EuroFighter **FM-J-150-A-0002**

EF2000
DEVELOPMENT AIRCRAFT
DA7

FLIGHT MANUAL
VOLUME 1

EuroFighter

Alenia – Aeronautica
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CAUTION

- This publication is valid only if it is composed of the above listed pages.
- Ensure that any preceding changes have been incorporated before inserting latest change.

GENERAL INFORMATION

NOTES TO USERS

SCOPE

This manual contains the necessary information for safe operation of the EF2000 aircraft. These instructions provide you with a general knowledge of the aircraft and its characteristics and specific normal and emergency procedures. Your experience is recognized therefore, basis flight principles are avoided.

APPLICABILITY

Information contained in this Manual is generally applicable to DA7 aircraft, fitted with:

- AV SP 3C/15
- FCS PH3 Rel 1
- UCS 3C Rel 2
- EJ200-01A, -01C, -03 A, -03B, -03Z or MK101E engines

ASSOCIATED MANUALS

This Manual is complementary to the following publications:

- PDM-J-150-A-0001: EF 2000 Performance Data Manual for DA3/DA7.
- CL1-J-150-A-0002: EF 2000 Flight Crew Checklist for DA7.

MANUAL STRUCTURE

The manual is divided into SECTIONS. Each section is divided into CHAPTERS. The chapters contain the entire information relevant to a specific aircraft system, e.g. Hydraulic System, or to a specific phase of flight (POF), e.g. Ground-Normal-and Emergency procedures.
The Manual consists of the following:

- General Information
- Section 1 - Description and Operation
- Section 2 - Normal Procedures
- Section 3 - Emergency Procedures
- Section 8 - Attack and Identification System

UPDATING PROCEDURES

This Manual will be updated/amended in form of Urgent Changes or Routine Changes.

URGENT UPDATE

Information involving safety or urgent operational requirements will be promptly forwarded by ALENIA by the use of an Interim Safety (INTSS) or Interim Operational Supplement (INTOS).
Interim Supplements will have limited distribution and will be forwarded to ALENIA Flt Ops, ALENIA Flt Test, ALENIA Airworthiness, relevant ALENIA SDR departmen and EPCs by Fax or E-Mail or as appropriate.
When instructed the number of the relevant INTSS/INTOS has to be written alongside the affected portion of the manual.

ROUTINE CHANGES

Routine changes are issued at certain intervals, or as required. Depending on the amount of the changes may consist of the following:

- An Operational Supplement (OS), or
- A Regular Change, or
- A complete Revision of the FM.

CHANGE IN FORM OF OS

An OS may include a change or an amendment of the FM. The OS will consist of a cover page (OS), giving instruction for the change/amendment, and a complete revision of the affected chapter (s) printed on blue paper. At the bottom part of each revised page of the entire chapter cross-reference to the OS-X (Nr of OS). This sort of change will be incorporated into the next regular change or revision.

REGULAR CHANGE

A regular change will consist of a change instruction page and replacement pages for the Title, Preliminary pages (where required) and complete revised chapters. Changes/amendments to the content of a subchapter will always result in the replacement of the entire affected chapter. The replaced pages/chapter (s) will carry the annotation CHANGE and the sequential change number at the bottom of each page. Preliminary pages, such as the Title page, List of Effective Pages and the relevant Section Table of Content will be amended/updated accordingly.

CHANGE SYMBOLS

The change symbol is a black line in the outher margin of the affected paragraph. It indicates text and/or tabular changes made to the current issue. Changes to illustrations are indicated by a note located under the figure number/title. Change symbols of a previous change will be removed.

SUPPLEMENTS

Supplements have to be inserted in the following order: INTOS/OS on top the FM and INTSS/SS on top of the INTOS/OS supplements. Their existence should be documented on the page RECORD OF AMENDMENTS.

FLIGHT LIMITATIONS

Flight limitations in general are not published in this FM. The responsibility for permanent updating of flight limitations in accordance with EF and national requirements is assured by ALENIA Airworthiness Department. The limitations are published within the applicable Airworthiness Flight Limitation (AWFL) for DA7.

CATORIZATION OF WARNINGS

As the warnings and their presentation the cockpit are well defined, CAT 2 warning captions red, while CAT 3 warning captions amber within Section 3 of the FM. Category 1 and Category 4 warnings are explicitly mentioned as CAT 1 and CAT 4 respectively. The Categories are defined as follows:

- CAT 1: Voice; MHDD/HUD Information; Flashing Attention Getters.
- CAT 2: Attention Getters; Attenson; Voice; RED Warning on DWP/MHDD.
- CAT 3: Attention Getters; Attenson; Voice; AMBER Warning on DWP/MHDD.
- CAT 4: Attenson; Voice; MHDD Information.

WARNINGS, CAUTIONS, NOTES

WARNING

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

CAUTION

OPERATING PROCEDURE, TECHNIQUE, ETC., WHICH COULD RESULT IN DAMAGE TO EQUIPMENT IF NOT CAREFULLY FOLLOWED.

NOTE

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

For information of the Cockpit warning System, refer to Warning System Moding Definition Document.

CORRECTIONS AND RECOMMENDATIONS

Any comments and suggestions intended to correct or improve the information in this manual should be submitted to:
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LIST OF ABBREVIATIONS

SHORT TERM	DESCRIPTION
A & I	Attack and Identification
A/A	Air to Air
AB	Airbrake
AC	Alternate Current
AC	Attack Computer
ACFC	Air Cooled fuel Cooler
ACIS	Armament Carriage and Installation System
ACOC	Air Cooled Oil Cooler
ACS	Armament Control System
ADL	Automatic Data Link
ADT	Air Data Transducer
ADS	Air Data System
AFC	Automatic Frequency Control
AFCV	Air Flow Control Valve
AG	Attention Getter
AICS	Air Intake Control System
AIPT	Air Intake Pressure Transducer
AM	Amplitude Modulation
AMRAAM	Advanced Medium Range Air to Air Missile
AOA	Angle of Attack
APU	Auxiliary Power Unit
APUCU	APU Control Unit
ATC	Air Traffic Control
ATS/M	Air Turbine Starter Motor
AVS	Avionic System
AWFL	Aircraft Airworthiness Flight Limitations
AVSOV	Avionic Shut-Off Valve
BBS	Baseline Build Standard
BC	Bus Control
BIT	Built In Test

SHORT TERM	DESCRIPTION
BITE	Built In Test Equipment
CAMU	Communication and Audio Management Unit
CAS	Calibrated Airspeed
CAU	Cold Air Unit
CBIT	Continous BIT
C+D	Controls and Display Subsystem
CFG	Constant Frequency Generator
CG	Center of Gravity
CIU	Cockpit Interface Unit
COMMS	Communications
CPCV	Cabin Pressure Control Valve
CPU	Central Processing Unit
CSDB	Common Source Data Base
CSG	Computer Symbol Generator
CSMU	Crash Survivable Memory Unit
CSV	Cabin Safety Valve
CTCV	Cabin Temperature Control Valve
CTR	Center
DASS	Defensive Aids Subsystem
D+C	Display and Controls
DC	Direct Current
DECU	Digital Engine Control Unit
Deg/DEG	Degrees
DEK	Data Entry Keyboard
DIFU	DECU Interface Unit
DME-P	Distance Measuring Equipment - Precision
DRL	Data Requirement List
DTD	Document Type Definition

SHORT TERM	DESCRIPTION
DVI	Direct Voice Input
DWP	Dedicated Warning Panel
EBSOV	Engine Bleed Shut-Off Valve
ECCM	Electronic Counter Counter Measures
ECR	Electronic Counter Reconaissance
ECS	Environmental Control System
ECU	Electronic Control Unit
EF2000	European Fighter 2000 Aircraft
EGT	Exhaust Gas Temperature
EMS	Engine Monitoring System
EPS	Emergency Power System
EPU	Emergency Power Unit
ERA	Emergency Ram Air
ERU	Ejection Release Unit
FCC	Flight Control Computer
FCOC	Fuel Cooled Oil Cooler
FCS	Flight Control System
FLIR	Forward Looking Infra Red
FRP	Flight Refueling Probe
FRS	Flight Resident Software
FT/ft	Feet
FTI	Flight Test Instrumentation
FWD	Forward
GB	Gearbox
GCU	Generator Control Unit
GLU	Ground Loading Unit
GPC	Ground Power Connector
GPS	Global Positioning System
GPU	Ground Power Unit
GTE	Ground Test Equipment

SHORT TERM	DESCRIPTION
GUH	Get-U-Home
GU	Guard UHF
GV	Guard VHF
HDD	Head Down Display
HDG	Heading
HF	High Frequency
HOTAS	Hands On Throttle and Stick
HP	High Pressure
HUD	Head Up Display
HYD	Hydraulic
IAS	Indicated Airspeed
IBIT	Initiated BIT
ICU	Interface Control Unit
IFF	Identification Friend or Foe
IFR	In-Flight Refueling
IMRS	Integrated Monitoring and Recording Subsystem
IMU	Inertial Measurement Unit
INS	Inertial Navigation System
IPU	Interface Processor Unit
ISA	International Standard Atmosphere
KCAS	Knots Calibrated Airspeed/Knots Corrected Airspeed
KDAS	Knots Displayed Airspeed
KEAS	Knots Equivalent Airspeed
kg	Kilogramme(s)
KN	Kilonewton(s)
KPa	Kilopascal(s)
kT/kt	Knots
KW	Kilowatt(s)
LDERU	Light Duty ERU
LES	Leading Edge System
LG	Landing Gear

SHORT TERM	DESCRIPTION
LGC	Landing Gear Computer
LHGS	L/H Glareshield
LINS	Laser Inertial Navigator
LP	Low Pressure
LRI	Line Replaceable Item
LTR/ltr	Liter
M	Mach
MASS	Master Arm Safety Switch
MDE	Manual Data Entry
MDLR	Mission Data Loader and Recorder
MDP	Manual Data Panel
MDR	Manual Data Recorder
MEL	Medium Range Air to Air Eject Launcher
MHDD	Multi Function Head Down Display
MIDS	Multi-Functional Information Distribution System
MK	Mark
MLG	Main Landing Gear
MLS	Microwave Landing System
MRAAM	Medium Range Air to Air Missile
MSL	Mean Sea Level
MSOC	Molecular Sieve Oxygen Concentrator
MSOG	Molecular Sieve Oxygen Generation
N/A	Not Applicable
NBC	Nuclear, Biological and Chemical
NC	Navigation Computer
NLG	Nose Landing Gear
NM	Nautical Miles
NRV	Non Return Valve
NSCAC	Non Safety Critical Armament Controller

SHORT TERM	DESCRIPTION
NWS	Nose Wheel Steering
ODM	Operational Data Manuals
OTF	On Top Fixing
PBIT	Power-Up BIT
PDC	Portable Data Carrier
PDU	Pylon Decoder Unit/Pilot's Display Unit
PIO	Pilot Induced Oscillation
PP	Present Position
PRSOV	Pressure Regulating and Shut-Off Valve
PRV	Pressure Reducing Valve
PSP	Personal Survival Pack
PTO	Power Take Off
PTT	Push to Talk
QA	Quality Assurance
QAWP	Quality Assurance and Airworthiness Panel
QTY	Quantity
RAD ALT	Radar Altimeter
RF	Radio Frequency/Rear Fuselage
RFA	Request For Alteration
RH	Right Hand
RMS	Root Mean Square
RNG	Range
ROL	Readout Lines
RPM	Revolution Per Minute
R/T	Radio Transmission
RT	Remote Terminal
RTB	Return to Base
RTO	Rejected Takeoff
RX	Receiver
SCA	Sub Contract Annex/ Software Change Amendment
SCAC	Safety Critical Armament Controller

SHORT TERM	DESCRIPTION
SDR	System Design Responsibility
Sec	Seconds
SK	Softkey
SL	Sea Level
SOV	Shut-Off Valve
SPS	Secondary Power System
SPSCU	Secondary Power System Control Unit
SRD	Software Requirement Document
STOL	Short Takeoff/Landing
STTE	Special To Type Test Equipment
S/W	Software
SWP1-5	Software Package (1-5)
TACAN	Tactical Air Navigation
TBA	To Be Advised
TBD	To Be Decided
TBT	Turbine Blade Temperature
TCV	Temperature Control Valve
TMC	Twin Missile Carrier
TO	Takeoff
T/R	Transmitter/Receiver
TRU	Transformer Rectifier
TSC	Twin Store Carrier
TSU	Tip Station Unit
TTU	Triplex Transducer Unit
TX	Transmitter
UCS	Utilities Control System
UHF	Ultra High Frequency
V	Volt
V/UHF	Very/Ultra High Frequency
VHF	Very High Frequency
VPROSV	Variable Pressure Regulating and Shut-Off Valve
VVR	Video Voice Recorder
VWS	Voice Warning System

AMENDMENT RECORD SHEET

RECORD OF INCORPORATED OR DELETED SAFETY AND/OR OPERATIONAL SUPPLEMENTS

The following table records supplements deleted or incorporated into this manual since the preceeding issue or change.

NO	TYPE & NO OF SUPPLEMENT	ISSUE DATE	SHORT TITLE	REMARKS

RECORD OF SUPPLEMENTS NOT INCORPORATED

The following table records supplements not yet incorporated into this manual. Interim supplements are recorded here as well.

NO	TYPE & NO OF SUPPLEMENT	ISSUE DATE	SHORT TITLE	REMARKS

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FIGURES

COCKPIT ILLUSTRATION

This Data Module contains an illustration showing the front cockpit layout.

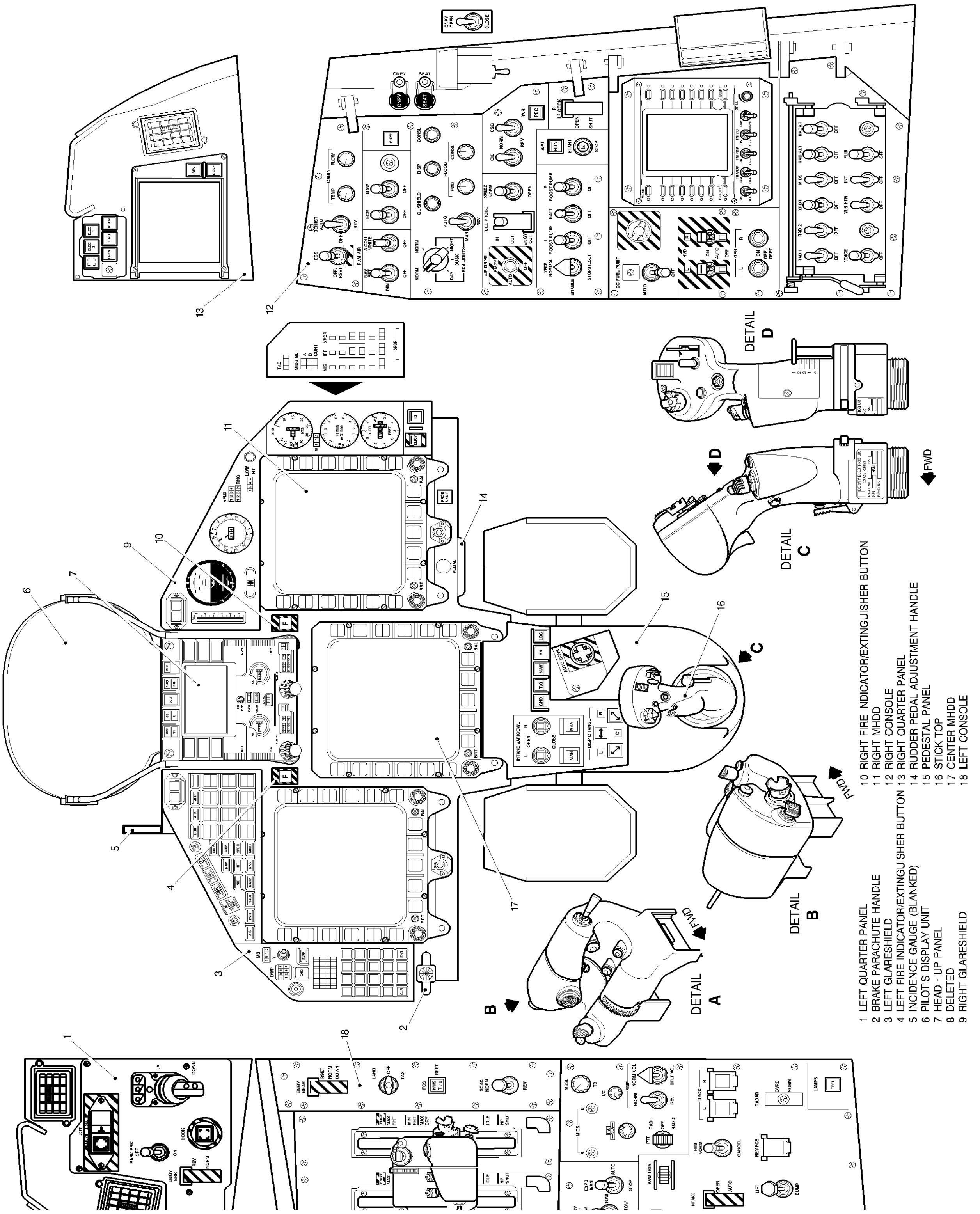


Figure A - Cockpit Illustration

ELECTRONIC DISPLAY FORMATS MHDD (AVS 3C)

MULTIFUNCTION HEAD DOWN DISPLAY FORMATS

The figures and tables that follow, present the MHDD formats that are available at avionics system package 3C/10 and their associated soft key functionality. The term "group" is used to describe which of the three MHDD the format is normally presented on, where groups A, B and C represent formats that appear on the left, center and right MHDD respectively. Each phase of flight has its own default MHDD formats which are presented automatically upon transition from one phase to another, refer to Table . The tables that describe the soft key functions refer to each key by a number (1-17), which describes its position on the display bezel. The keys are numbered from 1 to 17 in a counter clockwise sequence starting from key 1 which occupies the top left hand position. It should be noted that most formats contain a number of softkeys that have not been assigned functions. For reasons of convenience, some of the soft key functions that are common to a number of MHDD formats have been described together in a separate paragraph at the end of this chapter.

Default Formats

Phase of Flight	Group A	Group B	Group C
Ground	Autocue	Pilot Awareness	Engine/Stores
Take-off	Attack	Pilot Awareness	Engine
Navigation	Attack	Pilot Awareness	Elevation
Air-to-Air	Attack	Pilot Awareness	Elevation
Landing	Attack	Pilot Awareness	Engine

AUTOCUE FORMAT

The Autocue format Figure B and Table is a group A format which is selected by default during ground phase of flight. It supports the pilot during pre and post flight activities by presenting information necessary for the safe preparation of the aircraft for its intended task. The following types of data are presented.

- Control prompts (switch settings - limited functionality at SP3C/10).
- Flight control system status.
- Navigation system status.
- Caution indications.
- Failure indications.
- Store error indications.
- Displays and controls error indications.
- PDS load indications.
- Cryptovariable indications.
- Command eject indications.
- Operational status indications.

Autocue Format Soft Key Functions

Softkey Number	Softkey Caption	Softkey Description
5	PAGE UP	Selects the previous page of Autocue items (not available when first page is displayed).
6	PAGE DOWN	Selects the next page of Autocue items (not available when the last page is displayed).
12	ALGN HUD	Selects LINS rapid alignment mode (HUD optical transfer).
13	ALGN MEMO	Selects LINS memorized heading alignment mode.
14	ALGN NORM	Selects LINS normal alignment mode.
15	NAV SEL	Selects navigate mode.

ENGINE FORMAT

The engine format Figure C Table belongs to groups A and C and is selected by default during ground, take-off and landing phases of flight as a group C format. Engine low pressure turbine speed (NL), turbine blade temperature (TBT) and nozzle area (Aj) are represented by four circular displays. Important values are displayed by either infill, digital or analog readouts. Each display has an alphanumeric value corresponding to the analog data presented except for high pressure turbine speed which is represented by two separate rolling digit type displays. Intake positions are shown by two triangular markers which move against a fixed linear scale and by digital readouts. Fuel flow is indicated in digital form at the top of the display. Warning captions related to the engines are also shown on this format. The captions which are similar to those shown on the dedicated warning panel and include:

– Left and right DECU failure warnings (amber)
– Left and right reheat failure warnings (red or amber)
– Left and right oil over temperature warnings (amber)
– Left and right engine fire warnings (red)
– Left and right engine performance warnings (red)
– Left and right engine vibration warnings (amber)
– Left and right oil pressure warnings (red).

The SK associated with the engine format enable DECU lane selections to be made and other formats to be accessed.

Engine Format Soft Key Functions

Softkey Number	Softkey Caption	Softkey Description
4	L1 L2	Selects left DECU lane 1 or lane 2 as required.
14	L1 L2	Selects right DECU lane 1 or lane 2 as required.

FUEL FORMAT

The Fuel format Figure D Table belongs to groups A and C. Internal and external fuel tanks and contents are shown pictorially. Fuel levels are displayed using blue infill which alter with respect to fuel remaining. Each tank has a digital readout corresponding to the actual fuel remaining. Fuel transfer and boost pumps within the internal fuel tanks are displayed when running. During normal operation a running pump is indicated by a white infilled circle, however a pump that has failed or has been detected as running dry is indicated as a red infilled circle. The status of the low pressure fuel cocks is indicated by two symbols, each comprising a bar within a circle. The LP cock status is indicated as follows:

– Bar vertical = open
– Bar horizontal and symbol amber infill = shut
– Symbol red infill = failure

Engine feed lines are drawn between the boost pumps and the LP fuel cock symbols. During normal operation the engine feed lines are blue, however if low fuel pressure is detected within an engine feed line it will be displayed with amber dashes, and an amber 'LOW PRES' caption is displayed. Fuel feed temperatures are indicated in digital form (white digits) adjacent to the LP cock symbology. The indicated fuel temperature is displayed with an amber infill if the DWP fuel over temperature warning is triggered. The status of the fuel crossfeed valve is indicated by a boxed caption as follows:

– Caption present = crossfeed open
– Caption occulted = crossfeed closed
– Caption present + red infill = failure.

During fuel transfer, blue transfer lines are drawn between the receiving main group(s) and the fuel tank(s) currently transferring fuel. A fuel transfer menu displays the currently selected transfer option and all options that are available for selection (via the fuel format SK). Initiation of forward or rear selective transfer (via the fuel format SK) is indicated by one of two selective transfer captions. Similarly, during air-to-air refueling, blue lines are drawn between a flight refueling probe symbol and the fuel tanks that are currently being replenished. A flight refueling menu displays the currently selected refuel option and all other options that are available for selection (via fuel format SK).

Other information displayed on the fuel format includes a fuel total readout, a CG warning and a selector prompt to show the recommended selection to restore fuel balance.

Fuel Format Soft Key Functions

Softkey Number	Softkey Caption	Softkey Description
2	XFER AUTO UDWG UDFU STG1 STG2	Enables the automatic transfer sequence to be overridden. Selection of the required stage (AUTO, UDWG, UDFU, STG 1, STG 2) is achieved by repeated selection of the key until the desired stage is displayed on the key and boxed on the transfer menu.
3	XFER FWD	Isolates the fuselage rear group and enables all remaining transferable fuel to be transferred to the front group.
4	XFER REAR	Isolates the fuselage front group and enables all remaining transferable fuel to be transferred to the rear group.
5	TANK INTC	Enables the tank interconnection valve to be opened or closed as required (UCS 3C/2 onwards).
14	REFU STOP	Selection of this key stops fuel entering the aircraft during air-to-air refueling (only displayed when the AAR probe is deployed)
15	REFU STRT	Selection of this key restarts the air-to-air refueling after a REFU STOP selection.
16	REFU TOT INT SIM	Enables tank groups to be selected for refueling. Selection of the required option (TOT, INT, SIM) is achieved by repeated selection of the key until the desired option is displayed on the key and boxed on the refueling menu (only displayed when AAR probe is deployed and external fuel tanks are fitted).

HYDRAULIC FORMAT

The Hydraulic format Figure E Table belongs to groups A and C and provides a diagrammatic representation of the left and right hydraulic systems. The display shows the status of the valves and reservoirs along with associated information e.g. pressures, levels and temperatures. The information is displayed in analog and digital form.

Reservoir contents, primary flying control pressures and utilities pressures are displayed using green rectangular boxes with integral blue infills which alter with respect to contents or pressure as applicable. Each box has a readout of actual pressure or contents which is displayed adjacent to a white triangular pointer which provides a visual marker of the infill level for that box. If a system pressure or reservoir content within the hydraulic system falls below the safe level (indicated by a white marker within the box) the associated box(es) are displayed in red and the digital readout(s) of actual contents will be displayed against a red infill.

The status of the utility isolation valves is indicated by two symbols, each comprising a bar within a circle. An AUTO or MAN caption is displayed adjacent to the symbols to indicate whether the valves are being controlled automatically (by the hydraulic system) or manually (via softkey selection). The valve status is indicated as follows:

- Bar vertical = open
- Bar horizontal = shut.

Left and right hydraulic oil temperature is displayed against two separate static scales (green). Actual temperature (in °C) is displayed adjacent to a triangular marker which is able to move vertically against the static temperature scale. If a hydraulic over temperature occurs the static temperature scale is displayed in red.

Hydraulic Format Soft Key Functions

Softkey Number	Softkey Caption	Softkey Description
3	OPEN CLSD	Enables the left hydraulic system utility isolation valve to be opened or closed manually. Key will occult when the opposite system utility isolation valve is closed.
4	AUTO MAN	Enables the left utility isolation valve to be controlled manually or automatically. Key will occult when the opposite system utility isolation valve is closed.
14	OPEN CLSD	Enables the left hydraulic system utility isolation valve to be opened or closed manually. Key will occult when the opposite system utility isolation valve is closed.
15	AUTO MAN	Enables the right utility isolation valve to be controlled manually or automatically. Key will occult when the opposite system utility isolation valve is closed.

HEAD DOWN HUD FORMAT

The HUD format Figure F Table belongs to groups A and C and presents analog and digital readouts similar to those presented on the head-up display (HUD). Symbology presented on the format is categorized at follows:

– Attitude and directional symbology
– Navigation symbology
– Airdata symbology
– Autopilot symbology
– Attack symbology.

The main difference between the two displays is that the HDHUD format has a circular attitude display in addition to the HUD attitude symbology. The circular attitude display is divided into two sectors, one colored blue and the other brown, indicating pitch attitudes above and below the horizon respectively.

HUD Format Soft Key Function

Softkey Number	Softkey Caption	Softkey Description
2	GS M	Selects groundspeed or Mach number for display as required.
3	SRCE SPLT LINS NAV	Enables climb, dive, bank and VSI data source to be selected by repeated key selection until the desired option is displayed on the key. Options available include: SPLT - where the HUD uses LINS data and the HDHUD uses best navigation data (only available after a monitor trip has occurred). LINS - where HUD and HDHUD use LINS data. NAV - where HUD and HDHUD use best navigation data.
15	BARO RAD	Repeated selection of this key enables barometric altitude or radar altitude to be displayed or a combination of both.

PILOT AWARENESS FORMAT

The Pilot Awareness format Figure G Table is a group B format which displays navigational information in plan form using a combination of navigation symbology and digital readouts. The symbology can be displayed against a digitally generated map and one of four selectable grids; range, lat/long, geographical reference or bullseye. The orientation of the display can be selected to either 'north up' or 'track up' and provision is made to enable one of two display stabilization modes (aircraft/ground) to be selected. The scale of the display is adjustable via the X-Y controller which can also be used to slew the map and select different grids if required. One of two compass roses (120° or 360°) showing present heading and track can be superimposed on the display if required. The PA format also presents track/target data and a limited amount of miscellaneous information to assist the pilot to manage the aircraft safely. The display is active and therefore gives a true representation of aircraft positioning at all times. MHDD SK associated with the PA format enable a number of display modes to be selected and also enable additional information to be displayed and other MHDD formats to be accessed.

The PA format enables planned or unplanned routes to be displayed in plan form with respect to the aircrafts present position. Each leg of the route is represented by a green line except the current leg which is represented by a white line, together they connect all the waypoints in the route. The position of each point is marked by small white cross which is annotated with an individual waypoint number and a letter denoting the waypoint type. The present position of the aircraft is represented by a green triangle.

Pilot Awareness Format Soft Key Functions

Softkey Number	Softkey Caption	Softkey Description
1	MAG TRUE	Selects between true and magnetic heading (affects heading displays on all formats). Heading is prefixed by a 'T' when true heading is selected (magnetic is default).
2	TRK NTH	Selects the display orientation between 'track up' and 'north up' as required (track is default).
3	COMP 120 360	Enables one of two compass roses to be displayed on the PA format 120° or 360° if required. Softkey remodes to display COMP 120 or COMP 360 as necessary.
4	MAP TAC	Selects/de-selects map and tactical information display options on the PA format including: MAP (map only) TAC (tactical only) MAP+TAC (map and tactical) (a further selection occults both map and tactical data).

(Continued)

Pilot Awareness Format Soft Key Functions (Continued)

Softkey Number	Softkey Caption	Softkey Description
5	AIR LRTE HRTE LINF OFF	Allows the pilot to select information options for display on the PA format including: LRTE (low route) HRTE (high route) LINF (low information) OFF.
7	MAP FINE MED CRSE	Enables the map level to be selected options include FINE (fine), MED (medium) and CRSE (coarse and default). Fine is only available on the 80NM range scale.
8	TACT MIN NOR MAX	Changes the tactical data declutter selection between MAX and MIN settings. NOR is displayed to indicate normal state (NOR+ indicates the next selection will be MAX, NOR- indicates the next selection will be MIN). SK is available when the TAC or MAP+TAC options are selected).
12	C/D BALL	Enables the aircraft attitude to be displayed on the attack and elevation formats in the form a small 'attitude ball' type display.

(Continued)

Pilot Awareness Format Soft Key Functions (Continued)

Softkey Number	Softkey Caption	Softkey Description
13	A/C GND	Toggles the map stabilization mode between ground stabilized and aircraft stabilized.
14	FIX REJT	Enables the pilot to reject displayed fix errors.
15	FIX OTF ACPT	When FIX OTF is displayed selection of the key will perform an on-top-fix. After fixing the key remodes to FIX ACPT to allow the pilot to accept the displayed fix errors.
17	RTN PP DWP	When operating in window-on-the world mode this key enables the map to be slewed to present positon if RTN PP is displayed or the destination waypoint if RTN DWP is displayed. When window-on-the world mode is not selected the key remodes to perform the DFLT function.

HSI FORMAT

The HSI format Figure H Table belongs to group B and provides an indication of actual heading and track and steering information associated with the current route or TACAN beacon as required. All angular information is displayed against a 360° compass rose which is orientated such that the actual aircraft heading is always 'up' (marked by a lubber line). Aircraft present position is marked at the center of the compass rose by a green upwards pointing triangle. The actual track of the aircraft and bearing to next waypoint or TACAN beacon are displayed on the periphery of the compass rose by 'V' shaped markers. The bearing marker is distinguishable from the other markers by its bright green infill. Other markers on the compass rose reflect pilot selected heading and course which are set manually via the MHDD rotary controls. Pilot selected heading is indicated by a black and white marker on the periphery of the compass rose and is set via the left inner rotary control. Similarly the pilot selected course marker which is represented by a large gapped arrow at the center of the rose is adjusted via the right inner rotary control. The angular difference between set course (i.e. radial) and the bearing to current destination is shown by a moving lateral deviation which is read against a fixed scale. A to/from flag is also used to indicated whether the angular difference between the two is greater than or less than 90° (if less than 90° the to flag is shown and vice-versa). A number of digital readouts are positioned around the display providing range (plan) and bearing to destination, destination waypoint number and course setting.

HSI Format Soft Key Functions

Softkey Number	Softkey Caption	Softkey Description
1	MAG TRUE	Selects between true and magnetic heading (affects heading displays on all formats). Heading is prefixed by a 'T' when true heading is selected (magnetic is default).
8	NAV TAC	Selects the HSI mode to navigation or TACAN steering mode.
11	C/D BALL	Enables the aircraft attitude to be displayed on the attack and elevation formats in the form a small 'attitude ball' type display.

WAYPOINT FORMAT

The Waypoint format Figure I Table belongs to group C is able to present information associated the master waypoint list, the automatic route, and the manual route in the form of three separate waypoint lists. The lists are mutually exclusive and can be accessed by selection of three SK labelled 'WPT LIST', 'AUTO RTE' and 'MAN RTE'. When a list has been selected the details of all associated waypoints are presented in five columns; waypoint number, type, name, description and planned time of arrival. Extra data including range/bearing, lat/long, altitude (relative to sea level) can be revealed for any of the waypoints by selecting them with the X-Y controller. A paging facility is provided in cases where the number of points in the list exceeds the capacity of the display. The list can also be restricted to display waypoints of a specific type by repeated selection of a SK labeled 'TYPE'. Regardless of which list is selected the format also displays the order of the manual and automatic routes and highlights the destination waypoint in a separate display at the bottom of the format. The content and order of these routes can be edited via the X-Y controller if required.

Waypoint Format Soft Key Functions

Softkey Number	Softkey Caption	Softkey Description
2	WP LIST	Selects the waypoint master list for display.
3	AUTO RTE	Selects all waypoints in the automatic route for display.
4	MAN RTE	Selects all waypoints in the manual route for display.
15	TYPE ALL RTE LDG OVFL CAP MARK FUEL	Restricts displayed waypoints to a specific type, repeated selection of the key will toggle throught the following options. ALL (all waypoints listed) RTE (route points only) LDG (landing points only) OVFL (overfly points only) CAP (combat airpatrol points only) MARK (mark points only) FUEL (refueling points only).

RADIO FORMAT

The Radio format Figure J Table belongs to group C and presents the V/UHF frequencies for the manual channel and the 24 preset channels for radios 1 and 2. The data is presented in the form of two mutually exclusive lists one covering radio 1 details and the other covering radio 2, however, the format always displays manual channel data for both radios. The list has dedicated columns for preset number, frequency, mode, channel identifier etc. and can display up to 12 presets plus two manual channels at any one time. The remainder of the presets are listed on a second page which can be accessed by SK selection or by X-Y manipulation. The currently selected channel is identified by a green box which appears around its details.

Radio Format Soft Key Functions

Softkey Number	Softkey Caption	Softkey Description
2	RAD 1	Selects V/UHF radio 1 or radio 2 presets for display as required.
	RAD 2	
4	PAGE	When PAGE DOWN is displayed, selection of the key permits access to radio presets 13-24. When PAGE UP is displayed, selection of the key permits access to radio presets 1-12.

ATTACK FORMAT

The Attack format Figure K Table is a group A format which together with HOTAS controls, enable radar contacts to be displayed, tracked or nominated for attack. During operation in track-while-scan (TWS) mode radar contacts are displayed against one of two selectable range/azimuth display formats. The default format is a B-scope grid type presentation upon which the synthetic plot, track and target symbols are presented. The x-axis of the grid represents azimuth 60° either side of current heading and is marked every 20°. The y-axis represents the currently selected range scale which is selected using the X-Y controller. Scan volume is indicated against the grid by three vertical lines which together represent scan width and center and by a scanner elevation scale against which current bars scan pattern and coverage is displayed. The X-Y controller is used to adjust the scan width and bars scan pattern as well as steering the centerline of the pattern in azimuth. A rotary control on the throttles allows the scan volume to be steered in elevation.

SK selection enables the display to be changed to a plan position indication (PPI) type presentation if required. When PPI is selected radar contacts are displayed against a sector upon which range is indicated by arcs. Management of the PPI display is identical to that of the B-scope.

Velocity search (VS) and real beam ground mapping (RBGM) modes are provided as an alternatives to TWS and are accessed by SK selection. When in VS mode radar plots are shown against a velocity azimuth type display. The x-axis represents azimuth while the y-axis represents one of two X-Y selectable velocity scales (medium and high velocity). A green horizontal line divides the display into two halves, a lower half and an upper half representing relative opening an closure speeds respectively. Management of the display is the same as that described for operation in TWS in all other respects.

Attack Format Soft Key Functions

Softkey Number	Softkey Caption	Softkey Description
1	PPI B-SP	Enables Plan position Indication (PPI) or B-scope (B-SP) display modes to be selected.
2	RBGM	Selects real beam ground mapping mode.
3	TWS VS	Enables track while scan (TWS) or Velocity Search (VS) modes to be selected.
4	SCAN MAN	Enables the scanner to be controlled automatically (AUTO) or manually (MAN) as required.
6	AUTO RAID	Selects the automatic RAID assessment for the purpose of resolving track contentions.
9	VIS	Selects/ deselects VISIDENT mode against a specified track.

(Continued)

Attack Format Soft Key Functions (Continued)

Softkey Number	Softkey Caption	Softkey Description
11	SRCH AWS	Alters the emphasis between searching and tracking by allowing one of the following modes to be selected; Nomal (NORM), adaptive waveform scheduling (AWS) and priority search (PS).
12	XFOV	Selects SRAAM (AIM9-L) wider field of view scan pattern.
14	DCLT MIN NOR MAX	Allows the level of display declutter to be selected between MAX and MIN settings. NOR is displayed to indicate normal state.
15	AGE AUTO 5 10 15	Selects plot ageing times. The current plot ageing time is displayed on the key (AUTO, 5, 10, 15).

ELEVATION FORMAT

The Elevation Figure L Table is a group Group C format together with HOTAS controls, enables radar contacts to be displayed, tracked or nominated for attack. The contacts are displayed against one of two selectable formats; an altitude/range grid presentation known as 'profile' and an altitude/ azimuth grid presentation know as 'C-scope'. With the profile format selected the x-axis represents plan range in front of the aircraft while the y-axis represents altitude. Scanner elevation coverage is displayed using two diverging lines and the pattern can be steered in elevation via a rotary control on the throttles. The aircraft is represented by a small green triangle on the left of the display.

Elevation Format Soft Key Functions

Softkey Number	Softkey Caption	Softkey Description
2	PROF	Enables profile (range vs. height) or c-scope (azimuth vs. height) presentations to be selected.
	CSCP	
3	OUTL	Selects outline of cockpit hardware and horizon line for display (c-scope only).
5	FLIR	Enables FLIR to be selected between the SBY on ON states.
	SBY ON	

DASS FORMAT

The DASS format Figure M Table is a group C format that is able to present information relating to electronic support measures (ESM) as well as active and passive electronic countermeasures (ECM).

The DASS format is able to present airborne and surface threats that have been detected by onboard ESM sensors. Threats are analyzed by the DASS and are allocated an allegiance by comparing them against known threats (which are stored in a threat library) before being displayed on the DASS format as synthetic tracks. The type of track and its allegiance will determine its color, its shape and the appearance of its border. Generally speaking a color convention is used such that red tracks are considered 'hostile', green tracks are 'friendly' and amber tracks are unknown. The tracks are presented using a plan position technique where slant range and bearing of a particular track can be read against three concentric circles. A green inner circle positioned at the center of the display represents the host aircrafts present position while the blue middle and outer circles represent 20nm and 40nm slant ranges respectively. The display is orientated such that the aircrafts heading is always up (shown by a lubber line). Tracks where range estimates exceed 40nm are positioned at a fixed distance beyond the 40nm circle (regardless of their actual range), but occupy a position relative to their bearing. When tracks are displayed in this manner they are said to be positioned on the 'parking radius'. It should be noted that as no range data is available at SP3C/12 all tracks are positioned on the parking radius by default.

Platforms that are using active ECM techniques to jam the host aircrafts onboard sensors are identified as doing so by the addition of a inward pointing chevron which is displayed on the periphery of their track symbols. A red outward pointing 'threat arrow' is also displayed against tracks that are considered to pose a major threat and for which there are no countermeasures or evasive maneuvers. Indication that the host aircraft is using active or passive ECM techniques against a particular track is shown by a green inward pointing 'counteraction arrow' displayed against its track symbol. The couteraction arrow is mutually exclusive with the threat arrow described above.

Transmitters of the DASS are able to be selected between their transmit and inhibit states via soft key selection with all options (combinations) presented on drop out menus adjacent to their respective soft keys. When a particular transmitter is selected, positive confirmation that it is transmitting is provided by a dedicated transmission symbol. Other information available on the DASS format includes notification of transmitter; over heating, failures and degraded operation along with towed decoy availability, deployment and failure indications. Provision is also made to show the quantity of flare and chaff consumables remaining.

DASS Format Soft Key Functions

Softkey Number	Softkey Caption	Softkey Description
2	FMW BOTH NONE RGHT LEFT	Permits the enabling or inhibiting of the front missile warner transmitters. Repeated selection of the key toggles through the following options: BOTH (left and right transmitting) NONE (both inhibited) RGHT (right transmitting left inhibited) LEFT (left transmitting right inhibited).
3	AMW ENBL INHT	Permits the enabling or inhibiting of the rear missile warner transmitters. Repeated selection of the key toggles between the following states: ENBL (rear transmitting) INHT (rear inhibited).

(Continued)

DASS Format Soft Key Functions (Continued)

Softkey Number	Softkey Caption	Softkey Description
4	ECM BOTH NONE FWD AFT	Permits the enabling or inhibiting of the ECM transmitters. Repeated selection of the key toggles through the following options: BOTH (forward and aft transmitting) NONE (both inhibited) FWD (forward transmitting aft inhibited) AFT (aft transmitting forward inhibited).
5	DCOY ENBL INHT	Permits the enabling or inhibiting of the towed decoy transmitter. Repeated selection of the key toggles between the following options: ENBL (transmitting) INHT (inhibited).

STORES FORMAT

The Stores format Figure N Table belongs to groups A and C and provides a diagrammatic representation of weapon system status and current stores configuration. Stores are represented by white outlined symbols which are displayed in a plan form at positions relative to their host store station. Stores are selected for jettison by performing an X-Y insert over the appropriate store symbol(s) and the selection is confirmed when a cyan selection box is displayed around the store. When all the necessary stores have been selected for jettison a validation of the package can be performed by performing an X-Y insert on an icon marked 'ENT'. If the package fails the validation check a message will appear and flashing selection box(es) will be displayed around system rejected selections. Acceptance of a store for jettison is indicated by a cyan infill. Hung-up or degraded store positions are denoted by red boxing displayed around the affected stores. The stores format also displays MASS state, gun rounds remaining and a selective jettison not accepted warning.

Stores Format Soft Key Functions

Softkey Number	Softkey Caption	Softkey Description
2	CNFG ACPT	Displayed in ground phase of flight only to allow the pilot to accept single source stored configuration data.
3	CNFG REJT	Displayed in ground phase of flight only to allow the pilot to reject single source stored configuration data.
14	NO WPN	Deselects all weapons that are currently selected (key is made available when a weapon is selected).

COMMON SOFT KEYS

Common Soft Key Functions

Softkey Number	Softkey Caption	Softkey Description
1	W	Selects the Warnings Procedure Format for display (not 3C/10)
1	CHKL	Selects the Checklist Format for display (not available 3C/10)

(Continued)

Common Soft Key Functions (Continued)

Softkey Number	Softkey Caption	Softkey Description
6	ELEV	Selects Elevation format for display or reverts to the previously displayed format if the Elevation format is already selected.
7	FUEL	Selects Fuel format for display or reverts to the previously displayed format if the Fuel format is already selected.
7	ATCK	Selects Attack format for display or reverts to the previously displayed format if the Attack format is already selected.
8	ENG	Selects Engine format for display or reverts to the previously displayed format if the Engine format is already selected.
9	HYD	Selects Hydraulic format for display or reverts to the previously displayed format if the Hydraulic format is already selected.
9	MNTC	Selects Maintenance format for display or reverts to the previously displayed format if the Maintenance format is already selected.

