puter functions. It is initiated a MC switch-on and during program loading.

– Continuous MCST operates whenever the OFP is cycling and provides a background of principal MC functions.

GROUND TEST FACILITY (GFT)

The GFT cannot be used in conjunction with other software.
It is intended for use by maintenance personnel and operates only if the aircraft is on the ground. The GFT has three functions:

– equipment status display and test selections (STS)
– equipment integrity tests
– ground replay of data recorded during inflight monitoring (IFM replay).

SERVICING DIAGRAM

AIRCRAFT SERVICING

For servicing information refer to Figure 4-97.

TRAINER VARIANT

THE AIRCRAFT

A variant of the TORNADO MRCA is equipped with dual flight controls and is used primarily as a pilot trainer.
Certain differences exist in the location and/or function of equipments, between the strike and trainer versions. In addition, some controls and indicators have been duplicated in the rear cockpit of the trainer version (Figure FO-4). They are as follows:

AIRCRAFT GROSS MASS

The approximately average gross masses are as follows:

Operating mass	13700 kg
Operating mass, plus a full internal fuel load	18350 kg
Operating mass, plus a full internal fuel load, plus an external centerline tank	19750 kg
Operating mass, plus a full internal fuel load, plus two external wing tanks	21400 kg

SERVICING DIAGRAM

ITEM NO	ITEM DESCRIPTION	SPECIFICATION	ACCESS
1	NITROGEN	FSN 6830-00-782-2643	L121, L128 L/R330
2	HYDRAULIC FLUID	MIL-H-5606	L/R311
3	LIQUID OXYGEN	MIL-O-27210A GRADE A, TYPE II	L124
4	EXTERN. STARTING POWER	28 VDC, 32 kW.	L119
5	A/C BATTERY	24 VDC	L117
6	GEARBOX OIL	O-160	L/R270
7	ENGINE FUEL	NATO F-34 NATO F-35 NATO F-40	R252
8	WASH-SOLUTION DE-MINERALIZED WATER ETHYL ALCOHOL	 MIL-A-6091B MIL-C-5543A	R106
9	ELECTR. SYSTEMS EXTERNAL POWER	115/200 V, 400 Hz 3-PHASE	R120
10	AIR, COMPRESSED	MIL-P-5818	R127
11	CENTRAL MAINTENANCE PANEL		R252
12	ENGINE OIL	O-160	L/R323
13	FIRE EXTINGUISHER	BCF 1211, TYPE 260A	R316

Note: 1. Engine oils are fully miscible and may be mixed without restriction.

2. Gearbox oils may be mixed without restriction.

3. The aircraft is cleared to fly with a mixture of F-34/35 and F-40 fuels in any proportion, observing the operating instructions for F-40.
After the use of F-40 or a mixture of F-34/35 and F-40 and before flying to the operating instructions for F-34/35 fuel, either the aircraft must be defuelled and refuelled with F-34/35 or the aircraft must be refuelled with F-34/35 and flown to F-40 limits until 2 sorties have been flown on which the fuel remaining after each sortie was 2000 kg or less.

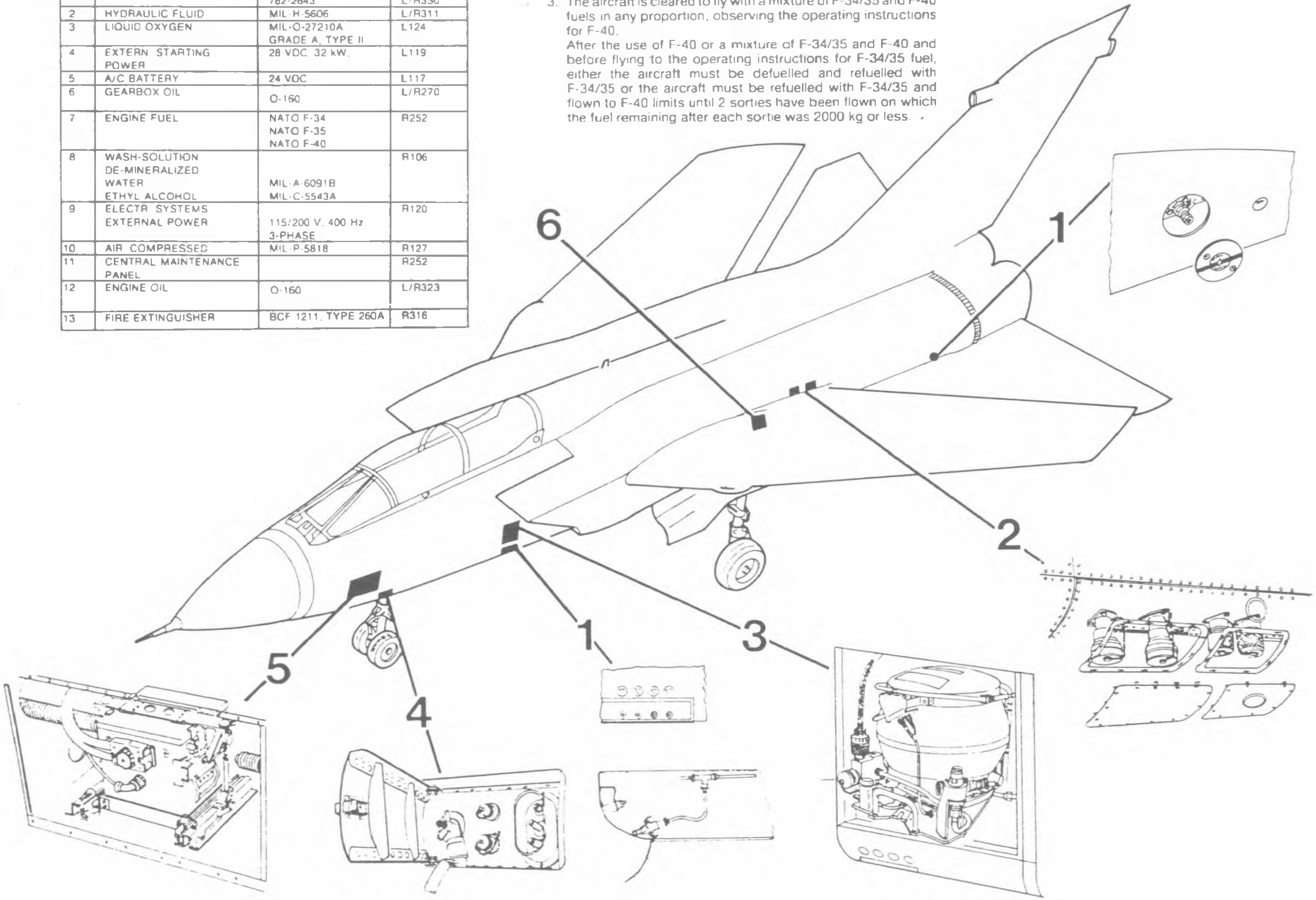


Figure 4-97 (Sheet 1 of 2)

SERVICING DIAGRAM

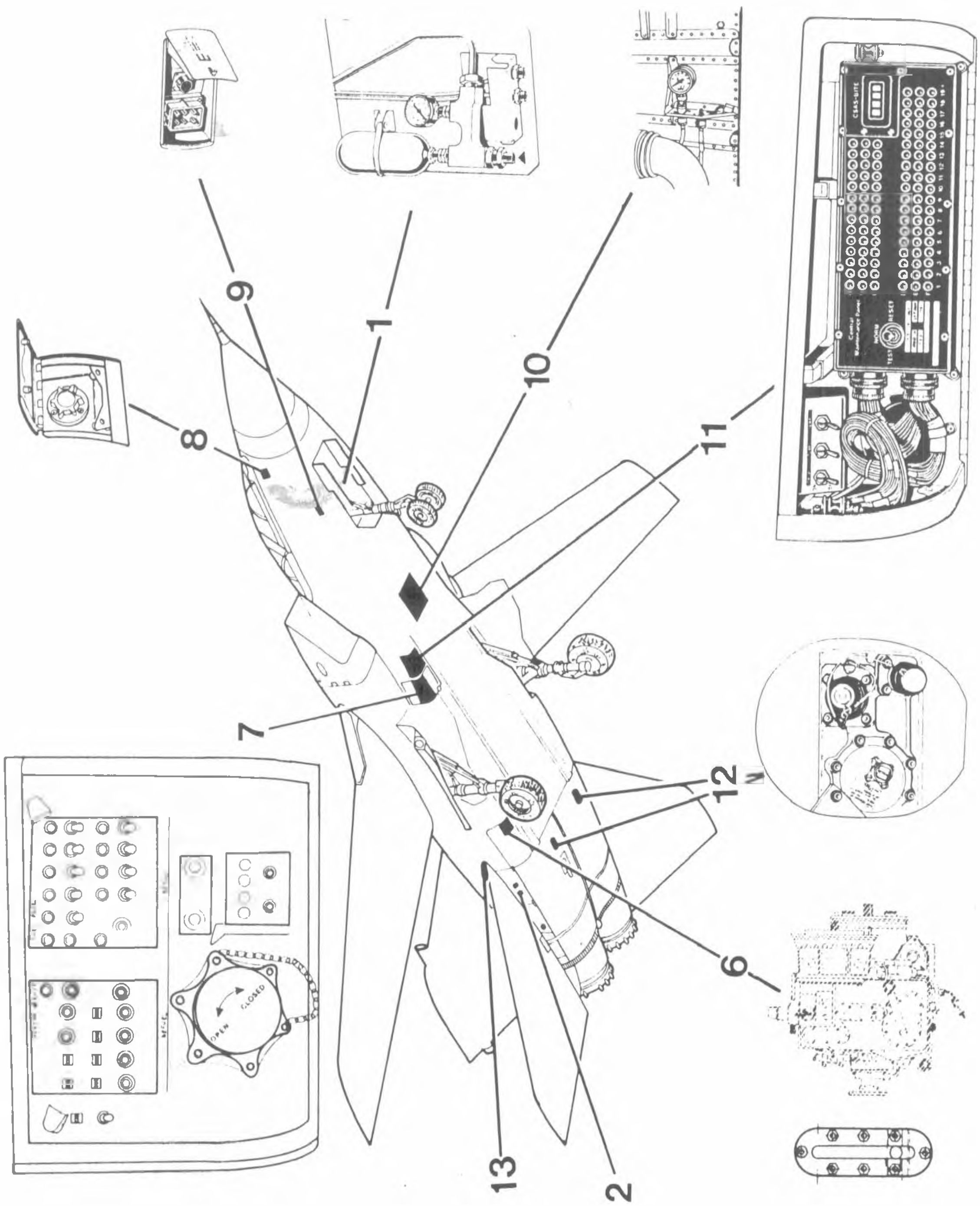


Figure 4-97 (Sheet 2 of 2)

TOTAL FUEL CONTENTS INDICATORS

The digital total fuel contents indicator (33, Figure FO-4) receives the same signals which are sent to the front cockpit fuel quantity indicator/selector unit.

REFUEL PROBE LIGHT CONTROL

A refuel probe light control (49, Figure FO-4) is located on the right console in the rear cockpit. It is a rotary dimmer switch marked REFUEL LIGHT, which with PROBE SELECTED OUT or EMERG OUT, controls the intensity of the refuelling boom floodlight.

CENTRAL WARNING PANEL (REAR COCKPIT)

The following duplicate captions are installed on the CWP in the rear cockpit. They operate in the same manner as their counterparts on the front cockpit CWP, GEN, L OIL P/R OIL P, L THROT/R THROT, L UTIL/R UTIL, AP TRIM, CSAS, TF MON, RAMP PFCS, PITOT, SLAT, FUEL, TRU.

LP COCK SWITCHES

The LP fuel cock switches installed in the rear cockpit (17, Figure FO-4), have the same functions as those in the front cockpit.

LANDING GEAR SYSTEM-SCHEMATIC

See Figure FO-11.

NOSE WHEEL STEERING MODE SELECTOR/INDICATOR

The nose wheel steering mode selector/indicator (16, Figure FO-4), installed in left front panel of the rear cockpit, has the same functions as that in the front cockpit.

EMERGENCY LANDING GEAR SELECTOR LEVER

The emergency landing gear selector lever, located on the left quarter panel of the rear cockpit (7, Figure FO-4), functions in the same way as the landing gear selector lever in the front cockpit.

BRAKE PRESSURE TRIPLE INDICATOR

The brake pressure triple indicator (2, Figure FO-4) is located on the left console in the rear cockpit and receives the same signals as those sent to the front cockpit brake pressure triple indicator.

ARRESTER HOOK PUSH BUTTON AND INDICATOR

The arrester hook push button and indicator located on the left anti-glare shield (20, Figure FO-4) functions in the same way as the push button and indicator in the front cockpit.

PRIMARY FLIGHT CONTROL SYSTEM

See Figure FO-13.

CONTROL STICK

The control stick (62, Figure FO-4) installed in the rear cockpit, has the same flying control functions as that in the front cockpit.

CONTROL STICK GRIP

The buttons and switches on the rear cockpit control stick grip operate in the same manner as those in the front cockpit but with the following exceptions:

- the trim button function overrides that on the front control stick but the EMERGENCY TRIM switches on the CSAS control panel have supreme control authority
- weapon release button is not operative
- gun and camera button is not operative

NOTE

The front and rear trim switches should not be operated simultaneously.

THREE AXES TRIM INDICATOR

The three axes trim indicator in the rear cockpit located on the left quarter panel (8, Figure FO-4) receives the same signals as those sent to the front cockpit trim indicator.

RUDDER PEDALS AND RUDDER PEDALS ADJUSTMENT HANDLE

The same functions are performed by the front and the rear rudder pedals and rudder pedals adjustment lever (61, 67, Figure FO-4).

SECONDARY FLIGHT CONTROL SYSTEM CONTROLS AND INDICATORS

The flap lever, the wing sweep lever and the lift dump feature are duplicated in the rear cockpit and have the same functions as those in the front cockpit.

SECONDARY CONTROL SURFACE POSITION INDICATOR

The four pointer secondary control surface position indicator (69, Figure FO-4) is located on the left quarter panel in the rear cockpit and receives the same signals as those sent to the front cockpit indicator.

LIFT DUMP INDICATOR

A lift dump indicator (19, Figure FO-4) is duplicated in the rear cockpit and functions in the same manner as that in the front cockpit.

EMERGENCY AIRBRAKES AND EMERGENCY FLAPS SWITCHES

The function of the emergency airbrakes and emergency flaps switches is the same as that in the front cockpit.

ACCELEROMETER

The accelerometer in the rear cockpit is located on top of the CRPMD (28, Figure FO-4), and functions in the same way as the front cockpit accelerometer.

COMBINED SPEED INDICATOR

The combined speed indicator (CSI), in the rear cockpit is installed in the main instrument panel (21, Figure FO-4).

VERTICAL SPEED INDICATOR

The vertical speed indicator (13, Figure FO-4) is located on the main instrument panel in the rear cockpit and the instruments is connected to S1 Static Pressure source.

AOA INDICATOR

A measurement of local AOA sensed by an airstream direction probe supplies signals to both the front and rear AOA indicator. The rear cockpit AOA indicator is located on top of the CRPMD (25, Figure FO-4).

HORIZONTAL SITUATION INDICATOR

The horizontal situation indicator (HSI) (24, Figure FO-4) is located on the main instrument panel in the rear cockpit and is parallel to the front cockpit HSI. The signals driving the lateral and the elevation deviation bars and the associated validity signals are all routed through an HSI junction box where they are buffered separately to each HSI. The heading error and approach course signals for the AFDS are taken only from the front cockpit HSI, and thus the heading index and the track/select setting knobs on the HSI in the rear cockpit cannot be used for setting inputs to the AFDS.

ATTITUDE DIRECTOR INDICATOR

The attitude director indicator (ADI) (22, Figure FO-4) is located on the main instrument panel in the rear cockpit. The flight director and rate signals are buffered signals derived from the front ADI supplies.

FLOODLIGHTS

The red floodlight over the rear cockpit CRPMD is controlled by the CRPMD floodlight switch (26, Figure FO-4).

INTERNAL LIGHTS CONTROL PANEL

The INTERNAL LIGHTS control panel located on the right console in the rear cockpit, carries the same facilities as that in the strike version.

UPPER INSTRUMENTS LIGHTS DIMMER SWITCH

The INSTRUMENTS light switch (27, Figure FO-4) in the rear cockpit, controls the intensity of the lighting for the accelerometer and the AOA indicator.

ANTI-DAZZLE SWITCH

The anti-dazzle switch (3, Figure FO-4), located on the left console in the rear cockpit, has the same function as that in the front cockpit.

PRESS-TO-TRANSMIT SWITCH (MISCELLANEOUS SWITCH PANEL)

There is no miscellaneous switch panel installed in the rear cockpit.

PRESS-TO-TRANSMIT CONTROLS

PTT buttons are installed in the rear cockpit as follows:

- Control Stick Grip
- Throttle

HDDR CONTROL PANEL

The HDDR control panel is located on the right quarter panel (55, Figure FO-4), and has the same functions as that in the strike version.

NAVIGATION MODE CONTROL PANEL

The navigation mode control panel is located on the left main instrument panel (65, Figure FO-4).

NAVIGATOR'S HAND CONTROLLER AND SWITCHES

The navigator's hand controller and switches are located on the right console (53, Figure FO-4) and have the same functions as those in the strike version, but the PHASE 1 pushbutton is installed on the left of the hand controller.

DOPPLER CONTROL PANEL

The doppler panel is located on the left console (71, Figure FO-4) in the rear cockpit.

TV/TAB DISPLAY UNIT

Only the right hand unit is installed.

ENGINE INSTRUMENTS

The following engine instruments are duplicated in the rear cockpit:

- engine temperature indicators (57, Figure FO-4)
- nozzle area indicators (58, Figure FO-4)
- engine RPM indicator (32, Figure FO-4)

AUTOPILOT ENGAGE INDICATOR

An autopilot engage indicator, located on the left front panel of the rear cockpit, has the same function as that in the front cockpit.

REVERSE THRUST INDICATORS

Reverse thrust indicators, marked L/R, are installed on the anti-glare panel in the rear cockpit (18, Figure FO-4) and have the same functions as those in the front cockpit.

REVERSE THRUST SELECTOR SWITCH

A toggle switch (18, Figure FO-4), with the positions ON-FRONT-OFF, is fitted on the anti-glare panel in the rear cockpit. The switch functions as follows:

ON	Pre-arm/selects reverse thrust and lift dump from rear cockpit.
FRONT	Enables pre-arm/selection of reverse thrust and lift dump in front cockpit (via throttle rocking facility).
OFF	Pre-arm/selection of reverse thrust and lift dump in front cockpit is inhibited (i.e. no throttle rocking facility).

THROTTLES

A set of throttles is installed in the rear cockpit (5, Figure FO-4), and with respect to engine power settings they are mechanically interconnected with those in the front cockpit.
However, these throttles have no HP SHUT position and reverse thrust of lift dump "rocking" facility (refer to REVERSE THRUST SELECTOR SWITCH).
The airbrakes selection switch is mounted on the right hand throttle lever and functions in the same manner as that in the front cockpit, it has override authority over the front cockpit switch.
The relight button installed on the rear of each throttle functions in the same manner as those in the front cockpit.
The radar lock-on/reject button installed on the right throttle is not operative.

EMERGENCY JETTISON BUTTON

An emergency jettison button is installed on the left hand quarter panel of the rear cockpit (10, Figure FO-4). It has the same function as that in the front cockpit.

CREW DUTIES

GENERAL

The purpose of this section is to provide a compact collection of material wherein each crewmember can readily determine his duties in relation to the accomplishment of the over-all mission. Instructions relating to crew duties do not include information which is already covered in other sections.

NOTE

> Software changes have a potential impact on procedural information in this section as well as on the description of the avionic equipment.
> Prior to system operation the crew shall be informed of the actual software standard loaded. This shall be accomplished in whatever detail necessary to meet the requirements of the specific mission.

CREW COORDINATION

Close coordination between crewmembers is of prime importance to ensure the optimum degree of mission success and safety during all phases of operation. This coordination is not necessarily limited to actions alone. Complete familiarity with one's crew position, the relevant responsibilities and a working knowledge of the other crewmember's duties will contribute immeasurably toward crew coordination. Each crewmember shall be constantly on the alert and should notify the responsible crewmember of any deviation or discrepancy which could affect successful accomplishment of the mission. Liaison between individuals concerned shall be established prior to initiating any action or procedure which will alter aircraft configuration or require correlation of activities between crewmembers. Prior to flight, each crewmember shall throughly familiarize himself with all aspects of the mission which affect his particular station, and those include:

1. Applicable instructions in the flight information publications
2. Route of flight
3. Navigation
4. Air refuelling information
5. Weaponry
6. ECM activities
7. Normal and emergency communications procedure
8. Penetration, approach, missed approach, landing patterns, altitudes, and obstructions at both destination and alternate airfields

Pilot's Duties

The pilot is responsible for the aircraft and for the successful accomplishment of the mission as prescribed by appropriate command directives. In no istance will the safety of the aircraft or crew be compromised.

Navigator's Duties

The navigator will insure that sufficient mission preparation is carried out in accordance with command directives to complete the mission successfully. During all phases of flight, the navigator will ensure that all required equipment is operating correctly for the task being performed and will continuously monitor the aircraft position. During operations with malfunctioning equipment, or in emergency situations, the navigator shall respond with the required corrective actions and checklists. During critical phases of flight, the navigator will monitor aircraft configuration, terrain clearance, and flight to ensure the immediate recognition of a dangerous condition. The pilot will be advised immediately of any impeding situation or condition which would compromise safety of aircraft.

AVIONIC SYSTEM OPERATION

Mainly the navigator's duties are discussed in the following text. A rigid distinction between navigator's and pilot's duties cannot always be made, e.g. in operations with RPMD and working stores. Although the workload may be shared between the pilot and navigator, the required actions will appear under the navigator's part.
Operation of the avionic system is divided into mission preparation procedures and enroute procedures. Mission preparation procedures include the insertion of mission (and map) data into the MC and sensor alignment. Enroute procedures consist primarily of navigation mode monitoring, steering mode selection and navigation updating and weapon aiming.

OFP LOAD CHECK

The OFP is loaded from an external tape reader or via RDE facility of the CVR.

CRPMD – OFF

To confirm OFP has been loaded, DATA keyboard with AGT on TV/TAB shall be selected. The OFP configuration (Software standard) loaded is displayed as a read-out on the TV/TAB.

MISSION DATA INSERTION

Under normal configurations, the flight crew will be briefed for a mission for which route points, weapons, targets to be attacked, etc. have been preplanned.
Mission data (Figure 4-98) are to be stored in the MC to fulfil navigation and attack capability. They will be prepared and loaded into the MC (Figure 4-33) by one of the following methods:

- Rapid Data Entry (RDE)
- Manual data insertion using a TV/TAB

RAPID DATA ENTRY

To insert data via CVR, obtain a cassette prerecorded with the relevant mission (and map) data and proceed as follows:

RDE/MDE:

Master switch – OFF
Mode selector – REPLAY
Cassette – Insert
Tape position readout – Check 000
Master switch – STBY
Tape drive switch – REV until TAPE POS stops
Mode selector – DATA ENTRY
Master switch – START until TV/TAB displays RDE COMPLETE, FAULT or FAILED, then STBY
TV/TAB – NAV/PLAN

MCCP Program Fail

If the FAIL lamp on the MCCP illuminates during loading, then the tape should be run in reverse until the tape position indicator stops counting and the FAIL lamp is extinguished.

NOTE

With RDE cassettes prepared by a Cassette Preparation Ground Station (CPGS), "RDE FAULT" and a "/" may appear on the TV/TAB.

If TV/TAB indicates RDE FAULT:
TV/TAB – Fault line in ROL, amend and ENTER

If TV/TAB indicates RDE FAILED:
CVR – Repeat RDE or manually amend

If MCCP FAIL or CWP CMPTR caption lit:
CVR master switch – STBY
MC – Recycle, if required

If the FAIL lamp illuminates again when the tape drive is resumed, the recorder should be switched to STBY and the cassette re-inserted or changed.

CVR – Repeat RDE (new cassette or enter manually)

TYPICAL MISSION DATA

```
TRAINING MISSION 06/06/83 TEST CHART ROUTE
/DEST
1        48D19.12N    011D56.35E    +01515  FT    340    ----K
2        48D19.53N    011D57.90E    +01492  FT    340    0420 K
3        48D19.27N    011D56.07E    +01512  FT    340    ----K
A        48D25.70N    011D35.18E    ------  FT    ---    0420 K
B        48D32.72N    010D51.65E    ------  FT    ---    0420 K
C        48D55.76N    018D19.74E    ------  FT    ---    0420 K
D        48D16.36N    009D43.55E    ------  FT    ---    0420 K
E        48D06.24N    010D29.08E    ------  FT    ---    0420 K
F        47D54.23N    010D55.28E    ------  FT    ---    0420 K
X        47D51.79N    011D29.07E    +00567  FT    ---    0420 K
X2=      03547N       00567W        +00587  FT    ---    ----K
G        48D05.62N    012D12.03E    ------  FT    ---    0420 K
H        48D33.71N    012D13.08E    ------  FT    ---    0420 K
Y        49D02.45N    011D55.29E    +01276  FT    ---    0420 K
Y1V      00897N       01564W        +01123  FT    ---    ----K
Y2R      01452N       01956W        +01356  FT    ---    ----K
J        48D41.69N    010D54.20E    ------  FT    ---    0420 K
4        48D32.98N    011D26.01E    ------  FT    ---    0420 K
5T       47D59.51N    010D15.00E     119X 001     5W     ----K
6 =      47D48.12N    011D01.54E    +03081  FT    235    0420 K
/RTE
2ABCDEFXGHYJ2-123456-
/TOT
X   15.59.82
Y   16.05.40
/K
LW       P+2.3        R+0.7         Y-3.1         0000
LF       P-0.7        R-0.3         Y+0.4         0000
RF       P-0.2        R-0.2         Y-0.1         0000
RW       P-0.3        R-0.7         Y+0.7         0000
/ALT
+03420 FT             +12000 FT
/MAP
REF NO   5354          02
S1       04845.104   +0.000
S2       08265.081   +0.000
S3       09975.037   +0.000
M1       43D00N   37D00N   019D00E   000D00E   600   00047.503
M2       49D00N   43D00N   016D00E   005D00W   600   00474.983
M3       55D00N   49D00N   014D00E   011D00W   600   00950.003
M4       42D00N   38D00N   019D00E   006D00E   540   01425.044
M5       45D00N   42D00N   016D00E   006D00E   540   05225.003
M6       47D00N   45D00N   014D00E   006D00E   540   07124.996
M7       50D00N   47D00N   013D00E   006D00E   540   08549.981
M8       56D00N   50D00N   011D00E   006D00E   540   10449.932
M9       55D00N   49D00N   002D00E   011D00W   500   12349.953
M10      60D00N   55D00N   000D00E   009D00W   650   13299.942
/GRID
48D45.00N             010D00.00E          015
/INT
A01      48D47.00N    008D05.00E
A02      48D22.00N    007D50.00E
A03      47D54.00N    007D37.00E
B04      48D02.46N    011D27.65E
B05      48D02.46N    011D27.65E
/+
```

Figure 4-98

If TV/TAB indicates RDE COMPLETE:

CVR cassette – Check loaded
Mode selector – MAN or AUTO
Master switch – STBY or ON

The CVR tape position reading can then be noted as the beginning of the recorded flight log.

MANUAL DATA ENTRY

Map Film Data

TV/TAB – PLN, DATA, SYN
Select alphanumeric key
Key-in film and map data
ENTER
Toggle after each line

Mission Data

TV/TAB, CRP.MD – Enter system time, manual data entry if required, check mission data.

Each line of navigation information from the mission data is selected for display in the ROL on the TV/TAB (Figure 4-99).

When one or all of the appropriate characters of a particular ROL have been inserted, the data are entered into the MC via the ENTER key (Figure 4-100).

Present Position Data (PP)

The following procedure allows the navigator to enter or modify position coordinate data of the aircraft parking spot. These data shall be available in the MC for SAHR alignment and operation.
When WPT with PP coordinates loaded:

TV/TAB – NAV/WPT
Toggle to WPT corresponding to PP
W – Z
Toggle writing marker over WPT designator
PP (O), ENTER

NOTE

Present Position data should not be inserted using TV/TAB prior to NAV MODE (MC) selection.

When no WPT with PP coordinates loaded:

TV/TAB – NAV, WPT, W – Z
Toggle writing marker over WPT designator
PP, 0 – 9
Key-in desired data
ENTER

NOTE

Present Position data display cannot be called up on TV/TAB prior to NAV MODE (MC) selection.

Destination Data (DEST)

Insert data as follows:

TV/TAB – PLN, DEST, WPT/FXPT/TGT
Toggle to required designator
UTM, if required
0 – 9
Key-in desired data
ENTER

Destination Data via Range/Bearing (R/B)

Insert data as follows:

TV/TAB – PLN, DEST, WPT/FXPT/TGT, R/B
Toggle to referred destination
Select alphanumeric key
PP symbol overwrite with referred destination
Toggle writing marker to referred destination
Change alphanumeric from referred to required destination
0 – 9
Key-in range and bearing
ENTER

NOTE

For R/B insertion presentation, north will be counted as 000°, 360° is not accepted.

READOUT LINES

WPT	A 00° 00 · 00 N 000° 00 · 00 E + - - - - - FT - - - - - - - - - - K When height, ground speed and/or range and bearing is initially inserted, each dash of the relevant figure visible must be overwritten with a digit. Single digit changes may be made without the need to change the whole read-out line B 50° 42 · 40 S 115° 32 · 01 W + 456 FT 12.47.55 500 K
FXPT ALL SENSORS	1 □ ——— ——— ——— ——— ———
TACAN FIXPT	3 T ——— ——— 101X000.9W
TGT	Y ——— ——— + 140 FT 13.40.50 420 K
MVT	Z ——— ——— 014°/20 ——— ———
WS	U ——— ——— + - - - - - FT ——— - - - - K
INT	C07 ——— ———
OFS R/B	Y1R 00000 N 00000 E + - - - - - FT Y1R 50192 N 31656 E + 100 FT Y1R ◄◄ X032° 20/ 9.762 NM + 100 FT
R/B	G ◄◄ B 275° 40/130 · 062 NM ——— ——— ———
UTM	D 32V MP 85403246 ——— ——— ———
SLDE	B 50° 42 · 40 S 115° 32 · 01 W + 456 FT 237 500 K
NAV ERROR	ERR V ◄ 0 · 53 NM ↓ 0 · 71 NM + ——— A
RTE	O→[ ] - - O→[D] ABCDE1XF – 123 –
POS	O→[T] 51° 30 · 40 N 002° 20 · 10 E AT 17.21.39 A+15250FT
MKR*	⁜→[T] ——— ——— ———
MAP* SLEW	+→[T] ——— ——— ———
MAP SLEW / MKR SLEW	In this case P is the first unused WPT in the NAV Computer. If an unused WPT is not available, writing MKR is blank and a DEST must be manually inserted T→[P] ——— ——— ——— ** P ——— ——— + - - - - - FT - - - - - - - - - K ***
GRID	GRD ——— ——— 9 NM
DTG	O→[F] 50 KG/M 2130 KG 270° 284 NM OH43
TOT	TOT X 07.20.10
W/V	270/ 37
K	LW P+2 · 4 R+0 · 7 Y+1 · 2
SYN****	MAP GSGS5314 TOR FILM AB-E1
ALT	ALT +0342FT + 12000FT
TIME	15. 21. 32

□ = CHARACTER CONTRAST INVERTED
* = AFTER INSERTION VIA NHC
** = READOUT LINE AFFECTED BY ENTER ACTION
*** = READOUT LINE AFFECTED BY DOUBLE ACCEPT
——— = REPEATING LINE ABOVE
**** = BY USE OF TOGGLE

Figure 4-99

PROGRAM INSERT KEYBOARDS (TYPICAL)

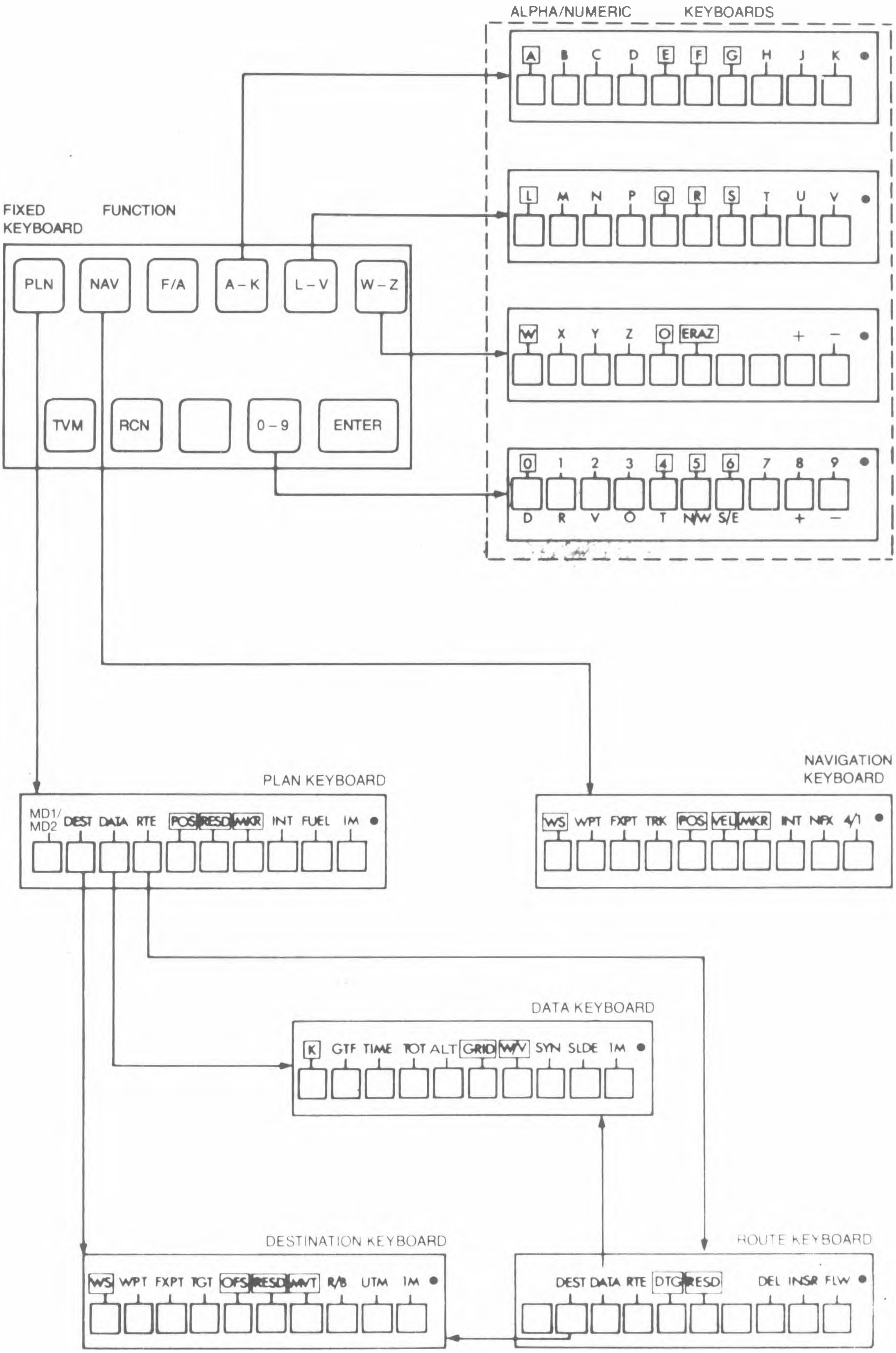


Figure 4-100

Offset Data (OFS)

Insert data as follows:

If offset data in northings/eastings:
TV/TAB – PLN, DEST, OFS
Toggle to required OFS and TGT designator
0 – 9
Change OFS type symbol (if required)
Key-in feet northings/eastings, height ft
ENTER

NOTE

- Maximum value to enter in northings and eastings are 64999 ft.
- The MC may not accept the full numerical value and will round-up to the last significant bit.

If offset data in range and bearing from the TGT:

TV/TAB – PLN, DEST, OFS R/B
Toggle to required OFS and TGT designator
0 – 9
Change OFS type symbol (if required)
Key-in range/bearing, height ft
ENTER

Intelligence Points (INT)

Insert as follows:

TV/TAB – PLN/NAV, INT
Toggle to required designator
A – K
Key-in prefix (A/B/C)
0 – 9
Key-in latitude and longitude
ENTER

Slide Data

Slide enable/cancel:
1. TV/TAB – PLN, DATA, SLDE

Slide display:

1. TV/TAB – PLN, DEST, WPT/FXPT/TGT
   Toggle to required designator
   NFX, F/A
2. CRPMD – Scale 4, STB

NOTE

For cancellation of slide data insertion, press SLDE key again.

Wind Data

Insert as follows:

TV/TAB – PLN, DATA, W/V, 0 – 9
Key-in wind direction and speed
ENTER

Route Data

When route data are not present in MC, insert as follows:

TV/TAB – PLN, MD1/MD2 as required, RTE
Toggle writing marker in front of – –
INSR (press number of destination less one)
Select alphanumeric key
Key-in route
De-select alphanumeric key
INSR (press number of fixpoints less one)
Select alphanumeric key
Key-in fixing route
ENTER

When route data are present in MC:

TV/TAB – PLN, MD1/MD2 as required, RTE
Toggle writing marker over first character of route change
INSR/DEL as required
Alter route data as required
ENTER

NOTE

Pressing ENTER on TV/TAB, with RTE displayed will delete the previously inserted TOT.

Grid Data

The method of calculating grid data is as follows:

- Determine the route centre (latitude/longitude) by drawing or calculation.
- Measure the distance (NM) between the East and West extremities of the route.
- Measure the distance (NM) between North and South extremities of the route.
- The useful area of the TV/TAB screen is approximately 15 x 10 cm, and the scale is entered in the MC as NM/display cm.
- Calculate the scale determining the greater value of East/West NM divided by 15, and North/South NM devided by 10.

The grid data held in the MC are displayed on the TV/TAB and may be corrected and entered when the following keyboard pushbuttons are pressed in the sequence shown:

TV/TAB – PLN, MD1/MD2 as required DATA, GRID, 0 – 9
  Key-in route centre coordinates and scale
  ENTER

DATA INSERTION USING MAP SLEW OR COMPUTER MARKER FACILITIES

In addition to the data insertion via TV/TAB MFKs and RDE, data may be inserted by means of the RPMD/CRPMD slew or MKR facility. Only plan position of waypoints can be inserted by this method. Change of destination designator and additional information, e.g. height and GS, have to be inserted again via TV/TAB MFKs.

RPMD Map Slew (Pilot and Navigator)

Insertion of coordinates using the RPMD map slew facility is carried out as follows:

1. NMCP – NAV mode selected
2. RPMD Mode – SL
3. PHC – Slew feature to display centre. Insert
4. TV/TAB – NAV, WS
   Toggle to T
   Relabel destination
   ENTER

CRPMD Map Slew (Navigator)

Insertion of coordinates using the CRPMD map slew facility is carried out as follows:

Pre NAV mode selection:
1. TV/TAB – Destination displayed in ROL

Post NAV mode selection:
1. TV/TAB – ROL as required
2. NMCP – MAP SLEW, caption lit
3. NHC – Slew feature to display centre. Insert
4. TV/TAB – Relabel if required
   ENTER (twice for automatic relabellig)
5. NMCP – Deselect MAP SLEW, caption out

CRPMD Computer Marker (Navigator)

Insertion of coordinates using the CRPMD computer marker is carried out as follows:

1. NMCP – NAV mode selected
2. TV/TAB – MKR
3. NHC – Slew marker to feature. Insert
4. TV/TAB – Relabel if required
   ENTER (twice for automatic relabelling)

Data Insertion via Store PP (Pilot and Navigator)

1. PWAMS – Store PP
2. TV/TAB – NAV, WS, check U/V/W
   Relabel if required
   ENTER

or

1. TV/TAB – POS
   Relabel if required
   ENTER

System Time Adjustement

The navigator can modify previous or existing system time to suit any desired reference time by the following actions:

1. TV/TAB – PLN, MD1/MD2 as required DATA, TIME, 0 – 9
   Key-in system time
   ENTER

BAA Update

1. TV/TAB – POS, 0 – 9
   Key-in actual alt
   ENTER

Time Early/Late

1. TV/TAB – PLN, MD1/MD2 as required RTE, ENTER
   Planned G/S entered against all route DEST
   Confirm no DEST entered twice before TOT destination
      Enter system time
      PLN, DATA, TOT
      Toggle to required TOT destination
      0 – 9
      Key-in TOT
      ENTER

NOTE

- If MAN-HOLD or NMCP is selected, TEL gives count-down to take-off time.
- If AUTO-STEER is selected, TEL readout is valid when airborne.
- Pressing ENTER on the TV/TAB with RTE displayed will delete the previously inserted TOT.

MISSION DATA CHECK

NOTE

All destination data should be checked in digit form on the TV/TAB and the position itself on the CRPMD. NAV MODE selection on NMCP is not necessary in this case.

CRPMD – M+S, scale as required, NRM or NTH up

To check read-out line and map position:

TV/TAB – WPT/FXPT/TGT/OFS as required. Shift to required destination. Check ROL values
NMCP – MAP SLEW
CRPMD – Check position of DEST on map

Map Slew

To check map position only (route shall already be inserted):

1. TV/TAB – PLN, MD1/MD2 as required, RTE
   Toggle to first destination
2. NMCP – MAP SLEW, caption lit
3. TV/TAB – Toggle through AFP
4. CRPMD – Check map position at screen centre
5. NMCP – Deselect MAP SLEW, caption out

Route Follow

1. TV/TAB – PLN, MD1/MD2 as required, RTE
   Toggle to first destination, FLW
2. NMCP – MAP SLEW, caption lit
3. NHC – Push
   Move forward MKR on TV/TAB Plan format and map on CRPMD moves back oriented along route
4. CRPMD – Check steering route, follow at screen centre
5. NMCP – Deselect MAP SLEW, caption out

GTF Format

1. TV/TAB – PLN, DATA, GTF, L–V
   Key-in T,S,T
   ENTER, wait for 5 sec
   Check EQM format for contrast inverted readouts

If IFM/SSD replay required:

2. TV/TAB – IFM/SSD, PGE
   Check IFM/SSD for contrast inverted readouts

To revert to basic OFP format:

3. TV/TAB – RTN (regain EQM format)
   OFP
   Press twice

SET-UP, ALIGNMENT AND TEST OF SENSOR AND DISPLAYS

This part describes the set-up, alignment and test procedures used to operate the navigation system. In addition to information already covered in this section, operational aspects of the system are briefly described and special considerations are provided to assist in the employment of each mode.

Before the full navigation system capabilities can be realized, the sensors and displays shall be run-up to their operating state, checked and aligned. The time to complete the run-up is commensurate with the alignment accuracy required, the aircraft state of readiness and the pre-sortie period available for the system to reach an operational condition. To contend with these conditions, several methods of set-up, alignment and test are made available for the principal navigation equipment.

The following depicts sequencing and approximate timing for setting up, align and testing the different systems:

COMPUTER ENGAGEMENT

1. TV/TAB 1 and 2 – ON
2. MCCP:
   IFU 1 and 2 – Both ON
   WFG – ON
   MC – ON

Check CWP whether MC and IFU1 warnings are out. Check left TV/TAB goes blank and right TV/TAB displays SW load (T-P-SW-X108-01-P) in ROL.
Running system time displayed on the RH corner of the TV/TAB is an additional check for an operating computer.
In case of TV/TAB remaining dark or display is disturbed in any format, recycling of TV/TAB, WFG or both may solve the problem.

SAHR SYSTEM ALIGNMENT

MC shall be on to provide the SAHR with accurate compensation terms.

SAHR
1. MODE – FREE, check 8888
2. Variation – Set

NOTE

For shelter operation, SAHR may fail and require realignment outside.

To obtain a valid TRUE HDG on the SAHR control panel, the correct local variation has to be set.

3. SAHR heading – Check, if FES caption out, slew to IN heading

After alignment is completed, availability of AD+SR and, with DOPPLER engaged, DP+SR mode is indicated on the NMCP.

NOTE

In flight the COMP mode shall be used with caution. Deviations of ± 2° in straight and level and ± 20° in turns are possible.

IN SYSTEM SET UP AND ALIGNMENT

Normal Alignment

Gyrocompass alignment is provided as the normal method for aligning the system.

INCDU
1. D31/D32 – OFF
2. ALIGN – NORM
3. Mode – IPI
4. STATUS – 7/blank
5. DIS – HDG/DR, check heading, ENTER if required. PP, enter lat/long
6. Mode – ALN
7. DIS – D31/D32, insert as required
8. LH STATUS – 0
9. Mode – NAV

Rapid Inertial Alignment

This procedure shall not be used within 10 min after RPD HTR was applied (Figure 4-101).

INCDU
1. D31/D32 – OFF
2. ALIGN – RPD
3. Mode – STBY, STBY light steady, IPI
4. STATUS – 7/blank
5. DIS – HDR/DR, check heading, enter if required. PP, enter lat/long
6. Mode – ALN
7. LH STATUS – 4 to 0
8. Mode – NAV (RPD HTR light on for about 2 minutes)

IN RPD ALN TEMPERATURE

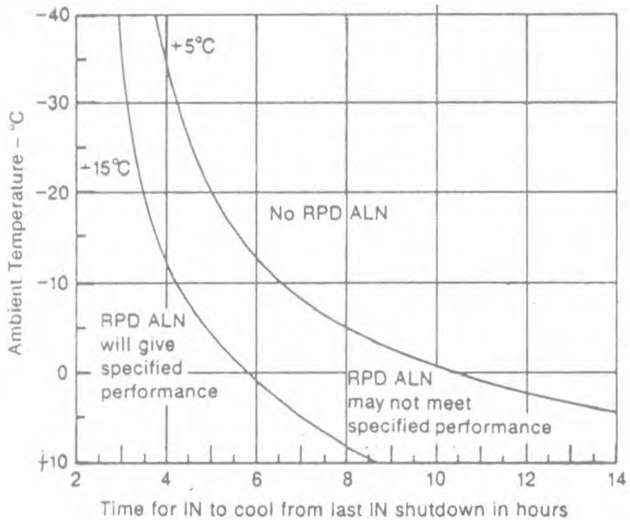


Figure 4-101

NOTE

Do not RPD ALN if:
- STBY light flashes
- STATUS indicator flashes
- RPD HTR is applied within last 10 minutes.

Memorized Heading Alignment

Memorized heading alignment can only be carried out successfully if the aircraft has not been moved since the IN was switched off.

INCDU
1. D31/D32 – OFF
2. ALIGN – MEM HDG
3. Mode – IPI
4. STATUS – 7/blank
5. DIS – HDR/DR, check heading. PP, enter lat/long
6. Mode – ALN
7. LH STATUS – 0
8. Mode – NAV

Rapid HUD Alignment

The measurement phase is carried out on completion of a flight or at any convenient time prior to the next flight.
Measurement of unsurveyed object:

If IN running:
1. INCDU:
   DIS – PP, check position, FIX if required
   ALIGN – HUD MEAS
   Mode – ALN
   LH STATUS – 4 to 0, inform pilot
   DIS – ALN BRG

If IN off:
1. INCDU:
   D31/D32 – OFF
   ALIGN – HUD MEAS
   Mode – IPI
   STATUS – 7/blank
   DIS – HDG/DR, check heading, enter if required. PP, enter lat/long
   Mode – ALN
   LH STATUS – 4 to 0, inform pilot
   DIS – ALN BRG
2. HUD mode – AUTO
3. PHC – Slew to defined object
4. INCDU:
   NAV display – Note stored bearing
   Mode – OFF

The aircraft is returned to the predetermined point on the airfield and positioned with the same object in the HUD field of view.

Alignment:
1. INCDU:
   D31/D32 – OFF
   ALIGN – RPD HUD
   Mode – IPI
   STATUS – 7/blank
   DIS – HDG/DR check heading, enter if required. PP confirm position
   Mode – ALN
   DIS – ALN BRG, confirm prestored bearing or enter known true bearing
   LH STATUS – 0, inform pilot
2. HUD mode – AUTO
3. PHC – Slew to defined object
4. INCDU:
   LH STATUS – 0
   Mode – NAV

CRPMD/RPMD AND GMR SET UP AND TEST

The GMR and the CRPMD/RPMD are prepared for use and tested as follows:

CRPMD Set Up

Continue:

CRPMD:
1. MODE – M, INT after 5 seconds
2. Display – NRM
3. IND, MKR, MAP – Set
4. CURS – OFF
5. FRZ/INT HOLD – FADE
6. S-S/CONT INV – S-S
7. FADE – As required
8. SCALE – 20/40/80

Range rings and scale may be set as required.

CRPMD Test

1. CRPMD TEST – MAP, PL1 and PL2 lights on. Observe PP marker at display centre and track line at 135°/315° about that centre (Figure 4-102).

2. NHC – Cursor/marker switch up, 90 sec after M selection align test frame, insert. Align projected Map Test frame with ARD generated Map Test format as required. Press Insert button when correclty aligned. The difference between the Map Test Format shown in Figure 4-102 and the ADR generated Map Test Format is that the 135° track line extends to the edge of the frame.

3. CRPMD TEST – MKR, PL1 and PL2 lights out. MKR test format correct (Figure 4-13), adjust THRESHOLD, OFF (to deselect test format). Check the electronically generated symbology and the 8 grey shades of video pattern which varies from darkest shade at the top of screen to lightest at the vertex. Adjust with THRESHOLD control on the MRCP. The in-use projection lamp is extinguished, and map-drive inhibited.

RPMD Test Alignment (Pilot)

1. RPMD:
   Mode – T, align display, insert
   PL Test – PL1 and PL2 lights on

CRPMD MAP TEST FORMAT

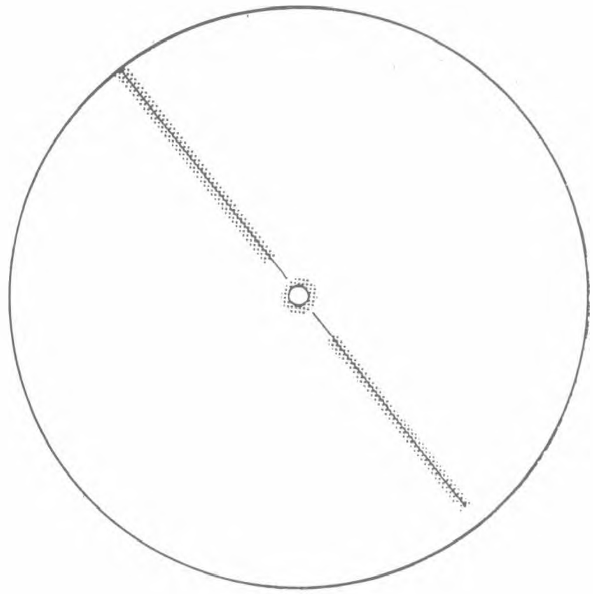


Figure 4-102

CRPMD/RPMD Check (Pilot/Navigator)

1. CRPMD/RPMD – Functional cross-check

The cross check includes the following checks:

RPMD – R
CRPMD – STB, map does not move, passive MKR at centre
RPMD – STB light on, no change of display
CRPMD – NTH UP, map north orientated, check PP and track-line
RPMD – NTH light on, map north oritentated. SL, check function PP, check PP moves to marker. Check all SCALES. PP, check PP moves to marker
CRPMD – NRM, map track orientated, PP at bottom display

MRCP Set Up

MRCP – Set as required

Except:
Frequency – FIXED FREQ
TEST/NO GO – Lamp extinguished
DIM – Lamp extinguished

MRI – Lamp extinguished
AUTO/MAN – AUTO
STC – 5
THRESHOLD – As set during MKR test
IF GAIN – Fully forward
ELEV TILT – Mid-position
SCAN Speed – FAST
Receiver Gain – LIN
Pulse Width – LONG
Beam Shape – PENCIL
SCAN WIDTH – 5

GMR Test

After 3 min warm up:

1. MRCP – TEST, light out after 1 minute, NO GO out (CWP GMR captions out)

NOTE

After TEST selection, CWP GMR warning is illuminated for approx. 2 sec.

GMR/CRPMD Taxi Checks

1. CRPMD:
   MODE – Deselect INT (in safe area)
   GMR – Functional test then M + S and INT
   The functional test includes the following checks:
   BRT – Turn clockwise until a raster line is just visible in the ambient lighting condition
   CURS – On
2. NHC:
   Enable – Lower position. Check cursor movement change of readouts (RANGE and ACROSS TRACK)
   Enable – Upper position
3. CRPMD:
   CURS – OFF, clear of readouts (RANGE and ACROSS TRACK)
   SCALE – Select all scales in turn, confirming that PP remains constant, and leave at 40 to ensure that a good display will be seen at the next selection
   RANGE RINGS – 5 + 10, check concentric about PP
   B SCN – Press, range rings displayed as horizontal lines. Deselect, range rings concentric about PP
   RANGE RINGS – OFF
   STB – Press, map stabilized about centre of display marker by passive MKR. Track line coincident with Y axis
   NRM – Press, PP moves to bottom of display, map is track orientated
4. MRCP – Check all controls and leave in FIXED FREQ

DOPPLER TEST

When the aircraft on ground, the Doppler is always in TEST mode when switched on.

1. DOPPER – ON, check test velocities
   SEA/LAND as required
   Check TEST deselected

After takeoff, check range of test values to active data. If test is required in flight, press TEST button (Figure 4-28).

RADAR ALT TEST

1. RAD ALT – Set bug 50 ft, PRESS TO TEST, check 100 ± 10 ft, cross-check HUD, and low height warnings.

ESRRD TEST

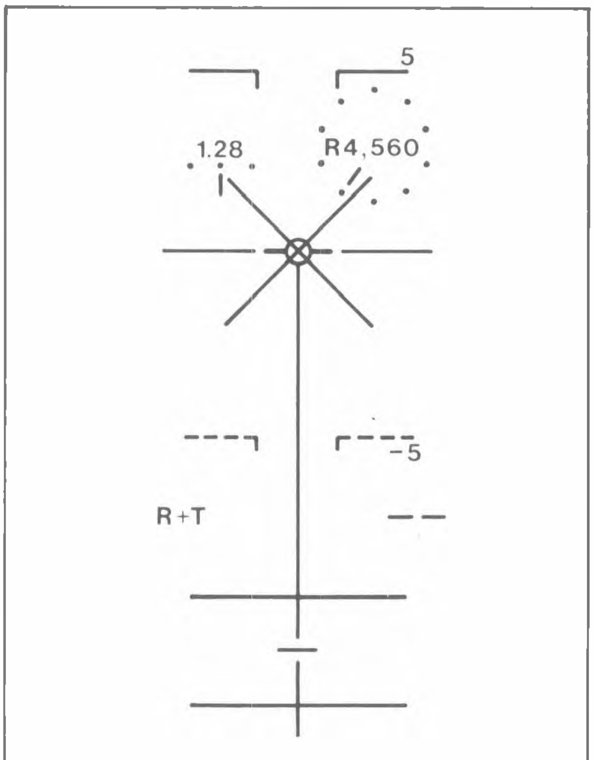
1. ESRRD
   – MODE – TEST
   – TFR – NORM
   After a warm-up time of approx. 90 seconds:
   – Check test format (Figure 4-17), select ES or CR as required

In addition to the ESRRD test format, the ESRRD repeats the CRPMD MRK TEST display when the MODE selector is set to RPTR, and the TF TEST format when ES/CR is selected. Gain and brightness should be checked.

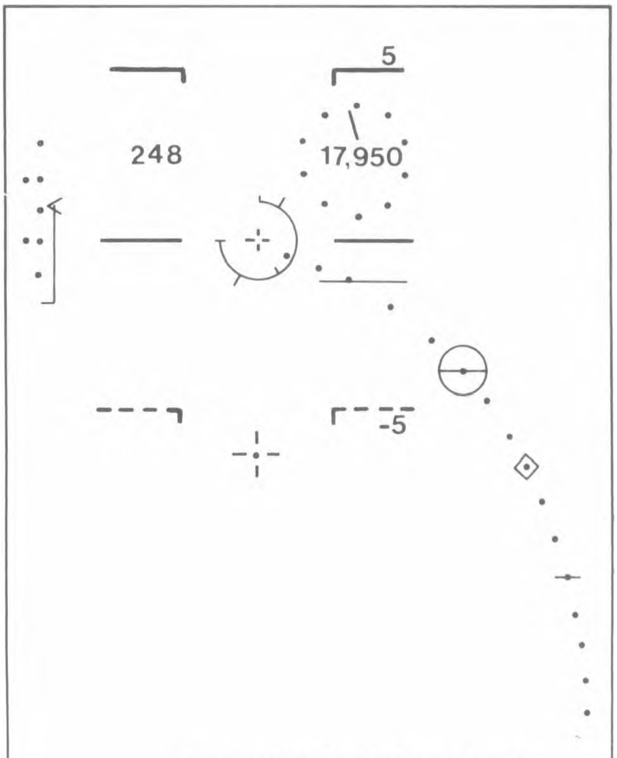
HUD SET UP

Select the HUD MODE to DIR and allow 30 seconds warm-up; thereafter set up the HUD control panel as follows: VV, KCAS, MAG; SBS to OFF. Adjust the display brightness as required. With the MODE switch set to T2, the Attack Test Format Bombs (1, Figure 4-103) is displayed; if TRUE is

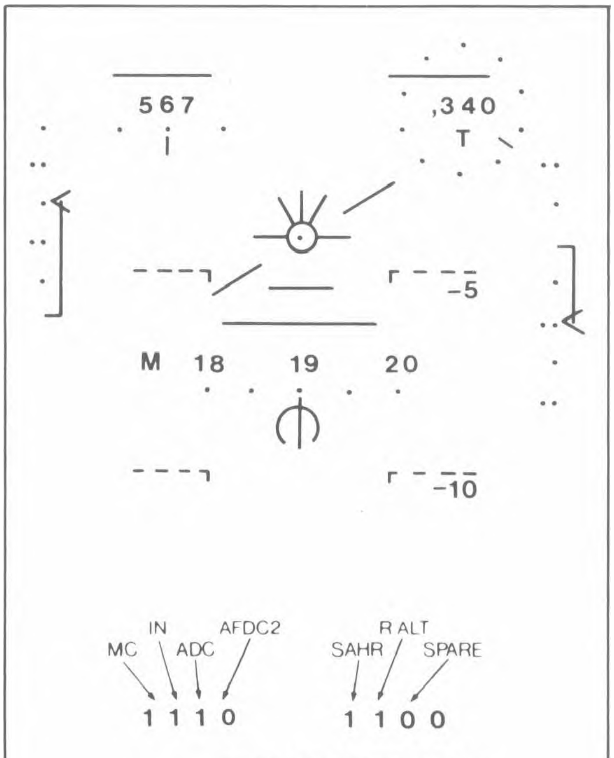
HUD TEST FORMATS



1 ATTACK TEST FORMAT (BOMBS)
MODE T2, MAG SELECTED



2 ATTACK TEST FORMAT (GUN/ROCKET)
MODE T2, TRUE SELECTED



3 NAVIGATION TEST FORMAT
MODE T1 (EXAMPLE)

NOTE

Digits may differ and will depend on good (1) or invalid (0) input channel status

Figure 4-103

selected, the Attack Test Format Guns/Rockets (2, Figure 4-103) can be viewed. Select the MODE switch to T1 to display the Navigation Test Format (3, Figure 4-103). When terminated, select AUTO and dial in the existing QNH setting.

1. HUD – Check test formats (Figure 4-103) and SBS, select AUTO and modes as required, camera as required.

HUD SENSORS

The following sensors provide heading and attitude references for various HUD modes:

- DIRECT: SAHR (True/Mag), IN
- AUTO: MC (True/Mag), IN
- NAV: MC (True/Mag), IN

HSI TEST

To accomplish this test (Figure 4-104), set the servo-pneumatic altimeter to 1013 mb and go to RESET mode. Select the HSI MODE switch to the desired positions, press TEST and observe the display according to the HSI Test table. Deselect TEST when terminated. For HSI/BDHI heading source refer to Figure 4-105.

1. HSI modes – TEST, check altimeter 1250 ft, select TAC, deselect TEST

TFR SET UP AND TEST

Allow 3 minutes for the equipment to warm up:

1. TF RADAR – STBY, FIXED FREQ
2. TF RADAR – Press TEST, NO GO light out, check ESRRD display, deselect TEST, B-RISK light out

NOTE

- If IN is not aligned (e.g. when status 4 not indicated), TFR/CWP warning will illuminate till the end of test cycle. A TFR/CWP caption together with a NO GO signifies a genuine failure.
- To repeat a TFR TEST on ground, a pause of 10 sec shall be made (after the white TEST caption on the TFR CP is extinguished), before initiating a new interruptive BITE.

The TEST format is generated for a zero ft/sec ground speed and 350 ft altitude. If CR is selected, the zero command line, test pulse, CRAM line and range scale are displayed (Figure 4-21).
If ES is selected, only the zero command line is displayed.
If the TEST light remains out when pressed, press again. Illumination of the TEST light indicates start of the BITE accompained by a NO GO light, which occults after 3 to 5 sec. 2 sec after TEST is lit, press TEST again to reset the system. The test cycle will continue and the BITE be terminated after 10 sec. The test mode will be extended by another 30 sec failure reporting time in case of NO GO lit.

NAVIGATION MODING AND STEERING

NAVIGATION MODE SELECTION

When sensor warm-up times and alignment status permit any particular mode to be used, the upper half of the relevant pushbutton on the NMCP is illuminated white.

NMCP
NAV MODE – All available, select MAIN

If once a mode other than MAIN has been selected first, MAIN mode can only selected after MC restart.

STEERING MODE SET UP

With MC switch on and NAV MODE selection the FLT PLN/MAN and STEER/HOLD lights illuminate.

STEERING MODE SELECTION

1. NMCP
   Steering – As required

HSI TEST

HSI MODE SWITCH	NAV	TAC	DF	APP I
MODE FLAG DISPLAY FAIL FLAG GLIDE FLAG AZ-FLAG TO-FROM FLAG	NAV In View In View In View From	TAC In View In View Retracted Retracted	ADF In View In View Refracted Retracted	APP In View In View In View Retracted
RANGE DISPLAY	Blank	Blank	8888 (with TAC on)	Blank
LATERAL DEV. BAR EL DEV. BAR	1/4 Right 1/2 UP	0 1/2 UP	0 1/2 UP	0 0
COMPASS CARD ACTUAL TRACK POINTER DMD TRACK POINTER AND COUNTER	045 ± 1 045 ± 1 045 ± 1	HDG (M) HDG (M) (lubber) 045 ± 1	HDG (M) HDG (M) (lubber) (lubber)	HDG (M) HDG (M) (lubber) MAN SET

Figure 4-104

HSI/BDHI HEADING REFERENCE SOURCES

HSI MODE	SENSOR (HEADING)	
	HSI	BDHI
NAV	MC (True) (IN only when MC failed) (True)	SAHR (Mag)
TAC	SAHR (Mag)	SAHR (Mag)
APP 1	SAHR (Mag)	SAHR (Mag)
ADF	SAHR (Mag)	SAHR (Mag)

NOTE

The Figure shows the sensors providing heading references for the variuos HSI mode and the BDHI.

Figure 4-105

AFP Steering

The following action can only be done as first steering selection after MC engagement with flight plan inserted:

1. NMCP – Press FLT PLN button, check AUTO-STEER on
2. TV/TABs – Check navigation data in Plan and Nav formats
3. HUD/HSI – Check navigation data

In all other cases proceed as follows:

1. TV/TAB – Call up 1st DEST out of RTE or overlay displayed RTE by writting MKR
2. NMCP – Check HOLD light on
3. Press STEER button
4. Press FLT PLN button, check AUTO-STEER light on
5. (P + N) – Recheck navigation data in both cockpit

MFP Steering

1. TV/TAB – Call up required DEST in ROL or overlay DEST in displayed RTE by writing MKR
2. NMCP – Press STEER button, check MAN-STEER lights on
3. (P + N) – Check navigation data

Prior to overflying the destination prepare next DEST. At the moment when the destination is overflown, the MAN-HOLD lights illuminates.

1. NMCP – Press STEER button, check MAN-STEER lights on
2. (P + N) – Recheck navigation data in both cockpits

Steering Mode Transitions

Examples of automatic and manually selected steering mode transitions are shown in Figure 4-37.

HOLD TO AFP

This mode conversion may be made once only following initial MC switch on (see AFP steering), and is carried out by pressing the FLT PLN pushbutton on the NMCP.

NOTE

If flight plan route data is not available, the operation has no effect and the FLT PLN and STEER pushbuttons will continue to display captions MAN and HOLD.

HOLD TO MFP

This mode conversion can be carried out at any stage of the flight.
To engage the MFP mode from the HOLD mode, the required destination shall be displayed on the read-out line of one TV/TAB or one destiantion out of the inserted RTE overlayed by writting MKR. The STEER pushbutton on the NMCP is then pressed.

AFP TO HOLD

The AFP mode is automatically deselected and the HOLD mode engaged when the last planned destination has been overflown.
The last command track is used continuously for steering reference in HOLD mode.
The conversion can be carried out manually, at any time, by pressing the FLT PLN pushbutton on the NMCP.

MFP TO HOLD

The MFP mode is automatically deselected and the HOLD mode selected when the required destination has been overflown.
The conversion can also be carried out manually when required by pressing the STEER pushbutton on the NMCP.

MFP TO AFP

The navigator may change from MFP to AFP mode if the next destination is one of the planned destinations (e.g. if the aircraft has purposely deviated from the planned route and is rejoining the route at a destination contained in the flight plan).
The mode conversion is carried out by pressing the FLT PLN pushbutton on the NMCP. If the next destination is not a planned destination, the pushbutton is inoperative.

1. TV/TAB – Confirm present DEST is part of inserted RTE
2. NMCP – Press FLT PLN, check AUTO-STEER light on

AFP TO MFP

1. TV/TAB – Check required DEST prepared
2. NMCP – Press FLT PLN, check MAN-HOLD lights on
3. Press STEER, check MAN-STEER lights on

Rapid Change of Destination

A new steering can be acquired quickly, if the new destination is part of the flight plan route, using the following procedure:

1. TV/TAB – PLN, RTE
2. Toggle writing marker over new destination (in AUTO-STEER not possible with already passed part of RTE)

If in AUTO-STEER:

3. NMCP – Press FLT PLN, STEER button, check MAN-STEER lights on
4. Press FLT PLN check AUTO-STEER lights on

If in MAN-STEER:

3 NMCP – Press STEER button, check MAN-HOLD lights on
4 Press STEER, check MAN-STEER lights on

NAVIGATION UPDATING

Navigation data can be updated by either fixing or correction of existing navigation data via TV/TAB.

PLANNED FIXING

Planned fixing is carried out onto prepared fixpoints of fixing routine only when AFP STEER mode is selected.

1. TV/TAB – Confirm next fixpoint

Phase 1

Radar required planned fixes can be either Phase 1 Stabilized or Phase 1 Marker.

2. STABILIZED:
   TV/TAB – F/A
   CRPMD – STB
   NWAMS – Sensor as required
   NHC – Slew marker to radar return. Insert

2 MARKER:
   CRPMD – NRM/LK AHD
   TV/TAB – F/A, MKR
   NWAMS – Sensor as required
   NHC – Slew marker to radar return on refresh and insert

The results of manual correction can be improved by use of GMR Lock-On facility.

If Lock-On required:

3. CRPMD – LCK ON
4. NWAMS – Press RDR ACPT, SEL illuminated

NWAMS Sensor Selection

In Phase 1 Stabilized and Phase 1 Marker for height measurement a height sensor is required. Besides RDR ALT selection or use of system height with BARO/IN selected, the GMR in HT FIND mode or TFR may be used.

If Height Find required:

1. CRPMD – STB, SCALE 20 or less
2. MRCP – PENCIL, AUTO
3. TV/TAB – Less than 20 NM to fixpoint
4. NHC – Slew marker to radar return. Insert
5. NWAMS – HT FIND, SEL illuminated
6. MRCP ELEV TILT – Overlay MKR with height line
7. NHC – Insert

If TF Elevation required:

1. TFR Mode – Confirm ON
2. NWAMS – TF ELEV, SEL illuminated, RDR ALT SEL light out below 2.5 NM

Continue with Phase 1/Phase 2 drill.

NOTE

RDR ALT is automatically selected below 5000 ft unless overridden by a manual selection.

Phase 2

Under VMC condition, results of Phase 1 fixing can be checked and if required improved by Phase 2 HUD fixing. This method can be used separately without any correction by the navigator following the FXPT and F/A selection.

2. TV/TAB – Confirm F/A
3. CRPMD – Deselect LCK ON as required

4. NWAMS – Sensor as required
5. PHC – Phase change. Align ranging reticle with fixpoint. Insert

NOTE

For Phase 2 fixing, GMR AGR mode can be used for height measurement.

If AGR required:
6. CRPMD/PHC panel (SS7) – AGR
7. NWAMS – RDR ACPT, SEL lit

OTF AND TACAN FIXING

OTF and TACAN fixing are two additional methods for updating the NAV/ATTACK system without use of GMR.

OTF

2. TV/TAB – Confirm F/A
3. NMCP – OTF
4. PWAMS – OTF lit

When overhead fixpoint:
5. PWAMS – STORE PP, OTF out

In addition, height can be updated by inserting via NHC when overhead FXPT, providing RA is operative and correct height of FXPT has been inserted before.

6. NHC – Insert, if height error required

TACAN Fixing

1. TACAN – Check correct station
2. TV/TAB – F/A
3. NMCP – TACAN

The result is displayed in the ROL together with an arrow, showing the direction of the fix correction, and an A for acceptable or R for doubtful correction.

Accept/Reject

1. TV/TAB – Check error line, PFX/HTFX as required
2. NMCP – Reject Phase 2 errors if required ACCEPT/REJECT
3. TV/TAB – NAV

If "R" is indicated:

Correction will change to contrast inversion after first press of ACCEPT, and full correction will be taken by the MC after second press of ACCEPT.

NOTE

Before selecting ACCEPT, pressing PFX allows only plan position update; pressing HTFX allows only height update.

UNPLANNED FIXING

Phase 1/Phase 2

For unplanned fixing in general all fixing methods described before can be performed after:

1. Insert fixpoint data if require (or overlay route point by writing marker as required)
2. On TV/TAB, with destination data in ROL, press NFX
3. Continue with Planned Fixing drills.

Radar Map Matching

With GMR available MAP Matching fix can be performed without any previous preparation.

1. TV/TAB – Not in F/A
2. CRPMD Mode – STB
3. TV/TAB – F/A
4. NHC – Slew map to align with radar image. Insert

Visual Map Matching

1. TV/TAB – Not in F/A
2. CRPMD – STB
3. TV/TAB – F/A
4. NHC – Slew map feature under radar origin (PP on CRPMD), and when coincident with identified ground feature, insert

OTF

1. TV/TAB – Not in F/A
2. NMCP – OTF
3. PWAMS – OTF lit
4. TV/TAB – F/A

When overhead fixpoint:
5. PWAMS – STORE PP, OTF out

If pilot inserting coordinates:

6. RPMD Mode – SL
7. PHC – Slew map feature under display centre. Insert

If navigator inserting coordinates:

6. NMCP – MAP SLEW
7. NHC – Slew map feature under display centre. Insert
8. RPMD/NMCP – Deselect slew function

Alternative OTF

1. TV/TAB – Not in F/A
2. NMCP – OTF
3. PWAMS – OTF lit

When overhead fixpoint:
4. PWAMS – STORE PP, OTF out
5. TV/TAB – Insert fixpoint data, NFX, F/A

TACAN Fix

1. TV/TAB – FXPT. Shift toggle to required FXPT NFX
2. TACAN – Check correct station
3. TV/TAB – F/A
4. NMCP – TACAN

Map Matching, TACAN, and unplanned OTF are two dimensional fixes. Unplanned height updating is possible only over open sea.

Height Fix Over Sea

1. TV/TAB – Not in F/A
2. NMCP – OTF
3. TV/TAB – F/A
4. NHC – Insert

Accept/Reject

1. TV/TAB – Check error line
2. NMCP – ACCEPT/REJECT
3. TV/TAB – NAV

INTEGRATED SYSTEM REVERSIONARY MODES

MC FAILURE

In the event of an MC failure, reversionary steering data are available from the IN for presentation to the HSI, HUD, ADI and INCDU. Using these displays, only manual steering is possible. MC failure also affects target acquisition, weapon aiming and release. Data, provided by the forward looking sensors and associated displays, are considerably degraded. A MC failure does not affect the availability of air data information.

INDICATIONS

F/C
- CWP – AP MON, TF MON (when TFR ON), AUTO P (if AP is engaged without RH or TF selected)
- AFDS – ATTD FAIL
- HSI – Range display occulted and display failure flag (in NAV mode)
- RPMD – Map fails
- PWAMS – All indications lost
- WCP2 – All indications lost
- HUD – Reverts to direct display
- ADI – Failure flag

R/C
- CWP – CMPTR, SAHR, AUTO P (if AP is engaged without RH or TF selected)
- TV/TAB – Display frozen
- CRPMD – Map fails
- NMCP – All indications lost
- WCP1 – CMPTR STATUS FAIL

ACTIONS

1. MCCP – Recycle MC

If recycle successful:

2. NMCP – MAIN
   Select steering
   Take a fix
   Double Accept

3. TV/TAB – Update TIME
   Re-enter TOT

NOTE

After MC recycle, check SAHR heading and slew to IN heading if necessary.

If recycle unsuccessful:

FACILITIES LOST

F/C
- RPMD – Map
- PWAMS
- PHC
- HUD – FD (if RH or TF not selected)

R/C
- TV/TAB
- NMCP
- NWAMS
- CRPMD – Map
- DOPPLER

FACILITIES DEGRADED

F/C
- HUD – Reverts to DIRECT (no Velocity/Attitude monitoring), no FD in TRACK mode
- HSI – NAV mode indications from IN data
- TFR – No cross-monitoring
- AFDS – No track acquire, auto-reversion to HDG HOLD if in RH or TF, no attitude monitoring
- ADI – No steering

R/C
- SAHR – COMP only
- GMR/CRPMD – NRM and LK AHD available only, with slant range video, range rings and cursors
- NHC – Radar cursor only
- WCP1 – REVN only
- HDDR – Manual only

REVERSIONARY ACTIONS

1. SAHR – COMP, update variation as required
2. INCDU – Navigation by D31/D32, update by FIX overhead fixpoint, check LH STATUS 9

If correction not required:
   FIX, LH STATUS blank

IFU-1 STATUS

Status	Facilities Lost	Facilities Degraded
10	IFU 1 – MC Link	As for status 11 and 12
11	PHC CSAS rate gyro	HUD: No stadiametric range No wings span control/display No wing sweep control TV/TAB: No fuel control display Air-to-Air attack with standby sight Visual attack with CCIP and manual release
12	PHC all select PWAMS lock-on reject SAHR – validity input to HSI	
13	ADC – validity input to HSI	Pilot's alt reverts to STBY HSI: No heading No actual track command track No cross track error
14	HSI heading	(TF/AFDS emergency disconnected in HDG ACQUIRE)
15	– actual track	
16	– command track	
18	DTG	
17	Baro – Alt Data	Pilot's alt revers to STBY
19	MC data	
1A	IN data	
1B	ADC data	Pilot's alt reverts to STBY
1C	TACAN data	

The STBY flag, on the pressure altimeter, will indicate degradation indicated by status 17 and 1B.

Figure 4-106

If correction required:
   Lat ENTER, Long ENTER, check LH STATUS blank

For Weapon Aiming (manual release only) refer to AER.1F-PA200-34.

IFU 1 FAILURE

For IFU1/IFU2 status refer to Figures 4-106/4-107.
INDICATIONS

WARNING

PRE MOD. 11029 IFU-1 BITE MAY PRODUCE FALSE FAILURE SIGNALS AT CRITICAL HEADINGS AND PRESSURE ALTITUDES (HSI FAIL FLAG AND AZIMUT, REVERSION SERVO ALTIMETER INTO STBY MODE).

CAUTION

THEREFORE UP TO 300 FEET UNSAFE HEIGHT MAY BE INDICATED TO THE PILOT WITHOUT ANY PREVIOUS WARNING BY THE STBY FLAG.

NOTE

This STBY flag may not be indicated if F/C and R/C altimeter differs by less than 300 feet.

R/C
CWP – IFU 1

ACTIONS

1. IFU 1 – Recycle

If unsuccessful:
2. Pressure Alt – STBY

NOTE

In flight phases when altitude is safety critical, the head down altimeter readings should be crossed-checked with alternate sources, e.g. HUD, RAD ALT, or R/C altimeter.

IFU 2 FAILURE

INDICATIONS

R/C
CWP – IFU 2

ACTIONS

1. IFU 2 – Recycle

IFU-2 STATUS

Status	Facilities Lost	Facilities Degraded
20	IFU 2 – MC link	As for status 22 and 23
21	NHC demand	
23	NHC all selections NWAMS NMCP MCP	
24	NWAMS NMCP	RWR: Height indication HDDR: No AUTO control

Figure 4-107

If unsuccessful:

CONSIDERATIONS

1. Navigation mode remains as selected, without indication. Subsequent system failures cause degraded modes to be selected automatically without indication.
2. Steering mode remains as selected, without indications. Auto steer changeover will occur in AFP.

For Weapon Aiming refer to AER.1F-PA200-34.

IN FAULT – NO IN CWP WARNING

INDICATIONS

Any combination of the following may indicate an undetected IN malfunction:

F/C
HUD – Velocity or Attitude Monitor trip
CWP – TF MON (when TFR ON), AUTO P (if AP engaged)
AFDS – ATTD FAIL

R/C
NMCP – Reversion to DP+SR without IN/CWP
TV/TAB – Flashing R with Doppler G/S correct MC PP rapidly diverging from actual PP
INCDU – Fault Status. False G/S

WARNING

IN DP + SR, HUD ACCURACY AND MONITORING ARE DEGRADED.

NOTE

The pilot should be informed when DP+SR mode has been selected or automatically reverted to.

ACTIONS

1. ECS – Confirm airflow, if failed RESET
2. INCDU, TV/TAB – Check IN validity
3. HUD – DIR, check IN-derived VSI, VV and climb/dive

If IN validity is good, and NMCP is in DP + SR:

4. NMCP – IN, but increase rate of IN monitoring

If IN malfunctioning is confirmed:

4. NMCP – DR + SR
5. HUD – AUTO/NAV
6. SAHR mode – Slave

If AFDS ATTD FAIL warning occurs:

7. ICO – Press

If AFDS ATTD FAIL remains or re-occurs:

8. INCDU – OFF

NOTE

To avoid IN damage, gentle manoeuvres for the first 5 min after INCDU switch off.

IN FAILURE

INDICATIONS

F/C
CWP – AP MON, TF MON (when TFR on), AUTO P (if AP is engaged without RH or TF selected)
AFDS – ATTD FAIL
TFR – HT FAIL

R/C
CWP – IN, AUTO P (if AP is engaged without RH or TF selected)
TV/TAB – Loss of KF and IN symbols
INCDU – RH STATUS symbol
NMCP – DP + SR SEL

WARNING

IN DP + SR, HUD ACCURACY AND MONITORING ARE DEGRADED.

NOTE

The pilot should be informed when DP + SR mode has been selected or automatically reverted to.

ACTIONS

1. ECS – Confirm airflow, if failed RESET
2. HUD – AUTO/NAV
3. SAHR Mode – SLAVE

If IN failure disappears:

4. INCDU/TV/TAB/HUD – Carry out IN FAULT validity checks and procedures

If IN failure is permanent:

4. INCDU – If dead, OFF. If live, leave in NAV

NOTE

To avoid IN damage, gentle manoeuvres for the first 5 min after INCDU switch off.

FACILITIES LOST

F/C

HUD - Attitude Monitoring, Degraded Vv Monitoring
AFDS – Attitude Monitoring
TRF – Cross-monitoring

R/C

NMCP – MAIN and IN modes
NWAMS – BARO-IN

SAHR FAILURE

INDICATIONS

F/C

CWP – AP MON, TF MON (when TFR is ON) AUTO P (if AP is engaged without RH or TF selected)
AFDS – ATTD FAIL
HSI – Display failure flag in TAC and ADF modes
ADI – FD fail flag

R/C

CWP – SAHR, AUTO P (if AP is engaged without RH or TF selected)
CRCU – FAIL
NMCP – DP + SR and AD + SR extinguished
BDHI – Compass OFF flag

ACTIONS

1. SAHR Mode (if SLAVE) – Change to FREE/SLAVE

If the SAHR is operating in the SLAVE mode, the source of failure may be the MDU. This may be checked by setting the MODE switch to FREE. The failure indications will be removed, if the MDU is the source of the fault indication.

If failure persists:

If SAHR re-alignment is required:
2. SAHR Mode – OFF, FREE/SLAVE

Maintain straight and level unaccelered flight until FAST ERECT SYNCH light out (approx. 2 min)

If re-alignment is not required or unsuccesful:
3. SAHR Mode - COMP, update variation

The MODE switch can be set to COMPASS to determine if the MDU signal is usable without benefit of gyro stabilization

If failure still indicated:

4. SAHR Mode – OFF

CAUTION

COMPASS MODE SELECTION INVALIDATES THE SAHR ATTITUDE OUTPUTS. THIS MODE SHALL NOT BE SELECTED UNLESS ABSOLUTELY NECESSARY.

FACILITIES LOST

F/C

HUD – Attitude Monitoring, Degraded Vv Monitoring
HSI – Magnetic Heading
TFR – Attitude Monitoring

R/C

NMCP – DP + SR and AD + SR modes
TV/TAB – Doppler velocities

ADC STATUS

Status	Facilities Lost	Facilities Degraded
30	ADC-MC link	As for 31 to 36
31	Mach	HUD: No Mach display AFDS: No MACH HOLD mode Wpn Aim: Gun accur, and LOFT attack
32	IN- Pressure Altitude and Vertical channel	Vertical navigation HUD: No Baro height, vertical speed TFR: Reversion to secondary source, no cross-monitoring
34	True Air Speed AFDS and AP	Wpn Aim: Gun and bombing accuracy NMCP: No AD + SR mode TV/TAB: Wind data not updated
35	AOA	Wpn Aim: Reversionary gun aim HUD: No AOA display
36	Total Temperature	Wpn Aim: Gun accuracy
37	ADC in toto	As for status 31 to 36

Figure 4-108

ADC FAILURE

For ADC status refer to Figure 4-108.

INDICATIONS

R/C
CWP – ADC
NCMP – AD + SR out

ACTIONS

1. TV/TAB – Manually insert W/V
2. Pressure Alt – STBY

CONSIDERATIONS

1. No Vv monitoring for HUD
2. If AP is engaged without RH or TF selected, AUTO P caption on CWP

CRPMD FAILURE

INDICATIONS AND FAULTS

Indications		Fault	Con-dition
CWP	CRPMD		
	MAP FAIL	Map drive unserviceable	1
	RDR FAIL	DSC or display fault	2
CRPMD	MAP FAIL	Projection lamp overheat	3
CRPMD	RDR FAIL	RDU or DSC overheat	4

ACTIONS

Condition 1:
1. CRPMD – Recycle from OFF

Condition 2:
1. CRPMD – Recycle MAP/MKR TEST

If unsuccessful:
2. CRPMD – Recycle from OFF

Condition 3:
1. CRPMD – R, for cooldown period

Condition 4:
1. CRPMD – OFF, for cooldown period

NOTE

If CRPMD recycled, GMR requires 3 min warm-up.

RPMD FAILURE

INDICATIONS

F/C
RPMD – FAIL

ACTIONS

1. RPMD – Recycle

If map suppressed, projection lamp is overheated:
2. RPMD – OFF, for cooldown period

NOTE

If CRPMD, RDR FAIL is illuminated, see GMR FAILURE.

GMR FAILURE

INDICATIONS AND FAULTS

Indications			GMR Fault	Condition
CWP	MRCP	CRPMD		
GMR	NO GO	GMR FAIL	Tx low power, waveguide pressurization or LRU overheat	1
GMR	NO GO		LRU failure or BITE detected fault	2
GMR R UTIL	NO GO		R utility failure	3
GMR			Input power, dynamic loop, input data or stabilization failure. Pre mod. 01485, 55°AoB exceeded Post mod. 10912: in TA only, 55°AoB exceeded	4

ACTIONS

Condition 1:
1. ECS – Confirm airflow; if failed, RESET
2. MRCP – DIM (see Note 1)

If it is operationally essential to prevent auto switch-off:
3. CRPMD – FAIL O'RIDE within 20 sec

CAUTION

THIS ACTION MAY DAMAGE THE GMR.

4. CRPMD – Recycle from M (see Note 2)

Condition 2:
1. CRPMD – Recycle from M (see Note 2)

Condition 2 (accompanied by TFR failures):
1. TFR – OFF
2. CRPMD – Recycle from M (see Note 2)
3. TFR – STBY/ON

Condition 3:
1. CRPMD – M

Condition 4:
No action possible

NOTE

- If fault is transmitter low power, GMR will operate in mapping modes with DIM selected. DIM is inhibited in tracking modes (no LCK ON).
- If CRPMD recycled, GMR requires 3 min warm-up.

Effects

Navigation system updating is limited to On-Top-Fixing, TACAN fixing, and Phase 2 fixing.
Attack modes are restricted to visual attacks. Air-to-ground ranging is not available. Blind navigation attacks are possible but weapon delivery accuracy depends on the accuracy of MC present position calculation. Updating prior to blind attacks is therefore desirable.

DOPPLER FAILURE

INDICATIONS

F/C
CWP – TF MON (when TFR ON)
R/C
CWP – DPPLR
NMCP – DP + SR out

ACTIONS

1. System accuracy – Monitor

FACILITIES DEGRADED

F/C
HUD – Degraded Vv Monitoring
TFR – Primary data only

R/C
TV/TAB – No Doppler values
SAHR – Aircraft velocity compensation terms from ADC only
MAIN Mode – Performance

If TV/TAB Flashing R:

ACTIONS

1. LAND/SEA switch – Check position
2. Doppler/IN groundspeed – Compare
3. Doppler – TEST, check test values if correct, consider IN fault

If Doppler G/S or TEST velocities in error:
4. Doppler – Leave in TEST

If IN fault suspected:
4. IN – IN FAULT validity checks

There is some degradation of performance, particularly as vertical velocity information from the Doppler is lost (see also HUD Failures, VV Monitor Trip). A failure whilst in the DP + SR mode results in an automatic reversion to the AD + SR mode.

TV/TAB FAILURE

INDICATIONS

R/C
TV/TAB – Loss of data from one or both display units
MCCP – WFG OHEAT

NOTE

If the waveform generation fails, which is indicated by the WFG FAIL light on the MCCP, both display units have failed.

ACTIONS

If WFG OHEAT out:
1. Affected TV/TAB – Recycle
2. MCCP – WFG recycle

If not successful and no TV/TAB remains functional:
3. MCCP – WFG OFF
4. TV/TAB – Use reversionary keyboards (Figure 4-42)

If WFG OHEAT on:
1. MCCP – WFG OFF
2. TV/TABs – Use reversionary keyboards

NOTE

WFG can be recycled after cooldown period.

Effects

1. Normal Steering functions are available
2. Normal CRPMD functions are available to monitor destinations
3. TV/TAB Shift Key can be used to toggle; MAP SLEW can be used to monitor destination on CRPMD
4. NHC and PHC Insert can still be used to define new destinations
5. F/A normal functions available

RAD ALT FAILURE

INDICATIONS

F/C
CWP – R ALT
R ALT – Failure flag
R/C
CWP – R ALT

ACTIONS

1. TF – Discontinue
2. HUD – BARO

CONSIDERATIONS

1. If AP is engaged in RH mode, AUTO P caption and OLPU with break away cross
2. BARO IN automatically selected as height sensors

HUD, TF and AFDS Failures are deleted from this Section, refer to Section 3.

SECTION V

OPERATING LIMITATIONS

TABLE OF CONTENTS

Title	Page
Introduction	5-1
Configurations	5-1
Minimum Crew Requirement	5-4
Minimum Equipment	5-4
Engine Operation	5-4
Fuel System	5-15
Flight Refuelling	5-16
Airspeed and Mach	5-20
Prohibited Manoeuvres	5-20
Normal Acceleration and Manoeuvres	5-20
Angle of Attack and Manoeuvres	5-21
Altitude	5-25
Mass	5-25
Centre of Gravity	5-26
Ground Stability and Operation	5-27
Approach and Landing	5-29
Crosswind	5-35
Arresting Systems	5-37
Environmental Conditions	5-38
Environmental Control System	5-38
Hydraulic System	5-39
Emergency Power System	5-39
Flight Control System	5-39
Avionic System	5-40
Autopilot and Flight Director System	5-43
Instruments	5-51
Electro Magnetic Compatibility	5-52
Armament and External Stores	5-53
Weapon Aiming	5-59
Miscellaneous	5-64
Computing	5-68

NOTE

Refer to other sections of the Flight Manual for operating limitations that are characteristic of a particular phase of operation; i.e., emergency procedures, starting procedures, auxiliary equipment operation, etc.

INTRODUCTION

This section reflects the NAMMO Release to Service Document, Issue 2 Change 12 and includes the aircraft in the clean configuration (with or without pylons) and the presently cleared external stores configurations. It includes limitations that shall be observed for safe operation of the aircraft. This limitations are relevant to the aircraft with fully serviceable systems, unless otherwise stated.
If not otherwise stated, all data depicted in this section are relevant both for clean aircraft and for aircraft loaded with external stores.
The airspeed, Mach number, altitude, and angle of attack values refer to the HUD (Head Up Display) and the normal acceleration values refer to the pilot's accelerometer.

NOTE

The aircrew will make all necessary entries in the appropriate document to indicate any limitation that has been exceeded.

NEVER-EXCEED LIMITS (N.E.)

These values represent the full design flight envelope or the highest figure for which all aspects have been investigated in flight and ground tests. These limits are never to be exceeded because consequential effects beyond these levels are either hazardous or unknown.

CONFIGURATIONS

Aircraft configurations are defined as follows:

CLEAN

This refer to the basic aircraft without pylons, without external stores and without the flight refuelling probe. When any of these are fitted it is stated positively.

CRUISE/MNVR

These terms differentiate between the wing state with flaps and slats settings as defined in the table of Figure 5-1.

WING CONFIGURATION	SLAT	FLAP
25° CRUISE	UP	UP
25° MNVR	MNVR	MNVR
45° CRUISE	UP	UP
45° MNVR	MNVR	UP
67°	UP	UP

Figure 5-1

NOTE

The aircraft is cleared to operate at three wing sweep position, namely 25°, 45° and 67°. Other intermediate sweep positions are cleared on the ground and for transient use in flight.

SUMMARY TABLE OF LIMITATIONS

Max taxi and take-off: 27.500 (28.500 kg Post Mod. 11045). Max overload landing 23.500 kg. Touch and go: flaps MID — max 20.000 kg; flaps DOWN — max 18.000 kg

APU STARTER — 3 consec. starts with 30 sec between, then 30 min cooling	CROSSWINDS — Take-off/Landing (see Figure 5-31) — All CSAS 1st failures as for normal operations Except: I/B or O/B spoilers 15 kt I/B and O/B spoilers 10 kt — All single 2nd failure 20 kt (PDL, RDL, no YAW DAMP) Except: Rudder Locked 10 kt — Mech Mode (PR Link and RUDDER LOCKED) 10 kt — Mech Mode - Train (PR Link, PDL, RDL) 20 kt — Single engine (both gearboxes running/no TR) 20 kt — NWS—NSAS failure 15 kt — Flap/slat, Swept Wing 10 kt — External stores asymmetries on I/B pylons 10 kt
ENGINE START — 5 start attemps with 2 min between, then 30 min cooling — Pre mod. 10938 (Std. 3 gearbox) 3 min at 30°C, 5 min at 10°C, 8 min at -10°C right gearbox, 13 min at -10°C left gearbox — Post Mod. 10938 (std. 4 gearbox) 1 min up to -26°C	
EMERG RAM AIR — Max 400 KIAS/0.8 M < 25.000 ft — Cont. 250 KIAS (trans 400 KIAS)	
FUEL DUMPING — Only to 400 kg each	
MIN FUEL TEMP — Normal up to 80° C — Never exceed 90° C	TR Not Preselected — Max speed Normal up to max dry 165 KIAS — Emergency 200 KIAS
AIRBRAKES — 0.95 M — 0.5 g up to airframe inlet — 14 AOA	AOA — at thereshold 12 AOA at flare 15 AOA — X-Wind see Figure 5-32
AERODYNAMIC BRAKING — 18 AOA to 100 KIAS up to 15 kt X wind (14 AOA with stores)	TR preselected — Max AOA threshold 10, flare 12 — Max wind 25 kt, X-wind 20 kt — Full CSAS
X-DRIVE CLUTCH ENVELOPE — 200 KIAS at FL 300 — 300 KIAS at FL 400 — Record all engagement > 70% NH	LANDING GEAR — Normal operation 250 KIAS — Down 280 KIAS — Emerg lowering 200 KIAS

Figure 5-2

INSTRUMENT MARKINGS

NOTE

The following illustrations depict certain instruments and their markings.
No operational status nor condition is implied. The specific operational values or conditions are stated within the relevant text. These illustrations are not repeated within the text.

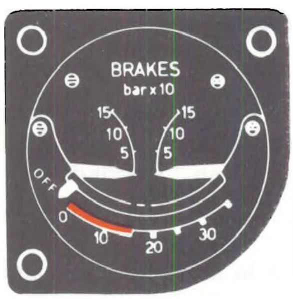
L.HYD/R. HYD PRESSURE INDICATOR
Normal Condition: 256 to 283 bar

VOLTMETER (Post Mod. 01662)

- 10V to 24V Battery voltage very low level
- 24V to 28V Battery voltage low level
- 28V to 32V Normal operating condition
- 32V to 35V Excessive output of battery charger

MAIN OXYGEN CONTENTS INDICATOR
Reads sector (below "O") when OXY TEST button is pressed.
Reads sector (above "10") to indicate System Failure

EMERGENCY OXYGEN PRESSURE GAUGE
"Full" Sector
"Refill" Sector



WHEEL BRAKES TRIPLE PRESSURE GAUGE
Brakes Accumulator Low Pressure Sector

Figure 5-3

MINIMUM CREW REQUIREMENT

The minimum crew for flight is two. Where operational necessity dictates, flight with the rear seat unoccupied may be authorised in VMC only, provided the requirement for such flights clearly overrides the risk involved.

MINIMUM EQUIPMENT

To ensure safe operation, the list in Figure 5-4 details the minimum equipment which shall be serviceable for operation in VFR or IFR conditions or ferry flights. Ferry flights are defined as mission which are flown to home base or a maintenance facility during daytime and in VMC only.

MINIMUM EQUIPMENT

MINIMUM EQUIPMENT	VFR	IFR	FERRY 6
Navigation Equipment			
Main Computer	1	X	–
Interface Unit 1	X	X	X
Interface Unit 2	1	X	–
Air Data Computer	X	X	X
Inertial Navigation	X	X	2
Secondary Attitude and Heading Reference	1	X	2
TACAN	–	X	2
Radio/Radar Altimeter	3	X	–
Doppler	1	X	–
Flight Instruments and Systems			
AFDS	X	X	–
Attitude Direction Indicator	X	X	X
Horizontal Situation Indicator	X	X	X
Head-Up Display	X	X	–
Pitot Static System	X	X	X
Servo-Pneumatic Altimeter	X	X	X
Vertical Speed Indicator	X	X	X
Combined Speed Indicator	X	X	X
Clock and Stopwatch or Pilots Wrist Watch	X	X	X
Standby Magnetic Compass	X	X	X
Communication Equipment			
VHF or UHF Transceiver	X	X	X
UHF Emergency Radio	X	X	X
Communication Control System	X	X	X
Lighting Equipment			
Anti-Collision Lights	X	X	X
Navigation Lights	X	X	X
Landing/Taxi Lights	X	X	X
Obstruction Lights	4	X	–
Instrument and Panel Lighting	4	4	–
Wander Lamps	4	4	–
Additional Equipment			
IFF Transponder	X	X	5
Intake De-icing System	X	X	–
Crash Recorder	X	X	X
SPILS (Post Mod. 00555)	X	X	–

1) Not required for certain missions
2) TACAN + SAHR or IN
3) For low level flights and/or weapon aiming/delivery
4) Only at night
5) Not required in formation if one aircraft is equipped with a serviceable IFF/SIF
6) Ferry Flight is defined as mission which is flown to home base or a maintenance facility during day time and in VMC only.

Figure 5-4

ENGINE OPERATION

All operating limits listed in this chapter are applicable to both MK101 and MK103 engines (full and derated SOT) unless otherwise stated.

APU OPERATION

Starter motor is restricted to three consecutive starts with 30 seconds between each, after which a 30 minute period is required before a further start is attempted.

APU running with wing sweep angles greater than 45° shall not exceed 5 minutes.

APU running is cleared up to a maximum fuel temperature of 80° C.

APU starting cannot be guaranteed at fuel temperature below 0° C when F44 is used.

For operations at or below −10° C observe following notes:

NOTE

- If APU rotates but shuts down within 5 secs the start switch should be held to ″on″ for 10 secs on the next start attempt.
- The APU START/OFF switch shall be set to OFF if the APU does not light up within 15 seconds.
- If APU fails to accelerate fully and stagnates for more than 10 secs, select APU to OFF.

GEARBOX WARM UP TIME

Pre mod. 10938 (standard III gearboxes). Prior to attempting an engine start, the APU shall be used to warm up SPS gearboxes in accordance with the times quoted in Figure 5-5.

Post mod. 10938 (standard IV gearboxes). No warm up time exceeding 1 minute stabilization time given as in the "Normal Procedure" is required.

ENGINE STARTING

The maximum tailwind component (including gusts) is 30 knots.

Engine starting is permitted within the ambient temperature range cleared in the paragraph "ENVIRONMENTAL CONDITIONS" of this section.

Up to 5 engine start attempts or dry crank cycles are permitted with a minimum of 2 min between the time the HP spool has stopped rotating and the subsequent selection.

After 5 unsuccessful engine start selections a 30 minute cooling period shall be observed.

A dry crank may be made without delay after a failed engine start, if necessary to reduce TBT. If dry cranking is not used after a failed engine start then a 2 minutes drainage period shall be allowed after HP spool has stopped rotating before a further selection is made.

NOTE

The start shall be cancelled if the TBT exceeds 675° C with and NH less than 65%.

TIME LIMITATIONS BELOW +0.5 "G"

NOTE

The most restrictive limit applicable to oil and/or fuel system shall be observed during engine operation under extreme attutude, zero or negative "g".

GEARBOX WARM-UP TIME

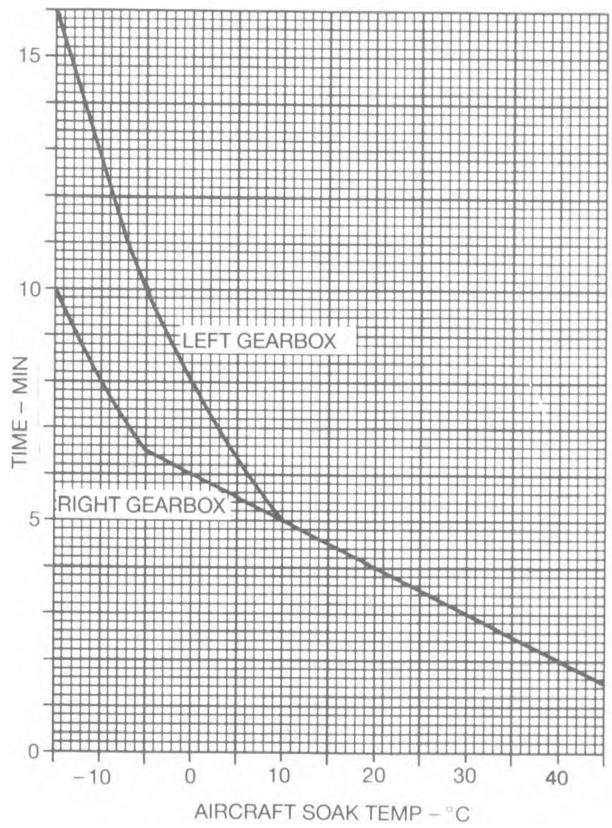


Figure 5-5

MK101 Engine

Engine operation is permitted within the envelope descripted in Figure 5-6, Figure 5-8 and Figure 5-9 and according to the recommendations stated on notes. The maximum time period of flight depends on modification status.

— If Pre mod. 30887 and 01570 both engines (or Pre mod. one engine and Post mod. the other engine) and Pre mod.00859 maximum time period of 3 seconds is allowed.
Between each excursion below 0 "g", positive "g" shall be restored for 10 seconds. The CWP OIL P caption will illuminate during negative "g" flight. If the warning persists for more than 5 sec. the throttle shall be placed to HP SHUT as an OIL SYST failure is indicated. Land as soon as practicable.

NOTE

- The requirement to observe the min positive "g" recovery periods between each excursion below 0 "g" does not apply during terrain following.
- Post mod. 00859, the CWP OIL P caption is red instead of amber.

— If Post mod. 30887 and 01570 both engines (and Pre/Post 00859):
Maximum tipe periods:

Dry range:	15 seconds
Reheat range:	5 seconds
Reheat with simultaneous a/c deceleration:	2,5 seconds

Below 7000 ft, negative "g" excursion up to 15 sec. are allowed with at least 60 sec. recovery time between each excursion in excess of 10 sec. Negative "g" excursions below 10 sec. are allowed 3 times provided that recovery times are of equal or greater duration. After third excursion, positive "g" shall be restored for 60 seconds.
Above 7000 ft, negative "g" excursion up to 3 cycles of 15 sec. are allowed providing that the recovery times are of equal or greater duration of each excursion. After the third cycle positive "g" shall be restored for 60 sec. The CWP OIL P caption will illuminate after 15 sec. below 0 "g" or when a supplementary lubrication system failure is detected. If the warning persists for more than 5 sec. the throttle shall be placed to HP SHUT as on OIL system failure is indicated. Land as soon as practicable.

NOTE

- The requirement to observe the min positive "g" recovery periods between each excursion below 0 "g". Do not apply during terrain following.
- Oil interruption is defined as any time when an OIL P caption on the CWP is lit or flickering (a/c not incorporating mod. 01570).
- The OIL P caption will illuminate during negative g flight. If the warning persists after recovery at positive flight, apply the relevant emergency drill.
- If engines of mixed standards are fitted to the same aircraft, it shall be flown to the most restrictive limitations.
- Recovery time is defined as length of time spent at positive with OIL P caption extinguished (g > + 0.5).

MK103 Engine

Engine operation is permitted within the envelope descripted in Figure 5-7, Figure 5-10 and Figure 5-11 and according to the raccomendations stated on notes.
The only time limitation below +0.5g related to MK103 engine is due to fuel system. Refer to Fuel System chapter para "Time limitations below to +0.5g" for applicable limitations.
The OIL P caption on CWP should not illuminate during negative "g" flight. If the light illuminates at any flight condition the throttle should be retarded to idle immediately. If the warning persists for more than 5 sec. the throttle shall be placed to HP SHUT as an oil system failure is indicated: land as soon as practicable.

NOTE

If Pre mod. 01361 (3 sec. time delay) the CWP OIL P caption may flicker around zero "g".

MK101 ENGINE OPERATING IN FLIGHT

Pre mod. 10781 Throttle handling should be avoided at aircraft angles of attack greater than 15 units AOA, in order to minimise the risk of surge. The risk of surge increases with angle of attack so that even at costant throttle setting there is a high probability of surge above 19 units AOA.

Post mod. 10781 Throttle opening from below 80% NH at incidences above 21 units AOA close to the minimum IAS/max altitude limit can result in surge.

MK101 ENGINE OPERATION LIMITATIONS DRY POWER AND REHEAT

CONDITION	MAX TIME PER FLT	NH %	NL %	AJ %	TBT °C
COMBAT	5 min	99.5 + trans. overswing to 102 for 10 sec per occurrence	103.5	LH 102 RH 100 Post mod. 10781 LH 100 RH100	MAX DRY TBT + 15 Note 1
MAX REHEAT >75% AJ	15 min Note 2			LH 75-102 RH 75-100 Post mod 10781 LH-75-100 RH 75-100	MAX DRY TBT - Note 1
MIN REHEAT ≤ 75% AJ	30 min Note 3			32-75	
MAX DRY	36 min Note 4			16	
MAX REVERSE	40 sec per appl.				
MAX CONT	Unlimited	98			MAX DRY TBT - 36 Note 5
MIN TAXI IDLE (ISA SLS TAXI Nozzle sel.)		Min 64.5	—	100/16	—
START/ RELIGHT	—	—	—	—	675 Note 6

NOTE

1. A two position TBT switch labelled DATUM and LOW is provided in the cockpit. This switch shall remain in the DATUM position, except for a momentary check of the maximum continuous limiting TBT as described in Note 5 below, and as required for ground checks or in the event of an engine surge which does not clear after having reduced AOA and moved the throttle of the relevant engine to idle.
2. The cumulative use of all operation above 75% Aj is limited to 20 minutes per flight.
3. The cumulative use of all operation above MAX DRY is limited to 30 minutes per flight.
4. The cumulative use of all operation above maximum continuous is limited to 36 minutes per flight.
5. Maximum continuous rating is defined as MAX DRY TBT minus 36° C, and can be checked by momentarily selecting LOW on the TBT datum switch with the throttle in the MAX DRY position. This determines the TBT to which the engine can subsequently be operated with manual use of the throttle when low datum has been deselected.
6. During relights, TBT is limited to 675°C, when NH is less than, 65%.

Figure 5-6

MK103 ENGINE OPERATION LIMITATIONS DRY POWER AND REHEAT

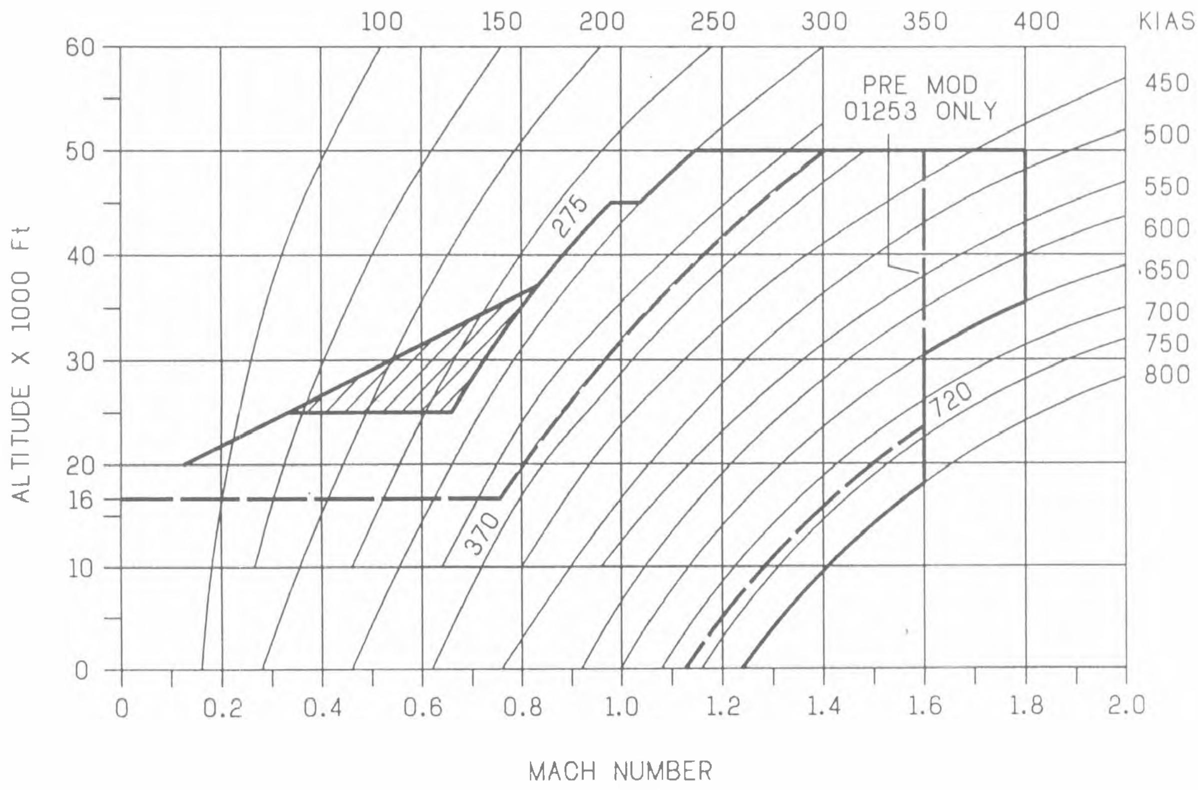
<table>
<tr><th>CONDITION</th><th>MAX TIME PER FLT</th><th>NH %</th><th>NL %</th><th>AJ %</th><th>TBT °C</th></tr>
<tr><td>COMBAT</td><td>5 min</td><td rowspan="4">101 + trans. overswing to 102 for 10 sec per occurrence</td><td rowspan="5">105</td><td>98</td><td>MAX DRY TBT + 23 Note 1</td></tr>
<tr><td>MAX REHEAT >75% AJ</td><td>15 min Note 2</td><td>75-98</td><td rowspan="4">MAX DRY TBT Note 1</td></tr>
<tr><td>MIN REHEAT ≤ 75% AJ</td><td>30 min Note 3</td><td>28-75</td></tr>
<tr><td>MAX DRY</td><td>36 min Note 4</td><td rowspan="3">10,5</td></tr>
<tr><td>MAX REVERSE</td><td>40 sec per appl.</td><td>100</td></tr>
<tr><td>MAX CONT</td><td rowspan="2">Unlimited</td><td>98</td><td>103.5</td><td>MAX DRY TBT - 36 Note 5</td></tr>
<tr><td>MIN TAXI IDLE (ISA SLS TAXI Nozzle sel.)</td><td>64.5</td><td>—</td><td>100</td><td>—</td></tr>
<tr><td>START/ RELIGHT</td><td>—</td><td>—</td><td>—</td><td>—</td><td>675 Note 6</td></tr>
</table>

NOTE

1. A two position TBT switch labelled DATUM and LOW is provided in the cockpit.
   This switch shall remain in the DATUM position, except for a momentary check of the maximum continuous limiting TBT as described in Note 5 below, and as required for ground checks or in the event of an engine surge which does not clear after having reduced AOA and moved the throttle of the relevant engine to idle.
2. The cumulative use of all operation above 75% Aj is limited to 20 minutes per flight.
3. The cumulative use of all operation above MAX DRY is limited to 30 minutes per flight.
4. The cumulative use of all operation above maximum continuous is limited to 36 minutes per flight.
5. Maximum continuous rating is defined as MAX DRY TBT minus 36° C, and can be checked by momentarily selecting LOW on the TBT datum switch with the throttle in the MAX DRY position. This determines the TBT to which the engine can subsequently be operated with manual use of the throttle when low datum has been deselected.
6. During relights, TBT is limited to 675°C, when NH is less than 65%.

Figure 5-7

MK101 ENGINE OPERATING ENVELOPE
X-DRIVE CLUTCH OPEN

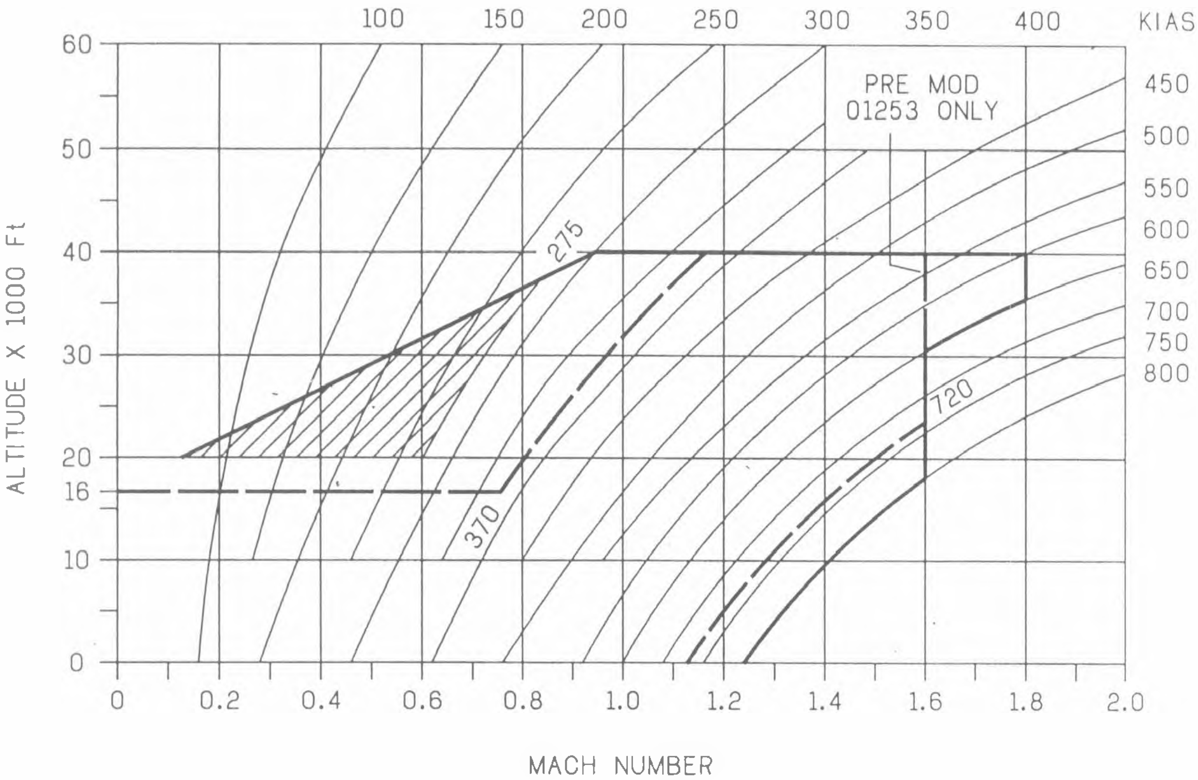


NOTE

- Maximum speed limit of 720 KIAS applies Pre Mod 01436
- Changes in wing sweep above 40000 ft are only permitted at constant throttles settings or while modulating the throttle in the reheat range.

Figure 5-8

MK101 ENGINE OPERATING ENVELOPE X-DRIVE CLUTCH CLOSED

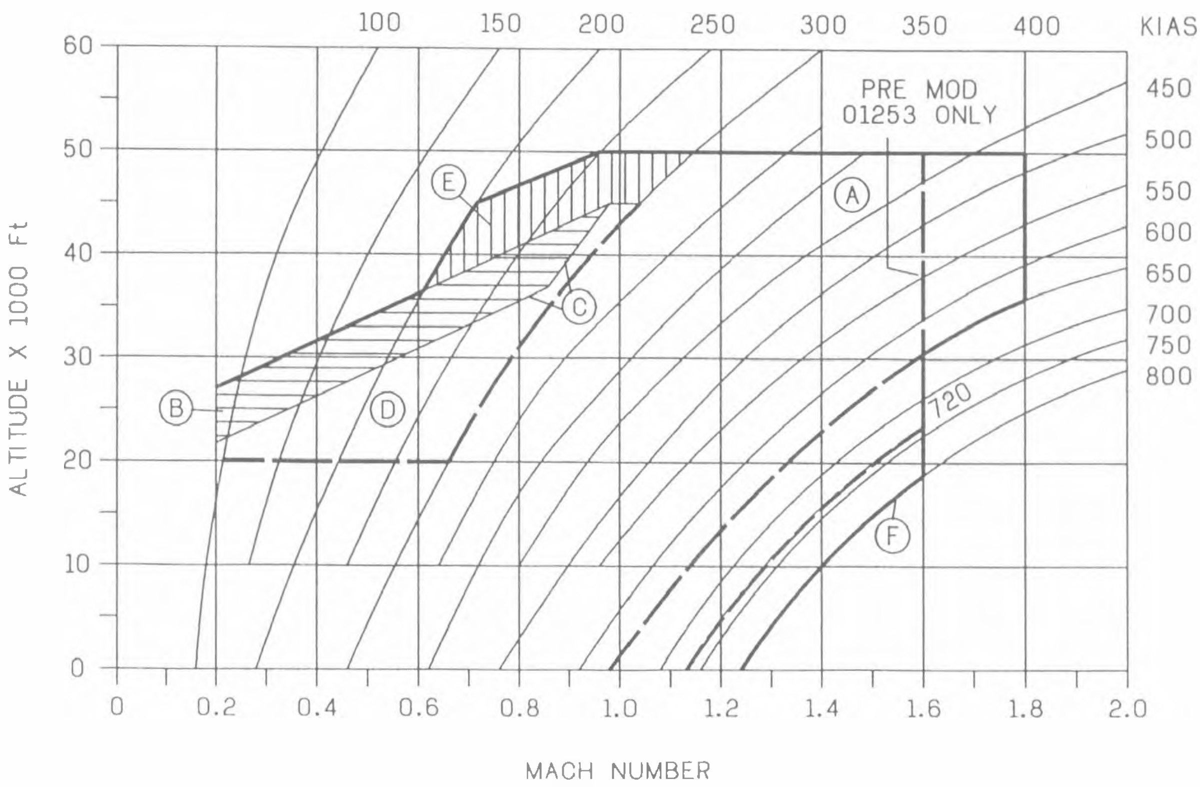


NOTE

– Maximum speed limit of 720 KIAS applies Pre Mod. 01436

Figure 5-9

MK103 ENGINE OPERATING ENVELOPE X-DRIVE CLUTCH OPEN



NOTE

A) Wing sweep above 40000 ft is only permitted at constant throttle setting or while modulating the throttle in the reheat range.

B) In this area incidence should not exceed 15 AOA and sweep is not permitted

C) Wing sweep is not permitted on or close to the LOCK-IN-SURGE line (LIS) boundary during slam deceleration to idle

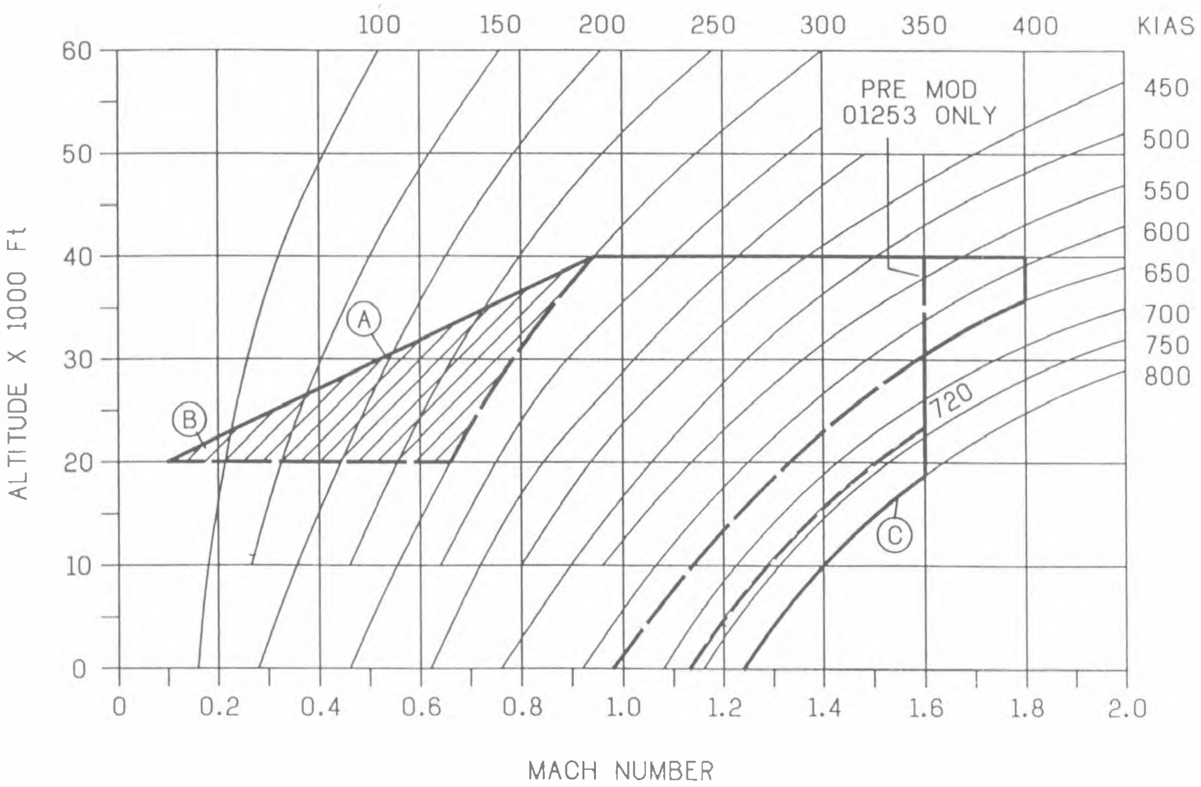
D) Above 20000 ft and below 300 Kts lock in surges may occur if the engine is reaccelerated from a sub-idle under shoot during wing sweeping at high incidence

E) Extended clearance for engines operating with F34 or F35 fuel only: maximum incidence 12 AOA. No dry engine handling. Wing sweep is not permitted.

F) Maximum speed limit depends upon engine modification state as follows:
Pre Mod. 31154 and 50189 – 650 Kts
Pre Mod. 01436 and or Post Mod. 31154, Pre Mod. 50189 – 720 Kts
Post Mod. 01436 and Post Mod. 31154 and 50189 – 750 Kts
Post Mod. 01436 and Post Mod. 31154, 50189 and 31194 – 800 Kts

Figure 5-10

MK103 ENGINE OPERATING ENVELOPE
X-DRIVE CLUTCH CLOSED



NOTE

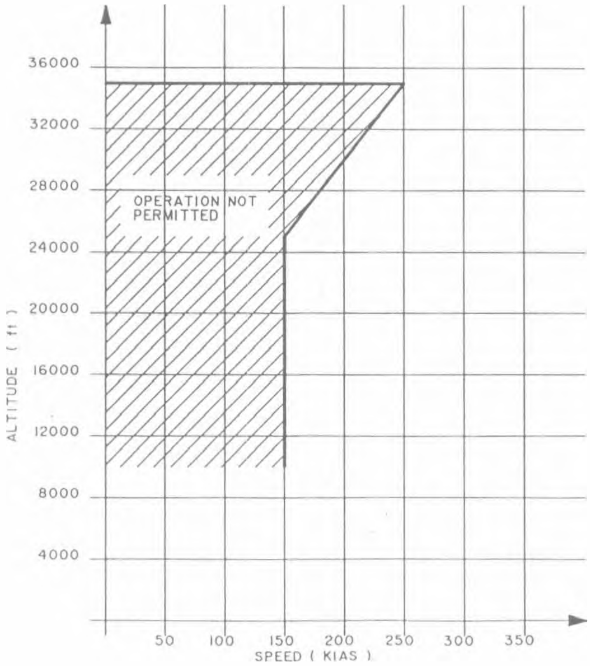
A) Maximum incidence of 15 AOA applies on or close to the LOCK-IN-SURGE (LIS) boundary during wing sweep operation. When approaching the LIS boundary, the incidence shall be gradually decreased to max 15 AOA if wing sweep and simultaneous throttle modulation are performed

B) Above 20000 ft and below 300 Kts lock in surges may occur if the engine is reaccelerated from a sub-idle undershoot diring wing sweeping at high incidence

C) Maximum speed limit depends upon engine modification state as follws:
Pre Mod. 31154 and 50189 – 650 Kts
Pre Mod 01436 and or Post Mod. 31154, Pre Mod. 50189 – 720 Kts
Post Mod. 01436 and Post Mod. 31154 and 50189 – 750 Kts
Post Mod. 01436 and Post Mod. 31154, 50189 and 31194 – 800 Kts

Figure 5-11

ASSISTED RELIGHT ENVELOPE



NOTE

MAX altitude with F-44 fuel is 25000 ft.

Figure 5-12

RELIGHT

In the event of engine flame out, immediate relights may be attempted at any speed and altitude. Assisted relight is the primary method of lighting the engine and is cleared in Figure 5-12.

NOTE

Assisted relight shall not be attempted above 15 AOA. During the relight engine throttle handling is not permitted.

Windmilling relights with the X-drive clutch open or closed, are cleared up to 30000 ft max altitude and 12% NH minimum (MK103: 14% NH minimum). Test experience has shown that to ensure a successful X-drive OPEN windmill relight, ignition should be delayed until T7 is below 400° C. When F-44 fuel is used, during windmill relights extreme T7 values may be observed. The relight should be continued provided that the 675° TBT limit is not exceeded. For deliberate engine shut downs refer following ENGINE SHUT DOWN paragraph.

CROSS DRIVE

The Cross Drive can be selected OPEN or closed as indicated in the envelope detailed in Figure 5-8, Figure 5-9, Figure 5-10 and Figure 5-11.
Cross-drive operation on ground and in flight are limited as shown in Figure 5-13.

ENGINE OPERATION UNDER ICING CONDITIONS

Ground, OAT at or below 0°C, debris guard fitted

Engine running is permitted at any power setting provided there is no ice accretion on the intake debris guard(s). If ice accretion is observed the engine(s) shall be reduced to idle power and shut down as soon as possible.
Further running is permitted when the intake(s), guard(s) and engine(s) are free of ice.

Ground, OAT at or below 0°C, debris guard not fitted

Engine running is permitted at any power setting provided there is no ice accretion on the auxiliary intake door damper links. The links shall be monitored for signs of ice accretion and, if ice is detected, the engine(s) shall be reduced to idle and shut down as soon as possible. Further running is permitted when the intake(s) and engine(s) are free of ice.

Ground, OAT between 0 and + 3°C, with or without debris guard fitted

Icing may occur within the intake(s). The limitation for debris guards not fitted shall be observed.

Take-off

Take-off in icing conditions is permitted under the following conditions:

- Forward visibility shall be more than 200 m when the ambient temperature is + 3°C or below.

- Pre mod. 00629 (Introduction of Rosemount Ice detector system)

X-DRIVE CLUTCH OPERATION

SPEED DIFFERENTIAL	INTERVAL BETWEEN SUCCESSIVE CLUTCH CLOSURES
Less than 15%	No limits
15% to 70% NH	COOLING INTERVALS: After 2 closures 10 min After 2 further closures 30 min After 3rd pair of closures 10 min After 4th pair of closures 30 min
≥ 70% NH	COOLING INTERVALS: After 1st closure 10 min After 2nd closure 30 min After 3rd closure 10 min After 4th closure 30 min

NOTE

Clutch closures in excess of 70% NH shall be recorded.

Figure 5-13

As the air intake anti-icing system cannot be checked on the ground, the horizontal/vertical extent of the airborne icing condition shall be such that the aircraft can excape from the icing conditions within 2 minutes from take-off. Having established that the AIR INTAKE anti-icing system is serviceable after takeoff, the aircraft is cleared to continue in icing conditions as cleared in following paragraph "Flight".

- Post mod. 00629
  Provided that the air intake anti-icing bite check is satisfactory, take-off is permitted if the aircraft can escape from the icing conditions within 4 minutes (Pre mod. 00218) or 5 minutes (Post mod. 00218: Introduction of 150 mm strut Pitot probe).
- Engine power setting shall not exceed 87% NH except for line up and take-off. Checks and operation above idle power shall kept to a minimum.
- The air intake anti-icing system shall be switched ON for take-off (Pre mod. 00629) or AUTO (Post mod. 00629).

WARNING

TAKEOFF IN SEVERE ICE CONDITION IS PROHIBITED.

Flight

WARNING

CONTINUOUS FLIGHT IN ICING CONDITIONS IS NOT PERMITTED.

In the event of an inadvertent or unavoidable encounter, provided that the air intake anti-icing is operating, the aircraft shall be flown to an ice free area within 4 minutes (Pre mod. 00218) or 5 minutes (Post mod. 00218) of the icing condition being entered (see Figure 5-14).

Penetration and Landing

WARNING

IF SEVERE ICE CONDITION ARE ENCOUNTERED, IMMEDIATE DIVERSION IS NECESSARY.

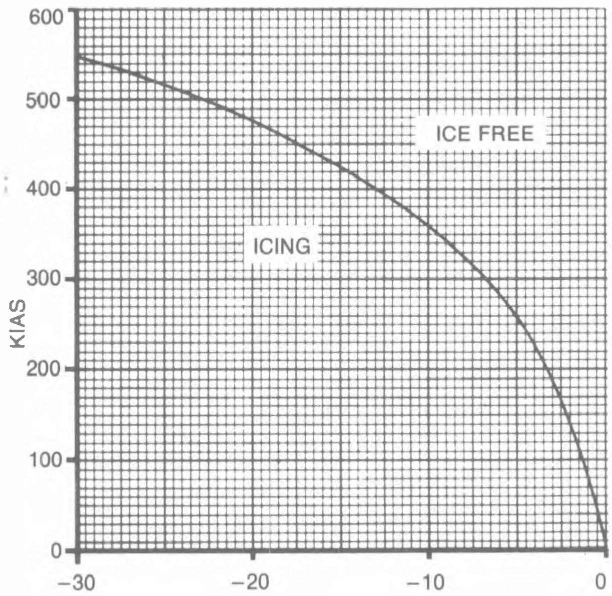
To minimise the effect of the icing encounter, the penetration and approach should be made at a speed greater than the minimum speed for the altitude/ground level ambient temperature shown in Figure 5-15. The airframe shall be monitored for signs of ice accretion. If this is detected the aircraft shall vacate the icing conditions as soon as possible. After landing shut down engines as quickly as practicable.

ENGINE SHUT DOWN

Ground

The maximum permitted tailwind component at engine shut down after a landing or rejected take-off is 15 knots in order to avoid fuel spillage onto the heated brakes.
After running at maximum continuous conditions or above, the engine should be idled for two minutes before shutting down (T7 below 450°C).

ICE FREE SPEED CHART



NOTE

Ice free speed is any aircraft speed which produce a total temperature sufficiently high to prevent ice forming on the airframe in icing conditions.

Figure 5-14

Flight

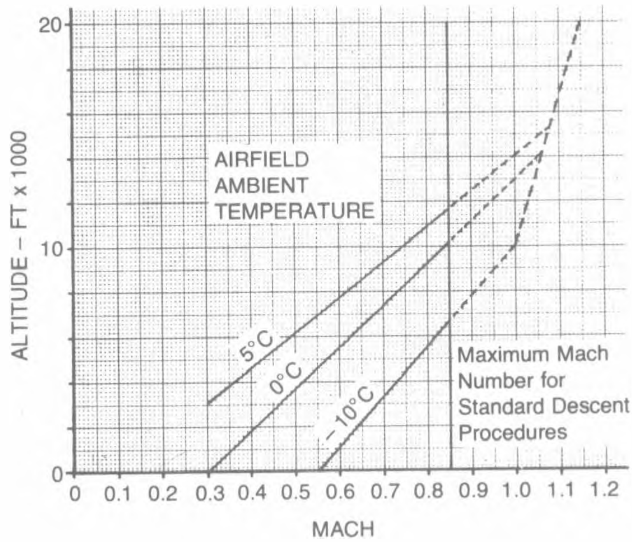
Practice engine shut-downs during flight are permitted only in full CSAS (no first failure) with the TRAIN switch set to NORMAL. When using F-40 fuel and with cross-drive OPEN, maximum altitude limits for deliberate shut-down are:

FUEL TEMPERATURE(°)	MAX ALTITUDE
40	9000
30	12000
20	15000

NOTE

The relationship between fuel temperature and altitude is linear.

MINIMUM AIRSPEEDS FOR PENETRATION OF LIGHT OR MODERATE ICING CONDITIONS



Example: If descending from 10000 ft at an airfield OAT of 0° C, an ice free speed of 0.85 M should be flown to final approach; thereafter time limitations as for Flight apply.

Figure 5-15

FUEL SYSTEM

The fuel system is cleared for fuel types F-34/35/44 and F-40. Alternative fuel is not allowed. During and after the use of F-40 or a mixture of F34/35/44 and F-40 the restrictions applicable to F-40 are to be followed. Before flying to the operating instructions for F34/35/44 fuel either:

- the aircraft shall be defuelled to the umpumpable level and refuelled with F34/35/44 or
- the aircraft shall be refuelled with F34/35/44 and flown to F40 limits until 2 sorties have been flown on which the fuel remaining after each sortie was 2000 kg or less.

When either F44 or a mixture of this fuel with F34/35/40 is used, the following limitation applies:
- Operation is limited to 50 consecutive engine running hours. The aircraft shall be operated for

5 hours on either F40 or F34/35 between periods of operation with F44 or mixtures.

FUEL TEMPERATURE

Indicated fuel temperature should not normally exceed 80°C and should never exceed 90°C. At fuel states below 600 kg gentle manoeuvres only shall be flown.

NOTE

Fuel tank temperature depends upon sortie profile and fuel contents and APU/engine ground running time.

FUEL DUMPING

Dumping shall be terminated when the contents of the respective group(s) reaches 400 kg.

BOOST PUMPS

Boost pumps shall not be switched OFF in flight except for:

- fuel balancing in the single engine case, when the crossfeed shall be selected OPEN before selective switching of booster pumps
- selective switching of booster pumps, with both engines running, if fuel imbalance cannot be rectified by differential throttles setting, emergency transfer or tank interconnect.

The minimum permitted normal acceleration with a boost pump low pressure warning is + 0,5 g.

LOW FUEL/NOSE DOWN ATTITUDE

If the red fuel low level caption illuminates on the CWP, reheat on the left engine shall be cancelled and dive angle reduced.
Reheat dives are prohibited below fuel contents of 800 kg fwd and 400 kg aft. Reheat shall be cancelled before airbrakes are used. Sustained dives at angles steeper than 60° when using reheat are to be avoided.

FRONT GROUP FUEL LEAK

In the event of a fuel leak the aircraft can be landed safely with a fuel states as follows:

In all configurations an acceptable fuel asymmetry is:

- Front heavy – no limit
- Rear heavy – 600 Kg

TIME LIMITATION BELOW 0,5 "G"

– Dry range	20 sec.
with simultaneous a/c deceleration	15 sec.
– Reheat range	5 sec.
with simultaneous a/c deceleration	2.5 sec.

MIN FUEL CONTENT FOR NEGATIVE G MANOEUVRES

The following limitations when flying below + 0.5 g shall be observed:

- in dry range, fuel per group shall be above 400 kg. per group Post mod. 10229 and more than 800 kg forward group and 400 kg aft group Pre mod. 10229
- in reheat range, fuel fwd group shall be above 800 kg. and in aft group above 400 kg.

WARNING

FLYING BEYOND THE LIMITS LISTED IN THE PARA "TIME LIMITATION BELOW 0.5 "G"" OF THIS CHAPTER, WILL CAUSE THE AMBER F AND/OR R PUMP CAPTION TO ILLUMINATE AND WILL MOST PROBABLY RESULT IN A RAPID REHEAT FLAME OUT/ENGINE RUNDOWN WITHIN 1 TO 3 SECONDS.

FLIGHT REFUELLING

RECEIVER ROLE

The air to air refuelling probe is cleared to be fitted and operated in flight within the following limitations:

CAUTION

ICING CONDITIONS SHALL BE AVOIDED WITH PROBE EXTENDED.

NOTE

When the flight refuelling probe is fitted (either stowed or out) the strip AOA indicator under reads by 1 unit AOA. The HUD is not affected.

The aircraft is cleared to receive fuel from the VICTOR K2, VC10 K MK2 and MK3, Buccaneer, Tornado, USAF KC135 and KC10A (centerline only), FAF C135F and C135FR, Tristair KCMK1 and KMK1 (under fuselage stations). In addition the aircraft is cleared to operate within the envelope defined in Figure 5-16 and Figure 5-17 observing the following limitations:

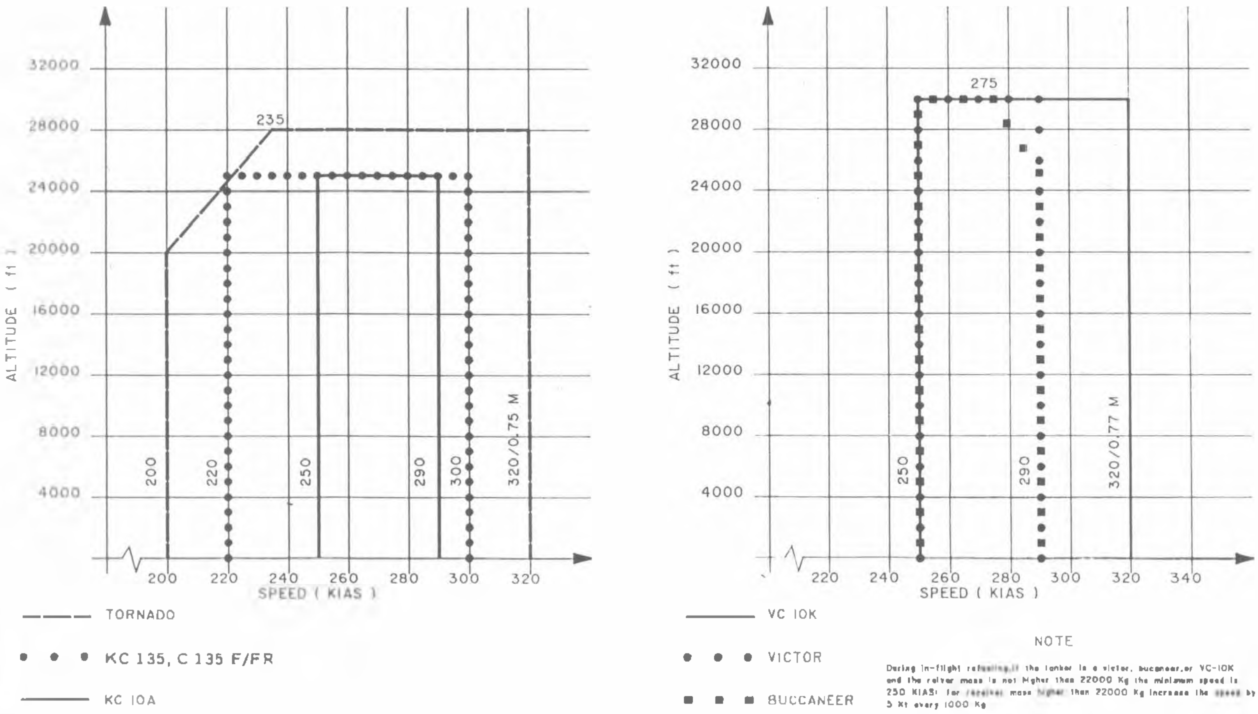
- Wing sweep: 25° CR or MNVR
- 45 CR or MNVR (except with Tornado tanker)
- Configurations: all cleared except for KC-135, C-135 F and C-135 FR that are restricted to refuelling Tornado in symmetric configurations only.
- Optimum speed 270 KIAS (KC-135: 275 KIAS)
- Selection of flaps to MID or LG to DOWN shall not be made when receiver and tanker are contact.
- Reheat selection is to be made prior to AAR contact.
- When use of reheat is necessary it is to be used on one engine only (preferably the left hand engine for easier airspeed control via right hand dry engine. In this case aft CG shift shall be considered).
- When attempting a contact, or while in contact, rapid throttle movements of the engine in RHT (e.g. to control closing speed/airspeed) should be avoided. With KC135, C135 F and C135 FR, change of RHT setting during contact is prohibited.
- If the tanker drogue is damaged during a contact, no further contact should be made on that drogue, except in operational emergency, due to the risk of loose items from the damaged drogue entering the right hand intake.
- Planned refuelling operations with second failure, CSAS modes, are prohibited.

NOTE

- K135 shall be to the following standard: a model of USAF/SAC
  - with in line pressure regulator
  - with BDA KIT and with either unmodified J.C. Carter MA 3 coupling, Pt. No 60381 or modified J.C. Carter MA 3 coupling, Pt. No 60381 (equipped with sleeve insert Pt. No 209108).
  - Refuelling restricted to using a maximum of two aerial refuelling pumps.
  - Boom positioning during refuelling shall be 4 degree right azimuth, 30 degrees elevation, with boom fully extended.
- K10A shall be to the following standard: a model of USAF/SAC
  - with either unmodified J.C. Carter MA 3 coupling, Pt. No 60381, or modified J.C. Carter MA 3 coupling, Pt. No 60381 (equipped with sleeve insert Pt. No 209108).
  - Refuelling restricted to using a maximum of two aerial refuelling pumps.
  - Refuelling permitted from fuselage drogue station only.

At the speed of 250 KIAS or above, due to flutter limitations the internal wing tanks should be kept full if there is fuel in the underwing tanks.

OPERATING ENVELOPE RECEIVER/TANKER



NOTE

- Optimum speed: all Tankers 270 KIAS (275 KIAS for KC135)
- Engagement △ speed should be 3-4 kt and shall not exceed 7 kt. For KC135, C135F, C135FR engagement △ speed should not exceed 2 kt. For KC 10A only engagement △ speed should not exceed 5 kt.
- All cleared configurations: KC135 C135 F and C135 FR are restricted to refuel Tornado in symmetric configurations.
- During in-flight refuelling, if tanker is a Victor, Buccaneer VC-10 K MK 2/3, Tristair, KC MK1, K MK1 and the receiver mass is not higher than 22000 Kg, the minimum speed is 250 KIAS; for receiver mass higher than 22000 Kg increase the speed by 5kt every 1000 Kg.

Figure 5-16

If before commencing refuelling, the remaining fuel is greater than 2100 kg, the wings will normally be full.

The flight refuel switch should be set to ALL. If internal wing fuel has already been transferred, than at speed above 250 KIAS the flight refuel switch should be selected to INT until the wing has filled, then be selected to ALL.

Before making contact, ensure the fuel transfer sequence switch is selected to NORM.

On completion of flight refuelling and after breaking contact, select flight refuelling tank selector switch to OFF and probe to IN.

CAUTION

- HF TRANSMISSIONS BY THE TANKER ARE NOT PERMITTED WHILST THE AIRCRAFTS ARE IN CONTACT OR WITHIN 150 FT OF EACH OTHER.
- TACAN IS CLEARED FOR SWITCH ON USE ONLY, AS NO AIR-TO-AIR TACAN TRIALS BETWEEN TORNADO AND TANKER HAVE BEEN PERFORMED.

Probe Nozzle Standard for Refuelling with USAF Tankers Post Mod. 01331

1. KC 135 and KC-10A with MA-3 Coupling (Pt No 60381)
   Refuelling probe and Adapter "Flight Refuelling Ltd" including weak link, non-return valve removed, fitted a J C Carter Flexible Type nozzle MA-2, Type 2 Class B (Manufactur's designation No 60318-2B).
2. KC 135 and KC-10A with modified MA-3 Coupling Pt No 60381 equipped with sleave insert Pt No. 209108
   Either: Standard FRL nozzle
   or:
   Refuelling probe and adapter "Flight Refuelling Ltd" including weak link, non-return valve removed, fitted aith a J C Carter flexible Type nozzle MA-2, Type 2 Class B (Manufactur's designation No 60318-2B).

NOTE

For KC135 standard refer to the applicable publication.

RECEIVER ROLE LIMITATIONS

Probe Condition	Max IAS/MNE	Normal acceleration	AOA
Stowed	No additional limitations required		
Operating	320/.77	Nominal 1g. gentle manoeuvring	NO ADDITIONAL LIMITATIONS
Locked-out not in contact	600/.92	0-2 g gentle manoeuvring	
Locked-out in contact	320/.77	Nominal 1g. gentle manoeuvring	12

Figure 5-17

TANKER ROLE

The Tornado is cleared for daytime (Pre mod. 13016)/night and day (Post mod. 13016) flight refuelling for dry and wet contacts within the envelope defined in Figure 5-18 observing the following limitations:

The cleared configurations are M1, M2, M1a and M2a (see Figure 5-47)

Airspeed changes with hose extended shall be kept within ± 10 KIAS at costant altitude.

For greater speed changes, the hose shall be retracted and retrailed.

The Buddy Buddy Pod is not cleared for operation in icing conditions.

POD OPERATING ENVELOPE

MODE	AIRSPEED (KIAS/M) (see fig. 5-14)		WING SWEEP DEG	ALT. FT
	MIN	MAX		
Hose Winding and Trailing	200 up to 20000 ft, then linear to 235 at max alt. (see fig. 5-14)	310/.75	25 CRUISE MNVR	up to 28000
Refuelling		320./75		

NOTE

- The optimum speed is 270 KIAS.
- MID Flap shall not be selected when tanker and receiver are in contact.
- Degraded CSAS Mode have not been tested, and planned operations shall be avoided.
- With the hose extended, aft CG limit is 26,5%.

Figure 5-18

B/B POD TRAINING MISSIONS LIMITATIONS

The B/B pods are not designed to be used for training the high number of contacts with partial hose retraction/extension (greater then 25) during one air refuelling training missions may lead to failures of the pod or a failure of single components.

The following additional limitation shall be observed during B/B air refuelling training missions:

- Maximum operating time with hose extended is 45 min.
  If an interval of 15 minutes or more is expected between series of training contacts, retract the hose and shut-down the B/B pod.
- During dry training contacts the B/B pod shall be kept full to provide better cooling for the pod's hydraulic system.
  If wet training contacts are performed, the B/B pod shall be refuelled when reaching 650 kg.

AIRSPEED AND MACH

The airspeed limits in Figure 5-19 refer to the clean aircraft. Maximum airspeed for airbrakes landing gear and arrestor hook operation are listed in Figure 5-20.

For external stores and Release/Launch and Jettison configuration, airspeed limits are shown in Figure 5-47 and Figure 5-46.

The following additional airspeed limitations apply if no moveable ribs are installed between the I/B wing pylons and the wing structure:

25° WSA airspeed ≤ 0.75 M
45° WSA airspeed ≤ 0.85 M
67° WSA no additional restrictions

With aircraft fitted with MK103 engines maximum speed depends upon engine modification state as follows:

- Pre mod. 31154 and 50189 - 650 kts
- Post mod. 31154, Pre 50189 - 720 kts
- Post mod. 31154 and 50189 - 750 kts
- Post mod. 31154, 50189 and 31194 - 800 kts
- MK103 engine only, below ISA 40° C maximum speed limits is 750 kts

PROHIBITED MANOEUVRES

The following manoeuvres are prohibited:

- Intentional stalls
- Intentional spins

NORMAL ACCELERATION AND MANOEUVRES

The normal acceleration limits for symmetric manoeuvres can be reached reducing the roll rates progressively to zero as the symmetric "g" is approached.
Normal acceleration limits for clean aircraft are shown in Figure 5-21. In addition apply the following limits:

- Above 600 KIAS in 45° WS cruise configuration the minimum permitted normal acceleration is 0 g NE.

MAX AIRSPEED (CLEAN AIRCRAFT)

Wing Configuration	Max speed (KIAS/M) (*)	
25° CRUISE/MNVR	500/.8	
25° MID	300/.55	
25° DOWN	225/.4	
45° CRUISE	630/1.6	
45° MNVR	600/1.0	
67° pre 01253	pre 01436	720/1.6
	post 01436	800/1.6
67° post 01253	pre 01436	720/1.6 ÷ 650/1.8
	post 01436	800/1.6 ÷ 650/1.8

(*) Limitation of the form 720/1.6 ÷ 650/1.8 are to be so interpreted: the limits is 720 KIAS from sea level to the altitude where 720 KIAS coincides with 1.6 M; then the limit is 1.6 M up to where 1.6 coincides with 650 KIAS; likewise, the limit becomes 650 KIAS from that altitude up to where 650 KIAS coincides with 1.8 M; then the limit becomes 1.8 M (this can be easily undersood on the Mach vs altitude charts).

Figure 5-19

– Pre Mod 30871 (both engines) at altitude below 7000 ft and speeds greather than 475 KIAS the minimum permitted normal acceleration is 0 g NE.

The normal acceleration limits when carrying external stores are given in Figure 5-42, Figure 5-47, Figure 5-46. For additional time limitations below +0.5 g refer to Engine Operation Chapter para "Time limitations below +0.5 g".

NOTE

If no delay timer installed (Pre mod 01361/01570) the CWP OIL P caption may flicker around 0 g.

WING SWEEP

Wing sweeping is cleared throughout the cleared flight envelope, but is not cleared during rapid rolling manoeuvres. The wings may be swept forward or aft at g values between +0.5g and 5.5g. To

MAX AIRSPEED FOR:

	CONDITION	MAX SPEED (KIAS/M)
AIRBRAKES ALL WSA	EXTENSION	0.95 M
LANDING GEARS ALL WSA	OPERATING HOLD EMERG. LOWERING	250 280 200
HOOK ALL WSA	EXTENSION HOLD (1)	250 500/0.8

(1) Aircraft limited to nominal 1g flight and gentle manoeuvres only, sideslip should be avoided.

Figure 5-20

minimise pivot wear, operate wing sweep below 4.5 g.

NOTE

- When sweeping the wings forward an increment of up to 0.5 g can occur.
- In the event of sweep jam at any intermediate position, the limitations for the more restrictive wing sweep position shall not be exceeded.

LANDING GEAR

Acceleration limits for landing gear operations are:

– Operating: 0 ÷ 3g (NE)
– Locked down: −2 ÷ 4g (NE)

AIRBRAKES

The minimum "g" for use of airbrakes is +0.5 g.

ANGLE OF ATTACK AND MANOEUVRES

The aircraft is cleared for flight with or without SPILS subject to the following limitations:

NORMAL ACCELERATION LIMIT CLEAN AIRCRAFT, ABOVE 15400 kg

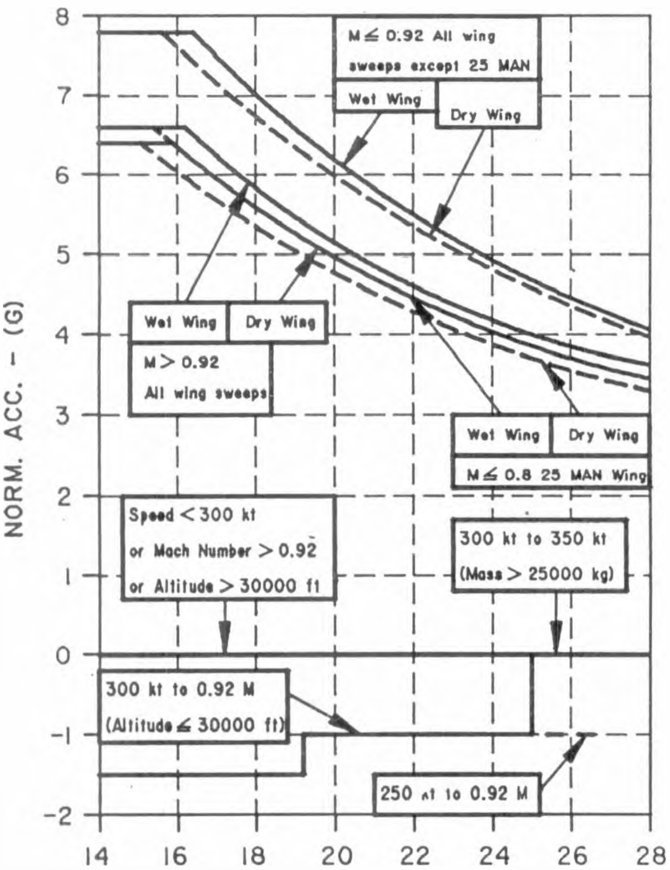


Figure 5-21

AOA Indications

All angle of attack limits quoted in this paragraph refer to HUD indications of AOA. Differences are to be excepted between HUD and strip indications of AOA during sideslip manoeuvres, particularly at high sideslip angles and during rapid rolling.

AOA limits for clean aircraft with SPILS ON or OFF are listed in Figure 5-22.

NOTE

When the flight refuelling probe is fitted (either stower or out) the strip AOA indications are effected so that the AOA limits quoted throughout this section should be reduced by 1 unit AOA, when reading from the strip indicator; the HUD is not affected.

Pitching Manoeuvres

The AOA is not to be increased beyond that point at which any of the following limitations is reached:

- the angle of attack limits
- the normal acceleration (g) limits
- heavy buffet or severe wing rock.

CAUTION

- IN ORDER TO AVOID PITCH-UP IN 45 CR WING, THE USE OF 45 MNVR IS RECCOMENDED WHEN MANOEUVRING ABOVE 400 KIAS/0.8M.
- AIRBRAKES SHALL NOT BE USED ABOVE 14 AOA.

NOTE

- Refer to Engine Operation chapter paragraph "Engine operation in flight" for relationship between AOA and throttle handling in flight.
- For AOA limits during landing with flap/slat failure, refer to Figure 5-35.
- The AOA during take-off shall not exceed 17 AOA.

- The maximum target AOA value for threshold is 12 units AOA and for flare 15 units AOA.
In turbolence and crosswind these values should be reduced as appropriate.

- Care should be taken when sweeping the wings near the angle of attack limits, as pitch up can occur when sweeping forward.

- Aerodynamic braking is permitted up to 18 AOA and down to 100 KIAS, under crosswind conditions as given in Figure 5-32 except when carrying stores where the limit is 14 AOA unless otherwise indicated in the relevant Figure 5-47.

- Max AOA limits for aircraft with external stores (including pylons) are contained in Figure 5-47.

- SPILS switching from OFF to ON and viceversa is permitted only below 10 AOA.

SIDESLIP OR YAWING MANOEUVRES

Provided that the rudder is trimmed central, full rudder pedal is permitted at any speed in nominal 1 "g" straight and level flight.

Otherwise, the rudder shall only be used to minimise slip-ball excursion.

STALLING OR SPINNING

WARNING

DELIBERATE STALLING OR SPINNING IS PROHIBITED.

GROUND ATTACK DIVES AND RECOVERY

Ground attack dives are permitted up to dive angles of 55°.

The radar altimeter shall not be used for primary height reference (see also AVIONIC SYSTEM paragraph).

ANGLE OF ATTACK LIMITS, CLEAN AIRCRAFT (SPILS OFF)

Wing	Never Exceed	Mach
25/45 CRS MVR 67	21	M < 0.92
45° CRS MVR 67°	17 18	M > 0.92
25 MID/FULL	21	N/A

ANGLE OF ATTACK LIMITS, CLEAN AIRCRAFT (SPILS ON)

Wing	Never Exceed		Mach
	100 to 350 KIAS	> 350 KIAS	
25° CRS	NO LIMIT	21	< 600/.92
25° MVR 45° MVR	NO LIMIT	NO LIMIT	
45° CRS	NO LIMIT	21	
67°	21	21	
45° CRS/MVR	17	17	M > .92
67°	18	18	
25 MID/FULL	21	–	N/A

NOTE

- SPILS OFF means Pre Mod. 00555 or Post Mod. 00555 with SPILS inoperative.
SPILS ON means Post Mod. 00555 with SPILS operative.
- No coarse lateral control inputs above 18 AOA with Mid and Full Flap setting.
- With flight refuelling probe fitted the incidence strip gauge underreads by 1 unit AOA. The HUD is unaffected.
- Yawing Manoeuvers. Rudder alone or crossed controls may be applied up to 18 AOA at M < .92 and up to 13 AOA at M > .92.

Figure 5-22

RAPID ROLLING

Rapid rolling is defined as the rapid and large application of lateral stick to achieve high rates of roll with large roll attitude changes. Rapid rolling for clean aircraft is permitted only within the limitations given in Figure 5-23. Rapid Rolling with external stores is permitted only within the envelope defined in Figure 5-24 and in Figure 5-47.

SPILS ON AOA
For limits below 0.92M see Figure 5-22.

SPILS OFF AOA

M < 0.92	M > 0.92
18	14

MINIMUM SPEED (SPILS ON and OFF)

WING SWEEP	SPEED
25 45 67	200 KCAS 240 KCAS 250 KCAS

WARNING

OPERATION BEYOND THE RAPID ROLLING ENVELOPE AT NEGATIVE "G" CAN BE EXTREMELY HAZARDOUS.

NOTE

- Rapid rolling is permitted in full CSAS with no first failure. With any CSAS failure, gentle rolling manoeuvres only are permitted.
- Rapid Rolling is prohibited above 750 KCAS
- Rapid Rolling is prohibited above 40,000 ft
- When flying with SPILS ON above 0.92M SPILS OFF limits apply.
- For "g" limitations for clean aircraft see Figure 5-23.
- The quoted AOA and "g" limits apply for entry conditions.
- During rapid rolling the AOA indications become unreliable.
- Rapid rolling in excess of 180° is only permitted between 0 and 2 g. With entry of less than 2 "g" rapid rolls can be increased, but not exceed 360°. Continuous rapid rolls in excess of 360° are not permitted.
- The aircraft is to be trimmed in nominally 1 'g' flight and not retrimmed under 'g' before rolling.
- Rapid rolling have not to be commenced in heavy buffet or in presence of adverse lateral handling phenomena.
- Intentional application of rudder is not permitted during rapid rolling (Pre or Post mod. 00555 with SPILS inoperative).
  Post mod 00555 with SPILS operative: when rolling above 18 units AOA, rudder may be used with lateral stick to improve roll rate.
- Continuous rapid rolls in excess of 360° are not permitted.
- Rapid rolling in excess of 180° is only permitted between 0 and 2 "g".
- Rapid rolling during wing sweeping or selection/deselection of flaps and slats, or with airbrakes operating or extended, is not permitted.
- Rapid rolling with landing gear or flaps extended or in operation is not permitted.

Outside the rapid rolling envelope, the aircraft is cleared for gentle rolling and for normal turning manoeuvres.

This means that the aircraft is cleared for all in service manoeuvre requirements, providing roll rate is progressively reduced to nominally 0 as the symmetric "g" or AOA limits is approached.

RAPID ROLLING G LIMITS
A MANOEUVRE ENTRY (FOR 180° ROLLS)

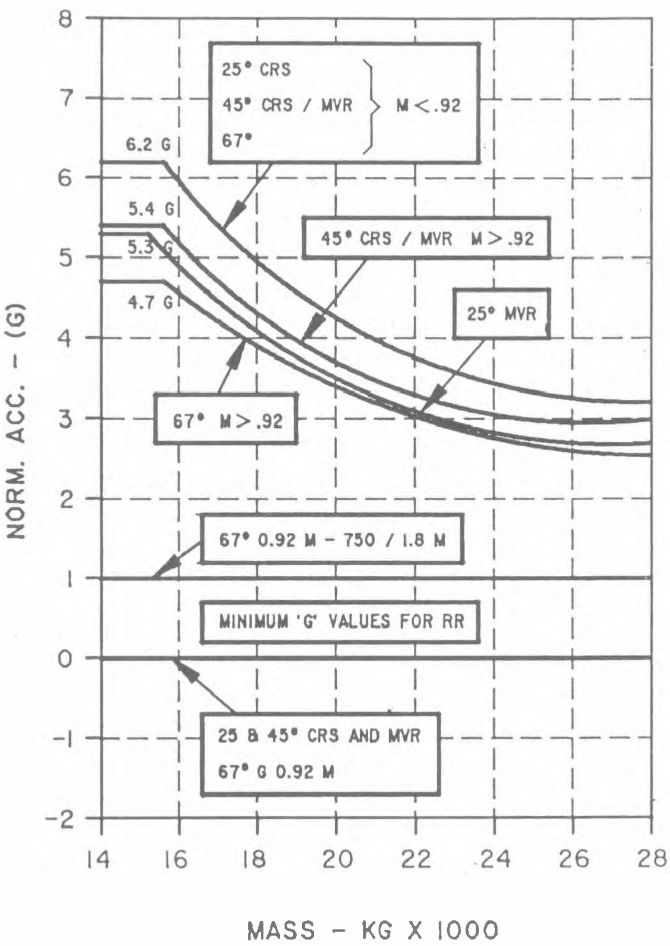


Figure 5-23

ALTITUDE

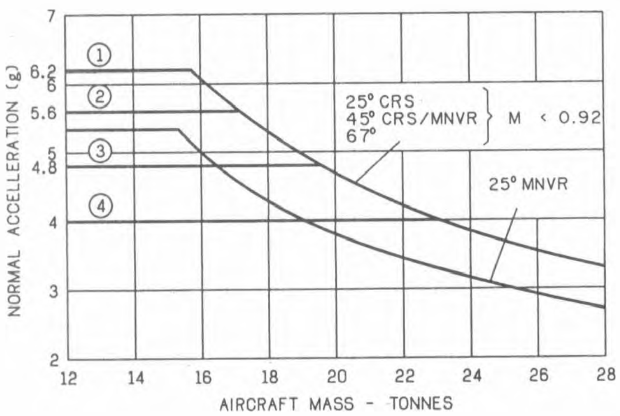
The aircraft is currently cleared to a maximum altitude of 50.000 ft MSL.
The minimum permitted altitude is unrestricted below 500 kt, while above 500 kt it is 100 ft above ground or sea level.

MASS

Maximum take-off mass is 27500 kg. (28500 Post mod 11045); maximum overload landing mass 23500 kg.

Maximum mass for touch and go landings with MID flaps is 20000 kg, with flaps DWN is 18000 kg.

RAPID ROLLING ACCELERATION LIMITS
(External stores configurations)



Group of external stores configurations	Configuration and state of i/b tanks fuel (if any) with or without o/b stores
Group 1	– A3, A4, B2, D2, D3, F2, F3, H2, K4
Group 2	– A2, A5, B1, B3, B4, D1, E1, F1, H1, K1, K2, K3 (all with empty i/b tanks); – E2
Group 3	– C1 (with empty i/b tanks); C2, C3
Group 4	– All configurations with full i/b tanks except A1, G1, M1

NOTE: – Empty i/b tanks state is with < 100 kg fuel left; Full i/b tanks state is with > 100 kg fuel left; Minimum g is zero for all cleared configurations.

Figure 5-24

For landing masses above 17000 kg, particular attention should be paid to minimise the sink rate at touch down (see Figure 5-31).

CENTRE OF GRAVITY

The centre of gravity of the aircraft clean or with any stores configurations cleared, shall be held within the below defined boundaries throughout the whole flight (Figure 5-25).

NOTE

- Fuel management plans shall be prepared for each flight to allow for variations of CG position due to fuel state and weapon release, so that CG limits can be respected.
- The airbrakes are cleared for use provided that the CG is forward of 26% in the 25° WS, slat/flap UP and LG down configuration.

CENTER OF GRAVITY POSITION

WING SWEEP	SLAT/FLAP	U/C	FWD LIMIT MAC	AFT LIMIT MAC
25°	MID (25° flap)	DOWN	14	28 (1)
	MID (35° flap)	DOWN	14	29 (1) + (2)
	DOWN	DOWN	14	29 (1)
	MNVR	UP	13	27.5
	UP	UP	13	27.5
45°	UP	UP	16	36.5
	MNVR	UP	16	36.5
67°	UP	UP	18	44

1. With LG up the CG will move approximately 1% forward.
2. The airbrakes are cleared for use provided that the CG is forward of 26% in the 25° WS, slat/flap UP and LG down configuration.

Figure 5-25

GROUND STABILITY AND OPERATION

STABILITY ON THE GROUND

NOTE

- The limitations and precautions as defined in AER.1F-PA200-5, Weight and Balance Data, shall be observed.
- The rear tank group contents shall not exceed those of the forward group by more than 900 kg without support under the rear of the aircraft.

CONFIGURATION AND FUEL STATES

The table shown in Figure 5-26 applies to aircraft not loaded with full ammunition belts or adequate ballast in lieu of ammunition.

For slopes less than 3° provided that the CG position is within the boundaries defined in Figure 5-25, the maximum permitted wing sweep angles during taxiing for various fuel states and stores configurations are as follows:

NOTE

- For aircraft fitted with full ammunition belts, or ballast in lieu of ammunition, the wing sweep values for fuselage stores of over 2000 kg are permitted.
- Maximum wing sweep angle is limited to 25° if the contents of the rear group exceeds those of the front group for all load configuration.
- The maximum AFT CG position for taxi is 27.7% MAC and the above table is based on this criterion.

AIRFIELDS

The aircraft is cleared to taxi, take-off from and land on asphalt or concrete runways which are subxtantially clear of snow, slush and ice, free from flooding and significant ponding and which meet the minimum load classification number (LCN) or single wheel load classification (SWL) values indicated in Figure 5-27.

In an emergency case, flooded runways can be used for landing, but the max crosswind component should not exceed 10 kt and thrust reverser shall be restricted to IDLE only.

Airfield Categories

- Cat D for 25° WS with flaps in MID or DOWN and full CSAS
- Cat E for other wing sweep and flaps in UP.

CONFIGURATION AND FUEL STATES LIMITATION

Wing Mounted Stores	Normal Fuel States	Maximum Wing Sweep Angle with Fuselage Mountage Stores	
		Up to 2000 kg	Over 2000kg
Inboard only	Part fuel Minimum Landing fuel	35°	45°
	Full fuel	45°	
Outboard with or without inboard	Minimum Landing fuel	25°	35°
	Full fuel Part fuel	35°	45°
None	Part fuel Minimum Landing fuel	45°	67°
	Full fuel	67°	

Figure 5-26

MINIMUM LCN OR SWL CLASSIFICATION VALUES

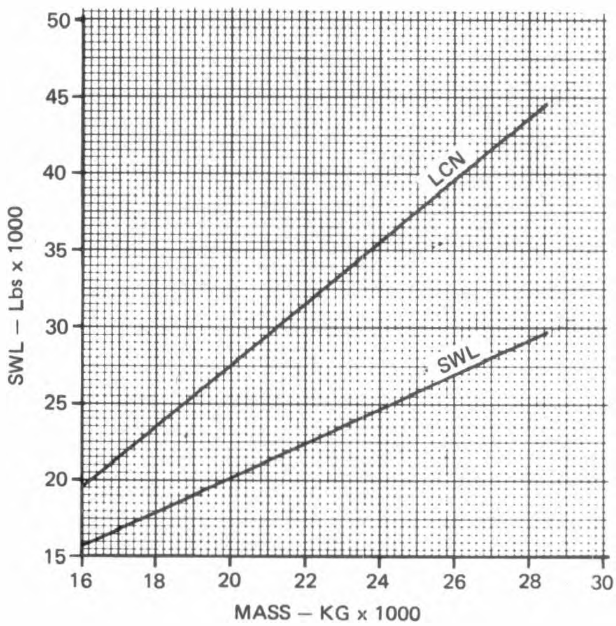


Figure 5-27

TAXIING

CAUTION

THE CANOPY SHALL BE CLOSED DURING TAXIING. FOR AMBIENT TEMPERATURE IN EXCESS OF + 30°C REFER TO "ENVIRONMENTAL CONDITIONS", CHAPTER.