(Continued)

Common Soft Key Functions (Continued)

Softkey Number	Softkey Caption	Softkey Description
10	WPT	Selects Waypoint format for display or reverts to the previously displayed format if the Waypoint format is already selected.
11	FREQ	Selects Radio format for display or reverts to the previously displayed format if the Radio format is already selected.
12	STOR	Selects Stores format for display or reverts to the previously displayed format if the Stores format is already selected.
13	HUD	Selects Head Down HUD format for display or reverts to the previously displayed format if the Head Down HUD format is already selected.
16	DASS	Selects Defensive Aids Sub System format for display or reverts to the previously displayed format if the Defensive Aids Sub System format is already selected.
16	MKR LOC	Locates the X-Y marker by positioning it adjacent to the MKR LOC key (Group A formats only).

(Continued)

Common Soft Key Functions (Continued)

Softkey Number	Softkey Caption	Softkey Description
17	NORM	Causes default format to be displayed for current phase of flight.
17	DFLT	Returns the format and soft keys to the default state, or as defined by PSMK.

Figure B - Autocue Format

Figure C - Engine Format

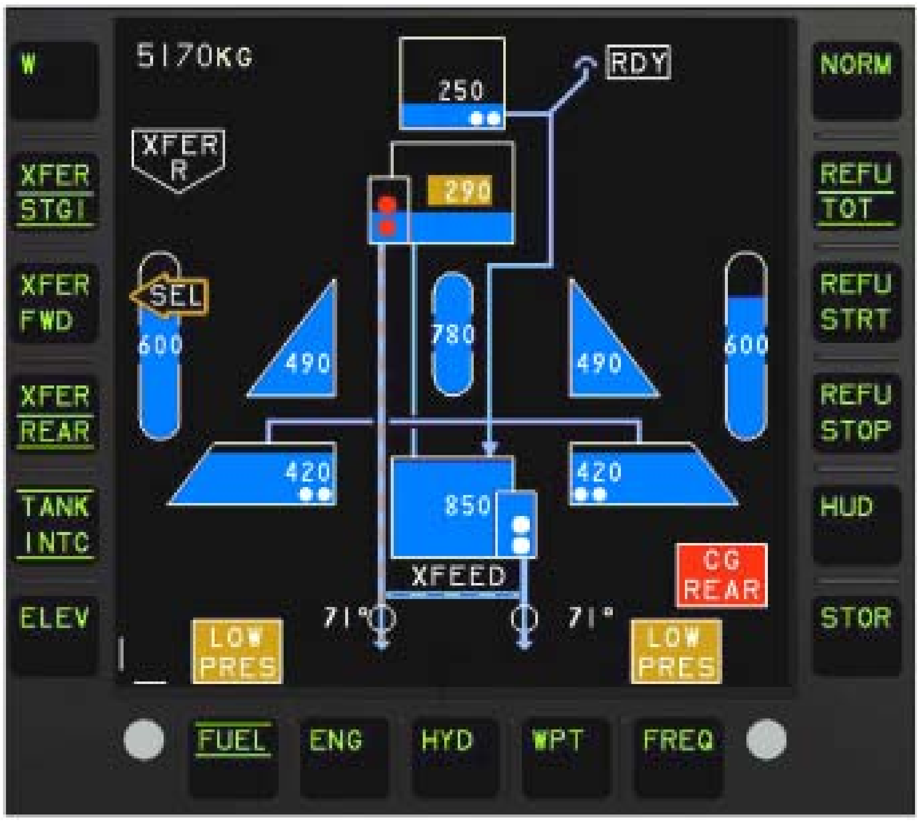


Figure D - Fuel Format

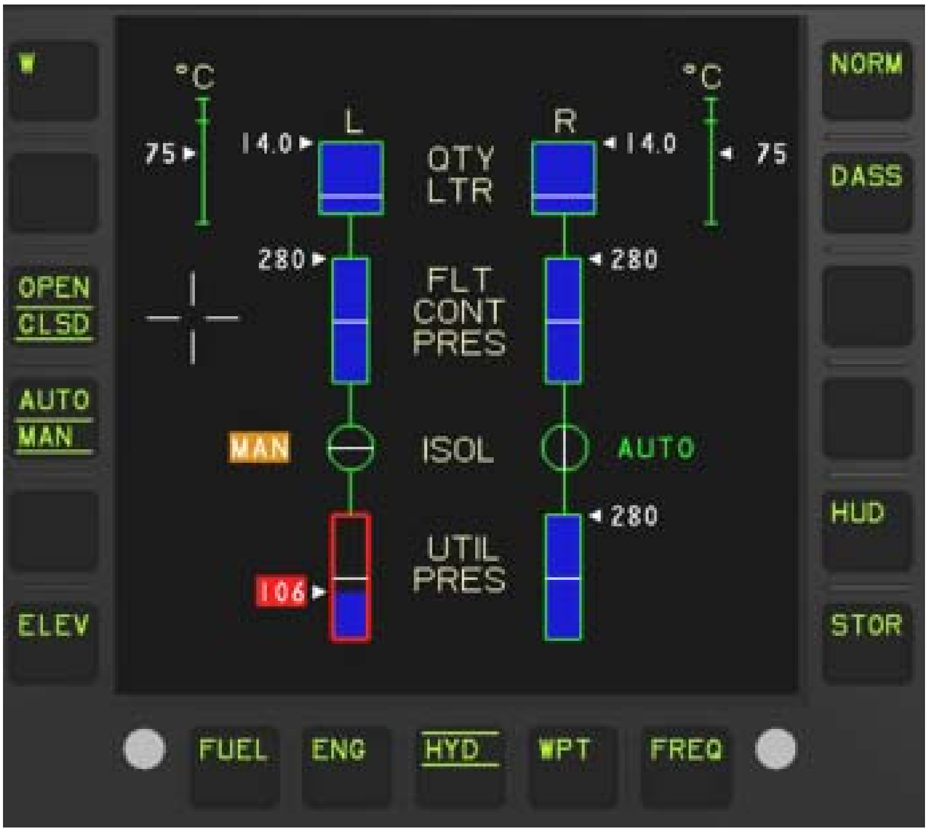


Figure E - Hydraulic Format

Figure F - Head Down HUD Format

Figure G - Pilot Awareness Format

Figure H - HSI Format

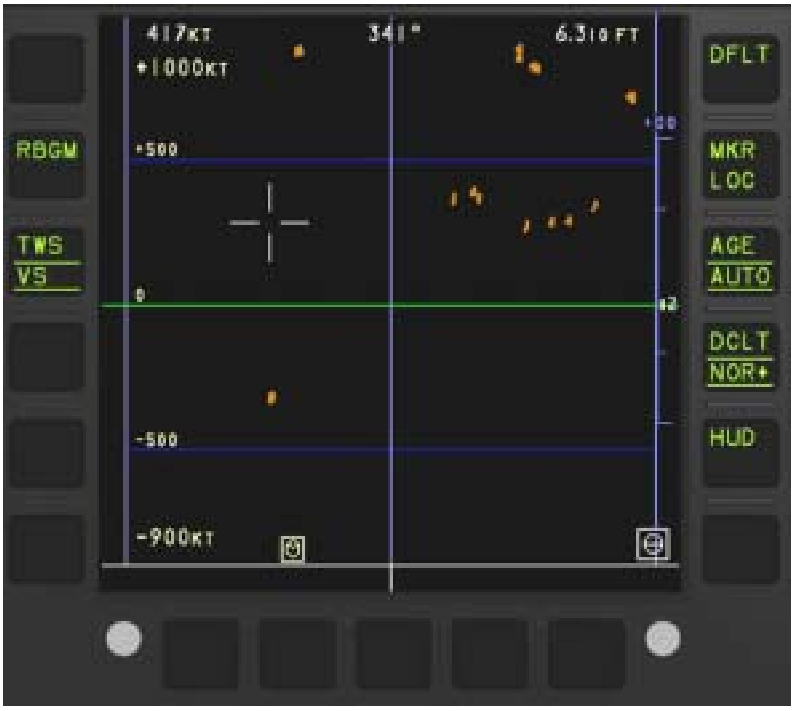
Figure I - Waypoint Format

Figure J - Radio Format

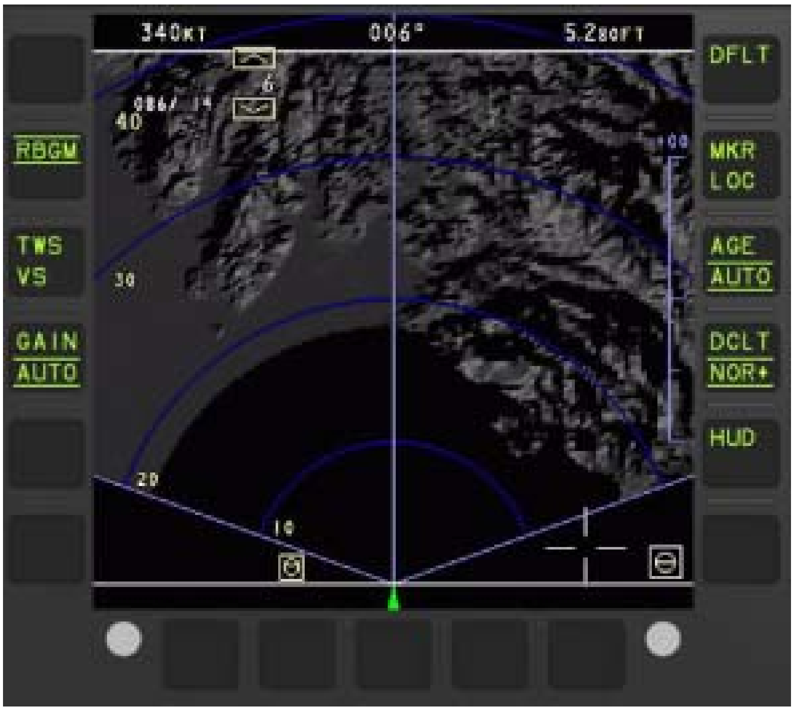
B-SCOPE

PLAN POSITION INDICATOR

Figure K - Attack Format (Sheet 1 of 2)

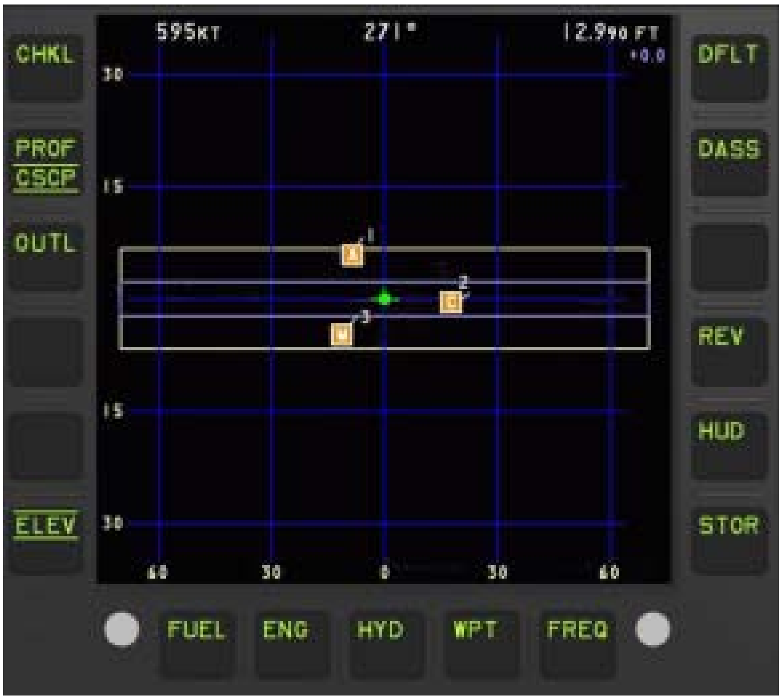


VELOCITY SEARCH



REAL BEAM GROUND MAPPING

Figure K - Attack Format (Sheet 2 of 2)



C-SCOPE

PROFILE

Figure L - Elevation Format

Figure M - DASS Format

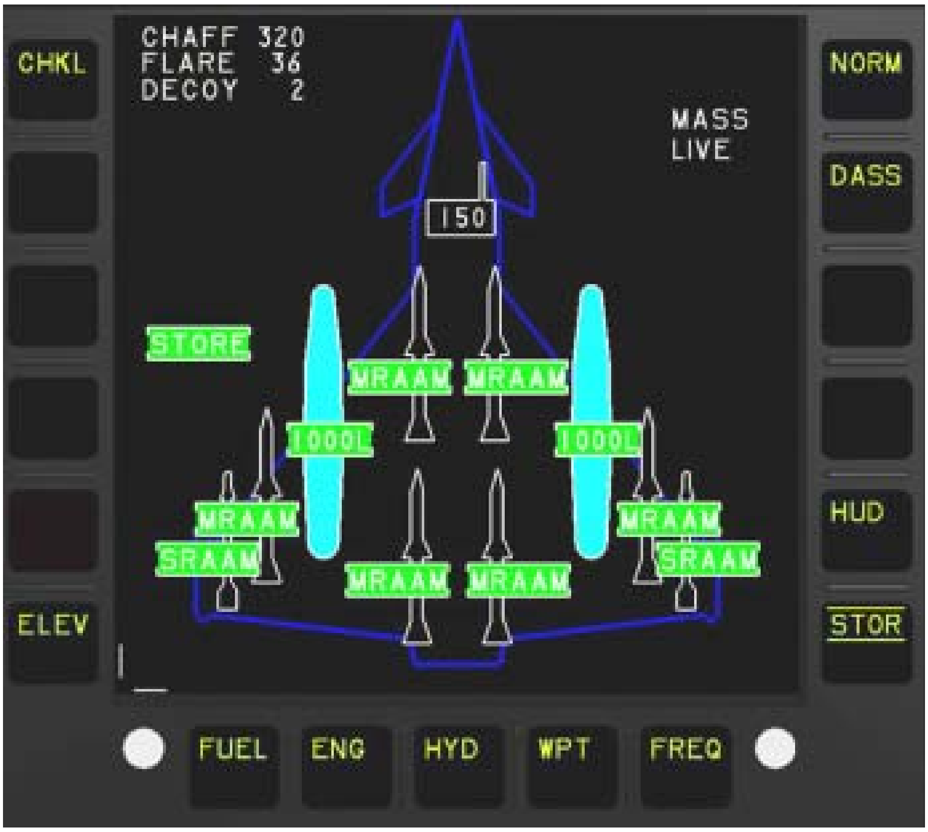


Figure N - Stores Format

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SECTION 1 - DESCRIPTION AND OPERATION

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THE AIRCRAFT

The EF-2000 is a high performance, supersonic, all-weather air-superiority fighter built by EuroFighter Company. Its primary mission is aerial combat, but it can also perform ground attack missions. The ECR 90 radar and the SRAAM and MRAAM missiles are the primary armament.

The two seat aircraft is a tandem configured aircraft which performs the secondary role of a trainer without comprising its primary role. Using the front cockpit controls the two seat aircraft provides equivalent navigation and weapon system capabilities as those available in the single seat aircraft. The rear cockpit controls duplicate most front cockpit controls for navigation and weapon system control.

External stores can be carried on thirteen hardpoints, three of which can be used for external fuel tanks. Up to ten air-to-air missiles can be carried. Air-to-surface munitions can be fitted to seven of the hardpoints, while still retaining six air-to-air missiles. The aircraft has a single internally mounted 27 mm Mauser gun.

The aircraft is powered by two Eurojet EJ200 two-spool axial flow turbofan engines, with afterburner.

The aircraft features a variable camber delta wing. Automatic slats on the wing leading edges and full span inboard and outboard flaperons on the wing trailing edges provide optimum wing camber at all angles of attack. The foreplanes provide control and additional lift, which adds to the aircraft STOL capability. The aircraft also has a conventional rudder. The speed brake is mounted on the top side of the central fuselage. The aircraft is aerodynamically unstable. Artificial stability is provided by a full authority quadruplex "fly-by-wire" flight control system. Pitch control is by means of the foreplanes and the flaperons. Roll and yaw controls is by means of the flaperons and the rudder.

The pressurized cabin is enclosed by an electrically operated clamshell canopy. The ejection seat provides safe escape from zero airspeed, zero height conditions.

An aircraft mounted auxiliary power unit (APU) provides compressed air to the air turbine starter motors (ATSM) for gearbox/system checking or engine starting and the environmental control system (ECS) for cockpit conditioning. Limited electrical power is provided to the aircraft systems from the APU generator. The APU can only be operated on the ground and allows the aircraft to operate independently of ground facilities.

AIRCRAFT GROSS MASS

The following gross masses are approximate to the nearest 300 kg and shall not be used for computing aircraft performance or for any type of operation.

CONFIGURATION	MASS (kg)
Operative gross mass empty (basic gross mass empty plus pilot plus oil plus 4 medium range air-to-air eject launchers plus 2 integrated tip stub pylon/launchers)	11 300
Takeoff gross mass (operative gross mass empty plus full internal fuel plus 4 advance medium range air-to-air missiles (AMRAAM) plus 2 side-winders AIM-9L)	17 000
Takeoff gross mass as above plus 3 full 1000 liter supersonic external fuel tanks (SFT)	19 800
Takeoff gross mass (operative gross mass empty plus full internal fuel plus 2 outboard wing pylons plus 4 AMRAAMs plus 6 side-winders AIM-9L)	17 700
Takeoff gross mass as above plus 3 full SFTs	20 500

AIRCRAFT DIMENSIONS

The overall dimensions of the aircraft are as follows:

Span	10.95 meters
Length	15.97 meters
Height (top of vertical tail)	5.29 meters
Wheel track	4.08 meters
Wheel base	4.18 meters

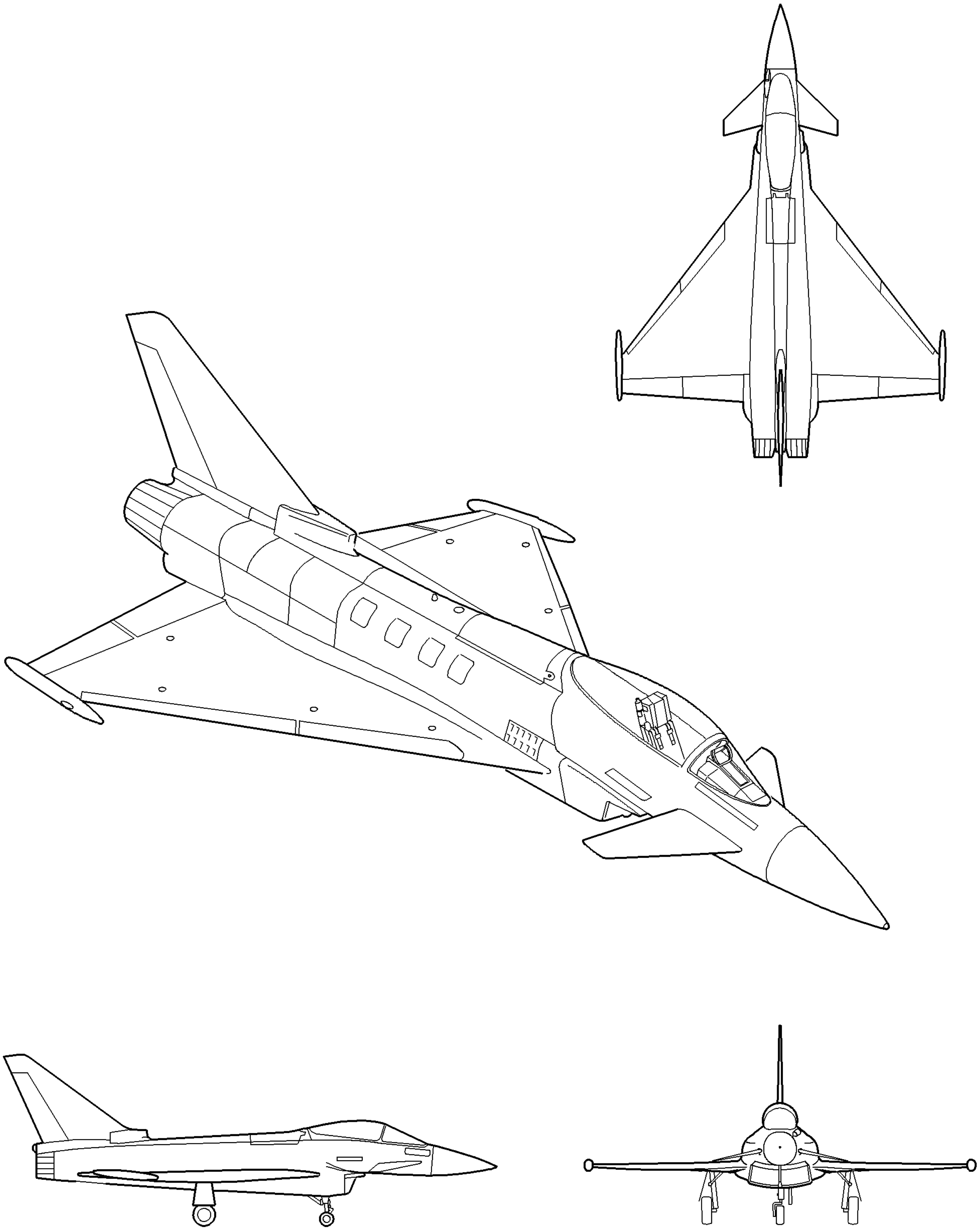


Figure 1.1 - Three Quarter View

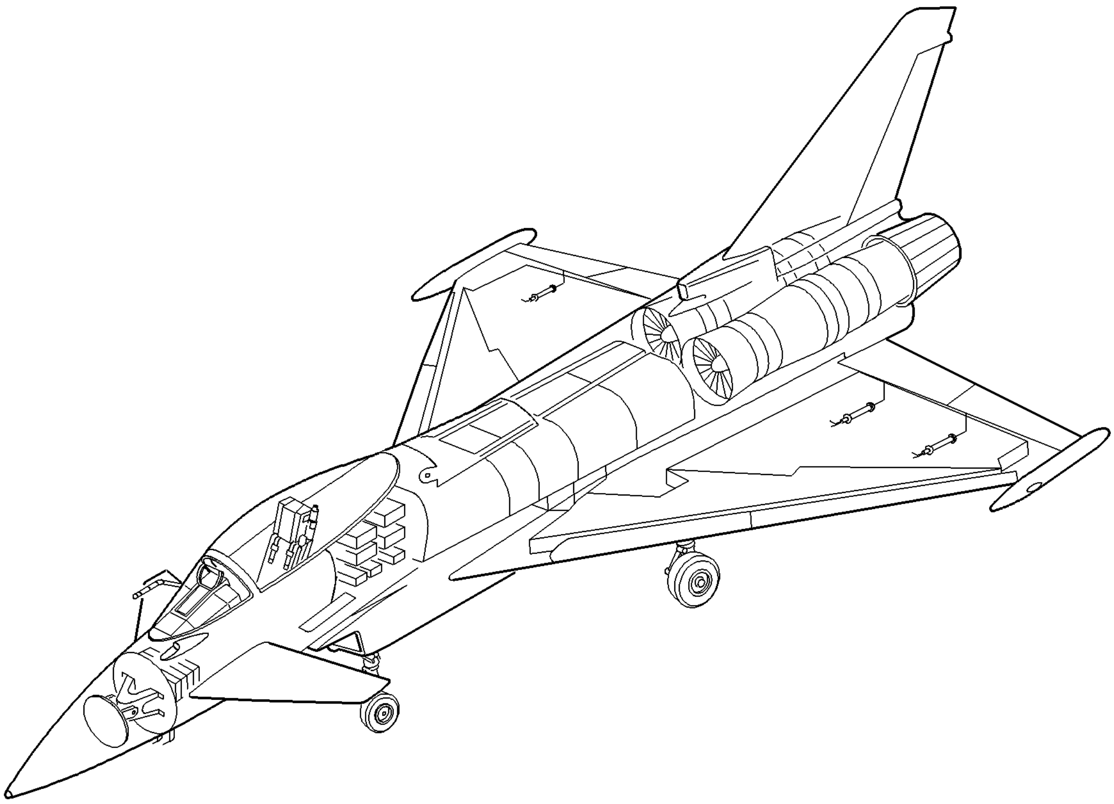


Figure 1.2 - Aircraft General Arrangement

COCKPIT DISPLAYS AND CONTROLS

The ejection seat, providing the pilot with a back angle of 18°, faces a display suite comprising five electronic display surfaces; the head up display (HUD), three multifunction head down displays (MHDD) and a dedicated warning panel (DWP). In normal circumstances, these displays present all the information required by the pilot to fly and manage the aircraft, however, a number of standby instruments are also included to provide basic flight data in the event of failures. In general, the controls and displays interface with their respective systems via the cockpit interface units (CIU), computer symbol generators (CSG) and databusses. However, for reasons of system integrity, certain controls and displays are hardwired directly to their associated equipment. The main interaction between the pilot and aircraft systems is achieved via a manual data entry (MDE) facility, the HUD, the MHDD and a through a number of 'voice, throttle and stick' (VTAS) controls. Extensive use of electronic displays and controls has enabled the number of conventional, panel mounted controls and indicators to be reduced to a minimum. Most of the conventional controls are intended for infrequent use, allowing them to be arranged on the left and right consoles.

LEFT AND RIGHT CONSOLES

The left console houses the throttle box which occupies most of its forward area, with most of the remaining space allocated to controls and indicators associated with the flight control and communication systems. Similarly controls for the fuel system, hydraulic system, lighting system and environmental control system, are arranged on the right console which also accommodates a systems gangbar panel.

LEFT AND RIGHT GLARESHIELDS

A MDE facility is provided on the left glareshield which enables the pilot to enter new data into a number of sub-systems or edit previously entered data. The left glareshield also houses the barometric pressure setting facility, a warning system attention getter and controls associated with the autopilot. The right glareshield is equipped with a number GUH airdata displays to enable a safe return to base if a major display failure occurs. In normal circumstances, however, some of the GUH indicators on the right glareshield are covered by a dedicated readout panel (DRP) which displays information relating to transponder and TACAN settings. The DRP is spring-loaded and hinged on the outboard edge of the right glareshield, and is normally latched closed. If required the panel can be manually released to reveal the hidden GUH indicators.

LEFT AND RIGHT QUARTER PANELS

Quick-reaction and emergency controls associated with take-off, landing and emergency functions are located on the left quarter panel. The right quarter panel also houses the DWP and a Discrete Audio Warning Generator (DAWG) panel which displays warnings associated with interim standard electrical power generation equipment.

NOTE

The DAWG panel is not fitted to DA3.

PEDESTAL PANEL

The pedestal panel is located in front of the stick top and is equipped controls that enable the phase of flight to be manually selected. The panel also contains a number of controls associated with the MHDD and FCS.

HEAD UP PANEL

The head up panel (HUP) provides location for controls and indicators associated with the HUD and the communications system. A number of GUH displays are also arranged on the HUP which provide information on fuel contents and engine rotor speeds. The engine fire indicator/extinguisher buttons are located on each side of the HUP.

COCKPIT REFERENCES

For cockpit layouts, refer to the following Data Modules:

- Cockpit Illustrations (DA1).
- Cockpit Illustrations (DA3).
- Cockpit Illustrations (DA5).
- Cockpit Illustrations (DA7).

ELECTRONIC DISPLAYS AND CONTROLS

Integration of the aircraft systems is achieved using multifunction electronic displays and controls in both cockpits. The main integrated displays and controls, Figure 1.3 and Figure 1.4 , are as follows:

- Head-up display (HUD) and HUD repeater.
- Multifunction head-down displays (MHDD).
- Dedicated warning panels (DWP).
- Manual data entry (MDE) facilities.
- Dedicated readout panels (DRP).
- Voice, throttle and stick (VTAS) facilities.

– Cockpit control and display unit (CCDU) (FTI and front cockpit only).

HUD

The aircraft is equipped with a HUD, comprising a head-up panel and a pilot's display unit (PDU). The HUD is a flight instrument which projects flight information, into the pilot's field of view. The head-up panel contains the controls associated with the display of information on the PDU. The panel also displays information on the fuel status, engine speed and the radios. The brightness, contrast and balance of the display on the PDU can be adjusted using thumbwheel controls.

MHDD

The aircraft is equipped with three MHDD which enable information on the status of the aircraft systems to be displayed. Each MHDD comprises a color display, capable of displaying data in raster, cursive, or raster/cursive format. The main display area is surrounded by a bezel containing 17 soft keys, controls for on/off, brightness and contrast, and two ambient light sensors.

DWP

The DWP is located on the right quarter panel and indicates aircraft system malfunctions on a reconfigurable dot matrix type display. Each display is capable of presenting 27 captions simultaneously, in three columns of nine.

MDE FACILITY

A MDE facility, is located on the left glareshield and contains moding keys, sub-system keys, a data entry keyboard and readout lines. These enable the pilot to select and input or update avionic systems data.

DRP

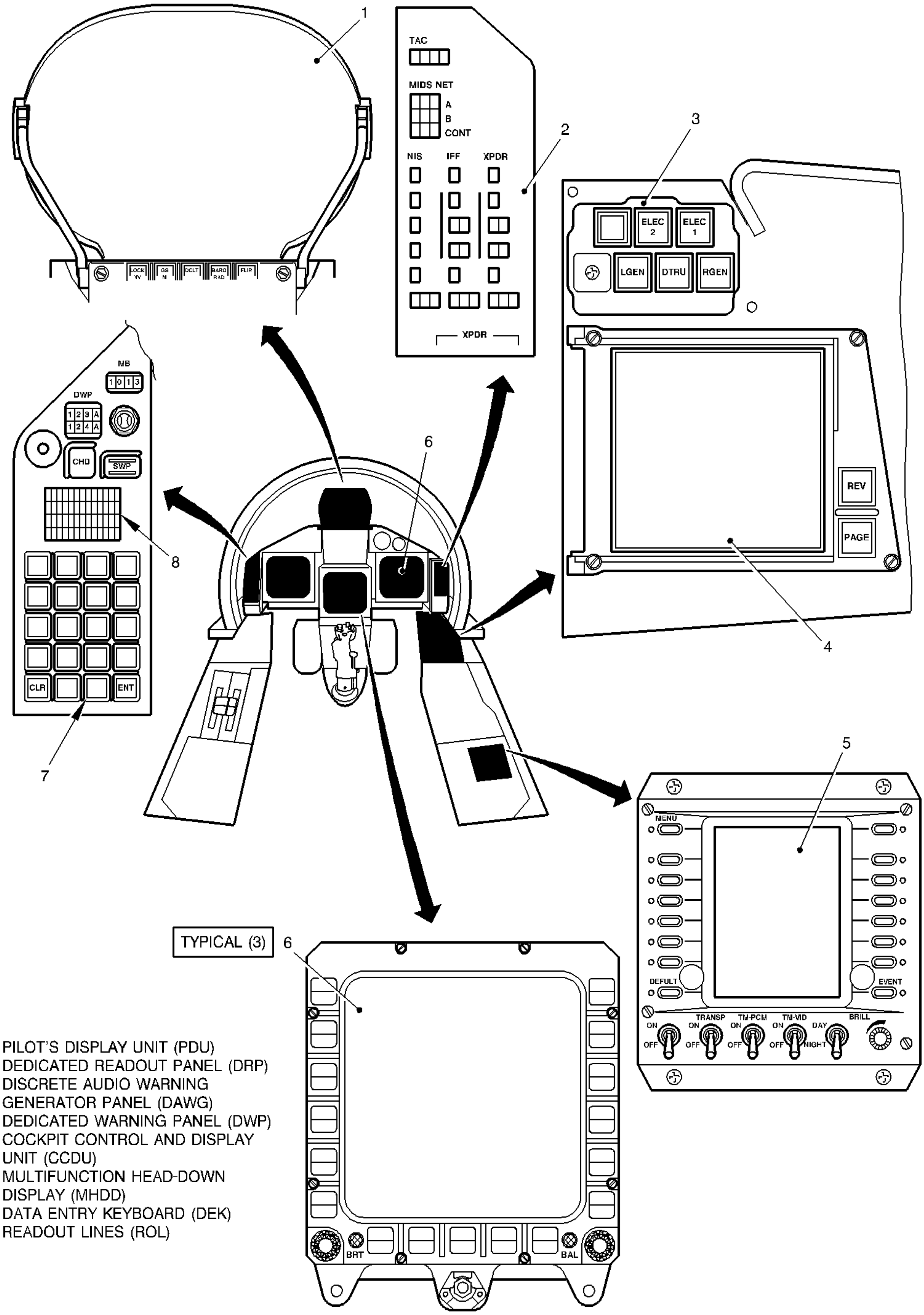
The DRP displays information concerning the IFF transponder (XPDR) and TACAN in readout line form. The panels are hinged on the outboard side of the right glareshields allowing access to the reversionary GUH instruments when required.

VTAS FACILITY

Controls located on the throttle and stick top that allow the pilot to perform certain cockpit functions without removal of hands from the throttle and stick.

CCDU (FTI ONLY)

The CCDU is located on the right console and comprises a control panel with integral switches and keys surrounding a visual display area. The CCDU provides control of the airborne instrumentation system, a visual indication of the system status and operation, and a visual display of instrumentation data.



1 PILOT'S DISPLAY UNIT (PDU)
2 DEDICATED READOUT PANEL (DRP)
3 DISCRETE AUDIO WARNING GENERATOR PANEL (DAWG)
4 DEDICATED WARNING PANEL (DWP)
5 COCKPIT CONTROL AND DISPLAY UNIT (CCDU)
6 MULTIFUNCTION HEAD-DOWN DISPLAY (MHDD)
7 DATA ENTRY KEYBOARD (DEK)
8 READOUT LINES (ROL)

Figure 1.3 - Electronic Displays and Controls - Cockpit Displays

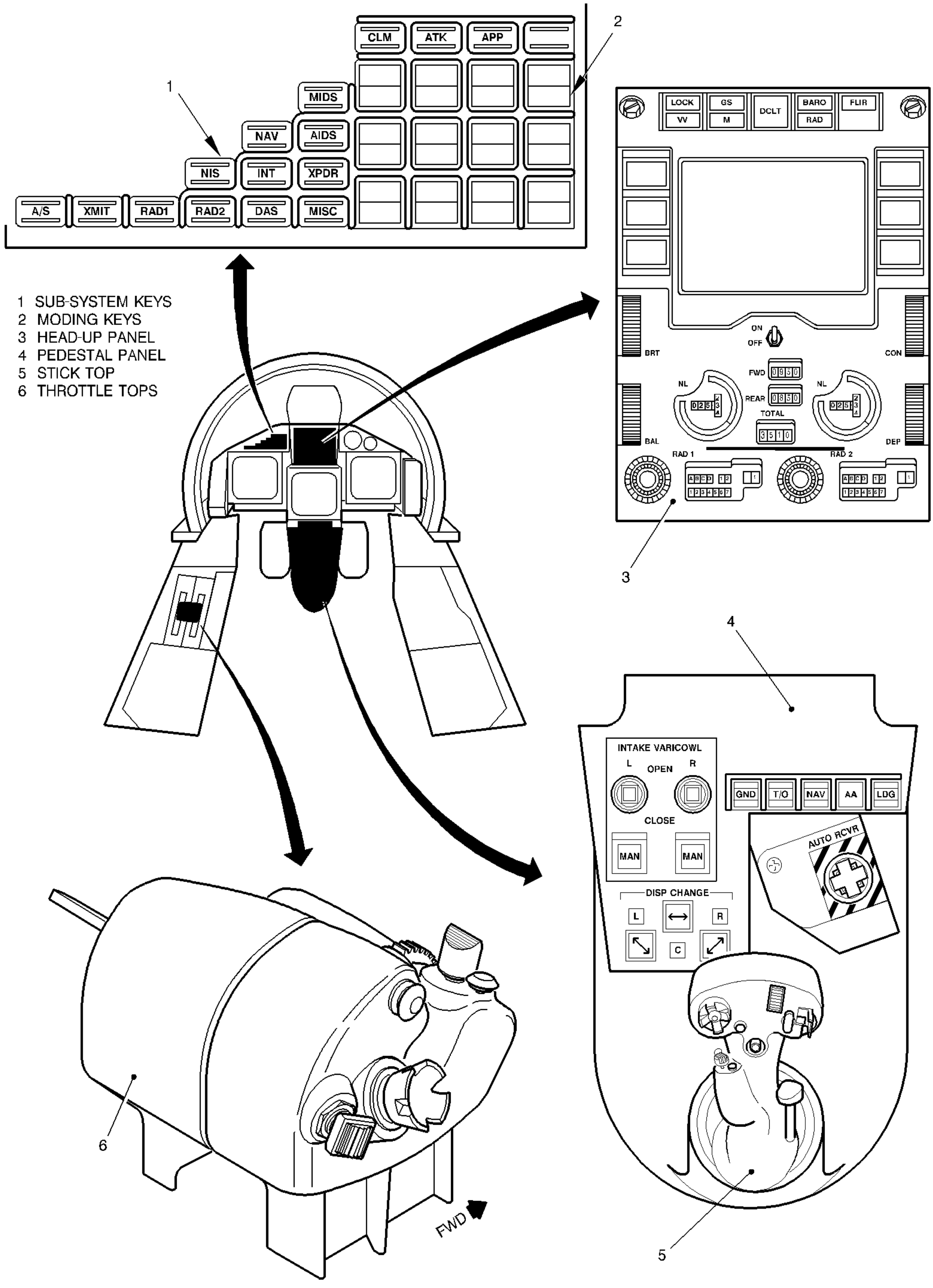


Figure 1.4 - Electronic Displays and Controls - Cockpit Controls

ELECTRONIC DISPLAY FORMATS HUD (AVS 3C)

HEAD UP DISPLAY FORMATS

The head up display format displays primary flight information during all phases of flight along with navigation, weapon aiming and tactical information when necessary. The content of the HUD format will change upon transition from one phase of flight to another and in response to declutter selection. Selection of any of the three air combat modes will also affect the symbology presented on the HUD. Some HUD symbology is displayed only briefly or under certain conditions and therefore for reasons of convenience examples of HUD symbology in this chapter have been restricted to a number of specific cases. A complete description of HUD symbology is provided in . Examples are as follows:

- Close navigation Figure 1.5
- Air-to-air attacks Figure 1.6, Figure 1.7, Figure 1.8
- Air Combat Modes Figure 1.9