Taxiing is permitted in wind speeds up to 50 kt and taxi nozzle should be used in preference to wheel brakes to minimise brake temperature.

The limitation on taxi distances and the minimum permitted turnaround period between consecutive sortie to avoid exceeding the temperature limitations of the main wheel tyres can be derived from following Figure 5-28 (26 ply tyres) and Figure 5-29 (24 ply tyres).

Explanation for operation of Figures 5-28 and 5-29

Consider two sorties to be flown by the same aircraft during the day with a minimum waiting time between sorties.

Sortie 1 aircraft weight	25.5 tonnes
Taxi out distance	3 km.
Taxi back distance	2 km.
OAT = 20°C = tyre bead temperature	
Sortie low level for two hours	
landing weight	17 tonnes

1. Enter chart on left hand side at point A which equates to 3 km taxi out, continue line until 25.5 tonnes weight line is intersected B.

2. Enter chart on left hand side at point C which equates to + 20°C tyre bead temperature and follow the guide line until point D is reached. This is the interconnection of the temperature guide line and a vertically projected line from point B.
This relates OAT, taxi distance and weight.

3. Continue from point D horizontally to waiting time E; as temperature is below 90°C no waiting is required.

4. Continue flight time F, follow cooling line for two hour sortie.

5. Enter landing graph at point G and follow guide to give temperature rise due to landing roll.

6. Enter brake graph at point H and follow guide line to say "light braking" then continue horizontally to point L.

7. Taxi back requires entry of taxi distance at point J until 17 tonnes weight line is intersected at point K draw vertical line from point K to point M which intersects the tyre temperature guide line starting at point L. This relates tyre bead temperature, distance and weight.

8. Enter the cooling graph at point N. For a second sortie at the same weight, taxi distance flight time the waiting time may be calculated as follows:

9. Return to the left hand side of the chart.

10. The taxi distance and weight points A and B are identical, draw the vertical line upwards from point B to point P where it intersects the 90°C horizontal line. This equates to the maximum bead temperature for take-off. Follow the guide line back to the axis and read off the tyre bead temperature equating to this condition at point Q = 35°C.
    This will be the maximum allowable temperature for the start of the taxi out for the second sortie.

11. Return to the cooling curve and follow the graph from point N to 35°C, point R. Read time of cooling = 2 hours 35 minutes.
    Apply note 2 (i.e. no brake heat) and substract 30 minutes:

Min. Cooling Time = 2 hours 5 minutes before second sortie.

Sortie 2 aircraft weight		25.5 tonnes
	taxi out distance	3 km
	taxi back distance	2 km
	landing weight	17 tonnes
	flight time = 2 hours with one hour at	25000 ft

12. Enter graph at point A for taxi distance and weight and at point Q for tyre bead temperature (calculated from cooling).

13. Intersect at point P, follow through wait time graph as 90°C is top value requiring no waiting time.

14. Enter flight time graph at point S.

15. Enter landing graph at point T.

16. Enter brake graph at point U – assume moderate braking is used.

17. Enter taxi back graph at point V.

18. At entry to cooling graph at point W apply note 4 and reduce tyre bead temperature by 20°C for time at altitude and center cooling graph at point X.

19. For a third identical sortie the cooling time will again be that required to reduce the tyre temperature to 35°C. This time, however, the full curve shall be used as during the landing run the brakes were used (note 2) and during the initial half hour brake heat will transfer to the tyre, preventing cooling.

Min. cooling time will be 2 hours 41 minutes before third sortie.

APPROACH AND LANDING

APPROACHES AND OVERSHOOTS

Approaches and overshoots are permitted for training purposes in full CSAS within the crosswind limits given in this chapter. Maximum aircraft mass is 19000 kg for the following configurations:

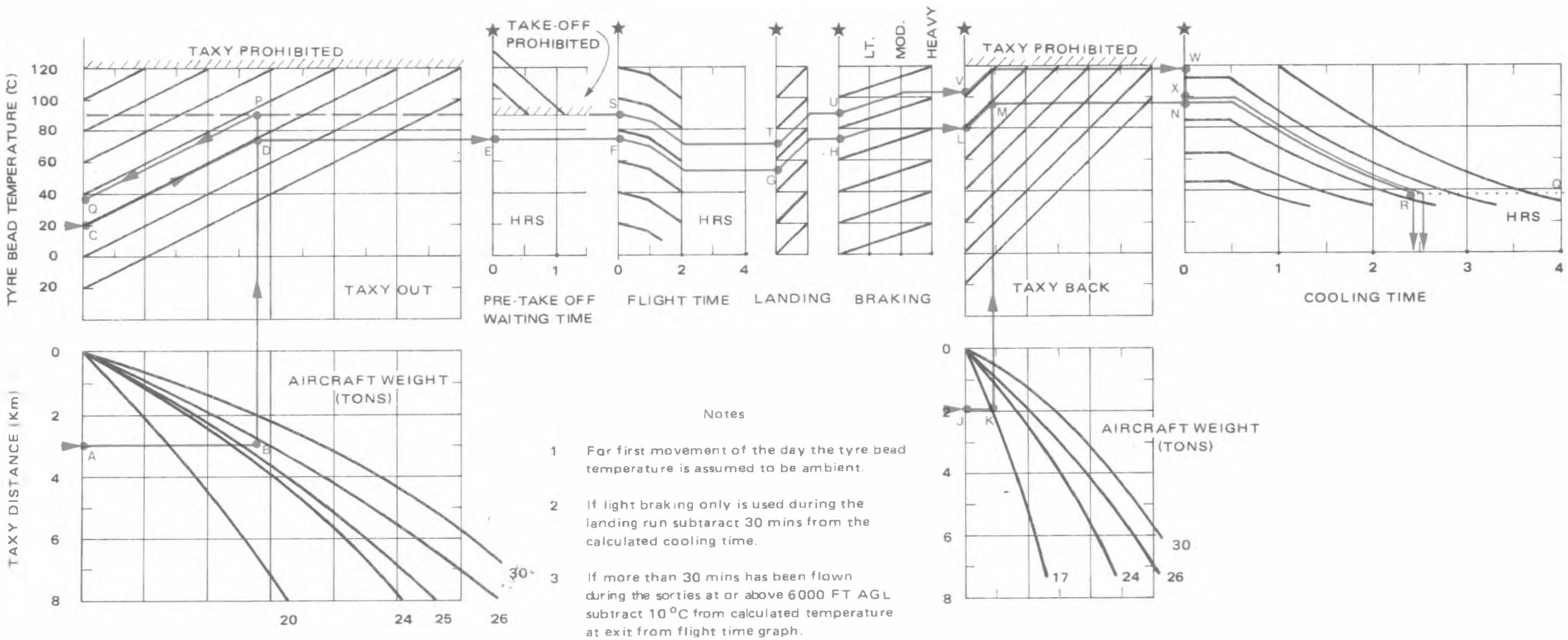
- 25° Cruise/MNVR
- 45° Cruise/MNVR   landing gear DWN
- 67°

Touch and go landing or full stop landings following approaches in above configuration are not permitted except for emergencies.

WARNING

SPILS SHALL BE SELECTED OFF FOR LANDING.

TYRE BEAD TEMPERATURE CHARACTERISTICS – 26 PLY MAIN WHEEL TYRES



Notes

1 For first movement of the day the tyre bead temperature is assumed to be ambient.

2 If light braking only is used during the landing run subtaract 30 mins from the calculated cooling time.

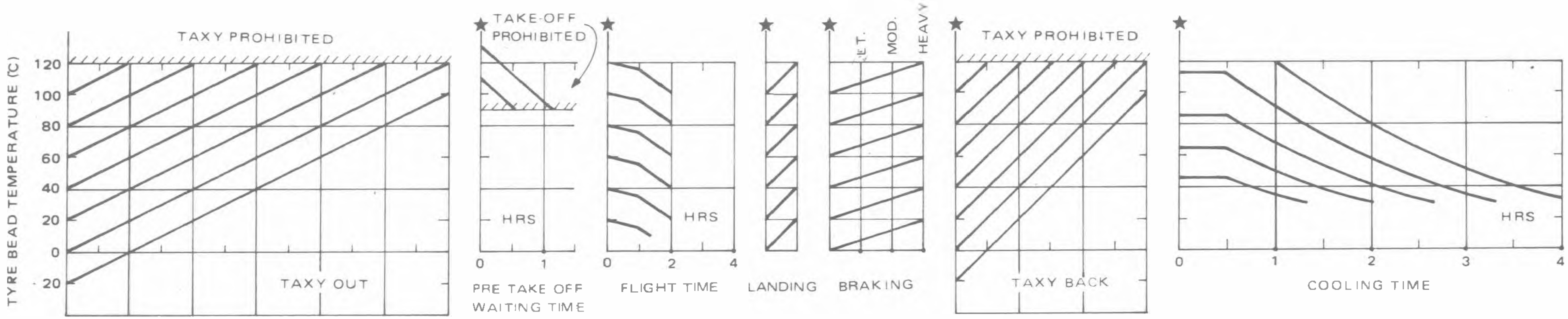
3 If more than 30 mins has been flown during the sorties at or above 6000 FT AGL subtract 10 °C from calculated temperature at exit from flight time graph.

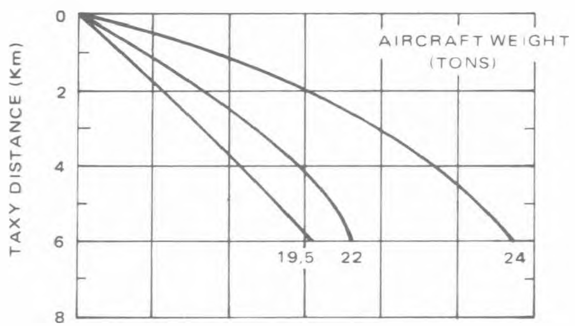
4 If more than 60 mins at or above 6000 FT AGL subtract 20°C from calculated temperature at exit from flight time graph.

★ : REFERENCE LINE

Figure 5-28

TYRE BEAD TEMPERATURE CHARACTERISTICS — 24 PLY MAIN WHEEL TYRES





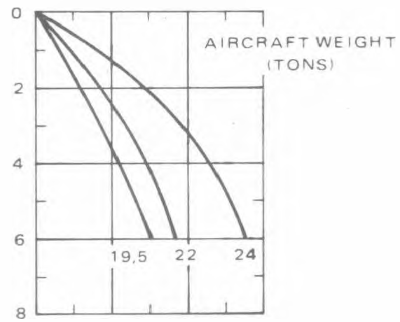
Notes

1 For first movement of the day the tyre bead temperature is assumed to be ambient.

2 If light braking only is used during the landing run subtaract 30 mins from the calculated cooling time.

3 If more than 30 mins has been flown during the sorties at or above 6000 FT AGL subtract 10 °C from calculated temperature at exit from flight time graph.

4 If more than 60 mins at or above 6000 FT AGL subtract 20°C from calculated temperature at exit from flight time graph.



★ : REFERENCE LINE

Figure 5-29

MAXIMUM NUMBER OF TOUCH AND GO LANDINGS

AMBIENT TEMP.°C	1st SORTIE OF THE DAY		SUBSEQUENT SORTIE	
< + 10	6	Notes 1, 2, 3, 4, 6	5	Notes 1, 2, 3, 5, 6
+ 10 to + 20	5		4	
+ 20 to + 32	4		3	
+ 32 to + 40	3		2	
+ 40 to + 45	2		1	

WARNING

SPILS SHALL BE SELECTED OFF FOR TOUCH AND GO LANDINGS.

NOTE

1. The maximum permitted number of touch and go landing is valid for a NATO standard airfield (3 km taxi out and 3 km taxi in).
2. Aircraft mass from 19.000 kg to 20.000 kg taxi out or taxi back distance less than 3 km, add 1 landing to the permitted number for each 1.5 km of reduction.
   Taxi out or taxi back distance more than 3 km, subtract 1 landing from the permitted number for each 1.5 km (and part thereoff) of excess.
3. Aircraft mass < 19000 kg and crosswind < 20 kt, add 2 landings to the permitted maximum. If taxi out or taxi back distance is less than 3 km, add 2 further landings for each 1.5 km reduction, or the maximum number is reduced by one for each 3 km of excess.
4. Following a first sortie on which the maximum permitted number of touch and go landing were performed a period of 1.5 hour is to be added to the minimum cooling period derived from Figure 5-28 and Figure 5-29. If a lesser number of touch and go landings were performed, this cooling period is reduced by 15 min. for each roller landing less then the maximum permitted number.
5. If a subsequent sortie with touch and go landings is planned, following:
   - a touch and go sortie. Note 4 shall be observed but in addition the tire cooling times shall be increased by 15 minutes for each planned landing, subject to an overall maximum of one less than the number permitted on the first sortie of the day
   - a normal landing sortie, the cooling period defined in Figure 5-28 and Figure 5-29, shall be increased by 15 minutes for each planned touch and go landing, subject to an overall maximum of less than the number permitted on the first sortie of the day.
6. If the maximum permitted number of touch and go landings is unavoidably exceeded by one, the permitted taxi back distance is reduced by 1.5 km.

Figure 5-30

TOUCH AND GO LANDINGS

Touch and go landings can be flown for training purposes and are restricted to the normal take-off/landing configurations with the flaps set to MID or DWN (Refer to "Touch and go landings", Section 2).
The maximum permitted number of touch and go landings are given in Figure 5-30.

VISUAL APPROACH

The aircraft is cleared to overshoot from any heigh above ground level, within the applicable limitations given in this section.

INSTRUMENT APPROACHES

The aircraft is cleared for instrument approaches using the following aids:
PAR: for precision approaches
SRA, TACAN, GMR: for non precision approaches.

WARNING

AS BOTH THE FRONT COCKPIT HEAD-DOWN ALTIMETER IN STAND-BY MODE AND THE REAR COCKPIT ALTIMETER OVERREAD BY 30 FT. ALL QUOTED VALUES SHALL BE INCREASED BY THIS AMOUNT TO OBTAIN INDICATED VALUES. NO CORRECTION NEEDS TO BE APPLIED TO THE HUD OR TO THE FRONT COCKPIT HEAD-DOWN ALTIMETER IN SERVO MODE.

CAUTION

RADAR ALTIMETER SHALL NOT BE RELIED UPON BELOW 200 FT AGL. THE RADAR ALTIMETER SHOULD NOT BE RELIED UP ON AS THE SOLE HEIGHT REFERENCE.

NOTE

- For an approach with full or mid flaps, 25 wing sweep and fully operative CSAS, the aircraft will come into category D.
- With other wing sweeps and flaps up it will come into category E.

LANDING/TAXI LIGHTS

The maximum permitted operation time of the landing lights is 30 minutes per operation, which shall be followed by a 15 minutes cooling period.

THRUST REVERSER

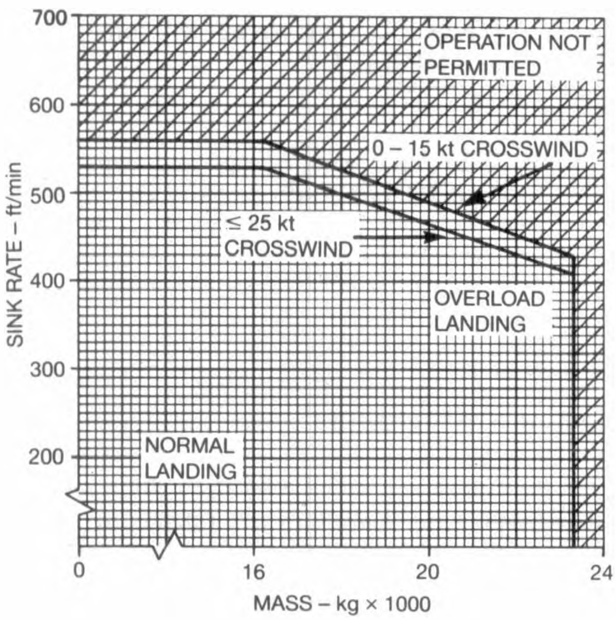
Thrust reverse is cleared with NWS engaged (NSAS operating) for normal operation up to MAX DRY from 165 KIAS down to reingestion warning anc at IDLE rating down to normal taxiing speed.

CAUTION

IF SELECTION OF THRUST REVERSE WAS MADE DURING TAXIING OUT, THE LOCKING SYSTEM HAS TO BE INSPECTED PRIOR TO TAKE-OFF.

In an emergency case TR may be used at speeds up to 200 KIAS with gentle throttle movements. When not using pre-armed thrust reverse, TR deployment is not to be initiated prior to nosewheel touch down. Selection is to be made at RPM of not more than 85% NH at speeds up to 165 KIAS and IDLE only at speeds from 165 to 200 KIAS.
TR shall not be selected or preselected until the airbrakes are indicating IN. Airbrakes are to remain IN during T/R operations.

TOUCH DOWN SINK RATE CHART



Post mod 11045 (Modified MLG airspring)

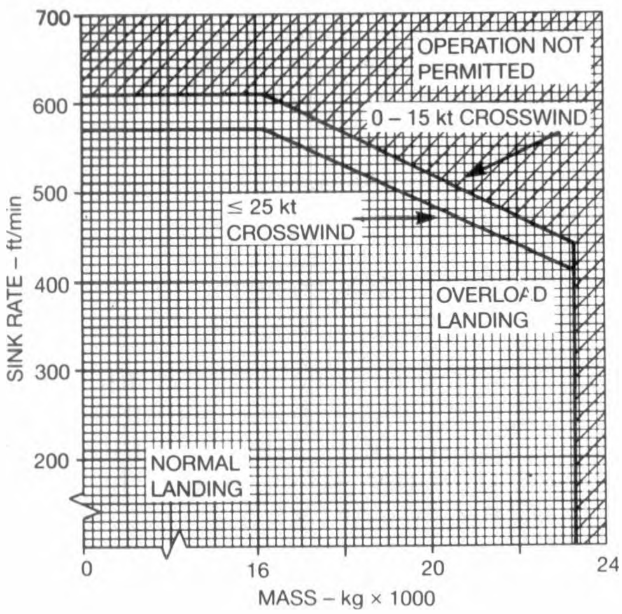


Figure 5-31

WARNING

- USE OF THRUST REVERSER IS PROHIBITED ON FLOODED RUNWAYS WITH ANY STANDING WATER OR SIGNIFICANT PONDING, EXCEPT IN EMERGENCY AND ONLY UP TO 10KT X-WIND.
- USE THRUST REVERSE WITH CAUTION ABOVE IDLE IN CASE OF ASYMMETRIC EXTERNAL WING STORE CONFIGURATION.

NOTE

- Wheel brakes may be applied, progressively up to full pedal pressure, 2 seconds after TR selection.
- For effect of crosswing limits on TR operation refer to Figure 5-32.

Thrust reverser preselection in flight for landing is permitted only when in full CSAS. Following additional restriction apply:

- The maximum target AOA value for threshold is 10 units AOA and for flare is 12 units AOA.
- Wind speed shall not exceed 25 kt. The crosswind component shall not exceed 20 kt.
- Power setting over the threshold shall not exceed 85% NH an this power level should not be exceeded during flare.
- At mainwheel touch down the throttles shall be reduced to idle and the nosewheel gently lowered to the runway.
- The engine RPM shall not be increased until after nosewheel touch down and NWS is engaged.
- Application of brakes shall be delayed until at least 1 second after nose wheel touch down with NWS engaged.
- Maximum mass 20.000 Kg.
- Preselection with asymmetric thrust reverse is not allowed.

NOTE

These limits have been imposed to minimise the possibility of a high de-rotation rate which could lead to structural damage. TR is only to pre-selected before landing when the pilot is reasonably sure of achieving a low sink rate at touch down. If the preselection limits are exceeded or a high sink rate touchdown appears possible, the preselection shall be cancelled immediately.

Asymmetric TR is permitted provided that the selection is performed with NW on the ground within the crosswind limits given in Figure 5-32.

CAUTION

MAXIMUM SPEED/ENGINE SETTING FOR TR SELECTION ARE:

- UP TO 140 KIAS AT IDLE OR UP TO 120 KIAS AT 80% NH (DRY RUNWAY ONLY): CONFIGURATIONS: CLEAN ± PYLONS ± O/B STORES ± I/B TANKS EMPTY ± U/F CBLS ± U/F BOMBS.
- UP TO 100 KIAS (AT IDLE ONLY): ALL REMAINING CONFIGURATION.

On dry runways only, after selection of T/R the throttle may be opened to max dry.
Particular care shall be observed when using asymmetric TR on wet runways, being prepared to cancel reverse thrust if excessive drift builds up.

WHEELS AND TYRES

The wheels and tyres are cleared for use up to the maximum emergency landing speed of 240 Knots ground speed (normal operation is up to 180 KIAS for landing). After a landing at speeds greater than 180 Knots ground speed the tyres shall be inspected for damage and shall be replaced after landings at a speed greater than 200 Knots ground speed.
The main wheel tyres shall be changed after an aborted take-off during which significant braking above 50 knots ground speed took place.

CAUTION

AT AIRCRAFT MASSES ABOVE 28.000 KG, DUNLOP OR GOODYEAR 26 PLY TIRES SHALL BE USED.

NOTE

Following an aborted take-off during which significant braking is used above 50 kt ground speed, further taxiing or ground movement is limited to immediately clearing the runway. The tyres should be treated with caution for 30 minutes and the tyres should not be rolled for 1.5 hours after clearing the runway.

WHEEL BRAKES

The wheel brakes shall carefully inspected after an aborted.take-off with brakes-on speed of more than 80 Knots ground speed.

CROSSWIND

Unless otherwise specified (Figure 5-47) the aircraft is cleared for take-off and landing within the following crosswind components (including gusts) depicted into the following Figure 5-32.

NOTE

Because of possible pitch up tendencies, the use of airbrakes should be avoided when carrying large underfuselage stores under sideslip conditions e.g. with crosswinds greather than 10 kt the kick off drift phase.

The maximum crosswind components with various degraded aircraft systems including CSAS and intermediate wing sweep are given in Figure 5-33.

MAXIMUM CROSSWIND COMPONENTS (Kt)

RUNWAY STATE	CLEAN ± U/W STORES (°)			U/F STORES ± U/W STORES			ALL CONFIG	
	NO T/R	SYMMETRIC T/R		NO T/R	SYMMETRIC T/R		ASYMMETRIC T/R	
		AT IDLE	UP TO MAX DRY		AT IDLE	UP TO MAX DRY	AT IDLE	UP TO MAX DRY
BRAKING ACTION GOOD	35	35	30	25	25	25	10	10
BRAKING ACTION MEDIUM	25	25	15	25	20	15	10	NC
BRAKING ACTION POOR	10	10	5	10	10	5	10	NC

NC : NOT CLEARED
(°) : Including pylons only or pylons + CBLS U/F

NOTE

- Stanag 3634 refers braking action to meter or equivalent measuring device readings. If braking device reading is not available: for dry runway use good braking action limits for wet runway use medium braking action limits.
- When using T/R on wet runways or on dry runways with crosswind greater than 15 kt, be prepared to reduce power to idle and to cancel T/R if excessive drift builds up.

Figure 5-32

CROSSWIND – LIMITS WITH DEGRADED AIRCRAFT SYSTEMS

<table>
<tr><th>MAX X-WIND COMPONENTS (Kt)</th><th>FAILURE CASES</th><th>MAX X-WIND COMPONENTS (Kt)</th><th>FAILURE CASES</th></tr>
<tr><td>20</td><td>– CSAS 2nd fail.: PDL; RDL;
NO YAW DAMP; Train Mode (Pitch/Roll link)
– Single engine failure</td><td rowspan="2">10</td><td rowspan="2">– CSAS 2nd fail.: I/B and O/B spoilers (1) (2) (3): Rudder lock; Mech. Mode (P/R link plus Rudder Lock)
– W/SW other than 25
– Flap/slat
– Mass asymmetries of wing mounted tank or two shoulder mounted stores on the same side.</td></tr>
<tr><td>15</td><td>– CSAS 1st fail: I/B or O/B spoilers (1) (2)
– NWS
– NSAS</td></tr>
<tr><td colspan="4">(1) Use rudder with caution, with I/B or O/B spoiler failure be prepared to reduce T/R to IDLE and if necessary cancel if excessive drift builds up.
(2) Following outboard spoiler failures the use of preselected lift dump is prohibited.
(3) With both I/B and O/B spoilers failed use of T/R above IDLE is prohibited.</td></tr>
</table>

Figure 5-33

NOTE

- CSAS 1st failure are limited as for normal operation except I/B or O/B spoilers.
- For combination of failure cases the most restrictive limitation applies.

ARRESTING SYSTEMS

It is recommended that selection of hook down should be delayed until within approximately 200 m of the cable.

CAUTION

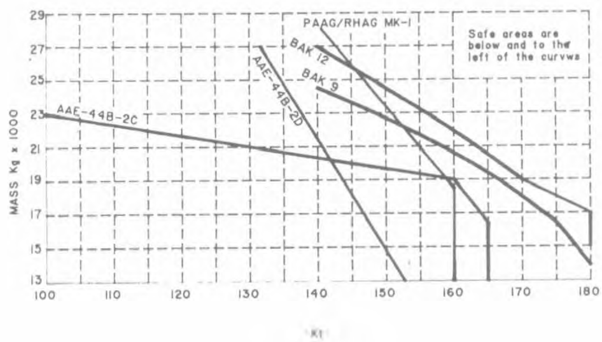
THERE IS A RISK OF MISSED ENGAGEMENT DUE TO HOOK BOUNCE OR HOOK ARM SWING DUE TO DISCONTINUITIES IN THE RUNWAY SURFACE, OR DURING ASYMMETRIC THRUST REVERSE. ON RUNWAYS FITTED WITH CENTRE LINE LIGHTS, AN OFF-CENTRE LINE ATTEMPT SHOULD BE MADE WITH A MAXIMUM OFFSET OF 10 METERS. IF ASYMMETRIC TR IS USED THE HOOK SHALL NOT BE LOWERED OR USED WITH ENGINE POWER ABOVE IDLE.

A selection of the most common arresting systems and performance data are shown in Figure 5-34. Safe barrier
engagement can be expected below and to the left of the curves which represent the respective arresting system.

NOTE

- The nosewheel shall be on the ground and the wheel brakes released before cable engagement.
- After engagement neither wheel brakes nor TR have to be applied.
- The aircraft is clear to trample over the rigged and derigged-down cables of the above arrestor gears in the clean configuration and in the stores configurations as defined in Figure 5-47 except that, when the aircraft is fitted with external fuel tanks mounted on the U/fuselage pylon, the crossing speed of the rigged cable is limited to 10 kt.
- Formation take-off and landing movements over the rigged and derigged-down arrestor cables are permitted.
- In an emergency the arrestor hook may be selected down in flight during the approach, to achieve an approach end engagement.
- The maximum speed limit for hook extension in flight is 250 KIAS. The maximum speed with the hook extended in flight is 500 KIAS/0.8 M and the aircraft is limited to nominal 1 g flight with gentle manoeuvres; sideslip should be avoided.

ARRESTING SYSTEM



WARNING

- During cable engagement into barrier AAE-44B-2C the nosewheel shall be centralised and the NWS selected to HIGH when stopped to improve aircraft stability during the pull back.
- Neither wheel brakes nor TR should be used during the pull back phase.
- Barrier PAAG shall be used for emergency case only; use RHAG MK1 arrester characteristic.

Figure 5-34

ENVIRONMENTAL CONDITIONS

The aircraft is cleared for takeoff, landing and engine running in ground level ambient temperature of -15°C to + 32°C (Post mod. 00839, 01229 and 00924; -15°C to +45°C).

Engine starts on the ground shall not be attempted below -15° C when F44 fuel is used.

NOTE

For operation above 32°C the following procedures shall be followed:

Pre mod. 00839:
Check the correct functioning and freedom from binding of the canopy locking/unlocking mechanism using the external handle immediately prior to aircrew manning.
Above 38°C minimise the effect of solar radiation upon the canopy locking mechanism.

Pre mod. 01229: for operation above + 32°C.
The head box ventilation may be reinstated by fitting mod. 00924.

In addition following a flight, or storage in a hangar or hardened a/c shelter (HAS) at temperature above 0°C the aircraft is cleared additionally to operate in ground level ambient temperatures of -15°C to -20°C after exposure for up to 6 hours in wind speeds less than 10 kt or for up 2 hours in wind speed greater than 10 kt. In ground level ambient temperature of -20°C to -25°C the a/c is clear to operate after exposure for up to 3 hrs in wind speeds less than 10 kt or for up to 1 hr in wind speed greather than 10 kt.

Following storage in HAS at internal HAS temp. between 0°C and -15°C, the a/c is cleared for immediate operations in ground level ambient temperature of -15°C to -25°C provided that APU and engine starts are carried out inside the HAS.
In the ground ambient temperature range from + 30°C to + 45°C the following limitations apply:

- The ECS shall be selected to ERA for all pre flight activity including taxiing. If a significant hold prior to take-off occurs the canopy should be closed. ECS selected to ON and one engine power set in the range of 80% to 85% NH. This condition should not exceed 10 minutes.

The canopy should remain fully open during all pre flight activity. For taxiing the canopy should be closed.

NOTE

A canopy cover should be used whilst the aircraft is parked in the sun for more than 1 hour and only to be removed immediately prior to the first engine start.

The aircraft may be exposed in the inoperative condition to temperature within the range of -20°C to +50°C. Above 30°C the canopy cover shall be in position.

RAIN CONDITIONS

The aircraft should not be left in precipitations unless the canopy seals are inflated.
Access to the cockpit and avionic compartment is to be kept to the minimum essential for aircraft safety or crewing. The airbrakes are to be kept closed.
The aircraft is cleared for flight in precipitation levels up to heavy rain (i.e. 15mm/hour intensity).

ENVIRONMENTAL CONTROL SYSTEM

ECS

The ECS shall be selected to EMERG RAM AIR or to ON at all times when electrical power is being applied to the aircraft. Performance take-off shall be effected with ECS to ERA: normal take-off, ECS to ON.

ECS FAILURE

(Post mod. 00921/00859)
If an air system failure is indicated on the CWP, the air system master switch should be reset. If reset is unsuccessful, EMERG RAM AIR shall be selected.

(Pre mod. 00921/00859)
There is no cockpit warning of an ECS shut down at aircraft altitudes below 27000 ft (nominal).

EMERGENCY RAM AIR

The maximum permitted speed and altitude for selection of EMERG RAM AIR are 400 KIAS and 25000 ft respectively. With emergency ram air selected, maximum permitted speed for continuous operation is 250 KIAS; with transient operation up to 400 KIAS/0.8 M, altitude should be below 25000 ft.

HYDRAULIC SYSTEM

Failure cases (single system operation).
The aircraft is cleared for subsonic speed and gentle manoeuvres only. Operation of wing sweep and flaps/slats under high load conditions can result in reduced or zero surface travel rates.
In-flight single system operation of wing sweep is only permitted following a real failure of one hydraulic system and shall not exceed two wing sweep movements during the remainder of flight.
In-flight single system operation of slaps/slat is only permitted following a real failure of one hydraulic system and shall be kept to the minimum required for landing.
Excedence of in flight single system operation could result in damage (seizure) of wing sweep and/or flap/slat system.

EMERGENCY POWER SYSTEM

The emergency power system is cleared for use. The EPS cockpit control switch may be selected to the AUTO or ON position as required.
Once the One Shot Battery (OSB) is activated (EPS cockpit light on) it can supply power for 3 minutes in case of double engine flame out or 7 min. (20 min. Post mod. 11019) in case of double generator/TRU failure.
If a double generator/TRU failure occurs once the OSB is activated, the RH engine shall be handled with caution below 20.000 ft and kept at max dry above 20.000 ft (F-40). If F34/F35 is used the RH engine may be handled as required.

FLIGHT CONTROL SYSTEM

Take-off is not permitted except in full CSAS.
The PFCS is cleared for flight subject to the satisfactory completion of the pre-flight control checks carried out in full CSAS:
After a maximum of 7 flights or a maximum period of 7 consecutive days, whichever comes first, a CSAS pre-flight BITE check shall be carried out.
On aircraft equipped with SPILS (Post mod. 00555) the SPILS BITE check is to be performed concurrently with the CSAS pre-flight BITE check. If a SPILS failure is detected, the SPILS may be switched off, and the aircraft flown to non SPILS limits.
If the first CSAS pre-flight BITE attempt results in a "NO GO", one further attempt only is permitted.
If during the pilot's pre-take-off control checks, any CSAS failure caption illuminates, a reset may be attempted and the control check repeated. If the caption does not reappear the aircraft may be flown. If the caption reappears a CSAS pre-flight BITE check has to be performed. Recurrent first failures, even if successfully reset in flight, should be reported for rectification.

Flap/Slat failures

Where a flap or slat failures result in not standard flap/slat combination, the speed and normal acceleration limits used should more restrictive of:

- Those shown under appropriate to resulting slat position as indicated in "Airspeed and Mach", and "Normal accelerations and manouevres" paragraphs.
- Those appropriate to resulting slat position, as given in the above mentioned paragraphs.

CAUTION

SLAT DOWN SHOULD BE TAKE AS EQUIVALENT TO FLAP MID.

NOTE

If a flap/slat jam occurs after a selection by the high lift lever, the lever shall be returned to the position appropriate to the actual flap position. If a flap/slat jam occurs after MNVR selection by the throttle switch, the switch shall be selected to the up position.

AOA LIMITATIONS DURING LANDING

FLAPS	SLATS	MAX TARGET AOA FOR APPROACH	MAX TARGET AOA FOR FLARE	AOA LIMIT (NE)	ESSENTIAL WARNINGS
UP	UP	12	14	16	4
	MNVR	14	16	18	2, 3, 6, 7
	DOWN	14	16	19	1, 2, 6, 7
MNVR	UP	12	14	15	4
	MNVR	12	14	17	4
	DOWN	12	14	17	1, 2
MID	UP	10	13	15	–
	MNVR	12	15	18	7
	DOWN	12	15	19	7
DOWN	UP	6	9	13	5
	MNVR	10	13	16	–

NOTE

1. With high roll inertia (o/b pods or heavy i/b stores) the aircraft is very prone to divergent lateral PIO. This effect is greatly increased in high crosswind and turbulences and under such conditions landing is extremely hazardous.
2. Lateral handling may be sensitive without wing stores fitted.
3. With high roll inertia lateral PIO is possible but controllable.
4. Lateral handling may be sensitive.
5. Approach and landing are not recommended because of the danger of a "nosewheel first" touch down.
6. In roll direct link limited/inadequate roll control authority is available. In presence of even low crosswinds (as low as 5 kt); roll control limits can be reached which could make landing hazardous.
7. When carrying underfuselage tanks or bombs flare incidence above 15 units AOA are likely to result in contact between the tank or rear bombs and the ground.

Figure 5-35

Landing should be performed in full CSAS, 25 WSA, SPILS off, within the limitations shown in Figure 5-35.

Flap Operation With Degraded CSAS

With degraded lateral CSAS and large U/FUS stores, approach and landing shall not be flown with flaps in DOWN.

Slat Selection

At engine power settings below 82% NH, manoeuvre slats shall be manually selected UP and the position confirmed before selecting a wing sweep position aft of 45°.

Airbrakes

Airbrake operation is limited to 0.95 M and shall not be used above 14 units AOA.
The "g" limits are from +0.5 g up to airframe limit. Additional limitations are contained in Figure 5-47.

Rudder

Provided that the rudder is trimmed central, full rudder pedal is permitted at any speed in nominal 1 g straight and level flight. With the landing gear operating or down, full rudder is not permitted and only small applications of rudder to minimise slip-ball excursion should be made.

SPILS System

The SPILS system is introduced by mod. 00555 and can be selected ON/OFF in the cockpit. For Post mod. 00555 aircraft, the system can be selected ON at all times during flight.

CAUTION

LANDING/ROLLERS ARE NOT PERMITTED WITH SPILS ON.

OFF or ON selection shall be made below 10 units AOA in nominal 1 g flight. When a CWP red SPILS or CSAS (First failure or Second failure) is indicated, the SPILS is to be considered inoperative or significantly degraded; the aircraft shall then be flown to Pre mod. 00555 SPILS OFF AOA limits until the system has been reset. The above apply also to CSAS TRAIN mode selection.

Refer to Figure 5-22 for AOA limits (clean a/c) with SPILS operative. AOA limits during rapid rolling are contained in chapter "Angle of attack and manouvres" (Rapid rolling paragraph); relevant limits for external stores configurations are contained in Figure 5-47.

SPILS shall be selected OFF before gun firing and shall not be reselected until the AOA probe have been fully tested on the ground for serviceability (Pre mod. 01724).
Post Mod. 01724 preceding information does not apply.

AVIONIC SYSTEM

NAVIGATION MODES

All navigation modes are cleared for use.
If the navigation system is in Doppler/SAHR mode, the aircraft pitch angle and vertical velocity displayed on HUD may be in error and shall not be relied on in IMC flying.

POST MOD 16130 (SWIT-P-NCC P200B SOFTWARE)

Unplanned Fixing

In an unplanned fix sequence the selection of TOO or AGG after the selection of NFX will suppress the generation of an error ROL and prevent correct operation of the PHC and NHC.

Unplanned Height Fixing

On some occasions no height error is obtained on insert during an unplanned height fix. Selection of NAV and reselection of the height fix is usually successful.

Range and Bearing RDE Data

RDE Waypoint and offset information cannot be input in range and bearing format.

NAVIGATION SENSORS

Radar Altimeter

The radar altimeter should not relied below 200 feet AGL and as the sole height reference.

Inertial Navigator (IN)

The IN may revert to IP1 or auto shut down as a result of operation of the main UHF transmitter from the lower UHF aerial. The lower UHF aerial should be used with the main UHF transmitter under emergency condition only pending resolution of the susceptibility. There is no restriction placed on aerial selection when using the emergency UHF transmitter only.

NOTE

Below 15°C rapid IN alignment mode should not be used, due to degraded performance, for the first alignment of the day.

FORWARD LOOKING SENSORS

Ground Mapping Radar

The GMR modes and facilities are cleared for use, with the following exceptions and limitations:

- Height find mode is inaccurate and shall not be relied upon.
- Terrain Avoidance mode (TA) is cleared for use above 1000 ft AGL.
- Beacon mode is not cleared.
- Frequency agility is cleared for use. National security regulation shall be applied.
- Due to RF hazard, do not operate the radar when personnel are within the scan angle at less than 17 m distance.

CAUTION

CRPMD SHOULD BE SWITCHED M OR M + S AT ALTITUDES ABOVE 20.000 FT MSL. PRE MOD. 11183/11317
POST MOD. 11183/11317 PRECEDING INFORMATION DOES NOT APPLY.

Terrain Following Radar

Due to RF hazard, the radar shall not be operated when personnel are within the scan angle at less than 39 m distance.

ESRRD

In E-scope mode, flight path marker shall not be used.

AUTOPILOT AND FLIGHT DIRECTOR SYSTEM

AFDS GENERAL LIMITATIONS

NOTE

A successful pre-flight BITE check of Autopilot and Flight Director is to be carried out prior to flight. If unsuccessful the flight may only continue after the related AFDS circuit breakers have been pulled.

The AFDS is cleared for use, subject to the general AFDS limitations given below and to the specific mode limitations given in the following chapters.
Any compatible combination of the following modes may be used:

Pitch Attitude Hold
Roll Attitude/Heading Hold
Altitude Hold
Track Acquire
Mach Hold
Autothrottle
Heading Acquire
Terrain Following
Radar Height Hold

The Approach mode is not cleared for use.
The Autopilot shall not be used with MID or FULL flaps selected, or with landing gear down.
The Flight Director is cleared for switch on throughout the flight envelope of the aircraft. The Flight Director shall be selected during TF and RHH mode flying except during weapon aiming when the FD may be switched off.
The primary flight control system shall be engaged in full CSAS with no failures.
The manual trim system shall not be operated with the autopilot engaged. Operation of the manual trim system can cause large transients when the autopilot is disconnected.
Stores may be released and jettisoned with the autopilot engaged. However see AFDS Automatic Terrain Following mode paragraph for a warning concerning the TF ride setting. When the track mode is engaged, the aircraft may be offset from the planned track at weapon release. In these circumstances, the autopilot will turn the aircraft to regain track, after weapon release.
Maximum aircraft mass shall be 26000 Kg unless otherwise stated.

AFDS MODING PROBLEMS

Inadvertent A/P Disconnect

WARNING

INADVERTENT AP DISENGAGEMENT CAN OCCUR WITHOUT ADEQUATE WARNING OR INDICATION.
THE STATUS OF THE AP SHALL BE MONITORED BY REFERENCE TO THE AFDS CONTROL PANEL AND THE AP ENGAGEMENT INDICATOR.

Head up Status Indicator/Selectors (Post Mod. 01749)

WARNING

MISSELECTION WITH THE INDICATOR/SELECTORS ON THE COAMING CAN OCCUR. IN THIS CASE ATTEMPTED AUTOPILOT ENGAGEMENTS WILL RESULT IN IMMEDIATE AUTOPILOT DISCONNECT WITH NEITHER AP COMPUTER IDENTIFIED AS UNSERVICEABLE. SUBSEQUENT ATTEMPTS TO REENGAGE WILL RESULT IN THE SAME AP BEHAVIOUR. THE SITUATION CAN BE RESOLVED ONLY BY USE OF ICO FOLLOWED BY RESELECTION AND REENGAGEMENT.

AUTOTHROTTLE

The autothrottle is cleared for use, with or without other AFDS modes, subject to the following limitations.
The autothrottle is cleared for use with all stores configurations as defined in Figure 5-47.

AUTOTHROTTLE SPEED RANGE

WING	MIN SPEED MAX AOA (AOA)	MAX SPEED (KIAS/M)
25° CRUISE and MNVR	12	500/.8
45° CRUISE and MNVR 67°	10	.92

NOTE

The minimum speed limit is defined by the maximum angle of attack (AOA) at engagement. After engagement the AOA may be increased during manoeuvres within the limits defined in Figure 5-22 for clean aircraft and Figure 5-47 for external store configurations.

Figure 5-36

The maximum engagement height is 30.000 ft AMSL and there is no minimum height limit.
For autothrottle speed range refer to Figure 5-36.

WARNING

DURING CONFIGURATION CHANGES, THE AUTOTHROTTLE MAY NOT BE CAPABLE OF MAINTAINING THE SELECTED AIRSPEED. IF THE AUTOTHROTTLE IS DRIVEN AGAINST THE IDLE OR MAX DRY STOPS IT WILL DROP OUT.

AFDS CRUISE MODES

The AFDS Cruise modes are cleared for use in any compatible combinations, subject to the general AFDS limitations given on the relevant paragraph and to the mode limitations given below.
For AFDS cruise modes Flight envelope refer to Figure 5-37.

Autopilot

Configurations A1 and A1a are limited to 23.000 kg.
All configurations as defined in Figure 5-47 are cleared.

AP CRUISE MODES FLIGHT ENVELOPE

WING	Min Speed Max AOA (KIAS/AOA)	Max Speed (KIAS/M)	Min Height (FT AGL)	Maximum Altitude (FT AMSL)
25° MID	200/9	300/.55		10000
25°CRUISE & MNVR	250/9	500/.8	1000	
45° CRUISE & MNVR	300/9	550/.9		30000
67°	350/9	600/.92		

Figure 5-37

ALTITUDE HOLD

Maximum rates of climb/descent at engagement in day VMC is 5000 ft/min, at night and/or IMC is 2000 ft/min.
Below 2000 ft AGL, in any conditions, the maximum descent rate at mode engagement shall not exceed 2000 ft/min.
Pitch oscillations may be encountered when stores are carried on the underwing pylons at the following conditions:

- 25° WS above 0.75M
- 45° WS above 0.85M
- 67° WS above 0.75 when the cg is aft of 33% MAC

The pitch oscillations may become severe and can be safety critical at low level in IMC. If oscillations are encountered the autopilot should be disconnected.

MACH HOLD

Mach hold may only be engaged when the aircraft is stabilized at the required mach number.

ATTITUDE/HEADING HOLD

Attitude/Heading hold may only be engaged when the aircraft is in trim.

WARNING

SHARP STICK INPUTS SHALL BE AVOIDED WHEN USING THE ASO, OTHERWISE, LARGE AMPLITUDE, SUSTAINED PITCH OSCILLATIONS MAY OCCUR. IF SUCH OSCILLATIONS ARE ENCOUNTERED, THE AUTOPILOT SHOULD BE DISCONNECTED USING THE ICO AND THE APPROPRIATE PIO RECOVERY ACTION SHOULD BE TAKEN.

NOTE

Autopilot disconnect can occur when transmitting from the lower UHF antenna.

FLIGHT DIRECTOR

The flight director is cleared for use, subject to the general AFDS limitations and to the limitations given below. All store configurations as defined in Figure 5-47 are cleared. The minimum engagement height is 500 ft AGL in day VMC and 1000 ft AGL at night and/or IMC.
For Flight Director speed range refer to Figure 5-38.

AFDS TERRAIN FOLLOWING MODE

The limitations listed below are common for AFDS automatic terrain following mode and AFDS manual terrain following mode. For all TF operations the flight director shall be selected.
Fixed Frequency is cleared for use; frequency agility is cleared for use, national security regulation shall be applied.

FD SPEED RANGE

WING	MIN SPEED MAX AOA (AOA)	MAX SPEED (KIAS/M)
25° CRUISE and MNVR	12	500/.8
45° CRUISE and MNVR 67°	10	.9

NOTE

The minimum speed limit is defined by the maximum angle of attack (AOA) at engagement. After engagement the AOA may be increased during manoeuvres within the limits defined in Figure 5-22 for clean aircraft and Figure 5-47 for external store configurations.

Figure 5-38

NOTE

All TF radar control panel and ESRRD selections are cleared, except for:

- ZCL selection Post Mod. 11133 is not cleared and shall not be selected (Pre mod. 11133 ZCL selection is cleared)

- Weather mode B is not cleared and shall not be selected on ESRRD control panel.

Post Mod. 11133 Anti J mode and Anti C mode are not cleared for use.

Pre Mod. 01882:

- SW/INH switch shall be deselected (INH indicators OFF) for all TF operations.

- W RSK indicator shall not be illuminated for all TF operations

Post Mod 01882 ECCM mode selector shall not be selected.

The main computer shall be in Main or IN/MC mode.

The primary and secondary data sources shall be serviceable and selected ON and the system shall be operating on the primary attitude source with automatic cross monitoring.

Alternatively the aircraft shall be operated within the additional sensor failure limitations, given below, under "Sensor Failure" paragraph.

The upper UHF Transmission antenna shall be selected for all UHF transmission.

TACAN operation is only permitted in the receive mode.

All (Auto and Manual) TF flying shall be visually monitored against external references, or flown in accordance with the limitations for night or IMC operations, given under operation in night VMC and IMC paragraphs.

The aircraft CG position shall be forward of the following limits:

- 25 wingsweep: 25% MAC

- 45 wingsweep: 32,5% MAC

- 67 wingsweep: 44% MAC, aircraft mass up to 23000 kg
  38% MAC, aircraft mass up to 26000 kg

When in AUTO and MAN TF the maximum operating height is 10000 ft AMSL.

NOTE

The maximum permissible peak to valley height is 3000 ft.

All ride settings are cleared subject to the limitations depitched in Figure 5-47. For MK101 engines only, following overriding limitations apply:

- Pre mod. 30871 (Both engines): soft ride only above 475 KIAS.

- Pre mod. 30887 (One or both engines): soft or medium ride only

WARNING

- THE RADAR REFLECTIVITY OF LARGE UNBROKEN SURFACES AS SNOW, ICE, SAND OR CALM WATER CAN BE EXTREMELY LOW AND TFR RETURNS MAY BE LOST. CAUTION SHOULD THEREFORE BE EXERCISED DURING TF FLYING OVER SUCH TERRAIN COVER.

- TESTS HAVE SHOWN THAT THE TF RADAR CANNOT BE RELIED UPON TO DETECT OBJECTS OF LOW REFLECTIVITY SUCH AS SUPPORTING CABLES, ELECTRICITY DISTRIBUTION WIRES, SLIM CYLINDRICAL ANTENNA TYPE MASTS AND AIRBORNE OBJECTS SUCH AS HANG-GLIDERS. PERFORMANCE OF THE TF SYSTEM SHALL BE CLOSELY MONITORED WHEN SUCH OBSTACLES ARE APPROACHED IN VMC. AIRCREW SHALL BE PREPARED TO TAKE OVER MANUALLY TO AVOID SUCH OSTACLES. FOR NIGHT OR IMC REFER OPERATION IN NIGHT VMC AND IMC PARAGRAPHS.

- WHEN APPROACHING STEEP HIGH CLIFFS INBOUND, NOTICEABLE PITCH ACTIVITY AND SOME HEIGHT OVERSHOOT OVER THE CLIFF MAY BE EXPERIENCED. (BETA SPIKES, MULTIPHAT EFFECTS).

- WHEN TURNING OVER CALM WATER, DOPPLER TRANSIENTS MAY CAUSE AN OSCILLATORY PITCHING AND ROLLING MOTION (I.E. REPEATED SWITCHING BETWEEN NORMAL TF OPERATION AND CLOSED LOOP PULL UP/WINGS LEVEL).
IF THIS OCCURS, THE TF-SYSTEM SHOULD BE DISCONNECTED USING THE ICO.

- WHEN USING THE HEADING ACQUIRE MODE WITH TF HEADING CHANGES TOWARDS OBSTACLES OR RISING GROUND SHOULD BE AVOIDED.
THIS IS BECAUSE IN THIS MODE, THE TF TURN RATE LIMITING SYSTEM IS BY-PASSED.
CONSEQUENTLY THE TURN RATE CAN EXCEED 2°/SEC LEADING TO A REDUCTION IN THE TF-RADAR COVERAGE OF THE TERRAIN IN THE DIRECTION OF THE TURN.

- UNPREDICTABLE SYSTEM REACTION MAY BE CAUSED BY PRECIPITATION OR CLOUD FORMATIONS.
(DUE TO WEATHER EFFECTS ON SENSORS SUCH AS TF-RADAR AND DOPPLER).

Sensor Failure

Subject to Day VMC only and an SCH not below 1000 ft., Auto TF operations are cleared with SAHR or Doppler sensors failed or inoperative.

NOTE

With the Doppler failed, a temporary TF MON caption is acceptable over calm water, provided that the aircraft height is carefully monitored and the HT and TURN FAIL lights on the TFR CP are not illuminated. TF is not cleared with other sensor failed or inoperative.

AFDS AUTOMATIC TERRAIN FOLLOWING MODE

The automatic Terrain Following (TF) mode is cleared for use in conjunction with any compatible lateral mode, subject to the general AFDS limitations and to the Auto TF mode limitations given below.

NOTE

Before using Auto TF on any sortie, an in-flight functional check of the operation of the TF system shall be carried out in accordance with the appropriate procedure given in Section 2 of this manual.

Store Configurations and Speed Limitations

The store configurations listed in Figure 5-47 are cleared to the speed ranges shown.

WARNING

- DURING NORMAL OPERATION THE AUTO-TF SYSTEM CAN COMMAND LARGE CLIMB ANGLES AND IT MAY NOT BE POSSIBLE TO AVOID LARGE SPEED LOSSES EVEN USING REHEAT.
  IF THE MINIMUM SPEED LIMIT CANNOT BE RESPECTED, TF SHALL BE DISCONTINUED.
- THE TF SYSTEM IS CAPABLE OF IMPOSING LOAD FACTORS WHICH ARE OUTSIDE THE CLEARED ENVELOPE FOR WEAPON RELEASE (MEDIUM AND HARD RIDE TF AND THE AUTO PULL-UP). IF THE NATURE OF THE TERRAIN IN THE VICINITY OF THE RELEASE POINT IS SUCH THAT SIGNIFICANT TF-VERTICAL MANOEUVRES ARE LIKELY, SOFT RIDE SHOULD BE SELECTED.
- UNDER CERTAIN CIRCUMSTANCES THE OPEN LOOP PULL-UP IS NOT CAPABLE OF ACHIEVING ZERO DEGREES OF BANK ANGLE AND/OR OF ENSURING A SAFE FLIGHT PATH AWAY FROM THE TERRAIN. THEREFORE THE PILOT SHALL MONITOR THE AIRCRAFT ATTITUDE AND FLIGHT PATH DURING OPEN LOOP PULL-UPS AND IF INSUFFICIENT WINGS LEVEL/ PULL-UP PERFORMANCE IS OBSERVED, MANUAL CONTROL SHOULD BE TAKE USING THE ICO. HOWEVER OVER RAPID CONTROL INPUTS SHOULD BE AVOIDED AS THEY MAY LEAD TO PIO'S.

Minimum Set Clearance Height

Pre Mod 11133 for Minimum Set Clearance Height refet to Figure 5-47
Post Mod 11133 Minimum Set Clearance Height is 500 ft. The limitation above are applicable in day VMC, for operation in night VCM and IMC refer to the relevant paragraph.

Operation In Night VMC and IMC

Auto TF operation in Night VMC or in IMC is permitted under the following conditions/limitations:

Pre Mod 11133

- Maximum speed and minimum set clearance height: refer to Figure 5-47.

- Man made obstacles of height greater than SCH minus 200 ft should not be over flown. An allowance shall be made for the excepted navigation accuracy.

- TF operation is not permitted in clouds with heavy vertical activity, or such like conditions (may be visible on the GMR in the 4-6 NM range). Auto TF shall not be used unless good radar returns are visible on the ESRRD. The terrain returns shall not be obscured by weather returns anywhere out to 2 NM.

- In case of deliberate or non deliberate interruption of TF-flying (open loop pull up)

  - disengage A/P via ICO and
  - climb immediately to safe cruise altitude (see note below)

  Before regaining TF-operation, a functional TF check has to be performed successfully.
  Continuous monitoring of the ESRRD is mandatory. In case of failure or abnormal indications TF-flying is to be discontinued immediately.
  Turns using heading acquire shall not be made if the nature of the terrain in the direction of the turn is unknow.

Post Mod 11133 the operations in night VMC and IMC are not cleared.

NOTE

- All abnormal behaviour shall be reported in the TF/AFDS crew debrifing form.

- During an OLPU autothrottle drop-out may occur leading to considerable speed excursions.

- If any of the following symptoms are observed, it should be assumed that the TF behaviour is abnormal, the TF system shall the be disengaged and the aircraft climbed to safe cruise altitude:

  - Loss of ZCL or CRAM line from the ESRRD display.
  - Any abrupt change of shape or location of ZCL or CRAM line.
  - Break-up of either ZCL or CRAM line into separate non-overlapping short lines.
  - Noticeable jitter of either ZCL or CRAM line anywhere except at the extremities.
  - Terrain returns not visible on the ESRRD out to 2 NM, allowing for the effects of radar shadowing and the effects of overflying peaks.
  - Terrain returns obscured by weather returns anywhere out to 2 nm.
  - Terrain returns reach the CRAM line.
  - Lyre bird audio, and/or flashing attntion getters, and/or manoeuvre monitor audio.
  - Excessive climb or dive angle (in normal TF operation the climb/dive angle should be within the range +20° to -10°).
  - Radar altimeter height read out less than selected set clearance height for protracted periods.
  - Excessive positive or negative normal acceleration.

AFDS MANUAL TERRAIN FOLLOWING MODE

The Manual Terrain Following mode is cleared for switch on throughout the flight envelope of the aircraft. The mode is cleared for use in conjunction with any compatible lateral mode subject to the general AFDS limitations and the Manual TF Mode limitations given below.

NOTE

Before using Manual TF on any sortie, an in-flight functional check of the operation of the TF system shall be carried out in accordance with the appropriate procedure given in section 2 of this manual.

Store Configurations and Speed Limitations

All store configurations given in Figure 5-47 are cleared for manual TF, subject to normal fuel usage. For speed limitations refer to Figure 5-39 and Figure 5-47

WARNING

DURING NORMAL OPERATION THE AUTO-TF SYSTEM CAN COMMAND LARGE CLIMB ANGLES AND IT MAY NOT BE POSSIBLE TO AVOID LARGE SPEED LOSSES EVEN USING REHEAT. IF THE MINIMUM SPEED LIMIT CANNOT BE RESPECTED, TF SHALL BE DISCONTINUED.

Minimum Set Clearance Height (SCH)

Pre Mod. 11133 for Minimum Set Clearance Height refer to Figure 5-47.
Post Mod. 11133 Minimum Set Clearance Height is 500 ft. The limitations above are applicable in day VMC, for operation in night VMC and IMC refer to rhe relevant paragraph.

Operation in Night VMC or IMC

Night VMC Operation is permitted only under the following additional limitations:

- Minimum set clearance height: 750 ft
- Visual reference: unobstructed sight of the ground is mandatory.
- Terrain severity: moderate terrain only (max permissible height difference peak to valley 1500 ft).
- Monitoring: continuous cross monitoring with the ESRRD.
- IMC: manual TF flying in IMC is not cleared.

SPEED

WING	MIN SPEED (KIAS)		MAX SPEED (KIAS/M)
	Aircraft Mass < 23000 kg	Aircraft Mass > 23000kg	
25° CRUISE AND MNVR	375	400	500/.8
45° CRUISE AND MNVR	385	400	.9
67°	450	485	.9

NOTE

This table is incorporated intoFigure 5-47.

Figure 5-39

AFDS AUTOMATIC RADAR HEIGHT HOLD MODE

The Automatic Radar Height Hold mode is cleared for use over the sea, subject to the general AFDS limitations and to the mode limitations given below. Engagements of automatic RHH mode in Day VMC shall be made in stabilised flight conditions (1 ± 0.2g) with a maximum sink rate of 500 ft/min, at a maximum engagement height of 1500 ft AMSL. For min. engagement height refer to Figure 5-47.

All Auto RHH flying shall be visually monitored against external references, or flown in accordance with the limitations for night or IMC operations.

The speed limitations and stores configurations listed in Figure 5-47 are cleared to the speed ranges shown.

Aircraft CG is as for auto/manual TF and maximum sea state is 5 (approximate wave height: 10 ft). When using the TRK mode, in conjunction with the RHH mode the main computer shall be in the Main Mode or IN/MC mode.

WARNING

- UNDER CERTAIN CIRCUMSTANCES THE OPEN LOOP PULL-UP IS NOT CAPABLE OF ACHIEVING ZERO DEGREES OF BANK ANGLE AND/OR ENSURING A SAFE FLIGHT PATH AWAY FROM THE TERRAIN.
  THEREFORE THE PILOT SHALL MONITOR THE AIRCRAFT ATTITUDE AND FLIGHT PATH DURING OPEN LOOP PULL-UPS AND IF INSUFFICIENT WINGS LEVEL/ PULL-UP PERFORMANCE IS OBSERVED, MANUAL CONTROL SHOULD BE TAKEN USING THE ICO.
  HOWEVER OVER RAPID CONTROL INPUTS SHOULD BE AVOIDED AS THEY MAY LEAD TO PIO'S.

- CONSIDERABLE HEIGHT LOSSES/GAINS MAY BE EXPECTED WHEN SWEEPING THE WINGS AFT/FORWARD. UP TO 150 FT HEIGHT LOSS CAN BE EXPECTED WHEN THE WINGS ARE MOVED FROM FULLY FORWARD TO FULLY AFT, AND A HEIGHT GAIN OF SIMILAR MAGNITUDE CAN BE EXPECTED DURING SWEEPS FROM FULLY AFT TO FULLY FORWARD.
  THE EFFECT CAN BE REDUCED BY PAUSING AT THE INTERMEDIATE WING SWEEP POSITION.

- THE AUTO PULL-UP SYSTEM ASSOCIATED WITH THE RHH MODE IS CAPABLE OF IMPOSING LOAD FACTORS WHICH ARE OUTSIDE THE CLEARED ENVELOPE FOR WEAPON RELEASE.

- CONSIDERABLE HEIGHT CHANGES (UP TO 100 FT) CAN OCCUR DURING LONGITUDINAL ACCELERATIONS (HEIGHT GAIN) AND DECELERATIONS (HEIGHT LOSS). THE MAGNITUDE OF THE HEIGHT CHANGE CAN BE REDUCED BY ACCELERATING OR DECELERATING AT LOWER RATES.

Operation In Night VMC or IMC

Auto RHH Operation is permitted at Night or in IMC under the following additional limitations:

- Prior to engagement of the RHH Mode, the radar altimeter should be checked to ensure that the read-out is not frozen and the display is consistent with other sensors.
- The minimum cockpit monitoring that will enable the aircrew to identify abnormal systems behaviour in time to take appropriate recovery action is given in Figure 5-4.
- The flight director shall be selected during all Auto RHH operations carried out at night or in IMC.
- Minimum height: refer to Figure 5-47.

CAUTION

THE UPPER ANTENNA SHALL BE SELECTED FOR ALL UHF TRANSMISSIONS.

AFDS MANUAL RADAR HEIGHT HOLD MODE

The manual radar height hold mode is cleared for switch on throughout the flight envelope of the aircraft. The mode is cleared subject to the general AFDS limitations and the manual RHH mode limitations given below. The mode is cleared for use over the sea and in Day VMC only. Speed range and height are defined in Figure 5-47. Maximum aircraft mass is 25.000 kg. All store configurations are cleared except A1a configuration in 25° wing sweep. Maximum sea state and UHF transmission as for AFDS automatic radar height hold mode.

INSTRUMENTS

INSTRUMENTS AND IMC FLIGHT

The aircraft is cleared for night and IMC flight. The HUD is a simplex system and shall be cross monitored with the head-down flight instruments. In case of significant difference between HUD and head-down indications, the head-down flight instruments shall be used as the primary source unless other indications (e.g. rear cockpit) suggest otherwise.

ADI

The Attitude Director Indicator is mounted on the front cockpit main instrument panel which is fitted forward by 9 degrees towards the longitudinal fuselage datum line (LFD).
The ADI only compensates for 5 degrees and show ± 0 degrees when the LFD is 4 degrees above the horizon. Therefore any ADI, mounted with a tilt angle in relation to the aircraft LFD, will show pitch error indications as a function of this tilt angle and the applied bank angle.
In conditions other than straight and level flight, the indicated pitch attitude on the ADI differs from actual aircraft pitch up to approximately minus 17 degrees at 180 degrees roll.

INDICATIONS ADI VERSUS HUD
(ATTITUDE VERSUS VECTOR)

ADI (degrees)	Banck Angle (degrees)	Hud (degrees dive)
0	0	CA. 0
0	60	CA. -5
0	90	CA. -9
0	120	CA. -13
0	180	CA. -17

WARNING

AT LOW ALTITUDES, FAILURE TO CONSIDER INCREASES ACUTAL DIVE ANGLES RESULTING FORM THESE ADI ERRORS MAY PUT THE CREW INTO A CONDITION WHERE RECOVERY WILL NOT BE POSSIBLE.

ELECTRO MAGNETIC COMPATIBILITY

Generally, the equipments will operate without mutual electro magnetic interference and are not susceptible to external electro magnetic influences.

WARNING

THE AIRCRAFT SHALL NOT BE EXPOSED TO FIELD STRENGTHES IN EXCESS THOSE INDICATED IN FIGURE 5-40.

To avoid the above mentioned field strengths safe heights/distances to ground/sea based and airborne, transmitting stations shall be observed.

WARNING

IT IS RECOMMENDED TO AVOID FLYING THROUGH A CYLINDRICAL HIRTA (HIGH INTENSITY RADIO TRANSMISSION AREA) OF 1000 METERS DIAMETER AND 500 METERS HEIGHT AROUND PATRIOT RADARS OPERATING IN HIGH POWER MODE.

FIELD STRENGTH

Frequency band	Max. safe field strength (volt/meter)
100 KHz to 1 MHz	50 v/m
1 MHz to 2 MHz	20 v/m
2 MHz to 30 MHz	10 v/m
30 MHz to 500 MHz	50 v/m

NOTE

These values are valid for continuous wave radiation and for mean power density of pulsed radiation.

Figure 5-40

NOTE

For safe height/distance to transmitting stations refer to applicable IAF document.

FORMATION FLYING

Tornado, Phantom and F104 aircrafts are cleared to formate on Tornado with active radar. All other aircrafts are cleared provided that where applicable, the formating aircrafts radar and HF systems are not trasmitting.

WARNING

WHERE FLYING IN FORMATION THE USE OF AIRBRAKES IS PROHIBITED ABOVE 0.75 MACH.

EMC ASPECTS OF VARIOUS EQUIPMENTS

V/UHF

- Operation of Ground Mapping Radar and Terrain Following Radar (standby or transmit mode) may desensitise the V/UHF receiver when using the lower UHF aerial by injecting noise into the V/UHF receiver.
- With TACAN or IFF in operation, transmissions on the UHF EMERG may affect main UHF reception.
  Undemanded transfer of VHF/UHF control from one cockpit to the other may occur.
- Transmission from the main UHF equipment on the lower UHF aerial may cause corruptions of the INS and radar displays. Autopilot disconnects can also occur.
  The lower UHF aerial should be used with the main UHF transmitter under emergency conditions only, pending resolution of the susceptibility. There is no restrictions placed on aerial selection when using the emergency UHF transmitter.

IFF

- The IFF receiver may be interfered by UHF transmissions.

AP

- TF no go status conditions can occur during transmission from lower UHF antenna, during operation in TF/AFDS modes lower UHF antenna transmissions is prohibited.
- TF no go status conditions can occur during TACAN operation. During operation in TF modes use is permitted only in TACAN RECEIVE mode of operation.

IN

- The IN may revert to IP1 or auto shut down as a result of operation of the main UHF transmitter from the lower UHF antenna. The lower UHF antenna should be used with the main UHF transmitter under emergency conditions only pending resolution of the susceptability. There are no restrictions placed on aerial selection when using the emergency UHF transmitter only.

ARMAMENT AND EXTERNAL STORES

GUN SYSTEM

The clearance of aircraft for gun firing depends on the compliance with several mod's. The status of aircraft shall be checked with maintenance. Refer to flight limitations shall be made and will be found under Weapon Aiming in this section.

The aircraft is cleared for gun firing, single or both guns, at the slow rate and fast rate, in the air-to-ground and air-to-air mode.

Post Mod. 00555
SPILS shall be selected OFF before gun firing and shall not be reselected until the AOA probes have been fully tested on ground for serviceability. AOA readings can be erroneous after gun firing.

Pre mod. 01560
To reduce the risk of link pile ups in the LH link compartment, the maximum burst length with the left gun is limited to 2 seconds up to 120 rounds fired, then 1 second up to fire out.

Engine handling (MK101 and MK103 engines) is permitted throughout the cleared flight envelope.

AMBIENT TEMPERATURE LIMITATION

Ambient Temperature C°	Loading Limitations N° of rounds per gun
27	180
30	174
35	164
40	153
45	142

Figure 5-41

Gun firing in flight shall not be continued if one of the following warning indications on the CWP illuminate.

- Amber CSAS
- Amber GEN
- Amber TRU

NOTE

- Self clearing pop surges may occur above 5 units AOA and when operating in REHEAT, reheat may extinguish.
  The probability of surge and reheat extinction increase with altitude.
- The rounds indication on WCP 2 Pt No 20097 may be erroeus. Therefore, althoug the indication reads zero, there may be rounds left in the gun. Regardless of the recording appropriate safety precautions shall be taken.
- Pre Mod. 00964: the main computer rack side plates shall be inspected after gun firing.
- With negative "g" gun stoppages may occur due to empty cases and/or links pile up in the tube.
- Link jams due to derailed links may occur in L/H link chutes.
- Only 27 mm ammunition to the ECP 5011 primer cap standard is cleared for use as follows:
  - Target Practice (TP) DM18/DM28.
    Armour Piercing High Explosive (APHE) DM13 with BD Fuze DM791.
  - Armour Piercing (AP) DM33
    High explosive (HE) DM21 with PD Fuze DM341
- There is a high probability of an engine locked in surge when firing beyond the locked in surge line.
- During Air-to-Air firing with warshot ammunition DM13 and DM21 (APHE/HE mixed belt) in rain the pitch attitude of the aircraft should not be decreased on a constant heading during or within 6 seconds of ceasing gunfiring.

PYLONS/ADAPTER/LAUNCHER

NOTE

Underwing pylons shall be carried symmetrically.

Pylons and/or Kormoran launcher and/or Sidewinder adapter and launcher may be fitted as part of all cleared store configurations defined in Figure 5-47.

SUBSONIC FUEL TANKS

Subsonic fuel tanks may be carried on stations 3, 4, 7 and 8, according to the limits given in Figure 5-47. The jettison limitations of full or empty tanks from I/B wing or U/FUS SHLDR pylons are given in Figure 5-46.

CBLS 200

CBLS 200 may be carried on stations 7 and/or 8, according to the limits given in Figure 5-47. With WPU-SU2 and SU3 up to 4 practice bombs of the same type may be carried in each CBLS 200. With WPU-SU2, only one type of bomb shall be used per sortie. Full or empty CBLS 200 may be jettisoned according to the limits given in Figure 5-46.

BOMBS

Up to 7 MK82 FF/Ret, MK83 FF/Ret, BL755 or MK20 bombs may be carried on stations 3, 4, 5, 6, 11, 12 and 13, according to the limits given in Figure 5-47. If it is required to load less than 7 bombs they shall be loaded in the following order: station 6, 5, 12 and 11, 4 and 3.
Release and/or selective jettison are permitted under the conditions listed in Figure 5-46.
Freefall and retarded bombs shall not be mixed. Up to 2 Special Weapon may be carried on stations 7 on 8.

A/A MISSILES

AIM-9L SIDEWINDER missiles (or AIM-9L simulator) are cleared for use with all stores configurations cleared on stations 3 and 4.

Release and/or selective jettison is permitted under the following conditions:

Pre mod. 01460

- Max speed: 500 KIAS/.8 M
- Wing sweep angle: 25°

- Post mod. 01460
  Envelope as cleared in Figure 5-47, not exceeding 1.8 M
- CRUISE and MNVR only
- No firing during rapid rolling
- In 25 and 45 wing sweeps max load factors

Without underwing tanks
Symmetric store configurations no limit
Asymmetric store configurations
M < 0.92 nw = 120 t;
M > 1.0 no limit
Linear interpolation between 0.92 M and 1.0 M

With underwing tanks
Symmetric store configurations – nw = 104 t
Asymmetric store configurations – nw = 98 t

- In 67 wing sweep, max load factor

Without underwing tanks
Symmetric store configurations
No limit up to 16 AOA; nw = 110 t, 16 to 20 AOA
Asymmetric store configurations
M < 0.92 nw = 120 t up to 16 AOA, nw = 110 t 16 to 20 AOA
M > 1.0 no limit up to 16 AOA, nw = 110 t 16 to 20 AOA
Linear interpolation between 0.92 M and 1.0 M

With underwing tanks
Symmetric store configurations – nw = 104 t
Asymmetric store configurations – nw = 98 t

After launch the taileron and slats shall be inspected for signs of damage.
Missile launch is not permitted with slats extended or flaps in mid or down position.

NOTE

- Missile launch is not permitted above the LIS (lock-in surge) line (Figure 5-8, Figure 5-9, Figure 5-10 and Figure 5-11). Above 25000 ft and below 275 Kts the lowest throttle setting is MAX DRY.

- Pre Mod 11063 for missile launch the WRB shall be pressed for 1 second minimum.

- Target Acquisition is possible
  - in Boresight mode up to 2,5 g
  - in Slave mode up to 3,5 g (if target is within HUD FOV)

- The Launch of Sidewinder AIM9L may result in the ingestion of the exhaust plume, causing one or both engines to surge and the reheats to extinguish above 20000 ft/below 500 KIAS. Following missile launch, the aircraft should be manoeuvred to avoid flying through the missile plume. Engine instrument should be monitored for signs of surge.

- Pre mod. 10829. During AIM9L firing the trigger shall be pressed for 3 seconds.

P4AX (ACMI)

The P4AX Airborne Instrumentation Subsystem (AIS) of the ACMI system is cleared for carriage and use when mounted on the right hand inboard pylon with the configurations as defined in Figure 5-47.

NOTE

Automatic switch over from LH to RH station is not possible with an ACMI-Pod installed. Therefore fuselage masking effects and loss of lock-on can be experienced during manoeuvres.

A/G MISSILES

Kormoran missiles are cleared for carriage, launch and jettison from the fuselage shoulder station 7 and 8.

NOTE

- The harmonization data given below are to be inserted via TV/TAB-MFK.

	PITCH	ROLL	YAW
LH Shoulder	- 1°	+ 1°	- 0.3°
RH Shoulder	- 1°	- 1°	+ 0.3°
Definition of signs	- down	- left	- CCW

- HF-SSB transmission shall be cancelled at least 10 seconds prior to release.

CHAFF/FLARE DISPENSER

The chaff/flare dispenser system BOZ-102/107 is cleared for use throughout the envelope defined in Figure 5-47

MW-1

MW-1 is not yet cleared for use.
4MW-1 containers may be carried on stations 5 and 6, 7 and 8, 9 and 10, 11 and 12. Aircraft loading has to be carried out in according to AER.1F-PA200-33. The MW-1 containers and thier submunitions may be carried, released and jettisioned subject to the limitations given in Figure 5-45, Figure 5-46 and Figure 5-47.
The flight envelope for MW-1 is:

- Speed 400-600 KIAS
- Straight and level
- Min. Height 150 ft

Limitation for Reversionary Mode. For interval selection on WCP1 the following minimum values are allowed dependent on aircraft velocity:

A/C Vel (kt)	KB44	All other submunitions
≤ 600	20 ms or more	60 ms or more
≤ 550	25 ms or more	70 ms or more
≤ 500	25 ms or more	80 ms or more
≤ 450	30 ms or more	90 ms or more
≤ 400	30 ms or more	100 ms or more

NOTE

By use of three minimum intervals the corresponding minimum carpet lenghts are selected

STORE MANAGEMENT SYSTEM

With the present aircraft configuration a simulated release of weapon is possible with Bogus capability. The Bogus facility on SMS is usable with the MK83FF.

NOTE

For detailed Bogus coding refer to AER.1F-PA200-34-1.

STORES CONFIGURATIONS

The stores configurations cleared for being carried on MWCS are grouped within the table in Figure 5-47 according to the following code:

Group A: Tanks ± AIM9-L ± 2 CFD or Tanks ± AIM9-L ± ACMI POD ± TRAINING MISSILE

Group B: CBLS200 ± Tanks ± AIM9-L ± 2 CFD or CBLS 200 ± Tanks ± ACMI POD ± TRAINING MISSILE

Group C: MK83FF or RET ± Tanks ± AIM9-L ± 2 CDF

Group D: BL755 ± Tanks ± AIM9-L ± 2 CFD

Group E: Kormoran ± Tanks ± AIM9-L ± 2 CFD

Group F: MK82FF or RET ± Tanks ± AIM9-L ± 2 CFD

Group G: MK-20 Rockeye ± Tanks ± AIM9-L ± 2 CFD

Group H: Recce Pod ± Tanks ± AIM9-L ± 2 CFD

Group K: Special Weapon ± Tanks ± AIM9-L ± 2 CFD

Group L: MW-1 ± Tanks ± AIM9-L

Group M: Refuelling pod ± Tanks ± AIM9-L ± 2 CFD

NOTE

Limitations of the form 570/.85 ÷ 550/.92 are to be so interpreted: the limit is 570 KIAS from sea level to the altitude where 570 KIAS coincides with 0.85 M; then the limit is 0.85 M up to where 0.85 M coincides with 550 KIAS; likewise the limit becomes 550 KIAS from that altitude up to where 550 KIAS coincides with 0.92 M; then the limit becomes 0.92 M (this can be easily understood on the Mach vs altitude charts).

RELEASE/LAUNCH AND JETTISON LIMITATIONS

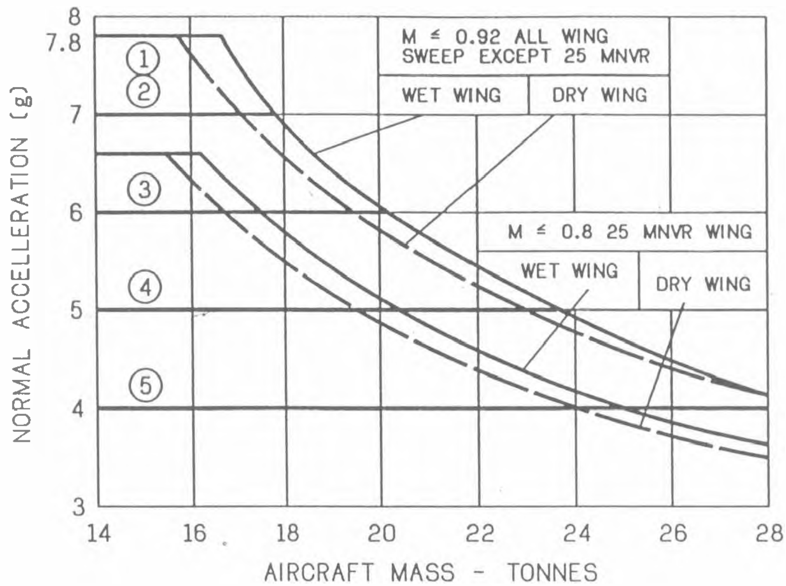
For external stores release/launch and jettison limitation, refer to Figure 5-46.

If the carriage limitations of Figure 5-47 and the release/launch or jettison limitation as indicated in the notes of Figure 5-46 differ, the more restrictive ones shall be observed.

The bomb release limitations quoted do not make allowance for aircraft self damage risks.
Safe separation and bomb functioning has been tested and evaluated only in straight and level flight releases and loft releases.

Jettison limits refer to "controlled" jettison of stores, i.e. when aircraft flight parameters can be controlled

SYMMETRIC MANOEUVRE ACCELERATION LIMITS (Nz) FOR STORES ON MWCS



Group of external store configurations	Configuration and state of i/b tank fuel (if any) with or without o/b stores
Group 1	– A3, A4, B2, D2, D3, F2, F3, H2, K4
Group 2	– A2, A5, B1, B3, B4, D1, E1, F1, H1, K1, K2, K3 (all with empty i/b tanks); – E2
Group 3	– C1 (with empty i/b tanks); C2, C3
Group 4	– A1, M1 (both with empty i/b tanks) – G1 (with full or empty i/b tanks); – All Configurations with full i/b tanks except A1, M1 – G2, G3, M2 (empty Pod).
Group 5	– A1, M1 (both with full i/b tanks) – M2 (full Pod).

NOTE

- Empty i/b tanks state is with < 100 kg fuel left; full i/b tanks state is with > 100 kg fuel left; negative g is -1 for all configurations except for A1 (full inboard tanks) G1, G2, G3 and M1, M2 (Full Pod). For these the limit is zero.
- For rapid rolling with external stores refer to Figure 5-24.

Figure 5-42

CARRIAGE STATION

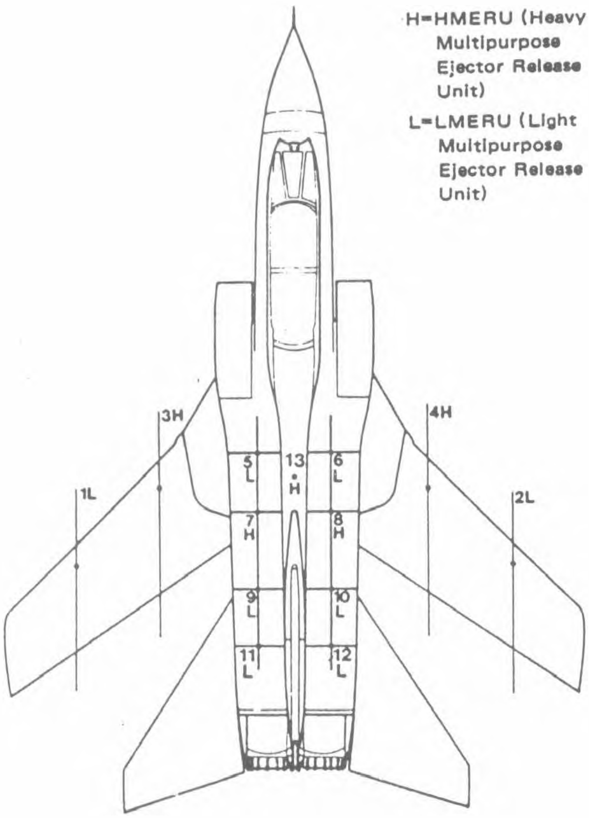


Figure 5-43

and the occasion cannot be considered an extreme emergency. In less controlled jettison cases collisions may occur between the aircraft and jettisoned stores or between individual jettisoned stores, thus introducing a hazard to the aircraft. Sideslip should be minimised at jettison/release where practicable (jettison characteristics of certain stores are sensitive to sideslip, particularly empty tanks, and MW-1). Axial acceleration should be minimised at jettison where practicable; operation of airbrakes and/or rapid engine throttling during jettison/release is not recommended.

NOTE

With the MASS to "SAFE", emergency jettison is not possible.

WEAPON AIMING

Weapons are cleared for release/launch/firing in aiming modes as detailed in Figure 5-45.

WEAPON AIMING MODES LIMITATIONS

BOMBS MODES

Aiming Line

As a safety precaution the target bar shall be kept in the gap during lay-down attacks with MK83/BL755 or MK106 Mod. 1 G ballistics selected.
Laydown attacks with 28lb PB ballistic selected will result in grossly unsafe TOL indications because the safety constants are optimised for freefall profiles. Depending on the attack speed and height the aiming line may not appear in the HUD FOV.
TOL mecanisation uses single source data and therefore independent checks of aircraft height, speed and dive angle shall therefore be made during an attack. It is recommended that attacks are completed with the ranging reticule/target bar maintained below the top of the aiming line.

Navigation Modes

Main and IN/MC modes only shall be used when carrying out Dive, CCIP and Loft attacks.
If DO/SA or ADC/SA modes have been entered then laydown attacks only should be carried out within the following limits:

- Speed 350 - 550 KIAS
- Dive angle: nominal straight and level

With software X107, when operating in DO/SA the HUD climb/dive and vertical velocity displays suffer from lags and errors of varying magnitude. In this mode pilots shall monitor the aircraft attitude and flight path using outside visual references or head down instruments and shall not rely on HUD displays.

Lock-On Mode

Lock-on shall be deselected before cancelling Radar Offset (CRO).

NOTE

Following Cancel Radar Offset (CRO) with lock-on sensor the MC continues use of radar range to offset.

GMR-AGR

Roll and Pull entries to dive attacks shall not be attempted with AGR selected.
To prevent possible premature release due to asynchronous ranging problems, AGR should be selected at least 3 seconds before pressing the pickle button. Against sea targets AGR height sensing is unreliable.
Significant height above target errors can be introduced in bomb and gun attacks which will induce incorrect weapon aiming and unsafe HUD indications.
In particular the HUD break off cross shall not be used to initiate break off in AGR attacks against sea targets. Cross checking against independent height sensor is essential.

Flight Director Attacks

Manually flown flight director attacks will give unacceptably large azimuthal bombing errors and should not be used when releasing weapons.

Phase 2

Phase 2 should not selected until it can be guaranteed that the aiming point (offset or target) is below aircraft altitude. With phase 2 selected the aircraft should not then descend below the aiming point altitude.

NOTE

(X108/P200B software). The navigation fix error is updated in Phase 2 Planned attacked on insert, first release cue or reversion to integrated VV. If reversion to integrated VV occurs, as indicated by a flashing BARO IN button, such errors should be used with caution.

Phase 3

NOTE

- The point commands to the GMR remain on the Phase 2 target position when Phase 3 is entered. To remove possible errors azimuth corrections bringing the RR close to the aiming line should be made prior to entering Phase 3.
- If the Memory Mode is entered in an AGR attack the GMR reverts to pointing at the Phase 3 position.

Moving Target

NOTE

Azimuth manoeuvring and pitch angle variations during moving target attacks causes the derived velocities diplaced on the TV/TABs to fluctuate in symphaty with the bank angle variations. If the bank angle exceeds 55° RDR ACPT is automatically deselected and shall be reselected after the bank is reduced to avoid frozen values of target velocity being used in the calculations.

Height and Ranging Sensor

For Laydown and Dive attacks TF Elev is cleared only for simulated attacks.
(X108 only). During Phase 2 offset AGR attacks on loss of range lock AGR will be cancelled and integrated VV employed. Against certain targets this may give the appearance of AGR not being selectable.

TOO/CCIP

The azimuth positioning of the Ranging Reticle on entry to TOO/CCIP attacks is incorrect.

Visual Offset

Offset attacks using Rad Alt as height sensor shall only be attempted over flat terrain and with short offset distances.

NOTE

- The design philosophy for visual offset attacks assumed the offset would be in the HUD FOV. Care should be exercised if IP type attacks are flown because of the danger of large errors at weapon release.
- If the target marker or Offset marker go below -15°, each marker will separately jump to a "Memory" position. If the offset goes to Memory, no further updates are possible by the pilot.

Offset height

NOTE

All offset require input of height of the offset relative to MSL.

On Top Offsets

(P200B software only) When using on top offsets the weapon aiming height used will be correct with either Baro-IN or Rad Alt selected on the NWAMS prior to the OTF selection.
If an update of system height is required post target then Rad Alt shall be selected prior to selection OTF.
The selection of Rad Alt or Baro-IN after OTF will cancel IVV and the attack will then continue using the selected height sensor.

SMS

Base 10SMS
Deselection of a weapon package followed by a reselection may cause a wrong spacing which is displaced on WCP1. The spacing has to be reselected to the required value. To avoid an MC/SMS interface malfunction, weapon package shall be programmed after APU/Main engine power transfer has occurred. Rockeye bombs with SMS Pre Mod. 11188 shall be loaded on weapon computer via programming unit using BL755 WPU CODE NR 41/42 (BL755 SAFU setting 1.13 sec.).

Home-on-Jam

HOJ attaks are not possible against targets above or at coaltitude with the aircraft.

NOTE

Entry to manual HOJ is made easier by optimising the radar settings, and in particular the antenna depression, before selecting the radar accept.

Air-to-Air Search

(P200B software only) The air-to-air search modes are not cleared for use.

Loft Attacks

(P200B software only) The facility to change loft pull-up point is included in this OFP. The operation of this facility is not always correct and is not cleared for use.

Unplanned Attack

(P200B software only) Freeze mode does not work with planned attack.

Phase 2 Offset Loft

(P200B software only) The use of Rad Alt as a height sensor for phase 2 offset loft attacks requires caution. Large plan range errors may result from tromboning with shallow sight lines if Rad Alt is selected after CVO. Rad Alt may be used while working the offset but it is essential that the system remains in IVV after CVO and that Rad Alt is not re-selected.

Auto Loft Pull-Up

(P200B software only) After selecting a phase 2 offset in auto loft (i.e. LL and HL illuminated) the pilot shall CVO otherwise phase 3 will not occur.
When auto phase change to phase 3 in Low Loft is required (HL and LL WAMS captions both illuminated) care shall be exercised on subsequent changes to the loft modes to ensure the correct switching sequence is used.
Selection of High Loft after Low Loft should be delayed until the line of attack is achieved.

Low Loft

When carrying out loft release of 1000 lb bombs the minimum release height allowed is 100 ft above target height.
(X108 only). PHC corrections made during Phase 2 of loft attacks are ignored by the system on entering Phase 3. Therefore attacks which include Phase 2 corrections should be "dry only". Care should be taken to avoid inadvertent PHC inputs during the Phase 1 to Phase 3 transition.

NOTE

- If a valid auto release has been missed during the pull up and the release button remains pressed, a release will occur at around 45° climb angle. Large weapon miss distance may result. The moding is intended to ensure weapon release under operational conditions, thus during training flying it is to be advisable to break-off the attack at 40° if the release has not already occurred.
- (X108 only). When utilising the auto phase change facility (both HL and LL WAMS captions illuminated) care shall be exercised on subsequently changing the desired loft mode selection to ensure the correct switching sequence is carried out.
- (X108 only). When auto phase change to phase 3 in Low Loft is required Fix/Attack should be selected prior to High Loft. Also selection of High Loft should be delayed until the line of attack is achieved.

BOMB ATTACKS

Bomb Laydown

Planned and Unplanned Laydown attacks in Phase 1, Phase 2/3 and TOO mode; laydown attacks in the reversionary mode; moving target attacks (target speed up to 45 kt); auto attacks; palnned and unpalnned simulated attacks (attacks with practice bomb **over the sea**) in manual and automatic Home On Jam (HOJ) modes are cleared within the flight envelope detailed in Figure 5-44.

Bombs Dive/Medium Level

Planned and Unplanned dive attack in phase 2/3, TOO mode, dive attacks in reversionary mode, medium level attacks in phase 1; planned and unplanned simulated attack in manual and automatic HOJ modes are cleared for use within the flight envelope detailed in Figure 5-44.

Bomb Low Loft

Planned and unplanned low loft attacks; moving target attacks (target speed up to 45 kt); auto attacks; planned and unplanned simulated attacks in manual and automatic HOJ modes are cleared for use within the flight envelope detailed in Figure 5-44.

Bomb High Loft

Planned high loft attacks are cleared for use as detailed in National Documents.

BOMB ATTACK FLIGHT ENVELOPE

ATTACK PROFILE	SPEED (KIAS)		CLIMB/DRIVE ANGLE
	Min	Max	
LAYDOWN			
* Planned, direct, Phase 1, Phase 2/3	350	600	+ 10° to − 20°
Planned, offset, Phase 1, Phase 2/3	350	600	Straight and Level
* Unplanned TOO/CCIP	400	600	+ 5° to − 20°
DIVE			
Direct and offset	350	600	− 10° to − 20°
	350	550	up to − 45°
MEDIUM LEVEL			
Phase 1 (HT Sensor BARO/IN)	350	550/0.9M	+ 10° to − 10°
LOW LOFT			
Direct and offset (Max Reheat)	350	600	–
(Max Dry)	500	600	

NOTE

For HOJ (automatic and manual) mode flight envelope refer to the Figure above where indicated (*). Target speed up to 45 kt for moving target attacks in HOJ mode.

Figure 5-44

GUN MODES

Air-to-Ground (A/G) and Air-to-Air (A/A) live gun attacks are cleared.

With the exception of Reversionary Attacks, MAIN or IN/MC modes only shall be used for Gun attacks.

In Air-to-Ground attacks, the minimum range marker shall not be used. In addition operators should refer to the criteria in Section 6 (DIVE Recovery chart) of this manual.

In Air-to-Air, prior to incorporation of mod. 00942 the Range Circle and ballistic are incorrect.

Anomalous indications of radar height can be displayed on the HUD when in Air-to-Air modes.

NOTE

- **Air-to-Ground**

  The breakaway cross will remain on the HUD if the AGG mode is deselected whilst the cross is flashing. If so, reselect and deselect the mode when the cross has disappeared.

  Spurious slant range inputs, accompanied by a loss of range lock and subsequent updating of height above target by integrated VV, can result in incorrect height above target being used to determine the display of the breakaway cross. Therefore during AGG attacks using slant range sensors the breakaway cross should not be used as the sole indication of minimum safe height.

- Air-to-Air

  Primary Mode: particularly at low level the GMR tends to lock-on to the ground or clouds. If the gimbal limits are approached whilst the GMR is locked-on the system may revert to the Stadiametric mode. In this case the Ranging Reticle will overlay the aiming pipper.
  Authority is regained by deselecting and reselecting the mode. Difficulty can be experienced in rejecting the radar lock and redesignating the target once a false lock has occurred on the ground returns or clouds. This is because the radar relocks to the clutter. The minimum range of the radar lock-on has been found to vary.

GUN ATTACK

Gun air to ground

Air to ground gun attacks are cleared for use within the flight envelope as detailed below.

Attack profile	Speed (KIAS)		Dive Angle	Normal Accel.
	Min	Max		
Live and simulated	250 450	600/1.0M 550	−5° ÷ −20° > −20°	−1 to 5
Reversionary Mode	400	600	−5° ÷ −20°	−

GUN AIR-TO-AIR

Air-to-Air gun attacks (not in HOJ and reversionary mode) are cleared for use within the flight envelope as detailed below:

- **Radar lock on − Live Attacks**
  Speed 350-550 KIAS/1.0 M
  Height not below 1000 ft AGL
  Normal Acceleration: −1 to 5.0 g
  Max Altitude: 30000 ft

- **Radar lock on − Simulated Attacks**
  Speed 350-550 KIAS
  Height not below 1000 ft AGL

- **Stadiametric mode** (simulated only against manoeuvering targets; cleared for traking and firing against banner targets)
  Speed 350-550 KIAS
  Height not below 1000 ft AGL

- **CCIL Mode** (simulated only)
  Speed 350-550 Kias
  Height not below 1000 ft AGL

KORMORAN

Final target position update shall be made when the aircraft is in the firing range.
The static harmonisation angles shall not be measured for each station after attaching the Kormoran launchers and shall be inserted via TV/TAB-MFK after each MC software loading (see note on "A/G MISSILES" paragraph, Armament and External store chapter of this section). If the radar switches to AUTO HOJ during lock-on mode, target acquisition shall be repeated or a visual attack shall be initiated.
10 seconds before release and during release, sideslip angle and bank angle have to be minimised.
Firing track 180° ± 1° is inhibited.
When using the MVT mode with two targets the aircrew work load is very high which results in mode being operationally unacceptable.
GMR as a height and ranging sensor for Auto/Manual HOJ is not cleared for use.

NOTE

- The axial gyro is aligned in spite of flashing READY; that means firing is permitted.

- Hit probability is reduced when the missile is fired:
  - with bank angle > 40°
  - with manoeuvres that differ from stright and level flight.
  - within 10 sec after relight of alignment indicator "A" (after a hard manoeuvre)
  - in the Radar Acquisition mode and > 10 sec after target insert
  - in the Radar L.O. mode and > 20 sec after "Deselect L.O." or L.O. break (ECM)

WEAPON AIMING AND RELEASE – LAUNCH – FIRING

NOTE

- Weapon aiming limitations shall be observed.
- Weapons are cleared for release/launch/firing in aiming modes as detailed below.

BOMBS

Bomb type / Attack mode	MK 106	MK 76	MK 83 LDGP (2)	MK 82 LDGP	MK 83 HDGP	MK82 HDGP	BL-755	MK 20
LAYDOWN Planned Phase 1/2/3 MVG TGT Unplanned Phase 1/2/3 MVG TGT	 X X				 X (3) X (3)	 X (3) X (3)	 X (3) X (3)	
DIVE Planned Phase 2/3 Unplanned Phase 2/3		 X X	 X (3) X (3)	 X (3) X (3)				
LOW LOFT (including MVG TGT) HIGH LOFT		X (3)	X (3)					
MEDIUM LEVEL		X	X (3)	X (3)				
REVERSIONARY	X (1)	X (1)	X (1)	X (1)	X (1)	X (1)	X (1)	X (1)
AUTO ATTACK	X	X	X	X	X	X	X	

KORMORAN

Missile type / Attack mode	KORMORAN
Lock-on	X
Acquisition	X
Visual	X
Visual-2 (TOO)*	X

Bogus mode cleared
*Post Mod 13045

SIDEWINDER

Missile type / Attack mode	AIM-9L
Boresight	X
Lead	X
Slave	X

(cleared with AUTO/NORM selection)

GUNS

Software / Attack mode	SS7	Rev.
Air-to-Ground	X	X
Air-to-Air (4)	X	

MW-1

Attack Mode	Submission				
	KB-44	MIX 1	MUSA	MIX 2	STABO
Reversionary	X (5)	X (5)	X (5)	X (5)	X (5)
Bogus Mode					
TOO/CCIP	X	X	X	X	
Planned Ph 1, 2, 3	X	X	X	X	

(1): Using Panavia incidence Tables and standard Weapon Ballistic Tables.
(2): With this weapon selection on the SMS Bogus Bomb facility is usable.
(3): MWCS Single Bomb Ballistic.
(4): Software in Air-to-Air mode does not provide the necessary accuracy against manoeuvring target.
(5): Interim ballistics.

Figure 5-45

- If the target bearing is > 5° (deg) a missile loss may occur.
- Loss of station selection will result in automatic selection of the next missile available.
- If Rmax of the missile is extended, kill Probability is reduce.

SIDEWINDER (AIM9L) MODES

For launch the target shall be kept within the field of view of the HUD to confirm seekerhead lock-on.
In Station Select mode, Normal station switch over may occur as in Auto Mode. This does not impair system capability.

NOTE

Target acquisition is possible up to 3.3 g if the target is within the HUD field of view.
The Lead mode should not be entered unless the target position is within 3° perpendicular above the gun cross.
In the Boresight mode target acquisition should be initiated only below 2.5 g.
M + S should be selected on the CRPMD prior to an attempt to achieve lock-on in order to prevent spurious radar lock-on to clutter.

MISCELLANEOUS

LIGHTNING RISKS

Prior to embodiment of a lightning surge limiter no flying with dielectric nose radomes is allowed, where the probability of cumulonimbus clouds over the area is extremely high (>40%).

SPECIAL LIMITATIONS FOR TRAINER VERSION

There are no special aircraft limitations for the trainer version. However, there are major differences in the two cockpit indication (valid also for strike aircraft) due to pressure errors and therefore the following operational guidance is given.

- The master reference for airspeed, mach number and altitude is the HUD which gives the most accurate indications. Therefore, when flying the aircraft from the rear cockpit, cross monitoring shall be used between the cockpits to ensure that the limits are not exceeded.
- The rear cockpit pressure instruments always overread. The effect is greater at high IAS and mach number, reducing at low speed.
- With Head Down altimeter in the standby mode, the instrument overreads and may be up to 1500 ft in error in the unsafe sense at high speed.

WARNING

WITH THE AIRCRAFT ON THE GROUND AND THE ENGINES IN THE DRY RANGE, THE BUCKETS WILL DEPLOY IMMEDIATELY IF THE THRUST SELECTOR IS SELECTED TO ON.
DO NOT SELECT TR IN THE REAR COCKPIT TO ON WITH REHEAT SELECTED, BUT ALLOW 3 SECONDS TO ELAPSE AFTER REHEAT CANCELLATION BEFORE ACTIVATING TR.

NOTE

The rear cockpit thrust reverse selector shall not be preselected to ON if the LIFT DUMP indicates OL.

HELMET HGU DH 152

Aircrews using this type of helmet will be liable to lose if including the oxygen mask at ejection speeds of 450 KIAS and above.

RADAR WARNING EQUIPMENT (RWE)

The RWE is cleared for use.

NOTE

False alarms may occur.

ACTIVE ELECTRONIC COUNTERMEASURES (AECM)

The AECM is not cleared for use.
After the embodiment of the relative mods, the AECM is cleared for use in active mode "ON" subject to the following limitations:

1. no flying in Auto TF mode;
2. when flying TF in FD mode:
   - set a minimum clearance height of 1500 ft AGL
   - VCM only
   - pilot shall monitor E-scope and terrain
   - RAD ALT shall be observed to maintain sufficient clearance height.
3. no external store configuration including ACMI pod, MW-1 or special weapon.

The AECM in the active mode "OFF" is cleared for use.

RECONNAISSANCE SUBSYSTEM

The reconnaissance subsystem is cleared for use, subject to the following advisory notes:

- Due to the design characteristics aircrew cannot fully monitor pod ECS functioning o reset pod ECS.
- A/C ECS failure stops the airflow to the pod ECS and A/C ECS reset does not guarantee successfull pod ECS reset.
- During ground operation (Fan/Heater mode) at outside air temperature greater than +30°C, pod internal temperatures cannot be maintained within the required limits for in-flight operations.

Due to incorrect functioning of the window shutter the use of the RECCE sensors may not be possible at altitudes above 10000 ft.

NOTE

- Preconditioning of the LHOV is necessary in order to minimise defocusing and to prevent condensation due to temperature jump.
- In side oblique position (± 30°C) oscillations of the IRLS may occur, which will cause blurred imagery.

HF/SSB

On ground
The HF SSB is cleared for use.

In flight
Pre mod. 20160 and 11159:
The use of HF/SSB is restricted to receive mode only.

Post mod. 20160 and 11159:
For IT aircraft the use of HF/SSB is restricted to receive mode only.
For IS aircraft the use of the HF/SSB in the transmission mode in the frequency range 7.2 to 14 MHz is prohibited. Outside the above frequency range, the use of HF/SSB is unrestricted.

On aircraft Post Mod. 20160 but without Mod. 11159 embodied the following check shall be carried out before any sortie during which it is planed to use HF system.
After the aircraft has been set up in accordance with FCC, carry out HF-SSB checks prior to getting airborne as follows:

a. Taxi aircraft to a safe area that is at least 50 meters from other aircraft, buildings and ordnance.

b. Peform HF-SSB transmit tests (not BITE) on the allocated frequencies that are to be used for the sortie, with aircrew observing the CWP for any change of status to the generation system and/or the CSAS.

c. On completion of the HF-SSB tests, and if there are no unwanted performance system effects, proceed with sortie.

d. In the event of system malfunctions as a result of HF-SSB BITE tests, the HF-SSB sortie should be cancelled. The equipment should be inhibited by pulling the appropriate circuit breakers pending defect rectification.

CANOPY

Ground

The canopy may remain open without a supporting strut in wind speed gusting up to 50 kt for entry, exit and strapping in only.

Flight

Following loss of the canopy, the aircraft should be recovered as quickly as possible to speeds below 250 KIAS and an altitude of 15000 ft and below.

Cockpit Noise

In the transonic speed range an organ piping sound may be heard.

ESCAPE SYSTEM/PERSONAL EQUIPMENT

The escape system, in both its modes, is cleared for use, when initiated from either the front or rear crew position, throughout the flight envelope up to 625 KIAS.

CAUTION

AIRCREWS USING IT AIRCREW EQUIPMENT ASSEMBLY WILL BE LIABLE TO LOOSE THE HELMET AND OXYGEN MASK AT EJECTION SPEEDS OF 450 KIAS AND ABOVE.

COMPUTING

The following MC software standard (OFP) are cleared for use:

T-P-SW-X107-01-P (SS7-2B) – mod. 16100
T-P-SW-X108-01-P (SS7-2B) – mod. 16120
T-P-SW-X701-01-P (ST-5A) – mod. 16064
T-P-SW-X702-01-P (ST-6A) – mod. 16071
SWIT-P-MCC-P200B (SS7) – mod. 16130

NOTE

- Limitation and advisory notes of software standard 701 and 702 are defined in national documents.
- Software standards T-P-SW-X107-01-P and T-P-SW-X108-01-P includes Enhanced Ground Test Facility. Due to deviations of the EGTF from the software requirements, its usability is limited with T-P-SW-X107-01-P.
- When operating in DO/SA mode, the HUD climb/dive and vertical velocity displays suffer from lags and errors of varying magnitude. In this mode the pilot shall monitor the aircraft attitude and flight path outside visual references or head down instruments and shall not rely on HUD displays.
- The MC and HUD combination is not tested as a safety critical item. Therefore aircrew should never take HUD information as the sole indication of safety.

- If software standard SWIT-P-MCC-P200B is used with the 128MC, the program may occasionally stop. The program will restart after recycling the MC. This fault is cured by Mod 11294 (224K MC).

Computing Equipment

The following equipments are cleared for use:

- IFU1 and IFU1
- MC 64K (Mod 10137)
- MC 128K (Mod 11047)
- MC 224K (Mod 11294)
- Main Computer control panel

Rapid Data Entry (RDE)/Programme Loading

Rapid data entry of mission data and/or loading of the OFP via the cockpit voice recorder is cleared for use.

EXTERNAL STORES RELEASE/LAUNCH AND JETTISON

GROUP	STORE CONFIG.	STORE No.	STORE CONFIGURATION Pylons ± adaptors/Launchers ± 2 to 1 AIM9-L PLUS
A	TANKS Emergency Jettison	1	4 Tanks + CFD
		2	2 Tanks + CFD
		5	3 Tanks + CFD
B	CBLS200 Release	1	2 to 1 CBLS200 + 2 Tanks + CFD
		2	2 to 1 CBLS200 + CFD
		3	1 CBLS200 + 3 Tanks + CFD
		4	1 CBLS200 + 1 Tank + CFD
	CBLS200 Emergency Jettison	1	2 to 1 CBLS200 + 2 Tanks + CFD
		2	2 to 1 CBLS200 + CFD
		3	1 CBLS200 + 3 Tanks + CFD
		4	1 CBLS200 + 1 Tank + CFD
C	MK83 FF Release	1	5 to 1 MK83 FF +2 Tanks+CFD
		2	5 to 1 MK83 FF +CFD
		3	7 to 1 MK83 FF +CFD
	MK83 Ret. Release	1	5 to 1 MK83 Ret.+2 Tanks+CFD
		2	5 to 1 MK83 Ret.+CFD
		3	7 to 1 MK83 Ret.+CFD
	MK83 FF Emergency Jettison	1	5 to 1 MK83 FF +2 Tanks+CFD
		2	5 to 1 MK83 FF +CFD
		3	7 to 1 MK83 FF +CFD
	MK83 Ret. Emergency Jettison	1	5 to 1 MK83 Ret.+2 Tanks+CFD
		2	5 to 1 MK83 Ret.+CFD
		3	7 to 1 MK83 Ret.+CFD

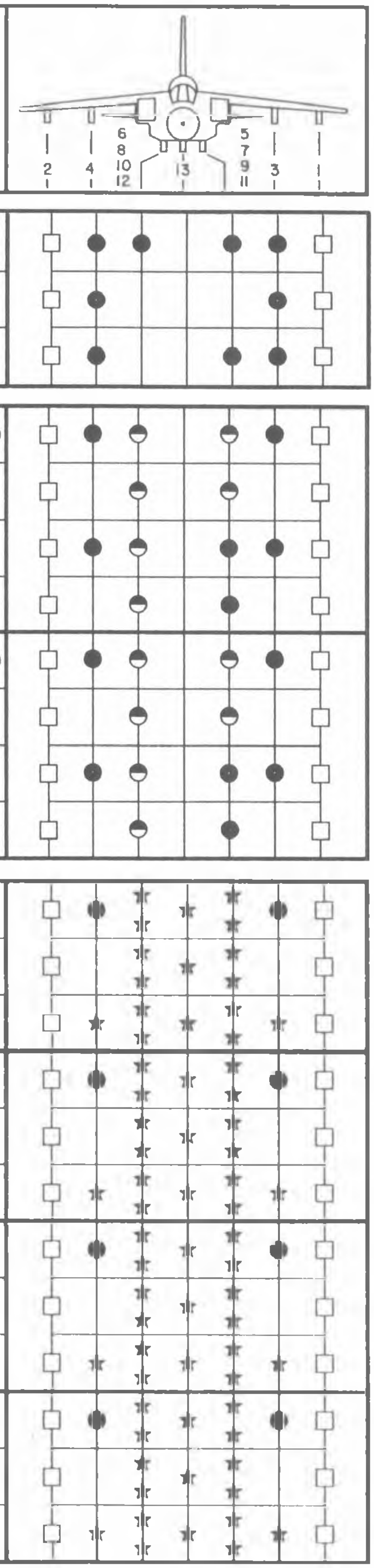


Figure 5-46 (Sheet 1 of 15)

EXTERNAL STORES RELEASE/LAUNCH AND JETTISON

GROUP	STORE CONFIG.	STORE No.	STORE CONFIGURATION Pylons ± adaptors/Launchers ± 2 to 1 AIM9-L PLUS
D	BL755 Release	1	5 to 1 BL755 +2 Tanks+CFD
		2	5 to 1 BL755 +CFD
		3	7 to 1 BL755 +CFD
	BL755. Emergency Jettison	1	5 to 1 BL755 +2 Tanks+CFD
		2	5 to 1 BL755 +CFD
		3	7 to 1 BL755 +CFD
E	Kormoran Release	1	2 to 1 Kormoran+2 Tanks +CFD
		2	2 to 1 Kormoran + CFD
	Kormoran Emergency Jettison	1	2 to 1 Kormoran+2 Tanks +CFD
		2	2 to 1 Kormoran + CFD
F	MK82 FF Release	1	5 to 1 MK82 FF +2 Tanks+CFD
		2	5 to 1 MK82 FF +CFD
		3	7 to 1 MK82 FF +CFD
	MK82 Ret. Release	1	5 to 1 MK82 Ret.+2 Tanks+CFD
		2	5 to 1 MK82 Ret.+CFD
		3	7 to 1 MK82 Ret.+CFD
	MK82 FF Emergency Jettison	1	5 to 1 MK82 FF +2 Tanks+CFD
		2	5 to 1 MK82 FF +CFD
		3	7 to 1 MK82 FF +CFD
	MK82 Ret. Emergency Jettison	1	5 to 1 MK82 Ret.+2 Tanks+CFD
		2	5 to 1 MK82 Ret.+CFD
		3	7 to 1 MK82 Ret.+CFD

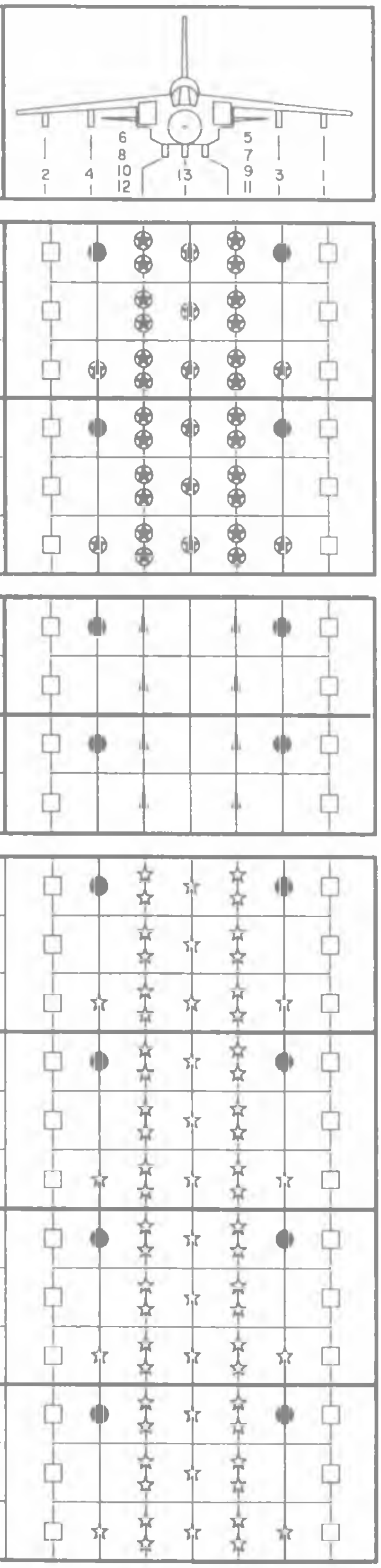
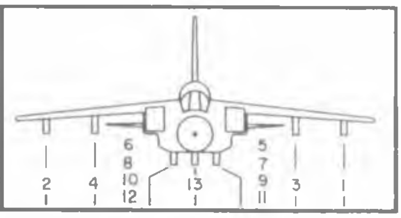


Figure 5-46 (Sheet 2 of 15)

EXTERNAL STORES RELEASE/LAUNCH AND JETTISON



GROUP	STORE CONFIG.	STORE No.	STORE CONFIGURATION Pylons ± adaptors/Launchers ± 2 to 1 AIM9-L PLUS
G	MK20 Release	1	5 to 1 MK20+2 Tanks+CFD
		2	5 to 1 MK20 + CFD
		3	7 to 1 MK20 + CFD
	MK20 Emergency Jettison	1	5 to 1 MK20+2 Tanks+CFD
		2	5 to 1 MK20 + CFD
		3	7 to 1 MK20 + CFD
H	Recce Pod Emergency Jettison	1	1 Recce Pod + 2 Tanks + CFD
		2	1 Recce Pod + CFD
L	MW-1 Submunit Release	1	MW-1 + 2 Tanks
		2	MW-1
	MW-1 Emergency Jettison	1	MW-1 + 2 Tanks
		2	MW-1
M	Refuel Pod Emergency Jettison	1	1 Refuel Pod +2 Tanks + CFD
			Hose Jettison
			Trailed Hose
	Refuel Pod Emergency Jettison	2	1 Refuel Pod + CFD
			Hose Jettison
			Trailed Hose

- ● 1500 L. Tank Full
- ○ 1500 L. Tank Empty
- AIM -9L
- ACMI Pod
- CBLS 200
- ★ MK83 FF/Ret.
- BL 755
- Kormoran
- ☆ MK-82 FF/Ret.
- MK 20
- Recce Pod
- Special Weapon
- MW - 1
- Refuel Pod
- □ C.F.D. Boz 102

Figure 5-46 (Sheet 3 of 15)

EXTERNAL STORES RELEASE/LAUNCH AND JETTISON

CONFIG SEE SUMMARY TABLES	CONDITION	HEIGHT (Ft AGL)	SPEED (KIAS/M)	G RANGE	MAX AOA	WING SWEEP
A1, A2 and A5	Selective/ Emergency Jettison		Full: up to 300	1 to 2		25 Mid/full flap
			2/3 to full: up to 550/.72 up to 550/.85		17 10	All
			Less 2/3 to empty: up to 500/.5 up to 550/.82 up to 550/.85		17 11 7.5	

A1, A2 and A5

- Jettison of tanks during take off rolls is cleared only with tank contents greater than 800 kg.
- The best recommended selective and emergency jettison conditions for all configurations are:
  25° WSA, 300 KIAS/ ≤ .6 M, nominal 1 g straight and level.
  Alternative conditions except for CBLS 200, if the above cannot be reached are:
  Any wing sweep, 400 KIAS/ ≤ .8 M, nominal 1g straight and level.
- After take off jettison of i/b tanks with/without other stores is permitted with cruise wing only.
- Carriage limitations are overriding.
- In an emergency case selective jettison of AIM-9L may be accomplished within the carriage envelope (Post mod. 01460 only).
- CFD not cleared for jettison, cardridges have to be removed.

A1

- The Ferry, CBLS 200 and Kormoran configurations are cleared only with WPU 20 097, 20 098 and 20 099.

Figure 5-46 (Sheet 4 of 15)

EXTERNAL STORES RELEASE/LAUNCH AND JETTISON

CONFIG SEE SUMMARY TABLES	CONDITION	HEIGHT (Ft AGL)	SPEED (KIAS/M)	G RANGE	MAX AOA	WING SWEEP
B1R, B2R B3R and B4R	Release	Ret. P.B: 50-5000 FF PB: 1000-10000	 350-600/.92 350-600/.92	 0.5 to 1.5 0.5 to 4		 All All
B1E	Selective/ Emergency Jettison	SL-5000	up to 300/.6	nom. 1		25 Mid/full flaps
		2/3 to full tank SL-5000	250-300/.6	nom. 1	15	25 Cruise
		2/3 full tank SL-5000	250-300/.6	nom. 1	9	
B2E	Selective/ Emergency Jettison	SL-5000	up to 300/.6	nom.1	N/A	25
B3E	Selective/ Emergency Jettison	Equal to B1E				
B4E	Selective/ Emergency Jettison	Equal to B1E				
For selective or emergency jettison of tanks refer to "A" configurations						

B1E, B2E, B3E, B4E:

- The best recommended selective and emergency jettison conditions for all configurations are:
  25° WSA, 300 KIAS/ ≤ .6 M, nominal 1 g straight and level.
  Alternative conditions, except for CBLS 200, if the above cannot be reached are:
  Any wing sweep, 400 KIAS/ ≤ 0.8 M, nominal 1g straight and level.
- The Ferry, CBLS 200 and Kormoran configuration are cleared only with WPU 20 097, 20 098 and 20 099.
- In an emergency case selective jettison of AIM-9L may be accomplished within the carriage envelope (Post mod. 01460 only).

B1R, B2R, B3R, B4R:

- Carriage limitations are overriding.
- The Ferry, CBLS 200 and Kormoran configurations are cleared only with WPU 20 097, 20 098 and 20 099.
- CFD not cleared for jettison, cartridges have to be removed.

Figure 5-46 (Sheet 5 of 15)

EXTERNAL STORES RELEASE/LAUNCH AND JETTISON

CONFIG SEE SUMMARY TABLE	CONDITION	HEIGHT (Ft AGL)	SPEED (KIAS/M)	G RANGE	MAX AOA	WING SWEEP
C1FF	Release	1000-10000	350-600/.92	nom. 1 to 4		All
C2FF	Release	"	"	"		"
C3FF	Release	"	"	"		"
C1Ret	Release	120-5000	420-580/.9	nom. 1		All
C2Ret	Release	"	"	"		"
C3Ret	Release	"	"	"		"

C1FF, C2FF, C3FF, C1Ret, C2Ret, C3Ret

- Carriage limitations are overriding.
- Pre mod. 13011:
  With all bombs except BL755 there are risks of releasing inert and jettisoning live. Control jettison only is permitted.
  Post mod. 13011:
  With all bombs except BL755 there are risks of jettisoning live when loaded to stations 3H, 4H, and 13H. Controlled jettison only is permitted from these stations.
- CFD not cleared for jettison, cartridges have to be removed.

C1FF, C2FF, C3FF

- Salvo is cleared up to speeds of 500 KIAS

C1Ret, C2Ret, C3Ret

- The plunger distance shall not exceed 10mm after having loaded the bomb.

Figure 5-46 (Sheet 6 of 15)

EXTERNAL STORES RELEASE/LAUNCH AND JETTISON

CONFIG SEE SUMMARY TABLES	CONDITION	HEIGHT (Ft AGL)	SPEED (KIAS/M)	G RANGE	MAX AOA	WING SWEEP
C1FF	Selective/ Emergency Jettison	Equal to A1				
C2FF	Selective/ Emergency Jettison	All	up to 500/.8 up to 600/.92 up to 600/.92	nom.1 to 4		25 45 67
C3FF	Selective/ Emergency Jettison	-	-	-	-	-
C1Ret	Selective/ Emergency Jettison	Equal to A1				
C2Ret	Selective/ Emergency Jettison	All	up to 500/.8 up to 600/.92 up to 600/.92	nom.1 to 4		25 45 67
C3Ret	Selective/ Emergency Jettison	-	-	-	-	-
For selective or emergency jettison of tanks refer to "A" configurations.						

C2FF, C3FF, C2Ret, C3Ret:

- The best recommended selective and emergency jettison conditions for all configurations are:
  25° WSA, 300 KIAS/ ≤ .6 M, nominal 1g straight and level.
  Alternative conditions, except for CBLS 200, if the above cannot be reached are:
  Any wing sweep 400 KIAS/ ≤ 0.8 M, nominal 1g straight and level.
- Carriage limitations are overriding.
- In an emergency case selective jettison of AIM-9L may be accomplished within the carriage envelope (Post Mod. 01460 only).
- Pre mod. 13011:
  With all bombs except BL755 there are risks of releasing inert and jettisoning live. Controlled jettison only is permitted.
  Post mod. 13011:
  With all bombs except BL755 there are risks of jettisoning live when loaded to stations 3H, 4H, and 13H. Controlled jettison only is permitted from these stations.
- CFD not cleared for jettison, cartridges have to be removed.

C2Ret, C3 Ret:

- The plunger distance shall not exceed 10 mm after having loaded the bomb.

Figure 5-46 (Sheet 7 of 15)

EXTERNAL STORES RELEASE/LAUNCH AND JETTISON

CONFIG SEE SUMMARY TABLES	CONDITION	HEIGHT (Ft AGL)	SPEED (KIAS/M)	G RANGE	MAX AOA	WING SWEEP
D1R	Release	100-5000	350-600/.92	nom.1		All
D2R	Release	"	"	"		"
D3R	Release	"	"	"		"
Post mod. 01422 SAFU settings of either 0.68 or 1.13 second are available. All SAFU in a single load are to be same.						
D1E	Selective and Emergency Jettison	Equal to A1				
D2E	Selective and Emergency Jettison	All	up to 500/.8 up to 600/.92 up to 600/.92	nom. 1 to 3		25 45 67
D3E	Selective and Emergency Jettison	"	"	"		"
For selective or emergency jettison of tanks refer to "A" configuration.						

D1R, D2R, D3R:

- Carriage limitations are overriding.
- The correct flip out tail function cannot be guaranted. Malfunction is more likely to occur at release airspeeds greater than 550 kt.
- Pre mod. 13011:
  With all bombs except BL755 there are risks of releasing inert and jettisoning live. Controlled jettison only is permitted.
  Post mod. 13011:
  With all bombs except BL755 there are risks of jettisoning live when loaded to stations 3H, 4H, and 13H. Controlled jettison only is permitted from these stations.
- CFD not cleared for jettison, cartridges have to be removed.

D2E, D3E:

- The best recommended selective and emergency jettison conditions for all configurations are:
  25° WSA, 300 KIAS/ $\leq$ .6 M, nominal 1g straight and level.
  Alternative conditions, except for CBLS 200, if the above cannot be reached are:
  Any wing sweep, 400 KIAS/ $\leq$ 0.8 M, nominal 1g straight and level.
- Carriage limitations are overriding.
- In an emergency case selective jettison of AIM-9L may be accomplished within the carriage envelope (Post Mod. 01460 only).
- CFD not cleared for jettison, cartridges have to be removed.

Figure 5-46 (Sheet 8 of 15)

EXTERNAL STORES RELEASE/LAUNCH AND JETTISON

CONFIG SEE SUMMARY TABLES	CONDITION	HEIGHT (Ft AGL)	SPEED (KIAS/M)	G RANGE	MAX AOA	WING SWEEP
E1R	Release	100-3300	350-630/.95	nom. 1		All
E2R	Release	"	"	"		"
E1E	Selective/ Emergency Jettison	Equal to A1				
E2E	Selective/ Emergency Jettison		up to 450/.8 up to 550/.85 up to 600/.95	nom. 1 to 4		25 45 67
For selective or emergency jettison of tanks refer to "A" configurations.						

E1R, E2R

- Carriage limitations are overriding.

E2E

- The best recommended selective and emergency jettison conditions for all configurations are:
  25° WSA, 300 KIAS/ ≤ .6 M, nominal 1g straight and level.
  Alternative conditions, except for CBLS 200, if the above cannot be reached are:
  Any wing sweep, 400 KIAS/ ≤ 0.8 M, nominal 1g straight and level.
- Carriage limitations are overriding.
- In an emergency case selective jettison of AIM-9L may be accomplished within the carriage envelope (Post Mod. 01460 only).
- The Ferry, CBLS 200 and Kormoran configurations are cleared only with WPU 20097, 20098 and 20099.
- CFD not cleared for jettison, cartridges have to be removed.

Figure 5-46 (Sheet 9 of 15)

EXTERNAL STORES RELEASE/LAUNCH AND JETTISON

CONFIG SEE SUMMARY TABLES	CONDITION	HEIGHT (Ft AGL)	SPEED (KIAS/M)	G RANGE	MAX AOA	WING SWEEP
F1FF	Release	1000-10000	350-600/.8	nom.1 to 4		All
F2FF	Release	"	"	"		"
F3FF	Release	"	"	"		"
F1Ret.	Release	110-5000	400-500/.8	nom. 1		All
F2Ret.	Release	"	"	"		"
F3Ret.	Release	"	"	"		"

F1FF, F2FF, F3FF, F1Ret, F2Ret, F3Ret:

- Carriage limitations are overriding.
- Pre mod. 13011:
  With all bombs except BL755 there are risk of realising inert and jettisoning live. Controlled jettison only is permitted.
  Post mod. 13011:
  With all bombs except BL755 there are risks of jettisoning live when loaded to stations 3H, 4H and 13H. Controlled jettison only is permitted from these stations.
- Pre mod 13023:
  With HMERU P/N 109506-4 only up to 4 MK 82 FF or Ret bombs may be carried on stations 5, 6, 11 and 12. With HMERU P/N 109506-6 up to 7 and 5 MK 82 FF bombs may be carried respectively.
- CFD not cleared for jettison, cardridges have to be removed.
- Salvo is cleared up to speeds of 500 KIAS.

Figure 5-46 (Sheet 10 of 15)

EXTERNAL STORES RELEASE/LAUNCH AND JETTISON

CONFIG SEE SUMMARY TABLES	CONDITION	HEIGHT (Ft AGL)	SPEED (KIAS/M)	G RANGE	MAX AOA	WING SWEEP
F1FF	Selective/ Emergency Jettison	Equal to A1				
F2FF	Selective/ Emergency Jettison	All	up to 500/.8 up to 600/.92 up to 600/.92	nom. 1 to 4		25 45 67
F3FF	Selective/ Emergency Jettison	-	-	-		-
F1Ret	Selective/ Emergency Jettison	Equal to A1				
F2Ret	Selective/ Emergency Jettison	Equal to F2FF				
F3Ret	Selective/ Emergency Jettison	Equal to F2FF				
For selective or emergency jettison of tanks refer to "A" configurations.						

F2FF, F3FF, F2Ret, F3Ret:

- The best recommended selective and emergency jettison conditions for all configurations are:
  25° WSA, 300 KIAS/ ≤ .6 M, nominal 1g straight and level.
  Alternative conditions, except for CBLS 200, if the above cannot be reached are:
  Any wing sweep, 400 KIAS/ ≤ 0.8 M, nominal 1g straight and level.
- Carriage limitations are overriding.
- In an emergency case selective jettison of AIM-9L may be accomplished within the carriage envelope (Post Mod. 01460 only).
- Pre Mod. 13011:
  With all bombs except BL755 there are risks of releasing inert and jettisoning live. Controlled jettison only is permitted.
  Post Mod. 13011:
  With all bombs except BL755 there are risks of jettisoning live when loaded to stations 3H, 4H, and 13H. Controlled jettison only is permitted from these stations.
- Pre Mod. 13023:
  With HMERU P/N 109506-4 only up to 4 MK 82 FF or Ret bombs may be carried on stations 5, 6, 11 and 12. With HMERU P/N 109506-6 up to 7 and 5 MK 82 FF bombs may be carried respectively.
- CFD not cleared for jettison, cardridges have to be removed.

Figure 5-46 (Sheet 11 of 15)

EXTERNAL STORES RELEASE/LAUNCH AND JETTISON

CONFIG SEE SUMMARY TABLES	CONDITION	HEIGHT (Ft AGL)	SPEED (KIAS/M)	G RANGE	MAX AOA	WING SWEEP
G1	Release	For 1, 2 sec fuze sett 200-400 ft For 4 sec fuze sett 600-4000 ft	For 1, 2 sec fuze sett 450-600/.92 For 4 sec fuze sett 400-600/.92	nom 1		All
G2	Release	Equal to G1				
G3	Release	Equal to G1				

G1, G2, G3

- Carriage limitations are overriding.
- Bomb fuzing time at release can be controlled by appropriate selection on WCP 1
  * TAIL FUZE selection corresponds to bomb fuzing time 1-2 sec.
  * NOSE AND TAIL FUZE selection corresponds to bomb fuzing 4 sec.
- Pre Mod. 13011
  With all bombs except BL755 there are risks of releasing inert and jettisoning live. Controlled jettison only is permitted.
  Post Mod 13011
  With all bombs except BL755 there are risks of jettisoning live when loaded to stations 3H, 4H and 13H. Controlled jettison only is permitted from these stations.
- CFD not cleared for jettison cartridges have to be removed.

Figure 5-46 (Sheet 12 of 15)

EXTERNAL STORES RELEASE/LAUNCH AND JETTISON

CONFIG SEE SUMMARY TABLES	CONDITION	HEIGHT (Ft AGL)	SPEED (KIAS/M)	G RANGE	MAX AOA	WING SWEEP
G1	Selective/ Emergency Jettison	Equal to A1				
G2	Selective/ Emergency Jettison	All	up to 500/.8 up to 600/.92 up to 600/.92	nom 1 to 3		25 45 67
G3	Selective/ Emergency Jettison	Equal to G2				
For selective or emergency jettison of tanks refer to "A" configurations.						

G2, G3:

- The best recommended selective and emergency jettison conditions for all configurations are:
  25° WSA, 300 KIAS/M 0.6 nominal 1 g straight and level
  Alternative conditions, except for CBLS 200, if the above cannot be reached are:
  any wing sweep, 400 KIAS/M ≤ 0.8 M, nominal 1 g straight and level
- Carriage limitations are overriding.
- In an emergency case selective jettison of AIM-9L may be accomplished within the carriage envelope (Post Mod. 01460 only)
- CFD not cleared for jettison, cartridges have to be removed.

Figure 5-46 (Sheet 13 of 15)

EXTERNAL STORES RELEASE/LAUNCH AND JETTISON

CONFIG SEE SUMMARY TABLES	CONDITION	HEIGHT (Ft AGL)	SPEED (KIAS/M)	G RANGE	MAX AOA	WING SWEEP
H1	Emergency Jettison		Full: up to 300 Empty: up to 500/.8 up to 525/.82 up to 525/.85	1 to 2	 < 9 < 9 < 7.5	25 Mid/full flaps 25 45 67
H2	Emergency Jettison		up to 500/.8 up to 525/.85 up to 525/.85		< 9 < 9 < 9	25 45 67

H1, H2:

- The best recommended selective and emergency jettison conditions for all configurations are:
  25 WSA, 300 KIAS/M ≤ 0.6 nomianl 1g straight and level.
  Alternative conditions, (except for CBLS200) if the above cannot be reached are:
  Any wing sweep, 400 KIAS/M ≤ 0.8, nominal 1g straight and level.
- Carriage limitations are overriding.
- In any emergency case selective jettison of AIM-9L may be accomplished within the carriage envelope (Post Mod. 01460 only).
- Throttle setting for Recce pod shall be 100% fwd /.0% aft.
- CFD not cleared for jettison, cartridges have to be removed.

H1:

- Jettison of tanks during take off rolls is cleared only with tank contents greater than 800 kg.
- After take off jettison of i/b tanks with/without other stores is permitted with cruise wing only.

CONFIG SEE SUMMARY TABLES	CONDITION	HEIGHT (Ft AGL)	SPEED (KIAS/M)	G RANGE	MAX AOA	WING SWEEP
L1	Submunition Release		NOT CLEARED			
L2	Submunition Release		NOT CLEARED			
L1	Emergency Jettison		NOT CLEARED			
L2	Emergency Jettison		NOT CLEARED			

Figure 5-46 (Sheet 14 of 15)

EXTERNAL STORES RELEASE/LAUNCH AND JETTISON

CONFIG SEE SUMMARY TABLES	CONDITION	HEIGHT (Ft AGL)	SPEED (KIAS/M)	G RANGE	MAX AOA	WING SWEEP
M1	Selective and Emergency Jettison	up to 30.000	up to 300/.6 up to 450/.7	nom.1 "	< 9 < 15	25 Mid/full flaps 25
	Hose Jettison		200 200-325	" "		25 Mid flaps 25
	Pod with trailed hose		200	"		25 Full flaps LG UP
M2	Selective and Emergency Jettison		up to 300/.6 250-300/.6	nom. 1 "	< 9 < 9	25 Mid/full flaps 25
	Hose Jettison		200 200-325	" "		25 Mid flaps 25
	Pod with trailed hose		200	"		25 Full flaps LG UP
For selective or emergency jettison of tanks refer to "A" configurations.						

All:

- The best recommended selective and emergency jettison conditions for all configurations are:
  25° W/SW, 300 KIAS/ ≤ .6 M, nominal 1g straight and level.
  Alternative conditions, except for CBLS 200, if the above cannot be reached are:
  Any sweep, 400 KIAS/ ≤ 0.8 M, nominal 1g straight and level.
- Carriage limitations are overriding.
- In an emergency case selective jettison of AIM9-L may be accomplished within the carriage envelope (Post Mod. 01460 only).
- Jettison in 1g flight, straight and level. Jettison in nose down attitudes is hazardous.
- Throttle setting, for C/L Buddy Buddy pod shall be 100% fwd 100% aft.
- For hose jettison (guillotining) cartridges ARD 863-1 shall be used.
- CFD not cleared for jettison, cartridges have to be removed.

Figure 5-46 (Sheet 15 of 15)

THIS PAGE LEFT INTENTIONALLY BLANK

EXTERNAL STORES CONFIGURATION AND CARRIAGE

GROUP	STORE CONFIG.	STORE No.	STORE CONFIGURATION Pylons ± adaptors/Launchers ± 2 to 1 AIM9-L PLUS
A	TANKS	1	4 tks full
			4 tks empty
		2	2 tks full ± ACMI
			2 tks empty ± ACMI
		3	AIM-9L ± ACMI
		4	ACMI
		5	3 tks full ± ACMI
			3 tks empty ± ACMI
	TANKS + CFD	1a	4 tks full
			4 tks empty
		2a	2 tks full ± ACMI
			2 tks empty ± ACMI
		3a	AIM-9L ± ACMI
		4a	ACMI
		5a	3 tks full ± ACMI
			3 tks empty ± ACMI

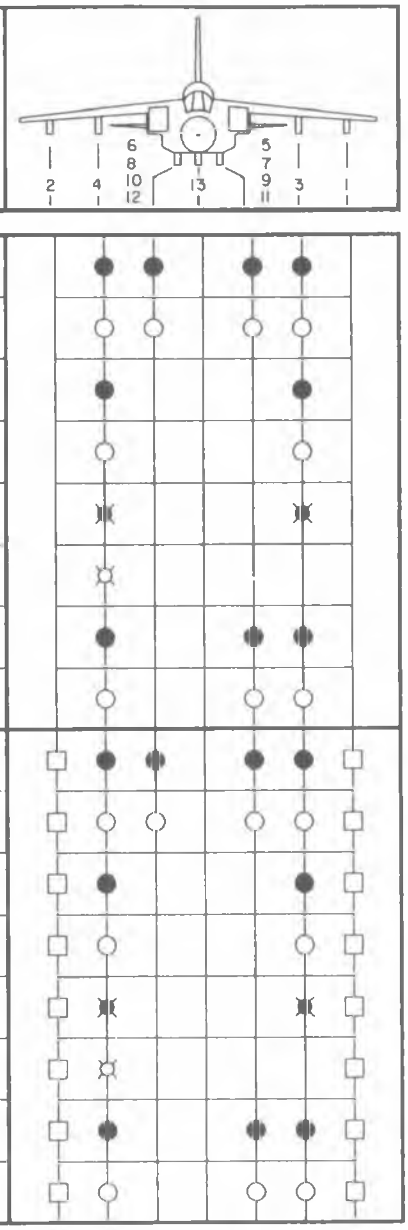
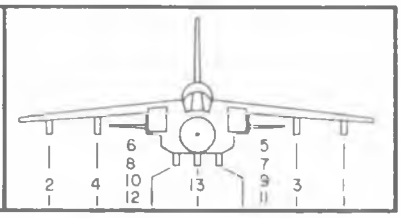
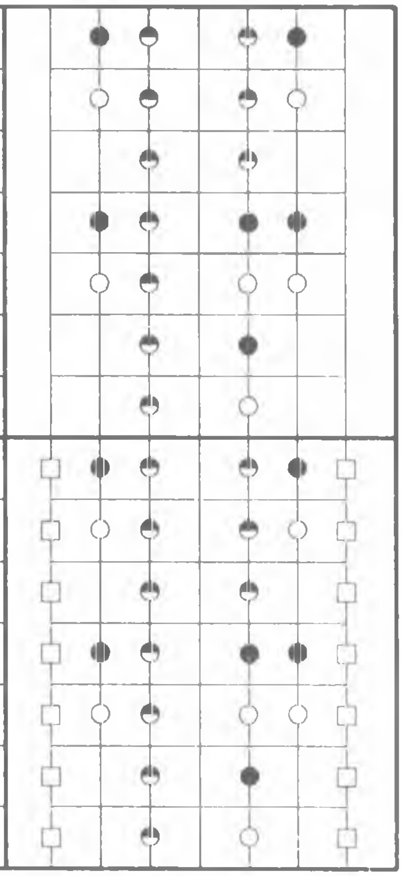


Figure 5-47 (Sheet 1 of 28)

EXTERNAL STORES CONFIGURATION AND CARRIAGE

GROUP	STORE CONFIG.	STORE No.	STORE CONFIGURATION Pylons ± adaptors/Launchers ± 2 to I AIM9-L PLUS
B	CBLS200	1	2to I CBLS200+ tks full ± ACMI
			2to I CBLS200+2tks empty± ACMI
		2	2to I CBLS200 ± ACMI
		3	I CBLS200+3 tks full± ACMI
			I CBLS200+3 tks empty± ACMI
		4	I CBLS200+I tk full + ACMI
			I CBLS200+I tk empty + ACMI
	CBLS200 + CFD	1a	2to I CBLS200+ 2 tks full±ACMI
			2to I CBLS200+ 2 tks empty ±ACMI
		2a	2to I CBLS200 ± ACMI
		3a	I CBLS200+ 3 tks full ± ACMI
			I CBLS200+ 3 ± ACMI
		4a	I CBLS200+ I tk full ± ACMI
			I CBLS200+ I tk empty ± ACMI
C	MK83 FF/Ret.	1	5 to I MK83 + 2 tks full
			5 to I MK83 + 2 tks empty
		2	5 to I MK83
		3	7 to I MK83
	MK83 FF/Ret. +CFD	1a	5 to I MK83 + 2 tks full
			5 to I MK83 + 2 tks empty
		2a	5 to I MK83
		3a	7 to I MK83





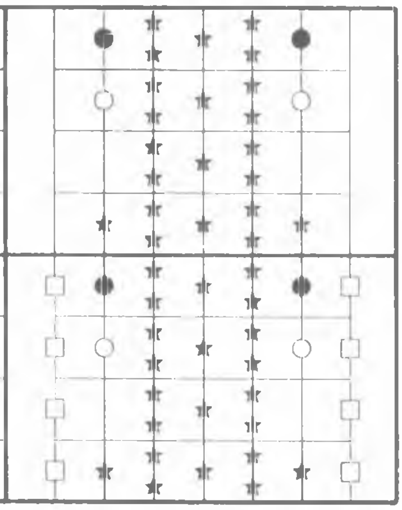
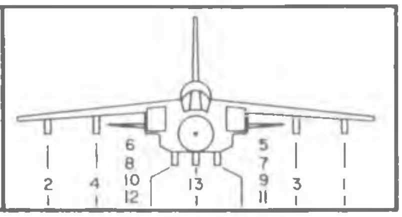
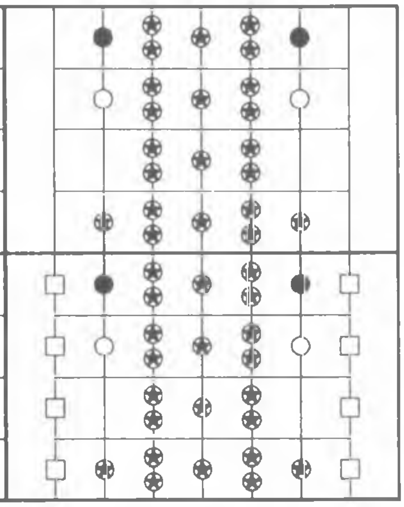
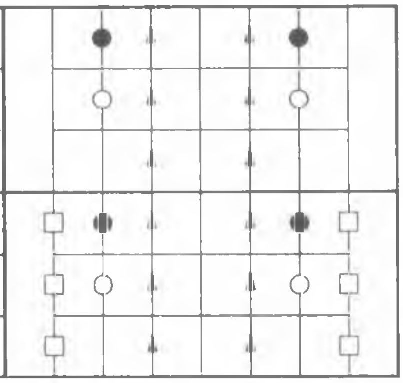


Figure 5-47 (Sheet 2 of 28)

EXTERNAL STORES CONFIGURATION AND CARRIAGE

GROUP	STORE CONFIG.	STORE No.	STORE CONFIGURATION Pylons ± adaptors/Launchers ± 2 to 1 AIM9-L PLUS	
D	BL755	1	5 to 1 BL755+2 tks full	
			5 to 1 BL755+2 tks empty	
		2	5 to 1 BL755	
		3	7 to 1 BL755	
	BL755 +CFD	1a	5 to 1 BL755+2 tks full	
			5 to 1 BL755+2 tks empty	
		2a	5 to 1 BL755	
		3a	7 to 1 BL755	
E	Kormoran	1	2 to 1 Kormoran+2 tks full	
			2 to 1 Kormoran+2 tks empty	
		2	2 to 1 Kormoran	
	Kormoran + CFD	1a	2 to 1 Kormoran+2 tks full	
			2 to 1 Kormoran+2 tks empty	
		2a	2 to 1 Kormoran	
F	MK-82 FF/Ret.	1	5 to 1 MK82+2 tks full	
			5 to 1 MK82+2 tks empty	
		2	5 to 1 MK82	
		3	7 to 1 MK82	
	MK-82 FF/Ret. + CFD	1a	5 to 1 MK82+2 tks full	
			5 to 1 MK82+2 tks empty	
		2a	5 to 1 MK82	
		3a	7 to 1 MK82	





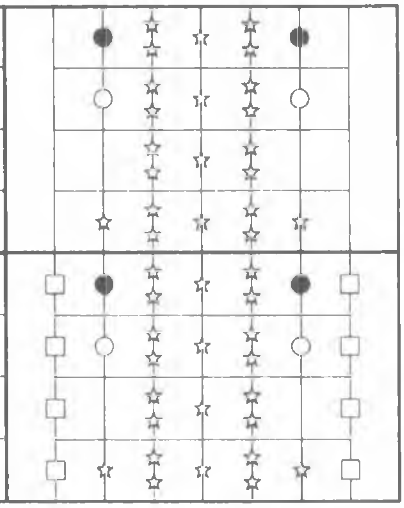
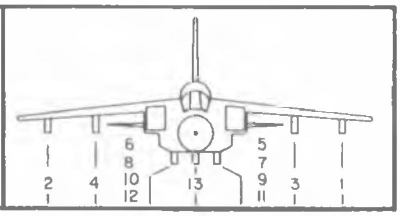


Figure 5-47 (Sheet 3 of 28)

EXTERNAL STORES CONFIGURATION AND CARRIAGE

GROUP	STORE CONFIG.	STORE No.	STORE CONFIGURATION Pylons ± adaptors/Launchers ± 2 to 1 AIM9-L PLUS
G	MK20	1	5 to 1 MK20 + 2 tks full
			5 to 1 MK20 + 2 tks empty
		2	5 to 1 MK20
		3	7 to 1 MK20
	MK20 +CFD	1a	5 to 1 MK20 + 2 tks full
			5 to 1 MK20 + 2 tks empty
		2a	5 to 1 MK20
		3a	7 to 1 MK20
H	Recce pod	1	1 Recce pod+2 tks full
			1 Recce pod+2 tks empty
		2	1 Recce pod
	Recce pod + CFD	1a	1 Recce pod+2 tks full
			1 Recce pod+2 tks empty
		2a	1 Recce pod
K	Special Weapon	1	2 to 1 SW+2 tks full
			2 to 1 SW+2 tks empty
		2	1 SW+3 tks full
			1 SW+3 tks empty
		3	1 SW+1 tk full
			1 SW+1 tk empty
		4	2 to 1 SW



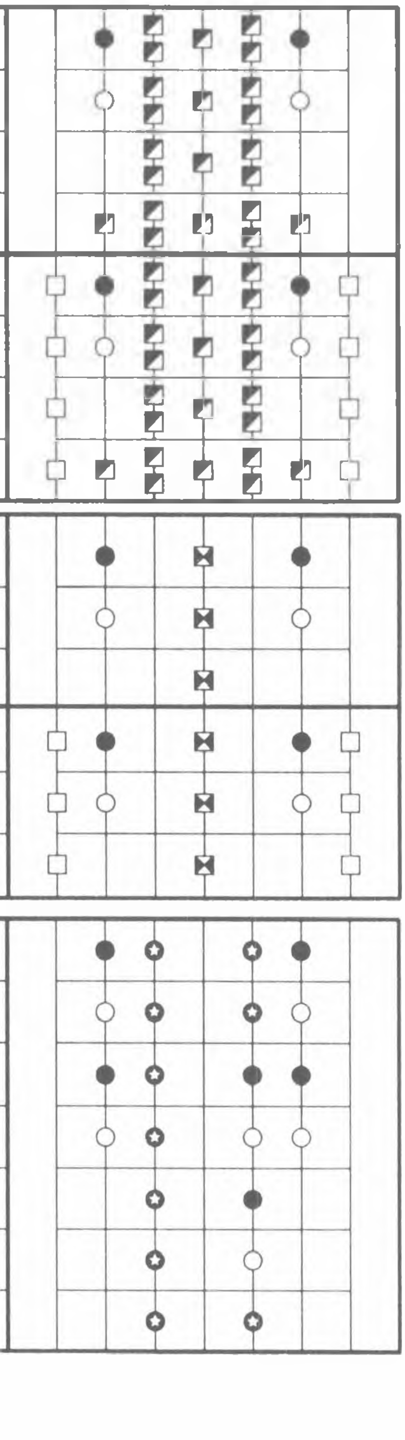
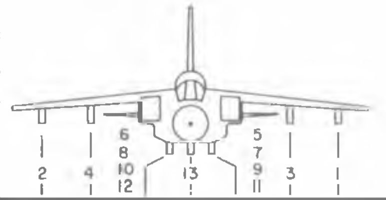
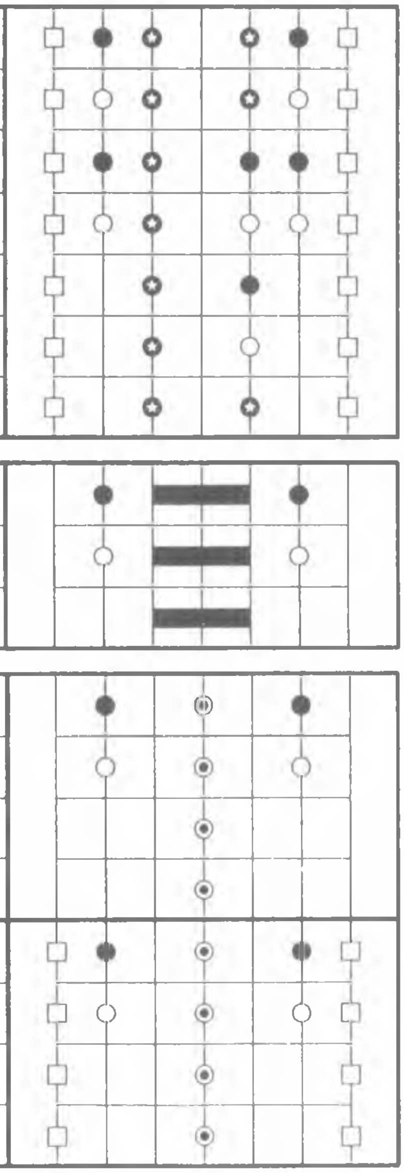


Figure 5-47 (Sheet 4 of 28)

EXTERNAL STORES CONFIGURATION AND CARRIAGE

GROUP	STORE CONFIG.	STORE No.	STORE CONFIGURATION Pylons ± adaptors/Launchers ± 2 to 1 AIM9-L PLUS
K	Special Weapon + CFD	1a	2 to 1 SW+2 tks full
			2 to 1 SW+2 tks empty
		2a	1 SW+3 tks full
			1 SW+3 tks empty
		3a	1 SW+1 tk full
			1 SW+1 tk empty
		4a	2 to 1 SW
L	MW - 1	1	MW-1 + 2 tks full
			MW-1 + 2 tks empty
		2	MW-1
M	Refuel pod	1	1 Refuel pod+2 tks full
			1 Refuel pod+2 tks empty
		2	1 Refuel pod full
			1 Refuel pod empty
	Refuel pod + CFD	1a	1 Refuel pod+2 tks full
			1 Refuel pod+2 tks empty
		2a	1 Refuel pod full
			1 Refuel pod empty





- 1500 L. Tank Full
- 1500 L. Tank Empty
- AIM-9L
- ACMI Pod
- CBLS 200
- MK83 FF/Ret.
- BL 755
- Kormoran
- MK-82 FF/Ret.
- MK 20
- Recce Pod
- Special Weapon
- MW - 1
- Refuel Pod
- C.F.D. Boz 102

Figure 5-47 (Sheet 5 of 28)

GENERAL NOTES

I Limitations of the form 570/.85 ÷ 550/.92 are to be so interpreted: the limit is 570 KIAS from sea level to the altitude where 570 KIAS coincides with 0.85 M: then the limit is 0.85 M up to where 0.85 M coincides with 550 KIAS; likewise the limit becomes 550 KIAS from that altitude up to where 550 KIAS coincides with 0.92 M; than the limit becomes 0.92 M (this can be easly understood on the Mach vs Altitude charts).

II If both **bold** and normal characters appear in a box, the **bold** characters indicate a **post mod 10777** condition. (Normal characters refer to pre mod 10777).
If only normal characters appear in a box, the limitations apply to both pre and post mod. 10777 conditions.

pre/post 10777	500/.9	550/.92	pre mod. 10777
		600/.92	post mod. 10777

III Tanks shall be considered empty when I/B external tank fuel state is less than 100 kg (each tank, normal sequence).

IV When the flight refuelling probe is fitted the strip gauge readings shall be reduced by 1 AOA. The HUD is not affected.

V When performing aggressive manoeuvres above 400 KIAS in the 45 CRS wing (as in Air-to-Air combact), the MNVR setting or other wing sweeps should be selected. The quoted speed covers the most limiting case in the event of a pitch up in the 45 CRS wing, preventing excessive load factor overshoots.

VI Due to pitch up tendencies the use of the airbrakes should be avoided in the approach configuration when carrying large underfuselage stores under sideslip conditions (max 10 knots X-winds in the kick off drift phase) and/or when carrying underwing stores above 12 AOA

VII Coarse asymmetric inputs are prohibited with the airbrakes extended except for the approach configuration in the kick off drift phase, with the additional limitation of note VI).

VIII Airbrakes shall not be used above 14 AOA.

IX When carrying 1 AIM9L or 1 ACMI Pod without training missiles, a 20 AOA symmetric limit shall be observed if other wing or fuselage pylons are loaded (For further information concerning ACMI Pod limitations refer to the relevant configurations).

X When rapid rolling close to the asymmetric AOA limit roll hesitations and/or roll performance degradation shall interpreted as a sign of AOA limit exceedence. Forward stick shall be applied to regain safe conditions and good roll characteristics.

XI Crosswind limits are defined for all configurations on para "crosswind" (in this section) except when specifically indicated.

EXTERNAL STORES CONFIGURATION AND CARRIAGE

GENERAL NOTES (cont'd)

XII Ground roll aerodynamic braking is cleared down to 100 KIAS, with/without lift dump, provided that the following angle of attack limits are not exceeded:

U/F STORE	MAX AOA		
	25° W/S CRS/MNVR	25° W/S Flaps mid/down Spoilers on/off	45/67 W/S
MW1	NC	NC	NC
Tank	14	15	14
MK83FF/Ret	14	15	14
MK82FF	16	15	16
MK82Ret	16	17	16
BL 755	13	15	13
MK 20	N/C	N/C	N/C
In flight Ref. Pod	17	19	17
Kormoran	20	20	20
Sp. weapon	20	20	20
CBLS 200	20	20	20
Recce Pod	20	20	20

NOTE

1) Max flare AOA applies to an A/C mass of 23243 kg; it can be increased by 1 unit for every 4000 kg mass reduction.
2) With wings swept, the max landing mass is limited by the tyre speed limit of 240 Kts

CA: Clean aircraft limits
NA: Not applicable
NC: Not cleared
* For overriding "g" limits depending on higher masses. Mach and speed see Fig. 5-42.
** For g-decrease during rapid rolling with external stores see Fig. 5-24.

Figure 5-47 (Sheet 7 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

EXTERNAL STORES CONFIGURATION AND CARRIAGE

CONF REF	I/B TANKS COND	CARRIAGE CONDITIONS SPEED (KIAS/M) 25°	45°	67°	MAX AOA	* G RANGE	RAPID ROLL COND. (FOR 180° ROLL) SPEED (KIAS/M) 25°	45°	67°	MAX AOA	** G RANGE
A1	Full	350/0 8	500/0 9	g > 0 5 550/0 9 g < 0 5 530/0 9 g > −0 5 500/0 9 **600/0.92**	19	0 ÷ 4	N/C	N/C	N/C	N/C	N/C
	Empty	C/A	g > 0 5 550/0 9 g < 0 5 530/0 9 g < −0 5 500/0 9 **600/0.9**		19	−1 ÷ 5	N/C	N/C	N/C	N/C	N/C
A2	Full	350/0 8	500/0 9	550/0 92 **600/0.92**	21	−1 ÷ 5	250	250	250	18	0 ÷ 4
	Empty	C/A	550/0 9 **600/0.9**	550/0 92 **600/0.92**	21	−1 ÷ 7	250	250	250	18	0 ÷ 5 6
A3	N/A	C/A	600/1 6	C/A	C/A	C/A	C/A	C/A	C/A	C/A	C/A
A4	N/A	C/A	C/A	C/A	C/A	C/A	C/A	C/A	C/A	C/A	C/A
A5	Full	350/0 8	500/0 9	g > 0 5 550/0 9 g < 0 5 530/0 9 g < −0 5 500/0 9 **600/0.92**	17	−1 ÷ 5	300	300	300	CRS 12	0 ÷ 4
	Empty	C/A	g > 0 5 550/0 9 g < 0 5 530/0 9 g < −0 5 500/0 9 **600/0.9**			−1 ÷ 7	300	300	300	MAN 15	0 ÷ 5 6

ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING

A1 (Full), A2 (Full), A5 (Full)
A1 (Full), A2 (Full), A5 (Full)

a. In the case of an abnormal fuel sequence resulting in the external wing tanks full, and the internal wing tanks not full, the maximum permitted carriage speed is reduced to 325 kt/0.7 M at 25° W/S and 350 kt/0.8 M in 45° and 67° wing sweep.
b. In the case of a fuel system failure leading to one i/b tank full and the other empty, only gentle manoeuvring is permitted and the AOA should be kept to a minimum.

A1, **A1**

The quoted limit AOA values shall be reduced by 6 units, when applying coarse lateral inputs

A5, **A5**

When carrying fuel in the underfuselage drop tank, fuel management shall be used to equally divide the tank fuel between the forward and aft internal fuel groups

A2 (Empty), A3, A4, A5
A2, A3, A4, A5

ACMI Pod can be carried in place of the Sidewinder AIM-9L, but can only be operated when carried on the right hand inboard wing pylon with or without the training missile on the left-hand inboard pylon (Refer also to note IX in general note para of this section).

A3, A4, **A3, A4**

When SPILS is engaged and operative clean A/C SPILS-ON limits apply

NOTE
For overriding "g" limits depending on increasing masses see Figure 5-21 and 5-23 for symmetric and asymmetric maneuvers respectively

EXTERNAL STORES CONFIGURATION AND CARRIAGE

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)															
MAN TF			AUTO TF				MAN RHH				AUTO RHH				ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD 10777)
SPEED (KIAS/M)			SPEED (KIAS/M)			MIN. SET CL. HT. (FT)	SPEED (KIAS/M)			MIN. HGT. (FT. ASL)	SPEED (KIAS/M)			MIN HGT (FT ASL)	
25°	45°	67°	25°	45°	67°		25°	45°	67°		25°	45°	67°		
All Ride Modes 375 – (500)0.8 M up to 23 000 kg 400 – (500)0.8 M up to 26 000 kg	SOFT/MEDIUM Ride: 385 – 0.9 M up to 23 000 kg All Ride Modes 400 – 0.9 M up to 26 000 kg	SOFT/MEDIUM Ride: 450 – 0.9 M up to 23 000 kg All Ride Modes 485 – 0.9 M up to 26 000 kg	N/C	N/C	N/C	350 ft VMC/350 ft IMC, VMC Night Post mods 20116 & 20167 (Pre mod 500 ft) < 500/0.8 SOFT Ride cleared only unless stated otherwise	300 – 500/0.8 up to 25 000 kg	350 – 600/0.8 up to 25 000 kg	400 – 600/0.9 up to 20 000 kg, N/C above	350 ft ASL (MIN) – 1500 ft ASL (MAX) cleared for DAY VMC only	300 – 350	N/C	N/C	300 ft VMC/500 ft IMC (300 ft IMC Post mods 20116 & 20167)	Configuration A1 in 25° WS is not cleared for MAN RHH
			370 – 500/0.8	400 – 450	N/C						300 – 500	370 – 550	450 – 550		
			(370 – 500)/0.8	400 – 450	N/C						(300 – 500)	370 – 450 < 430 >	400 – 460		() The handling limits are overriding < > Upper speed limits without ammunition or equivalent ballast SOFT/MEDIUM Ride cleared in MAN/AUTO TF See Autopilot Flight Director System (in this Section)
			370 – 500/0.8	400 – 550/0.9	420 – 550/0.9						300 – 500	350 – 550	400 – 550		All Ride Modes cleared in MAN/AUTO TF
			370 – 500/0.8	400 – 550/0.9	420 – 550/0.9						300 – 500	350 – 550	400 – 550		All Ride Modes cleared in MAN/AUTO TF
			370 – 500/0.8	400 – 550/0.9	420 – 550/0.9						300 – 500	350 – 550	400 – 550		All Ride Modes cleared in MAN/AUTO TF
			(370 – 500)/0.8	N/C	N/C						350 – (500)	450 – (530)	N/C		() The handling limits are overriding
			(370 – 500)/0.8	N/C	N/C						350 – 500	450 – 530	N/C		

Figure 5-47 (Sheet 8 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

EXTERNAL STORES CONFIGURATION AND CARRIAGE

CONF REF	I/B TANKS COND	CARRIAGE CONDITIONS					RAPID ROLL. COND (FOR 180° ROLL)				
		SPEED (KIAS/M)			MAX AOA	* G RANGE	SPEED (KIAS/M)			MAX AOA	** G RANGE
		25°	45°	67°			25°	45°	67°		
A1a	Full	450/0 8	500/0 8 450/0 9	g >0 5 550/0 9 g <0 5 530/0 9 g < −0 5 500/0 9 **600/0.92**	19	0 ÷ 4	N/C	N/C	N/C	N/C	N/C
	Empty	C/A	g >0 5 550/0 9 g <0 5 530/0 9 g < −0 5 500/0 9 **600/0.9**		19	−1 ÷ 5	N/C	N/C	N/C	N/C	N/C
A2a	Full	450/0 8	500/0 8 450/0 9	550/0 92 **600/0.92**	21	−1 ÷ 5	250	250	250	18	0 ÷ 4
	Empty	C/A	550/0 9 **600/0.9**	550/0 92 **600/0.92**	21	−1 ÷ 7	250	250	250	18	0 ÷ 5 6
A3a	N/A	C/A	600/1 6	650/1 8 750/1 6	C/A	M ≤ 0 92 −1 ÷ 7 8 M ≥ 0 92 0 ÷ 5	200 − 500/0 81	240 − 600/0 92	250 − 600/0 92	C/A	C/A
A4a	N/A	C/A	600/1 6 **600/1.6**	650/1 8 750/1 6	C/A	M ≤ 0 92 −1 ÷ 7 8 M ≥ 0 92 0 ÷ 5	200 − 500/0 81	240 − 600/0 92	250 − 600/0 92	C/A	C/A
A5a	Full	450/0 8	500/0 8 450/0 9	g >0 5 550/0 9 g <0 5 530/0 9 g < −0 5 500/0 9 **600/0.92**	17	−1 ÷ 5	300	300	300	CRS 12	0 ÷ 4
	Empty	C/A	g >0 5 550/0 9 g <0 5 530/0 9 g < −0 5 500/0 9 **600/0.9**			−1 ÷ 7	300	300	300	MAN 15	0 ÷ 5 6

ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING

A1a (Full), A2a (Full), A5a (Full), **A1a (Full), A2A (Full), A5a (Full)**

a. In the case of an abnormal fuel sequence resulting in the external wing tanks full, and the internal wing tanks not full, the maximum permitted carriage speed is reduced to 325 kt/0.7 M at 25° W/S and 350 kt/0.8 M in 45° and 67° wing sweep
b. In the case of a fuel system failure leading to one i/b tank full and the other empty, only gentle manoeuvring is permitted and the AOA should be kept to a minimum.

A1a, A2a, A3a, A4a, A5a (Empty), **A1a, A2a, A3a, A4a, A5a**

a. The full "g" clearance given in the relevant carriage tables are valid only for the combination:
   CFD Pod BOZ 102 P/N RP 683100 with LMERU P/N 109505-7/8 (Mod 13023)
b. Carriage of CFD Pod Boz 102 P/N RP 683100 with LMERU P/N 109505-5/6 (Mod 13011) is cleared within the following limitations
   M ≤ 0.92 = −1g to +5g (Symm. manoeuvres)
   M ≥ 1.0 = 0g to +4g (Symm manoeuvres)

   No Rapid Rolling, gentle menoeuvres only.
   – Ref mass 20500 kg; for higher masses Nz x Mass = Const rule applies
   – Nz to be interpolated linearly between Mach 0 92 and 1 0
c. Suspension lug height in respect to store line shall always be in accordance with MIL-A-8591

A1a, **A1a**
The quoted limit AOA values shall be reduced by 6 units, when applying coarse lateral control inputs.

A2a, (Empty), **A2a**
ACMI Pod can be carried in place of the Sidewinder AIM 9L, but can only be operated when carried on the right hand inboard wing pylon with or without the training missile on the left-hand inboard pylon. (Refer also to note IX in general note para of this section)

A3a, A4a, **A3a, A4a**
When SPILS is engaged and operative clean a/c SPILS-ON limits apply

A5a, **A5a,**
When carrying fuel in the underfuselage drop tank, fuel management shall be used to equally divide the tank fuel between the forward and aft internal fuel groups.

A1a, A2a, A3a, A4a, A5a, **A1a, A2a, A3a, A4a, A5a**
Asymmetric carriage of stores on o/b stations is not permitted.

NOTE

For overriding "g" limits depending on increasing masses see Figure 5-21 and Figure 5-23 for stmmetric and asymmetric manouvers respectively

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)

MAN TF				AUTO TF				MAN RHH				AUTO RHH				ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD 10777)
SPEED (KIAS/M)			MIN SET. CL. HT (FT.)	SPEED (KIAS/M)			MIN. SET. CL. HT (FT.)	SPEED (KIAS/M)			MIN. HGT. (FT. ASL)	SPEED (KIAS/M)			MIN HGT. (FT ASL)	
25°	45°	67°		25°	45°	67°		25°	45°	67°		25°	45°	67°		
All Ride Modes: 375 − (500)0.8 M up to 23.000 kg 400 − (500)0.8 M up to 26.000 kg	SOFT/MEDIUM Ride 385 − 0.9 M up to 23.000 kg All Ride Modes: 400 − 0.9 M up to 26.000 kg	SOFT/MEDIUM Ride. 450 − 0.9 M up to 23.000 kg All Ride Modes: 485 − 0.9 M up to 26.000 kg	500 ft VMC/350 ft VMC at 400 − 500 KIAS/750 ft VMC Night/IMC. N/C SOFT Ride cleared only unless stated otherwise	N/C	N/C	N/C	350 ft VMC/350 ft IMC, VMC Night Post mods. 20116 & 20167 (Pre mod 500 ft) < 500/0 8 SOFT Ride cleared only unless stated otherwise	300 − 500/0 8 up to 25 000 kg	350 − 600/0 8 up to 25 000 kg	400 − 600/0 9 up to 20 000 kg, N/C above	350 ft ASL (MIN) − 1500 ft ASL (MAX) cleared for DAY VMC only	300 − 350	N/C	N/C	300 ft VMC/500 ft IMC (300 ft IMC Post Mods 20116 & 20167)	Configuration A1 in 25° WS is not cleared for MAN RHH
				370 − 500/0.8	400 − 450	N/C						300 − 500	370 − 550	450 − 550		
				(370 − 500)/0 8	400 − 450	N/C						300 − (500)	370 − 450 < 430 >	400 − 460		SOFT/MEDIUM Ride cleared in MAN/AUTO FT SeeAFDS System (in this Section) () The handling limits are overriding < > Upper speed limits without ammunition or equivalent ballast
				370 − 500/0 8	400 − 550/0 9	420 − 550/0 9						300 − 500	350 − 550	400 − 550		All Ride Modes cleared in MAN/AUTO TF
				370 − 500 **370 − 500/0.8**	400 − 550 **400 − 550/0.9**	420 − 550 **420 − 550/0.9**						300 − 500	350 − 550	400 − 550		All Ride Modes cleared in MAN/AUTO TF
				370 − 500/0 8	400 − 550/0 9	420 − 550/0 9						300 − 500	350 − 550	400 − 550		All .Ride Modes cleared in MAN/AUTO TF
				N/C	N/C	N/C						300 − 350	N/C	N/C		
				370 − 500/0 8	400 − 550/0 9	420 − 550/0 9						300 − 500	370 − 500	450 − 550		

Figure 5-47 (Sheet 9 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

EXTERNAL STORES CONFIGURATION AND CARRIAGE

CONF REF	I/B TANKS COND	CARRIAGE CONDITIONS SPEED (KIAS/M) 25°	45°	67°	MAX AOA	* G RANGE	RAPID ROLL. COND. (FOR 180° ROLL) SPEED (KIAS/M) 25°	45°	67°	MAX AOA	** G RANGE
B1	Full	350/0 8	500/0 9	550/0 92 **600/0.92**	21	−1 ÷ 5	250	250	250	15	0 ÷ 4
B1	Empty	C/A	550/0 9 **600/0.9**	550/0 92 **600/0.92**	21	−1 ÷ 7	250	250	250	15	0 ÷ 5.6
B2	N/A	C/A	600/0 92	600/0 92	21	−1 ÷ 7 8	250	250	250	15	0 ÷ 6.2
B3	Full	350/0 8	500/0 9	g > 0 5 550/0 9 g < 0 5 530/0 9 g < -0 5 500/0 9 **600/0.92**	17	−1 ÷ 5	300	300	300	CRS 12	0 ÷ 4
B3	Empty	C/A	g > 0 5 550/0 9 g < 0 5 530/0 9 g < -0 5 500/0 9 **600/0.9**		17	−1 ÷ 7	300	300	300	MAN 15	0 ÷ 5 6
B4	Full U/F TANK	500/0 8	600/0 92	600/0 92	17	−1 ÷ 5	300	300	300	CRS 12	0 ÷ 4
B4	Empty U/F TANK	500/0 8	600/0 92	600/0 92	17	−1 ÷ 7	300	300	300	MAN 15	0 ÷ 5 6

ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING

B1 (Full), B3 (Full), **B1 (Full), B3 (Full)**

a In the case of an abnormal fuel sequence resulting in the external wing tanks full, and the internal wing tanks not full, the maximum permitted carriage speed is reduced to 325 kt/0.7 M at 25° W/S and 350 kt/0.8 M in 45° and 67° wing sweep.

b In the case of a fuel system failure leading to one i/b tank full and the other empty, only gentle manoeuvring is permitted and the AOA should be kept to a minimum.