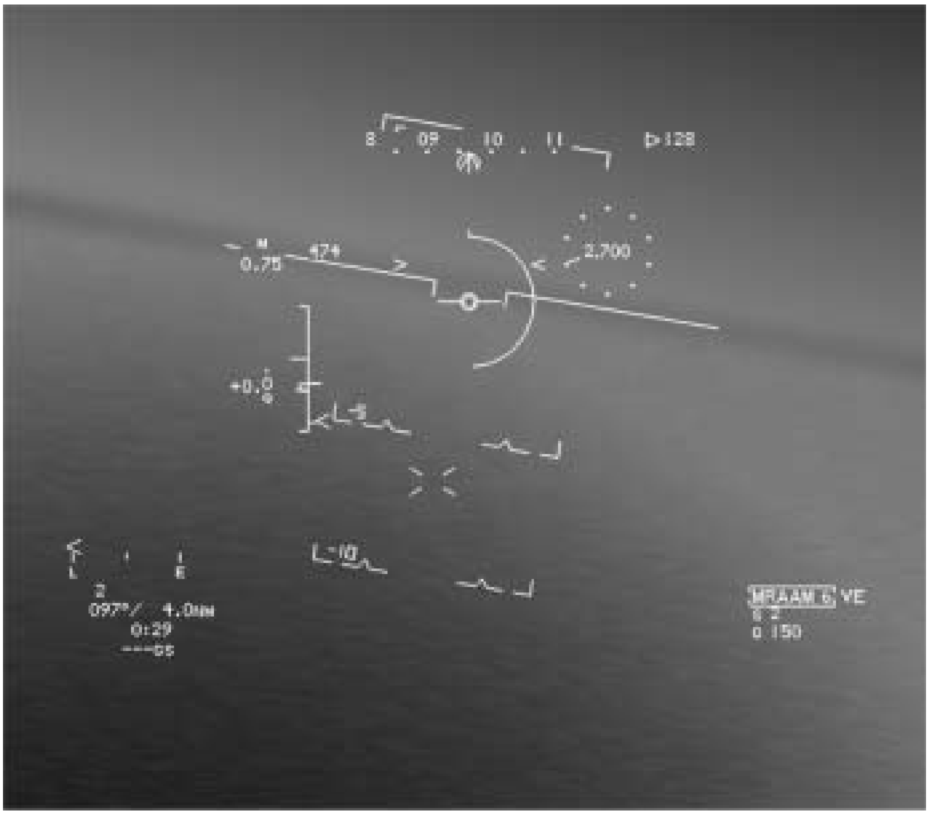


Figure 1.5 - HUD Navigation

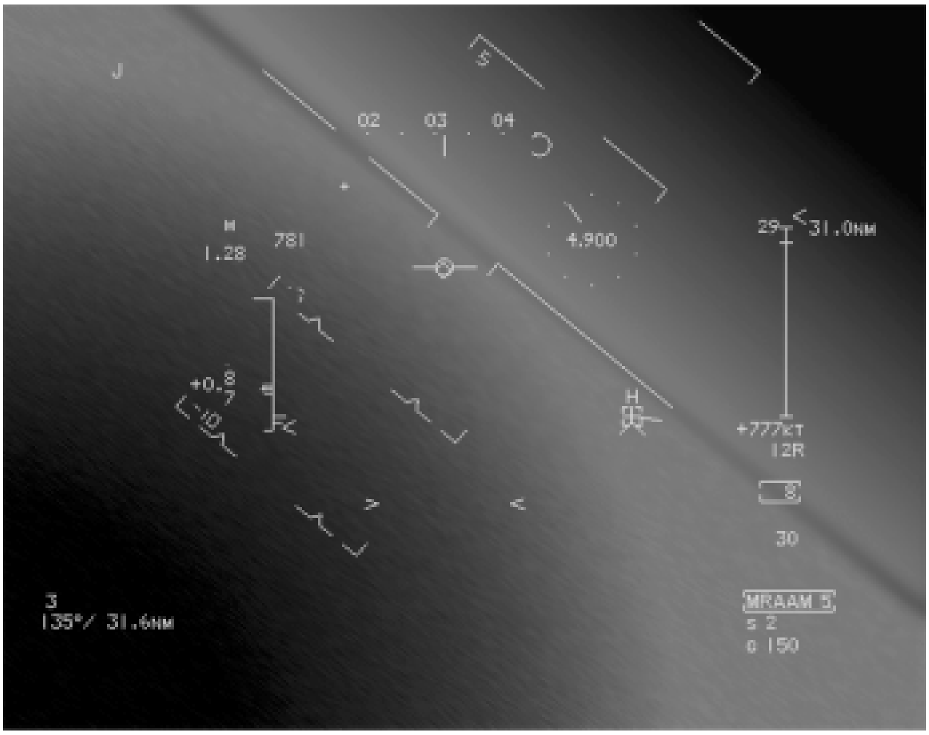


Figure 1.6 - Air-to-Air Attack AMRAAM

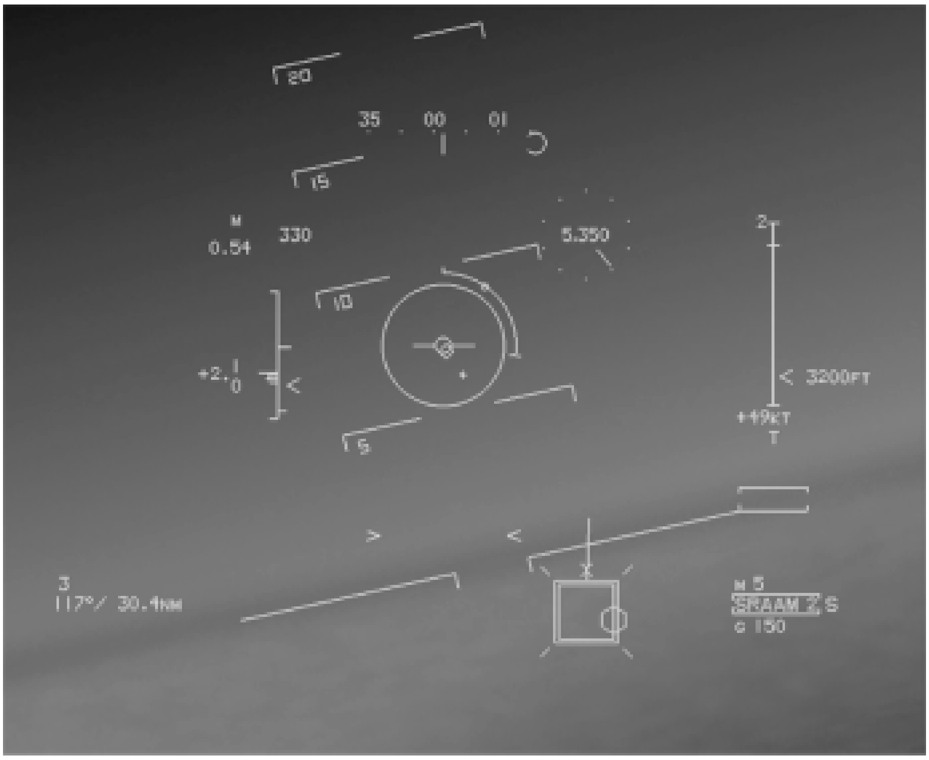


Figure 1.7 - Air-to-Air Attack SRAAM

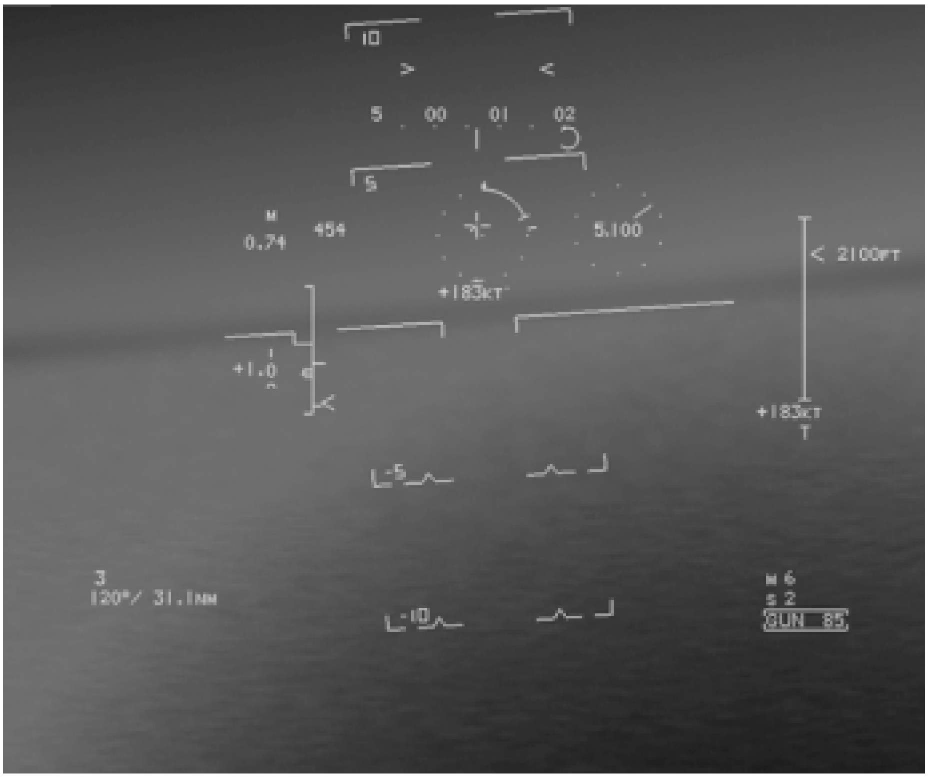
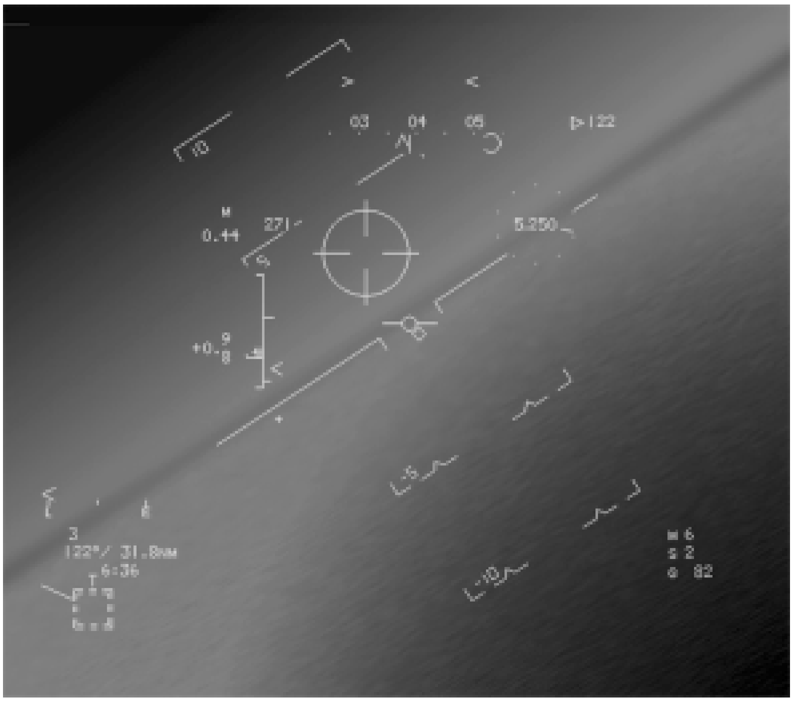
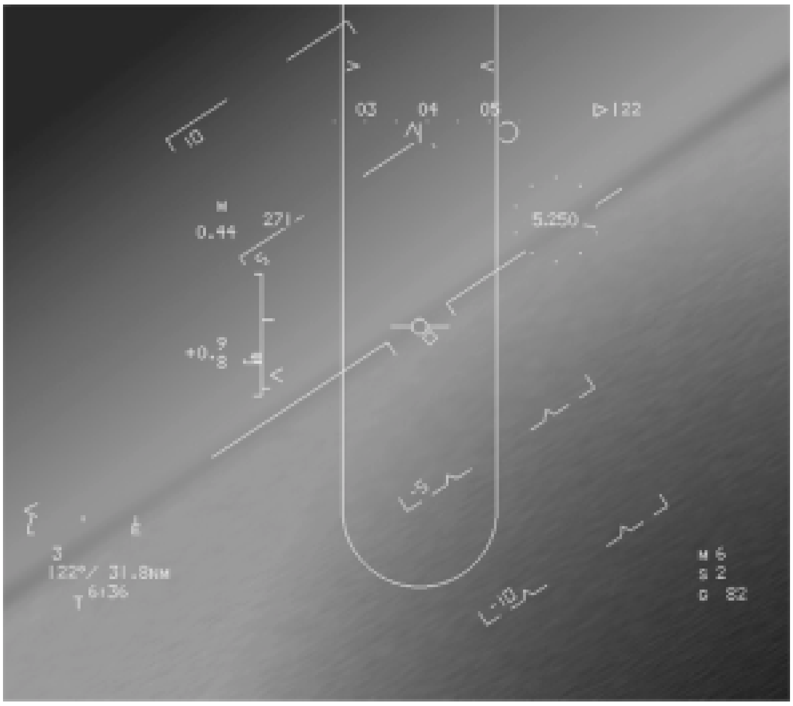


Figure 1.8 - Air-to-Air Attack Gun

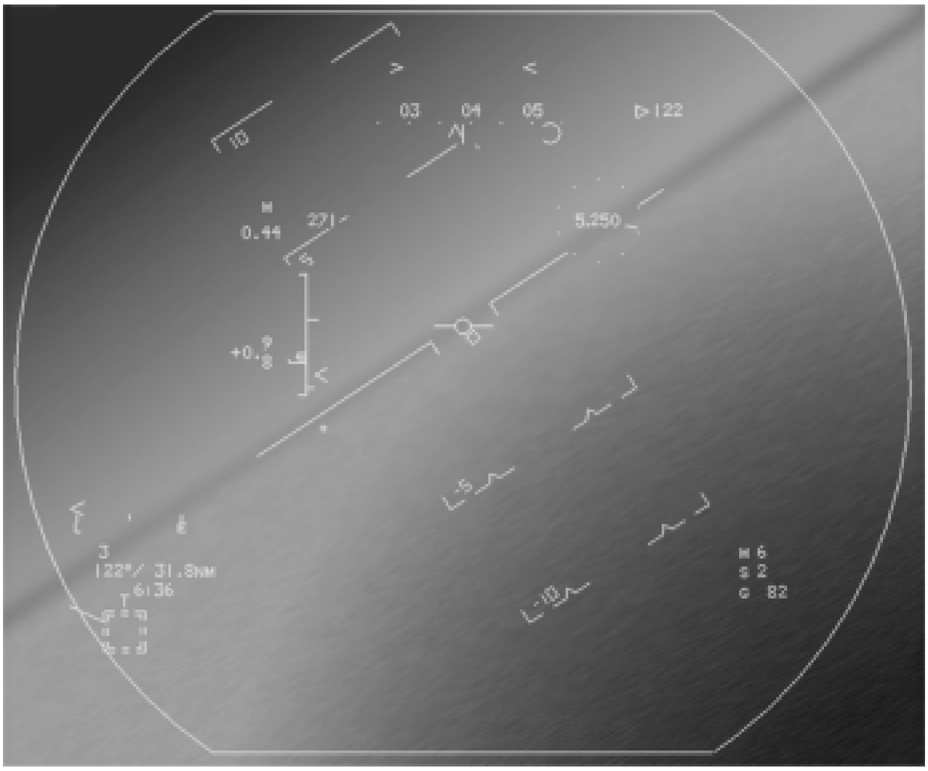


SLAVED ACQUISITION MODE



VERTICAL ACQUISITION MODE

Figure 1.9 - Air Combat Modes (Sheet 1 of 2)



HUD ACQUISITION MODE

Figure 1.9 - Air Combat Modes (Sheet 2 of 2)

COCKPIT CONTROLS AND INDICATORS

The cockpit controls and indicators are arranged on the left and right consoles and the surrounding panels, as indicated in Figure 1.10. The location of each control and indicator is shown in Figure 1.11 thru Figure 1.17 and the descriptions are summarized in Tables in the following order: For VTAS controls refer to Electronic Displays and Controls - VTAS pag. 37.

– Left console.
– Right console.
– Left and right quarter panels.
– Left glareshield.
– Right glareshield.
– Head-up panel and pedestal panel.
– Center panel.

Left Console - Controls and Indicators

FIGURE 1.11 ITEM NO.	CONTROL/INDICATOR	MARKING/CAPTION	REMARKS
1	Forward panel		
2	Emergency landing gear switch	EMGY GEAR RESET-NORM-DOWN	3-position switch spring-biased between forward and center with black/yellow coverguard
3	Land/taxi light switch	LAND-OFF-TAXI	3-position toggle switch
4	FCS selector/indicator	FCS-RSET NWS-T/O	Pushbutton switch, illuminated split-caption indicator
5	SCAC switch	NORM-REV	2-position toggle switch, locked in both positions
6	Rear panel		
7	Missile audio tone/telebrief volume/transmission control	MSSL TB	Rotary control
8	MIDS voice channel B volume/ transmission control	MIDS B	Rotary control (not fitted at AVS SP3B 1/15)
9	MIDS voice channel A volume/ transmission control	MIDS A	Rotary control (not fitted at AVS SP3B 1/15)
10	Intercom volume control	I/C	Rotary control
11	TACAN/MLS audio tone volume control	TAC MLS	Rotary control
12	Radio amplification volume switch	AMP NORM VOL-DFLT VOL	2-position toggle switch locked in both positions
13	Radio amplification selector switch	AMP NORM-REV	2-position toggle switch
14	Press to transmit switch	PTT RAD1-OFF-RAD2	3-position switch
15	Right gearbox air drive selector	GBOX R	Pushbutton switch with cover guard
16	Left gearbox air drive selector	GBOX L	Pushbutton switch with cover guard
17	Trim control override switch	TRIM NORM-CANCEL	2-position, locked toggle switch

(Continued)

Left Console - Controls and Indicators (Continued)

FIGURE 1.11 ITEM NO.	CONTROL/INDICATOR	MARKING/CAPTION	REMARKS
18	Radar override switch	RADAR OVRD-NORM	2-position toggle switch with black/yellow coverguard (not fitted at AVS SP3B 1/15)
19	Lamps test pushbutton	LAMPS TEST	Illuminated pushbutton
20	FCS laws switch	REV FCS	Illuminated pushbutton switch with coverguard
21	Reversionary instruments dimmer		Rotary control
22	Lift dump switch	LIFT-DUMP	2-position toggle switch, locked in the DUMP position
23	Intake emergency control switch	INTAKE OPEN-AUTO	2-position toggle switch, spring-biased to AUTO with black/ yellow coverguard
24	Cryptographic variable erasure control	CRYP ERASE	Pushbutton switch with coverguard
25	FCS test selector/indicator	FCS TEST BIT	Illuminated pushbutton switch with coverguard
26	Console ECS vent		
27	Configuration control override selector/indicator	CONFIG OVRD A-B-C	3 pushbutton switches with coverguard
28	Yaw trim switch	YAW TRIM	3-position toggle switch sprung to center
29	Left LP cock switch	L LP COCK OPEN-SHUT	2-position toggle switch with red coverguard
30	Towed decoy operating switch	DECOY CUT/STOW-TOW	2-position toggle switch (not fitted)
31	Expendable stores enable switch	EXPD MAN-AUTO-STOP	3-position toggle switch
32	Canopy jettison handle	CNPY JETT	Pull to jettison canopy
33	Left throttle box		
34	Right throttle box		

Right Console - Controls and Indicators

FIGURE 1.12 ITEM NO.	CONTROL/INDICATOR	MARKING/CAPTION	REMARKS
1	ECS master switch	ECS-OFF/RSET RAM AIR	3-position toggle switch, locked in OFF/RSET and RAM AIR positions
2	Demist switch	DEMIST AUTO-OFF-REV	3-position toggle switch
3	ECM enable switch	ECM-OFF	Two position locking toggle switch (not fitted)
4	Cabin temperature control	CABIN TEMP	Rotary control
5	Missile approach warning enable switch	MAW-OFF	Two position locking toggles switch (not fitted)
6	Cabin airflow control	CABIN FLOW	Rotary control
7	Expendables stores enable switch	EXPD-OFF	Two position locking toggle switch (not fitted)
8	Canopy unlocked indicator	CNPY	Illuminated warning indicator
9	Main display zone dimmer control	DISP	Rotary control
10	Canopy jettison safety pin stowage	CNPY	
11	Seat safety pin stowage	SEAT	
12	Consoles dimmer control	CONSL	Rotary control
13	Consoles floodlights control	FLOOD/CONSL	Rotary control
14	Forward panel		
15	Canopy control switch	CNPY OPEN-CLOSE	3-position toggle switch, spring-biased to center
16	Computer symbol generator switch	CSG NORM-REV	2-position toggle switch
17	Cockpit interface unit switch	CIU NORM-REV	2-position toggle switch
18	Video/voice recorder selector/ indicator	VVR/REC	Illuminated pushbutton switch
19	APU run indicator	APU/RUN	
20	Right LP cock switch	R LP COCK OPEN-SHUT	2-position toggle switch with red coverguard
21	APU control switch	APU START-STOP	3-position locking toggle switch, spring-biased to center
22	Center panel		
23	Cockpit control and display unit		

(Continued)

Right Console - Controls and Indicators (Continued)

FIGURE 1.12 ITEM NO.	CONTROL/INDICATOR	MARKING/CAPTION	REMARKS
24	ECS console vent		
25	MIDS enable switch	MIDS-OFF	2-position toggle switch, locked in MIDS position (not functional at SP3B 1/15)
26	Radar altimeter enable switch	RAD ALT-OFF	2-position toggle switch, locked in RAD ALT position
27	Radar enable switch	RADAR-OFF	2-position toggle switch, locked in RADAR position (not functional at SP3B 1/15)
28	Spare switch		2-position toggle switch, locked in forward position
29	FLIR enable switch	FLIR-OFF	2-position toggle switch, locked in FLIR position (not functional at SP3B 1/15)
30	IFF interrogator enable switch	INT-OFF	2-position toggle switch, locked in IFF position (not functional at SP3B 1/15)
31	Windscreen heater switch	W/S HTR-OFF	2-position toggle switch
32	Molecular sieve oxygen concentrator switch	MSOC-OFF	2-position toggle switch (removed)
33	Voice warning control switch	VOICE-OFF	2-position toggle switch, locked in VOICE position
34	Systems gangbar		Operates system switches simultaneously
35	Radio 1 enable switch	RAD 1-OFF	2-position toggle switch
36	Radio 2 enable switch	RAD 2-OFF	2-position toggle switch
37	Transponder enable switch	XPDR-OFF	2-position toggle switch locked in XPDR position
38	Left generator control switch	GEN L ON-OFF/RESET	2-position toggle switch locked in both positions
39	Right generator control switch	GEN R ON-OFF/RESET	2-position toggle switch locked in both positions
40	Left hydraulic control switch	HYD L ON-AUTO-OFF	3-position toggle switch locked and guarded out of OFF
41	Right hydraulic control switch	HYD R ON-AUTO-OFF	3-position toggle switch locked and guarded out of OFF
42	DC fuel pump switch	DC FUEL PUMP AUTO/OFF	2 position toggle switch, locked in AUTO
43	MASS	LIVE/STBY/SAFE	3-position rotary control

(Continued)

Right Console - Controls and Indicators (Continued)

FIGURE 1.12 ITEM NO.	CONTROL/INDICATOR	MARKING/CAPTION	REMARKS
44	Right boost pump switch	R BOOST PUMP-OFF	2-position toggle switch, locked in BOOST PUMP position
45	Battery master switch	BATT-OFF	2-position toggle switch, locked in BATT position
46	Left boost pump switch	L BOOST PUMP-OFF	2-position toggle switch, locked in BOOST PUMP position
47	Fuel transfer commit switch	XFER NORMAL-ENABLE-STOP RESET	3-position locking toggle switch
48	Fuel crossfeed switch	XFEED NORM-OPEN	2-position, locked toggle switch
49	In-flight refueling probe switch	FUEL PROBE IN-OUT-EMGY OUT	3-position, locked toggle switch
50	Air drive master switch	AIR DRIVE EMGY-AUTO-OFF	3-position toggle switch, spring-biased to AUTO. Locked in AUTO and OFF
51	Cockpit lighting mode select switch	AUTO- MAN-REV	3-position locking toggle switch
52	Forward floodlights control	FLOOD/FWD	Rotary control
53	Cockpit lighting mode switch	REV LIGHTS AUTO-MAN DAY/DUSK/NIGHT	5-position rotary control
54	Glareshield zone dimmer control	GL SHIELD	Rotary control
55	Navigation lights switch	NAV BRT-DIM-OFF	3-position locking toggle switch
56	Anti-collision lights switch	A COLL WHITE-OFF	2-position toggle switch

Left and Right Quarter Panels - Controls and Indicators

FIGURE 1.13 ITEM NO.	CONTROL/INDICATOR	MARKING/CAPTION	REMARKS
1	ECS vent		
2	External stores jettison control	JETT-EMGY/SEL	Pushbutton switch with raised protective barrier
3	Park brake switch	PARK BRK OFF-ON	2-position toggle switch locked in OFF position
4	Landing gear position indicators		Show green when gear down and locked

(Continued)

Left and Right Quarter Panels - Controls and Indicators (Continued)

FIGURE 1.13 ITEM NO.	CONTROL/INDICATOR	MARKING/CAPTION	REMARKS
5	Landing gear selector lever	UP-DOWN	LED lit during gear retraction/ extension. Locking collar mechanism
6	Arrester hook release pushbutton/indicator	HOOK	Illuminated pushbutton with protective guard/barrier
7	Emergency brakes switch	EMGY BRK REV-NORM	2-position toggle switch with black/yellow coverguard
8	Dedicated warning panel		
9	Discrete audio warning generator		

Left Glareshield - Controls and Indicators

FIGURE 1.14 ITEM NO.	CONTROL/INDICATOR	MARKING/CAPTION	REMARKS
1	E-4B standby compass		
2	Attention getter		Flashing light, press to cancel
3	Moding keys		12 multifunction illuminated push buttons. MDE facility.
4	Sub-system fixed function keys		12 illuminated push buttons. MDE facility
5	Barometric pressure set display	MB	4-digit readout line
6	Barometric pressure setting switch		4 position switch
7	Set waypoint key	SWP	Illuminated pushbutton
8	Data entry keyboard		20 multifunction illuminated push buttons. MDE facility
9	Readout lines		4x13 character readout lines. Used with MDE
10	Change destination key	CHD	Illuminated pushbutton
11	Writing marker toggle switch		5-position toggle switch spring-biased to center. Used with MDE
12	Set waypoint display		4-digit readout line
13	Destination waypoint display		4-digit readout line
14	Autopilot moding keys		Illuminated push buttons

Right Glareshield - Controls and Indicators

FIGURE 1.15 ITEM NO.	CONTROL/INDICATOR	MARKING/CAPTION	REMARKS
1	Attention getter		Flashing light, press to cancel
2	Stand alone reversionary attitude indicator		Stand alone instrument
3	Reversionary attitude indicator		GUH instrument
4	Base airfield code display (not used)	AFLD	4-digit readout line
5	Radar altimeter set height control	LOW-HT	Rotary control
6	Reversionary airspeed indicator		GUH instrument
7	Dedicated readout panel		Hinged to edge of glareshield
8	Transponder ident selector	ID	Illuminated pushbutton switch
9	Transponder emergency selector/indicator	EMGY	Illuminated pushbutton with black/yellow coverguard
10	Reversionary altimeter		GUH instrument
11	Reversionary vertical speed indicator		GUH instrument
12	Reversionary mach meter	M	3-digit readout line
13	Radar altimeter set height display		4 digit readout line
14	Base airfield range display (not used)	RNG	4-digit readout line
15	Reversionary heading indicator		GUH instrument
16	Slip indicator		GUH instrument
17	Reversionary AOA indicator		GUH instrument

Head-Up Panel and Pedestal Panel - Controls and Indicators

FIGURE 1.16 ITEM NO.	CONTROL/INDICATOR	MARKING/CAPTION	REMARKS
1	Fuel contents display	FWD-REAR-TOTAL	Three 4-digit GUH indicators
2	Right engine speed indicator	NL	Analogue/digital readout. Displays LP rotor speed (NL)

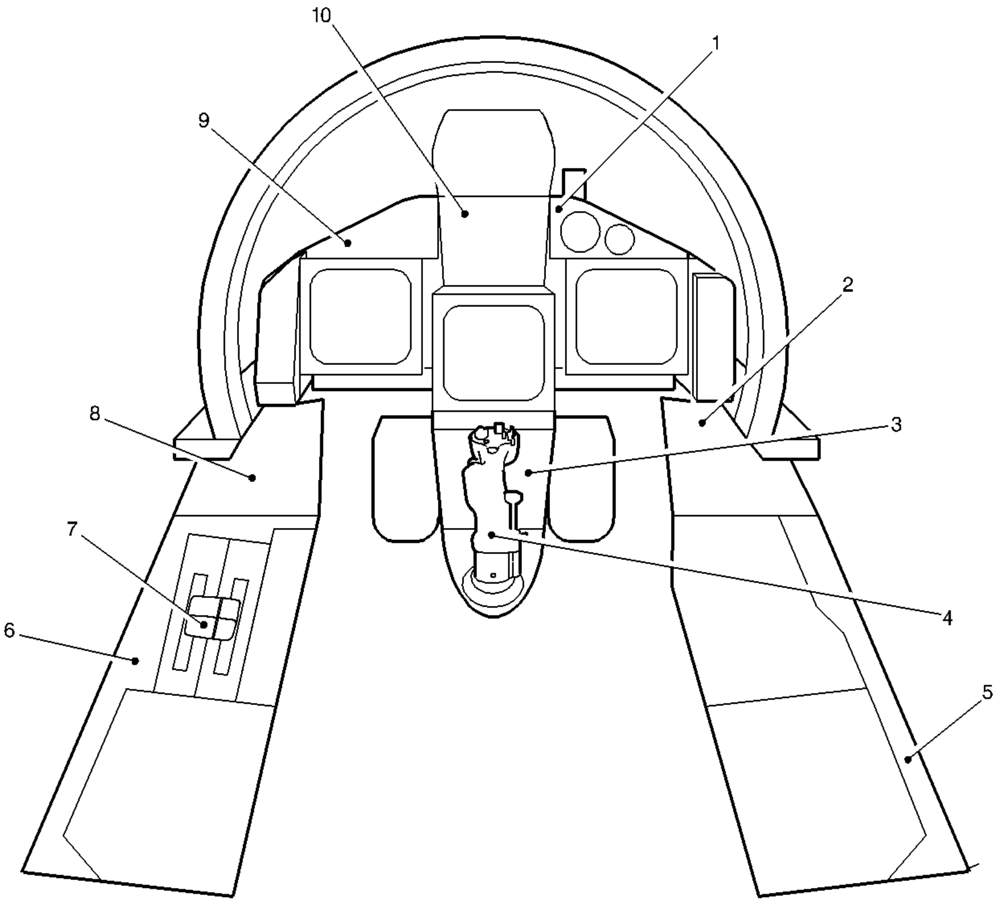
(Continued)

Head-Up Panel and Pedestal Panel - Controls and Indicators (Continued)

FIGURE 1.16 ITEM NO.	CONTROL/INDICATOR	MARKING/CAPTION	REMARKS
3	Radio 2 communication displays		Digital readouts - channel number, frequency and modes
4	Radio 2 control	RAD 2	2 rotary controls - channel select, volume and guard
5	Radio 1 communication displays		Digital readouts - channel number, frequency and modes
6	Radio 1 control	RAD 1	2 rotary controls - channel select/ volume
7	Left engine speed indicator	NL	Analogue/digital readout. Displays LP rotor speed (NL)
8	Head-up panel		
9	Phase of flight selector/ indicators		Illuminated pushbutton switches
10	Automatic recovery system control	AUTO RCVR	Pushbutton switch with barrier and hatched panel
11	Pedestal panel		
12	MHDD display change controls	DISP CHANGE L-C-R	Illuminated pushbutton switches
13	Manual intake varicowl controls	INTAKE VARICOWL L/R OPEN CLOSE	3-position toggle switches

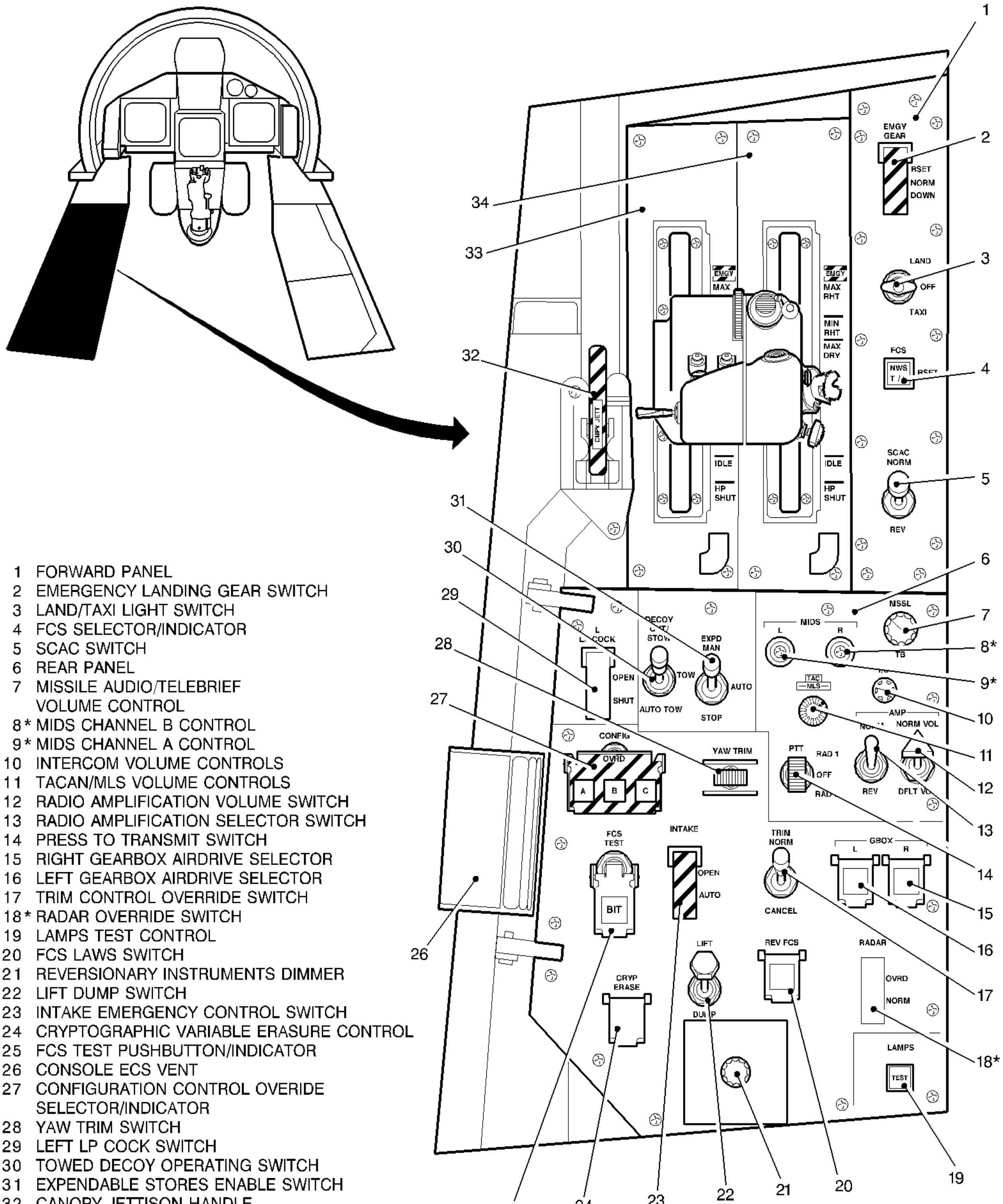
Center Panel

FIGURE 1.17 ITEM NO.	CONTROL/INDICATOR	MARKING/CAPTION	REMARKS
1	Fire warning pushbutton/ indicator (2)	F	Illuminated pushbutton selector/ indicators with black/yellow coverguards
2	Refuelling probe unlocked indicator	PROB UNLK	Illuminated indicator
3	Brake parachute operating handle		



1 RIGHT GLARESHIELD
2 RIGHT QUARTER PANEL
3 PEDESTAL PANEL
4 CONTROL STICK
5 RIGHT CONSOLE
6 LEFT CONSOLE
7 THROTTLES
8 LEFT QUARTER PANEL
9 LEFT GLARESHIELD
10 HEAD UP PANEL

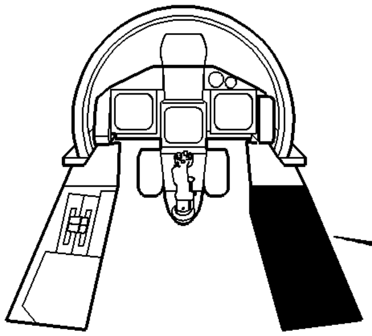
Figure 1.10 - Cockpit Consoles and Panels



1 FORWARD PANEL
2 EMERGENCY LANDING GEAR SWITCH
3 LAND/TAXI LIGHT SWITCH
4 FCS SELECTOR/INDICATOR
5 SCAC SWITCH
6 REAR PANEL
7 MISSILE AUDIO/TELEBRIEF VOLUME CONTROL
8* MIDS CHANNEL B CONTROL
9* MIDS CHANNEL A CONTROL
10 INTERCOM VOLUME CONTROLS
11 TACAN/MLS VOLUME CONTROLS
12 RADIO AMPLIFICATION VOLUME SWITCH
13 RADIO AMPLIFICATION SELECTOR SWITCH
14 PRESS TO TRANSMIT SWITCH
15 RIGHT GEARBOX AIRDRIVE SELECTOR
16 LEFT GEARBOX AIRDRIVE SELECTOR
17 TRIM CONTROL OVERRIDE SWITCH
18* RADAR OVERRIDE SWITCH
19 LAMPS TEST CONTROL
20 FCS LAWS SWITCH
21 REVERSIONARY INSTRUMENTS DIMMER
22 LIFT DUMP SWITCH
23 INTAKE EMERGENCY CONTROL SWITCH
24 CRYPTOGRAPHIC VARIABLE ERASURE CONTROL
25 FCS TEST PUSHBUTTON/INDICATOR
26 CONSOLE ECS VENT
27 CONFIGURATION CONTROL OVERIDE SELECTOR/INDICATOR
28 YAW TRIM SWITCH
29 LEFT LP COCK SWITCH
30 TOWED DECOY OPERATING SWITCH
31 EXPENDABLE STORES ENABLE SWITCH
32 CANOPY JETTISON HANDLE
33 LEFT THROTTLE BOX
34 RIGHT THROTTLE BOX

* NOT FITTED

Figure 1.11 - Cockpit Left Console



1 ECS MASTER SWITCH
2 DEMIST SWITCH
3 ECM ENABLE SWITCH
4 CABIN TEMPERATURE CONTROL
5 MAW ENABLE SWITCH
6 CABIN AIRFLOW CONTROL
7 EXPENDABLE STORES ENABLE SWITCH
8 CANOPY UNLOCKED INDICATOR
9 MAIN DISPLAY ZONE DIMMER SWITCH
10 CANOPY SAFETY PIN STOWAGE
11 SEAT SAFETY PIN STOWAGE
12 CONSOLE ZONE DIMMER SWITCH
13 CONSOLES FLOODLIGHT CONTROL
14 FORWARD PANEL
15 CANOPY CONTROL SWITCH
16 COMPUTER SYMBOL GENERATOR SWITCH
17 COCKPIT INTERFACE UNIT SWITCH
18 VIDEO/VOICE RECORDER SELECTOR/INDICATOR
19 APU RUN INDICATOR
20 RIGHT LP COCK SWITCH
21 APU CONTROL SWITCH
22 CENTER PANEL
23 COCKPIT CONTROL AND DISPLAY UNIT
24 ECS CONSOLE VENT
25 MIDS ENABLE SWITCH
26 RAD ALT ENABLE SWITCH
27 RADAR ENABLE SWITCH
28 SPARE SWITCH
29 FLIR ENABLE SWITCH
30 IFF INTERIGATOR ENABLE SWITCH
31 WINDSCREEN HEATER SWITCH
32* MSOC SWITCH
33 VOICE WARNING CONTROL SWITCH
34 SYSTEMS GANGBAR
35 RADIO 1 ENABLE SWITCH
36 RADIO 2 ENABLE SWITCH
37 TRANSPONDER ENABLE SWITCH
38 LEFT GENERATOR CONTROL SWITCH
39 RIGHT GENERATOR CONTROL SWITCH
40 LEFT HYDRAULIC CONTROL SWITCH
41 RIGHT HYDRAULIC CONTROL SWITCH
42 DC FUEL PUMP SWITCH
43 MASS SWITCH
44 RIGHT BOOST PUMP SWITCH
45 BATTERY MASTER SWITCH
46 LEFT BOOST PUMP SWITCH
47 FUEL TRANSFER COMMIT SWITCH
48 CROSSFEED SWITCH
49 FUEL REFUELING PROBE SWITCH
50 AIRDRIVE MASTER SWITCH
51 COCKPIT LIGHTING MODE SWITCH
52 FORWARD FLOODLIGHT CONTROL
53 COCKPIT LIGHTING MODE SWITCH
54 GLARESHIELD ZONE DIMMER SWITCH
55 NAVIGATION LIGHTS SWITCH
56 ANTI COLLISION LIGHTS SWITCH
* NOT FITTED

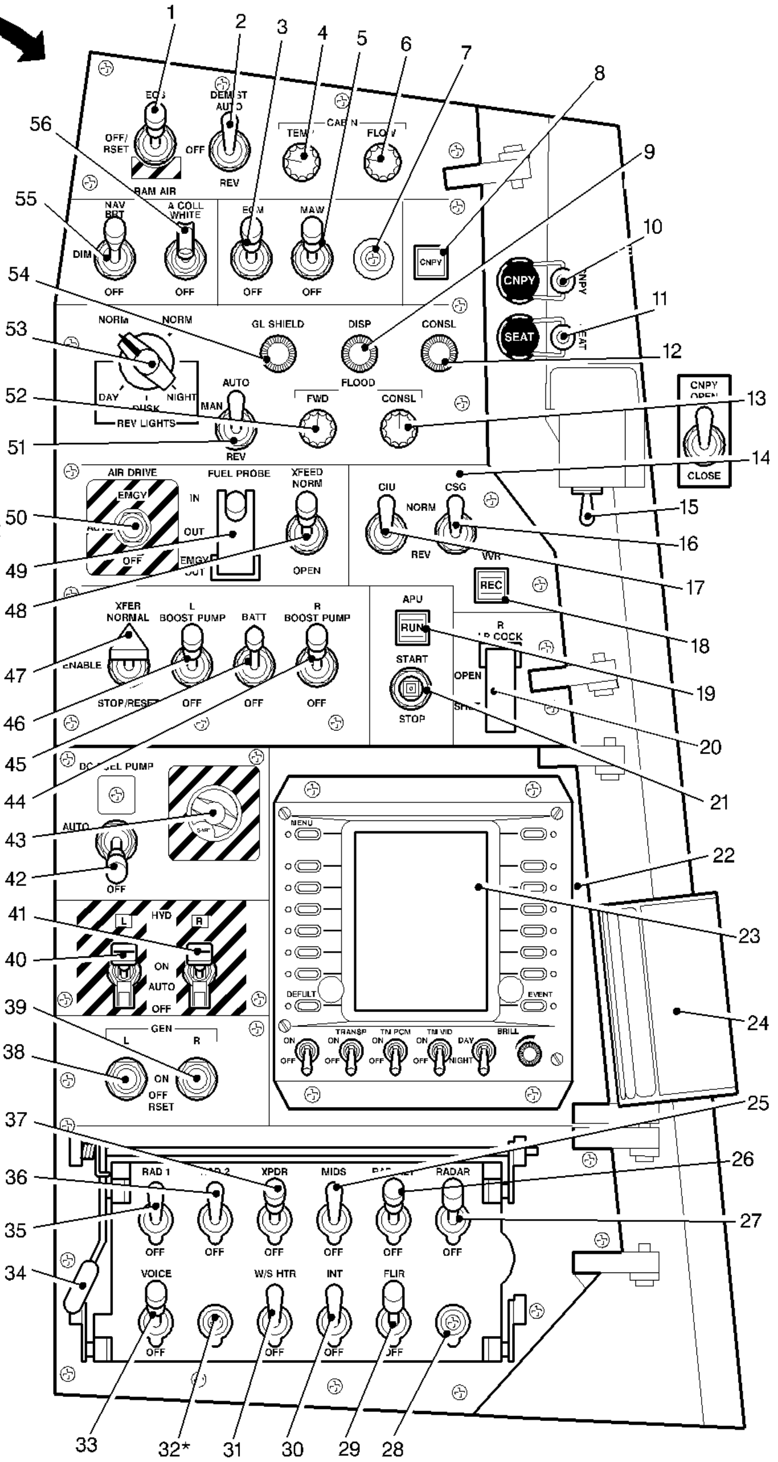
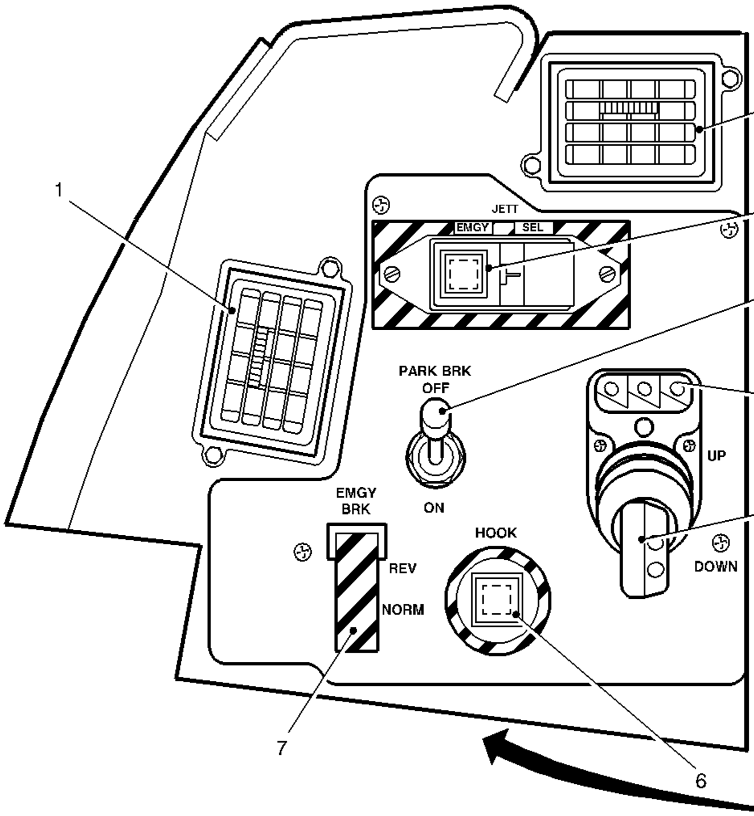
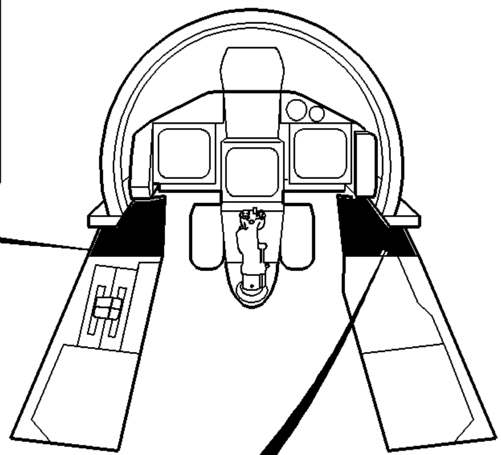


Figure 1.12 - Cockpit Right Console





1 ECS VENT
2 EXTERNAL STORES JETTISON CONTROL
3 PARKING BRAKE SWITCH
4 LANDING GEAR POSITION INDICATORS
5 LANDING GEAR SELECTOR LEVER
6 ARRESTER HOOK RELEASE PUSHBUTTON/INDICATOR
7 EMERGENCY BRAKES SWITCH
8 DEDICATED WARNING PANEL
9 DISCRETE AUDIO GENERATOR WARNING PANEL