B1, B2, B3, B4, **B1, B2, B3, B4**

ACMI Pod can be carried in place of the Sidewinder AIM-9L, but can only be operated when carried on the right hand inboard wing pylon with or without the training missile on the left-hand inboard pylon (Refer also to note IX in general note para of this section).

B3, B4, **B3, B4**

When carrying fuel in the underfuselage drop tank, fuel management shall be used to equally divide the tank fuel between the forward and aft internal fuel groups.

NOTE

For overriding "g" limits depending on increasing masses see Figure 5-21 and 5-23 for symmetric and asymmetric maneuvers respectively

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)

MAN TF SPEED (KIAS/M) 25°	45°	67°	AUTO TF SPEED (KIAS/M) 25°	45°	67°	MIN. SET CL. HT (FT.)	MAN RHH SPEED (KIAS/M) 25°	45°	67°	MIN. HGT. (FT. ASL)	AUTO RHH SPEED (KIAS/M) 25°	45°	67°	MIN HGT. (FT ASL)	ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD. 10777)
All Ride Modes: 375 − (500)0.8 M up to 23 000 kg; 400 − (500)0 8 M up to 26 000 kg	SOFT/MEDIUM Ride: 385 − 0.9 M up to 23.000 kg; All Ride Modes: 400 − 0.9 M up to 26.000 kg	SOFT/MEDIUM Ride: 450 − 0.9 M up to 23.000 kg; All Ride Modes: 485 − 0.9 M up to 26.000 kg	(370 − 500)/0.8	400 − (550)/0.9	420 − 500/0.8	350 ft VMC/350 ft IMC, VMC Night Post mods. 20116 & 20167 (Pre mod 500 ft) < 500/0.8 SOFT Ride cleared only unless stated otherwise	300 − 500/0 8 up to 25 000 kg	350 − 600/0 9 up to 25 000 kg	400 − 600/0 9 up to 20 000 kg, N/C above	350 ft ASL (MIN) − 1500 ft ASL (MAX) cleared for DAY VMC only	300 − (500)	350 − (550)	400 − 530	300 ft VMC/500 ft IMC (300 ft IMC Post mods 20116 & 20167)	() The handling limits are overriding
			370 − 500/0.8	400 − 550/0.9	420 550/0.9						300 − 500	350 − 550	400 − 550		
			370 − 500/0.8	400 − 550/0 9	420 550/0.9						300 − 500	350 − 550	400 − 550		
			(370 − 500)/0.8	N/C	N/C						350 − (500)	450 − (530)	N/C		() The handling limits are overriding
			370 − 500/0 8	N/C	N/C						350 − 500	450 − 530	N/C		
			370 − 500/0 8	N/C	N/C						350 − 500	450 − 530	N/C		

Figure 5-47 (Sheet 10 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

EXTERNAL STORES CONFIGURATION AND CARRIAGE

CONF REF	I/B TANKS COND	CARRIAGE CONDITIONS: SPEED (KIAS/M) 25°	CARRIAGE CONDITIONS: SPEED (KIAS/M) 45°	CARRIAGE CONDITIONS: SPEED (KIAS/M) 67°	MAX AOA	G RANGE	RAPID ROLL. COND. (FOR 180° ROLL): SPEED (KIAS/M) 25°	RAPID ROLL. COND. (FOR 180° ROLL): SPEED (KIAS/M) 45°	RAPID ROLL. COND. (FOR 180° ROLL): SPEED (KIAS/M) 67°	MAX AOA	G RANGE
B1a	Full	450/0.8	500/0.8 450/0.9	550/0.92 **600/0.92**	21	−1 ÷ 5	250	250	250	15	0 ÷ 4
B1a	Empty	C/A	550/0.9 **600/0.9**	550/0.92 **600/0.92**	21	−1 ÷ 7	250	250	250	15	0 ÷ 5.6
B2a	N/A	C/A	600/0.92	600/0.92	21	−1 ÷ 7.8	250	250	250	15	0 ÷ 6.2
B3a	Full	450/0.8	500/0.9 450/0.9	g > 0.5 550/0.9 g < 0.5 530/0.9 g < -0.5 500/0.9 **600/0.92**	17	−1 ÷ 5	300	300	300	CRS 12	0 ÷ 4
B3a	Empty	C/A	g > 0.5 550/0.9 g < 0.5 530/0.9 g < -0.5 500/0.9 **600/0.9**		17	−1 ÷ 7	300	300	300	MAN 15	0 ÷ 5.6
B4a	Full U/F TANK	500/0.8	600/0.92	600/0.92	17	−1 ÷ 5	300	300	300	CRS 12	0 ÷ 4
B4a	Empty U/F TANK	500/0.8	600/0.92	600/0.92	17	−1 ÷ 7	300	300	300	MAN 15	0 ÷ 5.6

ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING

B1a (Full), B3a (Full), **B1a (Full), B3a (Full)**

a. In the case of an abnormal fuel sequence resulting in the external wing tanks full, and the internal wing tanks not full, the maximum permitted carriage speed is reduced to 325 kt/0.7 M at 25° W/S and 350 kt/0.8 M in 45° and 67° wing sweep.

b In the case of a fuel system failure leading to one i/b tank full and the other empty, only gentle manoeuvring is permitted and the AOA should be kept to a minimum.

B1a, B2a, B3a, B4a, **B1a, B2a, B3a, B4a**

Asymmetric carriage of stores on o/b stations is not permitted.

B1a, B2a, B3a, B4a, **B1a, B2a, B3a, B4a**

a. The full "g" clearance given in the relevant carriage tables are valid only for the combination: CFD Pod BPZ 102 P/N 683100 with LMERU P/N 109505-7/8 (Mod 13023)

b Carriage of CFD Pod BOZ 102 P/N 683100 with LMERU P/N 109505-5/6 (Mod 13011) is cleared with the following limitations.
   $M \leq 0.92 = -1g$ to $+5g$ (Symm. maneuvers)
   $M \geq 1.0 = 0g$ to $+4g$ (Symm. maneuvers)

   No rapid rolling, gentle maneuvers only.
   - Ref mass 20500 kg; for higher masses Nz x Mass = Const. rule applies
   - Nz to be interpolated linearly betwwen Mach 0.92 and 1.0

c. Suspension lug height in respect to store line shall always be in accordance with MIL-A-8591

B3, B4, **B3, B4**

When carrying fuel in the underfuselage drop tank, fuel management shall be used to equally divide the tank fuel between the forward and aft internal fuel groups

NOTE

For overriding "g" limits depending on increasing masses see Figure 5-21 and 5-23 for symmetric and asymmetric maneuvers respectively

EXTERNAL STORES CONFIGURATION AND CARRIAGE

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)

MAN TF				AUTO TF				MAN RHH				AUTO RHH				ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD 10777)
SPEED (KIAS/M)			MIN. SET. CL. HT. (FT.)	SPEED (KIAS/M)			MIN SET. CL. HT (FT.)	SPEED (KIAS/M)			MIN. HGT. (FT. ASL)	SPEED (KIAS/M)			MIN HGT (FT ASL)	
25°	45°	67°		25°	45°	67°		25°	45°	67°		25°	45°	67°		
All Ride Modes: 375 – (500)0.8 M up to 23 000 kg 400 – (500)0.8 M up to 26 000 kg	SOFT/MEDIUM Ride: 385 – 0.9 M up to 23 000 kg All Ride Modes: 400 – 0.9 M up to 26 000 kg	SOFT/MEDIUM Ride: 450 – 0.9 M up to 23 000 kg All Ride Modes: 485 – 0.9 M up to 26 000 kg	500 ft VMC/350 ft VMC at 400 – 500 KIAS/750 ft VMC Night/IMC: N/C SOFT Ride cleared only unless stated otherwise	(370 – 500)/0.8	400 – (550)/0.9	420 – 500/0.8	350 ft VMC/350 ft IMC, VMC Night Post mods. 20116 & 20167 (Pre mod 500 ft) < 500/0.8 SOFT Ride cleared only unless stated otherwise	300 – 500/0.8 up to 25 000 kg	350 – 600/0.9 up to 25 000 kg	400 – 600/0.9 up to 20 000 kg, N/C above	350 ft ASL (MIN) – 1500 ft ASL (MAX) cleared for DAY VMC only	300 – (500)	350 – (550)	400 – 530	300 ft VMC/500 ft IMC (300 ft IMC Post mods 20116 & 20167)	() The handling limits are overriding
				370 – 500/0.8	400 – 550/0.9	420 550/0.9						300 – 500	350 – 550	400 – 550		
				370 – 500/0.8	400 – 550/0.9	420 – 550/0.9						300 – 500	350 – 550	400 – 550		
				(370 – 500)/0.8	N/C	N/C						350 – (500)	450 – (530)	N/C		() The handling limits are overriding
				370 – 500/0.8	N/C	N/C						350 – 500	450 – 530	N/C		
				370 – 500/0.8	N/C	N/C						350 – 500	450 – 530	N/C		

Figure 5-47 (Sheet 11 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

EXTERNAL STORES CONFIGURATION AND CARRIAGE

CONF REF	I/B TANKS COND	CARRIAGE CONDITIONS SPEED (KIAS/M) 25°	45°	67°	MAX AOA	* G RANGE	RAPID ROLL. COND. (FOR 180° ROLL) SPEED (KIAS/M) 25°	45°	67°	MAX AOA	* * G RANGE
C1	Full	350/0 8	500/0 9	g > 0 5 550/0 9 g < 0 5 530/0 9 g < -0 5 500/0 9 **600/0.92**	21	− 1 ÷ 5	250	250	250	15	0 ÷ 4
	Empty	C/A	q > 0 5 550/0 9 g < 0 5 530/0 9 g < -0 5 500/0 9 **600/0.9**			− 1 ÷ 6	250	250	250	15	0 ÷ 4 8
C2	N/A	C/A	600/0 92	600/0 92	21	− 1 ÷ 6	250	250	250	15	0 ÷ 4 8
C3	N/A	C/A	g > 0 5 550/0 9 g < 0 5 530/0 9 g < -0 5 500/0 9 **600/0.9**	g > 0 5 550/0 9 g < 0 5 530/0 9 g < -0 5 500/0 9 **600/0.92**	21	− 1 ÷ 6	250	250	250	15	0 ÷ 4 8

ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING

C1 (Full), **C1 (Full)**

a. In the case of an abnormal fuel sequence resulting in the external wing tanks full, and the internal wing tanks not full, the maximum permitted carriage speed is reduced to 325 kt/0.7 M at 25° W/S and 350 kt/0.8 M in 45° and 67° wing sweep.
b. In the case of a fuel system failure leading to one i/b tank full and the other empty, only gentle manoeuvring is permitted and the AOA should be kept to a minimum.

C3, **C3**

Asymmetric i/b bomb carriage is permitted as an emergency case only (bomb hang up) with a max AOA of 17 units. Gentle course changing maneuvers only are permitted in nominal 1g flight. During landing maximum AOA is 10 for approach and 12 during flare.

NOTE

For overriding "g" limits depending on increasing masses see Figure 5-21 and 5-23 for symmetric and asymmetric maneuvers respectively.

EXTERNAL STORES CONFIGURATION AND CARRIAGE

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)																	
MAN TF				AUTO TF				MAN RHH				AUTO RHH				ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD 10777)
SPEED (KIAS/M)			MIN. SET. CL. HT (FT.)	SPEED (KIAS/M)			MIN. SET CL. HT. (FT)	SPEED (KIAS/M)			MIN. HGT (FT. ASL)	SPEED (KIAS/M)			MIN HGT (FT ASL)	
25°	45°	67°		25°	45°	67°		25°	45°	67°		25°	45°	67°		
All Ride Modes: 375 – (500)0.8 M up to 23 000 kg; 400 – (500)0.8 M up to 26 000 kg	SOFT/MEDIUM Ride 385 – 0.9 M up to 23 000 kg; 400 – 0.9 M up to 26 000 kg	SOFT/MEDIUM Ride 450 – 0.9 M up to 23 000 kg; 485 – 0.9 M up to 26 000 kg	500 ft VMC/350 ft VMC at 400-500 KIAS/750 VMC NIGHT/IMC; N/C SOFT Ride cleared only unless stated otherwise	(370 - 500)/0.8	400 - 450	N/C	350 ft VMC/350 ft IMC, VMC NIGHT Post Mods 20116 & 20167 (Pre Mod 500 ft) < 500/0.8 SOFT Ride cleared only unless stated otherwise	300 – 500/0.8 up to 25 000 kg	350 – 600/0.8 up to 25 000 kg	400 – 600/0.9 up to 20 000 kg, N/C above	350 ft ASL (MIN) – 1500 ft ASL (MAX) cleared for DAY VMC only	300 - (500)	350 - (520)	400 – 460	300 ft VMC/500 ft IMC (300 ft IMC Post mods 20116 & 20167)	() The handling limits are overriding
				370 – 500/0.8	400 – 550/0.9	420 – 500/0.8						300 – 500	350 – 550	400 – 550		
				370 – 500/0.8	400 – 550/0.9	420 – 550/0.9						300 – 500	350 – 550	400 – 550		
				370 – 450	400 – 450	N/C						300 – 500	350 – 550	400 – 530 < 490 >		See Autopilot Flight Director System (in this section) < > Upper speed limit without ammunition equivalent ballast

Figure 5-47 (Sheet 12 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

EXTERNAL STORES CONFIGURATION AND CARRIAGE

CONF REF	I/B TANKS COND	CARRIAGE CONDITIONS SPEED (KIAS/M) 25°	45°	67°	MAX AOA	* G RANGE	RAPID ROLL. COND. (FOR 180° ROLL) SPEED (KIAS/M) 25°	45°	67°	MAX AOA	** G RANGE
C1a	Full	450/0 8	500/0 8 450/0 9	g >0 5 550/0 9 g <0 5 530/0 9 g < −0 5 500/0 9 **600/0.92**	21	−1 ÷ 5	250	250	250	15	0 ÷ 4
	Empty	C/A	g >0 5 550/0 9 g <0 5 530/0 9 g < −0 5 500/0 9 **600/0.9**			−1 ÷ 6	250	250	250		0 ÷ 4 8
C2a	N/A	C/A	600/0 92	600/0 92	21	−1 ÷ 6	250	250	250	15	0 ÷ 4 8
C3a	N/A	C/A	g >0 5 550/0 9 g <0 5 530/0 9 g < −0 5 500/0 9 **600/0.9**	g >0 5 550/0 9 g <0 5 530/0 9 g < −0 5 500/0 9 **600/0.92**	21	−1 ÷ 6	250	250	250	15	0 ÷ 4 8

ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING

C1a (Full), **C1a (Full)**

a. In the case of an abnormal fuel sequence resulting in the external wing tanks full, and the internal wing tanks not full, the maximum permitted carriage speed is reduced to 325 kt/0.7 M at 25° W/S and 350 kt/0.8 M in 45° and 67° wing sweep
b. In the case of a fuel system failure leading to one i/b tank full and the other empty, only gentle manoeuvring is permitted and the AOA should be kept to a minimum.

C3a, **C3a**

Asymmetric i/b bom carriage is permitted as an emergency case only (bomb hang up) with a max AOA of 17 units. Gentle course changing manoeuvres only are permitted in nominal 1g flight. During landing maximum AOA is 10 for approach and 12 during flare.

C1a, C2a, C3a, **C1a, C2a, C3a**

Asymmetric carriage of stores on o/b stations is not permitted.

C1a, C2a, C3a, **C1a, C2a, C3a**

a. The full "g" clearance given in the relevant carriage tables are valid only for the combination:
   CFD Pod BOZ 102 P/N RP 683100 with LMERU P/N 109505-7/8 (Mod 13023)
b. Carriage of CFD Pod Boz 102 P/N RP 683100 with LMERU P/N 109505-5/6 (Mod 13011) is cleared within the following limitations.

   $M \leq 0.92$ = −1g to +5g (Symm. manoeuvres)
   $M \geq 1.0$ = 0g to +4g (Symm. manoeuvres)

   No Rapid Rolling, gentle menoeuvres only.
   - ° Ref mass 20500 kg, for higher masses Nz x Mass = Const. rule applies
   - ° Nz to be interpolated linearly between Mach 0.92 and 1.0

c. Suspension lug height in respect to store line shall always be in accordance with MIL-A-8591

NOTE

For overriding "g" limits depending on increasing masses see Figure 5-21 and Figure 5-23 for symmetric and asymmetric manoeuvres respectively

EXTERNAL STORES CONFIGURATION AND CARRIAGE

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)																	
MAN TF				AUTO TF				MAN RHH				AUTO RHH				ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD 10777)
SPEED (KIAS/M)			MIN SET CL. HT (FT.)	SPEED (KIAS/M)			MIN. SET CL. HT (FT.)	SPEED (KIAS/M)			MIN HGT (FT ASL)	SPEED (KIAS/M)			MIN HGT (FT ASL)	
25°	45°	67°		25°	45°	67°		25°	45°	67°		25°	45°	67°		
All Ride Modes: 375 – (500) 0.8 M up to 23 000 kg 400 – (500) 0.8 M up to 26 000 kg	SOFT/MEDIUM Rides: 385 – 0.9 M up to 23 000 kg All Ride Modes: 400 – 0.9 M up to 26 000 kg	SOFT/MEDIUM Rides: 450 – 0.9 M up to 23 000 kg All Ride Modes: 485 – 0.9 M up to 26 000 kg	500 ft VMC/350 ft VMC at 400-500 KIAS/750 ft VMC NIGHT/IMC: N/C SOFT Ride cleared only unless stated otherwise	(370 – 500)/0.8	400 – 450	N/C	350 ft VMC/350 ft IMC, VMC Night Post Mods 20116 & 20167 (Pre Mod 500 ft) < 500/0.8 SOFT Ride cleared only unless stated otherwise	300 – 500/0.8 up to 25 000 kg	350 – 600/0.9 up to 25 000 kg	400 – 600/0.9 up to 20 000 kg, N/C above	350 ft ASL (MIN) – 1500 ft ASL (MAX) cleared for DAY VMC only	300 – (500)	350 – (520)	400 – 460	300 ft VMC/500 ft IMC (300 ft IMC post mods 20116 and 20167)	( ) The handling limits are overriding
				370 – 500/0.8	400 – 550/0.9	420 – 500/0.8						300 – 500	350 – 550	400 – 550		
				370 – 500/0.8	400 – 550/0.9	420 – 550/0.9						300 – 500	350 – 550	400 – 550		
				370 – 450	400 – 450	N/C						300 – 500	350 – 550	400 – 530 < 430 >		See Autopilot Flight Director System (in this section) < > Upper speed limit without ammunition or equivalent ballast

Figure 5-47 (Sheet 13 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

EXTERNAL STORES CONFIGURATION AND CARRIAGE

CONF REF	I/B TANKS COND	CARRIAGE CONDITIONS: SPEED (KIAS/M) 25°	45°	67°	MAX AOA	* G RANGE	RAPID ROLL. COND. (FOR 180° ROLL): SPEED (KIAS/M) 25°	45°	67°	MAX AOA	** G RANGE
D1	Full	350/0 8	500/0 9	g > 0 5 550/0 9 g < 0 5 530/0 9 g < -0 5 500/0 9 **600/0.92**	21	−1 ÷ 5	250	250	250	15	0 ÷ 4
D1	Empty	C/A	g > 0 5 550/0 9 g < 0 5 530/0 9 g < -0 5 500/0 9 **600/0.9**	g > 0 5 550/0 9 g < 0 5 530/0 9 g < -0 5 500/0 9 **600/0.92**	21	−1 ÷ 7	250	250	250	15	0 ÷ 5.6
D2	N/A	C/A	600/0 92	600/0 92	21	−1 ÷ 7 8	250	250	250	15	0 ÷ 6.2
D3	N/A	C/A	g > 0 5 550/0 9 g < 0 5 530/0 9 g < -0 5 500/0 9 **600/0.9**	g > 0 5 550/0 9 g < 0 5 530/0 9 g < -0 5 500/0 9 **600/0.92**	21	1 ÷ 7 8	250	250	250	15	0 ÷ 6 2

ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING

D1 (Full), **D1 (Full)**

a In the case of an abnormal fuel sequence resulting in the external wing tanks full, and the internal wing tanks not full, the maximum permitted carriage speed is reduced to 325 kt/0.7 M at 25° W/S and 350 kt/0.9 M in 45° and 67° wing sweep.

b. In the case of a fuel system failure leading to one i/b tank full and the other empty, only gentle manoeuvring is permitted and the AOA should be kept to a minimum.

D3, **D3**

Asymmetric i/b bomb carriage is permitted as an emergency case only (bomb hang up) with a max AOA of 17 units. Gentle course changing maneuvers only are permitted in nominal 1g flight. During landing maximum AOA is 10 for approach and 12 during flare

NOTE

For overriding "g" limits depending on increasing masses see Figure 5-21 and 5-23 for symmetric and asymmetric maneuvers respectively

EXTERNAL STORES CONFIGURATION AND CARRIAGE

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)																
MAN TF			AUTO TF				MAN RHH				AUTO RHH				ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD. 10777)
SPEED (KIAS/M)			SPEED (KIAS/M)			MIN SET. CL. HT. (FT.)	SPEED (KIAS/M)			MIN. HGT. (FT. ASL)	SPEED (KIAS/M)			MIN HGT (FT ASL)	
25°	45°	67°	25°	45°	67°		25°	45°	67°		25°	45°	67°		
All Ride Modes 375 – (500)0.8 M up to 23 000 kg 400 – (500)0.8 M up to 26 000 kg	SOFT/MEDIUM Ride 385 – 0 9 M up to 23 000 kg All Ride Modes 400 – 0.9M up to 26 000 kg	SOFT/MEDIUM Ride. 450 – 0 9 M up to 23.000 kg All Ride Modes 485 – 0 9 M up to 26 000 kg	(370 - 500)/0 8	400 - 450	N/C	350 ft VMC/350 ft IMC, VMC NIGHT Post Mods 20116 e 20167 (pre Mod 500 ft) < 500/0 8 SOFT Ride cleared only unless stated otherwise	300 – 500/0 8 up to 25 000 kg	350 – 600/0 9 up to 25 000 kg	400 – 600/0 9 up to 20 000 kg, N/C above	350 ft ASL (MIN) – 1500 ft ASL (MAX) cleared for DAY VMC only	300 - (500)	350 - (520)	400 – 460	300 ft VMC/500 ft IMC (300 ft IMC Post mods 20116 & 20167)	() The handling limits are overriding
			370 – 500/0 8	400 – 550/0 9	420 – 500/0 8						300 – 500	350 – 550	400 – 550		
			370 – 500/0 8	400 – 550/0 9	420 – 550/0 9						300 – 500	350 – 550	400 – 550		
			370 – 450	400 – 450	N/C						300 – 500	350 – 550	400 – 530 **400 – 550**		

Figure 5-47 (Sheet 14 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

EXTERNAL STORES CONFIGURATION AND CARRIAGE

CONF REF	I/B TANKS COND	CARRIAGE CONDITIONS					RAPID ROLL. COND. (FOR 180° ROLL)				
		SPEED (KIAS/M)			MAX AOA	* G RANGE	SPEED (KIAS/M)			MAX AOA	** G RANGE
		25°	45°	67°			25°	45°	67°		
D1a	Full	450/0 8	500/0 9 **500/0.8** **450/0.9**	g > 0 5 550/0 9 g< 0 5 530/0 9 g < −0 5 500/0 9 **600/0.92**	21	−1 ÷ 5	250	250	250	15	0 ÷ 4
	Empty	C/A	g > 0 5 550/0 9 g < 0 5 530/0 9 g < −0 5 500/0 9 **600/0.9**			−1 ÷ 7	250	250	250		0 ÷ 5.6
D2a	N/A	C/A	600/0 92	600/0 92	21	−1 ÷ 7.8	250	250	250	15	0 ÷ 6.2
D3a	N/A	C/A	g > 0 5 550/0 9 g < 0 5 530/0 9 g < −0 5 500/0 9 **600/0.9**	g > 0 5 550/0 9 g < 0 5 530/0 9 g < −0 5 500/0 9 **600/0.92**	21	−1 ÷ 7 8	250	250	250	15	0 ÷ 6 2

ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING

D1a (Full), **D1a (Full)**

a. In the case of an abnormal fuel sequence resulting in the external wing tanks full, and the internal wing tanks not full, the maximum permitted carriage speed is reduced to 325 kt/0.7 M at 25° W/S and 350 kt/0.8 M in 45° and 67° wing sweep.
b. In the case of a fuel system failure leading to one i/b tank full and the other empty, only gentle manoeuvring is permitted and the AOA should be kept to a minimum.

D1a, D2a, D3a, **D1a, D2a, D3a**

Asymmetric carriage of stores on o/b stations is not permitted.

D1a, D2a D3a, **D1a, D2a, D3a**

a. The full "g" clearance given in the relevant carriage tables are valid only for the combination: CFD Pod BPZ 102 P/N 683100 with LMERU P/N 109505-7/8 (Mod 13023)
b Carriage of CFD Pod BOZ 102 P/N 683100 with LMERU P/N 109505-5/6 (Mod 13011) is cleared with the following limitations:
   $M \leq 0.92 = -1g$ to $+5g$ (Symm. maneuvers)
   $M \geq 1.0 = 0g$ to $+4g$ (Symm maneuvers)

   No rapid rolling, gentle maneuvers only.
   - Ref. mass 20500 kg; for higher masses Nz x Mass = Const. rule applies.
   - Nz to be interpolated linearly between Mach 0.92 and 1.0
c. Suspension lug height in respect to store line shall always be in accordance with MIL-A-8591

D3a, **D3a**

Asymmetric i/b bomb carriage is permitted as an emergency case only (bomb hang up) with a max AOA of 17 units Gentle course changing maneuvers only are permitted in nominal 1 g flight During landind maximum AOA is 10 for approach and 12 during flare

NOTE

For overriding "g" limits depending on increasing masses see Figure 5-21 and 5-23 for symmetric and asymmetric maneuvers respectively.

EXTERNAL STORES CONFIGURATION AND CARRIAGE

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)																	
MAN TF SPEED (KIAS/M) 25°	MAN TF SPEED (KIAS/M) 45°	MAN TF SPEED (KIAS/M) 67°	MAN TF MIN. SET. CL. HT. (FT.)	AUTO TF SPEED (KIAS/M) 25°	AUTO TF SPEED (KIAS/M) 45°	AUTO TF SPEED (KIAS/M) 67°	AUTO TF MIN SET. CL. HT. (FT.)	MAN RHH SPEED (KIAS/M) 25°	MAN RHH SPEED (KIAS/M) 45°	MAN RHH SPEED (KIAS/M) 67°	MAN RHH MIN. HGT. (FT. ASL)	AUTO RHH SPEED (KIAS/M) 25°	AUTO RHH SPEED (KIAS/M) 45°	AUTO RHH SPEED (KIAS/M) 67°	AUTO RHH MIN HGT (FT ASL)	ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD 10777)
All Ride Modes: 375 – (500)0.8 M up to 23 000 kg 400 – (500)0.8 M up to 26 000 kg	SOFT/MEDIUM Ride: 385 – 0.9 M up to 23 000 kg All Ride Modes: 400 – 0.9 M up to 26 000 kg	SOFT/MEDIUM Ride: 450 – 0.9 M up to 23 000 kg All Ride Modes 485 – 0.9 M up to 26 000 kg	350 ft VMC/350 ft IMC, VMC Night Post mods. 20116 & 20167 (Pre mod. 500 ft) < 500/0.8 SOFT Ride cleared only unless stated otherwise	(370 – 500)/0.8	400 – 450	N/C	350 ft VMC/IMC SOFT Ride cleared only unless stated otherwise	300 – 500/0.8 up to 25 000 kg	350 – 600/0.9 up to 25 000 kg	400 – 600/0.9 up to 20 000 kg, N/C above	350 ft ASL (MIN) – 1500 ft ASL (MAX) cleared for DAY VMC only	300 – (500)	350 – (520)	400 – 460	300 ft VMC/500 ft IMC (300 ft IMC Post mods 20116 & 20167)	() The handling limits are overriding
				370 – 500/0.8	400 – 550/0.9	420 500/0.8						300 – 500	350 – 550	400 – 550		
				370 – 500/0.8	400 – 550/0.9	420 – 550/0.9						300 – 500	350 – 550	400 – 550		
				370 – 450	400 – 450	N/C						300 – 500	350 – 550	400 530 **400 – 550**		

Figure 5-47 (Sheet 15 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

EXTERNAL STORES CONFIGURATION AND CARRIAGE

CONF REF	I/B TANKS COND	CARRIAGE CONDITIONS SPEED (KIAS/M) 25°	45°	67°	MAX AOA	* G RANGE	RAPID ROLL COND (FOR 180° ROLL) SPEED (KIAS/M) 25°	45°	67°	MAX AOA	** G RANGE
E1	Full	350/0 8	500/0 9	g > 0 5 550/0 9 g < 0 5 530/0 9 g < −0 5 500/0 9 **600/0.92**	21	−1 ÷ 5	250	250	250	15	0 ÷ 4
	Empty	C/A	g > 0 5 550/0 9 g < 0 5 530/0 9 g < −0 5 500/0 9 **600/0.9**			−1 ÷ 7	250	250	250		0 ÷ 5 6
E2	N/A	C/A	630/0 95	630/0 95	M < 92 21 M > 92 16	−1 ÷ 7	250	250	250	M < 92 15 M > .92 WS 45° 13 WS 67° 11	0 ÷ 5 6

ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING

E1 **E1**

a. In the case of an abnormal fuel sequence resulting in the external wing tanks full, and the internal wing tanks not full, the maximum permitted carriage speed is reduced to 325 kt/0 7 M at 25° W/S and 350 kt/0 8 M in 45° and 67° wing sweep

b. In the case of a fuel system failure leading to one i/b tank full and the other empty, only gentle manoeuvring is permitted and the AOA should be kept to a minimum

E1, E2, **E1, E2**

When carring 1 U/F Kormoran or when carring only 1 i/b AIM-9 the symmetric AOA limit shall be reduced to 19 AOA

E2, **E2**

With empty Kormoran launchers the maximum speed shall not exceed 0.95 M

NOTE

For overriding "g" limits depending on increasing masses see Figure 5-21 and Figure 5-23 for symmetric and asymmetric manoeuvers respectively

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)																
MAN TF				AUTO TF				MAN RHH				AUTO RHH				ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD 10777)
SPEED (KIAS/M)			MIN. SET CL. HT. (FT.)	SPEED (KIAS/M)			MIN. SET CL. HT (FT.)	SPEED (KIAS/M)			MIN. HGT. (FT. ASL)	SPEED (KIAS/M)			MIN HGT (FT ASL)	
25°	45°	67°		25°	45°	67°		25°	45°	67°		25°	45°	67°		
All Ride Modes: 375 – (500) 0.8 M up to 23 000 kg 400 – (500) 0.8 M up to 26 000 kg	SOFT/MEDIUM Rides: 385 – 0.9 M up to 23 000 kg All Ride Modes 400 – 0.9 M up to 26 000 kg	SOFT/MEDIUM Rides: 450 – 0.9 M up to 23 000 kg All Ride Modes 485 – 0.9 M up to 26 000 kg	500 ft VMC/350 ft VMC at 400-500 KIAS/750 ft VMC NIGHT/IMC N/C SOFT Ride cleared only unless stated otherwise	(370 – 500)/0.8	400 – 450	N/C	350 ft VMC/350 ft IMC, VMC Night post mods 20116 & 20167 (pre mod 500 ft) < 500/0.8 SOFT Ride cleared only unless stated otherwise	300 – 500/0.8 up to 25 000 kg	350 – 600/0.9 up to 25 000 kg	400 – 600/.9 up to 20 000 kg, N/C above	350 ft ASL (MIN) – 1500 ft ASL (MAX) cleared for DAY VMC only	300 – (500)	370 (530) < 520 >	N/C	300 ft VMC/500 ft IMC (300 ft IMC post mods 20116 and 20167)	See Autopilot Flight Director System (in this section) ( ) The handling limits are overriding < > Upper speed without ammunition or equivalent ballast
				370 – 500/0.8	400 – 450	N/C						300 – 500	370 – 550	450 – 550		
				370 – 500/0.8	400 – 450	450 – 500/0.8						300 – 500	370 – 550	450 – 550		

Figure 5-47 (Sheet 16 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

EXTERNAL STORES CONFIGURATION AND CARRIAGE

CONF REF	I/B TANKS COND	CARRIAGE CONDITIONS SPEED (KIAS/M) 25°	CARRIAGE CONDITIONS SPEED (KIAS/M) 45°	CARRIAGE CONDITIONS SPEED (KIAS/M) 67°	CARRIAGE CONDITIONS MAX AOA	CARRIAGE CONDITIONS * G RANGE	RAPID ROLL. COND (FOR 180° ROLL) SPEED (KIAS/M) 25°	RAPID ROLL. COND (FOR 180° ROLL) SPEED (KIAS/M) 45°	RAPID ROLL. COND (FOR 180° ROLL) SPEED (KIAS/M) 67°	RAPID ROLL. COND (FOR 180° ROLL) MAX AOA	RAPID ROLL. COND (FOR 180° ROLL) ** G RANGE
E1a	Full	450/0 8	500/0 8 450/0 9	g > 0.5 550/0 9 g < 0 5 530/0 9 g < −0 5 500/0 9 **600/0.92**	21	−1 ÷ 5	250	250	250	15	0 ÷ 4
	Empty	C/A	g > 0 5 550/0 9 g < 0 5 530/0 9 g < −0 5 500/0 9 **600/0.9**			−1 ÷ 7	250	250	250		0 ÷ 5.6
E2a	N/A	C/A	630/0 95	630/0 95	M < 92 21 M > 92 16	−1 ÷ 7	250	250	250	M < .92 15 M > 92 WS 45° 13 WS 67° 11	0 ÷ 5 6

ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING

E1a (Full), **E1a (Full)**

a. In the case of an abnormal fuel sequence resulting in the external wing tanks full, and the internal wing tanks not full, the maximum permitted carriage speed is reduced to 325 kt/0.7 M at 25° W/S and 350 kt/0 8 M in 45° and 67° wing sweep.
b. In the case of a fuel system failure leading to one i/b tank full and the other empty, only gentle manoeuvring is permitted and the AOA should be kept to a minimum.

E1a, E2a, **E1a, E2a,**

Asymmetric carriage of stores on o/b stations is not permitted.

E1a, E2a, **E1a, E2a,**

a. The full "g" clearance given in the relevant carriage tables are valid only for the combination. CFD Pod BOZ 102 P/N 683100 with LMERU P/N 109505-7/8 (Mod 13023)
b. Carriage of CFD Pod BOZ 102 P/N 683100 with LMERU P/N 109505-5/6 (Mod 13011) is cleared with the following limitations:
   M ≤ 0.92 = −1g to +5g (Symm. maneuvers)
   M ≥ 1.0 = 0g to +4g (Symm. maneuvers)

   No rapid rolling, gentle maneuvers only.
   – Ref. mass 20500 kg; for higher masses Nz x Mass = Const. rule applies.
   – Nz to be interpolated linearly betwwen Mach 0.92 and 1.0
c. Suspension lug height in respect to store line shall always be in accordance with MIL-A-8591

E1a, E2a, **E1a, E2a**

When carrying 1 U/F Kormoran or when carrying only 1 i/b AIM-9 the symmetric AOA limit shall be reduced to 19 AOA.

E2a, **E2a**

With empty Kormoran launchers the maximum speed shall not exceed 0 95 M

NOTE

For overriding "g" limits depending on increasing masses see Figure 5-21 and 5-23 for symmetric and asymmetric maneuvers respectively

EXTERNAL STORES CONFIGURATION AND CARRIAGE

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)																
MAN TF				AUTO TF				MAN RHH				AUTO RHH				ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD. 10777)
SPEED (KIAS/M)			MIN. SET. CL. HT. (FT.)	SPEED (KIAS/M)			MIN SET. CL. HT. (FT.)	SPEED (KIAS/M)			MIN. HGT. (FT ASL)	SPEED (KIAS/M)			MIN HGT (FT ASL)	
25°	45°	67°		25°	45°	67°		25°	45°	67°		25°	45°	67°		
All Ride Modes: 375 – (500)0.8 M up to 23 000 kg 400 – (500)0.8 M up to 26 000 kg	SOFT/MEDIUM Ride: 385 – 0.9 M up to 23 000 kg All Ride Modes: 400 – 0.9 M up to 26 000 kg	SOFT/MEDIUM Ride: 450 – 0.9 M up to 23 000 kg All Ride Modes: 485 – 0.9 M up to 26 000 kg	500 ft VMC/350 ft VMC at 400-500 KIAS/750 ft VMC NIGHT/IMC N/C SOFT Ride cleared only unless stated otherwise	(370 – 500)/0.8	400 – 450	N/C	350 ft VMC/350 ft IMC, VMC Night Post mods. 20116 & 20167 (Pre mod 500 ft) < 500/0.8 SOFT Ride cleared only unless stated otherwise	300 – 500/0.8 up to 25 000 kg	350 – 600/0.9 up to 25 000 kg	400 – 600/0.9 up to 20 000 kg, N/C above	350 ft ASL (MIN) – 1500 ft ASL (MAX) cleared for DAY VMC only	300 – (500)	370 – (530) <520>	N/C	300 ft VMC/500 ft IMC (300 ft IMC Post mods 20116 & 20167)	See Autopilot Flight Director System (in this Section) () The handling limits are overriding < > Upper speed limit without ammunition or equivalent ballast
				370 – 500/0.8	400 – 450	N/C						300 – 500	370 – 550	450 – 550		
				370 – 500/0.8	400 – 450	450 – 500/0.8						300 – 500	370 – 550	450 – 550		

Figure 5-47 (Sheet 17 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

+5g (Sym
g (Symm.

EXTERNAL STORES CONFIGURATION AND CARRIAGE

CONF REF	I/B TANKS COND	CARRIAGE CONDITIONS: SPEED (KIAS/M) 25°	45°	67°	MAX AOA	* G RANGE	RAPID ROLL. COND. (FOR 180° ROLL): SPEED (KIAS/M) 25°	45°	67°	MAX AOA	** G RANGE
F1	Full	350/0 8	500/0 9	g > 0 5 550/0 9 g < 0 5 530/0 9 g < −0 5 500/0 9 **600/0.92**	21	−1 ÷ 5	250	250	250	15	0 ÷ 4
	Empty	C/A	g > 0 5 550/0 9 g < 0 5 530/0 9 g < −0.5 500/0 9 **600/0.9**			−1 ÷ 7	250	250	250		0 ÷ 5.6
F2	N/A	C/A	600/0 9 **600/0.92**	600/0 92	21	−1 ÷ 7 8	250	250	250	15	0 ÷ 6 2
F3	N/A	C/A	g > 0 5 550/0 9 g < 0 5 530/0 9 g < −0 5 500/0 9 **600/0.9**	g > 0 5 550/0 9 g < 0 5 530/0 9 g < −0 5 500/0 9 **600/0.92**	21	−1 ÷ 7 8	250	250	250	15	0 ÷ 6 2

ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING

F1 (Full) **F1 (Full)**

a. In the case of an abnormal fuel sequence resulting in the external wing tanks full, and the internal wing tanks not full, the maximum permitted carriage speed is reduced to 325 kt/0.7 M at 25° W/S and 350 kt/0.8 M in 45° and 67° wing sweep
b. In the case of a fuel system failure leading to one i/b tank full and the other empty, only gentle manoeuvring is permitted and the AOA should be kept to a minimum

F3, **F3**

Asymmetric i/b bomb carriage is permitted as an emergency case only (bomb hang up) with a max AOA of 17 units. Gentle course changing manoeuvres only are permitted in nominal 1 g flight. During landing maximum AOA is 10 for approach and 12 during flare

NOTE

For overriding "g" limits depending on increasing masses see Figure 5-21 and Figure 5-23 for symmetric and asymmetric manoeuvers respectively.

EXTERNAL STORES CONFIGURATION AND CARRIAGE

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)																	
MAN TF				AUTO TF				MAN RHH				AUTO RHH				ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD 10777)
SPEED (KIAS/M)			MIN SET CL. HT. (FT.)	SPEED (KIAS/M)			MIN. SET. CL. HT. (FT.)	SPEED (KIAS/M)			MIN. HGT. (FT ASL)	SPEED (KIAS/M)			MIN HGT. (FT. ASL)	
25°	45°	67°		25°	45°	67°		25°	45°	67°		25°	45°	67°		
All Ride Modes: 375 – (500) 0.8 M up to 23 000 kg; 400 – (500) 0.8 M up to 26 000 kg	SOFT/MEDIUM Rides: 385 – 0.9 M up to 23 000 kg; All Ride Modes: 400 – 0.9 M up to 26 000 kg	SOFT/MEDIUM Rides: 450 – 0.9 M up to 23 000 kg; All Ride Modes: 485 – 0.9 M up to 26 000 kg	500 ft VMC/350 ft VMC at 400-500 KIAS/750 ft VMC NIGHT/IMC; N/C SOFT Ride cleared only unless stated otherwise	(370 – 500)/0.8	400 – 450	N/C	350 ft VMC/350 ft IMC, VMC Night post mods 20116 & 20167 (pre mod 500 ft) < 500/0.8; SOFT Ride cleared only unless stated otherwise	300 – 500/0.8 up to 25 000 kg	350 – 600/.9 up to 25 000 kg	400 600/.9 up to 20 000 kg, N/C above	350 ft ASL (MIN) – 1500 ft ASL (MAX) cleared for DAY VMC only	300 – (500)	350 – (520)	400 – 460	300 ft VMC/500 ft IMC (300 ft IMC post mods 20116 and 20167)	( ) The handling limits are overriding
				370 – 500/0.8	400 – 550/ 09	420 – 500/ 08						300 – 500	350 – 550	400 – 550		
				370 – 500/0.8	400 – 550/0.9	420 – 550/0.9						300 – 500	350 – 550	400 – 550		
				370 – 450	400 – 450	N/C						300 – 500	350 – 550	400 – 530		

Figure 5-47 (Sheet 18 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

EXTERNAL. STORES CONFIGURATION AND CARRIAGE

CONF REF	I/B TANKS COND	CARRIAGE CONDITIONS					RAPID ROLL. COND. (FOR 180° ROLL)					ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING
		SPEED (KIAS/M)			MAX AOA	* G RANGE	SPEED (KIAS/M)			MAX AOA	** G RANGE	
		25°	45°	67°			25°	45°	67°			
F1a	Full	450/0 8	500/0 8 450/0 9 **500/0.9**	g >0 5 550/0 9 g <0 5 530/0 9 g < −0 5 500/0 9 **600/0.92**	21	−1 ÷ 5	250	250	250	15	0 ÷ 4	
	Empty	C/A	g >0 5 550/ 09 g <0 5 530/0 9 g < −0 5 500/0 9 **600/0.9**			−1 ÷ 7	250	250	250		0 ÷ 5.6	
F2a	N/A	C/A	600/0 92	600/0.92	21	−1 ÷ 7.8	250	250	250	15	0 ÷ 6.2	
F3a	N/A	C/A	g >0 5 550/0 9 g <0 5 530/0 9 g < −0 5 500/0 9 **600/0.9**	g >0 5 550/0 9 g <0 5 530/0 9 g < −0 5 500/0 9 **600/0.92**	21	−1 ÷ 7 8	250	250	250	15	0 ÷ 6.2	

F1a (Full) **F1a (Full)**

a. In the case of an abnormal fuel sequence resulting in the external wing tanks full, and the internal wing tanks not full, the maximum permitted carriage speed is reduced to 325 kt/0.7 M at 25° W/S and 350 kt/0.8 M in 45° and 67° wing sweep
b. In the case of a fuel system failure leading to one i/b tank full and the other empty, only gentle manoeuvring is permitted and the AOA should be kept to a minimum

F3a, **F3a**

Asymmetric i/b bomb carriage is permitted as an emergency case only (bomb hang up) with a max AOA of 17 units. Gentle course changing manoeuvres only are permitted in nominal 1 g flight. During landing maximum AOA is 10 for approach and 12 during flare

F1a, F2a, F3a **F1a, F2a, F3a**

Asymmetric carriage of stores on o/b stations is not permitted

F1a, F2a, F3a
F1a, F2a, F3a

a. The full "g" clearance given in the relevant carriage tables are valid only for the combination: CFD Pod BOZ 102 P/N RP 683100 with LMERU P/N 109505−7/8 (Mod. 13023)
b. Carriage of CFD pod BOZ 102 P/N RP 683100 with LMERU P/N 109505-5/6 (Mod 13011) is cleared within the following limitations:
   M ≤ 0.92 = −1g to +5g (symm. maneouvers)
   M ≥ 1 0 = 0g to +4g (symm maneouvers)
   No Rapid Rolling, gentle manoeuvres only.
   - Ref mass 20500 kg; for higher masses Nz x Mass = Conat rule applies
   - Nz to be interpolated linearly between Mach 0 92 and 1.0
c. Suspension lug height in respect to store line shall always be in accordance with MIL-A-8591

NOTE

For overriding "g" limits depending on increasing masses see Figure 5-21 and Figure 5-23 for symmetric and asymmetric manoeuvers respectively

EXTERNAL STORES CONFIGURATION AND CARRIAGE

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)																		
MAN TF				AUTO TF				MAN RHH				AUTO RHH				ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD 10777)
SPEED (KIAS/M)			MIN. SET. CL. HT. (FT.)	SPEED (KIAS/M)			MIN. SET. CL. HT. (FT.)	SPEED (KIAS/M)			MIN. HGT. (FT. ASL)	SPEED (KIAS/M)			MIN. HGT (FT ASL)	
25°	45°	67°		25°	45°	67°		25°	45°	67°		25°	45°	67°		
All Ride Modes. 375 – (500) 0.8 M up to 23 000 kg 400 – (500) 0.8 M up to 26 000 kg	SOFT/MEDIUM Rides: 385 – 0.9 M up to 23 000 kg All Ride Modes 400 – 0.9 M up to 26 000 kg	SOFT/MEDIUM Rides: 450 – 0.9 M up to 23 000 kg All Ride Modes: 485 – 0.9 M up to 26 000 kg	500 ft VMC/350 ft VMC at 400-500 KIAS/750 ft VMC NIGHT/IMC N/C SOFT Ride cleared only unless stated otherwise	(370 – 500)/0.8	400 – 450	N/C	350 ft VMC/350 ft IMC, VMC Night post mods 20116 & 20167 (pre mod 500 ft) < 500/0.8 SOFT Ride cleared only unless stated otherwise	300 – 500/0.8 up to 25 000 kg	350 – 600/ 9 up to 25 000 kg	400 – 600/ 9 up to 20 000 kg, N/C above	350 ft ASL (MIN) – 1500 ft ASL (MAX) cleared for DAY VMC only	300 – (500)	350 – (520)	400 – 460	300 ft VMC/500 ft IMC (300 ft IMC post mods 20116 and 20167)	( ) The handling limits are overriding
				370 – 500/0.8	400 – 550/ 09	420 – 500/ 08						300 – 500	350 – 550	400 – 550		
				370 – 500/0 8	400 – 550/0 9	420 – 550/0.9						300 – 500	350 – 550	400 – 550		
				370 – 450	400 – 450	N/C						300 – 500	350 – 550	400 – 530		

Figure 5-47 (Sheet 19 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

EXTERNAL STORES CONFIGURATION AND CARRIAGE

CONF. REF	I/B TANKS COND	CARRIAGE CONDITIONS SPEED (KIAS/M) 25°	45°	67°	MAX AOA	** G RANGE	RAPID ROLL. COND. (FOR 180° ROLL) SPEED (KIAS/M) 25°	45°	67°	MAX AOA	** G RANGE
G1	Full	350/0 8	500/0 9	g > 0 5 550/0 9 g < 0 5 530/0 9 **600/0.92**	21	0 ÷ 5	N/C	N/C	N/C	N/C	N/C
	Empty	C/A	g > 0 5 550/0 9 g < 0 5 530/0 9 **600/0.9**	g > 0.5 550/0 9 g < 0 5 530/0 9 **600/0.92**		0 ÷ 5	N/C	N/C	N/C	N/C	N/C
G2	N/A	C/A **500/0.8**	600/0 9	600/0 92	21	0 ÷ 5	N/C	N/C	N/C	N/C	N/C
G3	N/A	C/A **500/0.8**	g > 0 5 550/0 9 g < 0 5 530/0 9 **600/0.9**	g > 0 5 550/0 9 g < 0 5 530/0 9 **600/0.92**	21	0 ÷ 5	N/C	N/C	N/C	N/C	N/C

ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING

G1 (Full), **G1 (Full)**

a. In the case of an abnormal fuel sequence resulting in the external wing tanks full, and the internal wing tanks not full, the maximum permitted carriage speed is reduced to 325 kt/0.7 M at 25° W/S and 350 kt/0.8 M in 45° and 67° wing sweep.
b. In the case of a fuel system failure leading to one i/b tank full and the other empty, only gentle manoeuvring is permitted and the AOA should be kept to a minimum.

G3, **G3** `

Asymmetric i/b bomb carriage is permitted as an emergency case only (bomb hang up) with a max AOA of 17 units. Gentle course changing maneuvers only are permitted in nominal 1g flight. During landing maximum AOA is 10 for approach and 12 during flare.

NOTE

For overriding "g" limits depending on increasing masses see Figure 5-21 and 5-23 for symmetric and asymmetric maneuvers respectively.

EXTERNAL STORES CONFIGURATION AND CARRIAGE

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)																				
MAN TF				AUTO TF				MAN RHH				AUTO RHH								ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD 10777)
SPEED (KIAS/M)			MIN. SET. CL. HT. (FT.)	SPEED (KIAS/M)			MIN. SET. CL. HT. (FT.)	SPEED (KIAS/M)			MIN. HGT. (FT ASL)	SPEED (KIAS/M)			MIN HGT. (FT ASL)					
25°	45°	67°		25°	45°	67°		25°	45°	67°		25°	45°	67°						
N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C					
				N/C	N/C	N/C						N/C	N/C	N/C						
				N/C	N/C	N/C						N/C	N/C	N/C						
				N/C	N/C	N/C						N/C	N/C	N/C						

Figure 5-47 (Sheet 20 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

EXTERNAL STORES CONFIGURATION AND CARRIAGE

CONF REF	I/B TANKS COND	CARRIAGE CONDITIONS					RAPID ROLL COND. (FOR 180° ROLL)				
		SPEED (KIAS/M)			MAX AOA	* G RANGE	SPEED (KIAS/M)			MAX AOA	** G RANGE
		25°	45°	67°			25°	45°	67°		
G1a	Full	450/0 8	450/0 9 500/0 8	g >0 5 550/0 9 g <0 5 530/0 9 **600/0.92**	21	0 ÷ 5	N/C	N/C	N/C	N/C	N/C
	Empty	C/A	g >0 5 550/0 9 g <0 5 530/0 9 **600/0.9**	g >0 5 550/0 9 g <0 5 530/0 9 **600/0.92**		0 ÷ 5	N/C	N/C	N/C	N/C	N/C
G2a	N/A	C/A **500/0.8**	600/0 9	600/0 92	21	0 ÷ 5	N/C	N/C	N/C	N/C	N/C
G3a	N/A	C/A **500/0.8**	g >0 5 550/0 9 g <0 5 530/0 9 **600/0.9**	g >0 5 550/0 9 g <0 5 530/0 9 **600/0.92**	21	0 ÷ 5	N/C	N/C	N/C	N/C	N/C

ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING

G1a (Full), **G1a (Full)**

a. In the case of an abnormal fuel sequence resulting in the external wing tanks full, and the internal wing tanks not full, the maximum permitted carriage speed is reduced to 325 kt/0.7 M at 25° W/S and 350 kt/0.8 M in 45° and 67° wing sweep

b. In the case of a fuel system failure leading to one i/b tank full and the other empty, only gentle manoeuvring is permitted and the AOA should be kept to a minimum.

G1a, G2a, G3a **G1a, G2a, G3a**

Asymmetric carriage of stores on o/b stations is not permitted.

G1a, G2a, G3a, **G1a, G2a, G3a**

a. The full "g" clearance given in the relevant carriage tables are valid only for the combination:
CFD Pod BOZ 102 P/N RP 683100 with LMERU P/N 109505-7/8 (Mod 13023)

b. Carriage of CFD Pod Boz 102 P/N RP 683100 with LMERU P/N 109505-5/6 (Mod 13011) is cleared within the following limitations:

M ≤ 0.92 – > –1g to +5g (Symm. manoeuvres)
M ≥ 1.0 – > 0g to +4g (Symm. manoeuvres)

No Rapid Rolling, gentle menoeuvres only.
– Ref mass 20500 kg; for higher masses Nz x Mass = Const. rule applies
– Nz to be interpolated linearly between Mach 0.92 and 1 0

c. Suspension lug height in respect to store line shall always be in accordance with MIL-A-8591

G3a, **G3a**

Asymmetric i/b bomb carriage is permitted as an emergency case only (bomb hang up) with a max AOA of 17 units. Gentle course changing manoeuvres only are permitted in nominal 1g flight. During landing maximum AOA is 10 for approach and 12 during flare

NOTE

For overriding "g" limits depending on increasing masses see Figure 5-21 and Figure 5-23 for symmetric and asymmetric manoeuvres respectively

EXTERNAL STORES CONFIGURATION AND CARRIAGE

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)																	
MAN TF				AUTO TF				MAN RHH				AUTO RHH				ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD 10777)
SPEED (KIAS/M)			MIN. SET. CL. HT (FT.)	SPEED (KIAS/M)			MIN. SET CL. HT (FT.)	SPEED (KIAS/M)			MIN. HGT. (FT. ASL)	SPEED (KIAS/M)			MIN. HGT. (FT. ASL)	
25°	45°	67°		25°	45°	67°		25°	45°	67°		25°	45°	67°		
N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	
				N/C	N/C	N/C						N/C	N/C	N/C		
				N/C	N/C	N/C						N/C	N/C	N/C		
				N/C	N/C	N/C						N/C	N/C	N/C		

Figure 5-47 (Sheet 21 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

EXTERNAL STORES CONFIGURATION AND CARRIAGE

CONF REF	I/B TANKS COND	CARRIAGE CONDITIONS					RAPID ROLL. COND. (FOR 180° ROLL)					ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING
		SPEED (KIAS/M)			MAX AOA	* G RANGE	SPEED (KIAS/M)			MAX AOA	** G RANGE	
		25°	45°	67°			25°	45°	67°			
H1	Full	350/0 8	500/0 9	g >0 5 550/0 9 −5 < g > 0 5 530/0.9 g < −5 500/0 9 **600/0.92**	21	−1 ÷ 5	250	250	250	15	0 ÷ 4	H1 (Full) **H1 (Full)** a. In the case of an abnormal fuel sequence resulting in the external wing tanks full, and the internal wing tanks not full, the maximum permitted carriage speed is reduced to 325 kt/0.7 M at 25° W/S and 350 kt/0.8 M in 45° and 67° wing sweep b. In the case of a fuel system failure leading to one i/b tank full and the other empty, only gentle manoeuvring is permitted and the AOA should be kept to a minimum NOTE For overriding "g" limits depending on increasing masses see Figure 5-21 and Figure 5-23 for symmetric and asymmetric manoeuvers respectively.
	Empty	C/A	g >0.5 550/0 9 −5 < g > 0 5 530/0 9 g < −0 5 500/0 9 **600/0.9**			−1 ÷ 7	250	250	250		0 ÷ 5.6	
H2	N/A	C/A	g >0 5 550/0 9 −5 < g > 0 5 530/0 9 g < −0 5 500/0 9 **600/0.92**	g >0 5 550/0 9 −5 < g > 0 5 530/0 9 g < 0 5 500/0 9 **600/0.92**	21	−1 ÷ 7.8	250	250	250	15	0 ÷ 5.6	

EXTERNAL STORES CONFIGURATION AND CARRIAGE

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)																	
MAN TF				AUTO TF				MAN RHH				AUTO RHH				ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD 10777)
SPEED (KIAS/M)			MIN. SET. CL. HT. (FT.)	SPEED (KIAS/M)			MIN. SET CL. HT (FT)	SPEED (KIAS/M)			MIN. HGT. (FT ASL)	SPEED (KIAS/M)			MIN HGT (FT ASL)	
25°	45°	67°		25°	45°	67°		25°	45°	67°		25°	45°	67°		
All Ride Modes: 375 – (500) 0.8 M up to 23 000 kg 400 – (500) 0.8 M up to 26 000 kg	SOFT/MEDIUM Rides: 385 – 0.9 M up to 23 000 kg All Ride Modes 400 – 0.9 M up to 26 000 kg	SOFT/MEDIUM Rides: 450 – 0.9 M up to 23 000 kg All Ride Modes: 485 – 0.9 M up to 26 000 kg	500 ft VMC/350 ft VMC at 400-500 KIAS/750 ft VMC NIGHT/IMC N/C SOFT Ride cleared only unless stated otherwise	350 – 500/0.8	370 – 500/0.8	450 – 500/0.8	350 ft VMC/350 ft IMC, VMC Night-post mods 20116 & 20167 (pre mod 500 ft) < 500/0.8 SOFT Ride cleared only unless stated otherwise	350 – 500/0.8 up to 25 000 kg	370 – 500/0.9 up to 25 000 kg	450 – 550/.9 up to 20 000 kg. N/C above	350 ft ASL (MIN) – 1500 ft ASL (MAX) cleared for DAY VMC only	350 ÷ 500/0.8M	370 ÷ 550	450 ÷ 550	300 ft VMC/500 ft IMC (300 ft IMC post mods 20116 and 20167)	
				350 – 500/0.8	400 – 500/0.8	450 – 500/08										
				350 – 500/0.8	400 – 500/0.8	450 – 500/0.8										

Figure 5-47 (Sheet 22 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

EXTERNAL STORES CONFIGURATION AND CARRIAGE

CONF REF	I/B TANKS COND	CARRIAGE CONDITIONS					RAPID ROLL COND (FOR 180° ROLL)				
		SPEED (KIAS/M)			MAX AOA	* G RANGE	SPEED (KIAS/M)			MAX AOA	** G RANGE
		25°	45°	67°			25°	45°	67°		
H1a	Full	450/0 8	500/0 8 450/0 9	g >0.5 550/0.9 −5<g>0.5 530/0 9 g <−0 5 500/0 9 **600/0.92**	21	−1 ÷ 5	250	250	250	15	0 ÷ 4
	Empty	C/A	g >0 5 550/0 9 −0 5<g>0 5 530/0 9 g <−0 5 500/0 9 **600/0.9**			−1 ÷ 7	250	250	250		0 ÷ 5.6
H2a	N/A	C/A	g >0 5 550/0 9 −0 5<g>0 5 530/0 9 g <−0 5 500/0 9 **600/0.92**	g >0 5 550/0 9 −0.5<g>0 5 530/0 9 g <−0 5 500/0 9 **600/0.92**	21	−1 ÷ 7.8	250	250	250	15	0 ÷ 6 2

ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING

H1a (Full) **H1a (Full)**

a. In the case of an abnormal fuel sequence resulting in the external wing tanks full, and the internal wing tanks not full, the maximum permitted carriage speed is reduced to 325 kts/0.7 M at 25° W/S and 350 kts/0 8 M in 45° and 67° wing sweep
b. In the case of a fuel system failure leading to one i/b tank full and the other empty, only gentle manoeuvring is permitted and the AOA should be kept to a minimum

H1a, H2a, **H1a, H2a**

Asymmetric carriage of stores on o/b stations is not permitted

H1a, H2a, **H1a, H2a**

a. The full "g" clearance given in the relevant carriage tables are valid only for the combination: CFD Pod BOZ 102 P/N RP 683100 with LMERU P/N 109505−7/8 (Mod. 13023)
b. Carriage of CFD pod BOZ 102 P/N RP 683100 with LMERU P/N 109505-5/6 (Mod 13011) is cleared within the following limitations:
   M ≤ 0.92 = −1g to +5g (symm. maneouvers)
   M ≥ 1 0 = 0g to +4g (symm. maneouvers)
   No Rapid Rolling, gentle manoeuvres only
   - Ref. mass 20500 kg; for higher masses Nz x Mass = Conat. rule applies
   - Nz to be interpolated linearly between Mach 0 92 and 1 0.
c Suspension lug height in respect to store line shall always be in accordance with MIL-A-8591.

NOTE

For overriding "g" limits depending on increasing masses see Figure 5-21 and Figure 5-23 for symmetric and asymmetric manoeuvers respectively.

EXTERNAL STORES CONFIGURATION AND CARRIAGE

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)																	
MAN TF				AUTO TF				MAN RHH				AUTO RHH				ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD 10777)
SPEED (KIAS/M)			MIN. SET. CL. HT. (FT.)	SPEED (KIAS/M)			MIN. SET. CL. HT (FT.)	SPEED (KIAS/M)			MIN. HGT. (FT. ASL)	SPEED (KIAS/M)			MIN. HGT. (FT ASL)	
25°	45°	67°		25°	45°	67°		25°	45°	67°		25°	45°	67°		
All Ride Modes: 375 – (500) 0.8 M up to 23.000 kg 400 – (500) 0.8 M up to 26.000 kg	SOFT/MEDIUM Rides: 385 – 0.9 M up to 23.000 kg All Ride Modes: 400 – 0.9 M up to 26.000 kg	SOFT/MEDIUM Rides: 450 – 0.9 M up to 23.000 kg All Ride Modes: 485 – 0.9 M up to 26.000 kg	500 ft VMC/350 ft VMC at 400-500 KIAS/750 ft VMC NIGHT/IMC: N/C SOFT Ride cleared only unless stated otherwise	350 – 500/0.8	370 – 500/0.8	450 – 500/0.8	350 ft VMC/350 ft IMC, VMC Night post mods 20116 & 20167 (pre mod 500 ft) < 500/0.8 SOFT Ride cleared only unless stated otherwise	350 – 500/0.8 up to 25 000 kg	370 – 500/0.9 up to 25 000 kg	450 – 550/.9 up to 20 000 kg, N/C above	350 ft ASL (MIN) – 1500 ft ASL (MAX) cleared for DAY VMC only	350 ÷ 500/0.8M	370 ÷ 550	450 ÷ 550	300 ft VMC/500 ft IMC (300 ft IMC post mods 20116 and 20167)	
				350 – 500/0.8	400 – 500/0.8	450 – 500/ 08										
				350 – 500/0.8	400 – 500/0.8	450 – 500/0.8										

Figure 5-47 (Sheet 23 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

EXTERNAL STORES CONFIGURATION AND CARRIAGE

CONF REF	I/B TANKS COND	CARRIAGE CONDITIONS SPEED (KIAS/M) 25°	45°	67°	MAX AOA	* G RANGE	RAPID ROLL COND. (FOR 180° ROLL) SPEED ((KIAS/M) 25°	415°	67°	MAX AOA	** G RANGE
K1	Full	350/0 8	500/0 9	g > 0 5 550/0 9 g < 0 5 530/0 9 g < −0 5 500/0 9 **600/0.92**	21	−1 ÷ 5	250	2250	250	15	0 ÷ 4
	Empty	C/A	g > 0 5 550/0 9 g < 0 5 530/0 9 g < −0 5 500/0 9 **600/0.9**			−1 ÷ 7	250	2250	250		0 ÷ 5.6
K2	Full	350/0 8	500/0 9	g > 0 5 550/0 9 g < 0 5 530/0 9 g < − 0 5 500/0 9 **600/0.92**	17	−1 ÷ 5	300	3300	300	CRS 12	0 ÷ 4
	Empty	C/A	g > 0 5 550/0 9 g < 0 5 530/0 9 g < − 0 5 500/0 9 **600/0.9**			−1 ÷ 7	300	3300	300	MAN 15	0 ÷ 5.6
K3	Full U/F TANK	C/A	600/0 9	600/0 92	17	−1 ÷ 5	300	30300	300	CRS 12	0 ÷ 4
	Empty U/F TANK					−1 ÷ 7	300	30300	300	MAN 15	0 ÷ 5 6
K4	N/A	C/A	600/0 9	600/0 92	21	−1 ÷ 7 8	250	25250	250	15	0 ÷ 6 2

ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING

K1 (Full), K2 (Full)
K1 (Full), K2 (Full)

a. In the case of an abnormal fuel sequence resulting in the external wing tanks full, and the internal wing tanks not full, the maximum permitted carriage speed is reduced to 325 kt/0.7 M at 25° W/S and 350 kt/0.8 M in 45° and 67° wing sweep
b. In the case of a fuel system failure leading to one i/b tank full and the other empty, only gentle manoeuvring is permitted and the AOA should be kept to a minimum.

K2, K3 **K2, K3**

When carrying fuel in the underfuselage drop tank, fuel management shall be used to equally divide the tank fuel between the forward and aft internal fuel groups.

NOTE

For overriding "g" limits depending on increasing masses see Figure 5-21 and Figure 5-23 for symmetric and asymmetric manoeuvers respectively.

EXTERNAL STORES CONFIGURATION AND CARRIAGE

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)

MAN TF				AUTO TF				MAN RHH				AUTO RHH				ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD 10777)
SPEED (KIAS/M)			MIN. SET. CL. HT. (FT.)	SPEED (KIAS/M)			MIN. SET. CL. HT (FT.)	SPEED (KIAS/M)			MIN. HGT. (FT ASL)	SPEED (KIAS/M)			MIN HGT. (FT ASL)	
25°	45°	67°		25°	45°	67°		25°	45°	67°		25°	45°	67°		
All Ride Modes: 375 – (500)0.8 M up to 23 000 kg 400 – (500)0.8 M up to 26 000 kg	SOFT/MEDIUM Ride: 385 – 0.9 M up to 23 000 kg All Ride Modes: 400 – 0.9 M up to 26 000 kg	SOFT/MEDIUM Ride: 450 – 0.9 M up to 23 000 kg All Ride Modes: 485 – 0.9 M up to 26 000 kg	500 ft VMC/350 ft VMC at 400 – 500 KIAS/750 ft VMC Night/IMC: N/C SOFT Ride cleared only unless stated otherwise	(370 – 500)/0.8	400 – 450	N/C	350 ft VMC/350 ft IMC, VMC Night Post mods. 20116 & 20167 (Pre mod 500 ft) < 500/0.8 SOFT Ride cleared only unless stated otherwise	300 – 500/0.8 up to 25 000 kg	350 – 600/0.9 up to 25 000 kg	400 – 600/0.9 up to 20 000 kg, N/C above	350 ft ASL (MIN) – 1500 ft ASL (MAX) cleared for DAY VMC only	300 – (500)	370 (530) < 520 >	N/C	300 ft VMC/500 ft IMC (300 ft IMC Post mods 20116 & 20167)	( ) The handling limits are overriding < > Upper speed limit without ammunition or equivalent ballast
				370 – 500/0.8	400 – 450	450 – 500/0.8						300 – 500	370 – 550	450 – 560		
				(370 – 500)/0.8	N/C	N/C						350 – (500)	450 – (530)	N/C		( ) The handling limits are overriding
				370 – 500/0.8	N/C	N/C						350 – 500	450 – 530	N/C		
				370 – 500/0.8	N/C	N/C						350 – 600	450 – 530	N/C		
				370 – 500/0.8	400 – 450	450 – 500/0.8						300 – 500	370 – 550	450 – 550		

Figure 5-47 (Sheet 24 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

EXTERNAL STORES CONFIGURATION AND CARRIAGE

CONF REF	I/B TANKS COND	CARRIAGE CONDITIONS SPEED (KIAS/M) 25°	45°	67°	MAX AOA	* G RANGE	RAPID ROLL. COND. (FOR 180° ROLL) SPEED (KIAS/M) 25°	45°	67°	MAX AOA	** G RANGE
K1a	Full	350/0.8	500/0.9	g > 0.5 550/0.9 g < 0.5 530/0.9 g < −0.5 500/0.9 **600/0.92**	21	−1 ÷ 5	250	250	250	15	0 ÷ 4
K1a	Empty	C/A	g > 0.5 550/0.9 g < 0.5 530/0.9 g < −0.5 500/0.9 **600/0.9**			−1 ÷ 7	250	250	250		0 ÷ 5.6
K2a	Full	350/0.8	500/0.9	g > 0.5 550/0.9 g < 0.5 530/0.9 g < − 0.5 500/0.9 **600/0.92**	17	−1 ÷ 5	300	300	300	CRS 12	0 ÷ 4
K2a	Empty	C/A	g > 0.5 550/0.9 g < 0.5 530/0.9 g < − 0.5 500/0.9 **600/0.9**			−1 ÷ 7	300	300	300	MAN 15	0 ÷ 5.6
K3a	Full U/F TANK	C/A	600/0.9	600/0.92	17	−1 ÷ 5	300	300	300	CRS 12	0 ÷ 4
K3a	Empty U/F TANK					−1 ÷ 7	300	300	300	MAN 15	0 ÷ 5.6
K4a	N/A	C/A	600/0.9	600/0.92	21	−1 ÷ 7.8	250	250	250	15	0 ÷ 6.2

ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING

K1a (Full), K2a (Full)
K1a (Full), K2a (Full)

a. In the case of an abnormal fuel sequence resulting in the external wing tanks full, and the internal wing tanks not full, the maximum permitted carriage speed is reduced to 325 kt/0.7 M at 25° W/S and 350 kt/0.8 M in 45° and 67° wing sweep.
b. In the case of a fuel system failure leading to one i/b tank full and the other empty, only gentle manoeuvring is permitted and the AOA should be kept to a minimum.

K2a, K3a **K2a, K3a**

When carrying fuel in the underfuselage drop tank, fuel management shall be used to equally divide the tank fuel between the forward and aft internal fuel groups.

K1a (Empty) **K1a (Empty)**

The quoted limit AOA values shall be reduced by 6 units, when applying coarse lateral control inputs.

K1a, K2a, K3a, K4a
K1a, K2a, K3a, K4a

Asymmetric carriage of stores on o/b stations is not permitted.

NOTE

For overriding "g" limits depending on increasing masses see Figure 5-21 and Figure 5-23 for symmetric and asymmetric manoeuvres respectively

EXTERNAL STORES CONFIGURATION AND CARRIAGE

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)																	
MAN TF				AUTO TF				MAN RHH				AUTO RHH				ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD 10777)
SPEED (KIAS/M)			MIN. SET. CL. HT. (FT.)	SPEED (KIAS/M)			MIN. SET. CL. HT (FT.)	SPEED (KIAS/M)			MIN. HGT. (FT. ASL)	SPEED (KIAS/M)			MIN HGT (FT. ASL)	
25°	45°	67°		25°	45°	67°		25°	45°	67°		25°	45°	67°		
All Ride Modes: 375 – (500)0.8 M up to 23 000 kg 400 – (500)0.8 M up to 26 000 kg	SOFT/MEDIUM Ride: 385 – 0.9 M up to 23 000 kg All Ride Modes: 400 – 0.9 M up to 26 000 kg	SOFT/MEDIUM Ride: 450 – 0.9 M up to 23 000 kg All Ride Modes 485 – 0.9 M up to 26 000 kg	500 ft VMC/350 ft VMC at 400 – 500 KIAS/750 ft VMC Night/IMC N/C SOFT Ride cleared only unless stated otherwise	(370 – 500)/0.8	400 – 450	N/C	350 ft VMC/350 ft IMC, VMC Night Post mods. 20116 & 20167 (Pre mod 500 ft) < 500/0.8 SOFT Ride cleared only unless stated otherwise	300 – 500/0.8 up to 25 000 kg	350 – 600/0.9 up to 25 000 kg	400 – 600/0.9 up to 20 000 kg, N/C above	350 ft ASL (MIN) – 1500 ft ASL (MAX) cleared for DAY VMC only	300 – (550)	370 (530) < 520 >	N/C	300 ft VMC/500 ft IMC (300 ft IMC Post mods 20116 & 20167)	( ) The handling limits are overriding < > Upper speed limit without ammunition or equivalent ballast
				370 – 500/0.8	400 – 450	450 – 500/0.8						300 – 500	370 – 550	450 – 560		
				(370 – 500)/0.8	N/C	N/C						350 – (500)	450 – (530)	N/C		() The handling limits are overriding
				370 – 500/0.8	N/C	N/C –						350 – 500	450 – 530	N/C		
				370 – 500/0.8	N/C	N/C						350 – 600	450 – 530	N/C		
				370 – 500/0.8	400 – 450	450 – 500/0.8						300 – 500	370 – 550	450 – 550		

Figure 5-47 (Sheet 25 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

EXTERNAL STORES CONFIGURATION AND CARRIAGE

CONF REF	I/B TANKS COND	CARRIAGE CONDITIONS					RAPID ROLL. COND. (FOR 180° ROLL)					ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING
		SPEED (KIAS/M)			MAX AOA	* G RANGE	SPEED (KIAS/M)			MAX AOA	** G RANGE	
		25°	45°	67°			25°	45°	67°			
L1	Full	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	NOT CLEARED
	Empty	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	
L2	N/A	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	

EXTERNAL STORES CONFIGURATION AND CARRIAGE

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)																
MAN TF				AUTO TF				MAN RHH				AUTO RHH				ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD. 10777)
SPEED (KIAS/M)			MIN. SET. CL. HT. (FT.)	SPEED (KIAS/M)			MIN. SET CL. HT. (FT.)	SPEED (KIAS/M)			MIN. HGT. (FT. ASL)	SPEED (KIAS/M)			MIN. HGT. (FT ASL)	
25°	45°	67°		25°	45°	67°		25°	45°	67°		25°	45°	67°		
N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C
				N/C	N/C	N/C						N/C	N/C	N/C		N/C
				N/C	N/C	N/C						N/C	N/C	N/C		N/C
				N/C	N/C	N/C						N/C	N/C	N/C		N/C

Figure 5-47 (Sheet 26 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

EXTERNAL STORES CONFIGURATION AND CARRIAGE

CONF REF	I/B TANKS COND	CARRIAGE CONDITIONS					RAPID ROLL. COND. (FOR 180° ROLL)				
		SPEED (KIAS/M)			MAX AOA	* G RANGE	SPEED (KIAS/M)			MAX AOA	** G RANGE
		25°	45°	67°			25°	45°	67°		
M1	Full POD	350/0.8	500/0.85	500/0.85	21	0 ÷ 4	N/C	N/C	N/C	N/C	N/C
	Empty POD	C/A	500/0.85	500/0.85		−1 ÷ 5	N/C	N/C	N/C	N/C	N/C
M2	Full POD	C/A	500/0.85	500/0.85	21	0 ÷ 4	N/C	N/C	N/C	N/C	N/C
	Empy POD					−1 ÷ 5	N/C	N/C	N/C	N/C	N/C

ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING

M1 (Full)

a. In the case of an abnormal fuel sequence resulting in the external wing tanks full, and the internal wing tanks not full, the maximum permitted carriage speed is reduced to 325 kt/0.7 M at 25° W/S and 350 kt/0.8 M in 45° and 67° wing sweep

b. In the case of a fuel system failure leading to one i/b tank full and the other empty, only gentle manoeuvring is permitted and the AOA should be kept to a minimum

M1, M2

The quoted limit AOA values shall be reduced by 6 units, when applying coarse lateral control inputs.

NOTE

- For overriding "g" limits depending on increasing masses see Figure 5-21 and Figure 5-23 for symmetric and asymmetric manoeuvres respectively
- All these values are valid both Pre & Post Mod 10777

EXTERNAL STORES CONFIGURATION AND CARRIAGE

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)																
MAN TF				AUTO TF				MAN RHH				AUTO RHH				ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD 10777)
SPEED (KIAS/M)			MIN. SET. CL. HT. (FT.)	SPEED (KIAS/M)			MIN. SET CL. HT (FT.)	SPEED (KIAS/M)			MIN HGT (FT. ASL)	SPEED (KIAS/M)			MIN HGT (FT ASL)	
25°	45°	67°		25°	45°	67°		25°	45°	67°		25°	45°	67°		
All Ride Modes 375 – (500) 0.8 M up to 23 000 kg 400 – (500) 0 8 M up to 26 000 kg	SOFT/MEDIUM Rides 385 – 0 9 M up to 23 000 kg All Ride Modes 400 – 0.9 M up to 26 000 kg	SOFT/MEDIUM Rides: 450 – 0 9 M up to 23 000 kg All Ride Modes: 485 – 0.9 M up to 26 000 kg	500 ft VMC/350 ft VMC at 400-500 KIAS/750 ft VMC NIGHT/IMC: N/C SOFT Ride cleared only unless stated otherwise	370 – 500/0 8	400 – 450	N/C	350 ft VMC/350 ft IMC, VMC Night post mods 20116 & 20167 (pre mod 500 ft) < 500/0 8 SOFT Ride cleared only unless stated otherwise	300 – 500/0 8 up to 25 000 kg	350 – 600/ 9 up to 25.000 kg	400 – 600/ 9 up to 20 000 kg, N/C above	350 ft ASL (MIN) – 1500 ft ASL (MAX) cleared for DAY VMC only	300 – 500	370 – 530	N/C	300 ft VMC/500 ft IMC (300 ft IMC post mods 20116 and 20167)	See Autopilot Flight Director system (in this section)
				370 – 500/0 8	400 – 450	450 – 500/ 08						300 – 500	370 – 550	450 – 550		
				370 – 500/0 8	400 – 450	N/C						300 – 500	370 – 550	450 – 550		

Figure 5-47 (Sheet 27 of 28)

to a

THIS PAGE LEFT INTENTIONALLY BLANK

,alid bu

EXTERNAL STORES CONFIGURATION AND CARRIAGE

CONF REF	I/B TANKS COND	CARRIAGE CONDITIONS					RAPID ROLL. COND. (FOR 180° ROLL)				
		SPEED (KIAS/M)			MAX AOA	* G RANGE	SPEED (KIAS/M)			MAX AOA	** G RANGE
		25°	45°	67°			25°	45°	67°		
M1a	Full POD	400/ 0 8	500/0 8 450/0 85	500/0 85	21	0 ÷ 4	N/C	N/C	N/C	N/C	N/C
	Empty POD	C/A	500/0 85	500/0 85		−1 ÷ 5	N/C	N/C	N/C	N/C	N/C
M2a	Full POD	C/A	500/0 85	500/0 85	21	0 ÷ 4	N/C	N/C	N/C	N/C	N/C
	Empty POD					−1 ÷ 5	N/C	N/C	N/C	N/C	N/C

ESSENTIAL NOTES FOR CARRIAGE/RAPID ROLLING

M1a (Full):

a. In the case of an abnormal fuel sequence resulting in the external wing tanks full, and the internal wing tanks not full, the maximum permitted carriage speed is reduced to 325 kt/0.7 M at 25° W/S and 350 kt/0.8 M in 45° and 67° wing sweep.
b. In the case of a fuel system failure leading to one i/b tank full and the other empty, only gentle manoeuvring is permitted and the AOA should be kept to a minimum.

M1a, M2a:

The quoted limit AOA values shall be reduced by 6 units, when applying coarse lateral inputs.

M1a, M2a:

Asymmetric carriage of stores on o/b stations is not permitted.

M1a, M2a:

a. The full "g" clearance given in the relevant carriage tables are valid only for the combination: CFD Pod BOZ 102 P/N RP 683100 with LMERU P/N 109505-7/8 (Mod. 13023)
b. Carriage of CFD Pod BOZ 102 P/N RP 683100 with LMERU P/N 109505-5/6 (Mod. 13011) us cleared within the following limitations:
   $M \leq 0.92 = -1g$ to $+5g$ (symm. maneuvers)
   $M \geq 1.0 = 0g$ to $+4g$ (symm. maneuvers)

   No rapid rolling, gentle manoeuvres only.
   - Ref. mass 20500 kg; for higher masses Nz x Mass = Const. rule applies
   - Nz to be interpolated linearly between Mach 0.92 and 1.0
c. Suspension lug height in respect to store line shall always be in accordance with MIL-A-8591

NOTE

* For overriding "g" limits depending on increasing masses see Figure 5-21 and 5-23 for symmetric and asymmetric maneuvers respectively.
* All these values are valid both Pre & Post mod. 10777.