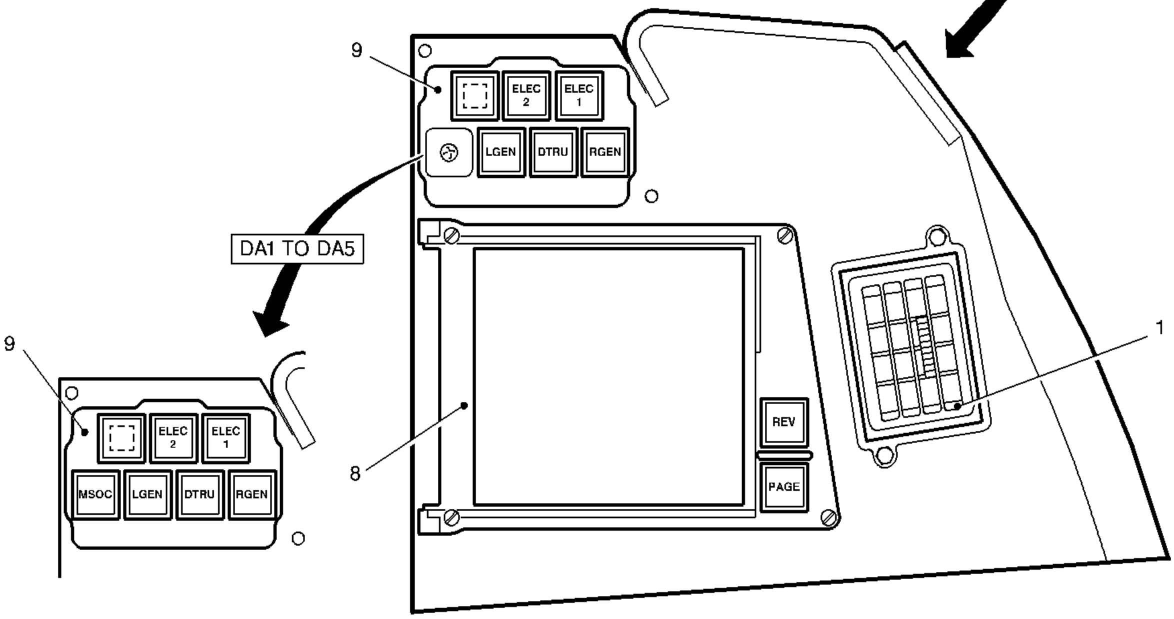
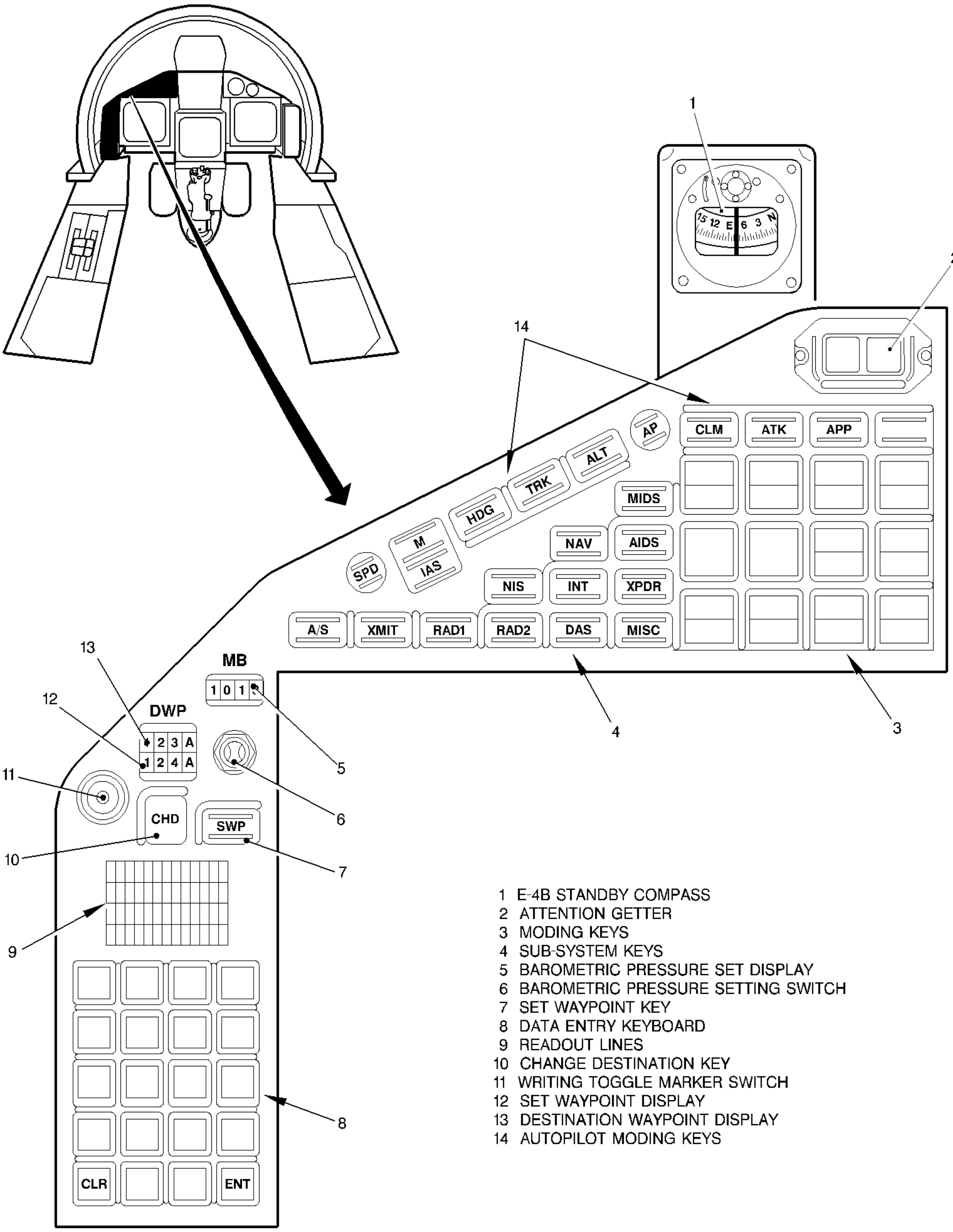
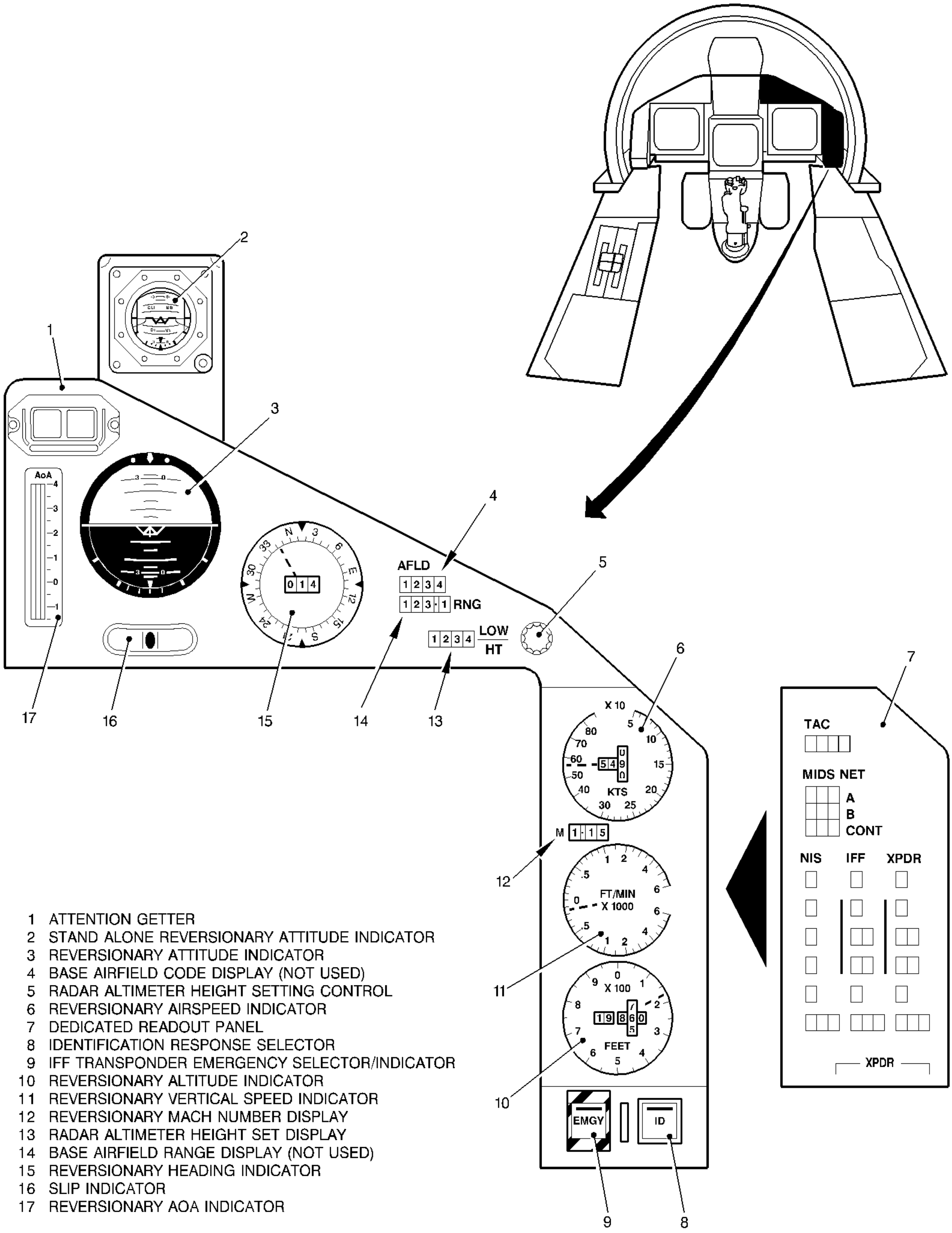


Figure 1.13 - Cockpit Left and Right Quarter Panels



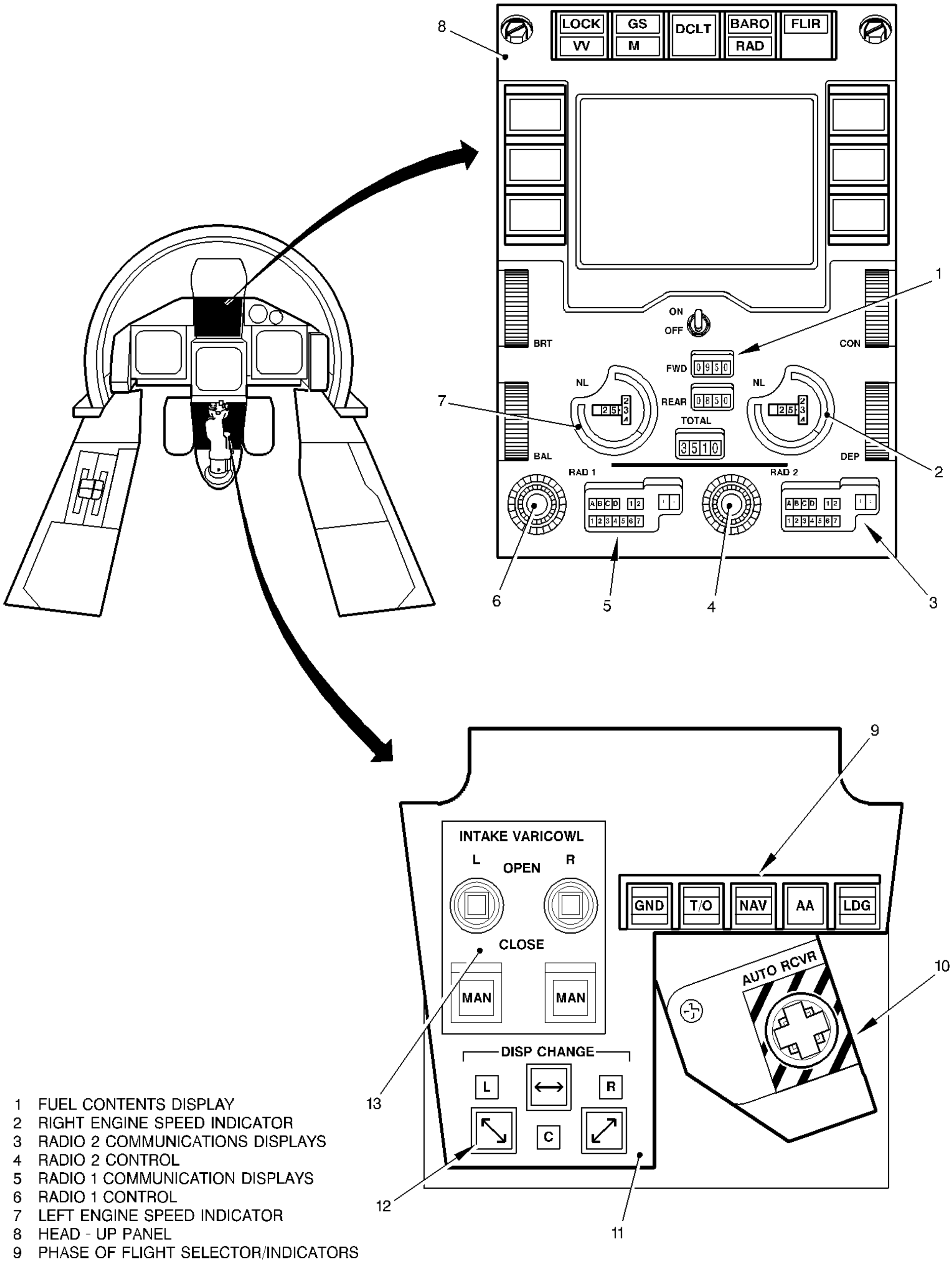
1 E-4B STANDBY COMPASS
2 ATTENTION GETTER
3 MODING KEYS
4 SUB-SYSTEM KEYS
5 BAROMETRIC PRESSURE SET DISPLAY
6 BAROMETRIC PRESSURE SETTING SWITCH
7 SET WAYPOINT KEY
8 DATA ENTRY KEYBOARD
9 READOUT LINES
10 CHANGE DESTINATION KEY
11 WRITING TOGGLE MARKER SWITCH
12 SET WAYPOINT DISPLAY
13 DESTINATION WAYPOINT DISPLAY
14 AUTOPILOT MODING KEYS

Figure 1.14 - Cockpit Left Glareshield



1 ATTENTION GETTER
2 STAND ALONE REVERSIONARY ATTITUDE INDICATOR
3 REVERSIONARY ATTITUDE INDICATOR
4 BASE AIRFIELD CODE DISPLAY (NOT USED)
5 RADAR ALTIMETER HEIGHT SETTING CONTROL
6 REVERSIONARY AIRSPEED INDICATOR
7 DEDICATED READOUT PANEL
8 IDENTIFICATION RESPONSE SELECTOR
9 IFF TRANSPONDER EMERGENCY SELECTOR/INDICATOR
10 REVERSIONARY ALTITUDE INDICATOR
11 REVERSIONARY VERTICAL SPEED INDICATOR
12 REVERSIONARY MACH NUMBER DISPLAY
13 RADAR ALTIMETER HEIGHT SET DISPLAY
14 BASE AIRFIELD RANGE DISPLAY (NOT USED)
15 REVERSIONARY HEADING INDICATOR
16 SLIP INDICATOR
17 REVERSIONARY AOA INDICATOR

Figure 1.15 - Cockpit Right Glareshield



1 FUEL CONTENTS DISPLAY
2 RIGHT ENGINE SPEED INDICATOR
3 RADIO 2 COMMUNICATIONS DISPLAYS
4 RADIO 2 CONTROL
5 RADIO 1 COMMUNICATION DISPLAYS
6 RADIO 1 CONTROL
7 LEFT ENGINE SPEED INDICATOR
8 HEAD - UP PANEL
9 PHASE OF FLIGHT SELECTOR/INDICATORS
10 AUTOMATIC RECOVERY PUSHBUTTON
11 PEDESTAL PANEL
12 MHDD DISPLAYS CHANGE CONTROLS
13 MANUAL INTAKE VARICOWOL CONTROLS

Figure 1.16 - Cockpit Head-Up Panel and Pedestal Panel

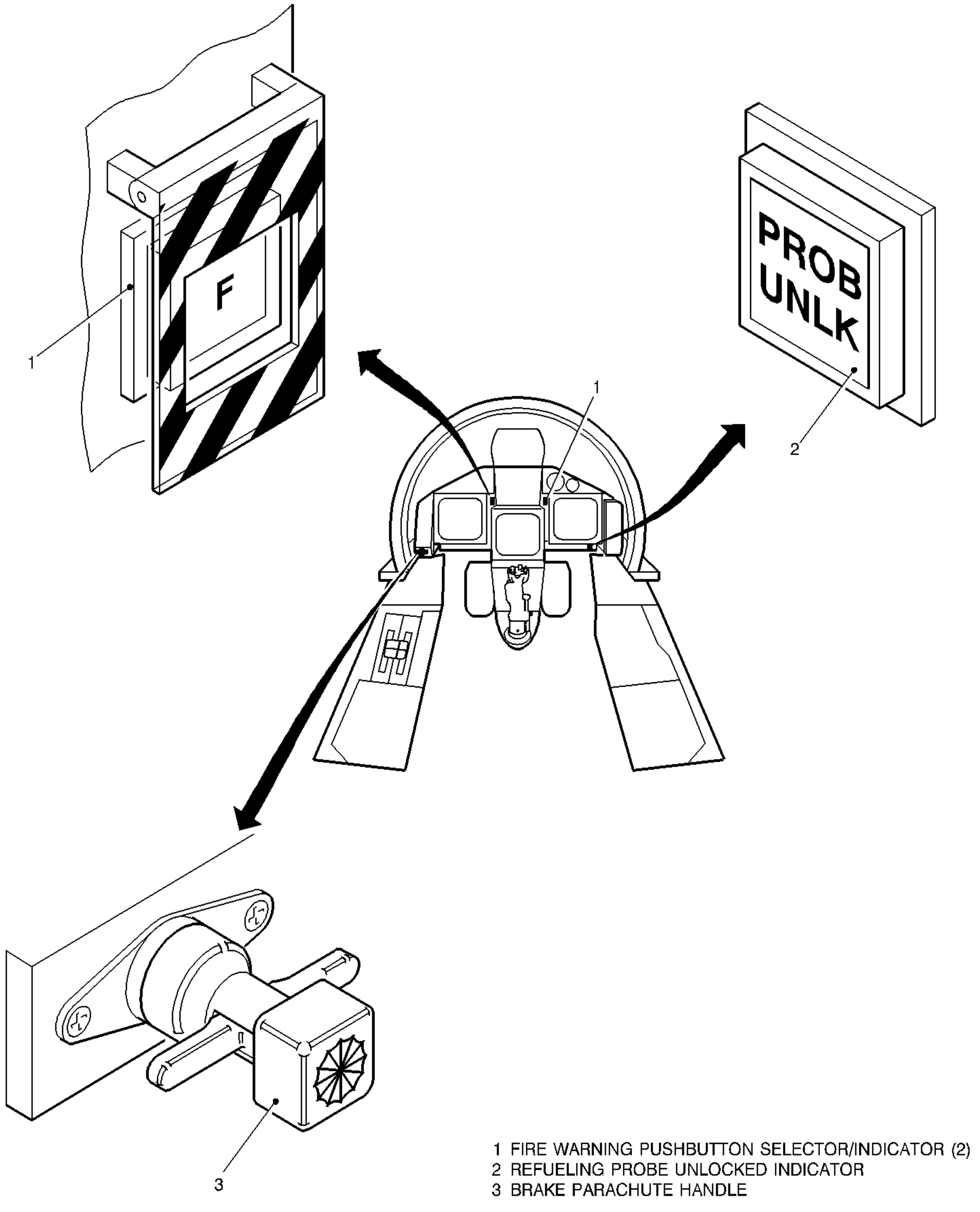


Figure 1.17 - Cockpit Center Panel

ELECTRONIC DISPLAYS AND CONTROLS - MHDD

The aircraft is equipped with three MHDD (Figure 1.18), each MHDD comprising a 152mm square cathode ray tube display area, surrounded by a bezel on which 17 soft keys (SK) are located. Each MHDD is independent and presents color graphic displays of selected information, the moding of which is controlled by phase of flight (POF) selection and thereafter by manual selection. There are default display formats which are presented automatically upon entry into each POF. Two light sensors continually monitor the ambient lighting conditions to maintain the contrast level of the displays.

POWER SUPPLIES

Each MHDD requires a 115/200V, 400 Hz three-phase AC power supply and a 28V DC power supply which are provided by the aircrafts AC and DC power generation systems. MHDD power supplies are identified in MHDD Power Supplies Table. Loss of AC or DC supply will render a MHDD inoperable.

MHDD Power Supplies

MHDD DESCRIPTION	AC SUPPLY	DC SUPPLY
Left MHDD	XP1	PP1
Center MHDD	XP1	PP1
Right MHDD	XP2	PP2

CONTROLS

The MHDD controls, surrounding the main display area, enable configuration of the display and control of other aircraft systems.

DISPLAY CONTROLS

Two dual-concentric rotary control knobs, each with 270° rotation and a center detent, Figure 1.18, control the following functions:

On - Off/Brightness: The left, outer control knob switches the MHDD on and off, and enables display brightness to be controlled. The MHDD is switched off when the rotary control is fully counter clockwise. Rotating the control clockwise from the center detent position brightens the display; anticlockwise rotation darkens the display.

HSI Heading Marker: The left, inner control knob controls movement of the HSI heading marker around the compass rose when the HSI format is selected. Rotation of the control clockwise of the the center detent position causes the heading marker to rotate clockwise, and vice versa. Returning the rotary control to the center detent position stops the heading marker rotation.

Foreground/Background Balance: The right, outer control knob is used to control the foreground/ background balance. Rotation of the control clockwise from the center detent position increases foreground/background balance, and vice versa.

HSI Course Marker: The right, inner control knob either controls the HSI course marker when the HSI format is selected in a similar way to the header marker control detailed above.

SK

There are 17 SK located on the bezel surrounding the display; six either side and five across the bottom. They enable various configurations of aircraft systems to be displayed.

The number of SK that are available on any of the MHDD depends on the format displayed. If any key function is duplicated on different formats, it retains the same position.

SYMBOL GENERATION

The MHDD formats are produced by one of two computer symbol generators (CSG). The output of the selected CSG is transmitted to the MHDD via dedicated links. Pushbutton legends and selections are transmitted onto the cockpit and avionic busses via the cockpit interface units (CIU).

FORMAT SYMBOLOGY GENERAL

In most cases, if information is presented in an analog format (e.g. thermometer scales or counter pointers), a digital readout is also presented. Red is used to indicate warnings or failure conditions requiring immediate action; amber indicates cautionary conditions. Green or white indicates correct or satisfactory conditions.

MHDD FORMATS

The MHDD provide the primary display for a number of systems and allow control selections for some systems to be made. The information is organized into the following formats:

- Autocue Format (ACUE).
- Engines Format (ENG).
- Fuel Format (FUEL).
- Hydraulics (HYD).
- Radio format (FREQ).
- Head Down HUD Format (HUD).
- Waypoints Format (WPT).
- Pilot Awareness Format (PA).
- HSI Format (HSI).
- Attack Format (ATCK).
- Elevation Format (ELEV).

– Stores Format (STOR).
– Reversionary Format (REV)
– Defensive Aids Sub-System (DASS).

An example of each of the above formats can be found in , Electronic Display Formats - Controls and Indicators.
In each POF, three of the formats are automatically selected for display by default. The default formats for each phase of flight are shown in MHDD Displays Table. The SK allow options associated with each format, or other display formats, to be selected.

DISPLAY CHANGE SELECTOR/ INDICATORS

Three pushbutton selector/indicators, labeled DISP CHANGE, Figure 1.19 , are located on the pedestal panel and allow the formats to be interchanged between the MHDD. The momentary action pushbutton controls have a double-headed arrow legend and an integral illumination source. When the lower right pushbutton is pressed, the display format and associated SK captions of the right MHDD are exchanged with those of the center MHDD. When the lower left pushbutton is pressed, the display format and associated SK captions of the left MHDD are exchanged with those of the center MHDD. When the center pushbutton is pressed, the display format and associated SK captions of the left MHDD are exchanged with those of the right MHDD.

POF SELECTION

The type of information displayed on the MHDD will change in accordance with current phase of flight. The phase of flight changes automatically in response to pilot actions but can also be changed manually via five pushbutton selector/indicators marked GND, T/O, NAV, AA and LDG, Figure 1.19.

NOTE

The AA pushbutton is an indicator only. AA POF cannot be manually selected via the POF selectors.

The selector/indicators are located on the pedestal panel. When a POF is selected, status bars appear above and below the caption on the appropriate selector/indicator, and the MHDD automatically configure to display the default formats MHDD Displays Table for that particular POF. The five phases of flight are as follows:

– Ground procedures (GND). The GND POF is divided into two phases; pre-flight for the start-up procedure, and post-flight, for shutdown. The pre-flight phase insures that the aircraft is in a state of operational readiness. Upon aircraft power-up, the POF is automatically selected and the Autocue format provides information on the status of a number of aircraft systems.
– Takeoff (T/O). The T/O POF is enabled when the MASS is selected to ‘LIVE’ (the last of the pre-flight actions), or weight-off-wheels is sensed, or movement of both throttles to a position equal or greater than 80% NL.
– Navigation (NAV). The NAV POF is selected automatically, when the landing gear is selected ‘UP’, or can be selected manually during the T/O POF.
– Air-to-air combat (AA) (indication only). The AA phase of flight is selected when a crew member selects AMRAAM, ASRAAM or air-to-air guns via the air-to-air weapon selector switches on the stick tops.
– Approach and landing (LDG). The LDG POF is automatically selected when the landing gear is selected ‘DOWN’.
– Ground Procedures (GND). Post flight the GND POF is automatically selected when the park brake is selected on (with weight-on-wheels).

MHDD Displays

PHASE OF FLIGHT SELECTED	FORMATS DISPLAYED UPON ENTRY LEFT MHDD	FORMATS DISPLAYED UPON ENTRY CENTER MHDD	FORMATS DISPLAYED UPON ENTRY RIGHT MHDD
GND	ACUE	PA	ENG/ STOR*
T/O	ATCK	PA	ENG
NAV	ATCK	PA	ELEV
AA	ATCK	PA	ELEV
LDG	ATCK	PA	ENG

* Engine format initially, followed by stores format when MASS set to STBY or LIVE.

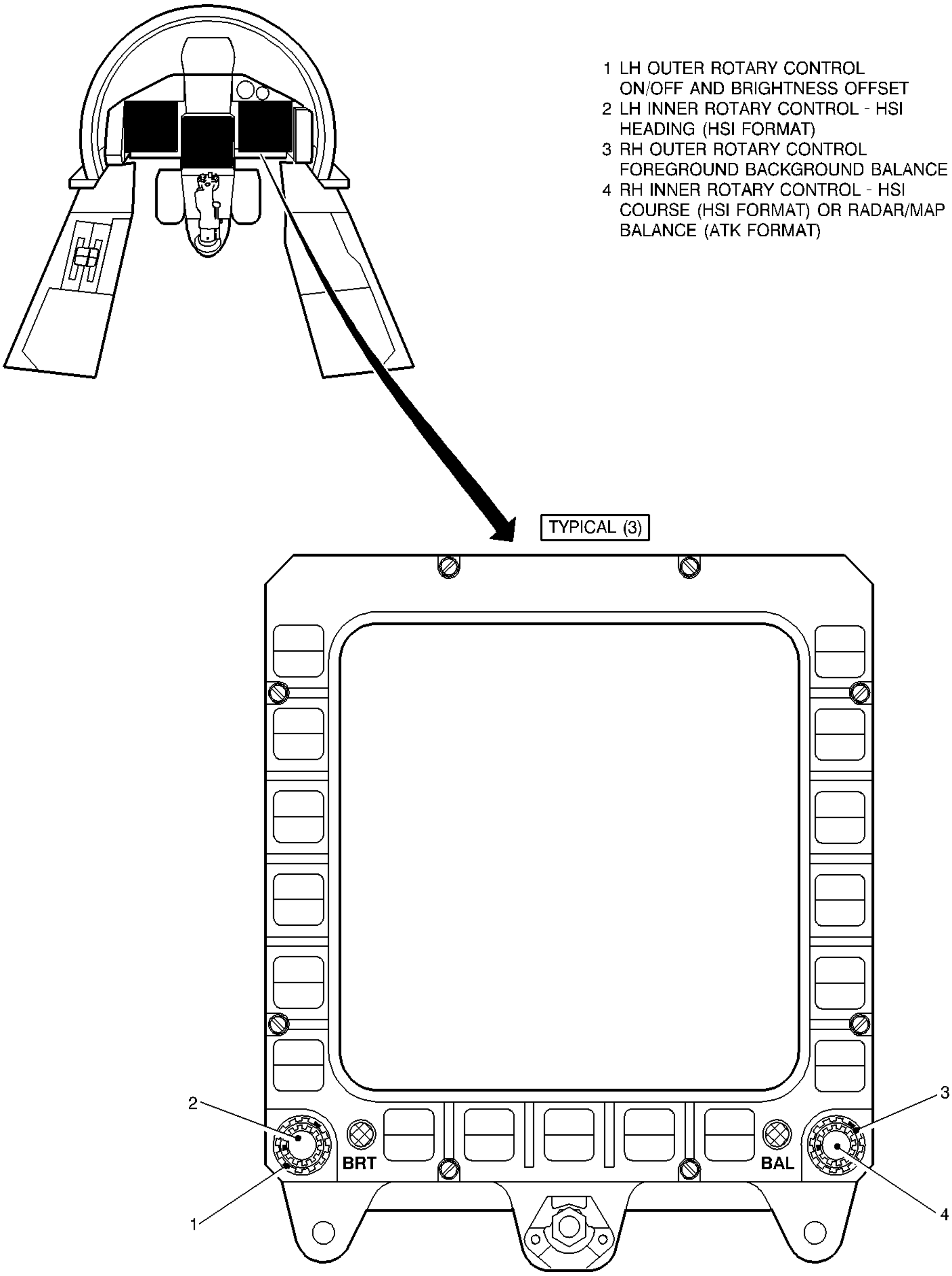


Figure 1.18 - Multifunction Head-Down Display

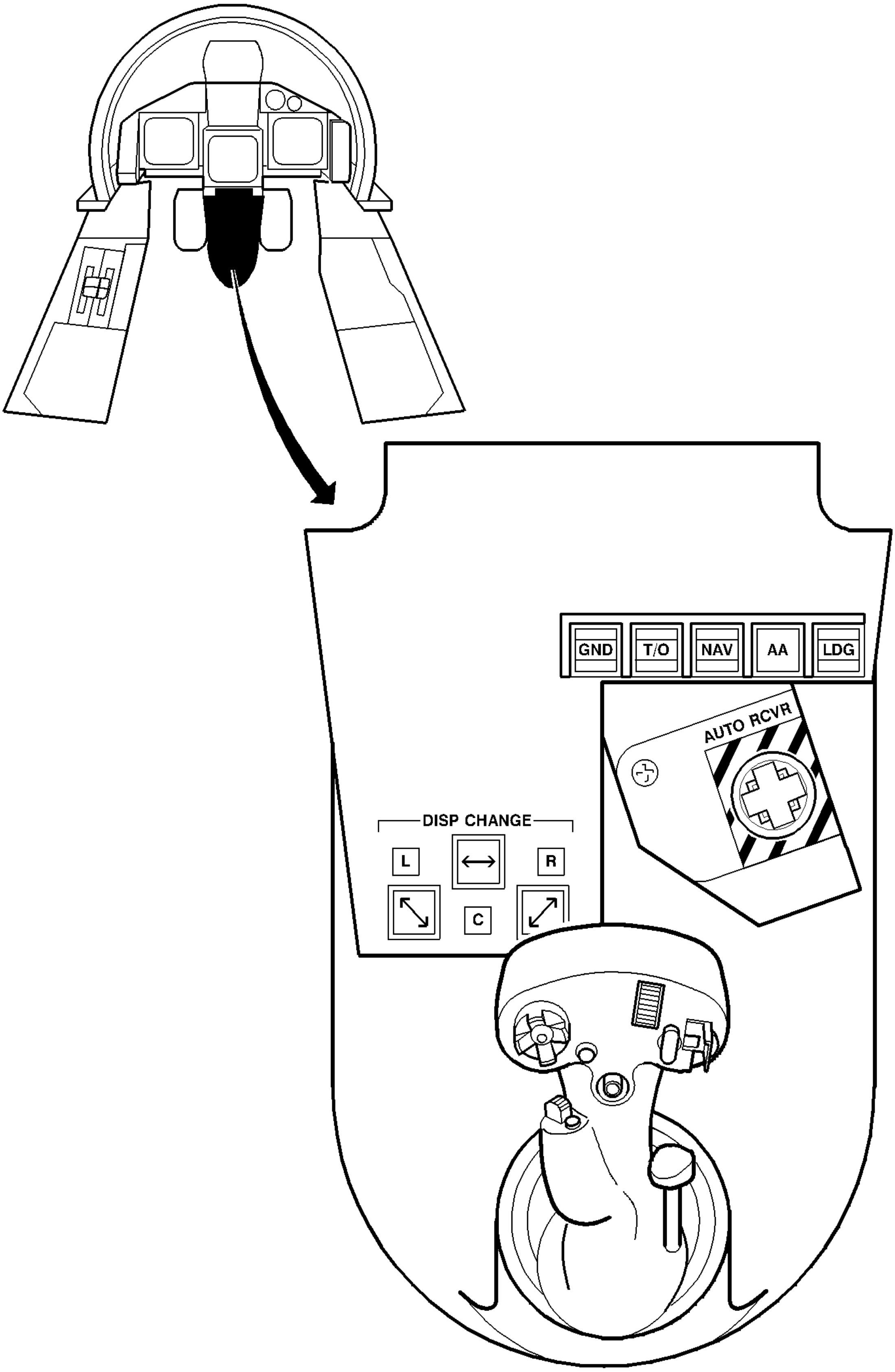


Figure 1.19 - Pedestal Panel

ELECTRONIC DISPLAYS AND CONTROLS - VTAS

The Voice, Throttle and Stick (VTAS) controls allow the pilot to carry out complex tasks with relative ease during high workload situations. The VTAS consists of a number of dedicated controls on the throttles and stick tops, and a Direct Voice Input (DVI) Facility. The throttles and control stick tops contain a number of controls to allow weapon system moding and sensor control and provide a hands on throttle and stick (HOTAS) facility.

NOTE

At AVS SP3 the prime aim of the DVI design is to provide a means of proving the performance of the DVI module in the CAMU. The design implementation is wholly passive, i.e. the DVI system has no effect on the Avionics sub-systems apart from the D&C sub-system which simply provides visual feedback of command recognition to the pilot.

The Direct Voice Input (DVI) facility will ultimately allow the pilot to activate non-safety critical moding and data entry functions as an alternative to using manual methods.

THROTTLE TOP CONTROLS

The throttle tops contain a total of twelve controls as follows:

OUTBOARD THROTTLE TOP

The outboard throttle top, Figure 1.20 , contains six controls (of which only four are functional at AVS SP3C):

- FTI event marker button
- SRAAM reject button
- Flare/chaff release switch
- Rotary control for adjustment of:
  - Radar scanner elevation during A-A search modes
  - Radar gain during A-S functions (from AVS SP3C 10 onwards).

FTI EVENT MARKER BUTTON

NOTE

If FTI cameras are installed on the aircraft, selection of the marker lock button will enable them to run.

The FTI event marker button enables an event counter within the FTI time code generator to be activated each time the button is operated.

CHAFF/FLARE INITIATE SWITCH

Chaff/Flares release is dependant on the availability of the Chaff/Flares dispense functionality. With the Expendable Release Manual Control set to EXPD or MAN and the MASS set to LIVE (for flare release):

- Operation of the switch in the forward direction initiates the dispensing of the default chaff only program or expendables program selected on the MDEF.
- Operation of the switch in the aft direction initiates the dispensing of the default chaff and flare program.

The sequence will be repeated upon re-selection of the control until the aircraft stores of chaff/flares packages are exhausted.

SRAAM REJECT BUTTON

When SRAAM is selected operation of this switch rejects the currently selected SRAAM station. Continued operation enables the pilot to toggle through rejecting the remaining available SRAAM. If the last remaining station is rejected all remaining SRAAM are reset to available. Selection feedback is available through the HUD.

RADAR ELEVATION CONTROL/RADAR AIR-TO-SURFACE GAIN

When the radar is operating in an air-to-air search mode, rotation of this control will reposition, in elevation, the center of the radar scan pattern. During air-to-surface operation, however, the control is assigned to adjust radar gain.

INBOARD THROTTLE TOP

The inboard throttle top, Figure 1.21, contains six controls (of which five are functional at AVS SP3C):

- X-Y controller/insert switch
- Auto throttle control switch
- Designated target list rotate/re-attack button.
- Communication control switch
- Airbrake selector.

X-Y CONTROLLER/INSERT SWITCH

The X-Y controller is an omni-directional finger-operated force-sensitive switch. Operation of this switch causes a cursor (the X-Y marker) to be moved, or 'slewed', across the electronic display surfaces where it is used to select various cursor selectable items (CSI), such as waypoints, plots, tracks or targets. The top of the switch is also depressible and this action is used to perform the insert function. Inserting is the basic function for the selection of CSI on the HUD and MHDD formats. Some CSI have a 'magnetic area' which extends beyond the boundary of the actual symbol, for example all track and target symbols. When the X-Y marker comes close enough to a magnetic point, it jumps to that point. Some CSI have a 'capture area' which also extends beyond the boundary of the actual symbol. This applies, for example, to the line CSI for radar scan width adjustment. CSI such as these may be selected by X-Y insert, without the X-Y being directly over the symbol.

There are two variants of the X-Y insert: short insert and long insert. For a short insert the time between pressing and releasing the X-Y controller must be less than 1 second. For a long insert this time must exceed 1 second. In the case of a long insert the desired action occurs after 1 second, whether the X-Y controller has been released or not.

For some functions, such as Elevation Bars and Radar Attenuation, an X-Y insert for more than 600 ms on the relevant icon increases or decreases values in pre-determined steps until either the limit of adjustment is reached or until the X-Y insert is released. In some cases, when the limit of adjustment in a given direction is reached, the value 'wraps around' from the highest to lowest or vice versa.

The second general function is dragging. This is a method of moving CSI on the formats. When the drag mode is engaged the X-Y marker is highlighted with a diamond. The procedure for dragging is as follows:

– Position marker over required CSI.
– Perform a short X-Y insert to 'pick-up' the CSI. The marker is highlighted with a diamond.
– Slew the X-Y controller to move the X-Y marker, with CSI attached, to its new position.
– Perform a short X-Y insert to drop the CSI at its new position.

In addition to inserting and dragging there are two other general facilities available on certain formats:

– Display of extra information by means of X-Y inserts on tracks, targets and waypoints. This action produces extra information in the Read Out Lines (ROL) located on the LGS, and/or in dedicated boxes on the MHDD, depending on the format. Extra information boxes with multiple pages can be paged by means of X-Y insert.
– Adjustment of display range scales, on formats such as the Attack, PA and Elevation, by means of 'bumping' the X-Y marker at the top or bottom of the format.

Should the marker ever be lost on the MHDD it may be found quickly by selecting the Marker Locate soft key (MKR LOC) on one of the following 'Group A' formats:

– Attack PPI
– Attack B-Scope
– Engines
– Fuel
– Hydraulics
– Stores
– Checklist
– Autocue
– Head Down HUD.

The X-Y marker then moves to a position on the MHDD format adjacent to the MKR LOC softkey. The marker locate mode is deselected by the first X-Y movement demand. Whenever the X-Y marker is located within the HUD the marker locate facility is not available and the annotation 'HUD' is shown next to the MKR LOC softkey position. The X-Y marker returns to the marker locate position as soon as the HUD mode is deselected.

The insert and slew functions are monitored continuously to check that neither has failed in the 'ON' position, i.e. continuous insert or continuous slew.

The X-Y insert monitor disables the insert function if it detects any continuous demand of longer than 5 seconds. In this case X-Y slew remains available as normal.

The X-Y slew failure monitor disables the slew function in either the X-axis or Y-axis if it detects any continuous slew demand in that axis of longer than 12 seconds. After this time the X-Y marker is displayed frozen in the axis in which it has failed at the position of the last valid slew demand. In this case slew in the other axis and X-Y function remains available as normal.

Failure of insert and slew in both axes results in the X-Y marker freezing at the last valid position.

Should a failed X-Y function be restored, the next controller demand detected as different from a current failed value drives the marker as normal. Therefore, should the pilot inadvertently insert for longer than 5 seconds, or slew more than 12 seconds, normal functionality is available as soon as a different demand is selected.

AUTOTHROTTLE CONTROL SWITCH

A four position switch that is spring biased to the center (null) position. Movement of the switch in the forward direction will increase the speed acquire datum as indicated on the HUD and movement in the aft direction will decrease the speed acquire datum. Pressing the switch downwards will have two different effects depending on the length of time it is depressed. A short press (< 1second) will engage/ disengage the autothrottle speed acquire function and a long press (>1second) will enable the pilot to toggle between the Mach Number and DAS speed acquire indications once the autothrottle has been engaged. Pressing the control to engage the autothrottle slaves throttle movement and power setting to the autothrottle. The state of the autothrottle (engaged/disengaged) is indicated on the left glareshield, along with an indication of the mode in operation (Mach/DAS).

DESIGNATED TARGET LIST ROTATE/RE-ATTACK

A momentary action button which is able to perform two functions as follows:

– A short press rotates the DTL such that the first designated target becomes the last, and all other designated targets are promoted by one position.
– A long press will facilitate re-attack of a previously engaged target.

COMMUNICATION CONTROL SWITCH

A six-position cup type switch, which is spring-biased to the center position.

Selecting and holding the switch in the forward or rearward position enables audio transmission via radio 1 and radio 2 respectively. Radio transmission causes playback of all audio warnings to be suspended, with the exception of GUH voice messages (visual display of any warnings remains unaffected). If a warning message has started to play, selecting the PTT control suspends the warning for the duration that PTT is selected; the warning continues upon deselection of the PTT control. If a warning occurs after the control is selected, the warning plays immediately.

The combined Voice Warning Suspend (VWS)/ Comms mute function is selected when the switch is moved upwards. Voice Warning is suspended in accordance with the following criteria:

– If the switch is moved upwards for <15 secs the duration of the VWS will be enabled for 15 seconds. If the switch is held upwards for ≥15 seconds then VWS is enabled for the duration that the switch is held, and voice warning will be available when the switch is released.
– If the system is operating in the ‘normal’ (non GUH) mode and there are no current warnings when VWS is selected, then a subsequent incoming warning will be played immediately irrespective of category.
– If a warning is playing at the time VWS is selected, that message stops immediately. If a further warning situation occurs after VWS has been selected, only warnings of a higher category than the one that existed when the suspend was selected will be enabled. At the end of the suspend period, any warnings that were suspended at the time the control was selected, or that occurred and were inhibited after the control was selected, are played to the pilot in accordance with their prioritization.
– Selection of the VWS does not inhibit the presentation of Catastrophic Warning messages.

Comms mute is enabled only for the duration that the switch is held in the up position. Upon release Comms mute is deselected immediately.

When the switch is pressed inward in the center position, simultaneous transmission on radio1 and 2 is enabled.

Downward movement of the switch will initiate the Direct Voice Input (DVI) press to recognize (PTR) function. Initial DVI functionality will be passive with respect to the avionics system except for the displays and controls sub-system.

Acknowledgement of DVI command recognition is provided by means of dedicated visual feedback. This involves the display of a dedicated ROL on the HUD. Release of the DVI PTR at any time immediately occults the HUD ROL.

The HUD ROL consists of an outline box containing letters, digits, DVI command words and/or abbreviations of DVI command words. The outline box is of fixed length and is capable of displaying a DVI feedback string containing up to 34 characters, including spaces. There will always be one character space between each separate syntax unit. If insufficient space remains in the HUD ROL for the display of a particular feedback string no DVI HUD ROL feedback will result, although subsequent words may be successfully recognized by the DVI system and a correct code output passed to the D&C sub-system.

The entire vocabulary consists of a 107 command words. A DVI sequence is entered by starting with a ‘top level’ command word (Table), followed by alphanumerics (Table) and/or progressively lower level command words (Table).