EXTERNAL STORES CONFIGURATION AND CARRIAGE

EXTERNAL STORES CONFIGURATION AND CARRIAGE (TF / RHH)																	
MAN TF				AUTO TF				MAN RHH				AUTO RHH				ESSENTIAL NOTES FOR TF AND RHH (FOR BOTH PRE AND POST MOD 10777)
SPEED (KIAS/M)			MIN. SET. CL. HT. (FT.)	SPEED (KIAS/M)			MIN. SET. CL. HT. (FT.)	SPEED (KIAS/M)			MIN. HGT. (FT. ASL)	SPEED (KIAS/M)			MIN. HGT. (FT ASL)	
25°	45°	67°		25°	45°	67°		25°	45°	67°		25°	45°	67°		
All Ride Modes 375 – (500)0.8 M up to 23 000 kg 400 – (500)0.8 M up to 26 000 kg	SOFT/MEDIUM Ride: 385 – 0.9 M up to 23 000 kg All Ride Modes 400 – 0.9 M up to 26 000 kg	SOFT/MEDIUM Ride: 450 – 0.9 M up to 23 000 kg All Ride Modes 485 – 0.9 M up to 26 000 kg	350 ft VMC/350 ft IMC, VMC Night Post mod 20116 & 20167 (Pre mod 500 ft) < 500/0.8 SOFT Ride cleared only unless stated otherwise	370 - 500/0.8	400 - 450	N/C	350 ft VMC/IMC SOFT Ride cleared only unless stated otherwise	300 – 500/0 8 up to 25 000 kg	350 – 600/0 8 up to 25 000 kg	400 – 600/0 9 up to 20 000 kg, N/C above	350 ft ASL (MIN) – 1500 ft ASL (MAX) cleared for DAY VMC only	300 - 500	370 - 530	N/C	300 ft VMC/500 ft IMC (300 ft IMC Post mods 20116 & 20167)	See Autopilot Flight Director System (in this section)
				370 - 500/0.8	400 - 450	450 - 500/0 8						300 - 500	370 - 550	450 - 550		
				370 - 500/0.8	400 - 450	N/C						300 - 500	370 - 550	450 - 550		

Figure 5-47 (Sheet 28 of 28)

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION VI

FLIGHT CHARACTERISTICS

TABLE OF CONTENTS

Title	Page
Introduction	6-1
Flight Control System	6-1
Manoeuvring Flight	6-4
High AOA, Stall, Loss of Control and Recovery	6-6
Handling with Spils	6-8
Train Mode	6-10
CSAS Failure	6-12
Flight With External Stores	6-13
Stores Release	6-14
Asymmetric Stores	6-14
Dive Recovery	6-15
Maximum AOA Chart	6-15
Maximum Load Factor Chart	6-15
Altitude Loss	6-16
Dive Recovery-Use	6-16

INTRODUCTION

This section contains the flight characteristics and the aircraft performances, based on the flight test results or calculated data. The CSAS and the variable wing sweep concept provide good handling quantities and low drag indices over the total flight envelope at a speed range of 120 kt up to 800 kt/2.0 M.

NOTE

Information in the following chapters is based on fully augmented aircraft. Some cases of CSAS failure, are specifically mentioned.

FLIGHT CONTROL SYSTEM

FULL CSAS

The command and stability augmentation system (CSAS) provides good to excellent flight characteristics over the whole operational flight envelope at all wing sweep angles and store configurations. Generally, only negligible trim changes will be encountered during wing sweep and landing gear operation and only minor trim changes during flap and airbrake operation. Also in the very unlikely case of a complete CSAS failure the aircraft exhibits acceptable flight characteristics over a large part of the flight envelope. In some combinations of center of gravity and store configurations, certain flight restrictions have to be observed.

CONTROL AUTHORITY/RATE SATURATION

The CSAS has full control authority about all aircraft axes and the pilot system is encouraged to use the full potential of the flight control system. In full CSAS the Manoeuvre Demand (MD) circuit provides artificial damping and demands constant pitch/roll rate for a given stick input, so that taileron/spoiler position is not in a fixed relation to stick position. However, this will not be apparent to the pilot.
Rapid control inputs may be applied; however, a Pilot Induced Oscillation (PIO) in pitch can be develop if a rapid stick movement of large amplitude is immediately followed by an abrupt stick reversal. This corrective control action may drive the taileron actuator to rate saturation, made obvious be excessive phase lag in the control system and thus lead a PIO.

WARNING

ABRUPT STICK REVERSAL SHALL BE AVOIDED AS EXCESSIVE INPUTS WILL DRIVE THE FLIGHT CONTROL SYSTEM INTO RATE SATURATION THUS PROVOKING THE RISK OF PIO.

There will be a strong best natural tendency to oppose the aircraft motion but this will result in a sustained oscillation. Recovery from a PIO is effected by releasing the stick. If circumstances prevent stick release, a deliberate effort shall be made to freeze it until it can be released or the oscillation has stopped. If the oscillation develop with AP engaged, the ICO shall, at the desired position, be operated before stick release/freeze.

WARNING

ONCE THE TAILERONS HAVE BEEN DRIVEN INTO SATURATION BY PITCH INPUTS, TAILERON ROLL CONTROL WILL BE LOST AND A ROLL OSCILLATION MAY DEVELOP. THIS WILL BE MORE PRODUCED IN 67W/SW WITH SPOILER INHIBITED AND AT SPEEDS BELOW 400 KT.

NOTE

The fact that oscillation will definitely damp out after stick release may not be immediately apparent to the pilot but the oscillations should cease within 2 cycles.

AFDS MODES WITH AP ENGAGED

Generally the AP should only be engaged in dynamically stabilized flight conditions, otherwise the pilot may be induced to abruptly counteract the high autority of the AP. Natural control inputs from the AP immediately followed by a stick reversal applied by the pilot may lead to PIO. Therefore is recommended to engage the AP with the FD approximately satisfied and within the specified system limits.
PIO's may be encountered under the following conditions:

Manual Trim Inputs with AP Engaged

Manual trim inputs in roll or pitch shall not be made with the AP engaged, because at automatic AP disengagement the aircraft will pitch and/or roll in the mistrimmed direction instantly. Subsequent counteractions taken by the pilot will not stop these motions but may lead to considerable PIO.

WARNING

SHOULD A PIO DEVELOP, PRESS ICO AND RELEASE OR FREEZE THE STICK.

Rapid Stick Inputs with the AP Engaged in Basic Mode

Sharp stick inputs, which result in ASO, may induce large pitch oscillations upon AP re-engagement. These will not subside even when the stick is released, as once the taileron actuators are driven into rate saturation, the AP will not be capable of dampening the oscillations.

WARNING

SHOULD A PIO DEVELOP, PRESS ICO AND RELEASE OR FREEZE THE STICK.

Open Loop Pull-Up/Closed Loop Pull-Up

In the low altitude modes TF and RH, the pilot shall not attempt to oppose an automatic pull-up, without having first pressed the ICO, otherwise this may aggravate the tendency to overcontrol and consequently induce PIO.

WARNING

TO AVOID THE RISK OF PIO, THE PILOT SHALL PRESS THE ICO BEFORE TAKING OVER CONTROL OF THE AIRCRAFT.

WING SWEEP

Three basic wing sweep settings are cleared for continuous flying: 25°, 45°, and 67° sweep. Other intermediate sweep positions are cleared for transient use only. While changing wing sweep, the more restrictive airspeed/Mach/AOA acceleration limitation shall be observed. If the wing sweep fails at an intermediate position, the limitation for the next lower wing sweep setting shall not be exceeded. Pilots should be aware that when sweeping the wings forward near the AOA limits, pitch-ups may occur. Care should be taken, when sweeping the wings aft to not overshoot the AOA limits when sweeping the wings aft.

Subsonic Flight

The aircraft displays its best manoeuvre capability in the 25° WS configuration at subsonic speeds up to 0.75 M/450 kt. for manoeuvring which may be further improved by using manoeuvre flap/slats. To avoid high buffet levels in the 25° WS configuration when operating close to the limit of 0.8 M, it is recommended to sweep the wings to 45° for manoeuvring.

Transonic Flight

For operation at transonic speeds a wing sweep either of 45° or 67° will provide the best performance. For optimum manoeuvring between 0.7 to 0.98 Mach, 45° manoeuvre wing should be selected. For supersonic acceleration 67° wing sweep will provide the best performace. When decelerating under "g-load" through Mach 1 up to 1.5 incremental "g" may be encountered at higher altitudes, due to the sudden shift of the centre of pressure.

Supersonic Flight

Substained supersonic flight or high speed low level operation should generally be flown with 67° wing sweep angle. However, for manoeuvring in the lower supersonic speed range, the 45° wing sweep angle configuration produces lower drag. Handling and manoeuvring qualities throughout the supersonic flight regime are good and straightforward.

ANGLE OF ATTACK

Keeping within the cleared AOA limits will ensure good handling quantities and safe aircraft manoeuvring at all configurations and wing sweeps with a sufficient safety margin. Depending on the flight conditions, the aircraft may be limited by angle of attack, g-load, or by aerodynamic phenomena. Moderate buffet and untidy lateral handling characteristics may be encountered at or near the upper limits, particulary at higher Mach numbers with 25° and 45° wing sweep. AOA should not be increased if heavy buffet or severe wing rock occurs. The landing gear has no effect on the maximum AOA.

FLAPS/SLATS

Only minor longitudinal trim changes during wing sweeping or during landing gear position are encoutered. Trim changes due to flap/slat movements or due to airbrake selections are small because of the automatic compensation in full CSAS: partial compensation is provided in pitch DL, however not in mechanical mode. Extending full flaps above 200 kt. will generate a moderate buffet which decreases with decreasing airspeed, and it is hardly noticeable by the pilot below 170 kt. When the flaps are passing the 15° position, gain changes within the lateral CSAS take place. If simultaneously a roll command is given, a noticeable change in the roll rate will occur (decrease of rate for flap extension, increase for flap retraction).
Pilots should be aware of this effect and avoid flap selection during roll commands in close formation.

WARNING

DURING APPROACHES WITH FLAPS IN UP OR FAILED AT LESS THAN 15°, ROLL CSAS WILL REMAIN IN HIGH-SPEED SETTING AND OVERCONTROL IN ROLL MAY RESULT. THIS TENDENCY WILL BE AGGRAVATED IN HEAVY EXTERNAL STORES (ESPECIALLY U/WING). IF LATERAL OVERCONTROL IS ENCOUNTERED, THE PILOT SHOULD TRY TO MINIMIZE ROLL STICK ACTIVITY AND MOMENTARY FREEZE OR RELEASE THE STICK. THIS WILL DAMPEN THE OSCILLATION WITHIN ONE CYCLE. IF THE OSCILLATION DOES SUBSIDE, IT IS RECOMMENDED TO JETTISON EXTERNAL STORES WHICH WILL IMPROVE LATERAL CONTROL OF THE AIRCRAFT.

RUDDER

Rudder command is conventional and proportional to pedal input, but scheduled by airspeed (q). With the rudder trimmed neutral, full rudder may be applied during all manoeuvring except rapid rolling, and not above 18 units AOA.

AIRBRAKES

To minimize pitch trim changes, an automatic pitch trim compensation signal is incorporated in the CSAS if airbrake extension exceeds 30 degrees. This signal is also operative in direct link (DL) mode but not in mechanical mode.
Airbrakes are Mach scheduled and full airbrake extension is available at speeds up to 0.8 Mach. Above this speed, the scheduling system progressively limits the deployement, in stages from 50 to 15 degrees. Only light buffet is felt with the airbrakes deployed. Normally the aircraft will be quite stable during airbrakes extension; however, should larger asymmetries in airbrake extension angle occur (up to 7° possible), a light dutch-roll oscillation can develop, especially at supersonic speeds. Additionally airbrake stepping can occur at slightly different airspeeds due to the triplex transducer unit (TTU) tolerances.

MANOEUVRING FLIGHT

In full CSAS the aircraft displays good handling qualities about all axes within the cleared AOA limits at all wing sweeps. Since the buffet onset in cruise wing occurs at a relatively low AOA (Figure 6-1). The use of manoeuvring devices is recommended to achieve the aircraft's full potential, thus delaying buffet onset considerably and improving aircraft performance up to 1.5 incremental g. The aircraft shows good roll performances with a roll rates up to about 150° per second. This is practically independent of wing sweep and/or stores configuration, roll rate is scheduled to a maximum of 40° per second.

NOTE

- Differences are to be expected between HUD and strip indications of AOA during sideslip manoeuvres, particularly at high sideslip angle.
- During dynamic pitching manoeuvres the pilot's strip gauge may lag by up to 1 unit AOA; allowance should be made for this effect during manoeuvres.

BUFFET

Aerodynamic buffet of the airframe is caused by the oscillatory separation of the airflow over some portions of the aircraft surface or when the local airflow approaches sonic velocity. Buffet is encountered in the subsonic to low supersonic speed region and depends on angle of attack, Mach number, wing sweep and wing configuration.
In 25° wing sweep with the clean aircraft above 0.7 M, the buffet intensity increase quire rapidly as load factor/angle of attack passes buffet onset conditions. With 45° and 67° wing sweep, the intensity rise is slower but also increases with increasing load factor. In manoeuvre wing buffet onset is delayed to a higher AOA and the intensity is reduced.

WING BUZZ

Torsional wing buzz can be encountered when flying at 12 to 13 AOA in 25° wing sweep between 0.65 to 0.8 M and 45° WS from 0.8 to 0.95 M. However this effect in 45° wing sweep is less. This phenomenon is indicated by a very steep rise in buffet level, a vertical acceleration up to ± 1 g at the pilot's station and the sensation of a wing vibration on top of the buffet. Transient manoeuvring within the described region will not trigger this phenomenon.

ASYMMETRIC WING BENDING

At 67° wing sweep in the Mach regime of 0.7 to 0.8 M and between 11 and 15 units AOA, the aircraft reacts to the asymmetric wing bending motion. It can be felt as a roll acceleration at the pilot's station and differs from the normal vertical acceleration felt during buffet onset.

ENGINE BEHAVIOUR AT HIGH AOA

The engine are particularly sensitive to flow distrubances down the intakes during high AOA manoeuvring. Especially above 30000 ft violent pop surges may be encountered with reheat thrust selected when manoeuvring close to the AOA limit. In max dry thrust the engines are marginally more tolerant to high AOA manoeuvring, exhiting less audible and pronounced surges.

The engines should be closely monitored during high AOA manoeuvring, and if a surge is suspected, throttles should be reduced immediately below MAX DRY and AOA decreased. If the TBT is still high or rising, the engines shall be throttled to IDLE and TBT monitored. If TBT rise persist, the affected engine should be shut down before reaching 800° C and relit within envelope.

It is unlikely that locked-in surge will be encountered within the current cleared AOA limitations, however, the probability of an engine overtemperature rises significantly if the AOA is exceeded.

AOA FOR BUFFET ONSET

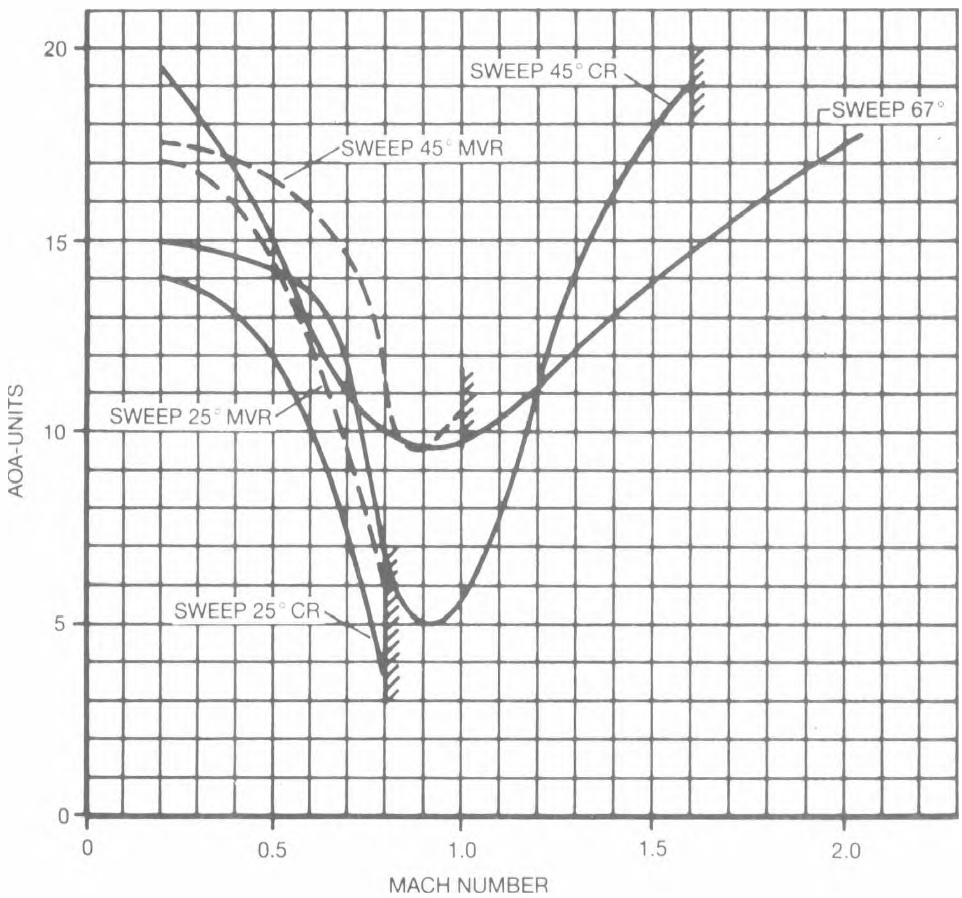


Figure 6-1

NOTE

Throttle handling should be avoided above 15 units AOA to minimize the risk of surge that increases with increasing AOA, so that event with constant throttle settings a high probability of engine surge exists if AOA exceeds 19 units.

HIGH AOA, STALL, LOSS OF CONTROL AND RECOVERY

For easy reference this chapter is divided into three separate parts as follows:

- Approach to stall and recovery
- Departure and recovery
- Developed spin and recovery

The accuracy of the AOA indication in the cockpit is highly dependent on sideslip and false indications of up to 5 units AOA are possible under extreme sideslip. Therefore normal manoeuvring, where sideslip can be easly induced, should be limited to 3 units below the maximum AOA. Above this limit up to the maximum allowable AOA, use of lateral and directional control should be smooth and sideslip be minimized. When manoeuvring above 14 units AOA the airbrakes shall be retracted. As a result of this, a safety margin is established between the cleared limitations and the actual stall, so that the aircraft will remain fully controllable at all wing sweep and configurations when flown within these limitations.

APPROACH TO STALL AND RECOVERY

Wing sweep and flap settings alter the characteristics of the approach to the stall but landing gear position has little effect. So far, high AOA manoeuvring trials in the cruise and manoeuvre wing configuration (without external stores) have revealed that no departures to uncontrolled flight conditions have occurred below 25 units AOA in symmetric coordinated flight conditions.
The aircraft exhibits natural pre-stall warning, and therefore any indication such as:

- Increase in buffet intensity
- Wing heaviness
- Wing rock or drop
- Stickforce lightening
- Nose slicing

below the AOA limit shall be taken as stall warning, and recovery to lower AOA be initiated. Recovery from the approach to the stall is straight forward and immediate by easing the stick forward.

WARNING

HIGH SIDESLIP CONDITIONS MAY REDUCE THE AOA AT WHICH A DEPARTURE MAY OCCUR, THEREFORE COARSE LATERAL STICK AND RUDDER INPUTS SHALL BE AVOIDED TO MINIMIZE SIDESLIP WHEN OPERATING CLOSE TO THE LIMITING AOA.

25° Cruise Wing

Buffet onset starts at AOA's as shown in Figure 6-1 and increases progressively as the limit is approached, reaching a buffet level rated as moderate to heavy. Wing rock occurs at higher AOA's followed by stick force lightening and decreasing wing rock as the AOA is further increased. The AOA range, for these phenomena, is rather wide at low Mach numbers but decreases rapidly when approaching 0.8 M.

25° Manoeuvre Wing

Compared to the 25° cruise wing configuration, buffet onset starts at higher AOA with decreased intensity. Wing rock is suppressed and the aircraft is completely stable about all axes up to the AOA limit. However, if manoeuvring close to 0.8 M, the aircraft behaviour is identical to the 25° cruise wing.

45° Wing Sweep

Buffet onset will occur at higher AOA with less pronounced intensity than in the 25° wing sweep configuration. Beyond buffet onset (Figure 6-1) wing rock and subsequent stick force lightening will be encountered when approaching the AOA limits. Roll control is more sensitive in this area. In manoeuvre wing, buffet onset is delayed to a higher AOA and the intensity is reduced.

67° Wing Sweep

Buffet builts up progressively from light to moderate in this configuration as AOA is increased to the limit. No significant handling effects are evident beyond the AOA range 13 to 15 units where the asymmetric wing bending can occur.

25° Mid Flap

In this configuration the buffet level remains low as AOA is increased to the limit. No lateral or directional movement is noticeable in this configuration.

WARNING

WITH FLAPS IN MID AND SLATS FAILED IN THE RETRACTED POSITION, THE AIRCRAFT STALL ABRUPTLY AT 15 UNITS AOA, RESULTING IN A NOSE UP PITCHING MOMENTS MOST LIKELY ACCOMPANIED BY WING DROP.

25° Full Flap

Full flap configuration generates light to moderate buffet at low AOA, e.g. to speeds above 200 kt, which will decrease with decreasing q and increasing AOA up to 10 units and then remain constant up to 13 units AOA. Above this value there is an increase in buffet to a moderate level which increases slowly but progressively as AOA is increased to the limit. Stability remains good about all axes to the AOA limit.

WARNING

WITH FULL FLAPS AND SLATS FAILED IN THE RETRACTED POSITION, ABRUPT STALL AND PITCH-UP WILL OCCUR AT APPROXIMATELY 13 UNITS AOA WHICH IS MORE PRONONCED THAN THE 25° MID FLAP CASE. FULL FLAPS SHALL NOT BE SELECTED IF THE SLATS FAIL TO EXTEND.

DEPARTURE AND RECOVERY

Low airspeed in conjunction with increasing AOA beyond the limits will result in significantly reduced aerodynamic control and stability, and lead to a departure or an out-of-control condition. The warning of departure at low airspeed and high AOA is short and insufficient for positive recovery action be effective before the departure occurs. In 25° cruise, 45° cruise and 67° wing sweep a departure is characterised by a sharp wing drop and yaw off the desired flight path.

WARNING

IN 25° AND 45° MANOEUVRE WING THE AIRCRAFT IS MORE RESISTANT TO DEPARTURE AND HIGHER ANGLE OF ATTACK VALUES CAN BE RECHED BEFORE THE AIRCRAFT DROPS A WING AND YAWS OFF INTO A DEPARTURE.

High sideslip may reduce the AOA where a departure occurs. Airbrakes, when extended, will mostly increase the sideslip thus provoking a departure at even lower AOA values.

Recovery

The recovery from departures is effective and rapid provided that the controls are centralized immediately and held central. The aircraft may continue rolling slowly in an inertial-reduced autorotation as AOA is reduced by the recovery action. With airspeed increasing above 180 kt and AOA on scale, any autorotation can be stopped immediately by easing the stick aft.

DEVELOPED SPIN AND RECOVERY

Developed Spin

Spinning trials and wind tunnel tests indicate that aircraft without external stores will encounter prolonged, fully developed spins in all cruise wing configurations. If recovery action is delayed, the aircraft may enter a fully developed spin. A developed spin can be recognized by the pilot as an oscillatory motion about all three axes, with AOA off scale and low airspeed indication (approx. 80 kt).
In 25° and 45° manoeuvre wing configurations, up to now no actual spins have been encountered but incipient spins could be provoked.

Recovery

For initial recovery action the controls shall be centralized immediately and held.
In the 25° and 45° manoeuvre wing or 67° cruise wing configuration the aircraft will most certainly recover to a low AOA possibly accompanied by persistent autorotation. If there is no indication of recovery to a low AOA and a spin is positively identified, the stick should be pulled fully aft to free the fin from the turbulent taileron airflow. Once the direction of spin is positively identified, full pro-spin roll control shall be applied to provide an initial pitch down moment to reduce AOA.
Roll control should not be applied when the direction of spin cannot be identified. As the rudder is aerodynamically blanked it is virtually ineffective and may be left centralized.
As soon as the unconfortable, hardedged motion subsides into a more regular rolling motion, centralize the stick to increase airspeed and maintain AOA on scale.

NOTE

If the controls are not centralized immediately when rotation stops, the aircraft will most certainly re-depart and enter a spin in the opposite direction.

With airspeed above 180 kt and AOA on scale the aircraft can be recovered as described under Departure. If flameout of one or both engines has occurred, relight should be attempted immediately after recovery.

WARNING

EJECT IF AIRCRAFT CONTROL IS NOT REGAINED AT 10000 ft AGL.

NOTE

If the controls during recovery are not applied to the limit stops, the recovery may be significantly delayed and consequently height loss will be considerable. In addition, one or both engines may surge, leading to an overheat condition.

HANDLING WITH SPILS

Spin prevention and incidence limiting system (SPILS) improves the resistance to departure from controlled flight by progressively limiting the attainable AOA's and pitch rates and reducing sideslip at high AOA with or without stores. This includes snatch pull-ups to high AOA and coarse lateral/directional control inputs at high. Manoeuvring to full aft stick for various aircraft configurations depends on the current flight limitations in Section V of this manual.

STICK FORCES AND DISPLACEMENTS

As AOA is increased above 12.7 units, the initial effect of SPILS is not readily noticeable, as the effect is gradual. However, if higher pitch rates or AOA's are demanded, stick forces are increased significantly and even two hands may have to be used to achieve the maximum manoeuvring potential.
The stick position is further aft when manoeuvring at high angle of attack where SPILS has an effect, with corresponding higher stick forces.
Above 14.4 units AOA or at lower values with sideslip, SPILS reduces roll and yaw control authority gradually with increasing AOA and larger lateral stick and rudder pedal displacements with

corresponding increase in forces are necessary to achieve a desired manoeuvre (Figure 6-2).

Roll response above 18 units AOA is low and will deteriorate with increasing AOA; however, it can be improved by coordinated rudder application. Zero authority in roll and yaw is reached at 27.5 units AOA.

REDUCTION OF ROLL/YAW COMMAND AUTHORITY

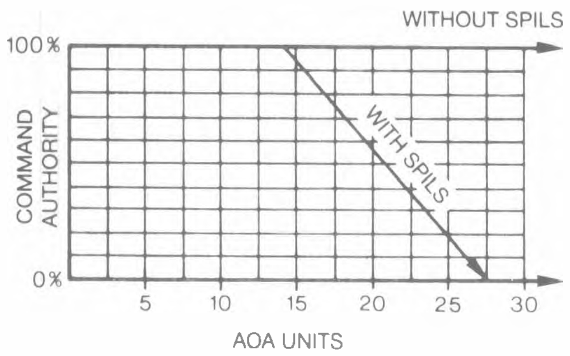


Figure 6-2

TAKEOFF

While handling during Normal Takeoff is unaffected by SPILS, slightly increased stick displacement with an associated increase in stick displacement with an associated increase in stick force is required for the Performance and Heavy Mass Takeoff.

MANOEUVRING

The authority of SPILS in limiting AOA and pitch rate is particularly noticeable during over-top manoeuvres, where full aft stick may be required when approaching the vertical position to avoid rapid airspeed bleed off below 100 kt. Stick pressure shall not be relaxed after the inverted position otherwise excessive height loss will occur.

Although nose-up pitch authority is restricted by SPILS, it has no effect on nose-down pitch control authority and can be reduced easily by forward stick input.

For configuration and flight conditions where no AOA limits apply, the maximum attainable AOA at full aft stick varies little with change of wing sweep; however AOA is greatly dependent on airspeed, external stores and CG conditions; e.g. at full aft stick, a clean aircraft at normal CG will reach approximately 25 units AOA, while up to 27 units can be achieved with stores.

Should SPILS fail, or be selected off due to mission requirements, the aircrew should be constantly aware, that without SPILS protection, reduced aft stick forces and correspondingly less aft stick displacements are required to achieve the maximum manoeuvring angle of attack. For the remainder of flight, special attention should be paid to avoid exceeding the non-SPILS AOA limits and thus prevent the risk of departure.

EFFECT OF SPILS ON AFT STICK FORCE

The example in Figure 6-3 shows the effect of SPILS on aft stick forces. They will vary with speed, altitude, configuration and CG but the effect is similar. E.g. for 25° MVR wing and 0.6 M in 10000 ft stick forces required to achieve 21 units AOA are:

- With SPILS ON, approx. 37 lbs.
- With SPILS OFF, approx. 26 lbs.

EFFECT OF SPILS ON AFT STICK FORCES

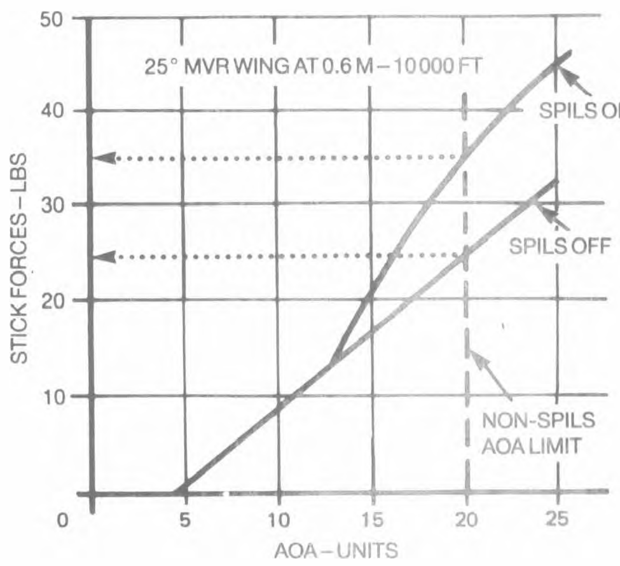


Figure 6-3

WARNING

IF A SPILS OR CSAS CWP WARNING OCCURS OR ABNORMALLY HIGH AOA IS NOTED, CENTRALISE CONTROLS IMMEDIATELY AND RECOVER THE AIRCRAFT WITHIN THE NON-SPILS LIMITS.

NOTE

- At speeds below 100 kt, SPILS shall not be relied upon to provide full protection at high AOA. Manoeuvring is restricted to gentle control inputs.
- The AOA limits with SPILS vary considerably with configuration and flight condition.
- The effect of SPILS renders the aircraft less susceptible to PIO. Should a PIO be encountered, the non-SPILS recovery technique applies.

EFFECT ON ATTAINED TURN CAPABILITY (TYPICAL)

Without SPILS the pilot is restricted to non-SPILS AOA values to prevent the aircraft from entering the departure prone area. With SPILS the aircraft may be flown to a higher AOA threshold, resulting in a better turn capability (see Figure 6-4).

EFFECT ON ATTAINED TURN CAPABILITY (CLEAN AIRCRAFT)

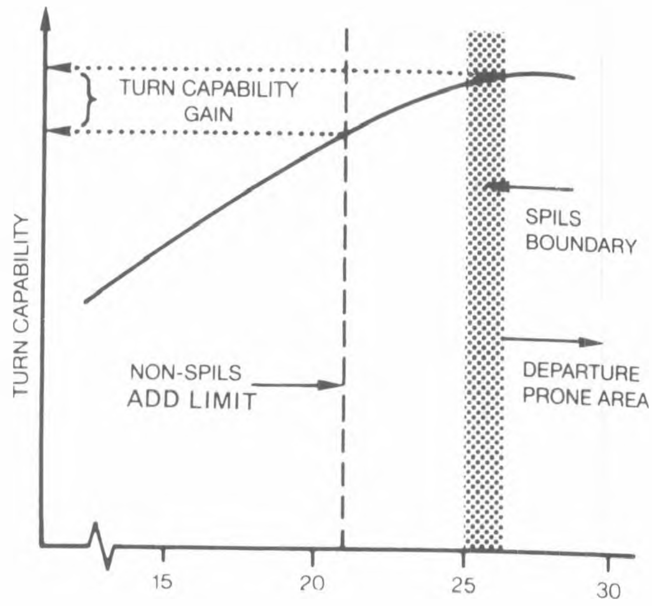


Figure 6-4

DEPARTURE PROTECTION

The degree of departure protection depends in wing sweep, flap/slat and airbrake position, stores configuration, airspeed and Mach number. With airbrakes extended, non-SPILS limits apply.

LOSS OF CONTROL AND RECOVERY

It is possible to provoke a departure from controlled flight by manoeuvring outside the cleared SPILS envelope.
If a departure or spin occurs, sufficient sideslip is generated to fail the SPILS and the system is automatically isolated from CSAS. The recovery procedure as for non-SPILS aircraft applies.

TRAIN MODE

The training mode allows the aircrew to fly with simulated CSAS failures in direct link or mechanical mode. System behaviour will be the same for any particular failure, regardless of whether it is genuine or selected via the TRAIN mode.

Selection of TRAIN is permitted provided the aircraft is trimmed straight and level in full CSAS prior to selection. All TRAIN mode selections and reset to full CSAS are to be made at nominal 1 g only.

The NORM/TRAIN switch shall be reset to NORM immediately after the required training mode has been selected and the CWS shall then be reactivated immediately by pressing one of the unlit pushbuttons on the CSAS control panel.
TRAIN modes may be selected for circuits, approaches, oveshoots and landing within the cross-wind limits defined in Section V of this manual.
The following limitations apply:

- TRAIN mode is not permitted with heavy U/FUS stores
- Touch-and-go's are not permitted with the following CSAS CP indications: red YAW DAMP (yaw no damp), INBOARD/OUTBOARD (spoilers) or red LOCKED (rudder). Approaches with rudder LOCKED shall be termined by overshooting.
- Landings and touch-and-go's are not permitted with red ROLL MD (roll DL) if the roll trim for level flight exceeds two increments on the trim increments on the trim indicator.

To operate in the training mode, proceed as follows:

- NORM/TRAIN selector switch – TRAIN
- Select a single mode on the CSAS control panel (Figure 6-5).
- NORM/TRAIN selector switch – NORM
- Clear the CWP to reactivate for genuine failures by pressing any unlit button on the CSAS CP. Selected mode will remain lit. On the CWP the CSAS caption disappears but PFCS remains.
- To terminate operation in the training mode, press lit button(s) on the CSAS CP.

Should a genuine CSAS failure occur when in the training mode, refer to CSAS Failure drill. If CSAS reset is successfull, TRAIN mode shall not be reselected.

If unsuccessfull, TRAIN mode shall not be used in conjunction with any genuine failure except where selection to mechanical mode may be made to improve roll control authority following a second failure of ROLL MD.

Additionally, TRAIN mode may be used to effect a reset where a P/R LINK and RUDDER first failure have been caused by hydraulic system pressure depressurization resulting from engine shut down, or by double generator failure.

SELECTION OF TRAIN MODES

Selection of TRAIN mode is permitted only with no CSAS failure. A combination of training modes other than those shown in figure 6-5 is not permitted.

<table>
<tr><th>CSAS CP INDICATION TRAIN MODE</th><th>LIMITATIONS</th><th>SELECTION/ DESELECTION ON CONTROL PANEL</th></tr>
<tr><td>ROLL MD and PITCH MD (Air data 2nd failure) see NOTE</td><td rowspan="2">Roll trim in level flight in full CSAS shall not exceed half an increment on the trim indicator</td><td>Press ROLL MD and PITCH MD</td></tr>
<tr><td>ROLL MD (Direct Link)</td><td>Press ROLL MD</td></tr>
<tr><td>Pitch MD (Direct Link)</td><td rowspan="2"></td><td>Press PITCH MD</td></tr>
<tr><td>YAW DAMP (No yaw damp)</td><td>Press YAW DAMP</td></tr>
<tr><td>INBORAD OUTBOARD (Spoilers Locked)</td><td rowspan="2">Roll trim in level flight in full CSAS shall not exceed half an increment on the trim indicator</td><td>Press INBORAD OUTBOARD</td></tr>
<tr><td>P/R LINK (Mech. mode in pitch and roll)</td><td>Selection:
Press ROLL MD and PITCH MD and P/R LINK or P/R LINK directly.
Deselection:
Press P/R LINK, then PITCH MD and ROLL MD</td></tr>
<tr><td>RUDDER/ LOCKED (Rudder Locked)</td><td>Roll trim in level flight in full CSAS shall not exceed two increments on the trim indicator</td><td>Press RUDDER</td></tr>
</table>

NOTE: Air data 2nd failure is equivalent to Pitch and Roll Direct Link.

Figure 6-5

CSAS FAILURE

Following a CSAS failure, the operation of the aircraft is limited as follows:

First Failures (Amber CWP indication)

- The aircraft shall be recovered to straight and level flight, at or above an altitude of 500 ft AGL and below 500 KIAS before attempting a reset.

- Reset is only permitted in Normal Mode. TRAIN Mode shall not be used to attempt a reset. (EXCEPTION: where a P/R link and RUD first failure have been caused by hydraulic system depressurization (L or R CONTR) resulting from engine shut down, the TRAIN mode may be used to effect a reset, only when hydraulic pressure has been re-established. If not CSAS will drop into Mechanical Mode.

- If reset is unsuccessful, rapid rolling is prohibited. The aircraft shall not be flown below 500 ft AGL, except for landing.
  Other limitations for the various failure modes are given below.

- If the CSAS reverts to 1st or 2nd failure in pitch or mechanical mode with i/b stores the following AOA limits apply:

	Pitch 1st failure or 2nd failure	Mech. Mode
MID flap 25°	15	15
MID flap 35°	21	15
FULL flap	21	15

Second Failures (red CWP indication)

As for first failures. In addition the use of airbrakes is prohibited.

- Crosswind Limitations for failure cases. These limitations are given on Crosswind Chapter in Section V.

- Thrust Reverse Limitations following CSAS failures. These limitations are given on Inboard/Outboard (spoilers) paragraph in this chapter.

PITCH MD

Reversion of the CSAS to PITCH DL will result in degraded pitch damping, however aircraft control is good. In manoeuvring flight, stick force per g is lighter than in full CSAS at high airspeed at all wing sweeps especially at aft C.G. conditions. Reversion to PITCH DL while manoeuvring under g will not result in undue pitching movements, and recovery to 1 g flight is achieved without difficulty. Reset attempts should be carried out at a safe altitude and airspeed under 1 g flight conditions, since positive or negative pitch transients may be encountered upon reengagement, the magnitude of the transients increasing with higher airspeeds. During flap and landing gear lowering slight trim changes have to be expected. More than normal back stick displacement is required for roundout.

ROLL MD

With the system reverted to ROLL DL, max differential taileron and spoiler authority is noticeable reduced. Pilot workload is increased during the approach due to partial loss of automatic turn compensation. Increased pilot's attention is required when landing in poor visibility or turbulent conditions. Proverse yaw associated with roll control inputs will be noticed if the flaps are down.

P/R LINK

Reversion to mechanical mode results in a large performance reduction. Due to increased response in pitch and degraded damping in pitch and roll, only gentle manoeuvres should be performed. Control in pitch is light and sensitive, and especially below 300 kt roll control is reduced. However, with carefull handling, the aircraft can be flown at all wing sweeps without difficulty and landed safely.

YAW DAMP

With the rudder not locked, damping about the yaw axis is degraded but turn coordination is still present. As the nosewheel steering augmentation system is inoperative in this failure condition, do not preselect thrust reverse and use IDLE thrust reverse only.

Rudder LOCKED

In the rudder is locked, the ROLL MD will be switched off except when in mid/full flap configuration. This will result in significant degraded roll damping and loss of automatic turn coordination. Large sideslip angles can develop during abrupt roll stick inputs. With the rudder locked, the pilot will be unable to kick off drift prior to touchdown. Thrust reverse may be used provided NSAS is available.

INBOARD/OUTBOARD (Spoilers)

Inboard or outboard spoiler failure results in reduced roll control, but overall aircraft handling is not degraded. With outboard spoilers failed, the nose-down pitching moment associated with activation of lift dump is increased. Therefore lift dump shall not be preselected and only IDLE thrust reverse may be used after the nosewheel is on the ground at airspeed above 110 KIAS.
A double spoiler failure reduces roll control markedly. During the approach coordinated rudder inputs should be used to assist retaining the wings level in crosswind conditions or turbolence. Lift dump will not be available.

Q-FEEL FAILURE

An apparent significant reduction in pitch stick forces will indicate a q-feel failure. In this case, all manoeuvring should be performed carefully in order to avoid overcontrol and overstressing the aircraft.

LOW SPEED HANDLING WITH MULTIPLE CSAS FAILURES

Multiple CSAS failures, indicated by any of the following CSAS control panel indications: ROLL MD, YAW DAMP, RUDDER/LOCKED, INBOARD/OUTBOARD (spoilers), will result in very poor lateral/directional handling; deteriorating further with flaps in DOWN and large U/FUS stores carried. For landing with degraded CSAS refer to Flight Control System Failure drill in Section III of this manual.

NOTE

A combination of mechanical mode and RUDDER LOCKED will result insignificantly reduced roll response at low speeds.

AIRBRAKES

A reduction in directional stability with airbrakes extended will be detected only with CSAS failed in roll, yaw, or with rudder locked.
In Mechanical Mode, airbrake extension produces an easily controllable pitch trim change (nose down subsonic - nose up supersonic).

FLIGHT WITH EXTERNAL STORES

MANOEUVRING

Aircraft handling qualities with the cleared stores throughout the flight envelope are straight forward; however with certain store configurations following phenomena will appear:

I/B Wing Tanks + AIM9L

When manoeuvring at 45° cruise wing with I/B wing tanks + AIM-9L with/without stores on O/B or U/FUS pylons, pitch-ups up to about 1 g (more pronounced with 2 AIM-9L) will occur between 0.8 - 0.92 Mach at 9-12 units AOA and below 15000 ft.

CAUTION

CARE SHOULD BE EXERCISED TO AVOID EXCEEDING THE STRUCTURAL LIMITS WHEN MANOEUVRING CLOSE TO THE G BOUNDARIES.

MW-1

When manoeuvring at 45° or 67° wing sweep with MW-1 and heavy wing (tanks, ± AIM-9L and O/B stores), lateral/directional oscillations may be encountered with/without AFDS engaged between 0.6 - 0.92 Mach. They are more pronounced at higher airspeed in low altitude with turbulence; however, the oscillations are not considered to be safety critical.

STORES RELEASE

Store separation has very little effect on the aircraft at release. In most cases, the incremental acceleration has been less than 0.5 g. During deliveries with retarded bombs, slight aircraft pitch down motions have been experienced as the weapons pass under the aircraft's tailerons. This phenomenon is due to the pressure distribution change on the taileron.

ASYMMETRIC STORES

FULL CSAS

The rolling moment of an aircraft asymmetric store conditions, caused by a lateral imbalance due to:

- operational store configuration or deliberate launch/release,
- hung store or
- external fuel tank transfer failure

may not be apparent to the pilot in 1 g flight as the CSAS will compensate for most of the effect. However, when manoeuvring, the asymmetric moment will increase linearly with increasing g and a proportionally higher roll control surface deflection is required for compensation. The same phenomenon occurs when slowing down at constant g and increasing AOA. Therefore, store asymmetrics will become more evident under high g conditions or during decelerations at high AOA. With full CSAS and operable spoilers the aircraft can be fully controlled, including manoeuvring within the cleared envelope, with less than half control surface deflection with any hung store or with one full U/WING tank, which constitutes the worst asymmetric store conditions.

SWEPT WING/SPOILER FAILURE

Conditions for spoiler not active are:

- Wing sweep greater than 55°
- Spoiler failure

Conditions for partial spoiler failure are:

- One pair of spoiler failed
- CSAS reverted to ROLL DL or Mechanical mode and flaps less than 15°

For all cases where spoiler are not or only partially operating, asymmetric stores may cause uncommanded rolling well below the buffet onset or limit AOA when increasing g or slowing down with increasing AOA. This situation will be aggravated during manoeuvring where larger control surface deflections are required for compensation. The CSAS will then drive the differential tailerons to their limits with the stick not more than half deflected, thus consuming full roll control surface deflection. A further increase in g load or AOA will cause the aircraft to roll into the heavy wing. Therefore, the only corrective action to regain control is immediate unloading of the aircraft to reduce g load and AOA. In a low airspeed condition use of proverse rudder is quite effective in assisting the differential tailerons.

NOTE

An asymmetric condition may develop slowly during flight, unnoticed by the pilot as he will compensate automatically by trimming from time to time. Caution shall be exercised as almost full roll control autority may be consumed by a mistrim and an additional roll stick demand will not produce a significant roll moment.

WARNING

- WHENEVER UNCOMMANDED ASYMMETRIC STORE CONDITIONS ARE ENCOUNTERED, SELECT 25° OR 45° WING SWEEP. FOR FINAL APPROACH AND LANDING A CONTROLLABILITY CHECK IS RECOMMENDED TO DETERMINE SAFE AIRSPEED AND AOA; IF UNABLE, DECREASE APPROACH AOA BY 2 UNITS.

- IF UNCOMMANDED ROLLING TENDENCIES ARE ENCOUNTERED DURING MANOEUVRING, THE AIRCRAFT SHALL BE UNLOADED IMMEDIATELY AND AT LOWER AIRSPEED PROVERSE RUDDER APPLIED TO REDUCE THE ASYMMETRIC MOMENT.

DIVE RECOVERY

Chart in figure from 6-6 to 6-8 may be used to determine altitude lost during recovery for altitudes from sea level up to 15000 ft. Separate charts are available to find altitude loss for weapon release in AER.1F-PA200-34-1.
The charts include all wing sweeps and depend mainly on true airpseed, dive angle and load factor. They are based on 17, 19, 21 or 23 units AOA.
The data in the chart are based on:

- Application of 2 g per second, starting at minimum breakoff height.

- A wings level pullout with 17, 19, 21 or 23 units AOA or an associated predetermined maximum load factor whichever is attained first.

- Constant maximum load factor or maximum AOA during the pullout until the aircraft's nose passes the horizon.

- Engine setting: depending on dive angle, the thrust setting for steady state approach or idle thrust to meet the airspeed criteria at minimum break-off height. When the aircraft's nose passes the horizon, application of power to MAX DRY.

NOTE

- No safety factor incorporated.

- The effect of speed increase at higher dive angles with power in IDLE in taken into consideration.

MAXIMUM AOA CHART

The Chart shows the relationship between Mach and maximum AOA and determines, which Maximum Load Factor chart is to be used for further calculation. At higher dive angles, the maximum speed attained during the pullout phase is the governing factor which determines the maximum AOA, and not the speed at minimum break-off heigh. For speeds ≥ 0.92 M the 17 AOA Maximum Load Factor chart only shall be used.
For speed < 0.92 M any AOA chart may be used. However, the max cleared AOA associated with a particular store configuration shown in Section V under 'External Store Configuration and Carriage', will determine which specific chart applies.

MAXIMUM LOAD FACTOR CHART

These chart are based on 17, 19, 21 or 23 units AOA and may be used to determine the maximum load factor for a desired wing configuration.

NOTE

- Maximum load factor for the respective wing sweep shall not be exceeded as buffet onset will occur.

- The maximum speed at start of pullout for 25° CR wing shall not exceed 0.6 M due to heavy buffet during recovery. For heigher airspeeds MVR wing should be selected.

ALTITUDE LOSS

This chart shows the relationship of airspeed, dive angle and load factor to determine the altitude loss during the dive recovery. The chart may be entered either with KTAS directly or, if altitude and temperature corrections are required, with KIAS.

DIVE RECOVERY-USE

MAXIMUM AOA CHART

Enter at KIAS (A), proceed horizontally to the right. Reenter at desired break-off heigh (B) and proceed vertically upward. The point of intersection (C) will determine which particular Maximum Load Factor chart applies.

MAXIMUM LOAD FACTOR CHART

Enter at KIAS (A), proceed horizontally to the right to intersect mass (B), project vertically down to intersect baseline (C). Parallel the guidelines for wing sweep (D) and continue vertically down to read maximum load factor (E).

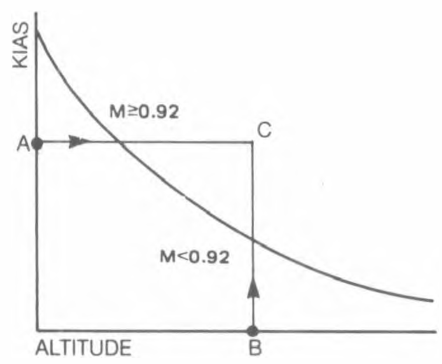
ALTITUDE LOSS CHART

Enter at KIAS (A), proceed vertically upward to intersect break-off heigh (B), project to the left and intersect temperature lines (C). Continue upward to read KTAS (D). Proceed vertically upward to intersect dive angle (E), project to the right to intesect load factor baseline (F) and parallel the guidelines for load factor (G). Continue to the right to read altitude lost (H).
The chart may be entered at KTAS (D) if no altitude and temperature corrections are required.

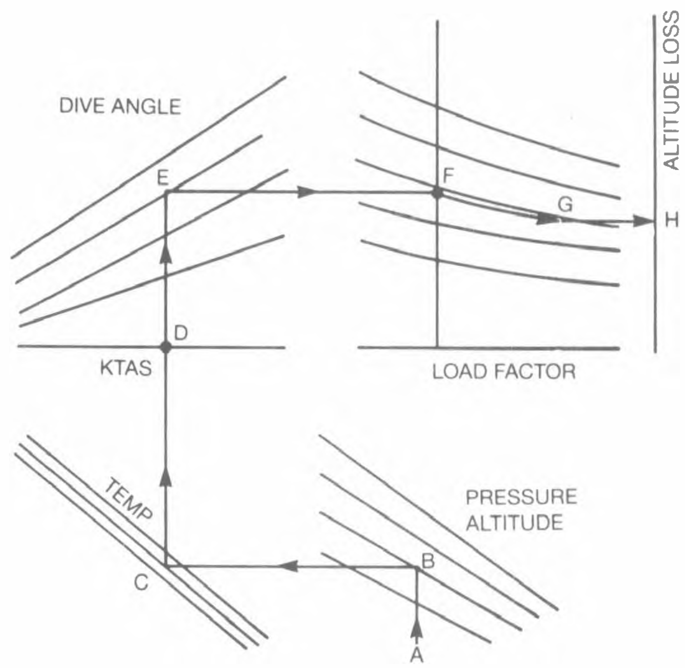
SAMPLE DIVE RECOVERY

		Find:	
Speed at start of pullout	– 450 KIAS	Max AOA during pullout	– 17 units
Break-off height	– 14000 ft	Max load factor during pullout	– 4.75 g
Mass	– 18000 kg	TAS	– 530 KTAS
Wing sweep	– 45 MVR	Altitude loss	– 2400 ft
Temp at 15000 ft	– −20°C	Height at end of pullout	– 11600 ft
Dive angle	– 45 degrees		

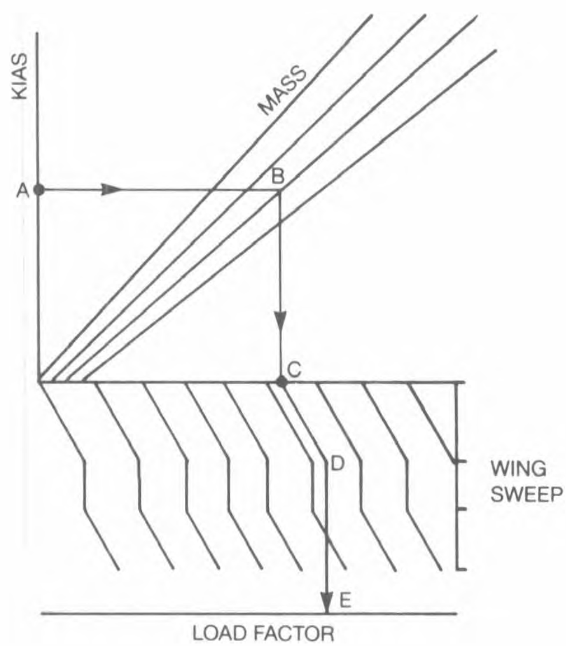
SAMPLE MAXIMUM AOA



SAMPLE ALTITUDE LOSS



SAMPLE MAXIMUM LOAD FACTOR



MAXIMUM AOA CHART

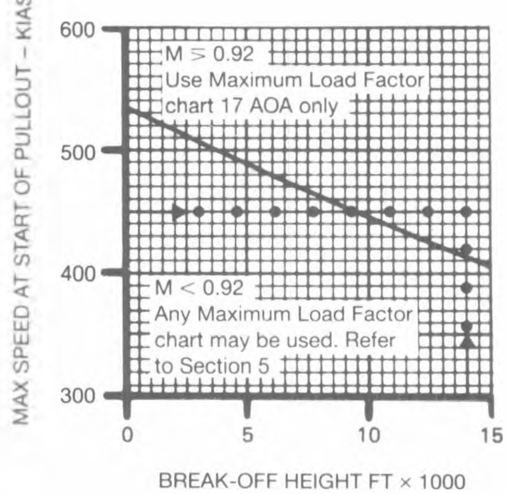


Figure 6-6

DIVE RECOVERY

DATE BASIS: ESTIMATED
DATE: 01. 01. 1986

FUEL GRADE: F-34, F-35, F-40
ENGINES: MK 101, MIN STANDARD

MAXIMUM LOAD FACTOR CHART

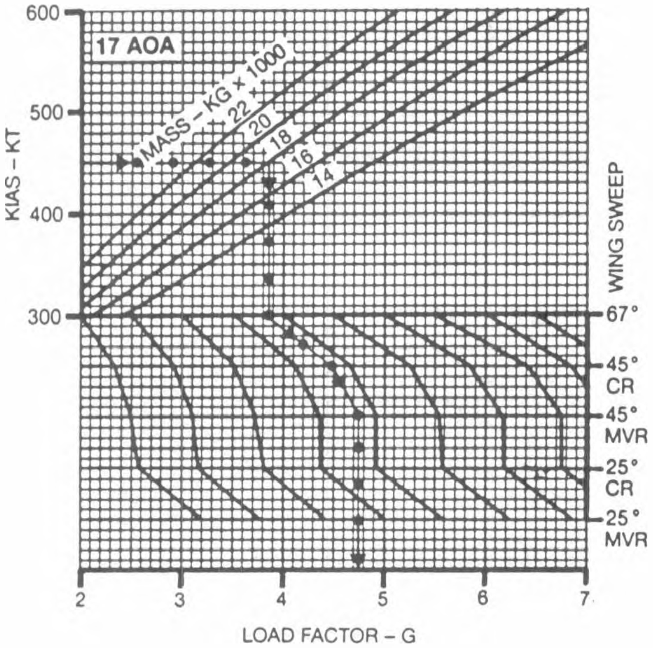


Figure 6-7.1

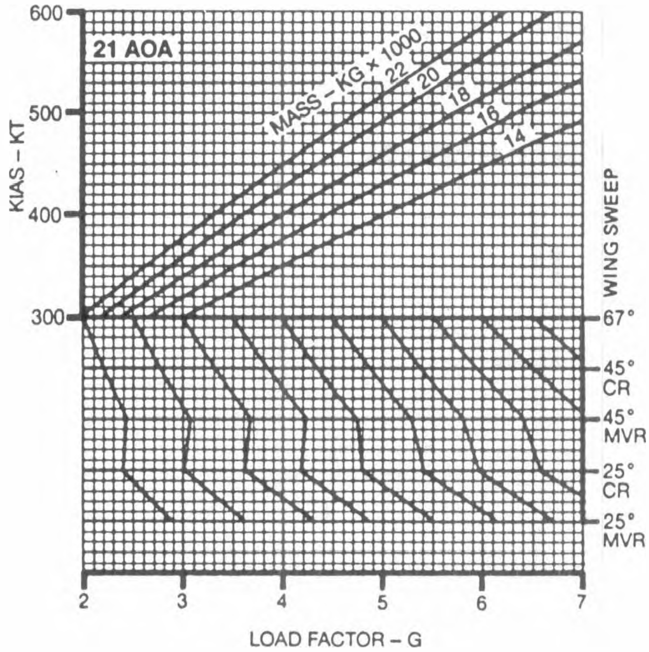


Figure 6-7.3

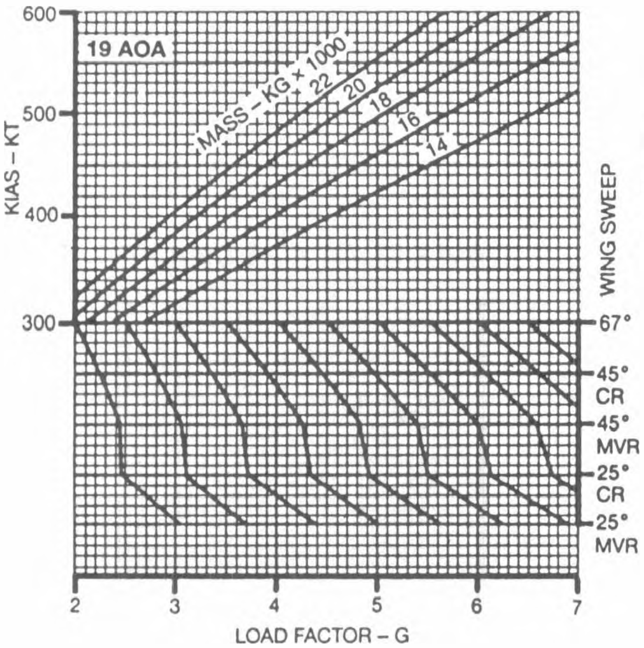


Figure 6-7.2

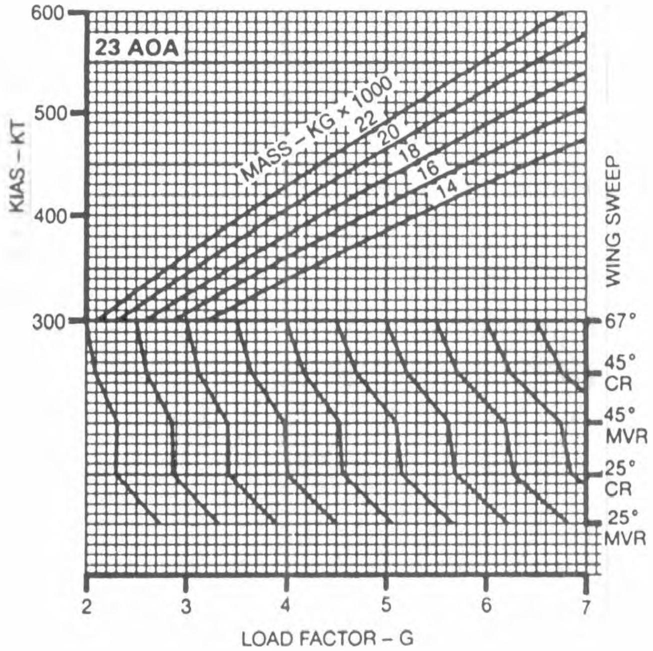


Figure 6-7.4

Figure 6-7

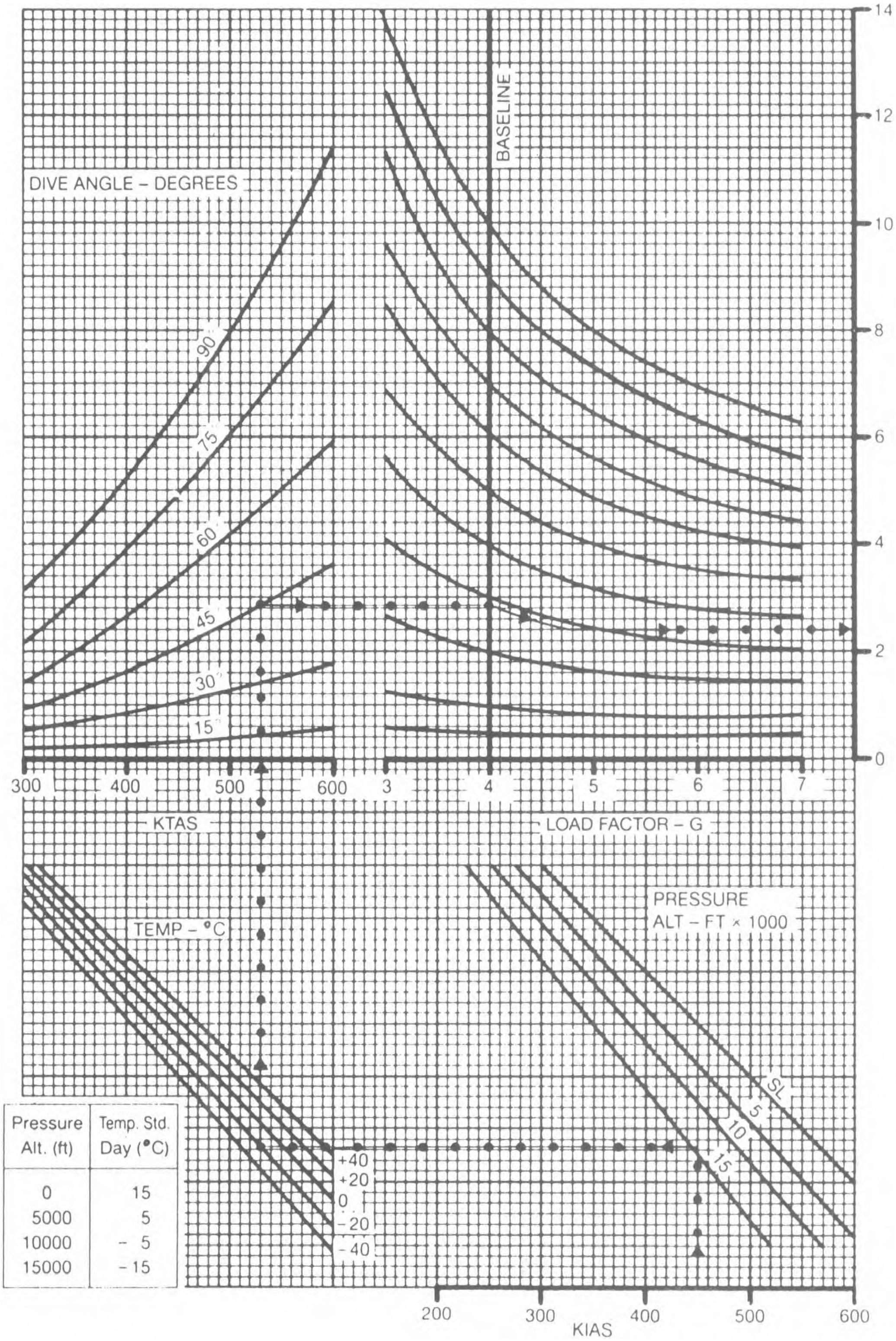
DIVE RECOVERY

DATE BASIS: ESTIMATED
DATE: 01. 01. 1986

CONDITIONS: THRUST FOR STEADY STATE APPROACH OR IDLE THRUST, WHICHEVER IS GREATER.

FUEL GRADE: F-34, F-35, F-40
ENGINES: MK 101, MIN STANDARD

ALTITUDE LOSS CHART



Pressure Alt. (ft)	Temp. Std. Day (°C)
0	15
5000	5
10000	− 5
15000	− 15

Figure 6-8

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION VII

ADVERSE WEATHER OPERATIONS

TABLE OF CONTENTS

Title	Page
Instrument Flight Procedures	7-1
Instrument Approaches	7-2
Night Flying	7-3
Cold Weather Procedures	7-4
Turbulence and Thunderstorms	7-7

INSTRUMENT FLIGHT PROCEDURES

GENERAL

The Aircraft is designed to perform operational missions in IMC and adverse weather conditions by day and by night. Some modifications of standard instrument procedures may be required where rapid acceleration rates and large climb or dive angles arise. Switch ON INTAKES ANTI-ICE (Post mod. 00629: this information is not applicable) when flying through area of visible moisture or in known possible icing conditions. During normal operating conditions, to prevent the windscreen from fogging, it is sufficient to switch ON the WINDSCREEN HEATER. However, if the aircraft was exposed in the open air to moist environmental conditions, STBY WS DEMIST and CANOPY DEMIST should be selected to avoid possible cockpit fogging.

HEAD UP DISPLAY

The HUD is the main flight monitoring display and all indications, whichever mode have been selected (DIR-AUTO-NAV), are considered to be the most accurate indications. However, since the HUD integrity is not yet proven, and the data source is single channel, the indications shall be regularly cross-checked with the Head Down Display (HDD) indications. In case of the HUD and HDD indications being significantly different, the HDD shall be used.

WARNING

IN CONDITIONS OTHER THAN STRAIGHT AND LEVEL FLIGHT, THE INDICATED PITCH ATTITUDE ON ADI DIFFERS FROM ACTUAL AIRCRAFT PITCH UP TO APPROXIMATELY 17 DEGREES (DIVE) AT 180 DEGREES ROLL. THEREFORE AT LOW ALTITUDES, FAILURE TO CONSIDER INCREASES ACTUAL DIVE ANGLES RESULTING FROM THESE ADI ERRORS MAY PUT THE CREW INTO A CONDITION WHERE RECOVERY WILL NOT BE POSSIBLE. USE ADI INFORMATION WITH EXTREME CAUTION.

Pressure error corrections to the HDD are required when using either the front cockpit altimeter in STBY mode or the rear cockpit altimeter

INSTRUMENT TAKEOFF

The instrument takeoff is carried out with a combination of visual outside references and HUD monitoring. After releasing the brakes, runway alignment can be maintained using outside visual references. The pilot should transfer his attention from outside references to the HUD indications (mainly IAS, AOA and pitch attitude), as the takeoff progresses.

Apply takeoff procedures and technique as described for Normal Takeoff in Section II.

INSTRUMENT CLIMB

After liftoff, maintain initially 13 AOA units if 50 ft obstacle clearance is required. After passing the 50 ft obstacle height, retract flaps and the landing gear, and derotate the aircraft slightly to establish a climb attitude of 10 degrees. Cross-check all flight and engine instruments as airspeed and altitude increase. Aim for 300 kt IAS at 1000 ft AGL. If 50 ft obstacle clearance is not required perform takeoff with approx 10 units AOA.
If a Maximum Dry Climb is desired, cancel REHEAT at 300 kt IAS and maintain MAX DRY to accelerate to a climb speed which is recommended in the Appendix, Performance Data.
If a Maximum Reheat Climb is preferred, remain in reheat thrust and accelerate to a climb speed recommended in the Appendix, Performance Data. Use forward pitch trim to reduce stick pressure during airspeed build-up. When the airspeed indication passes 0.65 Mach, select the wing sweep angle to 45°. Upon reaching the climb speed, establish a climb attitude of approximately 25° to maintain a constant airspeed climb. To prevent overshooting assigned altitude initiate level-off in good time. If the VSI reading is off scale use approximately 4000 to 6000 ft lead for Max Reheat Climb, or 10% of the VSI reading for Max Dry Climb to initiate level-off.

CRUISING FLIGHT

The maximum range or endurance schedules for various conditions and configurations can be found in Appendix, Performance Data.

HOLDING

The holding pattern shall be entered with the wing sweep angle set to 25°, the airspeed reduced to 250 kt IAS and a bank angle of not more than 30°.

INSTRUMENT APPROACHES

TACAN APPROACH

A typical TACAN approach is illustrated in Figure 7-1. Before descent into areas of possible or known icing conditions it is necessary, as precautionary measure, to switch INTAKES ANTI-ICE to the ON position (Post mod. 00629: this information is not applicable). Confirm the HUD readings against HDD indications, crosscheck the front cockpit altimeter indications against the rear cockpit altimeter indications under steady conditions.
At 300 kt IAS reduce throttles to 80% NH, extend the airbrakes and establish a constant airspeed descent rate. 2000 ft above the level-off altitude, reduce the rate of descent to about 2000 ft/min. Anticipate the level-off by 10% of the VSI. Retract the airbrakes and after reaching an airspeed of 250 knots IAS maintain 250 kt IAS until approx. 10-12 DME.
For further descent, the airbrakes may be used. Prior to the final approach fixpoint (FAF) select flaps to MID, lower the under-carriage, maintain 8 units AOA. During final, check approach speed and transit to 10 units AOA for the existing configuration. Lower full flaps as the commencement of the final descent and maintain 10 units AOA and appropriate approach speed.

NOTE

- In IMC all TACAN procedures, shall be radar monitored.
- The radar-altimeter shall be used only above 200 ft AGL in VMC with visual references.

TACAN APPROACH-SINGLE ENGINE

The TACAN approach, with one engine off, is identical to the normal TACAN approach, with the exception that a power setting of 85% NH is used for the let down, with the airbrakes in. The flaps should remain in the MID position during final approach, until landing is assured.

GCA (PAR) APPROACH

A typical GCA approach is illustrated in Figure 7-2. Descend to GCA pattern altitude and maintain 250 KIAS. Establish landing configuration with flaps in MID on base leg or 10 to 12 NM on final approach. Maintain 200 KIAS until completion of turn on to final approach. Determine final approach speed and transit to 10 units AOA for the existing configuration. Lower full flaps when starting final descent and continue with 10 units AOA and the appropriate approach speed.

CIRCLING APPROACH

Passing the TACAN FAF maintain 8 to 10 units AOA in the landing configuration with flaps in MID. After roll out onto final approach, lower full flaps when starting descent, and establish 10 units AOA.

SINGLE ENGINE GCA

The single engine GCA is flown basically as the normal GCA; the only exception is that the landing gear should be lowered on final descent and the flaps selected only to MID position. When the landing is assured, lower full flaps.

MISSED APPROACH

At the missed approach point, advance the throttles to MAX DRY and rotate to climb attitude. Rise the gear if climb is definitely established. Retract flaps not below minimum flap retraction speed from DOWN to MID position.

Maintain a climb rate of between 1500 to 2000 ft/m, accelerate to the desired airspeed, select flaps UP not below minimum flap retraction speed and follow the missed approach procedure.

NIGHT FLYING

PREFLIGHT

Check carefully the external lighting. When the BATT MSTR switch on the rapid takeoff panel is in the FLIGHT position. DC power is supplied by aircraft battery if the external ground power supply is not connected, or when neither the APU nor the engines are running. Under these conditions, the only available lighting in the front and rear cockpit are the wander lamps and gaseous tritium light sources if turned on.

When the external ground power supply is connected or the generator is on line, all the external and internal lights are available. The internal lights may be adjusted to a comfortable level by use of the dimmer switches on the internal lights panel or individual dimmers on the main instrument panel. Selecting "N" on the CWP will reduce the intensity of all CWP captions, attention getters, indicators and warning lights.

FLIGHT

Normally the takeoff is performed with the taxi light out. The night flying techniques do not differ essentially from those normally used by day during an IFR flight.

NOTE

> During normal operation, the navigation lights should be selected to FLASH. However, during instrument conditions, the navigation lights may be selected to STEADY and the anti-collision light switched to OFF, to avoid the vertigo inducing effects resulting from light being reflected from surrounding clouds.

During night formation flying, the leader should set his light switches to the following position:

Anti-collision lights	OFF
Formation lights	ON
Navigation lights	DIM/STEADY

NOTE

- During night flying, the correct indication of the lift dump indicator shall be confirmed by using the cockpit wander lamp prior to preselecting lift dump.
- The intensity of the red floodlight above the CSAS panel should be reduced to prevent reflections in the CSAS selector/indicators from causing some difficulties in identifying the lighted indicator.

TACAN PENETRATION – TYPICAL

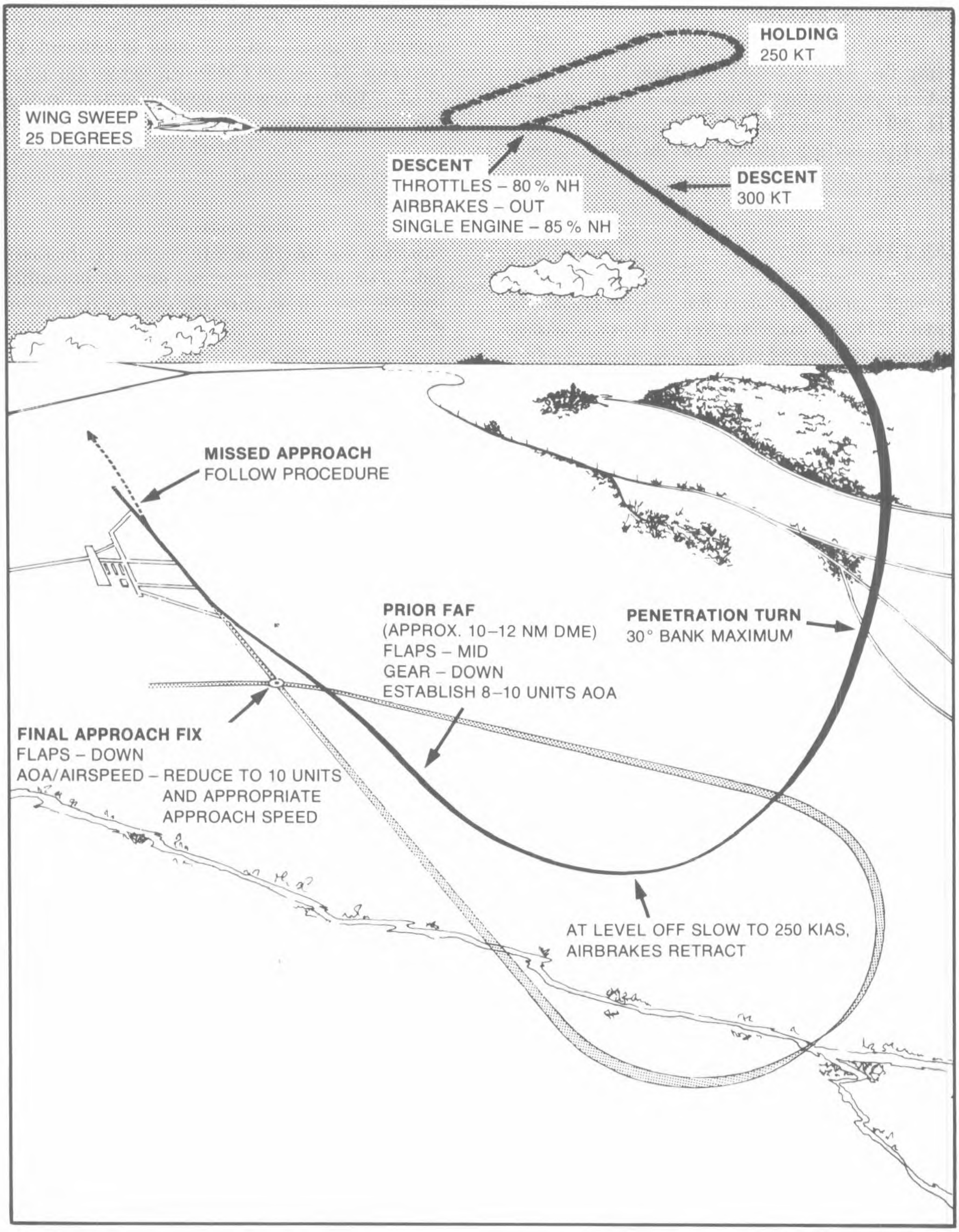


Figure 7-1

GCA (PAR) APPROACH — TYPICAL

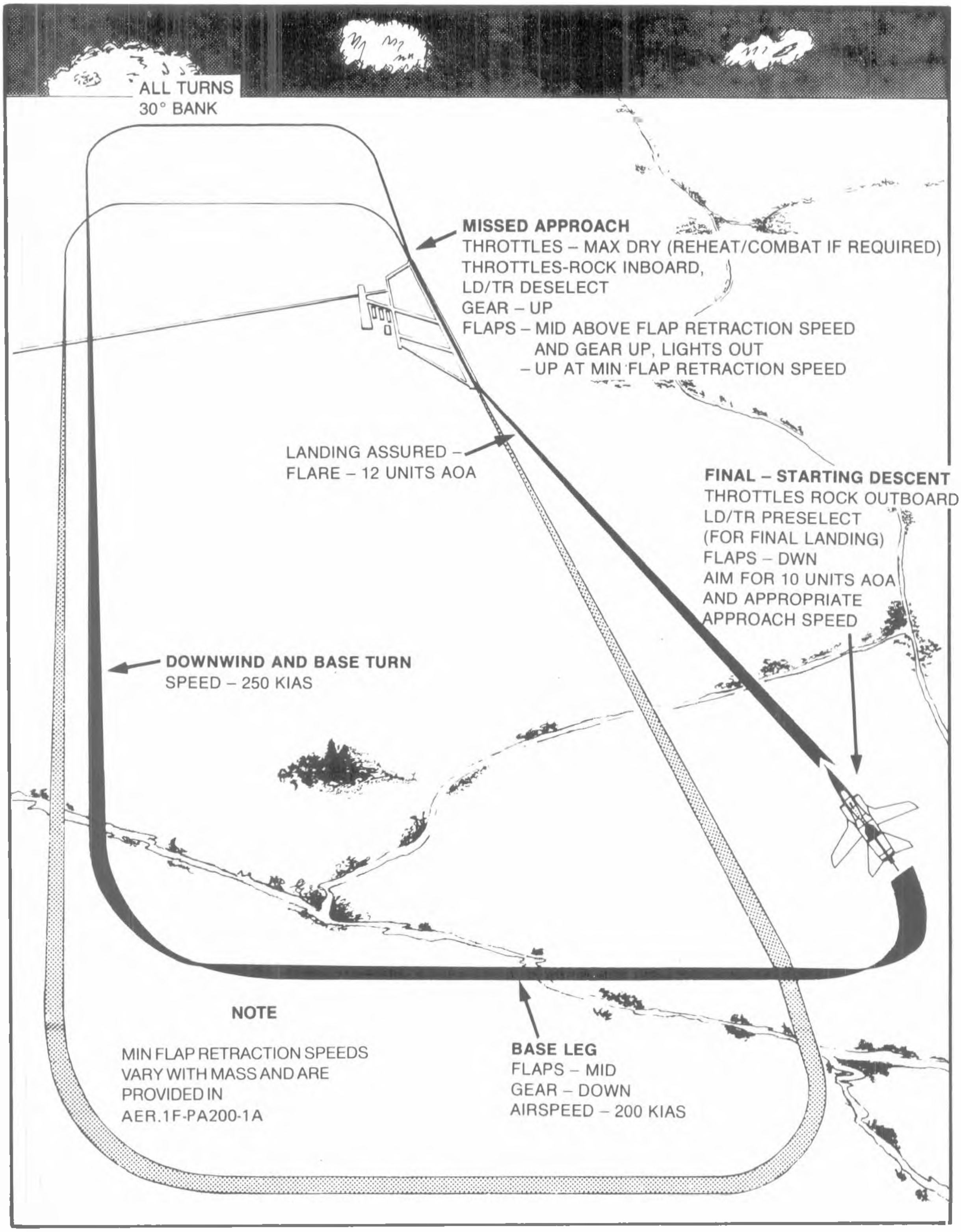


Figure 7-2

COLD WEATHER PROCEDURES

GENERAL

This chapter should be read in conjunction with Section V "ENVIRONMENTAL CONDITIONS".

GROUND OPERATION

The whole aircraft should be free from show, ice and frost. Snow, frost or ice on the aircraft, can be removed by the use of de-icing fluid or hot air. Inspect the aircraft carefully for possible fuel or hydraulic fluid leaks. Ensure that there are no water accumulations in the engine inlets or on control surfaces, where subsequent freezing may cause foreign object damage or binding. When the temperature is below + 3°C or less and the relative humidity is 50% or more, engine intake icing may occur during engine ground running.

CAUTION

WHEN ICING CONDITIONS EXIST USE LOW POWER SETTINGS AND AVOID RAPID THROTTLE MOVEMENT DURING ENGINE GROUND OPERATION IN ICING CONDITIONS, TO PREVENT ENGINE INTAKE ICE ACCUMULATIONS.

NOTE

If the aircraft has been cold soaked for a prolonged period (i.e. overnight) under extreme cold temperature (below -20°), an oxygen regulator deviation from functional requirements may be expected. In fact, with oxygen system selected to airmix, a reduction in oxygen flow capacity is present. Therefore, in the previous environmental condition, the oxygen system shall be selected to 100% until cockpit internal temperature rises and provides normal working of the regulator. Afterwards airmix can be selected.

Check flight controls, flaps and slats for correct operation. Before beginning the CSAS BITE test, it is necessary to move the controls fully through several cycles to warm-up the hydraulic fluid.

Before taxiing, depress and release the brake pedals to ensure freedom of operation and aircraft reaction in both directions.
When taxiing on snow, frost or ice patches, it is necessary to combine nose wheel steering with a differential braking action, because the nose wheel steering may not be fully effective.

A comparatively greater idle thrust than normal will be apparent and shall be taken into consideration during taxiing; concrete or painted areas on ramps, taxiways and runways are considerably slippery.

CAUTION

INCREASE THE SPACING BETWEEN TAXIING AIRCRAFT TO MAINTAIN A SAFE STOPPING DISTANCE AND TO AVOID POSSIBLE DAMAGE CAUSED BY PIECES OF ICE THROWN UP BY JET BLAST OF THE PRECEDING AIRCRAFT.

TAKEOFF

WARNING

TAKEOFF IN SEVERE ICING CONDITIONS IS PROHIBITED.

Taxi the aircraft to an ice free area on the runway to perform the run-up checks and the line-up. It is necessary to maintain the holding position at MIN REHEAT, in order to confirm proper engine indications in MAX DRY, and positive reheat light-up. Rain has little or no appreciable effect on the aircraft's flight characteristics. However, substantial ice build-up will cause distorsions in the shape of the airfoil surfaces with the result of a partial loss of lift, higher stalling speed and degraded overall handling characteristics.

WARNING

IF SEVERE ICING CONDITIONS ARE ENCOUNTERED, IMMEDIATE DIVERSION IS NECESSARY.

TURBULENCE AND THUNDERSTORMS

Depending on the severity of clear air turbulence (CAT) reduce in airspeed, select 45° wing sweep angle and change flight level to avoid the risk of structural damage.
Generally all types of clouds with suspected lighting build-ups or with visible thunderstorm build-ups should be avoided by use of the onboard radar or by requesting assistance from control agencies.
Penetration into thunderstorm areas has not been investigated to date, however if these conditions are encountered, the following precautionary measures are recommended:

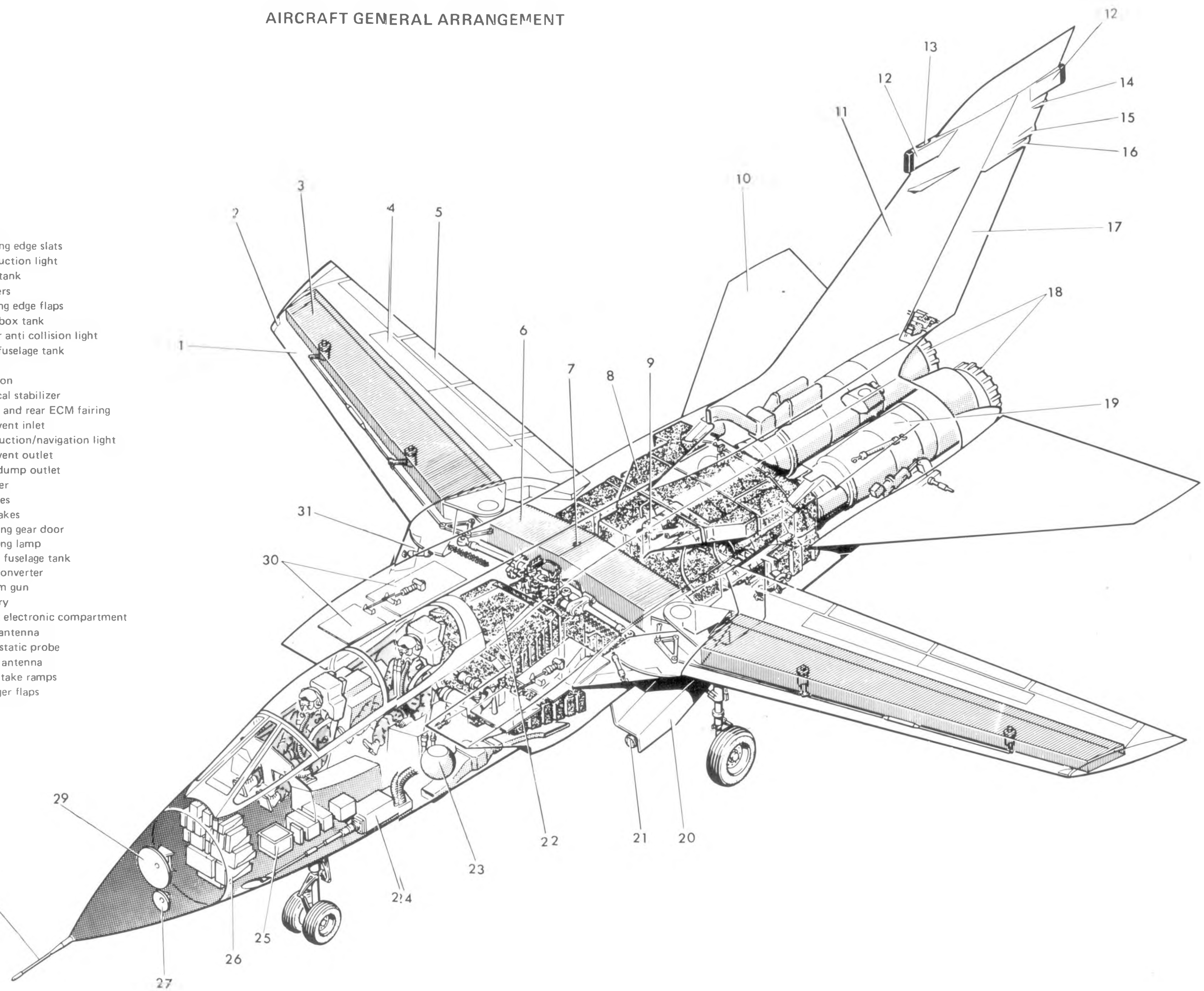
HUD/HDD – Fly attitude
Throttles – Adjust, don't chase airspeed
Wing sweep – 45° are recommended
Intake anti-ice – ON (Post mod. 00629: AUTO)
Antidazzle lights – ON
AFDS/Autopilot – OFF
Shoulder Harness – Tight
Internal Lights – Bright

NOTE

The optimum thunderstorm penetration airspeed is considered to be approximately 300 kt IAS, which is a compromise between pilot's comfort, controllability, and aircraft structural limits.

THIS PAGE LEFT INTENTIONALLY BLANK

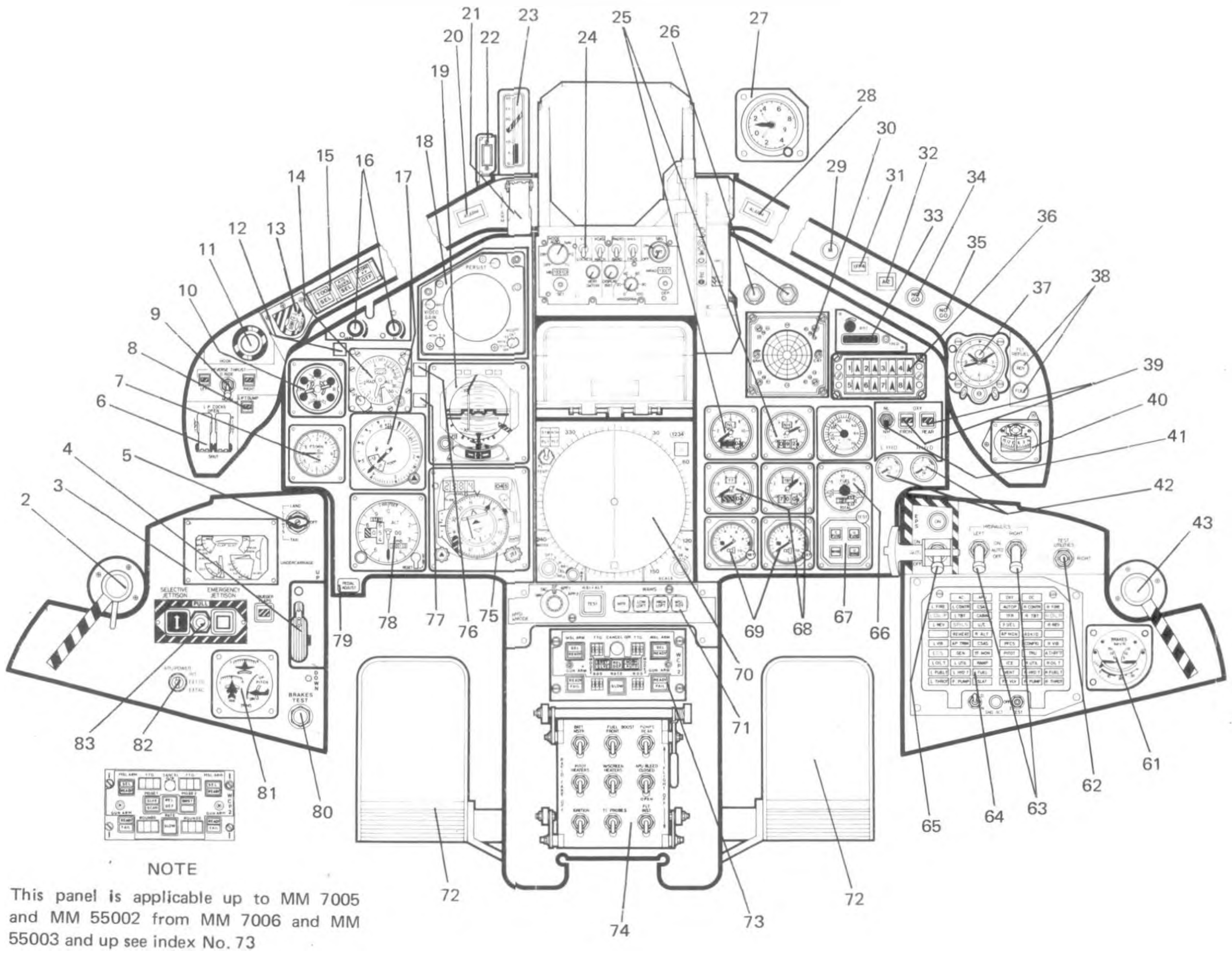
AIRCRAFT GENERAL ARRANGEMENT



1 Leading edge slats
2 Obstruction light
3 Wing tank
4 Spoilers
5 Trailing edge flaps
6 Wing box tank
7 Upper anti collision light
8 Rear fuselage tank
9 APU
10 Taileron
11 Vertical stabilizer
12 Front and rear ECM fairing
13 Fuel vent inlet
14 Obstruction/navigation light
15 Fuel vent outlet
16 Fuel dump outlet
17 Rudder
18 Engines
19 Airbrakes
20 Landing gear door
21 Landing lamp
22 Front fuselage tank
23 Lox converter
24 27 mm gun
25 Battery
26 Front electronic compartment
27 TFR antenna
28 Pitot static probe
29 GMR antenna
30 Air intake ramps
31 Krueger flaps

FRONT COCKPIT (STRIKE AND TRAINER)

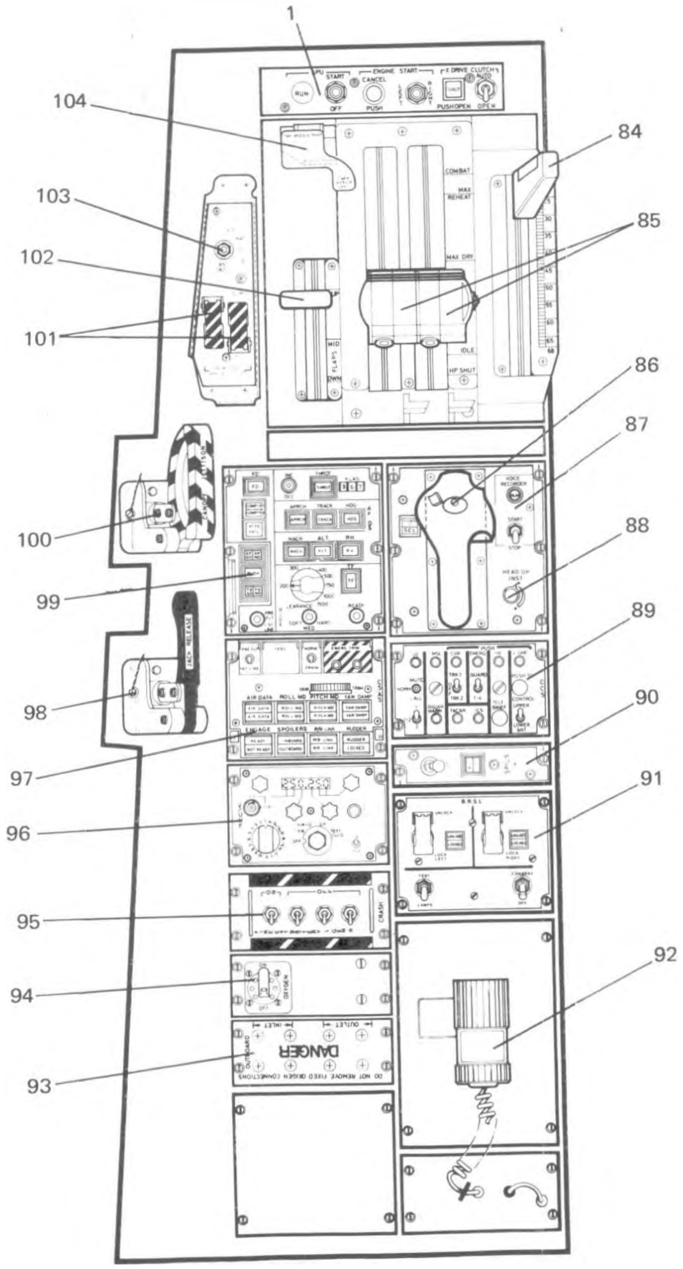
1 Engine start panel
2 Emergency landing gear selector lever
3 Secondary control surfaces position indicator
4 Landing gear selector lever
5 Landing/Taxi lights selector switch
6 Low pressure cocks selector switches
7 Vertical speed indicator
8 Lift dump indicator
9 Thrust reverse override switch and indicator
10 Landing gear position indicator
11 Arrester hook push-button and indicator
12 NWS indicator/selector
13 Master Armament Safety Switch
14 Radar altimeter
15 Pilot's Wams Panel
16 Instrument lights dimmer
17 Combined speed indicator
18 ESRRD (E-Scope repeater radar display)
19 Attitude director indicator
20 Attention getter
21 Late arm switch
22 Low height warning indicator
23 Angle of attack indicator
24 Head up display
25 Engine RPM indicator
26 Engine fire extinguisher buttons

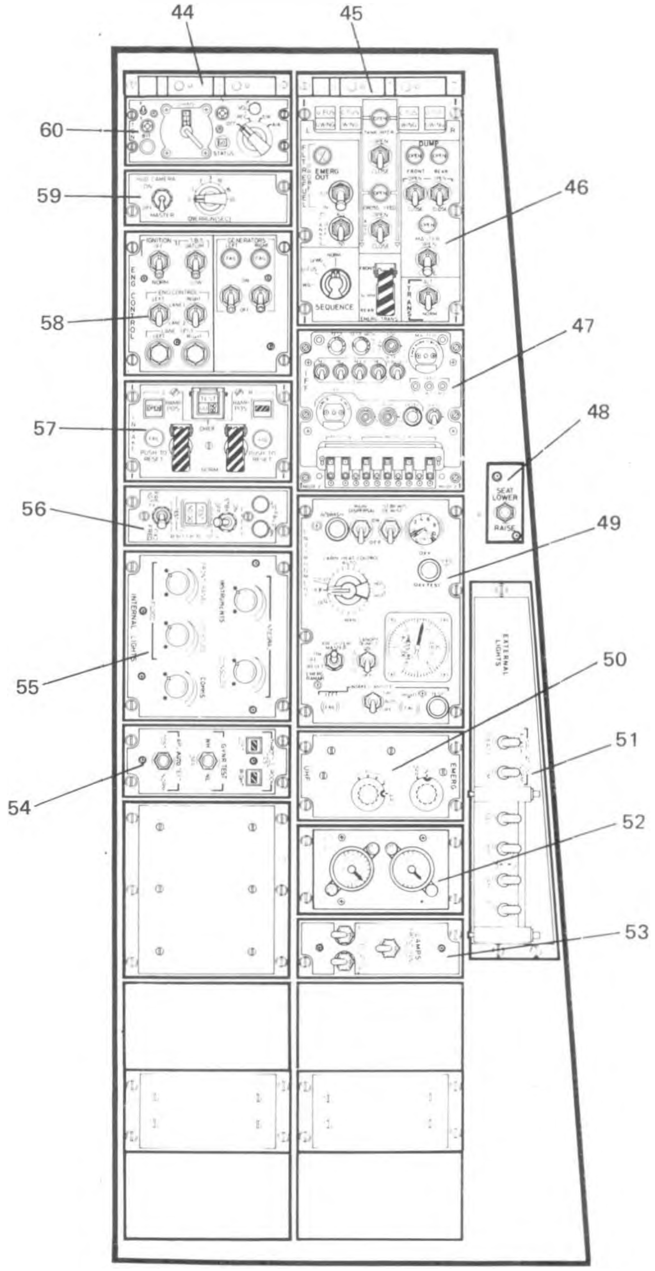


NOTE

This panel is applicable up to MM 7005 and MM 55002 from MM 7006 and MM 55003 and up see index No. 73

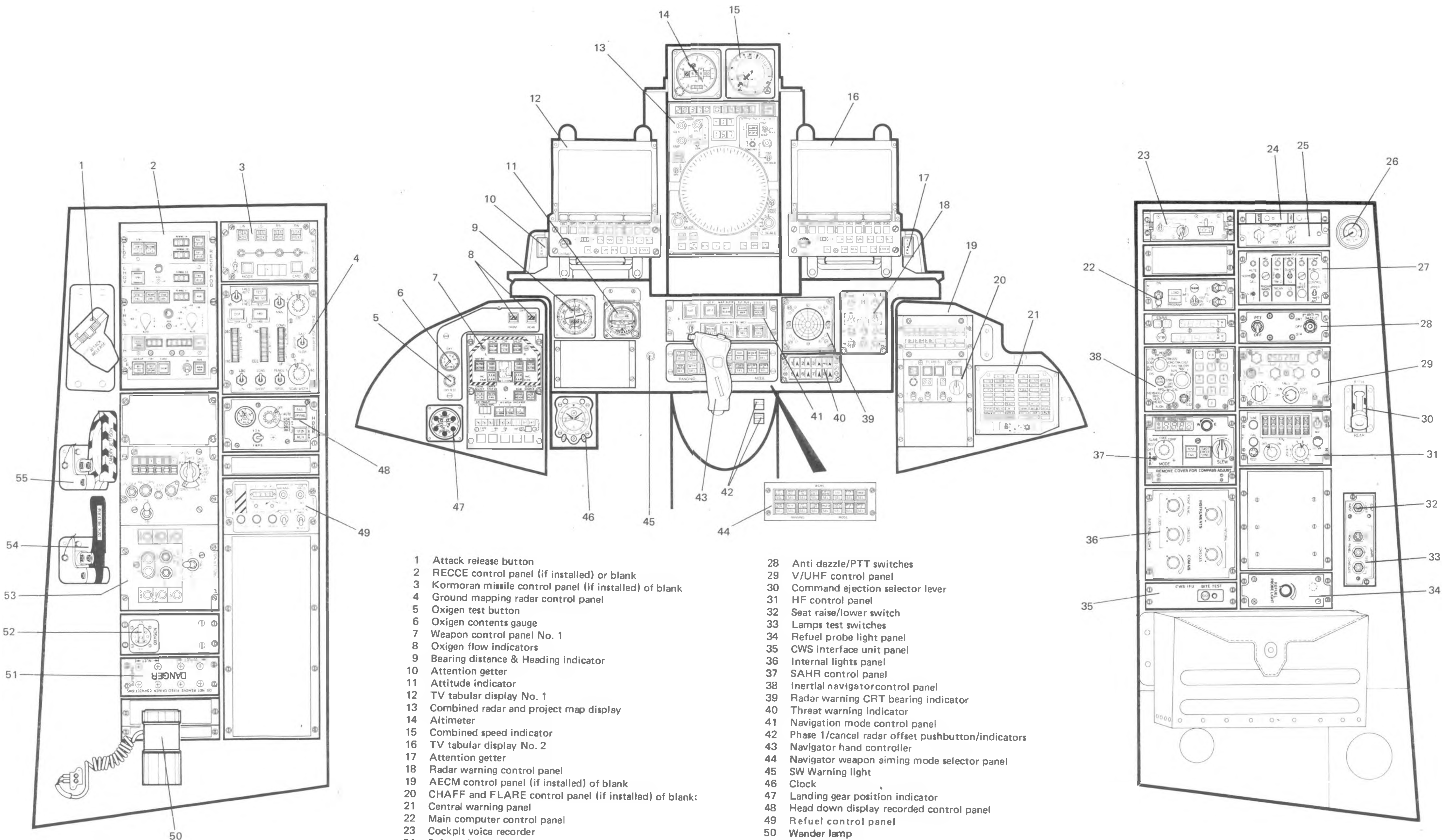
27 Accelerometer
28 Attention getter
29 Manouvre indicator
30 Radar warning CRT bearing indicator
31 IFF mode 4 indicator lights
32 Approach progress indicator
33 Remote channel/frequency indicator
34 Reheat operation light (Post Mod 01670 deleted)
35 Reheat operation light (Post Mod 01670 deleted)
36 Threat warning indicator
37 Clock
38 In flight refuelling indication lights
39 Oxigen flow indicators
40 Standby magnetic compass
41 Engine RPM indicator selector switch
42 Hydraulic pressure gauges
43 Brake selector lever
44 Safety pins stowage
45 Safety pins stowage
46 Fuel control panel
47 IFF control panel
48 Seat rise/lower switch
49 Environmental control panel
50 Emergency UHF
51 External lights control panel
52 Fuel temperature gauges





53 Lamps test panel
54 Engine test panel
55 Internal lights panel
56 Terrain following radar control panel
57 Air intake ramps control panel
58 Engine control panel
59 HUD camera control panel
60 TACAN control panel
61 Brakes triple pressure gauge
62 Hydraulic utilities test switch
63 Hydraulic pressurization switches
64 Central warning panel
65 Emergency power system switch/indicatorr
66 Engine fuel flow meter
67 Fuel content indicator and selector unit
68 Engine temperature indicators
69 Nozzle area indicators
70 Repeater projected map display
71 Pilot's HSI mode switch and WAMS indicator panel
72 Rudder pedals
73 Weapons control panel No. 2
74 Rapid take off panel
75 Horizontal situation indicator
76 Brisk indicator
77 AP indicator
78 Altimeter
79 Rudder pedals adjuster
80 Brakes test button
81 Three-axes trim indicator
82 APU power switch
83 Selective/emergency jettison button
84 Wing-sweep lever
85 Throttles
86 Pilot's hand controller
87 Voice recorder control panel
88 Head up instrument dimmer
89 CCS control panel
90 SPILS control panel
91 Bomb release safety lock control panel
92 Wander lamp
93 Oxigen connection panel
94 Oxigen supply panel
95 Crash panel
96 V/UHF control panel
97 CSAS control panel
98 Canopy jack release handle
99 AFDS control panel
100 Internal canopy jettison handle
101 Emergency flaps/airbrakes switches
102 Flaps lever
103 Anti-dazzle switch
104 Taxi thrust lever

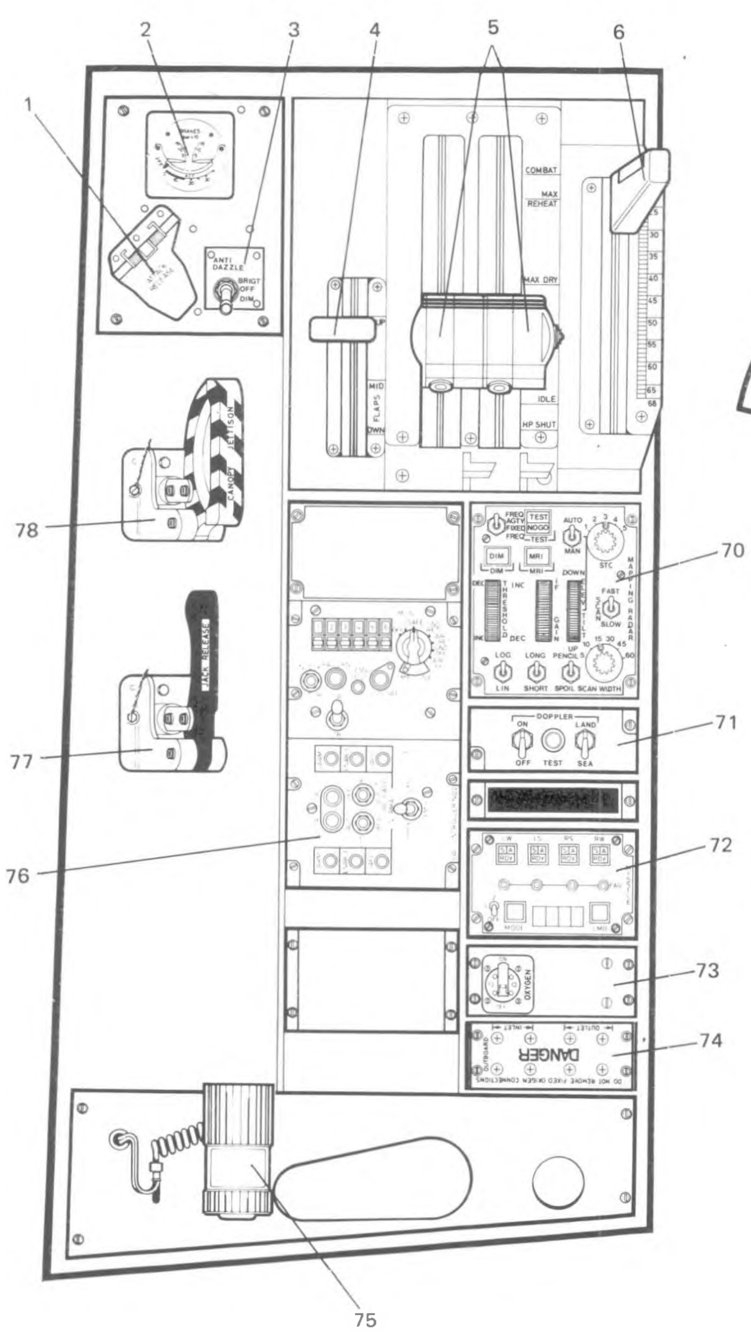
REAR COCKPIT (STRIKE)

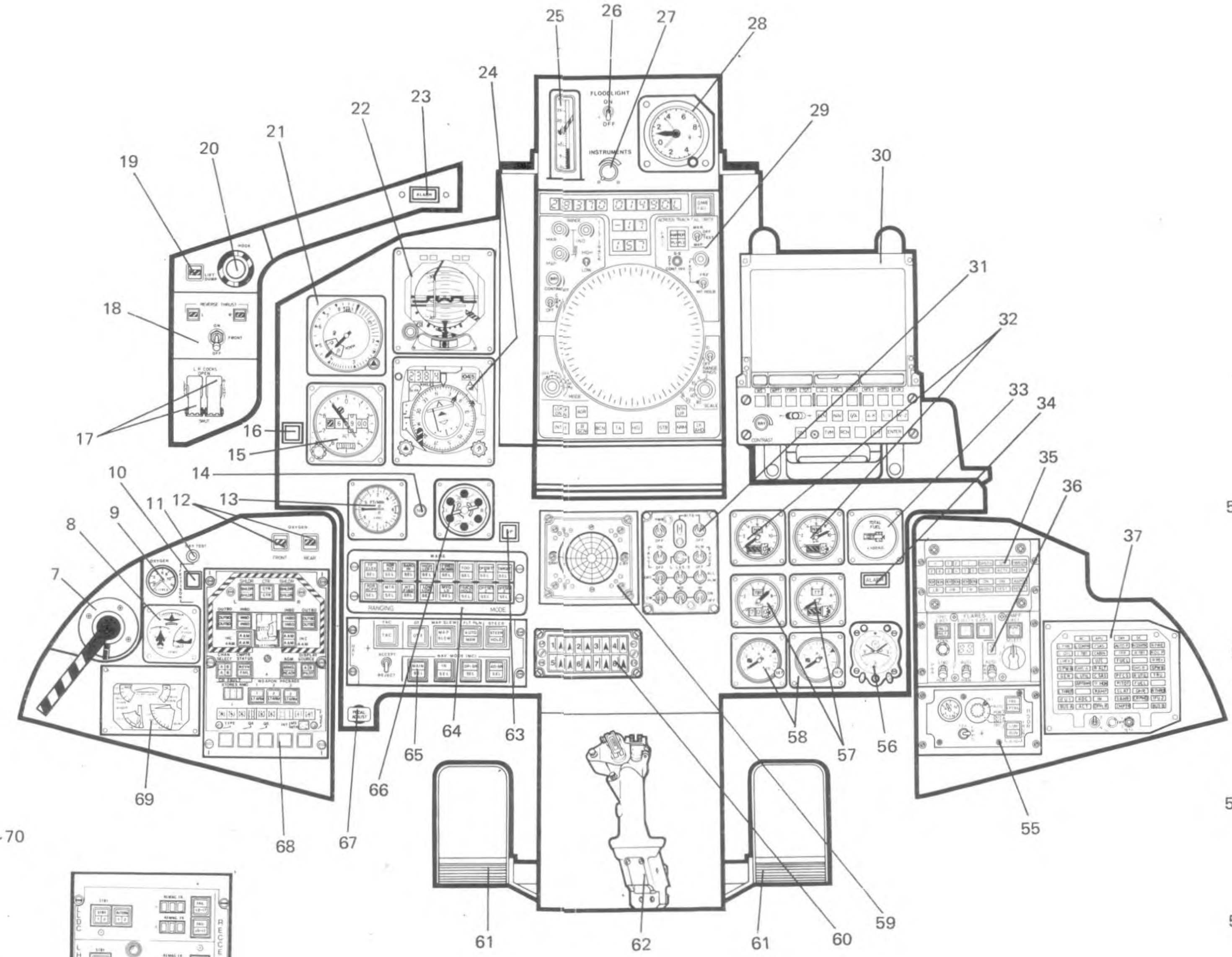


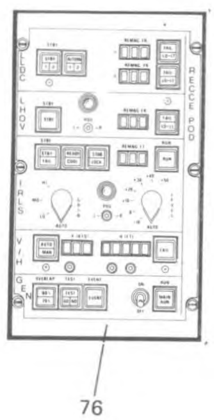
1. Attack release button
2. RECCE control panel (if installed) or blank
3. Kormoran missile control panel (if installed) of blank
4. Ground mapping radar control panel
5. Oxigen test button
6. Oxigen contents gauge
7. Weapon control panel No. 1
8. Oxigen flow indicators
9. Bearing distance & Heading indicator
10. Attention getter
11. Attitude indicator
12. TV tabular display No. 1
13. Combined radar and project map display
14. Altimeter
15. Combined speed indicator
16. TV tabular display No. 2
17. Attention getter
18. Radar warning control panel
19. AECM control panel (if installed) of blank
20. CHAFF and FLARE control panel (if installed) of blank:
21. Central warning panel
22. Main computer control panel
23. Cockpit voice recorder
24. Safety pin stowage
25. Doppler control panel
26. Voltmeter (Post Mod 01662)
27. CCS control panel
28. Anti dazzle/PTT switches
29. V/UHF control panel
30. Command ejection selector lever
31. HF control panel
32. Seat raise/lower switch
33. Lamps test switches
34. Refuel probe light panel
35. CWS interface unit panel
36. Internal lights panel
37. SAHR control panel
38. Inertial navigatorcontrol panel
39. Radar warning CRT bearing indicator
40. Threat warning indicator
41. Navigation mode control panel
42. Phase 1/cancel radar offset pushbutton/indicators
43. Navigator hand controller
44. Navigator weapon aiming mode selector panel
45. SW Warning light
46. Clock
47. Landing gear position indicator
48. Head down display recorded control panel
49. Refuel control panel
50. Wander lamp
51. Oxigen connection panel
52. Oxigen supply control panel
53. Special weapon control panel
54. Canopy jack release handle
55. Internal canopy jettison handle

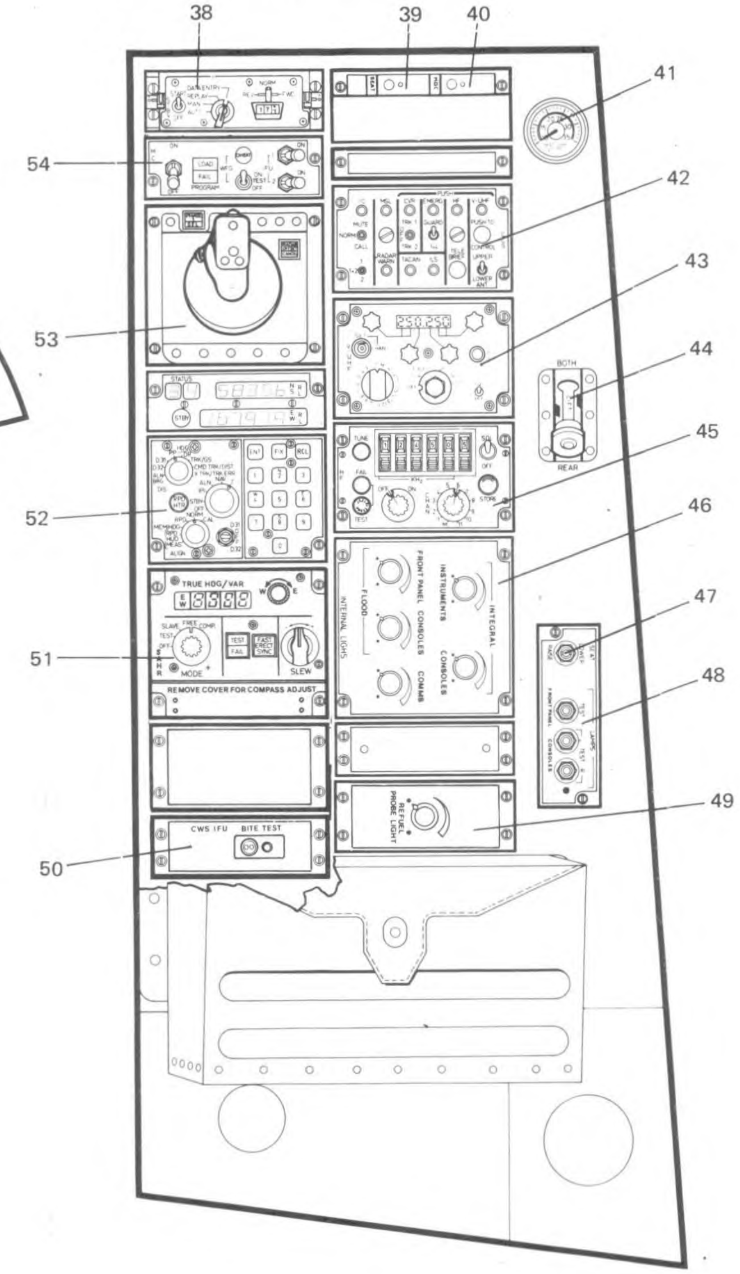
REAR COCKPIT (TRAINER)

1 Attack release button
2 Brake pressure triple indicator
3 Anti-dazzle light switch
4 Flaps lever
5 Throttles
6 Wing sweep lever
7 Emergency landing gear selector lever
8 Three axis trim indicator
9 Oxigen contents gauge
10 Emergency jettison button
11 Oxigen test button
12 Oxigen flow M.I.
13 Vertical speed indicator
14 SW warning light
15 Altimeter
16 Nose wheel steering engage indicator
17 LP cock switches
18 Rev. thrust override switch and indicator







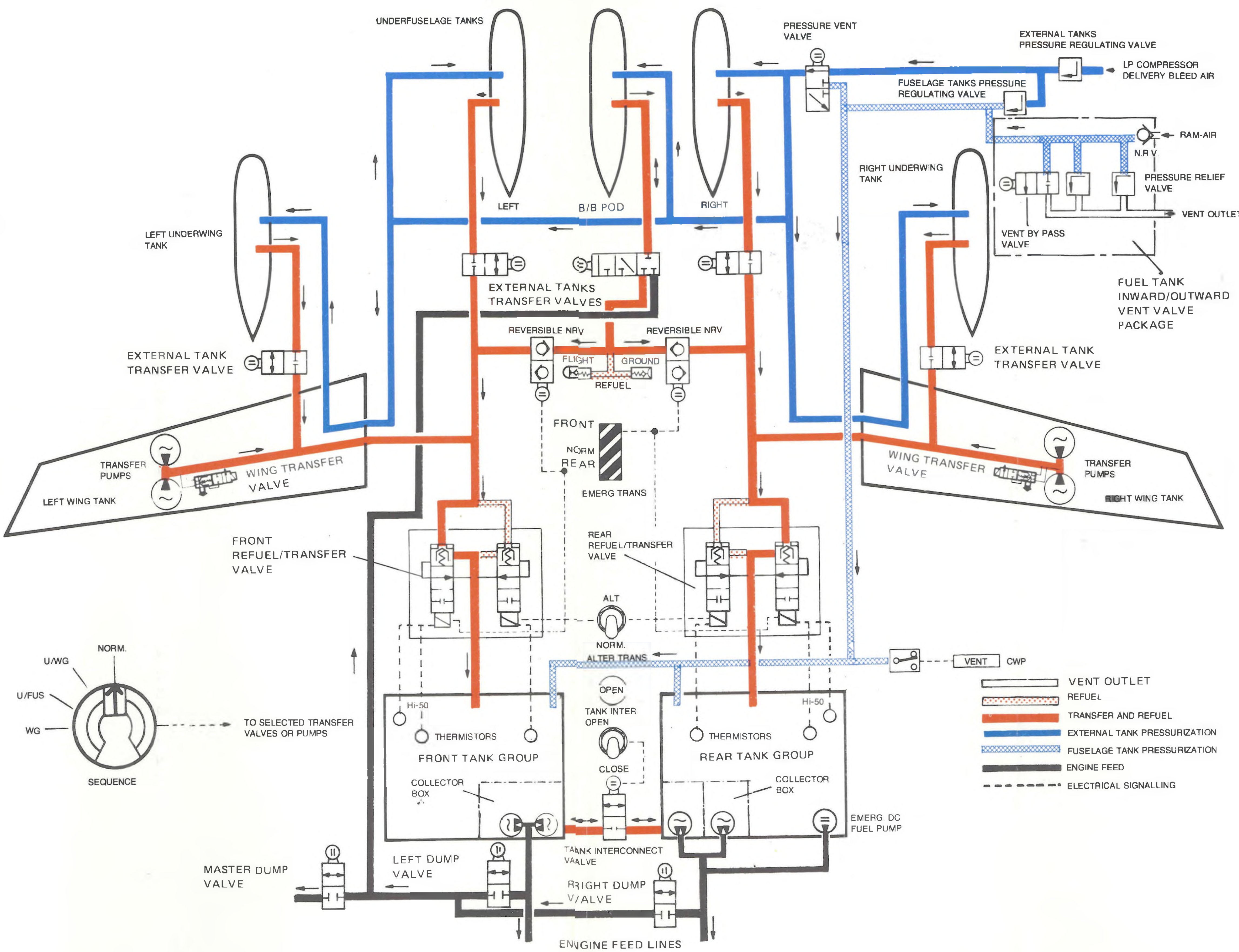


19 Lift dump indicator
20 Arrester hook button
21 Combined speed indicator
22 Attitude director indicator
23 Attention getter
24 Horizontal situation indicator
25 Angle of attack indicator
26 Floodlight switch
27 Instrument light dimmer
28 Accelerometer
29 Combined radar and projected map display
30 TB tabular display
31 Radar warning control panel
32 Engine RPM indicator
33 Fuel contents indicator
34 Attention getter
35 AECM control panel (if installed) or blank
36 CHAFF and FLARE control panel (if installed) or blank
37 Central warning panel
38 Cockpit voice recorder
39 Seat safety pin stowage
40 MDC safety pin stowage

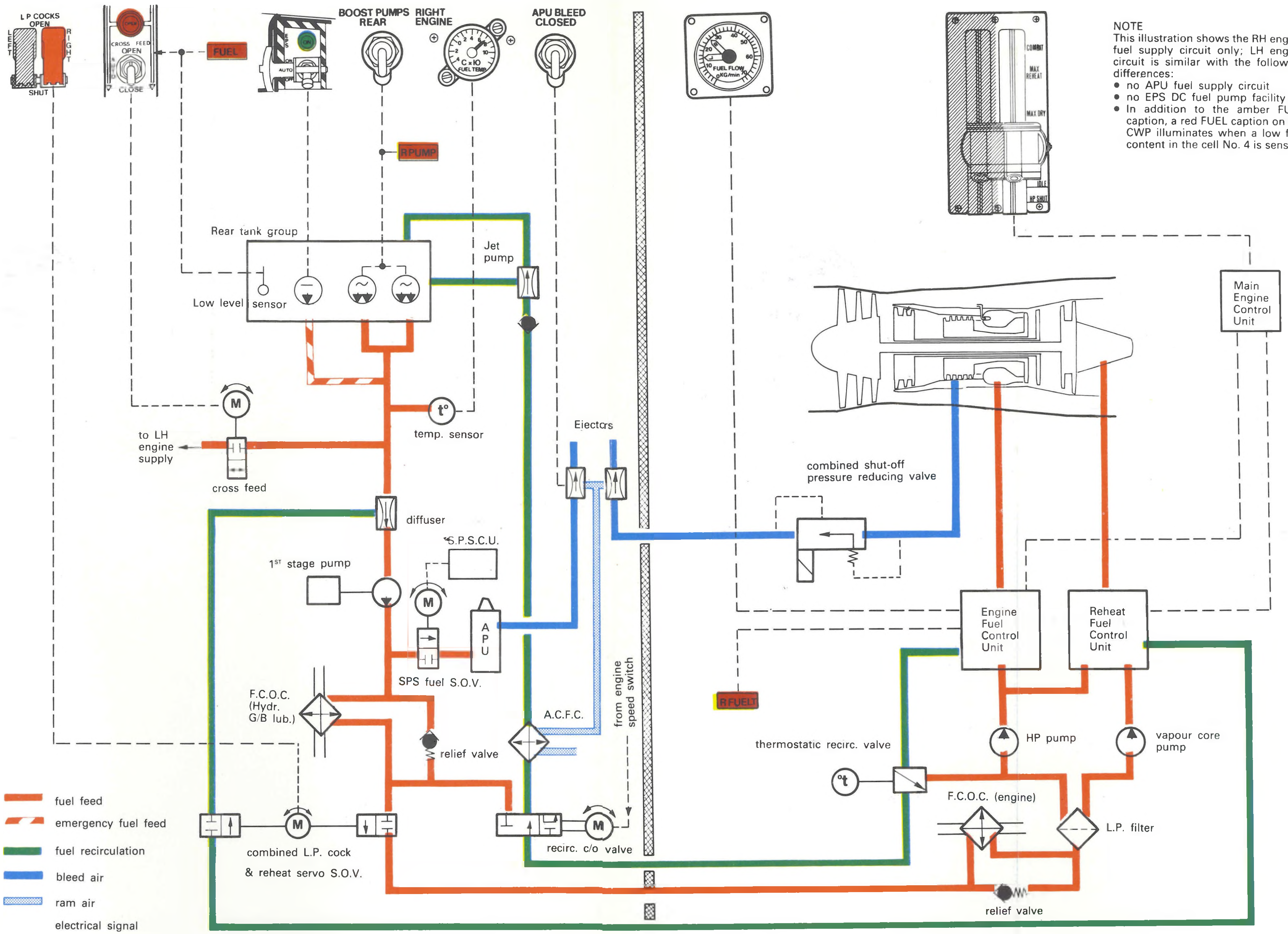
41 Voltmeter (Post Mod 01662)
42 CCS control panel
43 V/UHF control panel
44 Command ejection selector lever
45 HF control panel
46 Internal lights panel
47 Seat raise/lower switch
48 Lamp test switches
49 Refuel proble light panel
50 CWS interface unit panel
51 SAHR control panel
52 Inertial navigator control panel
53 Navigator hand controller
54 Main computer control panel
55 Head down display recorder panel
56 Clock
57 Engine temperature indicator
58 Nozzle area indicators
59 CRT bearing indicator
60 Threat warning panel
61 Rudder pedals
62 Control stick
63 Auto pilot engage indicator

64 Navigator weapon aiming mode selector panel
65 Navigation mode control panel
66 Landing gear position indicator
67 Rudder pedal adjustment lever
68 Weapon control panel N. 1
69 Secondary control surfaces position indicator
70 Ground mapping radar control panel
71 Doppler control panel
72 Kormoran missile control panel (if installed) or blank
73 Oxygen supply panel
74 Oxigen connection panel
75 Wander lamp
76 Special weapon control panel or alternatively RECCE POD control panel
77 Canopy jack release handle
78 Internal canopy jettison handle

REFUEL AND TRANSFER SYSTEM



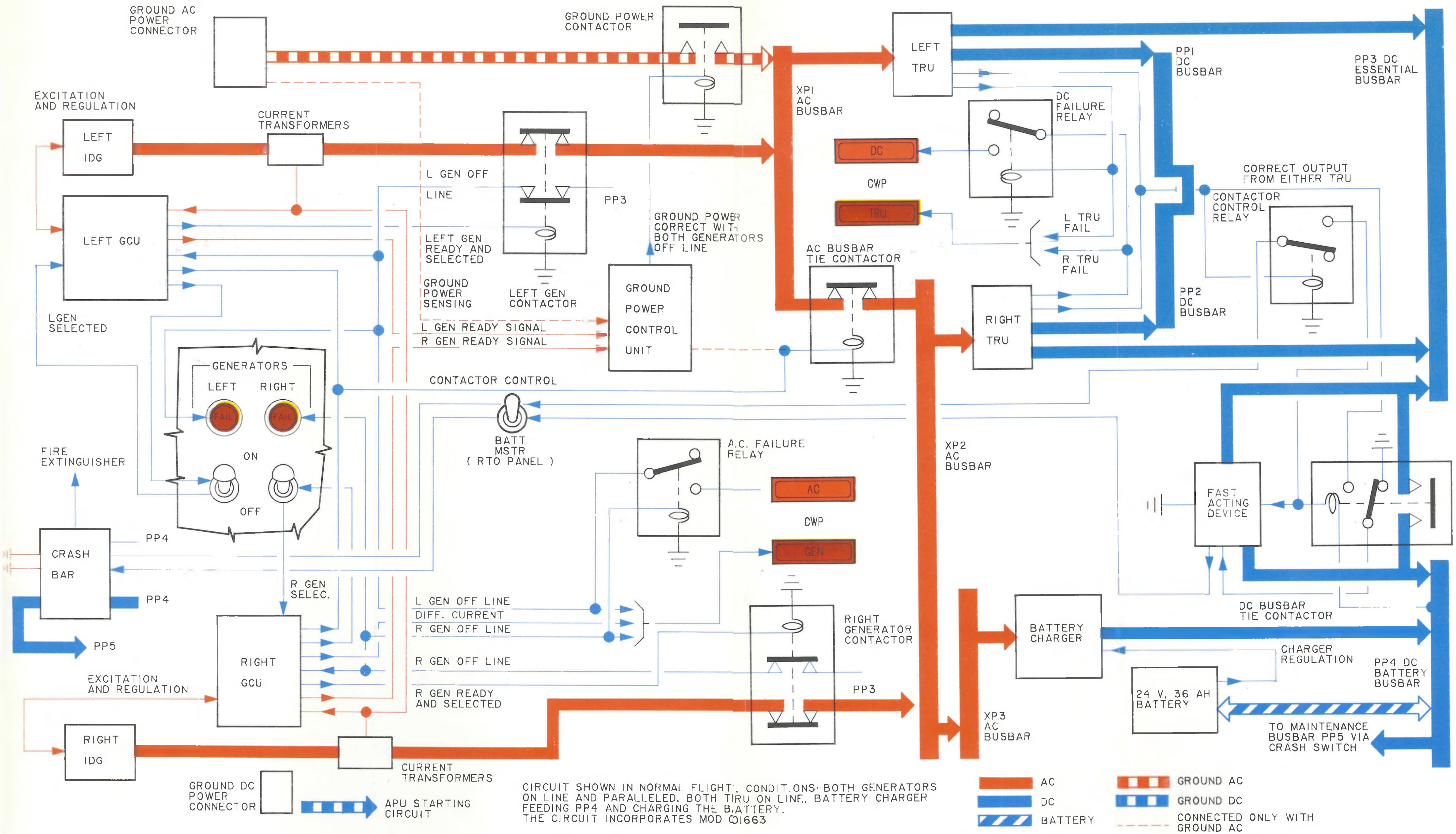
ENGINE FUEL SUPPLY (SCHEMATIC)



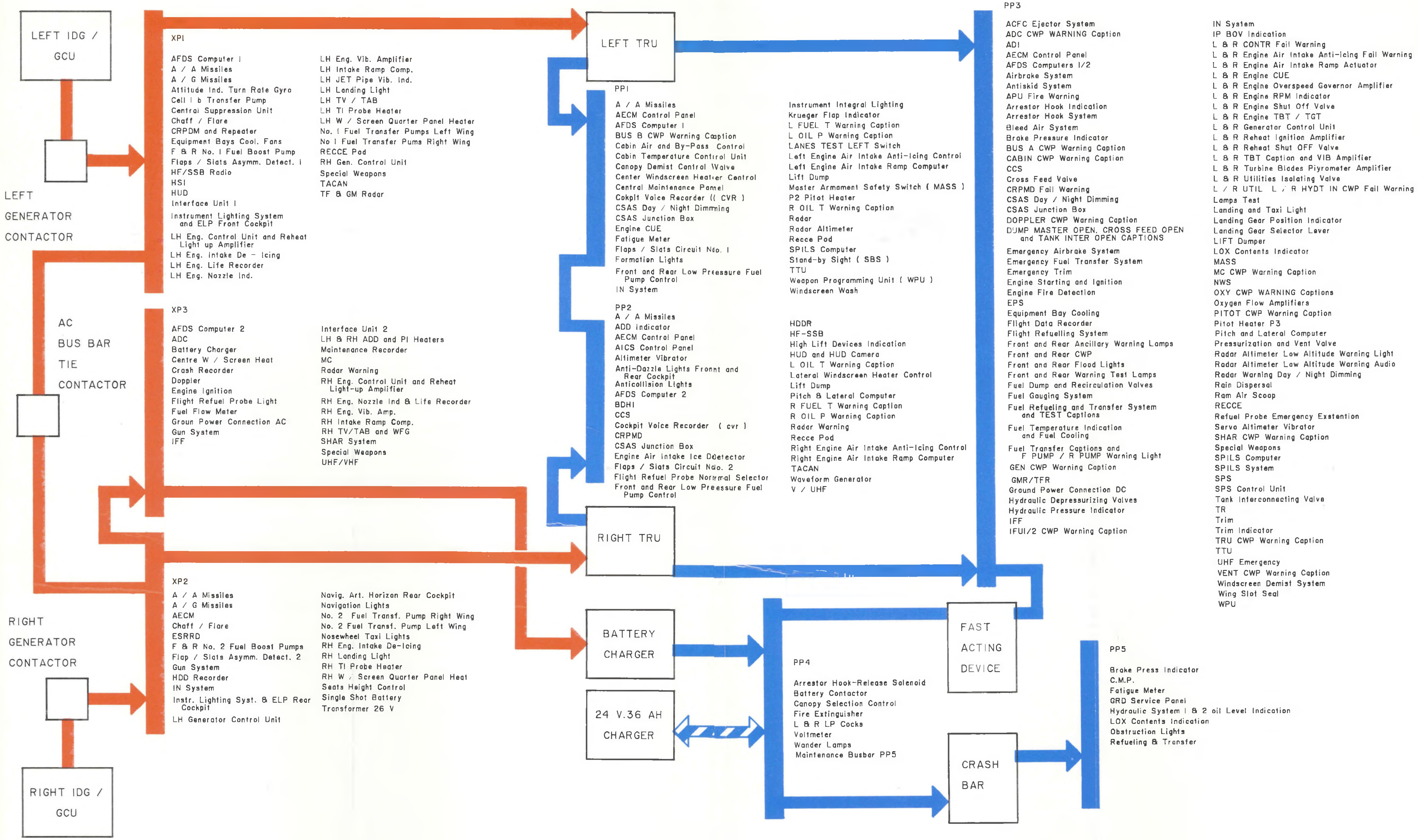
NOTE
This illustration shows the RH engine fuel supply circuit only; LH engine circuit is similar with the following differences:

- no APU fuel supply circuit
- no EPS DC fuel pump facility
- In addition to the amber FUEL caption, a red FUEL caption on the CWP illuminates when a low fuel content in the cell No. 4 is sensed.

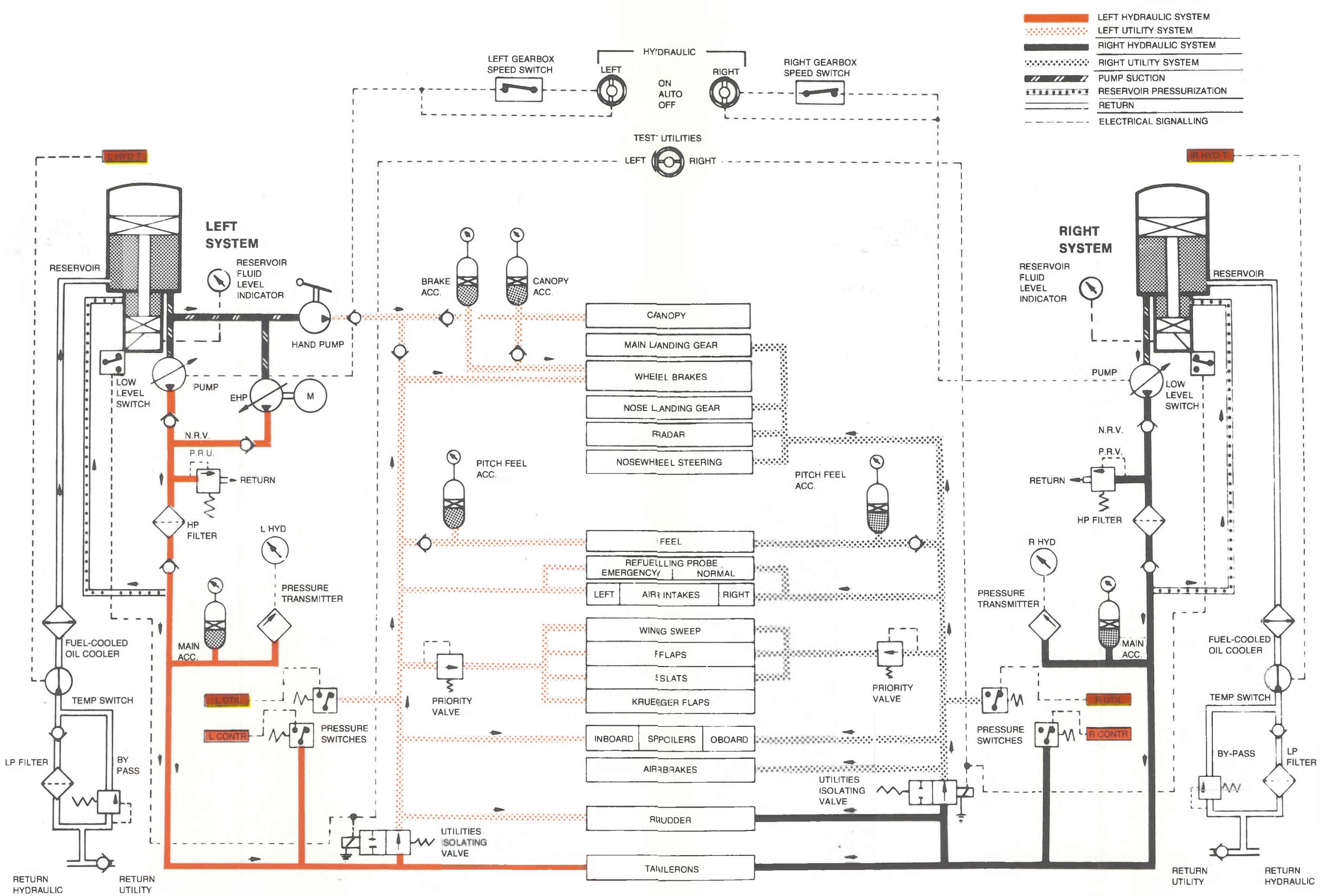
AC/DC SYSTEM


GROUND AC POWER CONNECTOR
GROUND POWER CONTACTOR
LEFT TRU
PPI DC BUSBAR
PP3 DC ESSENTIAL BUSBAR
EXCITATION AND REGULATION
CURRENT TRANSFORMERS
LEFT IDG
XPI AC BUSBAR
DC FAILURE RELAY
DC
CWP
TRU
L GEN OFF
LINE
PP3
LEFT GCU
CORRECT OUTPUT FROM EITHER TRU
CONTACTOR CONTROL RELAY
L TRU FAIL
R TRU FAIL
GROUND POWER CORRECT WITH BOTH GENERATORS OFF LINE
LEFT GEN READY AND SELECTED
AC BUSBAR TIE CONTACTOR
GROUND POWER SENSING
LEFT GEN CONTACTOR
GROUND POWER CONTROL UNIT
L GEN SELECTED
L GEN READY SIGNAL
R GEN READY SIGNAL
RIGHT TRU
PP2 DC BUSBAR
GENERATORS
LEFT
RIGHT
FAIL
CONTACTOR CONTROL
ON
OFF
BATT MSTR (RTO PANEL)
FIRE EXTINGUISHER
A.C. FAILURE RELAY
AC
GEN
XP2 AC BUSBAR
FAST ACTING DEVICE
CRASH BAR
PP4
PP5
R GEN SELEC.
L GEN OFF LINE
DIFF. CURRENT
R GEN OFF LINE
RIGHT GENERATOR CONTACTOR
BATTERY CHARGER
DC BUSBAR TIE CONTACTOR
RIGHT GCU
CHARGER REGULATION
PP4 DC BATTERY BUSBAR
R GEN READY AND SELECTED
24 V, 36 AH BATTERY
XP3 AC BUSBAR
TO MAINTENANCE BUSBAR PP5 VIA CRASH SWITCH
RIGHT IDG
GROUND DC POWER CONNECTOR
APU STARTING CIRCUIT
CIRCUIT SHOWN IN NORMAL FLIGHT. CONDITIONS-BOTH GENERATORS ON LINE AND PARALLELED, BOTH TRU ON LINE, BATTERY CHARGER FEEDING PP4 AND CHARGING THE BATTERY.
THE CIRCUIT INCORPORATES MOD O1663
AC
DC
BATTERY
GROUND AC
GROUND DC
CONNECTED ONLY WITH GROUND AC

AC/DC POWER SUPPLY



HYDRAULIC SYSTEM



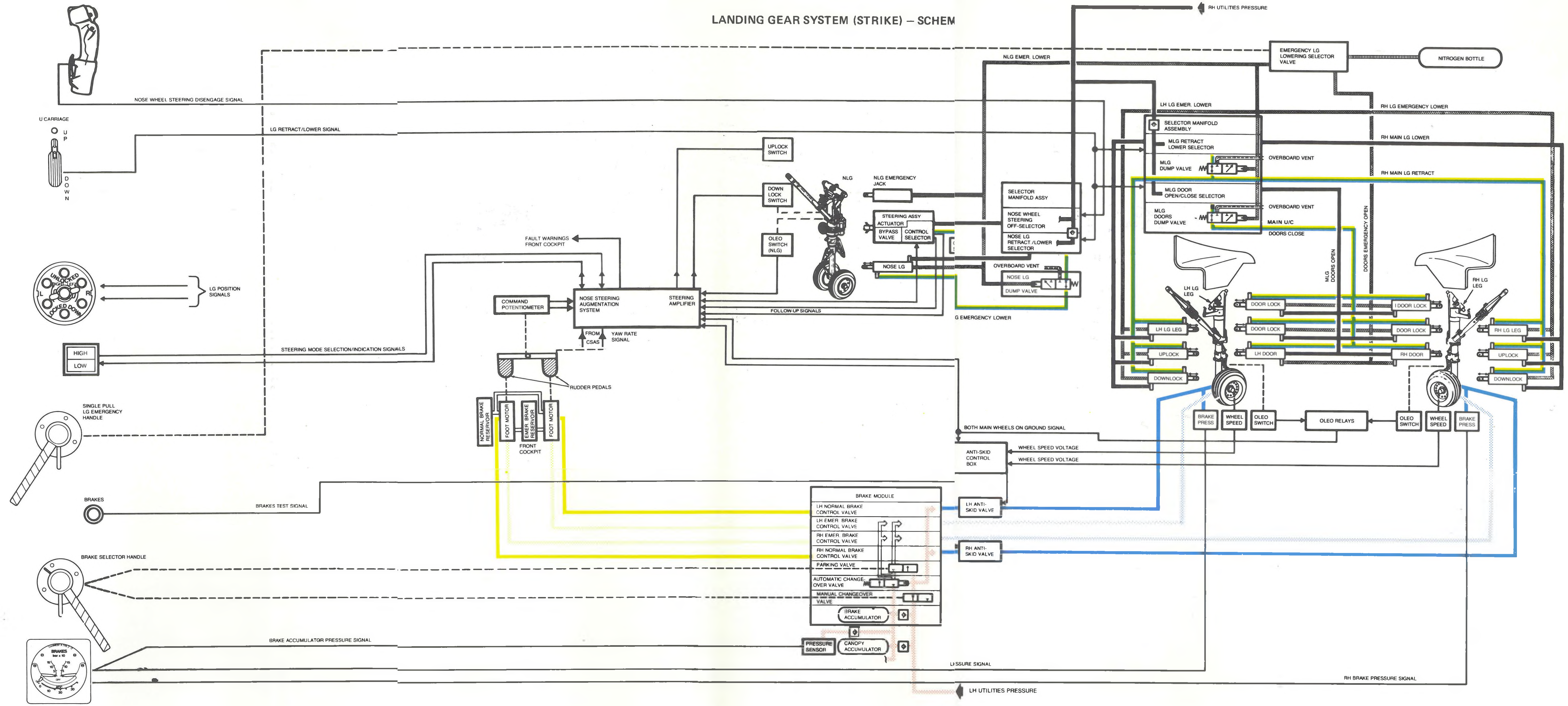
LANDING GEAR SYSTEM (STRIKE) – SCHEM

LINE CODE

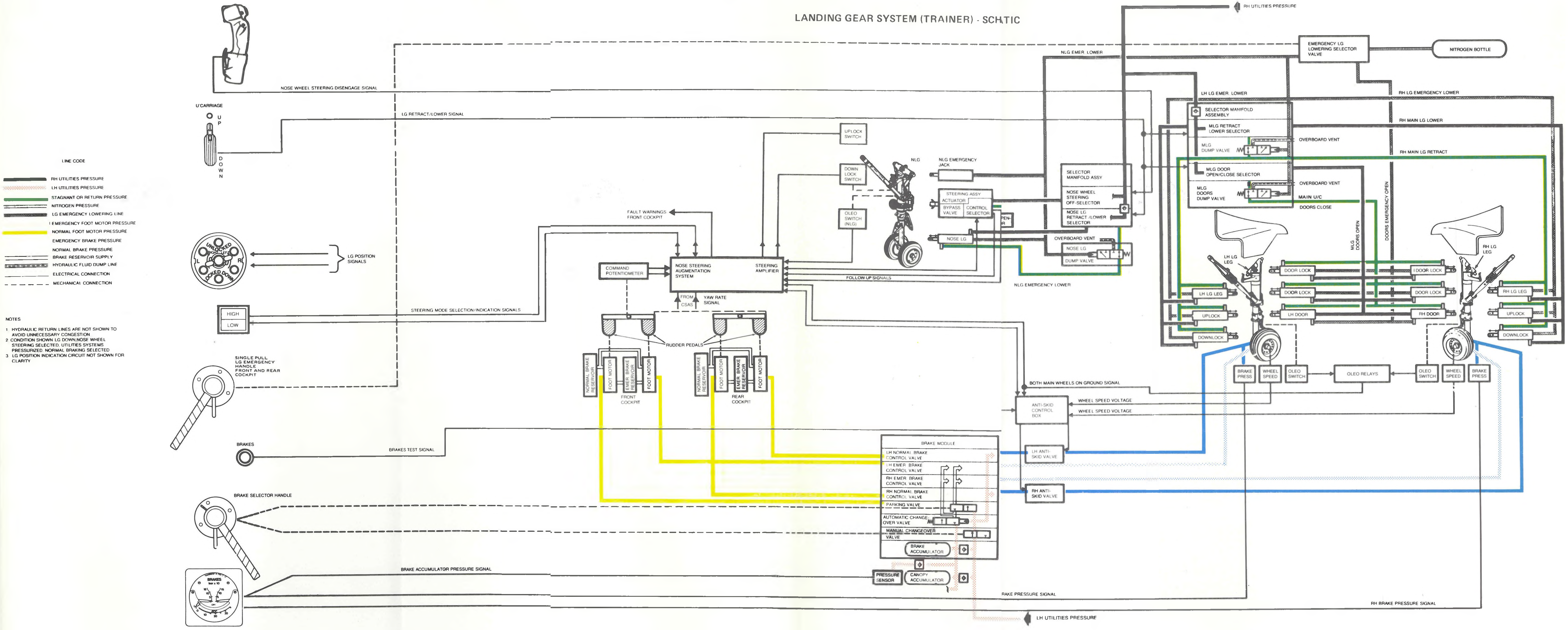
- RH UTILITIES PRESSURE
- LH UTILITIES PRESSURE
- STAGNANT OR RETURN PRESSURE
- NITROGEN PRESSURE
- LG EMERGENCY LOWERING LINE
- EMERGENCY FOOT MOTOR PRESSURE
- NORMAL FOOT MOTOR PRESSURE
- EMERGENCY BRAKE PRESSURE
- NORMAL BRAKE PRESSURE
- BRAKE RESERVOIR SUPPLY
- HYDRAULIC FLUID DUMP LINE
- ELECTRICAL CONNECTION
- MECHANICAL CONNECTION

NOTES

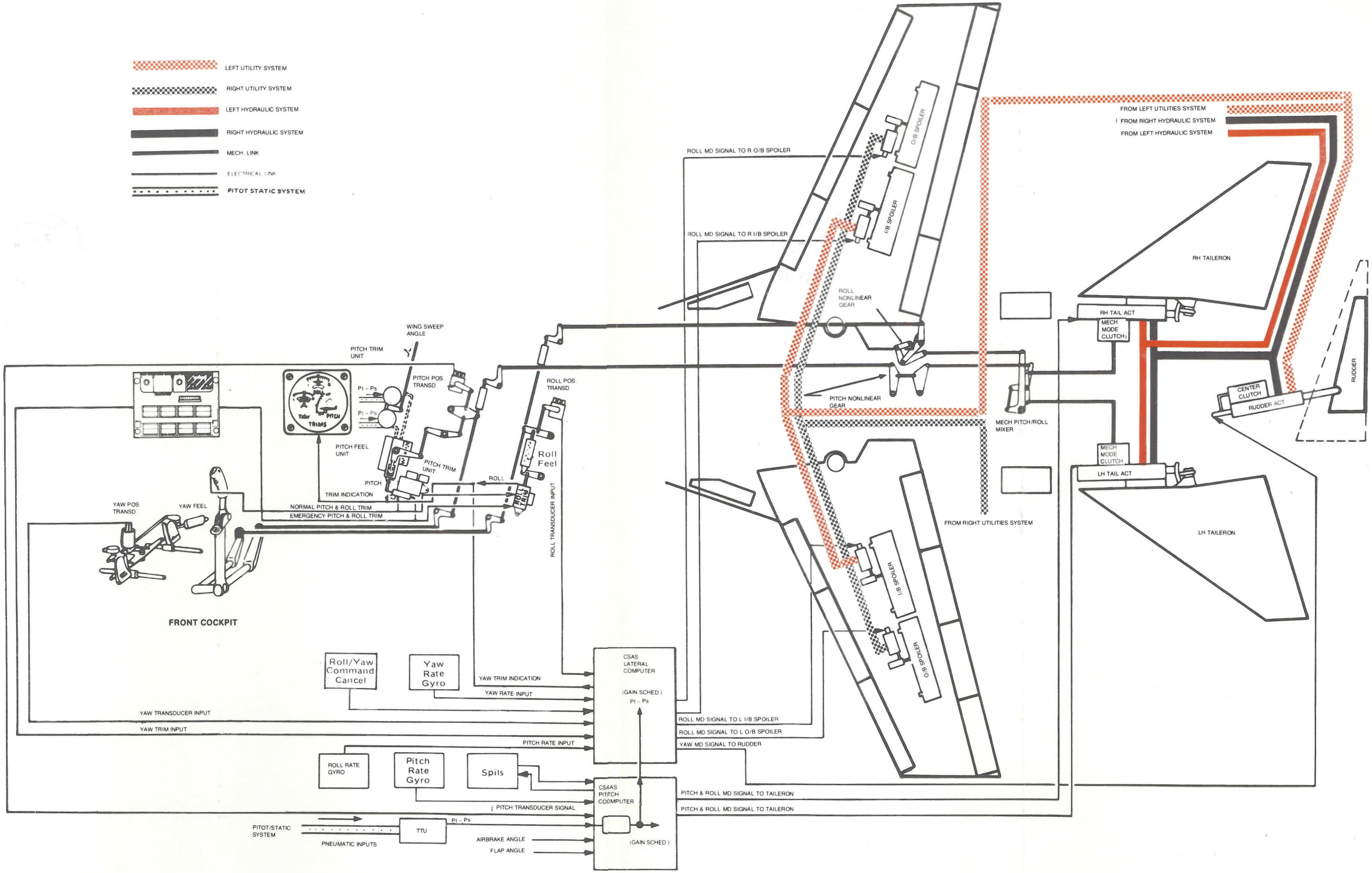
1. HYDRAULIC RETURN LINES ARE NOT SHOWN TO AVOID UNNECESSARY CONGESTION
2. CONDITION SHOWN LG DOWN,NOSE WHEEL STEERING SELECTED, UTILITIES SYSTEMS PRESSURIZED, NORMAL BRAKING SELECTED
3. LG POSITION INDICATION CIRCUIT NOT SHOWN FOR CLARITY



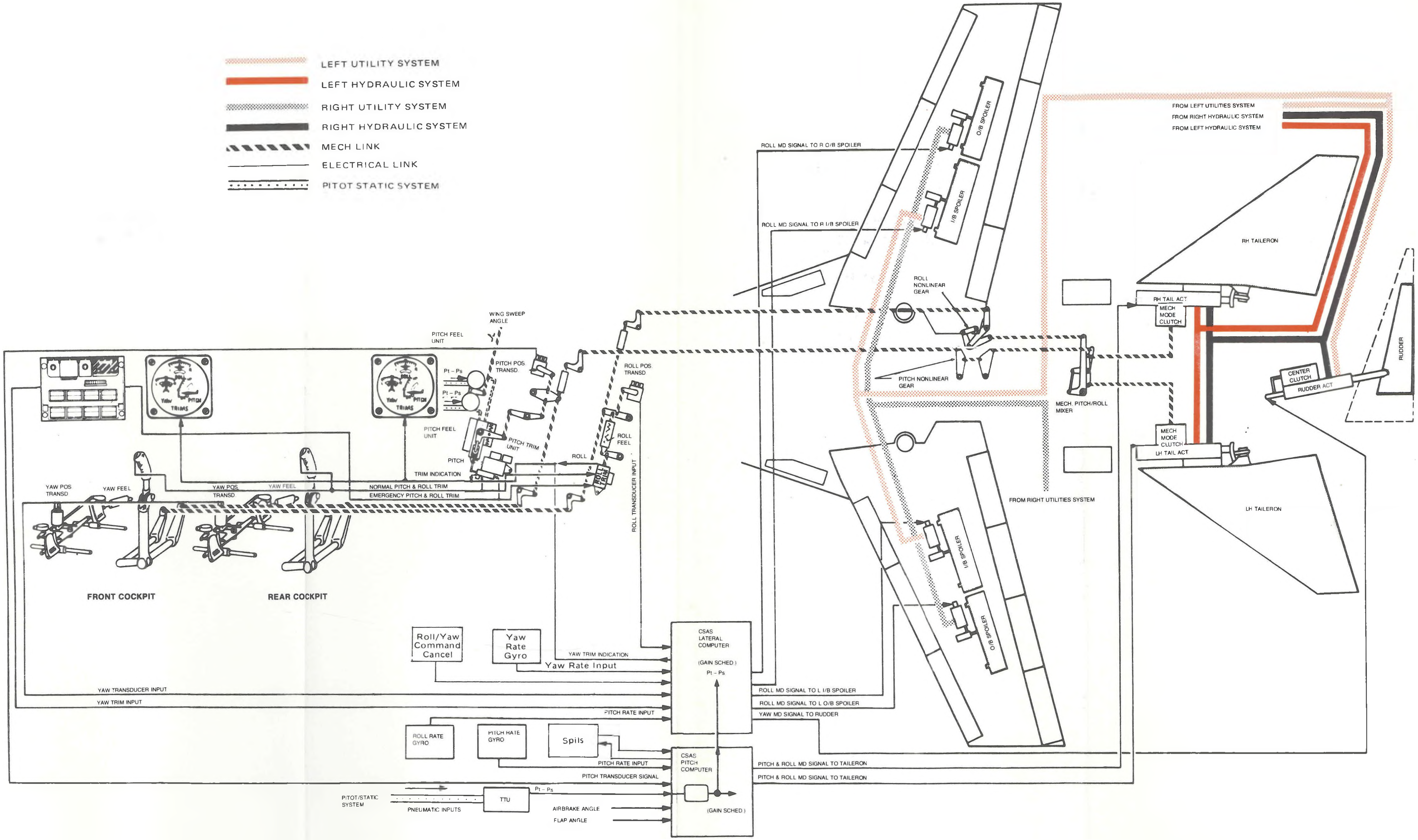
LANDING GEAR SYSTEM (TRAINER) - SCHEMATIC



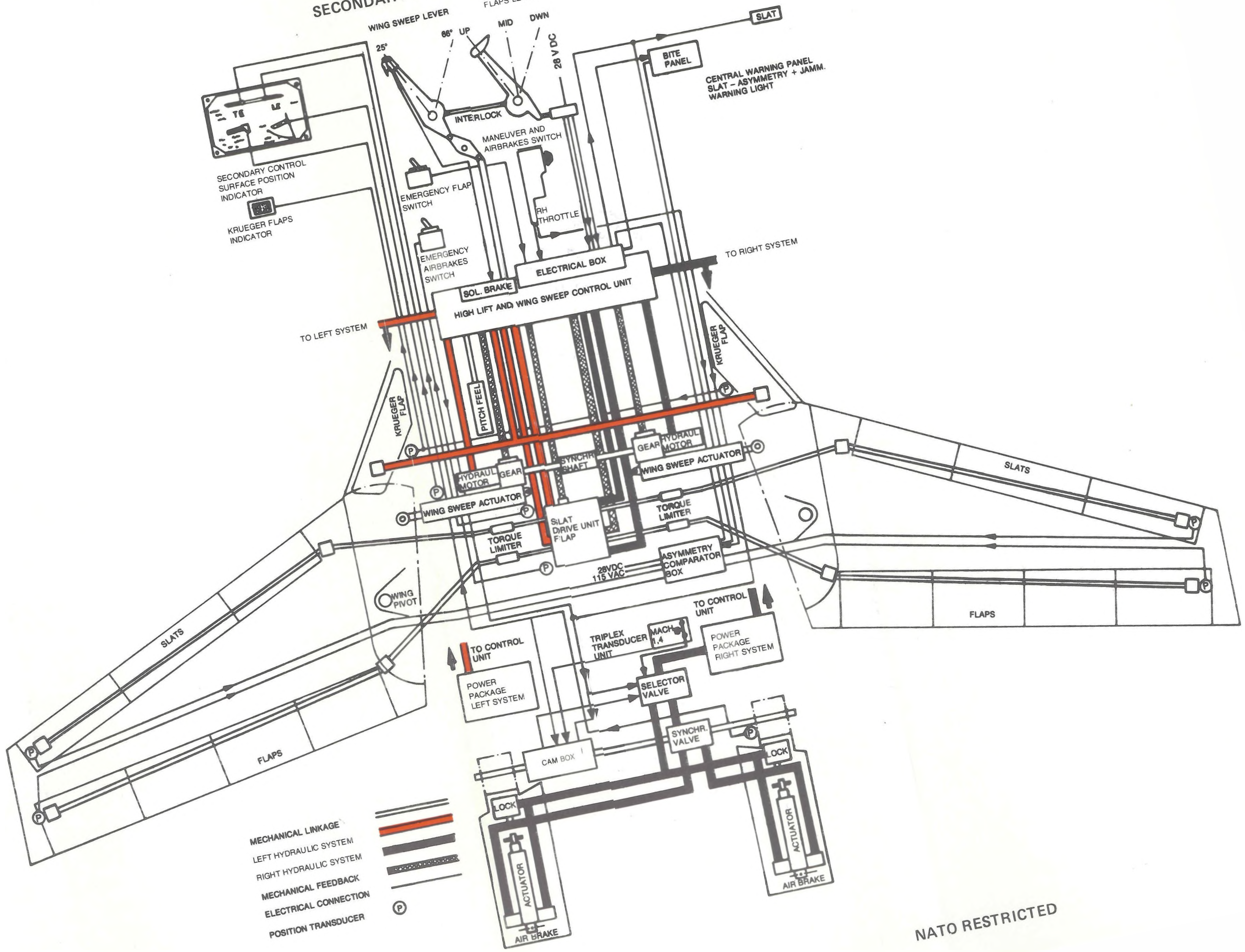
PRIMARY FLIGHT CONTROL SYSTEM (STRIKE)



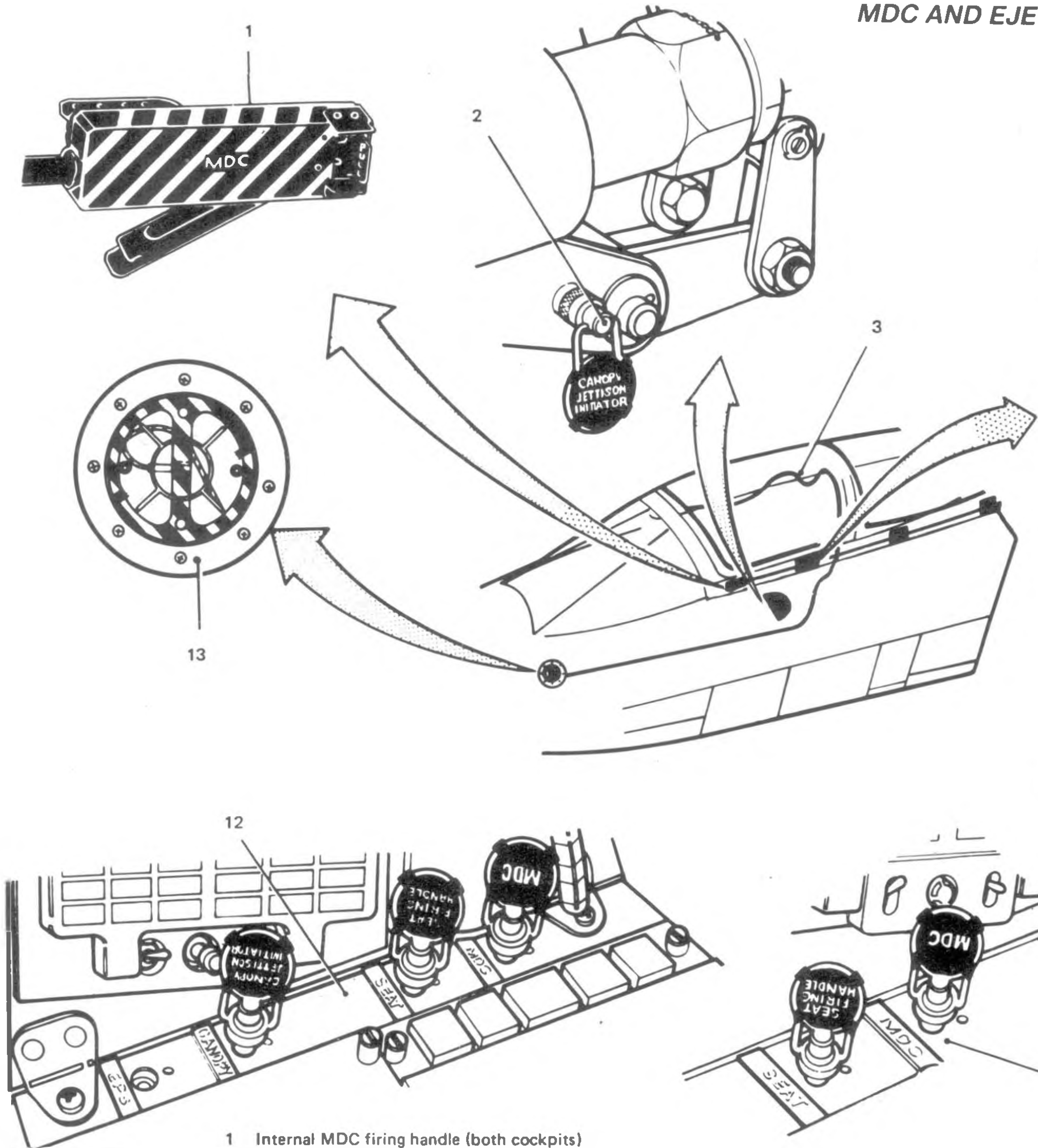
PRIMARY FLIGHT CONTROL (TRAINER)