NOTE

- As the alpha list is only used to designate the Track Cross Reference Indicator (TCRI), only 21 letters of the alphabet are required (the letters B, I, Q S and Z are not used for this task).

If a lower level command word or alphanumeric is entered that is not a legitimate command in relation to a higher level command word, then it will be ignored and will not be displayed in the HUD ROL. No HUD ROL prompts are available to facilitate the task of parameter specification. The HUD ROL is the only form of feedback to indicate to the pilot a correct DVI command, i.e. there are no audio tones or Digital Voice Output (DVO) status reports. There is no error correction facility. Recognition of the two error commands ‘DELETE’ and ‘BACK’ are indicated in the HUD ROL by the display of the feedback strings ‘DEL’ and ‘BACK’.

The entire DVI HUD ROL, including its contents is not subject to declutter control, and is classed as high priority information.

PTR selection causes playback of all audio warnings to be suspended, with the exception of GUH voice messages (visual display of any warnings remains unaffected). If a warning has already started to play, selecting the PTR control suspends the warning for the duration that PTR is selected; the warning continues upon deselection of the PTR control. If a warning occurs after the control is selected, the message plays immediately.

Top Level Commands and Feedback

COMMAND	FEEDBACK		COMMAND	FEEDBACK
UNDO	UNDO		DECLUTTER	DCLT
CLOSE	CLOSE		ELEVATION	ELEV
MARK	MARK		PA	PA
CONTENTS	CONTS		ATTACK	ATCK
PIGEONS	PIGEON		DISPLAY	DISP
TARGET	TARGET		MIDS	MIDS
BIN	BIN		SQUAWK	SQUAWK
EXPAND	EXPAND		TACAN	TACAN
INTERROGATE	INTER		ASSIGN	ASSIGN
TYPE	TYPE		MLS	MLS
LOCK	LOCK		ROUTE	ROUTE
DEST	DEST		RADIO	RADIO
PAGE	PAGE			

Commands and Feedback, Alphas and Numbers

COMMAND	FEEDBACK		COMMAND	FEEDBACK
ALPHA	A		ONE	1
CHARLIE	C		TWO	2
DELTA	D		THREE	3
ECHO	E		FOUR	4
FOXTROT	F		FIVE	5

(Continued)

Commands and Feedback, Alphas and Numbers (Continued)

COMMAND	FEEDBACK		COMMAND	FEEDBACK
GOLF	G		SIX	6
HOTEL	H		SEVEN	7
JULIET	J		EIGHT	8
KILO	K		NINE	9
LIMA	L		ZERO	0
MIKE	M			
NOVEMBER	N		DELETE	DEL
OSCAR	O		BACK	BACK
PAPA	P		GO	GO
ROMEO	R			
TANGO	T			
UNIFORM	U			
VICTOR	V			
WHISKEY	W			
X-RAY	X			
YANKEE	Y			

Lower Level Commands and Feedback

COMMAND	FEEDBACK		COMMAND	FEEDBACK
RADAR	RADAR		WAYPOINT	WPT
FLIR	FLIR		WARNINGS	WARN
UP	UP		NEXT	NEXT
DOWN	DOWN		PROCEDURES	PROC
DEFAULT	DFLT		CONSEQUENCES	CONS
BULLSEYE	BULL		PLATES	PLTS
BARS	BARS		NORMAL	NORM
MAP	MAP		WILCO	WILC
MTI	MTI		CANTCO	CANT
MIX	MIX		KEEP	KEEP
SEA	SEA		CLEAR	CLR
TWIS	TWIS		STANDBY	STBY
AIR-TO-AIR	AIR		AUTO	AUTO

(Continued)

Lower Level Commands and Feedback (Continued)

COMMAND	FEEDBACK		COMMAND	FEEDBACK
HEAD-DOWN	HEAD		MANUAL	MAN
PROFILE	PROF		CODE	CODE
DASS	DASS		RECEIVE	RECV
CHECKLIST	CHKL		TRANSMIT	XMIT
STANDARD	STD		AIR	AIR
EMERGENCY	EMGY		SURFACE	SURF
ENGINES	ENG		ENGAGE	ENGE
FUEL	FUEL		DISENGAGE	DIS
HYD	HYD		INVESTIGATE	INV
FREQS	FREQ		STUD	STUD
STORES	STOR		SECURE	SECR

AIRBRAKE SELECTOR

NOTE

It is not possible to manually select the airbrake to an intermediate position.

A three-position toggle switch which is spring-biased to the center position. Moving the switch forward causes the airbrake to retract (in), rearward movement causes the airbrake to extend (out). The status of the airbrake (either in or out) is displayed on the head-up display (HUD) pilot's display unit. Selection of the airbrake control also deselects autothrottle (if selected).

STICK TOP CONTROLLER

The control stick top, Figure 1.22, contains ten controls:

- Air-to-air weapon selector/SRAAM recage selector/PTA control
- Radar air combat mode and lock/break lock.
- IFF interrogate button.
- Air-to-air weapon release.
- Late arm safety interlock.
- Air-to-surface weapon commit/release button.
- Instinctive cut out (ICO) and nose wheel steering (NWS) disconnect.
- Autopilot engage/disengage control (autopilot not functional at FCS 3 Rel 1).
- Pitch and roll trim control/autopilot heading and height datum adjust (autopilot not functional at FCS 3 Rel 1).

AIR-TO-AIR WEAPON SELECTOR/SRAAM RECAGE SELECTOR/PRIORITY TARGET ACCEPT CONTROL

The air-to-air weapon selector/SRAAM recage selector/PTA is a center sprung, six position toggle switch.
Movement of the switch in a forward direction selects AMRAAM mode if there are AMRAAM available for selection. The system then chooses one of the following modes:

- Normal
- Home-on-jam (HOJ)
- Visual

Further operations of the switch in the forward direction enables the pilot to toggle between the system choice (if different from Visual) and Visual mode. The indication that AMRAAM has been selected, along with the quantity of available AMRAAM and if in Normal, HOJ or Visual mode is displayed on the HUD and MHDD/PA and MHDD/ATK formats.
Movement of the switch in the aft direction selects Air-to-Air Gun (AAG) mode. Upon selection of AAG mode, if radar lock follow is engaged then the system defaults to Mixed mode, which is a combination of both Primary and Secondary modes. This mode combines the accurate ranging and instantaneous aiming cues of the Director Gunsight (Primary mode) with the high maneuver prediction benefit of the Historic Tracer Line sight (Secondary mode). Further operations of the switch in the aft direction enables the operator to toggle between Mixed and Primary modes. If the aircraft is not in Lock Follow mode the only option available is Secondary mode and this

mode is therefore selected by default when entering AAG mode. An indication that the AAG mode has been selected along with rounds remaining is displayed on the HUD and MHDD/PA and MHDD/ATK formats.

A momentary press of the switch selects SRAAM mode (AIM 9L or ASRAAM) provided there is at least one SRAAM available for selection. Additional short presses of the switch enable the pilot to toggle between Slaved and Manual modes. In Slaved mode if a radar target exists then the SRAAM enters Slaved-to-Target mode; otherwise it enters Slave-to-Boresight mode. In Manual mode the pilot is able to control the SRAAM seeker look-angle via the X-Y controller.

With SRAAM selected, movement of the switch to the right enables the pilot to recage/uncage the SRAAM.

Movement of the switch to the left selects the front hemisphere Priority Target Accept function. The DTL is then reset such that the top six priority targets are presented, in order of system priority, as the new DTL. With AMRAAM selected, a missile is automatically allocated to each target within the DTL.

RADAR AIR COMBAT MODE & LOCK/BREAK LOCK SELECTOR

The radar air combat mode and lock/break lock selector is a center sprung, six-position toggle switch.

Movement of this switch forward selects the combined Slave/Boresight Acquisition Mode (SACQ). When radar lock has been achieved from this mode, selection of this switch causes the rejection of the lock track in that mode.

Movement of this switch aft selects the Vertical Scan Acquisition Mode (VACQ). When radar lock has been achieved from this mode, selection of the switch causes the rejection of the lock track in that mode.

Movement of the switch to the right selects HUD Acquisition Mode (HUDQ). When radar lock has been achieved in this mode, selection of the switch causes rejection of the lock track in that mode.

Pressing of the switch selects the Radar Lock/Break Lock function depending on the current radar status as follows:

- If the radar is locked onto a target, then Break Lock is initiated, or
- If ACM is selected, then ACM is cancelled. The Radar returns to the previously selected A-A mode, or
- If the Radar is in Search Mode, then operation of the switch causes the radar to lock onto the plot or track that is designated by the X-Y marker.

IFF INTERROGATE BUTTON

This button is used to initiate IFF interrogations on a particular track or volume designated by the X-Y marker.

LATE ARM SAFETY INTERLOCK/WEAPON RELEASE INHIBIT

The late arm safety interlock is a two-position slider control.

NOTE

> The position of this switch does not affect the Emergency/Selective Jettison function.

Movement of the switch forward selects the Late Arm Safety Interlock to OFF, exposing an orange marker. This facilitates access to the air-to-surface weapon commit/release button and allows the A-A Missile/Gun Trigger to be used for weapon release. Movement to the aft position selects the Late Arm safety Interlock to ON. In this position the air-to-surface weapon commit/release button is inaccessible and the A-A Missile/Gun Trigger is inoperative.

AIR-TO-SURFACE WEAPON COMMIT/RELEASE BUTTON

The air-to-surface weapon commit/release control is a momentary action pushbutton protected by a two position coverguard. With the guard in the closed position the pilot is physically unable to operate the pushbutton. With the guard open the button can be operated to initiate air-to-surface weapon commit/release modes.

PITCH AND ROLL TRIM BUTTON/AUTOPILOT HEADING AND HEIGHT DATUM ADJUST

PITCH AND ROLL CONTROL

Provided that the TRIM NORM-CANCEL switch or the DATUM ADJUST-TRIM switch (dependant upon aircraft fit), located at the rear of the left console, is selected to NORM or TRIM respectively , the pitch and roll trim button provides trim control in the pitch and roll axes. The button is spring-biased to the center and can be moved forward and backward to increment pitch demands, or left and right to increment roll demands. Throughout these operations, the rate of trim influence is constant.

When the toggle switch is in the center-biased position, any previous trim demand associated with the switch remains unchanged unless reset to a takeoff trim condition via the FCS RSET button, or trim demand is cancelled via the pitch/roll trim cut-out control.

HEADING AND HEIGHT ADJUSTMENT

NOTE

Autopilot functions are not supported at FCS 3 Rel 1 and therefore the VTAS control is permanently moded as a trim control.

If the AP is enabled or an AP mode is selected then the switch re-modes to its autopilot datum entry function.
When this mode is active movement of the switch to the left will cause the heading datum, displayed on the HUD, to change in an anti-clockwise direction and a movement to the right will cause the heading datum to change in a clockwise direction. Selection of the switch in the pitch axis will increment/ decrement the value of the barometric altitude (displayed on the HUD) to be acquired.

INSTINCTIVE CUT-OUT (ICO)/NOSE WHEEL STEERING SWITCH

NOTE

Autopilot functions are not supported at FCS 3 Rel 1 and therefore the ICO will only disengage the NWS and autothrottle functions.

With weight-on-nose wheel and nose wheel steering engaged, operation of the ICO switch disengages nose wheel steering. When the situation of 'weight-off-wheels' arises and the aircraft is configured to support autopilot/autothrottle functions then operation of the switch will disengage and deselect the autopilot and autothrottle functions. If the aircraft is configured to support FBI routines then operation of this switch will cancel any previously selected FBI routines.

AUTOPILOT ENGAGE/DISENGAGE BUTTON

NOTE

Autopilot functions are not supported at FCS 3 Rel 1 and therefore the AP Engage/Disengage VTAS control is unavailable.

This button is used to engage/disengage the autopilot, depending on the current mode.

AIR-TO-AIR MISSILE/GUN TRIGGER

The air-to-air missile/gun trigger is a three position switch which is sprung out. Initial pressing of the switch will select the first detent, with or without the Late Arm Interlock selected to LIVE (forward). This will select the HUD Only Record Mode which will cause the information on the HUD to be recorded at an increased frame rate on the VVR, unless the VVR is switched OFF.
If the Late Arm Interlock is selected to LIVE then a further press on the switch will cause it to enter the second detent and this will initiate the release/ launch/firing sequence provided that the following criteria are met:

– a weapon is currently selected
– MASS is LIVE
– a/c 'weight-off-wheels'.

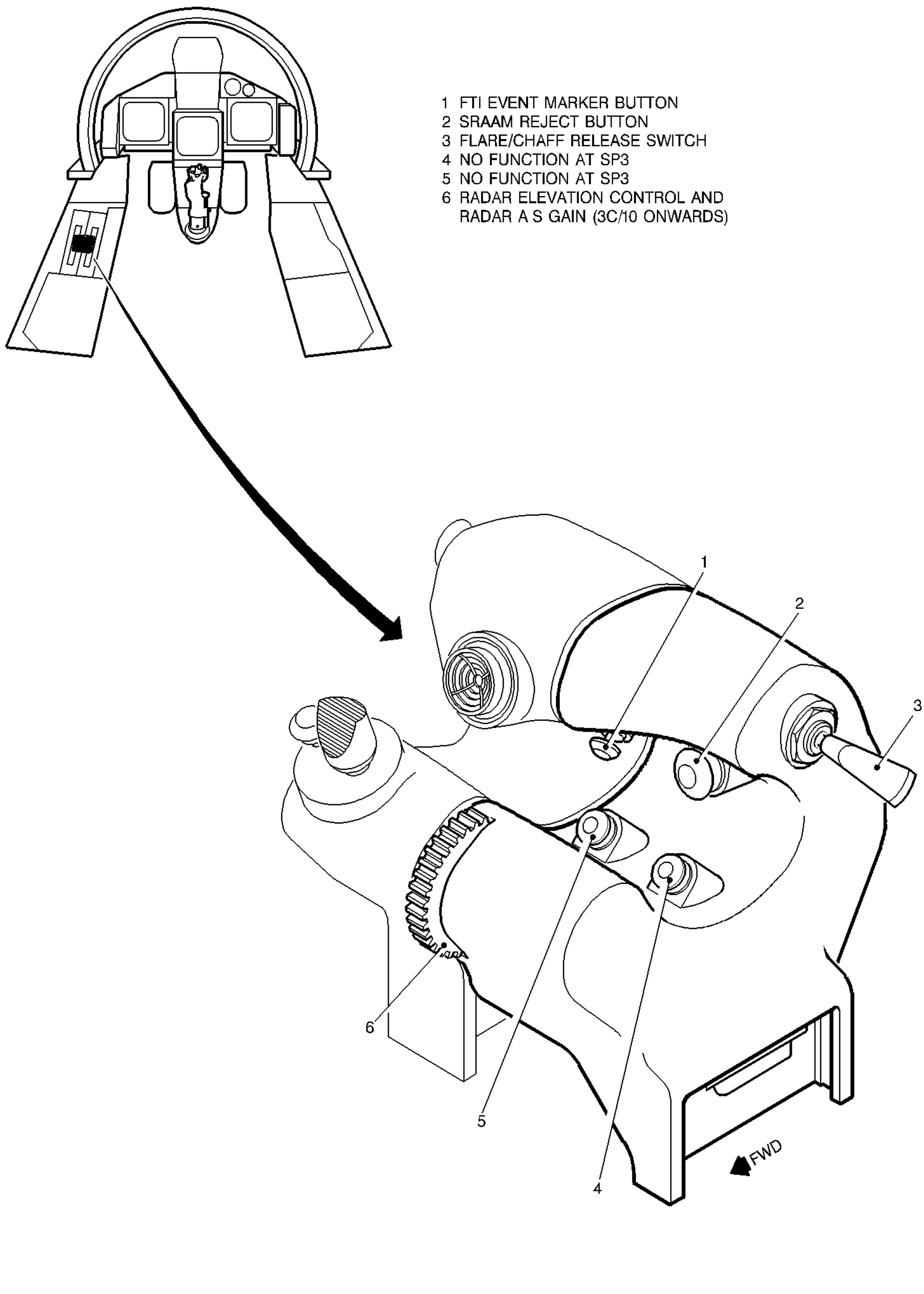


Figure 1.20 - VTAS - Left Throttle Top Controls

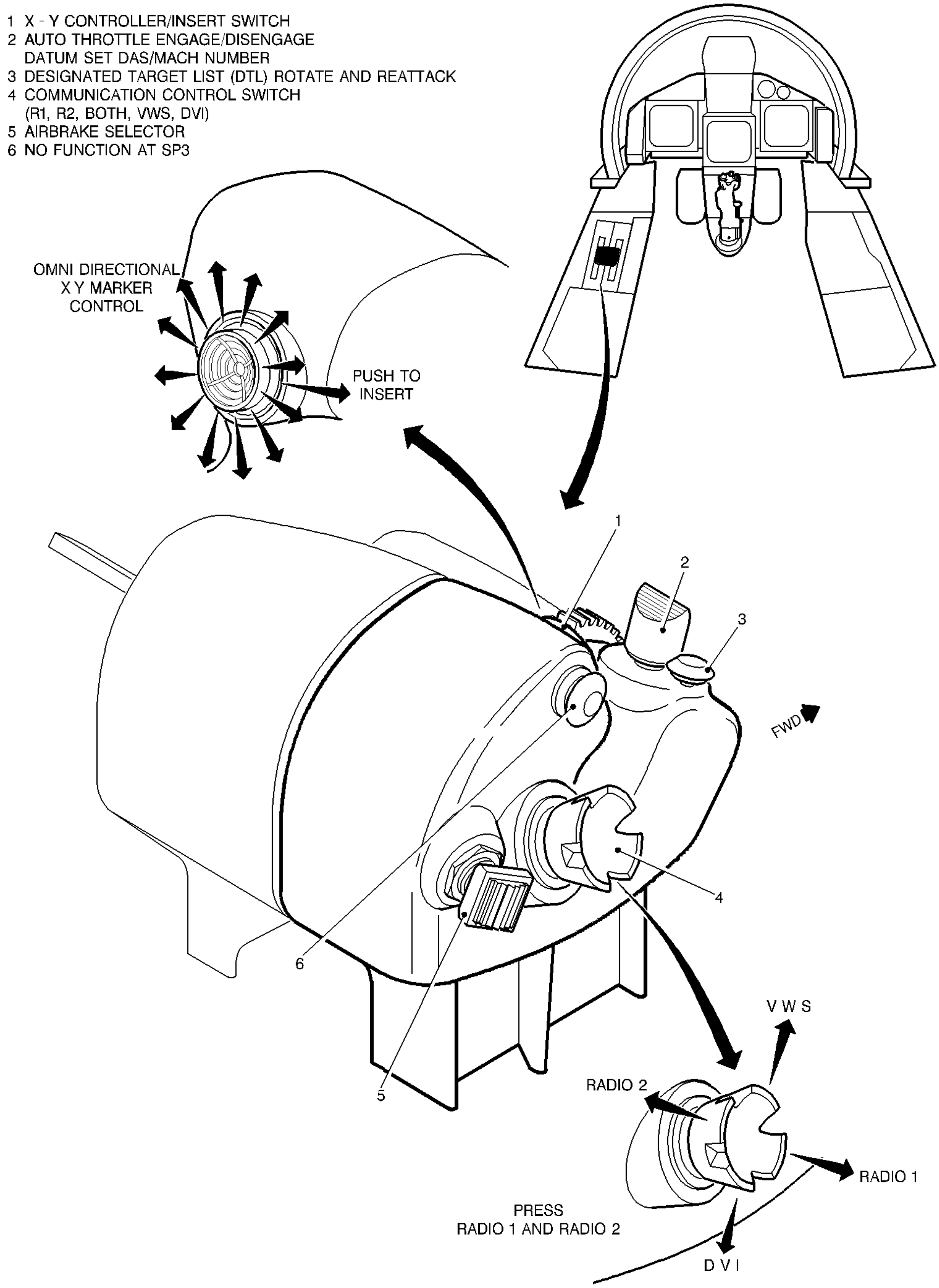


Figure 1.21 - VTAS - Right Throttle Top Controls

1 AIR-TO-AIR WEAPON SELECTOR/SRAAM CAGE/RECAGE/PTA SELECTOR
2 RADIO 1 PRESS TO TRANSMIT BUTTON
3 RADAR AIR COMBAT MODE & LOCK/BREAK LOCK SELECTOR
4 LATE ARM SAFETY INTERLOCK/WEAPON RELEASE INHIBIT
5 A-S WEAPON COMMIT/RELEASE SWITCH
6 PITCH AND ROLL TRIM, AUTOPILOT HEADING AND HEIGHT DATUM
7 IFF INTERROGATE BUTTON (3C/10 ONWARDS)
8 ICO/NWS DISCONNECT SWITCH
9 AUTOPILOT ENGAGE/DISENGAGE BUTTON
10 AIR TO AIR WEAPON RELEASE

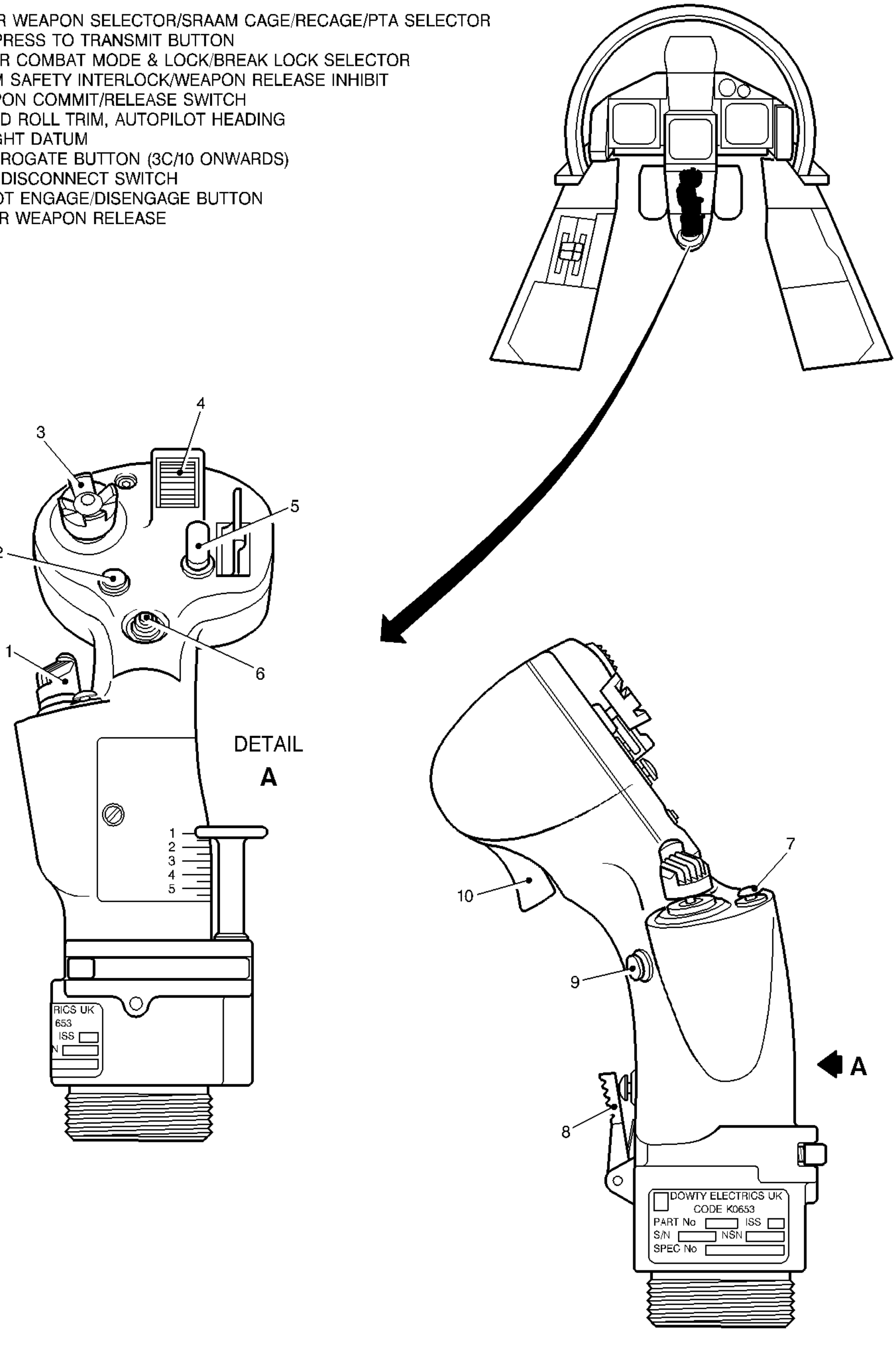


Figure 1.22 - VTAS - Stick Top Controller

GROUND PROXIMITY WARNING SYSTEM

NOTE

The GPWS is not safety or mission critical. The information provided to the pilot is advisory only and the pilot himself is responsible for performing the required pull up maneuver to ensure the safe flight of the aircraft.

The GPWS is an integrated system which accurately determines the position of the aircraft relative to the ground from data provided by the LINS, RAD ALT and GPS coupled with terrain and/or obstacle map data. The GPWS also utilizes FCS data, such as aircraft configuration data and g limits. By considering these data with an aircraft dynamic model and a PDS defined Minimum Separation Distance (MSD), the system continually computes the g required to clear the most critical terrain profile (ground and obstacle) within the aircraft's flight path. An allowance is made for position uncertainty, pilot reaction time and time to roll wings level. If within these allowances the GPWS predicts that a pull up maneuver at or above the pre-defined g level is required to prevent incursion below the clearance height above the terrain or obstacle, then a GPWS warning is activated. Simultaneously, a ‘Pull Up’ arrow is displayed on the HUD and HDHUD (if selected) to aid the pilot in the recovery.

GPWS EQUIPMENT

The GPWS equipment is located in the right hand avionics bay. It is powered by 115/200V, 400Hz, 3-phase AC from busbar XP2 and interfaces with other equipment via the Avionics databus.

INITIALIZATION

GPWS initialization procedure is performed automatically by loading the MSD data via the PDS. The GPWS accepts MSD data over the range 0 ft to 5000 ft in 25 ft increments. Where no MSD value is loaded via the PDS or a PDS download failure occurs the MSD defaults to a fixed value of 50 ft. There is no dedicated indication to inform the pilot if the MSD fails to load, although this would be indicated by means of the ‘PDS ERROR - D+C DATA’ prompt on the MHDD/ACUE format. The MSD value in use is displayed on the MDEF and MHDD/ACUE format.

The GPWS Terrain database and Obstacle database are loaded via the GLU. The pilot is informed if the data fails to load, is corrupted or if the aircraft ground PP is outside the area of definition of the terrain and/or obstacle databases via appropriate prompts on the MHDD/ACUE format, MHDD/ACUE Indications (GPWS) Table.

MHDD/ACUE Indications (GPWS)

INDICATION	MEANING
GLU ERROR - GPWS TERRAIN DATA	Terrain data not loaded or corrupted.
GLU ERROR - GPWS OBSTACLE DATA	Obstacle data not loaded or corrupted.
GPWS ERROR - TERRAIN AREA DATA	Present position outside terrain data area.
GPWS ERROR - OBSTACLE AREA DATA	Present position outside obstacle data area.
GPWS MSD - 1000	Current MSD setting for the GPWS.
PDS ERROR - D+C DATA	Possibility that MSD has failed to load from the PDS.

The GPWS defaults to the ON state on aircraft power up. The GPWS may be switched between ON and OFF via the MDEF (refer to Miscellaneous MDE and X-Y Functions pag. 329).

MODES OF OPERATION

The GPWS is operative in all POF, with the following provisos. The GPWS pull-up warning and related HUD and HDHUD symbology, and the ‘TERRAIN DATA’, ‘TERRAIN VALID’, ‘OBSTACLE DATA’ and ‘OBSTACLE VALID’ warnings are inhibited:

- When the aircraft has weight-on-wheels
- When in GND or T/O POF
- For 15 seconds after entering NAV POF from T/O POF (with weight-off-wheels)
- When the landing gear is selected down
- GPWS is set to OFF on the MDEF
- The GPWS has failed.

The GPWS has the following modes of operation:

- Primary Mode
- Reversionary Mode
- Acquisition Mode
- Off Mode.

The GPWS determines the mode of operation based upon input signal validity and availability, GPWS confidence level, height and map data validity and hardware status. This information is used to give an estimate of height and position uncertainty. These uncertainties are given a GPWS Height Figure of

Merit (FOM) and Position FOM, and are indicated by a number between 1 and 5 inclusive; the greater the number the larger the height or position uncertainty (GPWS Height FOM Table and GPWS Position FOM Table).

GPWS Height FOM

GPWS HEIGHT FOM	SYSTEM VERTICAL UNCERTAINTY
1	0 - 16 m (0 - 52 ft)
2	17 - 24 m (55 - 78 ft)
3	25 - 32 m (82 - 105 ft)
4	33 - 49 m (108 - 160 ft)
5	50 m+ (164 ft+)

GPWS Position FOM

GPWS POSITION FOM	SYSTEM POSITION UNCERTAINTY
1	0 - 48 m (0 - 158 ft)
2	52 - 76 m (170 - 250 ft)
3	80 - 100 m (262 - 328 ft)
4	104 - 144 m (341 - 472 ft)
5	148 m+ (485 ft+)

The pilot may view the system status by performing an X-Y insert over the PP symbol on the MHDD/PA format. An extra data box is presented that, amongst other information, displays the GPWS Height and Position FOM (Figure 1.23). The FOM information is available for view whenever the GPWS equipment is powered and serviceable, irrespective of whether the GPWS is selected ON or OFF at the MDEF.

PRIMARY MODE

The primary mode is the normal GPWS operating mode with all the major data inputs being valid and available at the required accuracy. The GPWS is considered to be operating in the primary mode when the height and position FOM are equal to 1. If the GPWS suffers a temporary loss of one or more of its sensors, e.g RAD ALT input data due to aircraft attitude, then the GPWS is able to minimize the effects of this temporary loss or intermittent sensor operation without inhibiting GPWS functionality.

REVERSIONARY MODE

The GPWS enters reversionary mode when the height and/or position FOM increase above 1. As the FOM increase the larger the height and position uncertainty and therefore the greater the height with which the aircraft is required to clear the terrain/ obstacles. When the FOM increase, the possibility of having nuisance warnings also increases. There is no dedicated warning to indicate to the pilot that the reversionary mode has been entered.

ACQUISITION MODE

If the GPWS FOM increase above a critical value as a consequence of a failure of the GPWS sensors or a prolonged period without data input, GPWS is automatically deselected and Acquisition mode is entered. In addition the DWP ‘GPWS’ warning and associated ‘GPWS’ voice message are presented. The system remains in Acquisition mode until a position of sufficient accuracy is determined, whereupon the GPWS fail warning is reset and the system enters either the Primary or Reversionary mode of operation, dependent upon height and position FOM.

OFF MODE

The pilot is able, via the MDEF, to select the GPWS between ON and OFF. When selected OFF all of the GPWS warnings and symbology are inhibited, with the exceptions of the MSD value displayed on the MDEF and MHDD/ACUE format, the ‘GPWS’ failure warning and the FOM on the MHDD/PA format. The legend ‘GPWS AVAIL’ is also presented on the MHDD/PA and HSI formats to remind the pilot that the GPWS is available but has been selected to OFF.

NORMAL OPERATION

TERRAIN/OBSTACLE WARNING

If, within the current flight path, the GPWS predicts that a pull up maneuver is required at or above a pre-defined g level to prevent incursion below the total system clearance height above the terrain or obstacle, then the voice warning ‘PULL UP’ is activated. The total system clearance height includes both the pre-defined MSD and an allowance for the GPWS height and position uncertainties. The warning is generated such that there is sufficient time for the pilot to react, to roll the wings level (if necessary) and to perform a pull up maneuver at or above the pre-defined g level.

Simultaneously, a flashing (4 Hz) pull up arrow is displayed on the HUD and, if selected, the HDHUD (Figure 1.24). The arrow is shown with its reference point centered on the aircraft symbol and is able to rotate around its reference point such that the arrow is always perpendicular to the horizon and points away from the ground. The breakaway cross is also displayed on all the MHDD formats (except for the

HDHUD and DRF formats) in order to improve the pilots awareness of the situation.

NOTE

> The GPWS pull up warning and associated GPWS pull up arrow will always suppress the low height warning and associated low height pull up arrow, i.e. the GPWS pull up warning and arrow will have precedence.

Continuous monitoring of the pilot response is carried out during the pull up maneuver by comparing the required g with the achieved g. The GPWS warning will reset and the pull up arrow will occult provided the aircraft has achieved the required trajectory that will allow the aircraft to clear the terrain or obstacle safely and outside the total system clearance height.

OFF MAP

When the aircraft position or its predicted trajectory is outside the area where the GPWS terrain data is defined the GPWS is not able to provide the pull up warning to clear both the terrain and obstacles. The pilot is alerted by the DWP warning ‘TERRAIN’, accompanied by the voice warning ‘TERRAIN DATA’. When the aircraft re-enters the defined area for terrain data then the GPWS pull up warning function to clear terrain and obstacles becomes available again, the DWP warning occults and the pilot is informed by the voice message ‘TERRAIN VALID’.

When the aircraft position or its predicted trajectory is outside the area where the GPWS obstacle data is defined the GPWS is not able to provide the pull up warning to clear obstacles, although it continues to provide the warning to clear the terrain. The pilot is alerted by the DWP warning ‘OBSTACLE’, accompanied by the voice warning ‘OBSTACLE DATA’. When the aircraft re-enters the defined area for obstacle data then the GPWS pull up warning function to clear obstacles becomes available again, the DWP warning occults and the pilot is informed by the voice message ‘OBSTACLE VALID’.

The terrain and obstacle warnings are inhibited when the GPWS is switched OFF at the MDEF or if the DWP ‘GPWS’ failure warning is triggered.

NOTE
'GPWS AVAIL' INDICATES THAT GPWS IS AVAILABLE BUT NOT SELECTED ON AT THE MDEF.

Figure 1.23 - MHDD/PA Format - GPWS Indications

NOTE

OUTER LINE OF ARROW FLASHES AT 4HZ. ARROW ROTATES ABOUT ITS REFERENCE POINT (AIRCRAFT SYMBOL) SUCH THAT IT ALWAYS POINTS AWAY FROM THE GROUND.

Figure 1.24 - HUD GPWS Pull Up Arrow

GET-U-HOME AND REVERSIONATY INSTRUMENTS

In the event of a failure resulting in the loss of the main cockpit displays, a number of get-u-home (GUH) instruments, located on the right glareshield and head-up panel, Figure 1.25 and Figure 1.26, provide the necessary flight information to assist a safe return to base. Two reversionary flight instruments are also fitted above the left and right glareshields to provide back-up attitude and heading information. The dedicated warning panel is able to operate in a reversionary mode if required, enabling the provision of a limited set of hardwired GUH warnings, refer to Get-U-Home Warnings.

GET-U-HOME INSTRUMENTS

During normal aircraft operation, the vertical row of GUH instruments on the right glareshield is covered by the dedicated readout panel (DRP). The panel, which is spring-loaded and hinged on the outboard edge of the right glareshield, is manually released to reveal the GUH instruments listed below:

- Reversionary airspeed indicator.
- Reversionary Mach number display.
- Reversionary vertical speed indicator.
- Barometric altitude indicator.

Additional GUH instruments are located on the right glareshield and the head-up panel:

- Fuel contents displays.
- Engine speed indicators.
- Reversionary angle of attack indicator.
- Reversionary attitude indicator.
- Reversionary heading indicator.

Figure 1.25 and Figure 1.26 show the layout of the instruments.

REVERSIONARY ANGLE OF ATTACK INDICATOR

The aircraft angle of attack is displayed on a thermometer type indicator, against a fixed vertical scale. The datum of the bar indicator is fixed at the zero degree position and increases in length upwards or downwards from this point to indicate positive or negative angles of attack respectively. The range of the instrument is –15° to +40°, marked at 5° intervals.

REVERSIONARY ATTITUDE INDICATOR

The attitude of the aircraft is displayed by a conventional attitude and direction indicator, which is divided into two sectors. The sectors, colored gray and black, indicate pitch attitudes above and below the horizon respectively. The aircraft is represented by a symbol fixed at the center of the instrument. Pitch angles are marked at 5° and 10° intervals to ±85° with the 30° and 60° marks separately identified. Above and below the 85° marks, climb and dive symbols, Figure 1.27, indicate vertical climb and dive respectively. A conventional slip ball indicator is incorporated immediately below the instrument.

REVERSIONARY HEADING INDICATOR

The reversionary heading indicator provides an indication of aircraft true heading to an accuracy of 1° over a 360° range. The instrument comprises a rotating compass card read against a fixed pointer at the top of the instrument. The display is marked in intervals of 10° with the cardinal points and the 30° and 60° marks separately identified. In the center of the display is a digital readout which supplies the same information, in parallel to the analog display, to a resolution of 1°.

REVERSIONARY AIRSPEED INDICATOR

Airspeed is indicated by a LED pointer on a circular scale. In the center of the display is a digital readout with a rolling last digit, which indicates the airspeed (to resolution of 1 kt), in parallel to the analog display. The resolution of the analog display is:

- 50 to 300 kt display resolution 5 kt
- 300 to 400 kt display resolution 10 kt
- 400 to 800 kt display resolution 16 kt.

REVERSIONARY MACH NUMBER DISPLAY

This three digit readout situated below and to the left of the airspeed indicator indicates Mach number (M) to a resolution of 0.01M. The legend M is engraved on the panel surface to the left of the display.

REVERSIONARY VERTICAL SPEED INDICATOR

Aircraft vertical speed is displayed on a circular scale via a LED pointer. The scale is marked at intervals of 100 ft/min up to 1000 ft/min and at 500 ft/min intervals between 2000 and 6000 ft/min. Rate of climb is indicated by clockwise deviation of the pointer; dive rate is indicated by counterclockwise deviation of the pointer.

BAROMETRIC ALTITUDE INDICATOR

The barometric altitude indicator comprises a circular analog indication of height up to 950 ft together with a digital readout of height up to 99 990 ft. The instrument is marked x100 and FEET. The analog scale is marked at 50 ft intervals up to 950 feet. The five digit readout, situated in the center of the instrument, indicates height in multiples of 10 ft. The last three digits of the readout are coincident with that displayed on the circular scale. Negative height can also be displayed on the indicator.

BAROMETRIC PRESSURE SETTING

Under GUH conditions, the barometric altitude indicator is adjusted using the normal barostatic pressure setting control, situated on the left glareshield.

FUEL CONTENTS DISPLAYS

The fuel contents display, is located on the head-up panel, comprise digital readouts, each of four-digit length. The readout lines are marked FWD, REAR and TOTAL and represent the amount of fuel remaining in the forward tank group, in the rear tank group, and the total fuel content respectively.

ENGINE SPEED INDICATORS

The engine speed indicators are located at the lower left and right of the head-up panel and consist of two non-linear curved gages, each with a digital readout in the center. The curved gage provides an analog reading of engine speed whilst the readout line provides a digital reading. Each gage represents zero to 105%.

REVERSIONARY FLIGHT INSTRUMENTS

The following reversionary flight instruments have been introduced in conjunction with current software (AVS SP 3C and FCS 2B2) and equipment standards.

– Incidence gauge (DA7 only)
– Attitude indicator (DA5 only)
– Standby magnetic compass (DA5 only).

INCIDENCE GAUGE (DA7 ONLY)

An incidence gauge is located above the left glareshield. The gauge is not cleared for use and is currently blanked (Figure 1.28).

ATTITUDE INDICATOR (DA5 ONLY)

The attitude indicator (AI), Figure 1.28 , is an electro-mechanical unit. The AI gives a visual indication of the aircraft attitude in pitch and roll. The instrument contains a vertical gyro driven by an electric motor. The gyro is pivoted on inner and outer gimbals and is connected to a barrel shaped display. The display shows aircraft attitude against fixed marks on the instruments case. The gyro has an automatic erection system to keep the spin axis vertical; it also has a caging and erection system to erect the gyro quickly when necessary. An integral inverter converts the 28 V DC supply from the PP3 Essential Busbar to AC to drive the three-phase gyro motor. The instrument is lit internally, and power for the lighting is supplied via the AI dimmer control, located on the left console.

Once it is powered the gyro takes two minutes to run up to its normal operating speed of 22 000 RPM. The attitude information should not be used during this period. Once the gyro is up to speed the internal erection system maintains accurate indications. In flight the gyro can be aligned quickly by pulling the caging button, located on the forward face of the indicator, at the lower right corner. Pulling the button will erect the display to within 1° of zero pitch and wings level within 12 seconds.

NOTE

> The fast erection knob should only be pulled in straight and level unaccelerated flight.

If the display loses power the gyro will continue to spin and give useful attitude information for approximately three minutes in straight and level flight, although the information is of reduced accuracy during this period.

PITCH

The moving barrel display on the AI shows pitch attitude against a fixed fluorescent yellow aircraft symbol. The top half of the display (identified CLI-MB) is colored blue, to represent sky, and the bottom half (identified DI-VE) is colored brown, to represent the ground. The horizon line is shown as a white boundary. Pitch lines are shown at 5°intervals from –80° to +80°. The ±30° and ±60° pitch lines are labelled.

BANK

Aircraft attitude about the roll axis is shown with a pointer which moves against the bank scale at the bottom of the instrument. The scale range is –90° to +90° and has marks at 0 and ±10°, ±20°, ±30°, ±60° and ±90°. The marks are white on a black background.

FAILURE WARNING FLAG

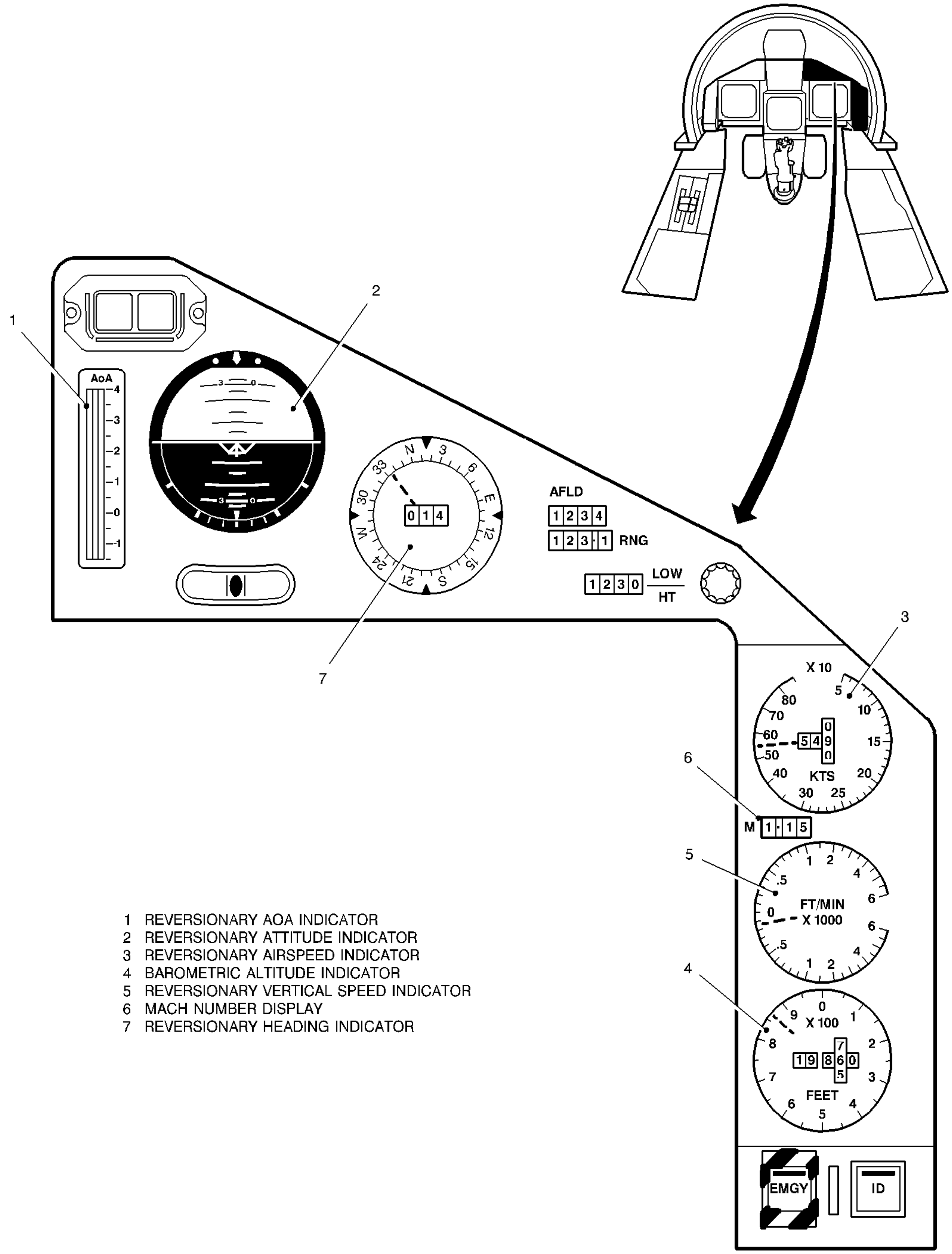
The AI has a red warning flag. The failure flag appears when:

– The 28 V DC supply from PP3 Essential Busbar is interrupted.
– Gyro caging is in progress. Pulling the fast erection knob cages the gyro and erects the display.
– The rotor speed decreases to less than 18 000 RPM.

MAGNETIC STANDBY COMPASS (DA5 ONLY)

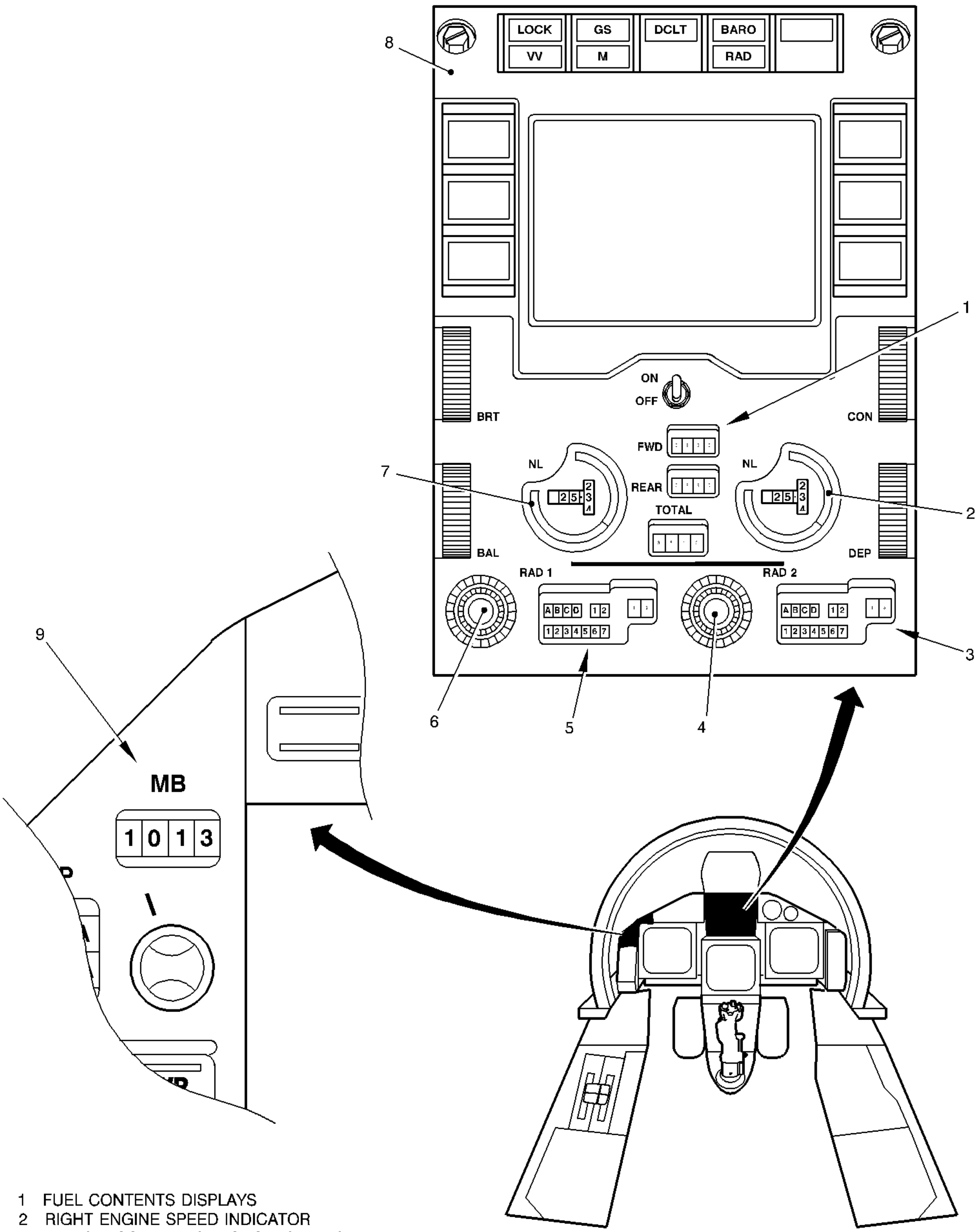
A conventional magnetic standby compass (E4B), Figure 1.28, is installed above the left glareshield. The compass incorporates liquid damping and temperature compensation. The direction of the Earth's magnetic field is detected by two permanent magnets suspended beneath the semi-conical scale of the compass. The complete assembly is supported on shock-protected jewelled bearings, inside a sealed aluminium-alloy body filled with silicon damping fluid. Changes in volume of the damping fluid, caused by variation in temperature, are compensated for by a diaphragm mechanism at the rear of the sealed casing.

The compass scale is graduated in 5° increments with numerical markings every 30°. The compass heading accuracy is only correct when not subject to acceleration. The standby compass is illuminated by an integral lamp supplied via the AI dimmer control.



1 REVERSIONARY AOA INDICATOR
2 REVERSIONARY ATTITUDE INDICATOR
3 REVERSIONARY AIRSPEED INDICATOR
4 BAROMETRIC ALTITUDE INDICATOR
5 REVERSIONARY VERTICAL SPEED INDICATOR
6 MACH NUMBER DISPLAY
7 REVERSIONARY HEADING INDICATOR

Figure 1.25 - GUH Instruments - Right Glareshield



1 FUEL CONTENTS DISPLAYS
2 RIGHT ENGINE SPEED INDICATOR
3 RADIO 2 COMMUNICATIONS DISPLAYS
4 RADIO 2 VOLUME CONTROL/CHANNEL SELECTOR
5 RADIO 1 COMMUNICATIONS DISPLAYS
6 RADIO 1 VOLUME CONTROL/CHANNEL SELECTOR
7 LEFT ENGINE SPEED INDICATOR
8 HEAD-UP PANEL
9 BAROMETRIC PRESSURE SETTING CONTROL

Figure 1.26 - GUH Instruments - Head Up Panel

1 ZENITH MARK (CENTER OF STAR = 90 DEGREES)
2 NADIR MARK (CENTER OF CIRCLE = - 90 DEGREES)

Figure 1.27 - Climb and Dive Symbols

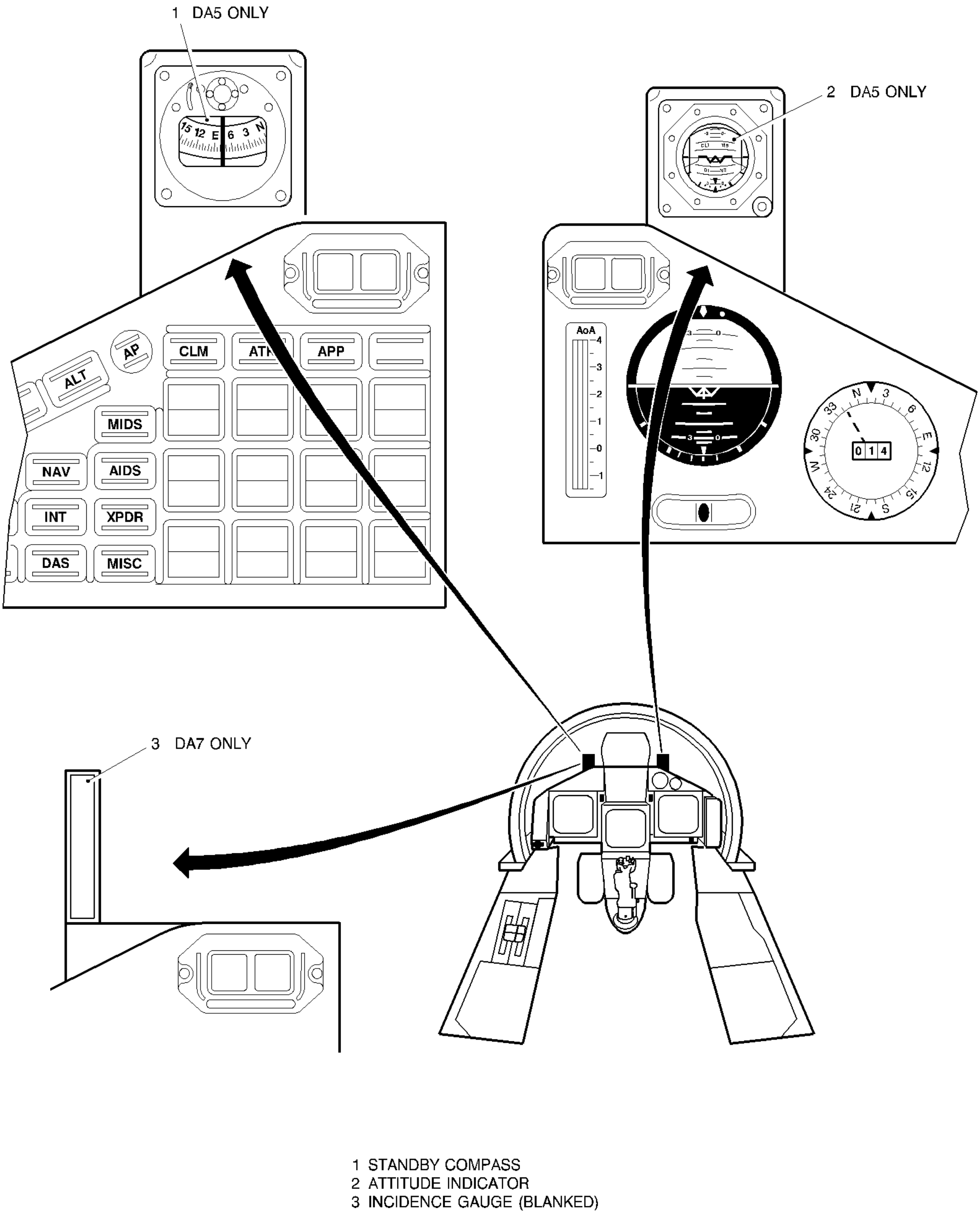


Figure 1.28 - Reversionary Flight Instruments

UTILITIES CONTROL SYSTEM (UCS)

The Utilities Control System (UCS) is an digital integrated control system consisting of seven computers connected to a dual redundant standby STANAG 3838 data bus.
The UCS Computers are the following:

– left and right Fuel Computers (alternatively Bus Controller)
– left and right Secondary Power System (SPS) Computers
– Front Computer
– Landing Gear Computer
– Maintenance Data Panel Computer

The Bus controller functions are resident in both fuel computers.
The computers communicate, via the UCS data bus, with themselves and with:

– Avionic Display and Controls (D&C) Subsystem via two Computer Symbol Generators (CSG 1 and 2) and the Right Hand Glare Shield (RGS).
– Avionic Integrated Monitoring and Recording Subsystem (IMRS) via the Interface Processor Unit (IPU).
– Flight Control System (FCS) and indirectly with Propulsion System (PRP), via two Flight Control Computers (FCC 3 and 4).
– Secondary Power System (SPS) via the Auxiliary Power Unit/Control Unit (APU/CU)

Each UCS computer provides control, monitoring and testing of the systems or sub-subsystems allocated to it.
The UCS incorporates Built-In-Test (BIT) functions to check the UCS computers as well as utility systems. IBIT of some non-UCS systems is also performed via the Maintenance Data Panel (MDP).
There are three types of BIT implemented PBIT, CBIT and IBIT.

– Power-up BIT, is performed simultaneously by all UCS computers on power up.
– Continuous BIT, is performed automatically and/or under the control of the application software.
– Initiated BIT, is performed by all UCS computers, with exception of the Landing Gear computer, IBIT is initiated via the MDP.

All UCS equipment failures detected by the computers are stored in nonvolatile memory and transmitted to the IPU on the UCS bus and then to the MDP on the Direct Data Links (DDL). These failures are also recorded on the PMDS for later evaluation by the ground crew.

The UCS is powered by the essential DC bus bars PP3 and PP4. For ground maintenance, DC power can be supplied to the selected computers by means of the maintenance bus bar PP5.

UCS - DESCRIPTION AND OPERATION

The UCS computers and software are designed primarily to support the general systems. The UCS software development is however dependent upon the development of the general systems. To align the UCS computer software releases to the UCS system integration requirements, the equipment software releases have been grouped together into UCS "Software Packages (SP)" releases.

FRONT COMPUTER

The Front Computer (FC) controls, monitors and tests the functions for the engine bleed air distribution subsystem, the air conditioning system, the windscreen and canopy system, and the oxygen system; radar liquid cooling, control of dehumidification functions and monitoring of liquid conditioning for pilot vest; it also monitors and tests the crew escape and safety system.

Electrical power to the FC is normally supplied by the essential bus bars PP3 and PP4 and by the primary bus bars PP1 and PP2.

CONTROL AND MONITORING OF ENGINE BLEED AIR DISTRIBUTION SUBSYSTEM

Engine bleed air from the 5th stage of the HP compressor is used for the environmental control system (ECS) and/or in cross bleed operation during single engine operation for the aircraft secondary power system (SPS) in the event of a single engine flame-out or failure.

A leak detection loop, which sends a signal to the UCS, is installed between the engine bleed SOVs and the pre-cooler. If a leak is detected the engine bleed SOVs (EBSOVs) are closed: as a consequence the air supply to all utilities is stopped.

During normal operation all ECS monitoring and control functions are accomplished by the UCS front computer which contains the ECS software.

If the ECS fails, the UCS front computer guarantees the flow of air to the MSOC and provides anti-g and canopy seal.

The pilot will select the ECS master switch to RAM AIR which gives direct control of the fans, the fan SOV, the AVSOV, the three-way valve and the ERA valve.

AIR CONDITIONING SYSTEM

The FC controls and monitors the operation of the ECS shut-off valve (SOV), under normal operation this valve is open and allows pre-cooled air to flow the following subsystems:

- Cooling
- Temperature Control
- Avionic Compartment Air Distribution
- Center fuselage Compartment Air Distribution
- Cockpit Air Distribution
- Canopy and Windscreen Demist Air Distribution
- Equipments Dehumidification

COOLING SUBSYSTEM

The FC commands the opening of the temperature control valve which lets air enter the cold air unit (CAU). If ram air is not available, for example when the engine is in the ground idle condition, the computer commands the inter-cooler ejector shut-off valve to open, allowing ram air into the inter-cooler. Opening and closing of the valve in flight is scheduled according to aircraft speed, altitude and angle of attack. The airflow temperature at the inter-cooler outlet is also monitored by means of a sensor.

TEMPERATURE CONTROL SUBSYSTEM

The following temperature control system valves are controlled by the FC:

- Temperature Control Valve (TCV);
- Cabin Temperature Control Valve (CTCV).

The CTCV position is controlled by the Front Computer according to the cabin temperature selection and the outputs of the following sensors:

- ETC Temperature Sensor, Cabin Inlet;
- ETC Temperature Sensor, Cabin Outlet;
- ETC Temperature Sensor, Water Extractor Outlet.

The output of the following sensors are also fed to the FC.

- Inter-Cooler Outlet Temperature Sensor
- Pressure Sensor Cabin ECS Inlet
- Pressure Sensor Cabin ECS Inlet Differential
- Pressure Sensor Cabin ECS Inlet Absolute
- Pressure Sensor MSOC Heat Exchanger Inlet
- Differential Pressure Sensor MSOC Heat Exchanger
- Pressure Sensor Cabin Inlet Absolute
- Pressure Transducer, Cabin Absolute

AVIONIC AND CENTER FUSELAGE COMPARTMENT AIR DISTRIBUTION

The cooling air for avionic and center fuselage compartments air distribution, the Front Computer monitors the position of the following valves, which are not controlled by the computer, but are opened or closed according to crew selection:

- Avionic Compartment SOV, also monitored by the RH SPS Computer (AVSOV)
- Cooling Fan SOV, Avionics Compartment (FAN SOV)
- Avionics Compartment Cooling Fan, also monitored by RH SPS Computer (AVSOV)

COCKPIT AIR DISTRIBUTION

The Air Flow Control Valve (AFCV) is an infinite positioning valve which maintains the airflow to the cabin according to crew selections. If the valve is out of range a mid default value will be assumed.

CANOPY AND WINDSCREEN DEMIST AIR DISTRIBUTION

The following valves are under the control of the FC:

- Windscreen Demist Shut-off Valve;
- Canopy Antimist Shut-off Valve.

CANOPY SYSTEM

The following functions for the Canopy System are monitored by the Front Computer:

- the OPEN-CLOSE position of the cockpit and external Canopy Selector Handles;
- the lock and unlock command transmitted to Canopy Lock/Unlock Actuator;
- the fully locked and unlocked position of the Shoot Bolts;
- the output of the Piston Position Transducers of the Canopy Actuator;
- the output of the Position Transducer of the Canopy Actuator Manifold Assembly;
- the output of the Temperature Transducer, on the Canopy Accumulator Manifold Assembly.

CONTROL AND MONITORING OF LIFE SUPPORT SYSTEM (LFE)

The FC provides control and monitoring of the following LFE subsystems:

- Breathing gas (Interim and Full Oxygen)
- Anti-g
- Liquid Conditioning Supply (aircrew)
- NBC

INTERIM OXYGEN SYSTEM

The FC selects automatically the auxiliary oxygen supply following a failure in the MSOG. The FC produces a warning signal when the ECU detect that the oxygen partial pressure falls below warning limits and selects the AOB. The FC monitors the position of the changeover valve in the AOB head and provides on DWP the MSOC or OXY warning.

Pressure and temperature sensors of the auxiliary oxygen bottle (AOB) enable the FC to calculate the content of the bottle.

The oxygen monitors transmit redundant temperature, pressure and BIT information to the FC. UCS IBIT monitors the warning signal and controls the test of the MSOC.

LIQUID CONDITIONING FOR PILOT VEST

The FC controls and monitors the liquid conditioning system as part of the LIFE system. System monitoring and back-up protection is provided by the UCS.

DEHUMIDIFICATION AIR

The ECS provides dehumidification air to the cockpit, avionic bay (front and centre fuselage) and radar bay while the aircraft is on the ground.

Initiation of the dehumidification function (by the ground crew via the MDP) causes the FC/ECS to reconfigure the ECS valves to allow dehumidified air to pass through the system thus reducing/removing the humidity in the cockpit and the avionic/radar bay.

MONITORING OF CREW ESCAPE SYSTEM

The FC monitors the following:

- Status of the Emergency Oxygen Selection handle;
- ARMED/SAFE handle position;
- Position of the CMS on Two Seat Aircraft
- Safety Pin Stowage (seat and canopy);
- Seat gone signal.

LANDING GEAR COMPUTER

The Landing Gear Computer (LGC) performs control, interfacing, monitoring and test functions, associated with the following systems and their constituent sub-systems:

- Landing Gear System:

  Sequencing;
  Indication;
  Weight on Wheels;
  Emergency Lowering.

- Brake System:

  Brake Control;
  Park Brake;
  Brake Cooling.

- Auxiliary Deceleration System:

  Brake Chute;
  Arrestor Hook.

The LGC is a single line replaceable item (LRI) enclosing two fully separated systems, referred to as System 1 and System 2. System 1 is electrically supplied by the essential busbar PP3, while System 2 is supplied by the essential busbar PP4.

LANDING GEAR SYSTEM

SEQUENCING

The LGC controls the landing gear selector valve manifold to switch hydraulic pressure to the actuators of the landing gears, the nose door and the main doors dependent on pilot's demand and actual gear/door position. The LGC de-energizes the baulk solenoid to lock the landing gear selector in the "down" position when weight on wheels is reported from the related subsystem. The LGC provides continuous fault detection and isolation for the entire sequencing and all associated components.

INDICATION

The LGC controls the four display elements according to the actual gear/door positions. In addition the LGC turns on all display elements upon reception of a lamps test signal, coming via the data bus from the cockpit.

WEIGHT ON WHEELS

Each system of the LDG independently controls the WOW relays dependent on the weight on wheel situation of the associated landing gears, the related relays always reflect the real weight on wheel conditions.

System 1 and System 2 have separate control of the WOW relays. It provides continuous fault detection and isolation for the entire weight on wheel subsystem. The LGC provides data on the state and the status of the entire weight on wheel subsystem collectively and individually to the UCS data bus and to other system/subsystem.

EMERGENCY LOWERING

For the emergency lowering system the LGC monitors both the position of the emergency gear switch, the wiring continuity of the related control lines and the electrical power.

BRAKE SYSTEM

BRAKE CONTROL

The LGC provides a dual redundant, stand-by brake system, controlling and monitoring two fully independent hydraulic circuits. The relevant circuit is selected either by the cockpit or by the computer itself, dependent on the results of supply pressure and/or failure monitoring.

The LGC controls the selected circuit, modulating the pressure at each brake via the related servo valves dependent on pilots demand and wheel speed information. The LGC provides the following functions dependent on the actual aircraft speed:

- brakes metering below 10 kts;
- adaptive skid control above 10 kts;
- touch down protection;
- locked wheel protection;
- cross over wheel protection.

PARK BRAKE

The LGC monitors the position of the park brake valve and monitors the status of the park brake accumulator.

BRAKE COOLING

Wheel brakes temperatures are kept low by cooling fans controlled by the LGC System 1.

AUXILIARY DECELERATION SYSTEM

The LGC monitors the entire auxiliary deceleration system.

BRAKE CHUTE

The LGC (System 2) monitors state and status of the following components:

- brake chute switch;
- chute lock and release unit;
- door lock unit.

The LGC also generates the associated cockpit warning.

ARRESTOR HOOK

The LGC monitors the health of the arrestor hook release solenoids and detects the position of the arrestor hook and the position of the release button. It also generates the associated cockpit warnings.
In addition the LGC turns on the indicator within the release button upon reception of a lamps test signal, coming via the data bus from the cockpit.

LEFT AND RIGHT FUEL COMPUTERS

The LH and RH fuel computers automatically control and monitor the fuel system and moreover can operate as bus controller (BC) for all message exchange on UCS data bus A and B.
The LH and RH fuel computers control and monitor the Pressurization and Vent system, the Fuel Transfer system, Ground Refuelling and Defuelling, In-flight Refuelling, Fuel Gauging and Level Sensing.
The two fuel computers monitor the fuel levels, transfer fuel to satisfy all the maneuver and mission requirements and match the average fuel consumption to avoid excessive depletion of the main fuel tanks.
The LH fuel computer is electrically supplied powered by the PP1 bus bar and PP3 essential bus bar.
The RH fuel computer is electrically supplied by the PP2 bus bar and PP4 essential bus bar. Power from the PP5 maintenance bus bar is used for ground maintenance functions.
Temperature and pressure sensors provide signals for monitoring the pressurization system and data is processed by the fuel computers for display on the MHDD.
Ground refuelling and defuelling procedures are initiated and monitored by the ground crew by using the MDP.

FUEL TRANSFER SYSTEM

The fuel transfer is fully automatic and it is controlled and monitored by the fuel computers by means of the signals received from the gauging and level sensing systems.
The position and serviceability of the transfer valves is monitored by signals sent to the UCS from microswitches located in the valve actuator.
Operation of the transfer pumps is monitored by pressure switches located outlet of each pump. The status of the valves and pumps is continuously displayed on the Fuel format on the MHDD and any failures are logged on the MDP.

GROUND REFUELING AND DEFUELING

The refueling procedure is controlled by the UCS in response to commands from the MDP. The refueling procedure is normally terminated automatically by the UCS.
Defuelling On-ground can be achieved by two different methods: Pressurized or Suction.
The Fuel computers and MDP provide the necessary monitoring and control functions.

IN-FLIGHT REFUELING

The fuel computers monitor and control the refueling process by means of the fuel level sensors and valves.

ENGINE FUEL SUPPLY

The fuel computers provide monitoring function for the following elements:

- Boost Pumps, Forward and Rear Fuselage Groups;
- Engine Fuel Crossfeed Valve (only monitored by the LH Fuel Computer);
- Fuel Temperature sensor, Engine feed;
- Low pressure fuel cock.

FUEL FLOWMETERING

The Fuel computers determine the fuel flow rates related to each engine. The fuel flow data are received from the DECUs via FCCs. The fuel computers also display the fuel flow to the pilot.

FUEL GAUGING AND LEVEL SENSING

Capacitance measuring level and gauge probes, located inside the fuel tanks, provide analogue signals to the fuel processors of the UCS fuel computers which determines the mass of fuel in each tank or tank group and provides a digital readout in Kg, on the MHDD and on HUP.
The Fuel Computers perform the following functions:

- Calculate the tank content;
- Calculate tank levels;
- Validate all probe and level sensor inputs;
- Calculate fuel properties;
- Generate fuel gauging outputs for display in the cockpit and the MDP and for use by FCS;
- Provide low fuel level warnings for display in the cockpit;
- Generate fuel level data for FUM.

FLIGHT CONTROL FUNCTIONS

The fuel computers provide fuel center of gravity calculations to allow Flight Control System (FCS) to compute aircraft center of gravity (CG).

LEFT AND RIGHT SPS COMPUTERS

There are two identical and interchangeable SPS computers.
The left SPS computer is electrically powered by the essential busbar PP3. The right SPS computer is electrically powered by the essential busbar PP4. For ground maintenance purposes, power is available from PP5 battery busbar.
The SPS computers provides the following functions:

SECONDARY POWER SYSTEM (SPS):

GROUND CHECK OUT

During this mode the SPS computers control and monitor the relevant gear box drive operation for electrical and hydraulic power generation using the APU or pneumatic ground cart.

ENGINES STARTING IN MAIN MODE

During this mode the SPS computers recognize the engine start request, control and monitor the relevant gear box and coupled engine acceleration up to engine light up using the APU or pneumatic ground cart.

ENGINE STARTING IN ALTERNATIVE MODE

The alternative engine starting mode uses the same function as above but using the running engine pneumatic power source to power the ATS/M.

IN-FLIGHT ENGINE FLAME OUT (SPS CROSS BLEED)

In this mode the SPS computers maintain the relevant gear box speed at 60% Nominal (± 4.5% transient) using the running engine pneumatic power source.
Cross bleed is maintained operative, if previously initiated (i.e. loss of engine in flight) during landing and taxi in order to have full hydraulic and electrical power.

ASSISTED ENGINE RELIGHT

During this mode the SPS computers engage the flame out engine and accelerate it up to engine light up speed using the running engine pneumatic power source.

HEALTH MONITORING

During all operational modes health monitoring of the SPS Gearbox, ATS/M and CV, PTO Shaft, SPS PRSOV and Air Pressure Sensor is provided.

LIFE MONITORING

During all operational modes, the following data is continuously monitored:

- ATS/M life consumption
- Gear box life consumption

HYDRAULIC SYSTEM (HYD)

The SPS computers provides the following functions:

HYDRAULIC PUMP DEPRESSURISATION

During engine starts the SPS computers control the hydraulic pump depressurisation valve and in the case of malfunction provide failure data via the UCS data bus to the IMRS.

UTILITIES ISOLATION

The SPS computers control and monitor the utilities isolation valve to protect the associated flight controls circuit against pressure loss due to external leakage and moreover provide state and status data of the utilities isolation valve to the UCS data bus for use in other system.

HYDRAULIC POWER GENERATION AND DISTRIBUTION SYSTEM

THe SPS computers control and monitor the complete hydraulic power generation system. They monitor the health of the entire hydraulic power generation and distribution system. The SPS computers perform continuous fault detection and diagnosis of all hydraulic system components and provide the calculated state and status data to the cockpit (displays/warnings).

FIRE PROTECTION SYSTEM (MSC):

The SPS computers monitor the outputs of the following:

- Engine Fire Detection System
- APU Fire Detection System (LH SPS computer only)
- Engine Fire Extinguishing System

Each SPS computer monitors the outputs from their relevant Engine Fire Detection system.

The LH SPS computer controls and monitors the APU Fire Detection/Extinguishing system.

When fire is detected, the relevant computer provides a visual warning via the cockpit displays and audio warning.

The computers also provide the failure data to the integrated monitoring and recording system (IMRS).

The SPS computers monitor the pressure of the fire extinguisher bottle and the electrical integrity of the electrical explosive devices (EED).

T2 PROBE (MSC)

Each SPS computer controls of the activation of the T2 probe heater on ground. The controls is performed at the first time on power up, with engine not running and then during engine start when the engine speed achieved 40% NH.

ECS FAILURE WARNINGS (ECS)

The right SPS Computers monitor the cooling fans for the avionic equipment coding and transmits FAN warning when the cooling fans do not operate when required.

LIFE SUPPORT SYSTEM (LFE)

The left SPS computers provides monitoring of the Molecular Sieve Oxygen Concentrator (Paramagnetic Oxygen Monitor) and back-up monitoring of the Auxiliary Oxygen Bottle (AOB) and moreover provides the warning data to the cockpit displays and failure data to the IMRS.

ICE DETECTION (MSC)

The left SPS computer control and monitors the ice detection system and provide warning data to the cockpit and failure data to IMRS.

MAINTENANCE DATA PANEL (MDP)

The MDP is the central point of the input/output for maintenance actions on the aircraft. The MDP operates in two modes:

- During flight
- On groundcrew action

The purpose of the MDP is to allow rapid access to the aircraft maintenance data by the ground crew.

The MDP will receive and record status, failure and fatigue data from aircraft systems. Data may be accessed by the ground crew upon request, either by the plain language display on the panel, and/or in a Portable Maintenance Data Store (PMDS) which shall be removed for ground analysis after flight.

The MDP performs five main functions:

- Recording
- Maintenance
- Data loading
- Monitoring
- Display

During flight the MDP operates automatically; it receives the following maintenance and servicing data from aircraft systems and stores them on the PMDS:

- Aircraft ident
- System/LRI failure data (up to 5 flights)
- Exceedance data (last flight status)
- Engine health monitoring data
- Structure health monitoring data
- SPS life monitoring data
- Hydraulic trend data
- Event marker data

On the ground, the groundcrew can perform aircraft inspection.

UCS - DATA BUS AND INTERFACES

The seven Utilities Control System (UCS) Computers are interfaced between each other and the equipment connected to the Data Bus by a Dual Standby redundant Serial Data Bus. The equipment are connected by means of Remote Terminals (RT) to the data bus, see Figure 1.29.

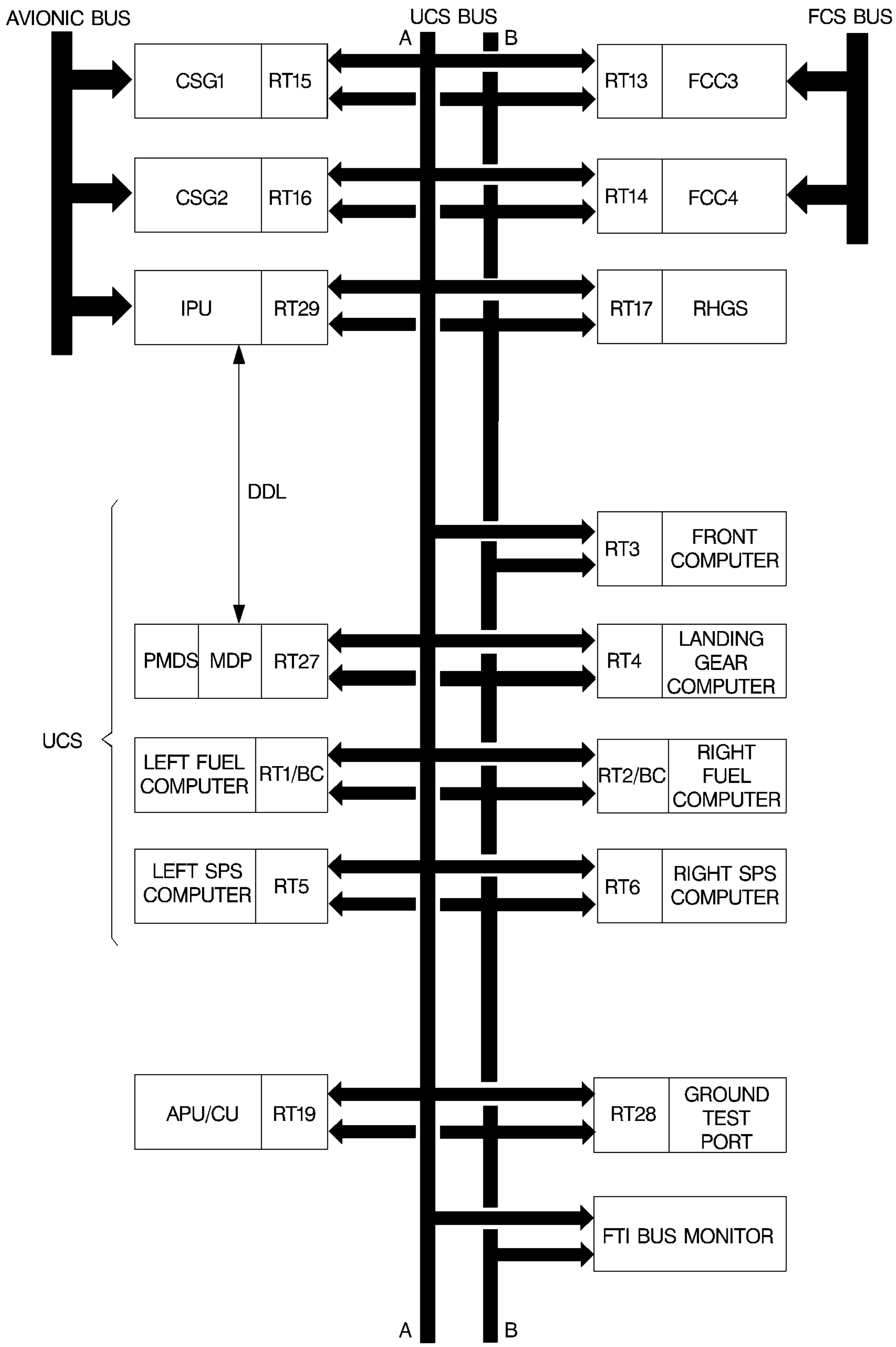


Figure 1.29 - UCS Architecture

The various systems (e.g. Avionics, Cockpit, Flight Controls and Propulsion exchange messages and data by means of the Data Bus under the control of the Bus Controllers located in the Left and Right Fuel Computers

UCS - DATA BUS

The method of communication of the UCS Data Bus and the electrical interface is according to the STANAG 3838 standard. The UCS Data Bus is a serial, dual, time division multiplex data bus, consisting of two shielded cables known as Data Bus A and Data Bus B, plus transformer couplers and stubs. The data bus interface circuits are inside the equipment connected to the bus.

BUS CONTROLLER

A Bus Controller is located in each Fuel Computers. Both of them are capable of performing the Bus Controller function in addition to their fuel functions.

The two UCS Fuel Computers can both operate, but not at the same time, as controllers of data flow for all transmissions on Data Bus A and B. While one Fuel Computer has control of the bus, the other computer operates as standby BC and also exchanges data as a RT.

When active as BC, each Fuel Computer directs data exchange over a preferred or primary bus, which is Data Bus A for the L/H Fuel Computer and Data Bus B for the R/H Computer.

Messages on the bus are transmitted on a cycles base and are scheduled according to a single transaction table which is repeated every major cycle.

In the event that the BC identifies a failed transmission on the primary bus and has not received the status word from the RT, the next message transmitted will be on the secondary bus. When the transmission to a RT has failed on both buses, the BC alternates commands from primary to secondary each major cycle.

ENGINES

Two 90 KN EuroJet EJ 200 turbofan engines with reheat are used to power the aircraft, see Figure 1.30

The EJ 200 engine is a two-spool turbofan of modular construction. It has a nominal overall pressure ratio of 26 to 1 and a nominal by-pass ratio of 0.4 to 1.

The low pressure (LP) has three compressor stages directly driven by a single stage cooled LP turbine. The high pressure (HP) has five compressor stages, directly driven by a single stage cooled HP turbine.

Compressor air bleeds are provided from both the LP and HP compressors for aircraft services. The main combustor is an annular vaporizing type on -01C engines, and an annular air spray burning type on -03 Standard engines. A full annular by-pass duct surrounds the core of the engine.

The reheat system is a full modulation, "burn and mix" system with Hot Shot Ignition, uses radial burners supplied via fuel manifolds, and ignited by hot shot in the main combustor. Three main manifolds, Primary, Core and Bypass, a number of valves, ensure correct distribution of fuel to the spray injectors.

The variable exit nozzle (VEN) consists of a convergent-divergent multi-petal exhaust nozzle to provide a variable throat area formed by the convergent petals and a variable exit area formed by the divergent petals.

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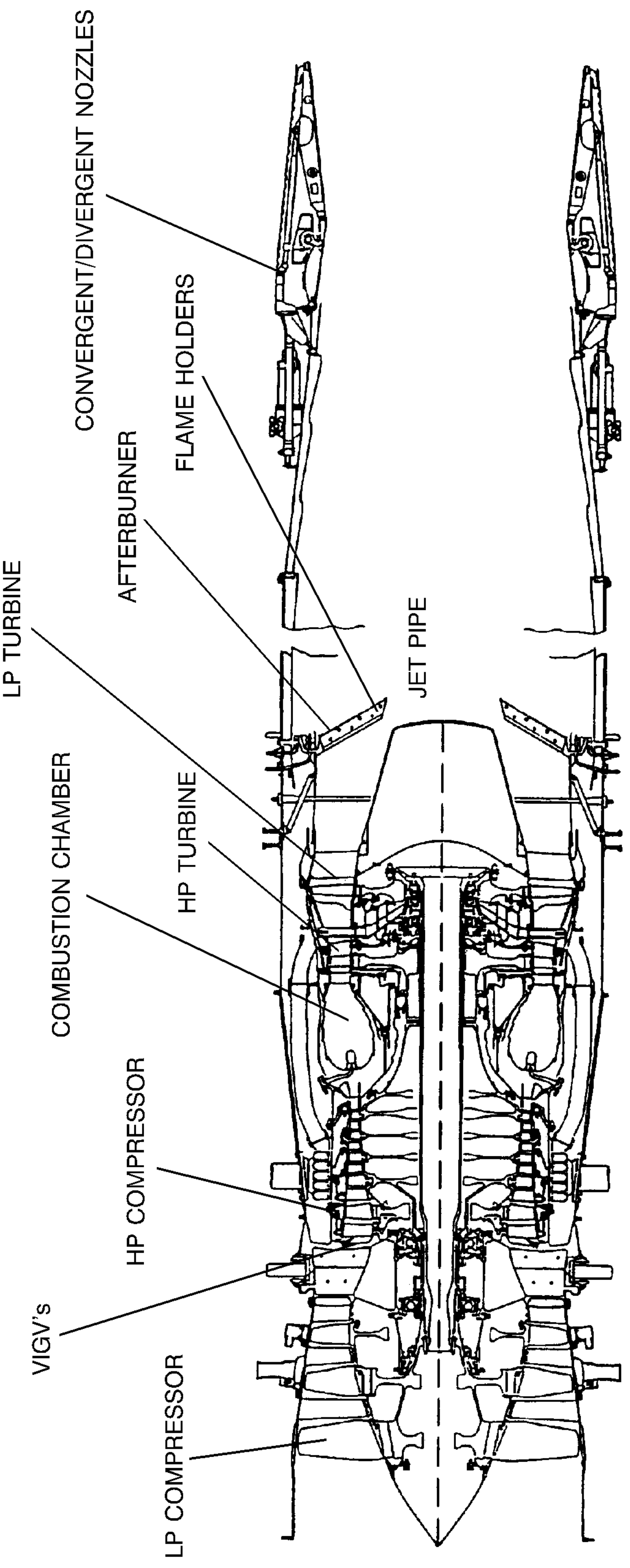


Figure 1.30 - EJ 200 Engine

ENGINE AIR SYSTEM

A controlled air flow passes through the variable-geometry aircraft intake into the engine air intake where is compressed by the three-stage LP compressor. On exit from the LP compressor, the air flow is divided between the bypass and the main stream.

MAIN STREAM AIRFLOW

The main stream air flow passes through variable inlet guide vanes and is further compressed by the five stage HP compressor before delivery to the combustion section.

The hot gas stream from the combustion chamber passes through single stage HP and LP turbines and the exhaust diffuser into the jet pipe where it joins the bypass stream air flow.

BYPASS STREAM AIR FLOW

The bypass stream air flows from the outer portion of the LP compressor through an annular bypass duct surrounding the HP compressor, the combustion chamber and turbine section. As the bypass air flow joins the hot gases, some of it flows through an annular passage between the front jet pipe and the heat shield, forming an insulating layer. Some air also flows through holes in the heat shield to provide a cooling flow on its inner surface.

BLEED AIR

During operation of the engine, air is bled internally to provide engine cooling, pressurization and bearing load balancing. Air is also taken from the second stage of the LP compressor for fuel tank pressurization and from the HP compressor fifth stage to supply the aircraft services and air turbine starter motors of the aircraft secondary power system.

ENGINE OIL SYSTEM

The oil system provides the oil flow to all the components requiring lubrication.

Its main components are:

AEROBATIC OIL TANK

It contains a rotating basket, driven by the external gearbox. The oil is held against the tank walls by centrifugal force, providing a continuous oil supply at all flight conditions, attitudes and accelerations.

The tank vent line contains a valve to seal (engine stopped) and pressurize (engine running) the oil tank.

PRESSURE PUMP

A gear-type pressure pump driven by the external gearbox provides the pressure to drive the feed oil system. Suction performance at high altitudes is augmented by the pressurized oil tank. A pressure relief valve limits the cold start oil pressure.
The feed oil system main delivery areas are:

– Front Bearing Chamber
– Rear Bearing Chamber
– Gearbox

SCAVENGE PUMP

A seven-stage gear pump driven by the external gearbox is provided for scavenging the system satisfactorily, up to the maximum operating altitude. The pump also provides the pressure for the oil tank pressurization.

GEARBOX

The external gearbox provides power for engine accessories and the aircraft gearbox, and also drives the rotating basket of the aerobatic oil tank.

FUEL COOLED OIL COOLER

Heat gained by the oil in the engine and gearbox is transferred to fuel being delivered to the engine through a heat exchanger in the fuel cooled oil cooler (FCOC).

ENGINE FUEL CONTROL SYSTEM

FUEL SYSTEM DESCRIPTION

Fuel is supplied to the main engine fuel metering unit (MFMU) for dry-range engine operation, and to the afterburner section when reheat is required. Fuel is also used to cool the digital engine control unit (DECU) and the lubricating oil through a FCOC.