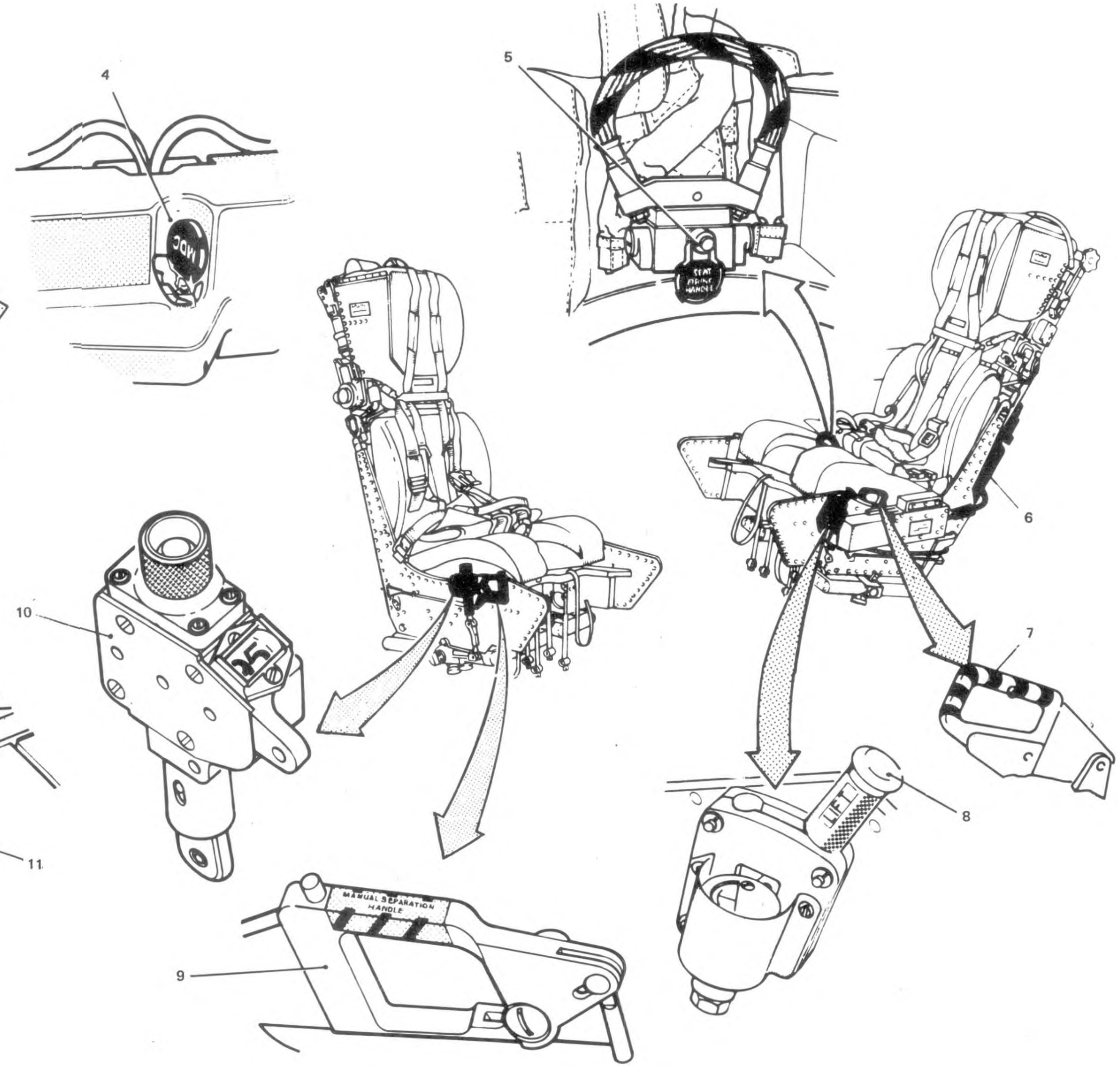


SECONDARY FLIGHT CONTROL SYSTEM



MDC AND EJECTION SEATS CONTROLS AND INDICATORS

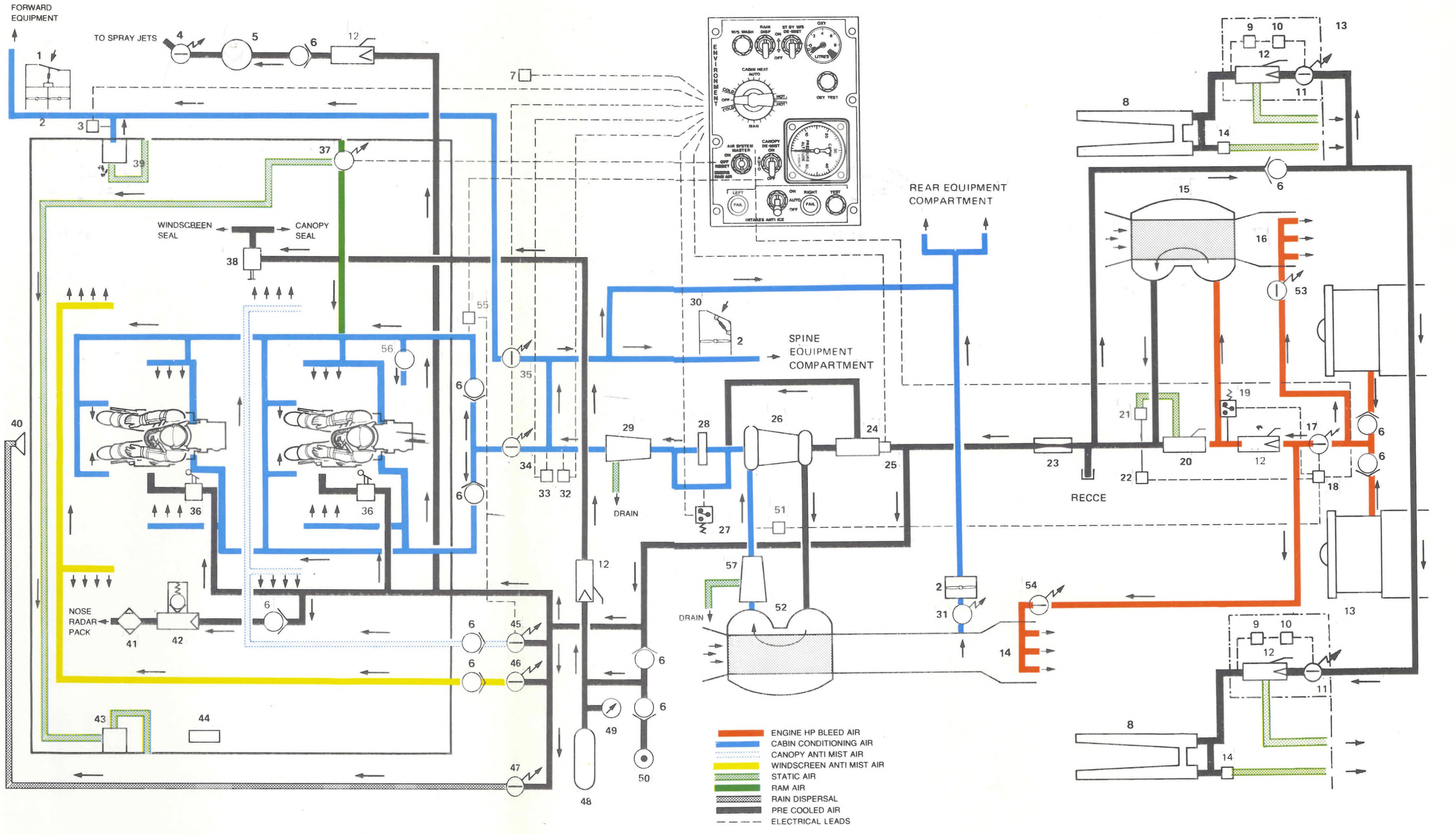




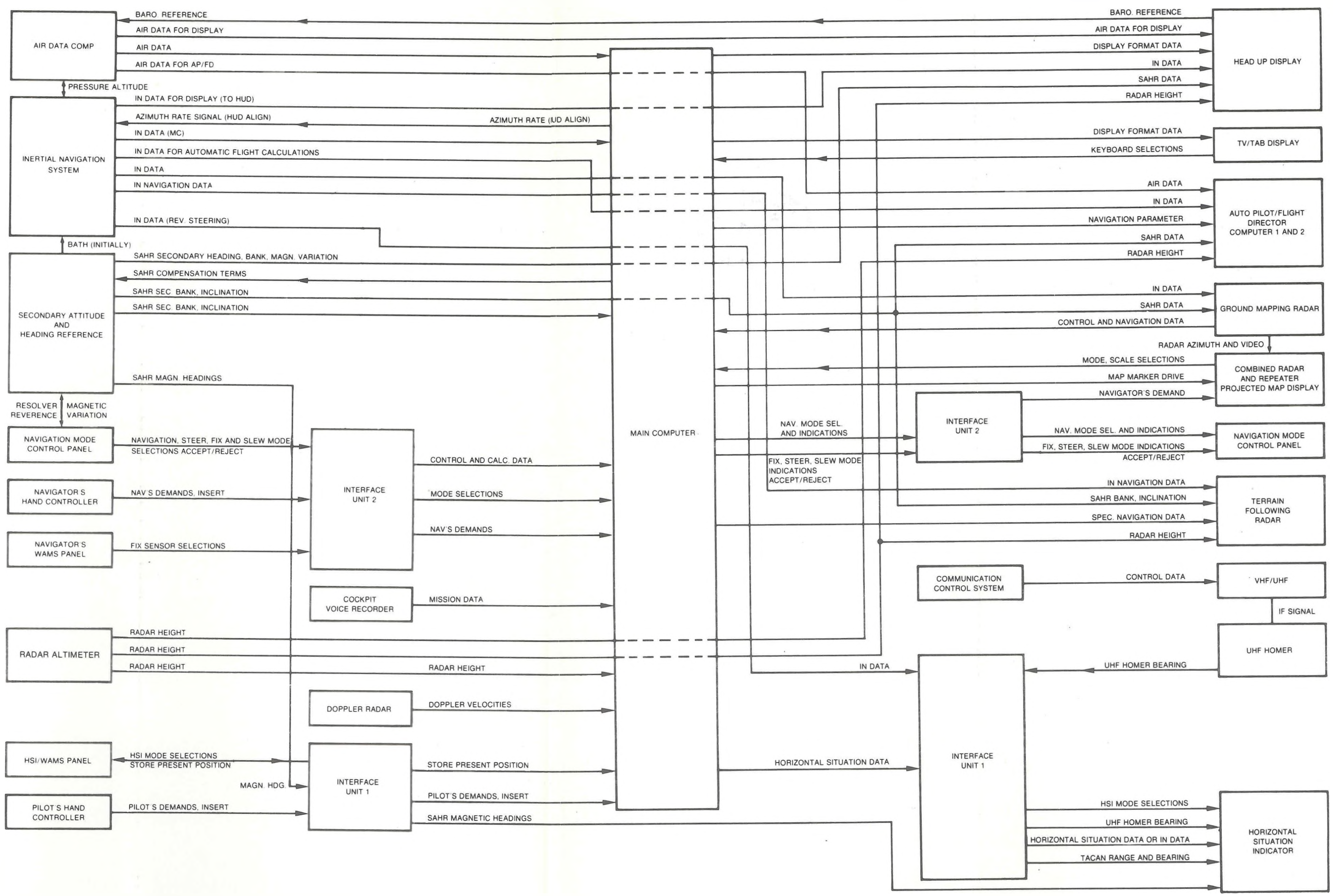
1 Internal MDC firing handle (both cockpits)
2 Canopy jettison initiator unit safety pin
3 MDC cords
4 MDC initiator unit safety pin (both cockpits)
5 Seat pan firing handle safety pin
6 Emergency oxygen bottle
7 Emergency oxygen bottle ring grip
8 Harness go-forward lever and emergency oxygen bottle pressure gauge
9 Manual separation handle
10 Pitch control unit
Post Mod 00996
Pitch control unit deleted
11 Safety pins stowage (rear cockpit)
12 Safety pins stowage (front cockpit)
13 External MDC firing handle

ENVIRONMENTAL CONTROL SYSTEM

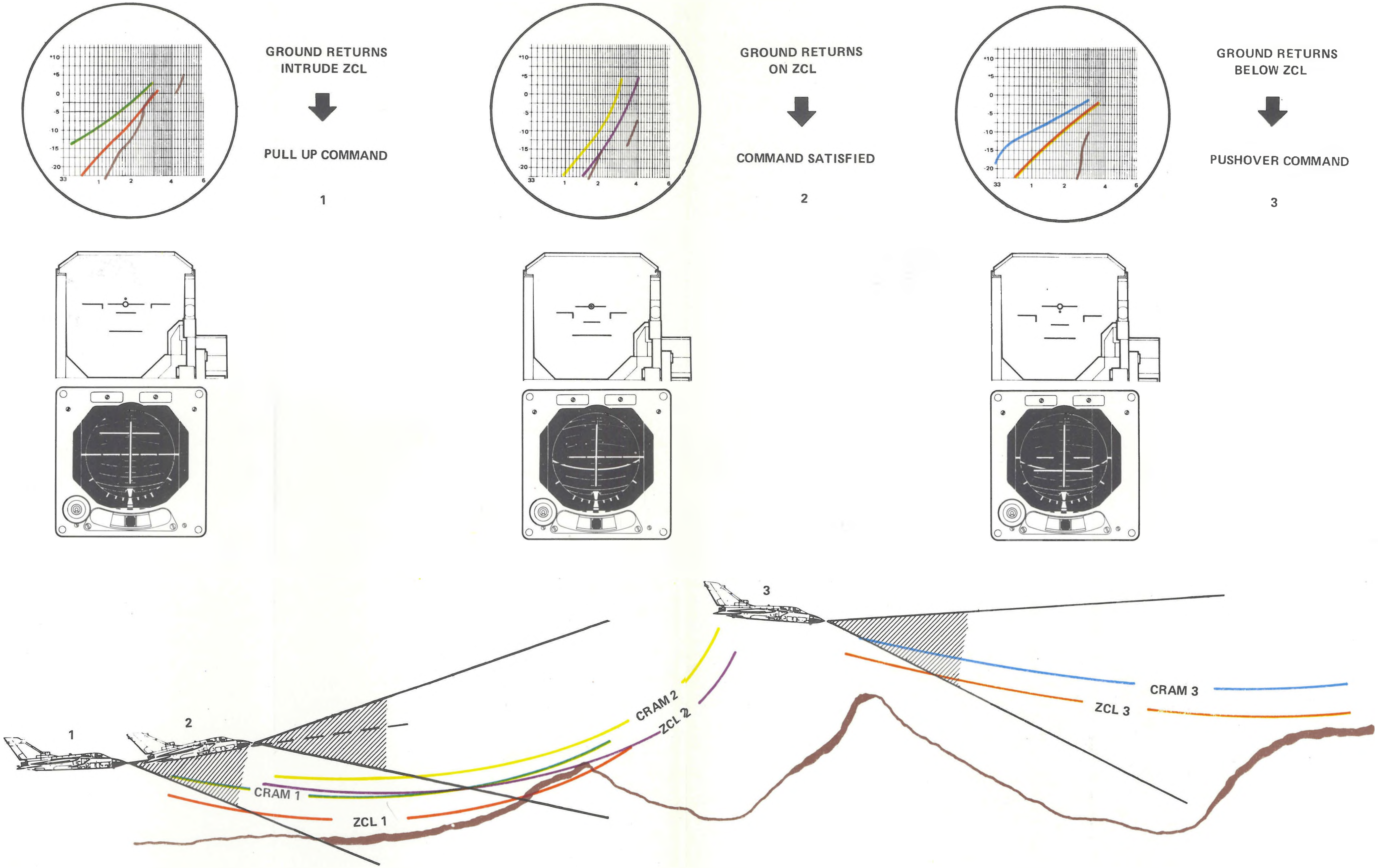
1 Pressure box door actuator
2 Fan
3 Cabin air outlet temprature sensor
4 Windscreen wash shut-off valve
5 Windscreen washer bottle
6 Non return valve
7 Skin sensors
8 Wing seal
9 Temperature sensor
10 Temperature controller unit
11 Wing seal shut-off valve
12 Pressure reducing valve
13 Combined pressure reducing and shut-off valve with integrated temperature sensor
14 Pressure relief valve
15 Primary heat exchanger
16 Ejectors
17 Air system master valve
18 Air system master valve controller
19 System pressure sensor
20 Primary heat exchanger outlet temperature valve
21 Primary heat exchanger outlet temperature sensor
22 Air system temperature sensor
23 Venturi restrictor
24 Temperature control valve
25 Temperature control valve actuator
26 Cold air unit
27 Differential pressure switch
28 Ice guard
29 Water extractor
30 Spine pressure box door actuator
31 Rear equipment compartment shut-off valve
32 Combined inlet overheat/underheat/temperature sensor
33 Manual temperature sensor
34 Cabin air shut-off valve
35 Cabin by-pass shut-off valve
36 Anti-g valve
37 Emergency RAM air valve
38 Canopy and windscreen seal inflation/deflation valve
39 Cabin pressure control valve
40 Rain dispersal nozzle
41 Air dryer
42 Pressure reducing/relief valve
43 Safety and inward relief valve
44 Canopy lock switch
45 Canopy de-mist control valve
46 Windscreen de-mist control valve
47 Rain dispersal control valve
48 Air reservoir
49 Pressure gauge
50 Ground charging point
51 Secondary heat exchanger temperature sensor
52 Secondary heat exchanger
53 Ejector shut-off valve (primary heat exchanger)
54 Ejector shut-off valve (secondary heat exchanger)
55 De-mist temperature sensor
56 Manual dump valve
57 Water extractor turbine inlet

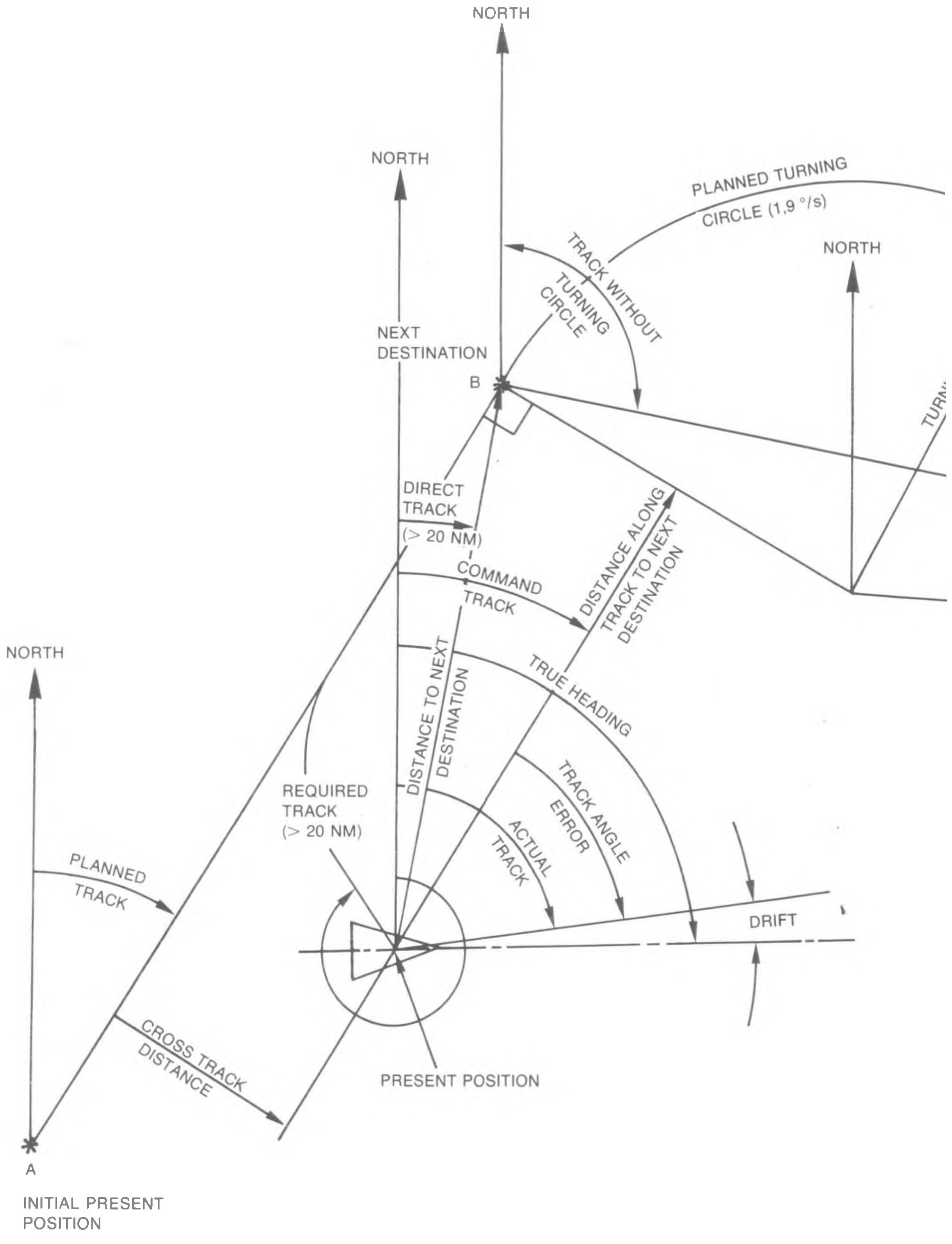


NAV/ATTACK SYSTEM - BLOCK DIAGRAM

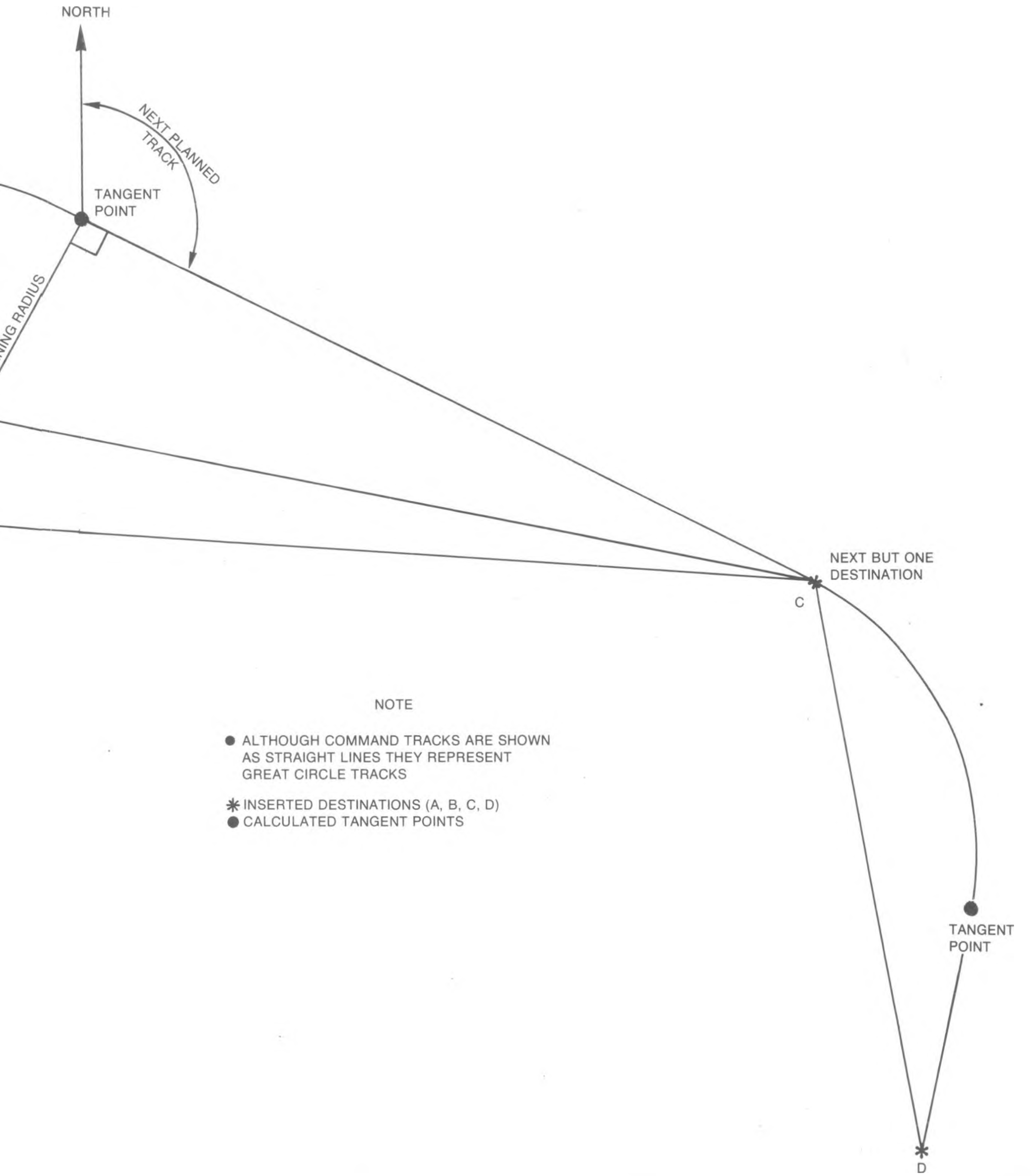


TERRAIN FOLLOWING DISPLAYS




NORTH
NORTH
PLANNED TURNING
CIRCLE (1,9 °/s)
NORTH
TRACK WITHOUT
TURNING
CIRCLE
NEXT
DESTINATION
B
DIRECT
TRACK
(> 20 NM)
COMMAND
TRACK
DISTANCE ALONG
TRACK TO NEXT
DESTINATION
NORTH
TRUE HEADING
DISTANCE TO NEXT
DESTINATION
TRACK ANGLE
ERROR
REQUIRED
TRACK
(> 20 NM)
ACTUAL
TRACK
PLANNED
TRACK
DRIFT
CROSS TRACK
DISTANCE
PRESENT POSITION
A
INITIAL PRESENT
POSITION

PROGRAMMED NAVIGATION GEOMETRY



NOTE

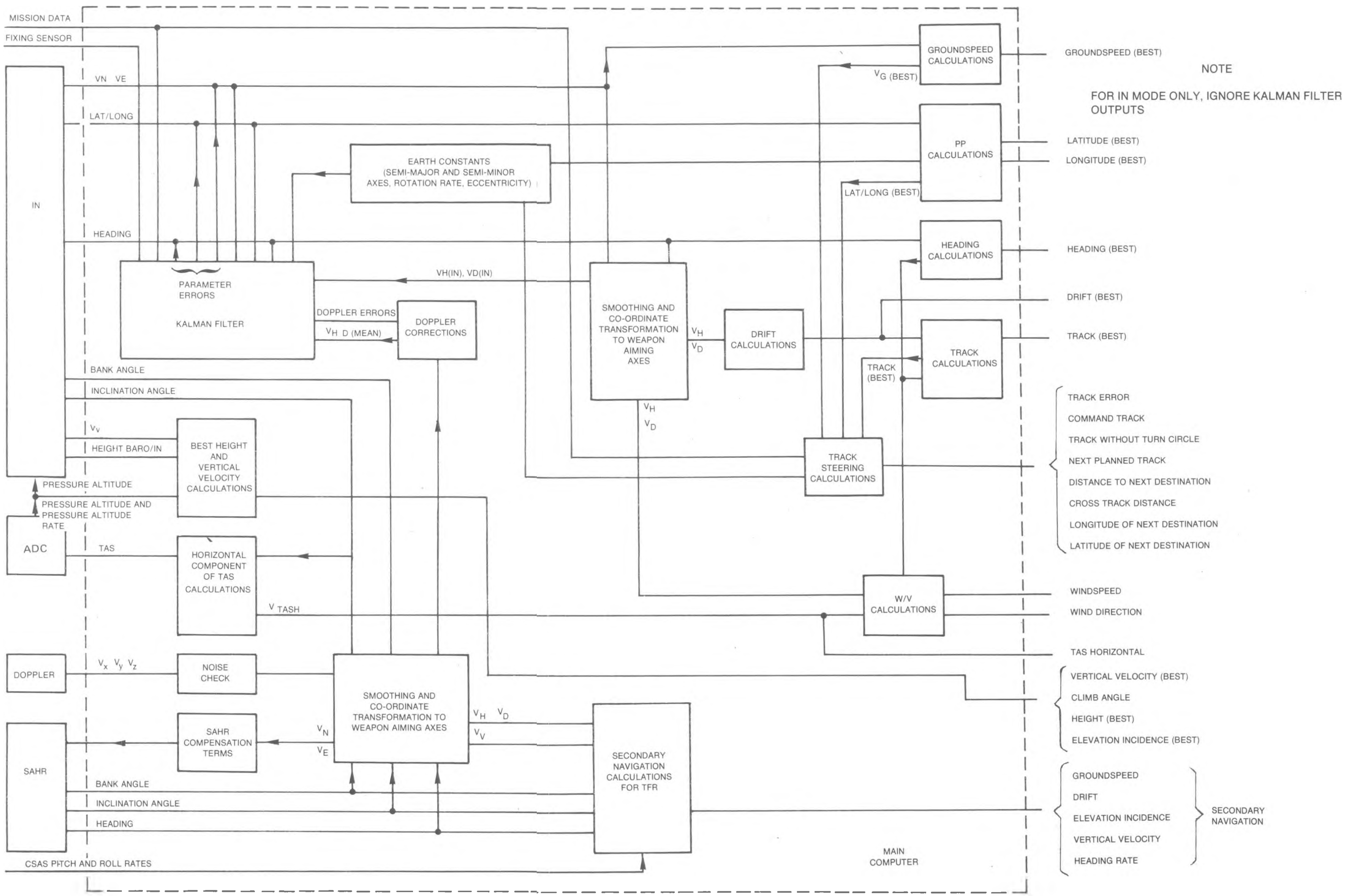
- ALTHOUGH COMMAND TRACKS ARE SHOWN AS STRAIGHT LINES THEY REPRESENT GREAT CIRCLE TRACKS

✱ INSERTED DESTINATIONS (A, B, C, D)
● CALCULATED TANGENT POINTS

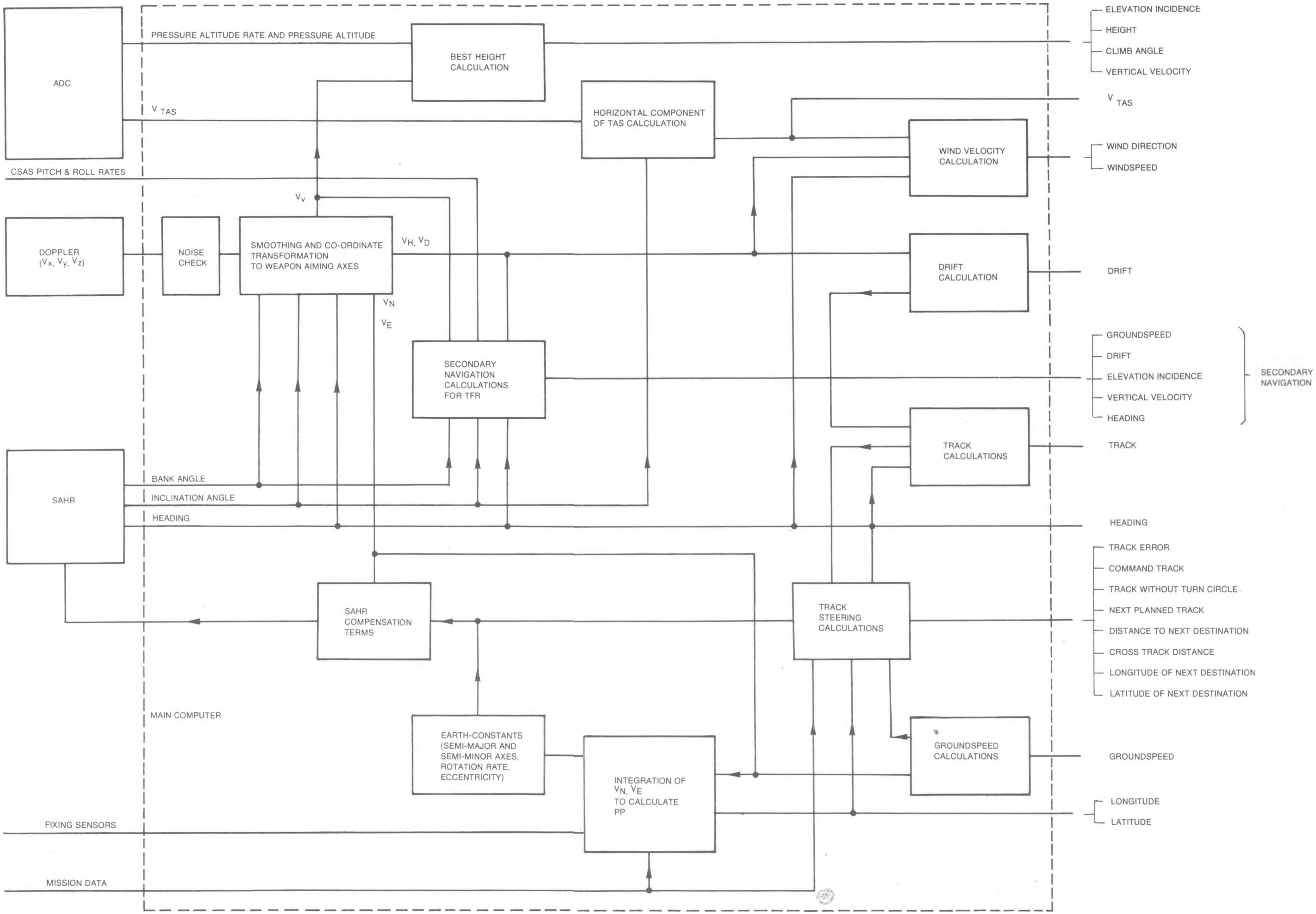
MAIN AND IN MODE - PARAMETER PROCESSING

NOTE

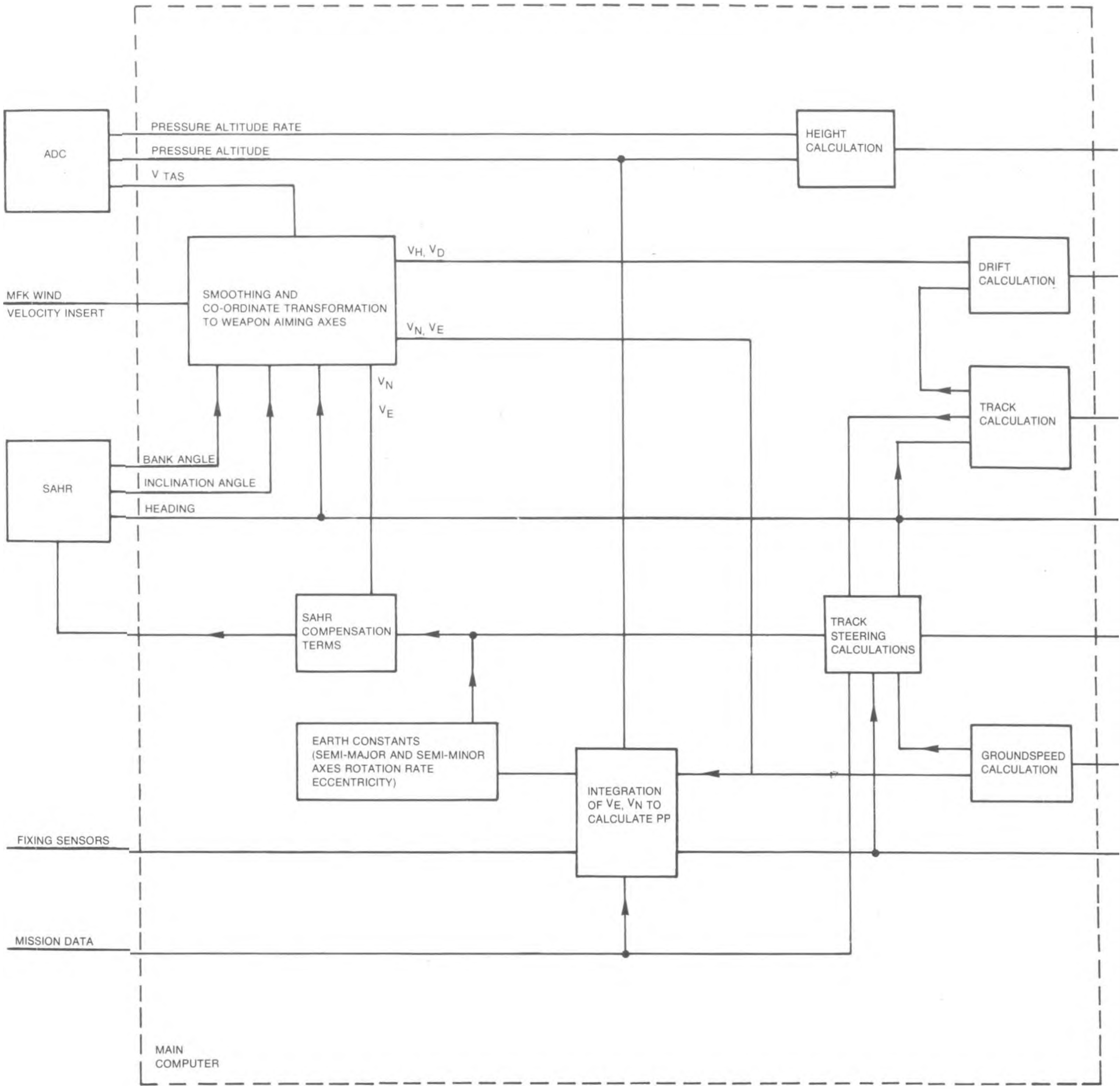
FOR IN MODE ONLY, IGNORE KALMAN FILTER OUTPUTS



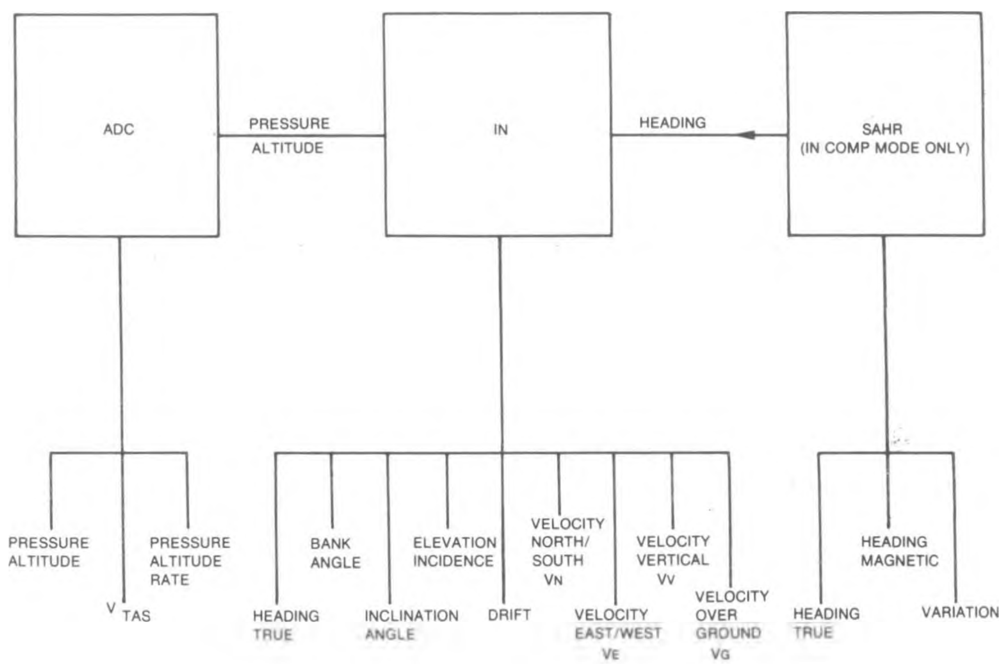
DOPPLER WITH SAHR MODE - PARAMETER PROCESSING

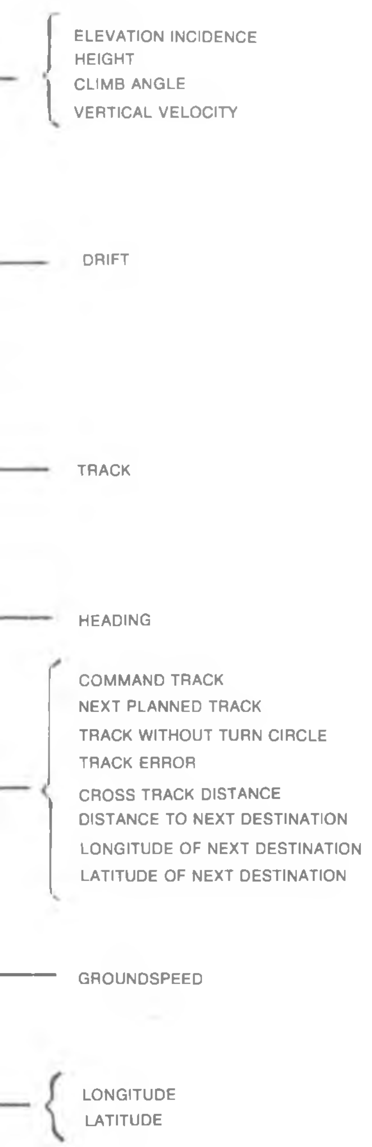


ADC WITH SAHR MODE



PURE IN- PARAMETER PROCESSING





ALPHABETICAL INDEX

A

Abandoning 3-8
Abort 3-4
AC System 1-46
Accelerometer 1-96, 4-170
Accept/Reject 4-190, 4-191
Active Electronic Countermeasures (AECM) 5-66
Actual track. 4-78
ADC Failure 4-19, 4-196
ADC Operation 4-19
ADI 5-51
Advanced Radar Display 4-22
Advice for Landing with Multiple CSAS Failures 3-42
Aerodynamic Braking 2-33
AFDS and Interfacing Subsystems 1-83
AFDS Automatic Radar Height Hold Mode 5-50
AFDS Automatic Terrain Following Mode 5-47
AFDS Central Warning Panel Captions 1-86
AFDS Computer Failure 3-49
AFDS Control Panel 1-83
AFDS Controls and Indicators 1-83
AFDS Cruise Modes 5-44
AFDS General Limitations 5-43
AFDS Manual Radar Height Hold Mode 5-51
AFDS Manual Terrain Following Mode 5-49
AFDS Mode Compatibility and Priority 1-88
AFDS Modes with AP Engaged 6-2
AFDS Moding Problems 5-43
AFDS Terrain Following Mode 5-45
AFP Steering 4-188
Aft Fuselage 2-3
After Contact 2-27
After Ejection 3-12
After First Engine Start 2-12
After Landing 2-36
After Landing Checks 2-36
After Refuelling 2-26
After Second Engine Start 2-14
After Take-Off/Departure Checks 2-25
After Touchdown Checks 2-32
Aiming Line 5-59
Air Data Computer 1-94
Air Data Computer (ADC) 4-19
Air Data System 1-94
Air Intake Automatic Operation 1-8
Air Intake Control Panel 1-7
Air Intake Ramp Failure 3-25
Air System Bleed Sources and Utilization 1-6
Air to Air Override Button (AAO) 4-44
Air to Air Refuelling 2-26
Air-to Ground Guns Button 4-142
Air-to-Air Override Button (AAO) 4-141
Air-to-Air Search 5-61
Airbrakes 1-78, 5-21, 5-40, 6-4, 6-13
Aircraft Dimensions 1-2
Aircraft Gross Mass 1-2, 4-166
Aircraft Servicing 4-166
Airfield Categories 5-27
Airfields 5-27
Airspeed and Mach 5-20
Alignment 4-17
Alignments 4-10
Alternative OTF 4-191
Altitude 5-25
Altitude Hold 5-44
Altitude Hold (Barometric) 1-90
Altitude Loss 6-16
Altitude Loss Chart 6-16
Angle of Attack 6-3
Angle of Attack and Manoeuvres 5-21
Angle of Attack (AOA) Indicator 1-98
Antenna Switch 4-154
Antenna/Receiver 4-45
Antenna/Receiver Unit 4-19
Anti-Collision Lights 1-123
Anti-Dazzle Lights 1-124
Anti-Dazzle Switch 4-171
Anti-g Valves 1-114
Anti-glare Shields 2-7
Anti-icing and De-icing System 1-115
Anti-Skid System 1-58
Antiskid Failure 3-65
AOA Indications 5-22
AOA Indicator 4-170
AOA Probes 1-94
AP 5-53
AP Check 2-29
AP Trim Failure 3-50
Approach and Landing 5-29
Approach and Landing Emergencies 3-62
Approach Progress Indicator (Not operative) 1-86
Approach to Stall and Recovery 6-6
Approach-end Cable Engagement 3-67
Approaches and Overshoots 5-29
APU Auto Test Switch 1-31
APU Bleed Switch 1-29
APU Operation 1-31, 5-4
APU Power Switch (Post mod. 00011) 1-29
APU Run Light 1-29
APU Starting System 1-28
APU Switch 1-29
Arm Restraint System 1-110
Armament and External Stores 5-53
Armament System 4-140
Armament System Controls and Indicators 4-141

Armament System Pre Mod. 4-145
Arrester Hook Push Button and Indicator 4-169
Arresting Hook System 1-62
Arresting Hook System Controls and Indicators . 1-62
Arresting Systems 5-36
Artificial Feel System 1-67
Assisted Relight 3-15
Asymmetric Stores 6-14
Asymmetric Three Tank Configuration 1-35
Asymmetric Wing Bending 6-5
Attack Release Switch 4-141
ATTD FAIL with AP MON 3-49
ATTD FAIL without AP MON 3-49
Attention Getters 4-146
Attitude Director Indicator 1-86, 4-170
Attitude Director Indicator (ADI) 1-98
Attitude Display 1-98
Attitude Hold 1-88
Attitude Monitor Trip 3-44
Attitude Monitoring 4-128
Attitude/Heading Hold 5-45
Audio Warning Alarms 4-152
Auto Loft Pull-Up 5-61
Auto Throttle 1-90
Automatic Hose Rewind 1-45
Automatic Selection. 4-80
Automatic Steering Override 1-92
Automatic Transfer 1-33
Automatic Transfer Failure 1-35
Autonomous Sensors 4-2
Autopilot 5-44
Autopilot and Flight Director System 1-82, 5-43
Autopilot Engage Indicator 1-86, 4-171
Autopilot Engagement/Manual Disengagement . . 1-92
Autopilot Engage/Disengage Button 1-86
Autopilot/Flight Director System Failure 3-49
Autothrottle 5-43
Auxiliary Power Unit 1-28
Avionic Equipment Compartment Cooling 1-115
Avionic System 5-41
Avionic System Operation 4-173
A/A Missiles 5-54
A/G Missiles 5-56

B

BAA Update 4-179
Barostatic Time-Release Unit 1-109
Basic Modes 1 88
Battery 1-48
Battery Charger 1-48
Battery Charger Failure (Post Mod. 01662) 3-34
Bearing Distance Heading Indicator (BDHI) 1-102
Bearing/Distance 1-102
Before Contact 2-26, 2-27
Before Starting Engines 2-10
Before Take-Off Checks 2-21
Bite . . . 4-13, 4-18, 4-41, 4-65, 4-69, 4-73, 4-157, 4-161
BITE Test 1-8
Bomb Attacks 5-62
Bomb High Loft 5-62
Bomb Laydown 5-62
Bomb Low Loft 5-62
Bomb Release Safety Lock (BRSL) Control Panel 4-145
Bombs 5-54
Bombs Dive/Medium Level 5-62
Bombs Modes 5-59
Boost Pump Low Pressure 3-26
Boost Pumps 5-16
Brake Failure 3-40
Brake Pressure Triple Indicator 1-61, 4-169
Brake Selector Handle 1-61
Brakes Test Button 1-61
Braking Technique 2-33
Breakaway 1-45
Buffet 6-4
Built-In Test Equipment 1-59
B/B Pod Training Missions Limitations 5-20
B/B Refuelling Pod Operation 1-44
B/B Refuelling System (Buddy-Buddy) 1-38

C

Cabin Air Conditioning System 1-112
Cabin Air Distribution 1-113
Cabin Temperature Control 1-113
Cable Engagement 3-65
Canopy 1-103, 5-68
Canopy and Windscreen Sealing 1-104
Canopy De-Misting 1-116
Canopy Jettison and MDC 1-107
Canopy Jettison Operation 1-106
Canopy Micro Detonating Cords (MDC) System . 1-106
Canopy System Controls and Indicators 1-104
Cassette Unloading 1-138, 1-142
CBLS 200 5-54
CCS Operation 1-130
CCS Panel 1-125
CCS Panel Controls 1-125
CCS Station Box Lights 1-125
Central Maintenance Panel (CMP) 4 162
Central Warning Panel 1-51, 1-96, 4-146
Central Warning Panel Captions 1-71
Central Warning Panel OXY Caption 1-123
Central Warning Panel (Rear Cockpit) 4-169
Central Warning System (CWS) 4-146
Centre Fuselage and Wing 2-3
Centre of Gravity 5-26
Chaff/Flare Dispenser 5-56
Channel Loading 1-133
Channel Selection 1-131
Channel/Loading 1-131

Circling Approach 7-3
Clean 5-2
Climb/Cruise 2-25
CMP Control and Indicators 4-162
CMP Power Supplies 4-162
Cockpit Noise 5-68
Cockpit Voice Recorder (CVR) 1-134
Cold Weather Procedures 7-4
Combined Radar and Projected Map Display (CRPMD) 4-22, 4-30
Combined Speed Indicator 4-170
Combined Speed Indicator (CSI) 1-96
Command Ejection 3-11
Command Ejection Selection Lever 1-108
Command track. 4-78
Communication Equipment 1-125
Computer Engagement 4-181
Computer Functions 1-73
COMPUTER INPUTS 1-83
Computing 5-68
Computing Equipment 5-69
Configuration and Fuel States 5-27
Configurations 5-2
Continuous Monitoring 4-162
Control Authority/Rate Saturation 6-1
Control Stick 4-169
Control Stick Grip 1-67, 4-169
Control Stick PTT Button 1-134
Controls and Indicators 1-143
CR Operation 1-143
Crash Panel 1-23, 1-51
Crash Recorder 1-142
Crash Recorder Equipment 1-142
Crew Concept 3-2
Crew Coordination 3-8, 4-172
Crew Duties 4-172
Critical Second Failures 1-71
Cross Drive 5-13
Cross track distance. 4-78
Cross-Drive System 1-28
Crosswind 5-35
Crosswind Landing 2-33
Crosswind Limits for First Failures 3-41
Crosswind Limits for Second Failures 3-42
Crosswind Take-Off 2-24
CRPMD Computer Marker (Navigator) 4-179
CRPMD Failure 4-196
CRPMD Map Slew (Navigator) 4-179
CRPMD Operation 4-35
CRPMD Set Up 4-183
CRPMD Symbols 4-23
CRPMD Test 4-183
CRPMD/RPMD and GMR Set Up and Test . . . 4-183
CRPMD/RPMD Check (Pilot/Navigator) 4-183
CRPMD/RPMD Malfunctions 4-44
Cruise 2-25
Cruise Modes 1-90
Cruise/MNVR 5-2
Cruising Flight 7-2
CSAS 1-63
CSAS Control Panel Controls 1-82
CSAS Controls and Indicators 1-67
CSAS Failure 6-12
CSAS Failures 1-69
CSAS First Failure 3-41
CSAS Second Failure 3-42
CUE Lane Test 1-14
CVR Control Panel 1-135
CVR Operation 1-136
CWP Indications 3-2

D

Data and Limitations 4-19
Data Insertion Using Map Slew or Computer Marker Facilities 4-179
Data Insertion via Store PP (Pilot and Navigator) 4-179
Data Storage. 4-77
DC Load Reduction 3-37
DC System 1-47
Departure and Recovery 6-7
Departure Protection 6-10
Departure-end Cable Engagement 3-66
Descent/Recovery 2-28, 3-59
Descent/Recovery Checks 2-28
Destination Data via Range/Bearing (R/B) 4-175
Destination Data (DEST) 4-175
Developed Spin 6-8
Developed Spin and Recovery 6-8
Digital Scan Converter (DSC) 4-22
Direct Link 1-64
Direct track. 4-78
Displays and Controls 4-3
Distance along planned track to next destination. 4-78
Distance to next destination. 4-78
Dive Recovery 6-15
Dive Recovery-Use 6-16
Doppler Control Panel 4-63, 4-171
DOPPLER Failure 4-66, 4-197
DOPPLER Malfunctions 4-66
Doppler Navigation Radar (DOPPLER) 4-63
Doppler Operation 4-65
Doppler Test 4-184
Doppler Transient Monitor 4-65
Double Engine Flame-Out Case 1-32
Double Engine Flameout 3-14
Double Generator Failure 3-31
Double Generator/TRU Failure case 1-32
Double Mission Data Store 4-140
Double TRU Failure 3-35
Downward Looking Sensors 4-3
Drogue Gun 1-109
Dry Crank 2-11

E

E-Scope/Radar Repeater Display (ESRRD) 4-47
ECS 5-39
ECS Failure 5-39
Effect of SPILS on AFT Stick Force 6-9
Effect on Attained Turn Capability (Typical) 6-10
Ejection 3-8
Ejection Altitude 3-8
Ejection Gun 1-108
Ejection Procedure 3-11
Ejection Seat Checks 2-4
Ejection Seat Controls 1-108
Ejection Seats 1-107
Ejection Sequence System 1-111
Electrical Power Supply System 1-46
Electrical Supplies 1-77
Electrical System Control and Indicators 1-49
Electrical System Failures 3-31
Electro Magnetic Compatibility 5-52
Electronics Unit (EU) 4-115
EMC Aspects of Various Equipments 5-52
Emergency Airbrakes and Emergency Flap Switches 1-80
Emergency Airbrakes and Emergency Flaps Switches 4-170
Emergency Equipment 4-146
Emergency Gear Retraction on the Ground 3-68
Emergency Ground Egress 3-4
Emergency Jettison Button 4-141, 4-172
Emergency Landing Gear Lowering Handle 1-61
Emergency Landing Gear Selector Lever 4-169
Emergency Oxygen Pressure Indicator 1-123
Emergency Oxygen System 1-120
Emergency Power Supply (EPS) System 1-31
Emergency Power System 5-39
Emergency Ram Air 1-113, 5-39
Engine Air Intakes 1-7
Engine Air System 1-3
ENGINE and INTAKE Control Panels L and R GEN FAIL Lights 3-31
Engine Behaviour at High AOA 6-5
Engine Control Panel 1-19, 1-51
ENGINE Control Panel L or R GEN FAIL 3-38
Engine Control System Failures 3-22
Engine fails to rotate 2-12
Engine Failure on Approach 3-53
Engine Failure (Mechanical) 3-19
Engine Failures 3-17
Engine Fire 3-13
Engine Fire during Take-off Roll 3-6
Engine Fire Extinguisher System 1-24
Engine Fire on the Ground 3-3
Engine Fuel Control System 1-9
Engine Fuel Overtemperature 3-29
Engine Fuel Supply System 1-36
Engine Handling in Flight 1-27
Engine Ignition and Relight System 1-17
Engine Instruments 4-171
Engine Instruments and Controls 1-19
Engine Intake De-Icing 1-116
Engine Oil and Fuel Overtemperature 3-22
Engine Oil Overtemperature 3-21
Engine Oil Pressure Low 3-21
Engine Oil System 1-8
Engine Oil System - MK 103 (Post mod. 01431) 1-9
Engine Operation 1-25, 5-4
Engine Operation Under Icing Conditions 5-13
Engine or Reheat Failure during Take-off 3-5
Engine Overheat and Fire Detection System 1-24
Engine Reheat System 1-15
Engine RPM Indicators 1-21
Engine running inside NATO Hardened Aircraft Shelters (HAS) 2-12
Engine Shut Down 5-14
Engine Speed Switch Failure 3-17
Engine Start Panel 1-19
Engine Starting 5-5
Engine Starting System 1-18
Engine Temperature Indicators 1-21
Engine Test Panel 1-19
Engine Thrust Reversal System 1-18
Engine Variable Nozzle System 1-16
Engine Vibration 3-19
Engine Vibration Detection 1-15
Engines 1-3
Enhanced Ground Test Facility (EGTF) 4-140
Environmental Conditions 5-38
Environmental Control Panel 1-116
Environmental Control System 1-112, 5-39
Environmental Control System Controls and Indicators 1-116
Environmental Control System Failure 3-51
EPS System Controls and Indicators Switch 1-32
EPS System ON light 1-32
Equipment Cooling 1-113
Equipment Failures Affecting the HUD 4-130
Equipment Interruptive Testing 4-162
Equipment Status-Go/No Go 4-161
Escape System/Personal Equipment 5-68
ESRRD 5-42
ESRRD Operation 4-49
ESRRD Test 4-184
Excess Battery Charging (Post Mod. 01662) 3-35
Exciter/Pulse Compressor 4-21
Explanation for operation of Figures 5-28 and 5-29 5-28
External Canopy Operating Handle 1-104
External Checks 2-3
External Jack Release Handle 1-106
External Lighting 1-123
External MDC Firing Handle 1-107
External Power Supply 1-49
External Tanks 1-33, 3-27

F

Failure of Drogue Chute or Auto Separation 3-12
Failure of Flaps to Extend 3-64
Failure of One Hydraulic System 3-39
Failure of One Utility System 3-40
Failure of Seat to Eject 3-12
Failure of Slats to Extend 3-64
Failure Resetting 1-71
Failure Warning Flags 1-102
Final Approach 3-59
Fire 3-13
Fire Warning System 4-152
First Failures 1-69
First Failures (Amber CWP indication) 6-12
Fixing (Phase 1/Phase 2) 4-87
Flameout/Relighting 3-14
Flap Operation With Degraded CSAS 5-40
Flap Retraction Speed 2-25
Flaps/Slats 6-3
Flaps/Slats Asymmetry Protection 1-78
Flap/Slat failures 5-40
Flap/Slat Feedback Shaft Failure 3-63
Flight 5-14, 5-15, 5-68, 7-3
Flight Control System 5-39, 6-1
Flight Control System Failures 3-41
Flight Crew 1-3
Flight Director 5-45
Flight Director Attacks 5-59
Flight Director Display 1-101
Flight Planning 2-1
Flight Refuel Probe Light 1-124
Flight Refuelling 5-16
Flight Refuelling Lights 1-44
Flight Restrictions 2-1
Flight With External Stores 6-13
Flight, Penetration and Landing 7-7
Floodlight 1-44
Floodlights 1-124, 4-170
Formation Flying 5-52
Formation Lights 1-123
Forward Looking Sensors 4-3, 5-42
Front Cockpit 2-1, 2-37, 4-3
Front Cockpit Hand Controller Panel 1-136
Front Group Fuel Leak 5-16
Fuel Balance 3-28
Fuel Control Panel 1-41
Fuel Cooling System 1-36
Fuel Dump 1-37
Fuel Dumping 5-16
Fuel Flow Indicator 1-21, 1-39
Fuel Pressurization and Vent System 1-36
Fuel Quantity Indicator/Selector Unit 1-39
Fuel Supply System 1-32
Fuel System 5-15
Fuel System Control and Indicators 1-39
Fuel System Failures 3-25
Fuel Tank High Temperature 3-30
Fuel Tanks 1-33
Fuel Temperature 5-16
Fuel Temperature Indicator more than 70° C ... 3-30
Fuel Transfer System 1-33
Full CSAS 1-63, 6-1, 6-14
Fumes in Cockpit 3-52
Function Switch 4-165
Fuselage Fuel Leak 3-25
Fuselage Tanks 1-33

G

G Stop Mechanism 1-109
GCA (PAR) Approach 7-2
Gearbox Failure 3-38
Gearbox Warm Up Time 5-5
Gearbox/Hydraulic System Failures 3-58
General 4-172, 7-1, 7-6
GMR Controls and Indicators 4-27
GMR Failure 4-197
GMR Malfunctions 4-22
GMR Modes and Operation 4-21
GMR Test 4-184
GMR-AGR 5-59
GMR/CRPMD Taxi Checks 4-184
Go Around 2-36
Grid Data 4-179
Ground 5-14, 5-68
Ground Attack Dives and Recovery 5-23
Ground Emergencies 3-3
Ground Mapping Radar 5-42
Ground Mapping Radar (GMR) 4-19, 4-140
Ground Operation 1-25, 7-6
Ground Refuelling and Defuelling 1-37
Ground Stability and Operation 5-27
Ground Test Facility (GFT) 4-166
Groundcrew I/C Connector 1-134
Ground, OAT at or below 0°C, debris guard fitted 5-13
Ground, OAT at or below 0°C, debris guard not fitted 5-13
Ground, OAT between 0 and + 3°C, with or without debris guard fitted 5-13
GTF Format 4-180
Gun air to ground 5-63
Gun Air-to-Air 5-64
Gun Attack 5-63
Gun Modes 5-62
Gun System 5-53
Gyro and Electronics Unit (GEU) 4-14

H

Hand Pump ... 1-53
Handling with Spils ... 6-8
Harness Go-Forward Lever ... 1-108
Harness Power Retraction Unit ... 1-110
Harness Release Mechanism ... 1-110
HDDR Cassette Loading ... 1-142
HDDR Control Panel ... 1-140, 4-171
HDDR Operation ... 1-142
Head Down Display Recorder (HDDR) ... 1-139
Head Up Display ... 7-1
Head Up Display (HUD) ... 4-140
Head up Status Indicator/Selectors (Post Mod. 01749) ... 5-43
Head-Up Display Control Panel ... 4-117
Head-Up Display Unit (HUD) ... 4-115
Head-Up Display (HUD) ... 1-86
Heading ... 1-102
Heading Acquire ... 1-90
Heading Hold ... 1-88
Heap-up Display Camera (HUD Camera) ... 1-137
Heavy Mass Take Off (not yet cleared) ... 2-24
Height and Ranging Sensor ... 5-60
Height Fix Over Sea ... 4-191
Helmet HGU DH 152 ... 5-66
HF/SSB ... 5-67
HF/SSB Bite ... 1-134
HF/SSB Control Panel ... 1-133
HF/SSB Radio ... 1-132
HF/SSB Radio Operation ... 1-133
High Altitude Ejection ... 3-11
High AOA, Stall, Loss of Control and Recovery ... 6-6
High Lift Devices ... 1-63
Holding ... 7-2
Home-on-Jam ... 5-61
Horizontal Situation Indicator ... 1-86, 4-170
Horizontal Situation Indicator (HSI) ... 1-98
Hose Jettison ... 1-45
Hot Start ... 2-11
HP4 Bleed Air ... 1-7
HP6 Blow-Off Valve (HP6BOV) ... 1-7
HSI Test ... 4-186
HT FAIL on TFR Control Panel ... 3-44
HUD Bite ... 4-129
HUD Camera Cassette Loading ... 1-138
HUD Camera Control Panel ... 1-138
HUD Camera Controls ... 1-137
HUD Camera Operation ... 1-138
HUD Failure ... 4-131
HUD Failures ... 3-43
HUD Malfunction ... 4-131
HUD Operation ... 4-126
HUD Sensors ... 4-186
HUD Set Up ... 4-184
HUD Symbol Repertoire ... 4-119
Hydraulic Accumulators ... 1-52
Hydraulic Cooling ... 1-53
Hydraulic Fluid Reservoirs ... 1-52
Hydraulic Overtemperature ... 3-40
Hydraulic Power Supply System ... 1-51
Hydraulic Pressure Indicators ... 1-53
Hydraulic Pumps ... 1-52
Hydraulic Supply ... 1-53
Hydraulic System ... 5-39
Hydraulic System Controls and Indicators ... 1-53
Hydraulic System Failure and Warnings ... 1-53
Hydraulic System Failures ... 3-39
Hydraulic System Operations ... 1-51

I

Ice Detection (Post mod. 00629) ... 1-115
Ice Detection (Pre mod. 00629: not installed) ... 1-115
IFF ... 5-53
IFF Control Panel ... 4-158
IFF Equipment ... 4-157
IFF Operation ... 4-160
IFF 4 Lamp ... 4-158
IFU 1 Failure ... 4-193
IFU 2 Failure ... 4-193
IN ... 5-53
IN Failure ... 4-14, 4-194
IN Fault – No IN CWP Warning ... 4-194
In Flight ... 4-18
In Flight Refuelling System ... 1-37
IN Malfunction ... 4-13
IN Operation ... 4-10
IN System set up and Alignment ... 4-181
In-Flight Display ... 4-165
In-Flight Monitor ... 4-165
Inadvertent A/P Disconnect ... 5-43
INBOARD/OUTBOARD (Spoilers) ... 6-13
Incorrect Fuel Transfer on FCP and/or Asymmetric Tank Contents and/or Amber FUEL ... 3-27
Inertial Navigator Control and Display Unit (INCDU) ... 4-6
Inertial Navigator Unit (INU) ... 4-6
Inertial Navigator (IN) ... 4-4, 5-42
Initial Checks ... 2-1, 2-27
Instinctive Cut Out Switch (ICO) ... 1-61
Instinctive Cut-Out ... 1-92
Instinctive Cut-Out Switch ... 1-86
Instrument Approaches ... 5-33, 7-2
Instrument Climb ... 7-2
Instrument Flight Procedures ... 7-1
Instrument Takeoff ... 7-1
Instruments ... 1-96, 5-51
Instruments and IMC Flight ... 5-51
Integral and Electroluminescent Lighting ... 1-124
Integrated Displays and Controls ... 4-89
Integrated Drive and Generator Unit ... 1-46
Integrated System Reversionary Modes ... 4-191

Intelligence Points (INT) 4-178
Interface Units (IFU 1 + IFU 2) 4-70
Internal Canopy Jettison Handle 1-106
Internal Canopy Operating Handle 1-104
Internal Checks Rear Cockpit (Strike) 2-15
Internal Checks Rear Cockpit (Trainer) 2-16
Internal Checks – Front Cockpit 2-5
Internal Jack Release Handle 1-104
Internal Lighting 1-124
Internal Lights Control Panel 4-171
Internal MDC Firing Handle 1-106
Internal Transfer 1-46
Introduction 3-2, 4-2, 5-1, 6-1
IP Blow-Off Valve (IP BOV) 1-6
Isolating Valves 1-52
I/B Wing Tanks + AIM9L 6-13
I/C Operation 1-134

J

Joining 2-26

K

Kalman Filter Software Routine. 4-80
Kormoran 5-64
Krueger Flap 1-63
Krueger Flaps Indicator 1-82

L

Lamps Test 1-125
Landing 2-29
Landing Gear 5-21
Landing Gear Collapsing 3-68
Landing Gear Emergency 3-67
Landing Gear Emergency Lowering System 1-56
Landing Gear Fails to Lower 3-68
Landing Gear Operation 1-62
Landing Gear Position Indicator 1-59
Landing Gear Retraction Failure 3-7, 3-67
Landing Gear Selector Lever 1-59
Landing Gear Selector Lever Warning 4-152
Landing Gear System 1-56
Landing Gear System Controls and Indicators 1-59
Landing Gear System-Schematic 4 169
Landing with a Known Blown tire 3-65
Landing with Flap/Slat Failure 3-63
Landing with Gear Unsafe 3-68
Landing with Wings Swept 3-62
Landing/Taxi Lights 1-123, 5-33
Lane Control 1-13
Lane Failure 3-23
Lane Failure to Reversionary 3-23
Later Arm Switch 4-141
Left Console 2-6
Left Fuselage/Wing 2-4
Left Quarter Panel 2-7
Leg Restraint System 1-110
Lift Dump Indicator 1-23, 1-82, 4-170
Lift – Dump System 1-79
Light Emitting Diodes (LED) 4-162
Lighting System 1-123
Lightning Risks 5-66
Limitations 4-6, 4-14, 4-19, 4-63, 4-67
Line Up Checks 2-21
Lock-On Mode 5-59
LOCK-On/Reject Button 4-44
Loft Attacks 5-61
Loss of Control 3-50
Loss of Control and Recovery 6-10
Loss of Symbology 3-43
Loss of Throttle Control 3-22
Low Altitude Ejection 3-11
Low Altitude Modes 1-91
Low Collector Box Contents 3-29
Low Fuel/Nose Down Attitude 5-16
Low Loft 5-61
Low Speed Handling with Multiple CSAS Failures 6-13
LP Cock Switches 4-169
LP Cocks Switches 1-42

M

Mach Hold 1-90, 5-44
Magnetic Detector Unit (MDU) 4-16
Magnetic Standby Compass 1-98
Main Accumulator Pressure Indicators 1-54
Main Computer Control Panel (MCCP) 4-72, 4-131
Main Computer Selft Test (MCST) 4 165
Main Computer System 4-70
Main Computer (MC) 4-3, 4-70, 4-140
Main Electronic Control 1-12
Main Instrument Panel 2-7
Main Landing Gear 1-56
Main Oxygen System 1-118
Main Oxygen System Contents Indicators and Test Button 1-120
Malfunction of HMERU 3-50
Manoeuvring 6-9, 6-13
Manoeuvring Flight 6-4
Manual Data Entry 4-175
Manual Data Insertion. 4-76
Manual Override Selection. 4-80
Manual Selection. 4 80
Manual Separation Handle 1-108
Manual Separation System 1 110
Manual Transfer 1-35
Manual Trim Inputs with AP Engaged 6-2
Map Coverage and Film Drive 4-23
Map Film Data 4-175

Map Slew 4-180
Mapping Radar Control Panel (MRCP) 4-27
Mass 5-25
Master Armament Safety Switch (MASS) 4-141
Maximum AOA Chart 6-15, 6-16
Maximum Dry Climb 2-25
Maximum Load Factor Chart 6-15, 6-16
Maximum Reheat Climb 2-25
MC Failure 4-191
MC Operation 4-73
MC Software Standard OFP T-P-SW-X107-01-P Differences 4-140
MCCP Program Fail 4-173
MDC Initiator Controls 1-106
Mechanical Mode 1-64
Memorized Heading Alignment 4-182
MFK and FFK Operation 4-113
MFP Steering 4-188
Min Fuel Content for Negative G Manoeuvres 5-16
Minimum Crew Requirement 5-4
Minimum Equipment 5-4
Minimum Power Check 2-22
Minimum Set Clearance Height 5-48
Minimum Set Clearance Height (SCH) 5-49
Miscellaneous 5-64
Miscellaneous Switch Panel, PTT Switch 1-134
Missed Approach 7-3
Mission Data 4-175
Mission Data Check 4-180
Mission Data Insertion 4-173
MK101 Engine 5-5
MK101 Engine Operating in Flight 5-6
MK103 Engine 5-6
Mode Sensor Failure 3-49
Moving Target 5-60
MRCP Set Up 4-183
MW 1 . . . . 5-56, 6-13

N

Navigation Controls 4-131
Navigation Facilities 4-78
Navigation Lights 1-123
Navigation Mode Control Panel 4-35, 4-171
Navigation Mode Control Panel (NMCP) 4-132
Navigation Mode Selection 4-186
Navigation Modes 5-41, 5-59
Navigation Modes and Operation 4-80
Navigation Moding and Steering 4-186
Navigation Processing 4-78
Navigation Sensors 5-42
Navigation Updating 4-86, 4-189
Navigation Weapon System Controls 4-133
Navigational AIDS 4-154
Navigator-Duties 4-172
Navigator-Hand Controller and Switches 4-171
Navigator-Hand Controller (NHC) 4-34, 4-136
Navigator-WAMS Control Panel (NWAMS) 4-133
Navigator-Weapon Aiming Mode Selector Panel 4-34
Negative-g Restraint System 1-110
Never-Exceed Limits (N.E.) 5-1
Next planned track. 4-78
Night Flying 7-3
NL/NH Indication Changeover Switch 1-21
Normal Acceleration and Manoeuvres 5-20
Normal Alignment 4-181
Normal Brake Indicating System 1-59
Normal Take-off 2-23
Nose 2-3
Nose Landing Gear 1-56
Nose Wheel Steering Mode Selector/Indicator 1-61, 4-169
Nosewheel Steering System 1-57
Nozzle Area Indicators 1-21
NSAS Failure 3-7, 3-62
NWAMS Sensor Selection 4-189
NWS Fails to Enter BITE 3-61
NWS Failure 3-7, 3-8
NWS Failure in Flight 3-61
NWS Runaway 3-7
NWS/NSAS Failures 3-61

O

Obstruction Lights 1-123
Offset Data (OFS) 4-178
Offset height 5-60
OFP Load Check 4-173
On Board Checkout and Monitoring Subsystem (OCAMS) 4-161
On Top Offsets 5-60
Open Loop Pull Up/Closed Loop Pull-Up 6-2
Operating Modes 1-88
Operation In Night VMC and IMC 5-48
Operation in Night VMC or IMC 5-49, 5-51
Optical Projection System 4-117
Optimum Braking 2-34
OTF 4-190, 4-191
OTF and Tacan Fixing 4-190
Out of Control 3-50
Oxygen Failures 3-52
Oxygen Flow Indicator 1-123
Oxygen Regulator 1-120
Oxygen Shut Off Cock 1-120
Oxygen Supply System Controls and Indicator 1-120
Oxygen System 1-118

P

Parachute and Combined Harness 1-109
Penetration and Landing 5-14
Performance Take-Off 2-24
Personal Equipment Connector (PEC) 1-111
Personal Survival Pack 1-111
Phase 1/Phase 2 4-190
Phase 2 5-59
Phase 2 Offset Loft 5-61
Phase 3 5-60
Photographic Equipment (Recce Pod) 4-157
Pillar Lights 1-124
Pilot-Display Unit (PDU) 4-115
Pilot-Duties 4-172
Pilot-Hand Controller (PHC) 4-43, 4-137
Pilot-Throttle Levers 4-139
Pilot-WAMS Control Panel (PWAMS) 4-137
Pitch 1-67
Pitch Control Unit 1-108, 1-109
Pitch MD 6-12
Pitch Trim 1-65
Pitching Manoeuvres 5-22
Pitot and Static Pressure Distribution 1-92
Pitot-Static System 1-92
Planned Fixing 4-189
Planned track. 4-78
Planned turning circle. 4-78
Pod Signal Lights 1-39
Post MOD 16130 (SWIT-P-NCC P200B software) 5-42
Potential Lock-In Surge Region 3-20
Power Supplies . 4-6, 4-14, 4-19, 4-45, 4-63, 4-67, 4-115
Power Supply 1-102, 4-70, 4-89
Power Supply Unit 4-21, 4-47
Pre Flight Checks 2-1
Pre-Landing Checks 2-30
Pre-Taxi Checks 2-18
Preflight 7-3
PreLanding 3-59
Preparation for Flight 2-1
Present Position Data (PP) 4-175
Press to Transmit Controls 1-134
Press-to-Transmit Controls 1-132, 4-171
Press-to-Transmit Switch (Miscellaneous Switch Panel) 4-171
Pressure-Sensitive Altimeter 1-98
Pressurization System 1-113
Pressurization/ECS Failure 3-51
Primary and Secondary Data Monitoring 4-54
Primary Flight Control Power Sources 1-67
Primary Flight Control System 1-63, 4-169
Primary Flight Controls and Indicators 1-67
Priority Valves 1-53
Probe Heating 1-94
Probe Heating Failure 3-37
Probe Nozzle Standard for Refuelling with USAF Tankers Post Mod. 01331 5-19
Processing 4-3, 4-70
Processor/Computer 4-21, 4-45
Prohibited Manoeuvres 5-20
Project Map Display 4-22
Pylons/Adapter/Launcher 5-54
P4AX (ACMI) 5-55
P/R Link 6-12

Q

Q-Feel Failure 6-13

R

RA Failure 4-70
RA Malfunctions 4-70
RA Operation 4-69
RAD ALT Failure 4-198
Radar Alt Test 4-184
Radar Altimeter 5-42
Radar Altimeter Indicator (RAD ALT) 4-67
Radar Altimeter (RA) 4-67
Radar Height Hold 1-91
Radar Map Matching 4-190
Radar Mount/Roll Unit 4-21, 4-47
Radar Pressurization 1-114
Radar Scale Marking 1-140
Radar Warning Equipment (RWE) 5-66
Rain Conditions 5-39
Range and Bearing RDE Data 5-42
Rapid Change of Destination 4-189
Rapid Data Entry 4-173
Rapid Data Entry (RDE). 4-75
Rapid Data Entry (RDE)/Programme Loading .. 5-69
Rapid HUD Alignment 4-129, 4-182
Rapid Inertial Alignment 4-181
Rapid Rolling 5-23
Rapid Stick Inputs with the AP Engaged in Basic Mode 6-2
Rapid Take-Off Panel 1-23, 1-39, 1-49
Rate of turn 1-101
Rear Cockpit 2-2, 2-37, 4-4
Rear Cockpit Artificial Horizon 1-103
Rear Fuselage Fire/Hot Gas Leak 3-13
Receiver Aircraft 1-38
Receiver Role 2-26, 5-17
Receiver/Transmitter 4 158
Receiving 1-132
Reconnaissance Subsystem 5-67
Recorders 1-134
Recovery 6-7, 6-8
Refuel Control Panel 1-42
Refuel Probe Light Control 1-44, 4-169
Refuel/Transfer Valve Failure – Probe Selected In 3-30
Refuel/Transfer Valve Failure – Probe Selected Out 3 30
Reheat Blowout 3-24

Reheat Control Failure 3-23
Reheat Electronic Control System 1-16
Reheat Fuel System 1-15
Reheat Ignition 1-16
Reheat Operation Lights 1-21
Release/Launch and Jettison Limitations 5-58
Releasing and Launching Equipment 4-140
Relight 5-13
Relight Push Buttons 1-17
Remote Frequency/Channel Indicator (RFCI) ... 1-131
Repeater Projected Map Display (RPMD) . 4-23, 4-41
Required track. 4-78
Reservoir Fluid Level Indicators 1-53
Reverse Thrust Indicators 4-171
Reverse Thrust Indicators and Override Switch .. 1-21
Reverse Thrust Selector Switch 4-171
Reversionary Modes 4-82
Reversionary Operation 4-87
RHH Checks 2-29
Right Console 2-7
Right Quarter Panel 2-7
Rocket Motor 1-109
Roll 1-67
Roll MD 6-12
Roll Trim 1-66
Route Data 4-178
Route Follow 4-180
RPMD Failure 4-196
RPMD Map Slew (Pilot and Navigator) 4-179
RPMD Operation 4-43
RPMD Test Alignment (Pilot) 4-183
Rudder 1-65, 5-40, 6-4
Rudder LOCKED 6-13
Rudder Pedal Adjustment 1-69
Rudder Pedals 1-69
Rudder Pedals and Rudder Pedals Adjustment
Handle 4-170

S

Safety Features 1-107
SAHR Control and Remote Compensator Unit
(CRCU) 4-16
SAHR Failure 4 195
SAHR Malfunction 4-18
SAHR Operation 4-17
SAHR System Alignment 4-181
Seat Lower/Raise Switch 1-108
Seat Pan Firing Handle 1-108
Seat Sub-Assemblies 1-108
Second Failures 1-69
Second Failures (red CWP indication) 6-12
Secondary Attitude and Heading Reference System
(SAHR) 4-14
Secondary Control Surface Position Indicator 1-80, 4-170
Secondary Flight Control System 1-77
Secondary Flight Control System Controls
and Indicators 1-80, 4-170
Secondary Power System 1-28
Secondary Power System Controls and Indicators 1-29
Selective Jettison Button 4-142
Sensing 4-2, 4-4
Sensor Failure 5-47
Serviceable Intercom 3-4
Servicing Diagram 4-166
Servo-Pneumatic Altimeter 1-96
Set-up, Alignment and Test of Sensor and Displays 4-180
Shut Down Checks 2-36
Sideslip or Yawing Manoeuvres 5-23
Sidewinder (AIM9L) Modes 5-64
Significant Second Failure 1-69
Single Ejection 3-11
Single Engine Approach/Landing X-Drive Open . 3-53
Single Engine Approach/Landing – X-Drive Shut 3-57
Single Engine Descent/Recovery – X-Drive Open 3-54
Single Engine Descent/Recovery – X-Drive Shut 3-57
Single Engine Emergencies 3-53
Single Engine Final Approach – X-Drive Open . 3-55
Single Engine Final Approach – X-Drive Shut .. 3-58
Single Engine Flameout 3-15
Single Engine GCA 7-3
Single Engine Operation 3-17
Single Engine Overshoot 3-53
Single Engine Pre Landing – X Drive Open 3-54
Single Engine Pre-Landing – X-Drive Shut 3-58
Single Engine Transit – X-Drive Open 3-53
Single Engine Transit – X-Drive Shut 3-57
Single Generator Failure with AC Busbar Tie
Contactor Open 3-34
Single Generator Malfunction 3-33
Single TRU Failure 3-37
Slat Selection 5-40
Slat & Flap System 1-63
Slide Data 4-178
Slip 1-101
SMS 5-60
Software Package 4-73
Software Queries to SW-X108 4-2
Software Standard Program 4-2
Software System Check 4-165
Special limitations for trainer version 5-66
SPILS BITE 1-77
SPILS Control and Indicators 1-73
SPILS Control Panel 1-73
Spils Failure 3-43
SPILS System 5-40
Spin Prevention and Incidence Limiting System
(SPILS) 1-71
Spin Recovery 3-51
Spoilers 1-64
Stability on the Ground 5-27
Stalling or Spinning 5-23
Stand Fixing. 4-82

Starting Engines 2-10
Starting Failures 2-11
Starting First Engine 2-10
Starting Second Engine 2-14
Steering Computation 4-83
Steering Mode Selection 4-186
Steering Mode Set Up 4-186
Steering Mode Transitions 4-188
Steering Modes and Operation 4-84
Stick Force Cut-Out 1-92
Stick Forces and Displacements 6-8
Store Configurations and Speed Limitations 5-47, 5-49
Store Management System 5-56
Stores Configurations 5-56
Stores Coverage 4-145
Stores Release 6-14
Strap in Procedure 2-4
Subsonic Flight 6-3
Subsonic Fuel Tanks 5-54
Supersonic Flight 6-3
Supplementary Data 4-74
Supplementary Warnings 4-146
Support Equipment 4-157
Surge 3-19
Swept Wing/Spoiler Failure 6-14
System Description 1-7
System Time Adjustement 4-179

T

Tacan Approach 7-2
Tacan Approach-Single Engine 7-2
TACAN Control Panel 4-154
TACAN Controls and Indicators 4-154
TACAN Equipment 4-154
TACAN Fix 4-191
TACAN Fixing 4-190
TACAN Modes and Operation 4-155
TACAN System Operation 4-155
Tailerons 1-65
Take-off 2-23, 5-13
Take-off Emergencies 3-4
Take-off on Slippery Runway 2-25
Takeoff 6-9, 7-6
Tank Fuel Temperature Indicators 1-42
Tanker Aircraft 1-38
Tanker Role 2-27, 5-19
Taxi Checks 2-20
Taxi Thrust Selector 1-19
Taxiing 2-18, 5-28
Telebriefing Connector 1-134
Television/Tabulator Display System (TV/TAB) 4-89
Temperature Probes 1-94
Terrain Following 1-91
Terrain Following Failures 3-46
Terrain Following Radar 5-42
Terrain Following Radar (TFR) 4-45
Test of Warning Lamps 4-152
Testing of Central Warning System 4-153
TF Checks (not lower than 200 ft above SCH) .. 2-29
TF Malfunctions 4-60
TF Monitor Warnings 3-48
TF Operation 2-29
TF Radar Control Panel 4-47
TFR Abnormal Operation 4-59
TFR Command Parameters 4-50
TFR Failures 3-46
TFR Modes and Operation 4-55
TFR Set Up and Test 4-186
TF/AFDS Control Panel 4-50
The Aircraft 1-1, 4-166
Three Axes Trim Indicator 4-169
Throttle PTT Button 1-134
Throttle Quadrant 1-80
Throttle Rock Test Indicators 1-80
Throttles 1-18, 4-172
Thrust Reverser 5-33
Thrust Reverser Unlocked 3-25
Time Early/Late 4-180
Time Limitation Below 0,5 "g" 5-16
Time Limitations Below +0.5 "g" 5-5
Tire Failure during Take-off Roll 3-5
TOO/CCIP 5-60
Total Fuel Contents Indicators 4-169
Touch and Go Landings 5-33
Touch-and-Go Landing 2-34
Track Acquire 1-90
Track angle error. 4-78
Track without turning circle. 4-78
Train Mode 6-10
Trainer Variant 4-166
Transformer – Rectifier Units 1-48
Transit 3-59
Transmitter 4-45
Transmitter Unit 4-19
Transmitter-Receiver 4-67
Transmitter/Receiver 4-154
Transmitter/Receiver Antenna Unit 4-63
Transmitting 1-132
Transonic Flight 6-3
Trigger 4 141
Trim System 1-65
Triplex Tranducer Unit 1-94
Turbine Bearing Overtemperature 3-20
Turbulence and Thunderstorms 7-7
TV/TAB Display Unit 4-171
TV/TAB Display Units (DU1 + DU2) 4 91
TV/TAB Failure 4 198
TV/TAB Formats 4 92
TV/TAB Malfunctions 4-113

U

UHF Emergency Radio 1-132
UHF Emergency Radio Control Panel 1-132
UHF Emergency Radio Operation 1-132
Unplanned Attack 5-61
Unplanned Fixing 4-190, 5-42
Unplanned Height Fixing 5-42
Unserviceable Intercom 3-4
Unstrap Procedure 2-5
Upper Instruments Lights Dimmer Switch 4-171
Utilities Test Switch 1-56

V

Velocity Monitor Trip 3-44
Vent System Pressure Low 3-30
Vertical Speed Indicator 4-170
Vertical Speed Indicator (VSI) 1-98
Vertical Velocity Monitoring 4-128
Visual and Audio Warnings 4-146
Visual Approach 5-33
Visual Map Matching 4-190
Visual Offset 5-60
Voice Recorder Indicator (RUN) 1-136
Voice Recorder Switch (START/STOP) 1-136
Voltmeter (Post Mod. 01662) 1-49
V UHF 5-52
V UHF Bite 1-131
V UHF Control Panel 1-130
V UHF Radio 1-130
V UHF Radio Operation 1-131

W

WAMS Indicator Panel 4-139
Wander Lamps 1-124
Warning Equipment 4-146
Warning Flags 1-103
Wave Form Generator (WFG) 4-89
Weapon Aiming 5-59
Weapon Aiming Modes Limitations 5-59
Weapon Aiming Symbols – Guns and Air-to-Air Missile 4-124
Weapon Aiming Symbols-Bombs 4-123
Weapon Control Panel (WCP) 1 4-142
Weapon Control Panel (WCP) 2 4-144
Weapon Release Button (WRB) 4-141
Weight and Balance 2-1
Wet Start 2-11
Wheel Brake System 1-57
Wheel Brakes 5-35
Wheels and Tyres 5-35
Wind Data 4-178
Windmill Relight 3-16
Windscreen Anti-Icing and De-Misting 1-116
Windscreen Heater Switch 1-118
Windscreen Rain Dispersal 1-115
Windscreen Wash 1-115
Wing Buzz 6-5
Wing or External Tank Transfer Failure 3-27
Wing Slats, Flaps and Krueger Flaps 1-77
Wing Slot Sealing 1-113
Wing Sweep 5-21, 6-3
Wing Sweep System 1-77
Wing Tanks 1-33, 3-27

X

X-Drive Clutch Does not Open 3-38
X-Drive Clutch Does not Shut 3-38
X-Drive Clutch Shuts Below 15% Diff 3-38
X-Drive Clutch Shut/Push Open Button 1-29
X-Drive Clutch Switch 1-29
X-Drive Clutch/Gearbox Failures 3-38
X-Drive Operation 1-31

Y

Yaw 1-67
Yaw Damp 6-12
Yaw Trim 1-66

Z

Zero Brake Pressure 3-40

1

10 NM Map Scale 4-140

2

25° Cruise Wing 6-6
25° Full Flap 6-7
25° Manoeuvre Wing 6-6
25° Mid Flap 6-7

4

45° Wing Sweep 6-7

6

67° Wing Sweep 6-7