Fuel from the aircraft tanks arrives both to the centrifugal and gear pumps for dry operation, and to the afterburner fuel pump for reheat operation.

A drain tank is used to collect fuel from the main manifold purge on engine shut-down, and from the reheat pump following reheat cancellation.

DRY FUEL SUPPLY

Dry engine fuel is fed from the gear pump to the MFMU, where the main metering valve (MMV) sets the engine fuel flow. In the event of loss of control of the MMV, the DECU controls fuel flow to the engine via the emergency spill valve (ESV).

REHEAT FUEL SUPPLY

On leaving dry section the fuel, via a DECU signal (throttle position), passes in the reheat regulator. This, contain three fuel-scheduling controls providing the core, bypass and primary manifolds with the correct flow.

Each control has a servo driven metering valve, positioned by a dual lane torque motor, reacting to signals from the DECU lane in control.

The reheat is lit by a hot shot injector, fed from an accumulator charged with fuel from the servo system. It is fired by a solenoid valve controlled by the DECU.

Fuel from the reheat fuel metering unit (RHFMU) is fed to manifolds by a system of distribution valves which pressurize the manifold system, to minimize reheat light-up times.

REHEAT OPERATION

Advancing the throttles beyond the MAX DRY and placing the throttles within the reheat range where at the MIN RHT, high pressure fuel is injected into the engine, thus enabling engine reheat operation.

Further forward movement of the throttles, through the reheat range until reaching the MAX RHT position, progressively increases fuel flow to the reheat, providing variable thrust,

the DECU controls and monitors the operation and will shut down the system, if a fault or flame out occurs.

DIGITAL ENGINE CONTROL UNIT

The DECU is a fuel cooled unit mounted on the LP compressor casing. Its main function is to control the engine according to demands from the throttle, received via the FCS bus, and to ensure that the engine functions throughout the flight envelope without exceeding any of its operational limitations.

The unit also supplies data to the Engine Monitoring Unit (EMU) and to the Maintenance Data Panel (MDP). The DECU carries out an "on-engine" failure check (BIT check) which is then routed to the EMU. The DECU is energized by moving the throttle to IDLE position. During operation, a Continuous BIT is carried out on the internal circuitry and connected accessories.

The DECU controls two individual, functionally identical lanes (lane 1 and 2) electrically powered by: PP3 for lane 1 and PP4 for lane 2. Only one lane is required to control each engine.

Engine overspeed protection against DECU processing faults is provided by means of an independent analogue overspeed governor within each DECU lane. This will limit engine fuel flow if either NL or NH exceed preset thresholds.

There are two high energy (HE) igniters, each individually controlled by a single lane for ground starting. If the engine does not accelerate above 30%NH within 25 seconds, the DECU will energize the second igniter.

Alternate lanes of the DECU are selected for engine control at each DECU power-up.

Aircraft system and engine signals (speed, temperature, VIGV's position and nozzle area) are monitored by the DECU. These signals are processed and then used for engine control.

The DECU contains no specific surge recovery logic, therefore in the event of "locked-in surge", pilot action will be required.

COCKPIT SELECTIONS

Two L1/L2 soft keys on the MHDD Engines format, can be operated by the pilot in order to change the DECU lane. The lane change will only be performed if the stand-by lane is not degraded or is not more degraded than the active lane.

A signal will be transmitted to the MHDD Engines format whether Lane 1 or 2 is operative. If both lanes have failed a DECU warning is triggered, the engine control is lost. In this case the engine will continue to operate in a safe rating (flight idle) independently from throttle movement and can be shut only by means of LP COCK switch.

DECU FUNCTIONS

On engine shut-down, an IBIT is carried out and then routed by the DECU to the EMU. The DECU will also ensure, that the VIGVs are scheduled to the closed position and the convergent/divergent nozzle are to the fully open position, before the engine stops, this being the position required for starting.

The Built-In Tests that are carried out at engine starting, during normal operation, and on engine shut-down, perform the following functions:

- functional monitoring of the engine systems, preflight and continuous monitoring during operation;
- test to isolate failures to individual LRIs;
- provide data to the integrated monitoring and recording system (IMRS) to indicate the serviceability status of the engine.

ENGINE MONITORING SYSTEM (EMS)

The EMS is a stand alone self testing system, part of the IMRS and provides on-board data processing for engine maintenance, to asses the status of the propulsion system and to provide maintenance data to the MDP via the IPU.

The EMS consists of an EMU which receives signals from the engine and from the DECUs.

Data for the Crash Survivable Memory Unit (CSMU) is supplied from the DECU via the FCS bus.

ENGINE STARTING SYSTEM

Ground starting is initiated by moving the throttle from HP SHUT to IDLE with the LP COCK switch (which also acts as ignition master switch) set to OPEN.

The light-up is achieved by two igniter plugs during in-flight relighting and by one of them during ground starts. In the event of a detected engine run-down, an auto-ignition logic commands both High Energy Ignition Unit (HEIU) channels.

With the AIR DRIVE switch set to AUTO, air supplied from either the APU or a ground supply, drives the gearbox via ATS/M.

The gearbox mechanically drives the engine and when self-sustaining speed is reached, the air supply to the ATS/M is cut-off and the engine takes over the gearbox drive.

After the second engine start, the APU is automatically shut-down or ground supply is cut-off.

During ground starts, automatic monitoring of NH and TBT is carried out by the DECU and the start is terminated if certain criteria are not met. However, during windmill or cross-bleed relights, this facility is not available.

TURBINE BLADE TEMPERATURE (TBT) MONITORING

If TBT exceeds 700°C during ground start cycle, fuel flow is reduced for two seconds. After fuel dip has occurred, fuel flow will return to the normal start schedule value, unless the start is cancelled manually or automatically.

AIR FLOW CONTROL SYSTEM

A self-contained hydraulic system controls the air flow through the engine by modulating the HPC VIGVs and the convergent-divergent exhaust nozzle.

The air flow control system consists of three sub-systems:

- hydraulic power generation unit (HPGU);
- variable guide vane actuation and control unit (VACU);
- nozzle actuation and control unit (NACU).

The hydraulic power from the pump to the VIGV's and nozzle actuators is controlled by separate servo valves for each sub-system, according to DECU demand.

Feedback of the VIGVs and nozzle position is supplied to the DECU.

HYDRAULIC POWER GENERATOR UNIT (HPGU)

The hydraulic power generator unit is an integrated package mounted on the main engine gearbox. A pressurized reservoir provides a source of oil which is supplied via a gearbox driven variable delivery, variable pressure, hydraulic pump, through a high pressure filter to the VACU and NACU.

VARIABLE GUIDE VANE ACTUATION AND CONTROL UNIT (VACU)

An electro-hydraulic servo valve is used to control the actuators for the VIGVs. Total loss of electrical signal results in the VIGVs moving to the closed position.

NOZZLE ACTUATION AND CONTROL UNIT (NACU)

An electro-hydraulic servo valve is used to control the four interconnected nozzle actuators. The valve is operated by a torque motor controlled by the DECU. Total loss of electrical signal causes the nozzle to move to the fully open position.

THROTTLES

LEFT AND RIGHT THROTTLE BOX FUNCTIONS

The left and right throttle box units are mounted on the left hand console (Figure 1.31). The left and right throttle boxes are identical, except for the throttle top controls. The pilot's throttle demand to the respective engine is made by moving the left and/or right throttle levers, each of which has a linear movement (forward and aft). The function of the throttle boxes is available when the Battery Master switch is made.

THROTTLE SETTINGS

Within the limits of travel, each throttle box has four regions of movement:

– HP COCK SHUT
– Dry Range
– Reheat Range
– Emergency.

These regions are considered successively, as they occur in a sequential manner with forward movement of the throttle. The functions associated with each region are described in the following paragraphs:

HP COCK SHUT

When the throttles are in the HP SHUT position, the respective engine is in a shut-down condition with the following results:

– the high pressure fuel shut off cock is closed
– the pneumatic drive is disconnected from the gearbox
– the start or relight sequence is cancelled
– the engine (if lit) is shut-down.

A manual release latch, which must be physically lifted to allow movement, denies movement of the throttles, preventing inadvertent ignition or shut down of the engines.

DRY RANGE (IDLE TO MAX DRY RANGE)

Forward throttle movement from HP COCK SHUT to the IDLE position at the aft limit of the DRY RANGE initiates the following (assuming that the AIRDRIVE switch is set to AUTO and the LP COCK switches are set to OPEN):

– the high pressure fuel shut off (HP Cock) is opened to allow fuel flow to the respective engine under DECU control;
– pneumatic power is applied to the respective Air Turbine Starter Motor (ATS/M) from an applicable source (APU, external air supply or engine crossbleed) thereby rotating the gearbox and engine.
– the engine igniters begin to spark, and once a start is achieved the engine is stabilized at idle speed.

NOTE

- Movement of the left throttle to IDLE will initiate the start sequence for the left engine.
- When this engine is stabilized, the movement of the right throttle to the IDLE position will initiate the start sequence for the right engine.

Throttle movement from IDLE to HP SHUT is physically prevented by the manual release latch, which must be physically lifted before the engine can be shutdown.
After engine start and initial engine stabilization, further throttle movement in a forward direction will progressively increase engine rotational speed through the DRY range, according to the throttle position within the DRY RANGE.
Movement of the throttles within this region is resisted by a force, applied in opposition to any commanded movement.
Maximum ‘dry’ thrust is achieved by advancing the throttles to the MAX DRY position. The throttles cannot be advanced beyond the MAX DRY setting without first overcoming a 40 Newton tactile detent thus reducing the possibility of inadvertent reheat selection.

REHEAT RANGE (MIN/MAX RHT RANGE)

Advancing the throttles beyond the MAX DRY places the throttle within the reheat range where at the MIN RHT setting high pressure fuel is injected into the engine under control of the DECU, thus enabling engine afterburner (reheat) operation.
Further forward movement of the throttles progressively increases fuel flow to the afterburner through the reheat range until reaching the MAX RHT position, as demanded by throttle position within Reheat Range.
At the aft limit of the throttle movement within the Reheat Range, a 40 Newton detent is provided so that rearward movement of the throttle, across the boundary from the Reheat Range to the Dry Range, requires the exertion of additional force, therefore reducing the possibility of inadvertent reheat cancellation.
At the forward limit of the throttle movement within Reheat Range, there is a further 150 Newton detent which indicates the maximum movement within this range. This detent minimizes the possibility of inadvertent selection of EMGY.

EMERGENCY (INDICATED AS EMGY)

NOTE

> Additional thrust by re-datuming the engine control system (Emergency) has been deleted, and the EMGY position will be deleted for production standard aircraft.

The EMGY (Emergency) position is indicated by yellow/black hatching on the throttle box, forward movement past the detent into EMGY maintains the Maximum Reheat thrust demand.

THROTTLE DEMAND SIGNALS

The throttle box contains two duplex rotary potentiometers giving four lanes of throttle demand input to the FCS. After FCS monitoring duplex throttle demand signals are wired to the DECU.

AUTOTHROTTLE

An autothrottle facility is available for selection by the pilot via a throttle top control. Details of the autothrottle description and operation can be found in Autopilot and Autothrottle System.

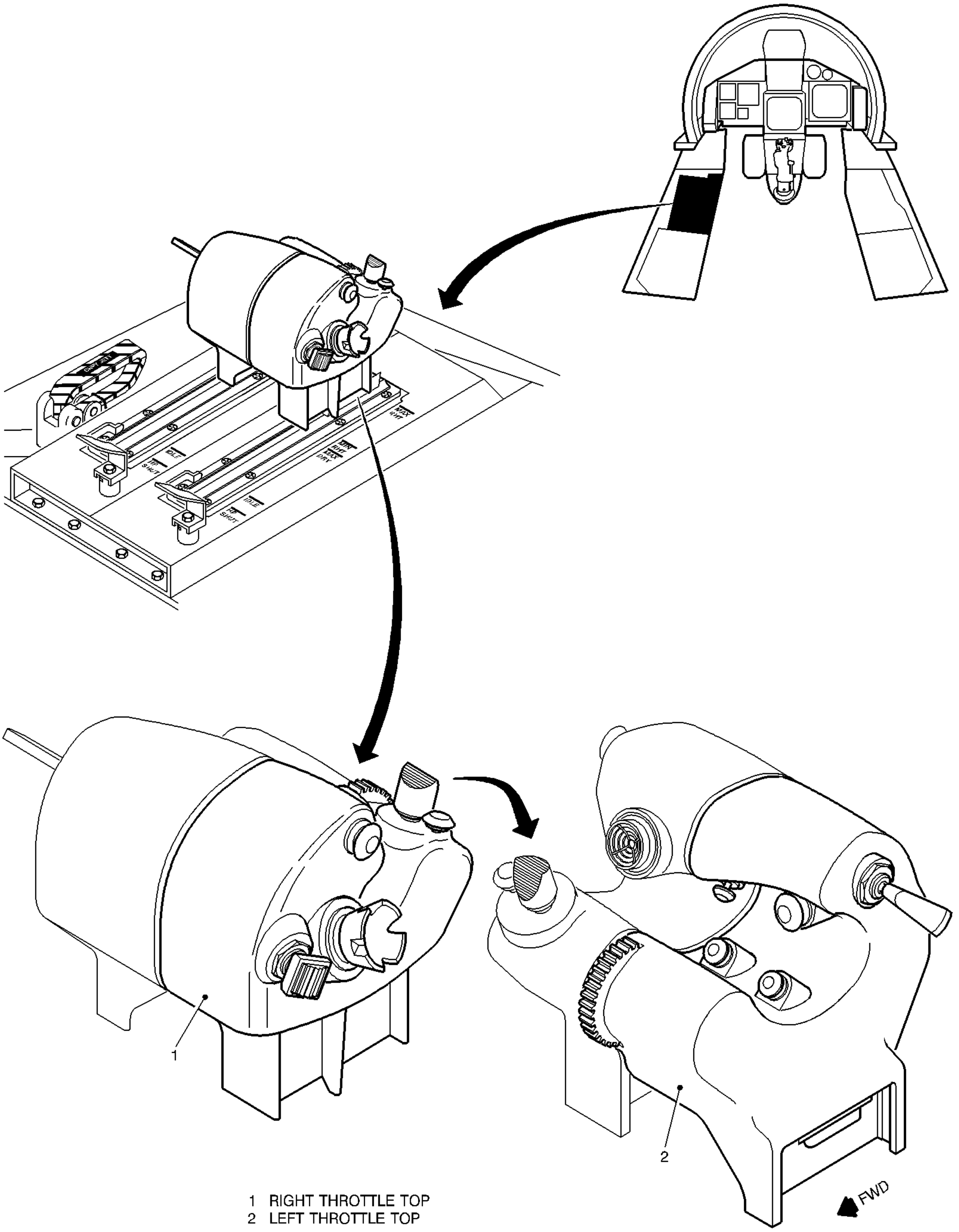


Figure 1.31 - Throttle Box

ENGINE CONTROLS AND INDICATORS

Engine controls and indication is achieved by a combination of dedicated switches, controls and displays, see Figure 1.32.
Engine information is displayed on the MHDD, HUP and DWP.

LEFT/RIGHT LP COCK SWITCHES

Two-position coverguarded toggle switches labeled L LP COCK and R LP COCK are located on the left and right consoles respectively, with the following positions:

OPEN (guarded):	L/R LP COCKs are opened and engine igniter circuits are enabled
SHUT (guard up):	L/R LP COCKs are closed and engine igniter circuits are disabled

THROTTLES

The throttles located on left console, control the engines from HP SHUT to MAX RHT passing through IDLE, MAX DRY and MIN RHT positions.

NOTE

The EMGY setting is not used.

MHDD

The engine (ENG) format, is selected by pressing the ENG SK. The following engines information is shown:

– Engines speed (%NL and NH)
– Lanes in use (1 or 2 selectable by SKs)
– AJ (%)
– Engines fuel flow (FF)
– TBT (°C)
– Left and Right Intake
– Engine warning captions

DWP

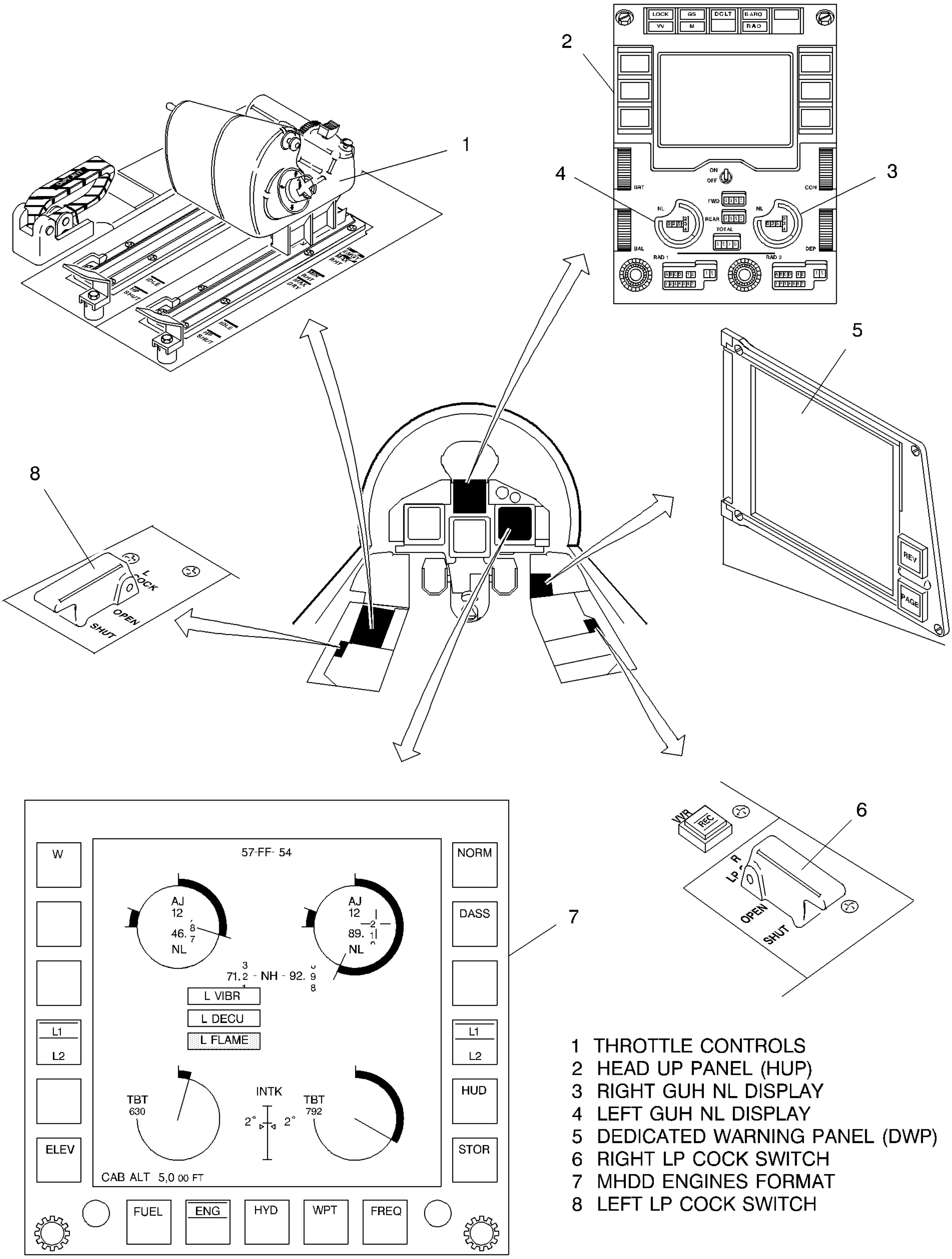
The DWP shows the dedicated engine warning captions.

HEAD UP PANEL (HUP)

The left and right engines NL (RPM%) values are shown in digital and analogue form.

NOTE

GUH indications/warnings consist of NL on HUP and L/R OIL P on DWP.



1 THROTTLE CONTROLS
2 HEAD UP PANEL (HUP)
3 RIGHT GUH NL DISPLAY
4 LEFT GUH NL DISPLAY
5 DEDICATED WARNING PANEL (DWP)
6 RIGHT LP COCK SWITCH
7 MHDD ENGINES FORMAT
8 LEFT LP COCK SWITCH

Figure 1.32 - Engine Controls and Indicators

ENGINE/APU FIRE PROTECTION SYSTEM

FIRE DETECTION SYSTEM

The Fire Detection System uses continuous length pneumatic thermal detectors to detect fire/overheat in the two engine bays and in the APU bay.
The system is electrically supplied by the PP3 and battery busbar.
A total of seven detectors are installed in the aircraft:

– Three in each of the two engine bays;
– One in the APU bay.

The temperature sensing units are set to give a fire warning signal when the average ambient temperature exceeds 260°C or if a short section of the sensor length is heated to a temperature over 550°C.
The warning signals from the two engine bays are sent directly to a dedicated Fire Warning Pushbutton Selector /Indicator and to the DWP (REV MODE).
The same warnings are sent to the Secondary Power System (SPS) computer which, in turn, provide signals to the cockpit (DWP NORMAL MODE, CAMU, MHDD/ENG).
The warning signal from the APU bay is sent to the APU control unit; this warning is sent to the SPS computer which, in turn, provide signal to the cockpit (DWP NORMAL MODE, CAMU).
All of the signals are also sent to the MDP via the UCS Data Bus.
The warning signals are cleared as soon as the temperature, in the zone where the sensing activated element is installed, decreases below the above value.

FIRE EXTINGUISHER SYSTEM

The fire extinguisher system, provides a means of putting out fires in the engine bays.
A single fire extinguisher bottle, with twin outlets, is located in the "V" bay between the two engines.
Two electrically detonated firing heads, installed at the bottle outlets are commanded by two Fire Warning Pushbutton Selector /Indicator located on the either side of the HUP.
Detonation of the appropriate explosive cartridge enables the entire contents of the bottle to be discharged into the affected engine bay.

FIRE DETECTION SYSTEM CONTROLS AND INDICATORS, SEE FIGURE 1.33

FIRE WARNING PUSHBUTTON SELECTOR / INDICATOR

The two Fire Warning Pushbutton Selector /Indicator have a flip-up cover and incorporate a screen labeled F. If a fire or overheat condition is detected in the engine bays, the appropriate indicator/ pushbutton "F" caption illuminates. When pressed, the entire extinguisher agent is discharged into the selected engine bay.

FIRE WARNING INDICATIONS

When fire is detected, the SPS computer provides a visual warning via the cockpit displays and audio warning.
The following warning captions are displayed to indicate the existence of APU/engine bay fire/ overheat:

– L/R FIRE on the MHDD/DWP;
– "F" Indicator/Pushbutton;
– APU FIRE on the DWP.

During APU start up the electrical power is not available to the DWP, however, a warning to the pilot in case of an APU fire is provided by the canopy horn giving an audio warning. The canopy horn signal is modulated in such a manner that cannot be confused with the normal canopy close warning.
This warning is in addition to what is provided by the normal warning system, which provides a warning once electrical power is available.
The operation of the horn warning is inhibited in flight, as the pilot has no means of disabling the device.

NOTE

If a fire occurs in the rear fuselage damage to the wiring looms can provide the following sustained or intermittent engine indications:

– TBT, NH, NL;
– Fuel Flow (FF);
– Nozzle (AJ);
– Engine Control warnings (L/R DECU);
– All engine related warnings.

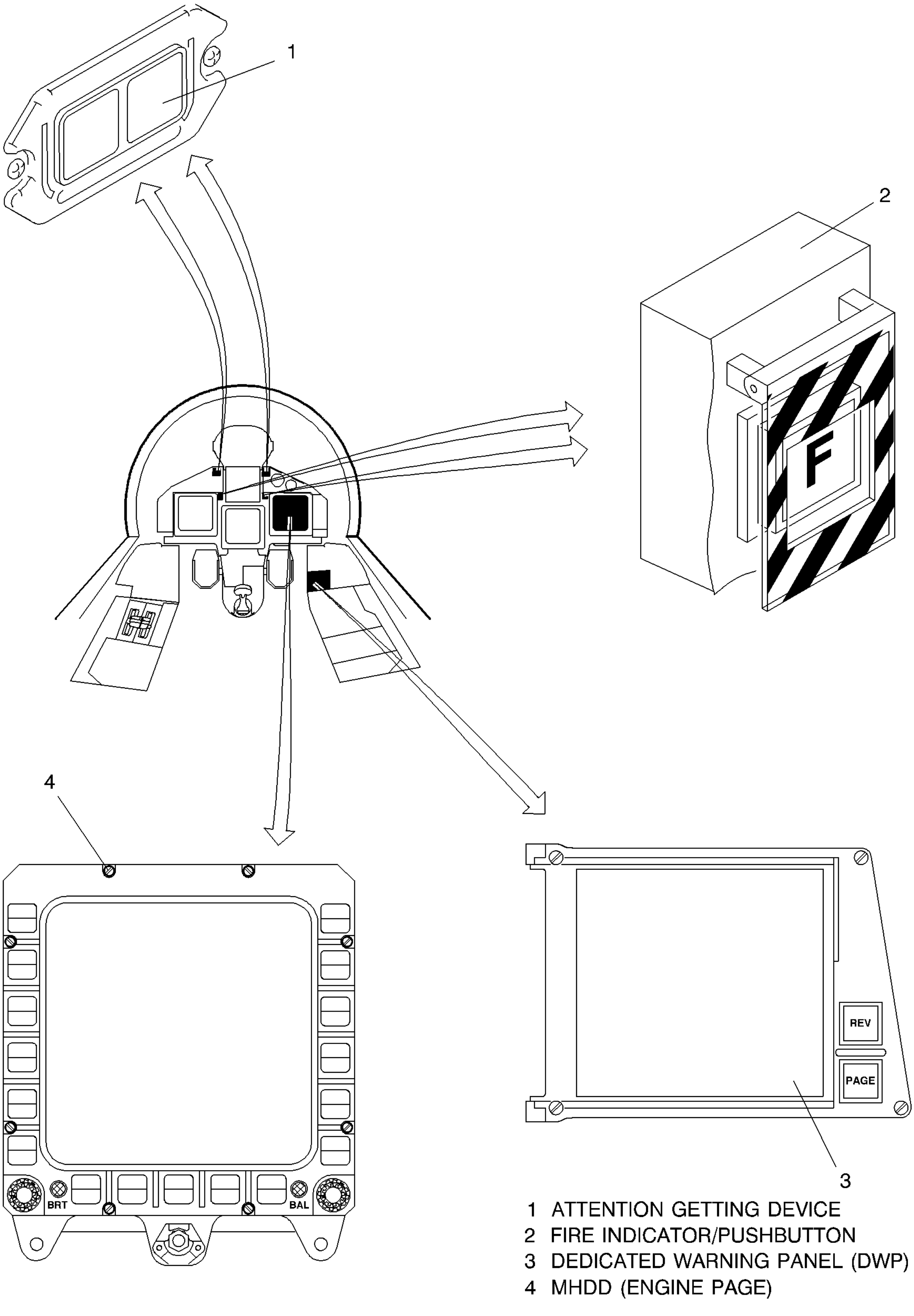


Figure 1.33 - Engine/APU Fire Protection System - Controls and Indicators

ENGINE OPERATION

At high power the engine may be limited by NH, NL, NL/√ & THgr, P3, T3, TBT or Nozzle Load. The exact regions for each limiter will vary from engine to engine, see Figure 1.34 illustrates the region where the limits apply.

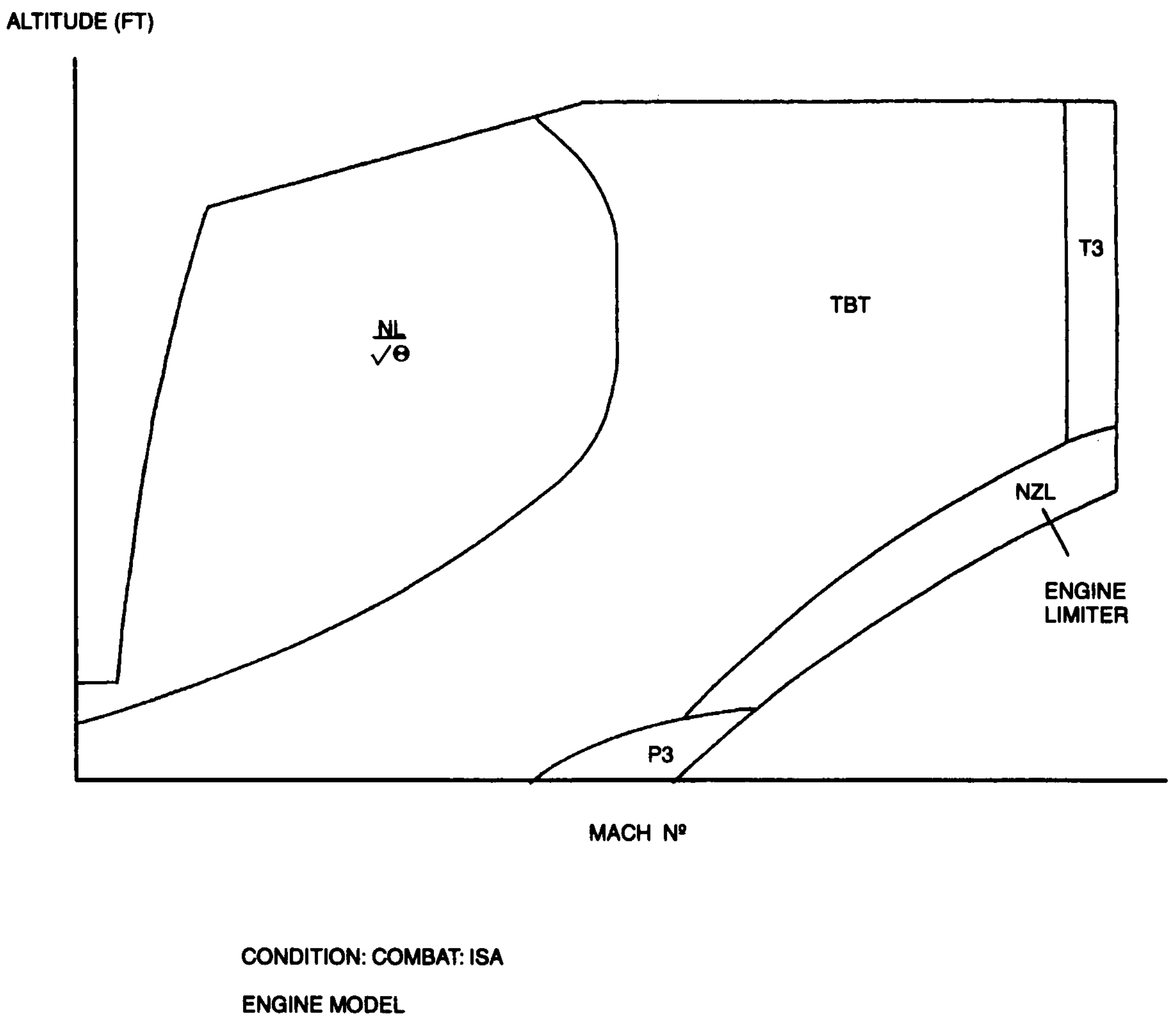


Figure 1.34 - Engine Limiters around the Flight Envelope

ENGINE HANDLING IN FLIGHT

The engine is controlled electronically, with various parameters governing engine behavior in different flight conditions.

In general, there is a fixed relationship between the throttle setting and NL, but changes in temperature, altitude and airspeed, which will normally cause variations in NH, TBT and AJ, may also cause small variations of NL for any given throttle setting.

In particular, the engine NH idle speed is scheduled with Mach, altitude and temperature. Thus, while stationary on the ground, the idle NH is normally between 68.5% and 72.5%; at high altitudes or in supersonic conditions, this can increases to MAX DRY.

Consequently a throttle response deadband may be noted in the idle region (due to the idle schedule).

NOTE

An engine standard fitted with DECU C2, the throttle response deadband is minimized through nozzle modulation.

DRY POWER OPERATION

Engine handling in the dry power range is controlled as follows:

– For steady state conditions by NL from throttle setting subject to minimum and maximum limits of NH, NL, NL√ & THgr, P3, T3 and nozzle load.
– For transient conditions the accelerations/ decelerations are limited by NH rate (NH Dot).

REHEAT OPERATION

In the reheat range, the throttle setting demands an appropriate nozzle area which in turn schedules reheat fuel flow (three stage reheat fuelling: priming, core and by-pass).

Total temperature, altitude and the turbine pressure ratio are additional parameters governing reheat operation.

During reheat operation the TBT rating schedule is increased by 16°C compared to MAX DRY TBT value.

The engine handling in the reheat range is controlled as follows:

– For steady state condition by Nozzle Area demanded by throttle setting.
– For transient conditions the reheat modulation is limited by Nozzle Area rate.

The reheat selection sequence is inhibited if the engine speed is below 85%NH but, once lit, the engine speed is allowed to reduce to 80%NH before automatic reheat cancellation.

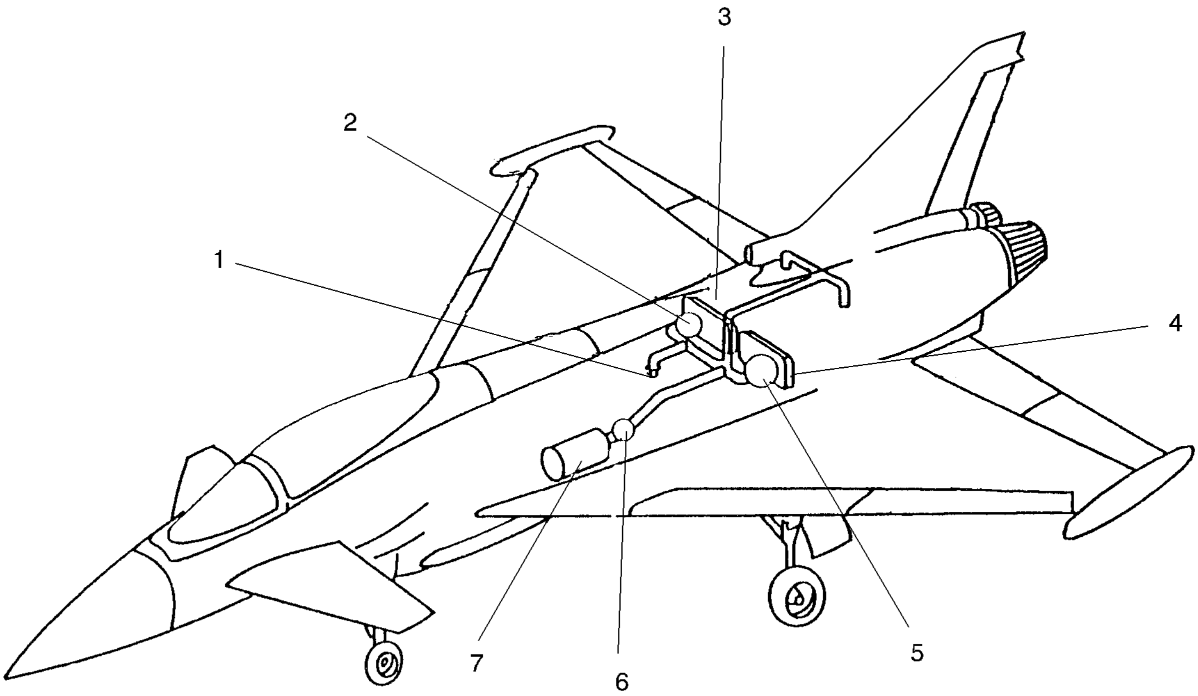
No special limitations are imposed on reheat handling. However, when operating above 30 000 ft at subsonic speed there is a possibility of transient buzz.

In any case the DECU will automatic cancel the reheat if the level of buzz or screech exceeds the detection system limits.

SECONDARY POWER SYSTEM (SPS)

The SPS, see Figure 1.35 consists of:

– An APU, including its control unit (APUCU).
– Two gearboxes (G/B).
– Two air turbine starter motors (ATS/M), including relevant control valves (ATS/M CV).
– Two SPS computers (which are parts of the UCS).



1 GROUND CONNECTION
2 R/H ATSM
3 R/H GEARBOX
4 L/H GEARBOX
5 L/H ATSM
6 APUSOV
7 APU

Figure 1.35 - SPS Main Components Location

AUXILIARY POWER UNIT (APU)

The APU provides compressed air, via the Pneumatic System to the ATS/M for gearbox/ system checking or engine starting and the ECS for the cockpit conditioning
The APU can only be operated on the ground and allows the aircraft to operate independently from ground facilities; it is located in a separate bay within the wing root on the left side of the fuselage, forward of the main under carriage.
The APU draws its air through an intake door in the APU bay and ducts its exhaust gases overboard through an exhaust in the upper fuselage/wing fairing.
The APU is gravity fed from the aircraft fuel system via a dedicated supply fuel shut-off valve, controlled by the APUCU.

TECHNICAL DESCRIPTION

The APU power section consists of a single centrifugal integral bleed compressor, a reverse flow annular combustor and a single-stage radial inflow turbine.
The compressor system consist of a single stage centrifugal compressor with a radial diffuser and an axial de-swirl.
The APU gearbox, in addition to providing mounting pads for the APU accessories provides a mounting pad for the generator for ground electrical power.
The lubricating system is an integral part of the APU and it is capable to operate without oil for 30 seconds without being damaged. In case of oil flow interruption the APUCU will shut-down the APU.
The intake door actuator is automatically operated by the APUCU; it open the air intake door when the APU starting sequence has been initiated and then closes it when the APU has been shut-down.

APU CONTROL UNIT (APUCU)

The APUCU monitors and controls all APU operations. It is installed in an unconditioned bay in the left side wing root close to the APU bay, but on the other side of the APU fire wall.

BUILT-IN TEST (BIT)

The APUCU contains a Built-In Test (BIT) to accomplish internal self-test without the assistance of support equipment.

INTERFACE WITH THE SPS COMPUTER

The APUCU interfaces the UCS by means of the UCS dual redundant data bus for:

– Status Signals;
– Inhibit Signals;
– Maintenance and Health Monitoring Signals.

MONITORING OF THE APU

The RUN mode indication on the right console and the APU FIRE caption on the DWP are shown.

SPS FUNCTION

The basic functions of the SPS are:

– To generate pneumatic power for main engine starting and systems operation during ground operation (APU).
– To convert pneumatic power from internal or external sources into mechanical power (ATS/M).
– To provide mechanical power to the A/C twin channel electric and hydraulic systems, during ground and flight operations (via gearboxes and PTO shaft).
– To provide mechanical power to the engines in order to permit ground starting (via gearboxes and PTO shaft).
– To provide the necessary BIT information for maintenance and health monitoring purposes to the SPS computers and UCS.

Each gearbox drives a Constant Frequency Generator (DA3/DA4/DA6) or an Integrated Drive Generator (DA1/DA2/DA5/DA7), a DC generator and a hydraulic pump.
The gearbox can be driven by its associated engine, or by its associated ATS/M. In the later case, the necessary compressed air is provided by the APU, by a pneumatic ground cart or by the other engine.
The SPS operates under active/passive control of UCS-SPS computers with the exception of the APU which is independently controlled by its APUCU.
During normal flight operations the UCS-SPS computers operate in a passive mode by exercising the following functions:

– Monitoring the usage and condition of the SPS components;
– Monitoring the condition of the engines and gearboxes, and initiating cross bleed mode when required;
– Inhibition of APU operation.

The APUCU is interfaced to the UCS computers for APU starting, stopping and operation.

SPS MODES OF OPERATION

The main SPS modes of operation, see Figure 1.36, Figure 1.37, and Figure 1.38 are:

– Ground Check Out Mode
– Main Engine Start Mode

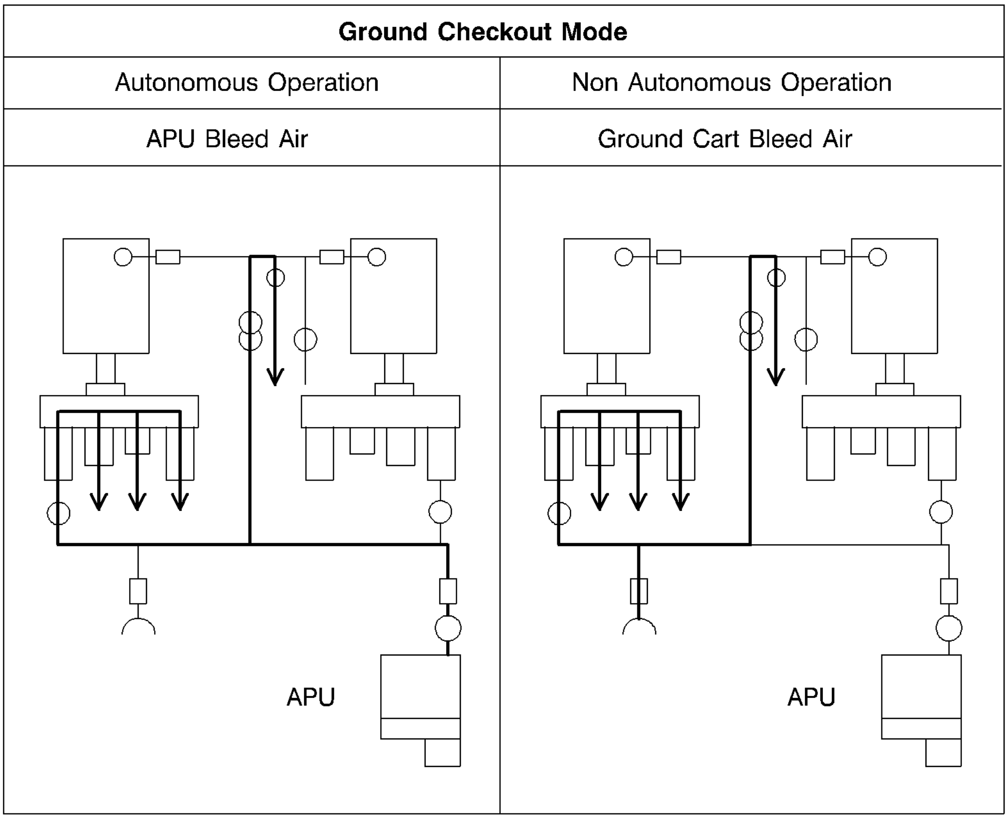


Figure 1.36 - Schematic Energy Flow Chart, Ground Checkout Mode

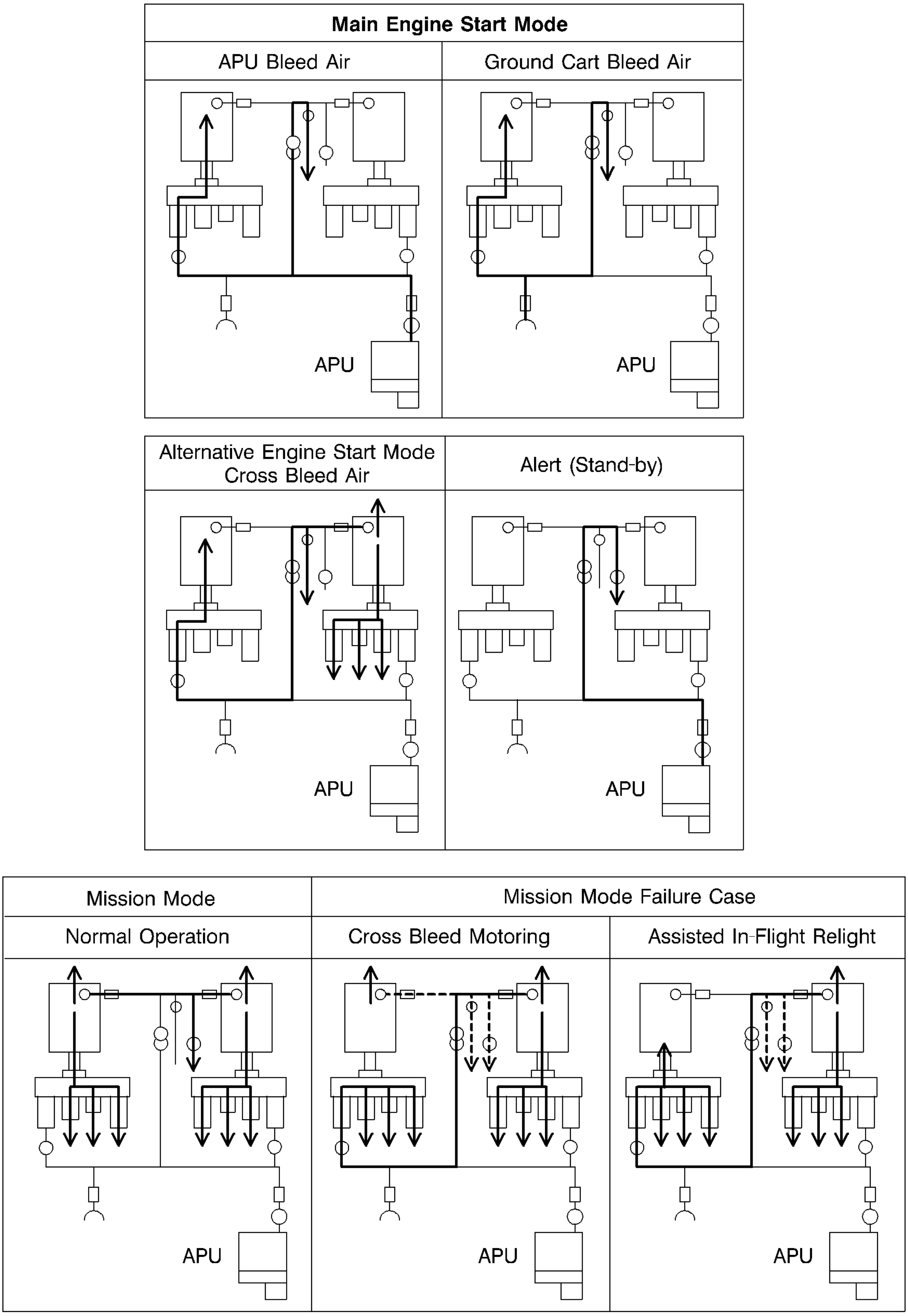
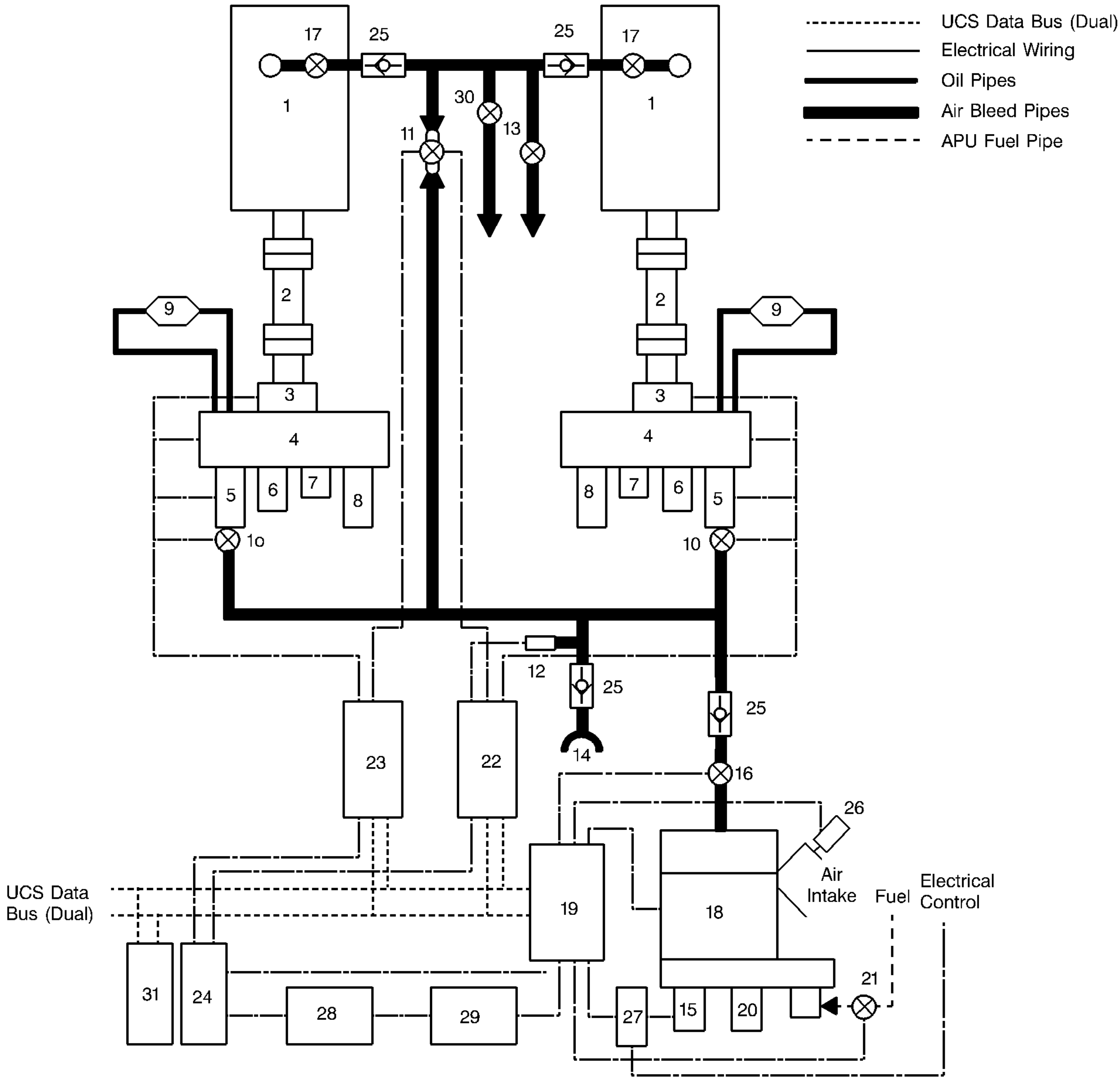


Figure 1.37 - Schematic Energy Flow Chart, Main Engine Start Mode



1 Main Engine
2 Flexible PTO Shaft
3 Free Wheel / Dog Clutch
4 Gearbox (AMAD G/B)
5 Air Turbine Starter Motor (ATS/M)
6 IDG or CFG
7 DC Generator
8 Hydraulic Pump (HP)
9 Fuel Cooled Oil Cooler
10 ATS/M Control Valve (ATS/M CV)
11 Pressure Reduction and Shut-off Valve (PRSOV)
12 SPS Pressure Sensor
13 Variable Pressure Reducing and Cut-off Valve (VPRSOV; ECS)
14 Ground Connections
15 APU Starter
16 APU Shut-off Valve
17 Engine Bleed Shut-off Valve (ECS)
18 Auxiliary Power Unit (APU)
19 APU Control Unit
20 APU Generator
21 Fuel Shut-off Valve
22 SPS Computer Left (UCS)
23 SPS Computer Right (UCS)
24 Cockpit Controls and Indications
25 Non-Return Valve
26 APU Air Intake Actuator
27 APU Contactor
28 APU External Start Facility (except DA1 and DA5)
29 MDP bay APU Controls and Indications
30 MSOC PRSOV (ECS)
31 Cockpit D & C Equipment, DWP/MHDD

Figure 1.38 - Secondary Power System (SPS), Schematic

GROUND CHECK OUT MODE

NON-AUTONOMOUS OPERATION

Ground cart bleed air drives both of the accessory gearboxes via its respective ATS/M for electrical and hydraulic system checks.

AUTONOMOUS OPERATION

APU bleed air drives either of the accessory gearboxes via ATS/M for electrical and hydraulic power for system checks. The APU is also capable of driving the APU standby generator at the same time.

NOTE

- To avoid depleting the battery unnecessarily, external power should be used to start the APU.
- The a/c battery is capable of starting the APU down to -25°C. Below this temperature, external electrical power supply is required.

The APU is automatically commanded to shut-down (and its operation inhibited) by the SPS computer when either the second engine has been started, the A/C speed is higher than 5 m/s or when the A/C weight on wheels (WOW) is not detected (flight condition).

The APU is automatically shut down if a fire is detected in the APU bay, as indicated by the APU FIRE warning (or modulated canopy horn during the APU starting phase).

From start to run, the APU reaches its steady-state condition in approximately 20-30 seconds.

The run-down time from run to stop is also approximately 30 seconds. The APU and both engines are normally started within 90 seconds after initiating the APU start sequence at ISA +15 SL.

Engine starts under the worst conditions are accomplished within 3 minutes after the APU has been started.

The APU is normally run with the canopy closed and the ECS switch set to ECS. During the first engine start sequence, the ECS is automatically commanded to shut-down (ECS PRSOV closed) when the MSOC PRSOV is commanded to open, thus supplying the MSOGS.

SYSTEM CHECK-OUT MODE

NOTE

- Before initiating the system check-out mode, the ECS must be manually shut off using the cockpit switch.
- Simultaneous motoring of both gearboxes is possible, providing that A/C hydraulic and electrical loads are minimized, thus allowing the FCS to enter its NORMAL mode. The run-down of one gearbox allows the FCS to remain in this mode.

The APU supplies compressed air to the gearbox mounted ATS/M which drives the gearbox, ensuring hydraulic and electrical power for systems autonomous ground check-out.
During the above operating modes the APU mounted electrical generator is capable of giving its full performance (10/15 KVA AC) (see note below).

NOTE

At present, the APU generator is installed but not electrically connected.

The power ratings of the APU are 10 KVA continuous load; 15 KVA for 2 hours; 20 KVA for 5 seconds.

MAIN ENGINE START MODE

ENGINE START WITH EXTERNAL GROUND CART

The procedures for engine starts using a ground cart are the same as when using the APU. The SPS computers recognize the ground cart as the pneumatic source.
Before initiating the starting sequence, the L/R GEN and L/R HYD switches should be in the OFF position to reduce loads on the engines.
After the engines have stabilized at IDLE, set the L/R GEN to ON and L/R HYD to AUTO.

ENGINE START PERFORMANCE

Engine starts under the worst ground environmental conditions are accomplished within 3 minutes after APU initiation.

ALERT (STAND-BY)

The APU supplies compressed air to the ECS and the MSOGS during alert time, or turn around time.

The APU drives a standby electrical generator and simultaneously supplies bleed air to the environmental control system (ECS) and molecular sieve oxygen concentrator (MSOC) for a maximum of two hours (to meet alert mode requirements).

AUTONOMOUS ENGINE START

Normal engine starting procedure is performed using air bled from the APU or a pneumatic ground cart then converted to mechanical power by the ATS/M.

All operations necessary to switch the relevant ECS valves are performed by the Front computer.

The ATS/M CV regulates the flow of pressurized air to the ATS/M: the ATS/M CV is controlled by the SPS computer, which also monitors gearbox and ATS/M speeds.

The ATS/M drives the gearbox to accelerate the engine up to 58-63%NH during engine starting (gearbox connected to the engine).

With the APU running, automatic sequential engine starting (LH engine first) can be performed by moving both throttles from the HP SHUT to the IDLE position at the same time.

When the throttles are set to IDLE (LP CICKs ON), the following occurs:

– The DECUs are energized.
– The SPS computer recognizes the APU as air source.
– When the SPS computer detects that the ATS/M has reached the cut-out speed (58 or 63%, depending on the scheduled IDLE), it commands the ATS/M CV to close.

The engine start cycle is terminated when the IDLE speed is achieved.

NH must be monitored by the pilot during starting. The start is to be aborted if NH stagnates or drops for more than 5 seconds during the start phase.

The DECU automatically monitors starts and aborts the start if any of the following conditions occur:

– TBT exceeds 850°C for 0.3 seconds.
– TBT exceeds 700°C for 5 seconds.
– The time taken to accelerate from 5% NH to 60% NH exceeds 60 seconds.

NOTE

TBT below 600°C does not register on MHDD Engine format.

Under normal operating conditions the time to idle is approximately 35 seconds.

If TBT exceeds 700°C, fuel flow is automatically reduced for 2 seconds or until TBT falls below 700°C.

Engine starting is aborted also if any of the following failures or abnormal conditions occur:

– 70 seconds after the pilot has placed the throttle to IDLE, the engine has not yet reached its idle speed (70%NH nominal).
– The pilot places the throttle to HP SHUT. In this case, the DECU senses the demand for a shut-down from the state of the signal from the throttle microswitch to the HPSOC closed solenoid.
– AIR DRIVE switch failure;
– 650°C<TBT<677°C for 5 seconds or >677°C;
– Gearboxes or related equipments failure.

CAUTION

CANCEL THE START SEQUENCE IF ABNORMALITIES OCCUR (E.G. FLAMEOUT, IGNITION FAILURE, ENGINE FIRE ETC.) BY MOVING THE RESPECTIVE THROTTLE TO THE HP SHUT POSITION, AND THE LP COCK TO THE SHUT POSITION.

NOTE

During a starting sequence, the ECS is rendered inoperative. At the end of the starting sequence, the SPS computer commands the PRSOV to close and the front computer commands the Variable Pressure Reducing Shut-Off Valve (VPRSOV) to open (and the MSOC PRSOV to close), thus recovering the ECS airflow.

ASSISTED START (A/C STATIC)

An assisted start assumes that the APU has already been shut down and can only be effected if the other engine is running with at least 85%NH (70%NL), otherwise the engine start will be aborted.

This procedure is initiated by moving the throttle of the second engine to IDLE. Upon detection of the engine starting request, the SPS computer checks the status of the APU (running or not), the air pipe pressure (pressure or no pressure) and the status of the other engine (running or not). If the result of the check is APU not running, there is no pressure in the SPS piping, and the opposite engine is running, the SPS computer commands the SPS PRSOV to open, the front computer closes the ECS PRSOV and to open the MSOC PRSOV.

NOTE

Cross bleed operation in progress can be indirectly checked by confirming that hydraulic/electrical warnings are occulted.

Avionics Software Packages AVs SP3A onward provides:

– X-Bleed in Progress
– Motoring in progress
– AIR DRIVE switch not in AUTO position

CAUTION

AS THERE IS NO WARNING ON THE DWP OF THE APU INTAKE DOOR TO FAIL TO COMPLETELY CLOSE, THE PILOT SHOULD REQUEST THE GROUND CREW TO VERIFY CLOSURE BEFORE TAXIING OUT (FOR AVS SP 2.20 ONLY).

ASSISTED START (A/C TAXIING)

After the first engine has been started, the pilot can:

– shut-down the APU and begin to taxi,
  or
– begin the taxi with the APU running.

When the A/C speed exceeds 5 m/s the APU (if still running) is commanded to shut-down by the SPS computers, which, at the same time, automatically initiates the cross-bleed.

Setting the throttle to IDLE and the AIR DRIVE switch momentarily to EMGY position, the gearbox stops X-Bleed and is then mechanically connected to the engine, which is driven up to the cut-out speed.

ASSISTED RELIGHT IN FLIGHT

CAUTION

BEFORE INITIATING THE ENGINE ASSISTED RELIGHT, THE PILOT MUST CHECK THAT THE HYDRAULIC PUMP ON THE OPPOSITE POWER CHANNEL IS NOT DEPRESSURIZED TO AVOID TRANSIENT LOSS OF HYDRAULIC POWER.

NOTE

In case of an engine flame-out or shutdown in flight, HP cross-bleed air from the live engine is automatically activated to drive the accessory gearbox of the flamed-out engine.

WINDMILLING RELIGHT

During windmilling relight, if the throttle is set to IDLE or above, the auto-ignition is controlled by the DECU that activates automatic relights.

RESTART AFTER A FAILED ENGINE START

Following a failed engine start the pilot can initiate a restart by moving the throttle to the HP SHUT position and then resetting to IDLE.

MISSION MODE (NORMAL OPERATION)

Each engine mechanically drives its respective accessory gearbox for hydraulic and electrical power.

MISSION MODE (FAILURE OPERATION)

The SPS computers are able to detect the following failures during normal operation:

– Loss of mechanical drive:
  The LH (RH) SPS computer detects the LH (RH) gearbox speed is lower than the speed of the relevant engine, which means that the engine is correctly running but a failure has occurred within its relevant gearbox or PTO shaft.
– Engine flame-out:
  The LH (RH) SPS computer detects the LH (RH) engine speed is lower than the idle speed.

In both cases, if the AIR DRIVE switch is in the AUTO position the involved SPS computer automatically recovers the failure by initiating the cross bleed procedure (Gearbox driven by ATS/M, which is supplied by engine bleed air).

During cross-bleed procedure, the gearbox is driven at a constant speed by the ATS/M. Gearbox-ATS/M speed is controlled by SPS computer at the following levels:

From UCS 3A onwards the speed setting is:

– 60% with A/C in flight;
– 30% with A/C on ground, whichever is the A/C speed, if the engine rating drops below 75%NH. The 60% speed is recovered if the engine accelerates up to 85%NH or above.

The cross-bleed is inhibited on ground, if A/C speed is below 5 m/s, unless it was activated during a previous phase of flight. In this case the cross- bleed is left operative during the complete taxi and after A/C braking; the cross-bleed will be stopped at engine shut-down or by moving the AIR DRIVE switch to OFF. In this way both hydraulic pumps will operate (during single engine landing) and all utilities (e.g. steering) will be available.

APU OPERATION

APU operation can be divided as follows:

- Starting;
- Steady-state;
- Shut-down.

STARTING

NORMAL OPERATION

The APUCU receives/provides signals via a cockpit control panel to allow the pilot to start/stop the unit. The APU starting sequence can be also initiated by the start signal generated by the external start facility.

This facility, not fitted on DA1 and DA2 prototypes, must be used for Quick Reaction Alert (QRA) only.

The starting time of the APU is around 25 seconds at ISA and ISA +15°SL, to obtain stabilized ready-to-load speed (95% of nominal speed) and includes the time necessary to perform self-BIT, valves and air intake door actuation.

The APU is also capable of restarting, without servicing actions, after completion of a 2 hours stand-by duty operation.

CAUTION

APU STARTING FROM THE AIRCRAFT INTERNAL BATTERIES IS NOT CURRENTLY PERMITTED DUE TO THE EXCESSIVE CURRENT NEEDED TO START THE APU WHICH COULD CAUSE UNACCEPTABLE DISCHARGING AND DAMAGE OF THE AIRCRAFT INTERNAL BATTERIES.

As a consequence of the APU START command:

- With start up, the APUCU continuously lights up the RUN caption of the APU cockpit indicator.
- When the APU reaches the 95% speed (ready-to-load speed) the APUCU continuously energizes the peripheral box of the APU cockpit indicator. Starting from this point, therefore, both APU caption and peripheral box are illuminated.
- The APUCU commands the APU shut-off valve to open.
- The APUCU sends a signal to both SPS computers (via the UCS Data Bus) indicating the APU is running.

FAILURES DURING STARTING SEQUENCE

The APU starting sequence is automatically interrupted and the shut-down procedure is automatically initiated in case of abnormal conditions and/or sensor failures are detected by the APUCU, which could lead to APU incorrect operation.

The APU starting is normally continued in case other failures or abnormal conditions different from those above described are detected by the APUCU.

START ATTEMPTS

If a starting sequence is aborted, the pilot can attempt to restart the APU by momentarily placing the APU cockpit switch to START, upon detection of both APU caption and peripheral box of the APU cockpit indicator are occulted.

STEADY-STATE OPERATION

At the end of the starting phase, the APU runs at its nominal speed. The APUCU receives signals from the SPS computer indicating which operating mode is required:

- Engine starting:
  the APU is required to operate at full load in order to supply compressed air to the ATS/M and mechanical power to the APU driven generator drive shaft;
- Gearbox motoring:
  the APU is required to operate at a variable load depending on the power level required by both A/C hydraulic and electrical systems. Mechanical power to the APU driven generator drive shaft is supplied at the same time;
- Stand-by:
  the APU is required to operate a variable load depending on ECS air request. Mechanical power to the APU driven generator shaft is supplied at the same time.

The APU steady-state operation is automatically interrupted in case of abnormal conditions and/or sensor failures are detected by the APUCU.

SHUT-DOWN

APU shut-down is initiated by any of the following actions:

- The pilot momentarily places the APU cockpit switch to the "STOP" position (manual action);

- The APUCU receives a data bus signal (STOP REQUEST) from SPS computer(s) when both engines are running or the A/C weight is not detected on wheels or the A/C speed is higher than 5 m/s or an SPS failure (see note below) has been detected (automatic action).

NOTE

SPS system failure is defined as ATS/M overspeed (UCS 2A onwards).

- The APUCU receives a hardwired signal from the fire detection system indicating a fire is present in the APU bay (automatic action);
- The ground crew places the three-position switch in the MDP bay to the "STOP/INHIBIT" position.

In the last three cases, the APUCU inhibits the APU cockpit START/STOP switch.

As a consequence of any of the above described actions, the following procedure is automatically initiated by the APUCU:

- The APUCU depowers the APU caption of the APU cockpit indicator.
- Upon receiving all "closed position" signals (from APU fuel shut-off valve, APU shut-off valve, APU intake door actuator) (NORMAL CASE) or 20 seconds after the APU intake door has been commanded to close (APU INTAKE DOOR ACTUATOR FAILURE CASE) the APUCU deenergizes itself.
- The peripheral box of the APU cockpit indicator is occulted.

The APU shut-down procedure is not interrupted in case of any failure.

APU IN-FLIGHT INHIBITION

The APU in-flight operation is automatically inhibited by two APU stop/inhibition signals generated by the two SPS computers and sent to the APUCU when at least one of the following conditions occurs:

- Both engines are running;
- SPS system failure:
  ATS/M overspeed (UCS 2A onwards);
- A/C speed is higher than a 5 m/s;
- A/C weight is not detected on wheels.

If the APUCU receives one of these signals it automatically initiates the APU shutdown sequence (if APU is running) and inhibits the start command from the cockpit.

SPS CONTROLS AND INDICATORS

The SPS Controls and Indicators, see Figure 1.39, are:

APU START/STOP SWITCH

It is a momentary three-positions center-off toggle switch (START/NEUTRAL/STOP), which is biased to the neutral position.

- START Position:
  The APUCU automatically initiates the APU starting sequence, including APUCU power-up BIT and operation of APUCU controlled equipment.
- STOP Position:
  The APUCU automatically initiates the APU shut-down sequence (including operation of APUCU controlled equipment). At the end of the sequence the APUCU shuts itself off.
- Neutral position:
  Return to this position has no effect on previous manual demands made via this switch and does not affect automatic control of the APU.

APU STATUS INDICATOR

APU status indication is provided as follows:

- During the APU starting phase (from generation of start input to attainment of 95% speed), the RUN caption only is lit up;
- As soon as 95% is exceeded and, therefore, during steady state operation, both APU caption and peripheral box are lit up;
- As soon as the APU shut-down sequence is initiated, the RUN caption is extinguished and the peripheral box only is illuminated up to the end of the APU shut-down sequence, and until the APUCU depowers itself.

APU EXTERNAL START SWITCH

The APU external start switch is located near of the ladder bay close to the canopy open/close control. This switch is enabled by three-position APU Stop/ Inhibit switch located in the left-hand side of the MDP bay, together with an APU Inhibit lamp. The external start switch should be used for "QRA" purpose.

APU THREE POSITION STOP/INHIBIT SWITCH

The APU Three Position Stop/Inhibit switch is located in the MDP bay.

- Upper position: The APU external start switch is enabled to operate.
- Centre position: The APU normal operation is allowed.

– Lower position: The APU is commanded to shutdown (if running) and APU operation is inhibited and the APU inhibit lamp is lit up.

NOTE

The APU external start is enabled only if the APU inhibit/external start enable switch is in the inhibit position (upper position) and both throttles are set to HP SHUT position.

APU STOP/INHIBIT LAMP

This lamp is located in the MDP bay near the three-position stop/inhibit switch. It is illuminated when the APU is in its inhibit status, upon operation of the above switch. This indication is available irrespective of the battery master switch position. This indicates that the APU is safe for maintenance.

AIR DRIVE SWITCH

Three position toggle switch which is biased (sprung) from the forward (EMGY) position to the center (AUTO).

The control is locked in the center position (AUTO) such that it must be unlocked prior to reselecting it to the aft position (OFF).

The control is locked in the aft position and must be unlocked prior to reselecting forward. The positions and functions of the switch are as follows:

AIR DRIVE - EMGY POSITION (ASSISTED ENGINE RELIGHT)

In case of engine flame-out (if the AIR DRIVE switch is in AUTO position), a cross bleed is automatically initiated using compressed air from the running engine.

At the pilot's discretion, the assisted engine relight is manually initiated by placing the throttle to IDLE and momentarily placing the AIR DRIVE switch to the EMGY position.

The engine and the gearbox are connected once the gearbox is synchronized with the engine by engagement of the gearbox actuated clutch.

The ATS/M of the starting engine is supplied with air bled from the running engine which then drives the engine via its gearbox to the appropriate rotational speed.

After the engine has accelerated to IDLE speed, the normal flight condition is recovered and the gearbox mechanically driven by its respective engine.

If the engine relight is not successful, the previous cross-bleed condition is automatically recovered.

NOTE

The SPS computer software does not allow an assisted engine relight when the A/C is on the ground and its speed is lower than 5 m/s (i.e. A/C stationary). If this condition exists, placing the switch to EMGY has no effect for the assisted engine relight.

AIR DRIVE - AUTO POSITION (GEARBOXES CROSS-BLEED MOTORING)

ON GROUND (A/C STATIONARY ONLY, I.E. SPEED LOWER THAN 5 M/S)

The AUTO position is mandatory to be able to perform all operations involving the ATS/M, i.e. engine starting (throttle to IDLE, air supply from APU, ground cart or opposite engine) and gearbox motoring. The latter case is in conjunction with the GBOX L/R pushbuttons.

IN FLIGHT (INCLUDING CONDITION OF A/C ON GROUND WITH SPEED HIGHER THAN 5 M/S)

The AUTO position is mandatory to perform the gearbox motoring, but mainly, to enable the SPS computers to automatically initiate cross-bleed if one of the following conditions occur:

– the engine speed falls below the IDLE value (i.e. engine flame-out);
– the gearbox speed falls below the engine speed (i.e. loss of mechanical drive to the gearbox).

In case of engine flame-out, the dead engine gearbox speed is maintained at 60% by cross-bleed (air from the running engine) until assisted or windmill relight procedure, as applicable, is successful.

Starting from this point the normal flight condition (gearboxes mechanically driven by their engines) is recovered.

NOTE

Due to the above, the AIR DRIVE switch must be checked before take off. If the switch is not in the AUTO position this is indicated on the MHDD/ENG format.

AIR DRIVE - OFF POSITION

During specific testing, when this position is selected, the SPS computer inhibits the ATS/M control valves, i.e., it command them to maintain their closed position and the gearboxes cannot be driven by their relevant ATS/M's.

WARNING

IN-FLIGHT SELECTION IS NOT PERMITTED. SELECTION DISABLES GEARBOX PNEUMATIC DRIVE WITH CONSEQUENT LOSS OF THE FOLLOWING SPS FUNCTIONS:

– ENGINE STARTING;
– GEARBOX MOTORING;
– CROSS-BLEED;
– ASSISTED ENGINE RELIGHT.

During ground procedures, selection of this position provides an additional means to protect the ground crew from inadvertent engine rotation and ignition or inadvertent gearbox-ATS/M operation.

LEFT/RIGHT GEARBOX AIR DRIVE PUSHBUTTON (L/R GBOX)

Two momentary action pushbuttons (GBOX L/R) are provided on right console.

NOTE

The above pushbuttons are only enabled when the AIR DRIVE switch is in the AUTO position.

Momentarily pushing the button the previously selected operation is cancelled.

Pushbutton selection allows pneumatic drive from any source (APU, external air supply or opposite engine) to be provided to the ATS/M-gearbox.

The above operation is used:

– On ground, for system check-out purpose (start/stop gearbox motoring);
– In flight:

  to reset the software routines, which govern the cross-bleed, thus reinitializing a cross-bleed operation which was previously automatically terminated;
– to allow the ATS/M to accelerate and stabilize at 60% speed before a deliberate engine shut-down, thus allowing the system to quickly initiate the cross-bleed as soon as the engine will be shut.

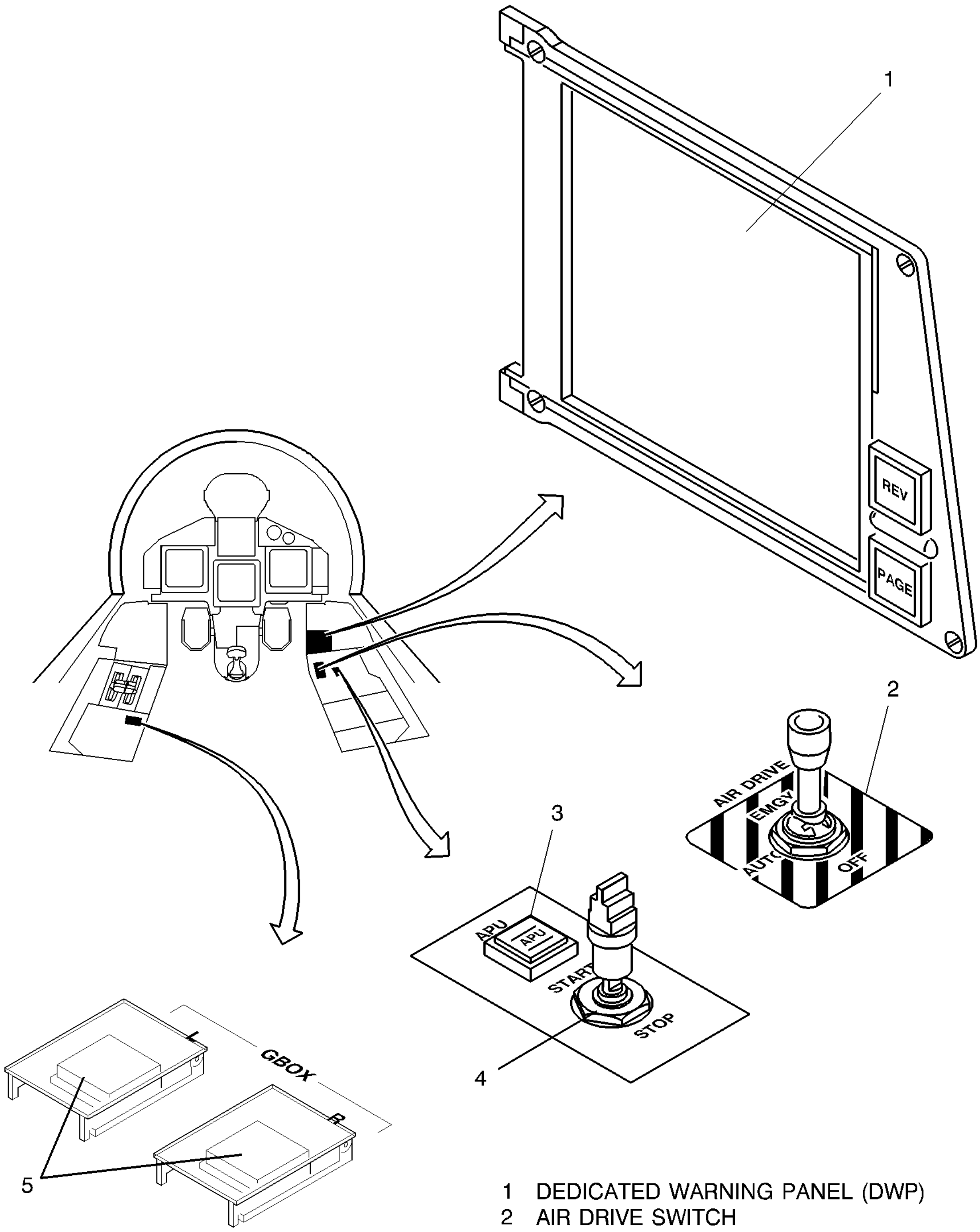
DISPLAYS AND WARNINGS

MULTI-FUNCTION HEAD DOWN DISPLAY (MHDD)

– L/R gearbox motoring in progress (AD L or AD R);
– L/R cross bleed in progress (L/R X BLEED IN PROG);
– AIR DRIVE switch out of AUTO position.

DEDICATED WARNING PANEL (DWP)

– L/R PTO failure (L/R POT);
– L/R gearbox failure (L/R GBOX);
– L/R GBOX oil overtemperature (L/R GBOX T);
– L/R ATS/M failure;
– APU air intake door actuator failure (APU DOOR)(AVS SP3 onwards);
– SPS piping air overpressure (SPS P).



1 DEDICATED WARNING PANEL (DWP)
2 AIR DRIVE SWITCH
3 APU STATUS INDICATOR
4 APU START/STOP SWITCH
5 LEFT/RIGHT GEARBOX AIR DRIVE PUSHBUTTON

Figure 1.39 - SPS Controls and Indicators

FUEL SUPPLY SYSTEM

Fuel is contained in two fuselage tank groups, a forward transfer tank and four wing tanks. External fuel can be carried under the fuselage and wings in jettisonable tanks. All tanks are pressurized to prevent fuel boiling at high altitudes and are vented to atmosphere during refueling/defueling. The primary aim of the fuel system is to provide an adequate supply of fuel to the engines whilst maintaining fuel asymmetry within acceptable limits. After initial switch setting during the pre flight checks, operation of the fuel system is controlled autonomously by two fuel computers.

All fuel is transferred sequentially to the fuselage tank groups before being supplied to the engines. External fuel is transferred by air pressure and internal fuel is transferred via transfer pumps. Each main group is equipped with a pair of boost pumps to maintain a pressurized supply of fuel to the engines via separate feed lines. The forward group feeds the left engine, the rear group feeds the right engine and a crossfeed facility is provided for abnormal operation.

Signals from gage probes and level sensors in the fuel cells enable the fuel computers to calculate fuel content, control refuel/defuel, control fuel transfer, and provide fuel content information for display purposes.

The status of the fuel system is displayed on a dedicated MHDD/FUEL format. Upon selection of the format a set of soft keys are made available to enable the fuel system to be controlled manually if required. The DWP is able to display a number of category 2 and 3 warnings in response to certain fuel system failures.

Other fuel system features include provision of an air-to-air refueling facility and a fuel recirculation system. The fuel recirculation system allows the fuel system to act as a heat sink for the electrical and hydraulic power generation systems and the accessory gearboxes. Fuel also assists cooling of engine oil and the DECU prior to combustion. The fuel system also provides a gravity fed fuel supply to the APU.

FUEL TANKS

All fuel tanks are pressurized and contain fuel gaging and level sensing probes. Where a tank contains more than one probe, the probes are divided between the fuel computers so that contents data is available with reduced accuracy in the event of a fuel computer failure. The same philosophy is applied to transfer pumps and all back-up probes contained in the fuel tanks.

FUSELAGE GROUPS

The fuselage tank system is an integral part of the fuselage structure (Figure 1.40) and comprises a forward and rear group each consisting of seven interconnected cells. The cells at the lowest point of the forward and rear group act as collector tanks and are supplied with fuel under gravity feed through flap valves which prevent reverse flow. Each collector tank is equipped with a pair of boost pumps which maintain a pressurized supply of fuel to the engines.

INTERNAL TRANSFER TANKS

The aircraft is equipped with five internal transfer tanks. Each transfer tank is equipped with two transfer pumps which enable it's contents to be transferred to the main groups. Each wing is divided into two separate tanks (forward and aft) to reduce CG movement caused by fuel 'slosh'. The remaining transfer tank known as the forward transfer tank is located in front of the forward group and is completely separate from the two fuselage fuel groups.

EXTERNAL TANKS

CAUTION

EXTERNAL FUEL TANKS SHOULD NOT BE JETTISONED ON THE GROUND.

External 1000 l fuel tanks can be carried at three stations, one under each wing and one under-fuselage on the aircraft centerline. Fuel is transferred from the external tanks to the fuselage groups by pressurized air. All external tanks are jettisonable.

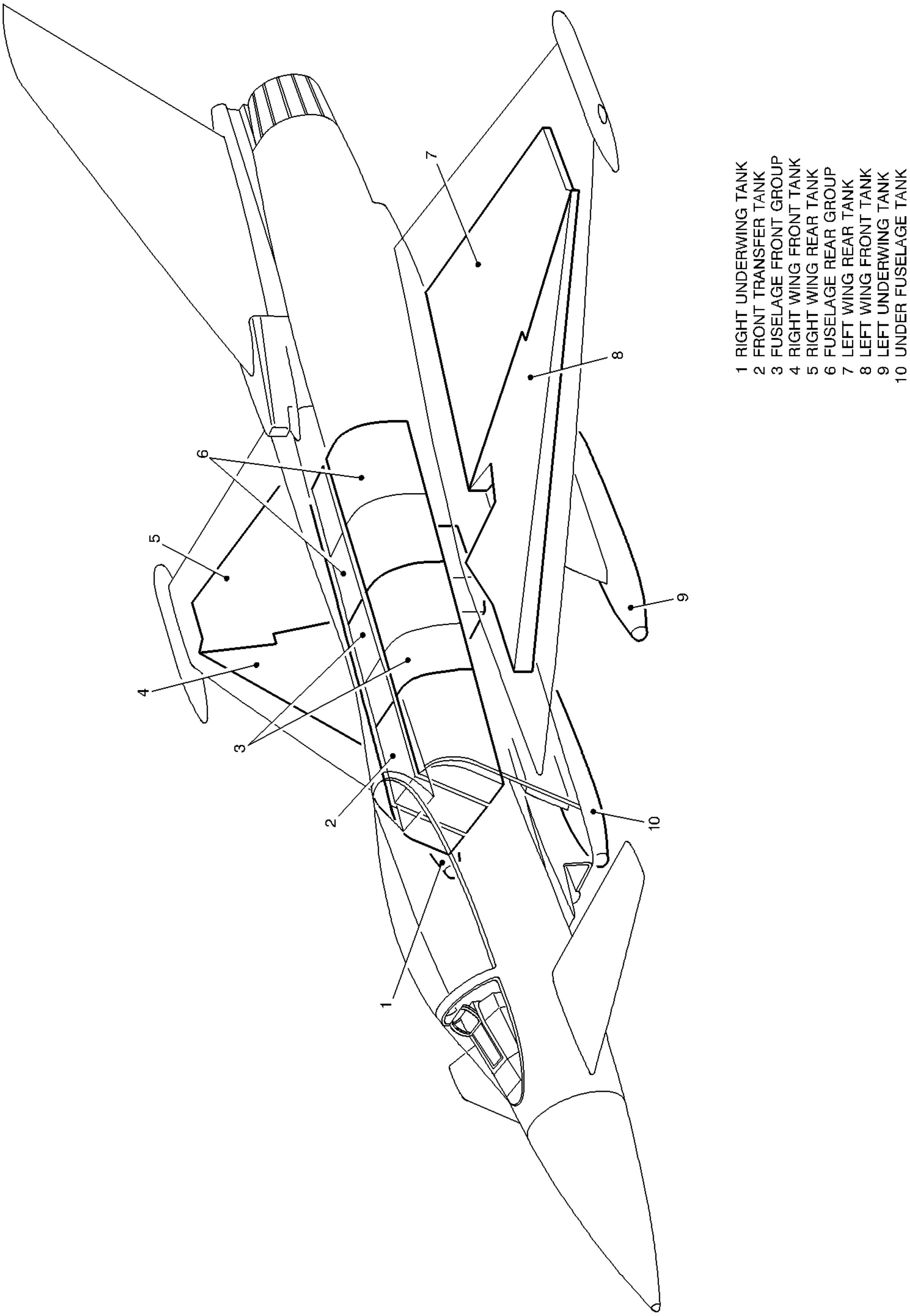


Figure 1.40 - Fuel Tank Location

FUEL TRANSFER SYSTEM

AUTOMATIC TRANSFER

Fuel transfer is fully automatic and is controlled and monitored by signals from the gaging and level sensing system and processed by fuel computers. In order to minimize CG movement during flight, transfer to the fuselage groups is sequenced as follows:

– underwing external tanks (if fitted)
– underfuselage external tank (if fitted)
– forward transfer and aft wing tanks
– forward wing tanks.

The transfer system, Figure 1.41, makes sure that fuel transfer is maintained to the collector tanks in all flight conditions except inverted flight during which the collector tank is sealed by 'flapper' valves. The transfer flow rates make sure that the main groups remain adequately supplied, but during sustained high engine demand, fuel levels in the main groups may drop as the rate of transfer is less than maximum engine demand.

Fuel flows into each fuselage group via the refuel/ defuel/transfer gallery and through the transfer valves whenever the high level sensors indicate that the fuel level in either fuselage tank group has fallen by approximately 50 kg from full and at least one engine is running. This condition is maintained until the sensor indicates that the tank group is full at which point the transfer valve will close.

NOTE

With aircraft fitted with UCS 3C1 software, the transfer isolate valve is controlled by the fuel computers such that, dependant upon the stage of fuel transfer, it can be scheduled either open or closed. At UCS 3C2 the transfer isolate valve is scheduled to open during all stages of fuel transfer.

UNDER WING AND UNDER FUSELAGE TRANSFER

UCS 3C1: Fuel from the external wing tanks, if installed, is transferred first; the left tank into the fuselage rear group and the right tank into the forward group. The corresponding external tank transfer valve is opened and fuel is transferred by air pressure controlled by the pressure/vent sub-system. The transfer isolate valve remains closed to make sure that fuel flows into the correct group. If an under fuselage tank is installed, under fuselage fuel transfer starts when either underwing tank is empty and the transfer isolate valve is opened to allow fuel to flow simultaneously into both fuselage groups.

UCS 3C2: Underwing and underfuselage fuel transfer is similar to that of UCS 3C1 with the exception that as the transfer isolate valve is scheduled to the open position during all stages of fuel transfer, fuel from each underwing tank is able to flow into both of the fuselage groups simultaneously.

NOTE

– Due to a rear group replenishment deficiency during periods of high engine demand, a change has been incorporated from UCS 3A onwards. The change enables the rear group refuel valve to be opened to supplement rear group replenishment if a rear group rundown occurs when the transfer valve is closed. During the period when the refuel valve is open a fuel XFER warning will be generated.
– During external tank fuel transfer (subject to all associated clearances) and at low engine RPM there is a possibility of fuel entering the external tanks from the refuel/ defuel/transfer gallery due to the head of fuel pressure in the forward transfer and the front wing tanks. This may be overcome by an increase in the engine RPM (>70%NL).

STAGE 1 TRANSFER

UCS 3C1: When all the external tanks are empty the transfer pumps in the forward transfer tank and the aft wing tanks are energized simultaneously to transfer fuel to the fuselage forward and rear groups respectively (Figure 1.42). When the first of these tanks is detected dry for >20 seconds, the transfer isolation valve is opened to enable the remaining Stage 1 contents to be shared between both fuselage groups. Stage 1 transfer is terminated when the forward transfer tank and either aft wing tank have been declared empty for >20 seconds at which point stage 2 transfer begins. If sustained high engine demand is maintained during stage 1 transfer, stage 2 transfer will be initiated to supplement stage 1 transfer to minimize main group depletion.

UCS 3C2: Stage 1 fuel transfer is similar to that of UCS 3C1 with the exception that the transfer isolate valve is scheduled open and therefore fuel from the forward transfer tank and the aft wing tanks is able to flow into both of the fuselage groups simultaneously.

Transition from Stage 1 to Stage 2 fuel transfer is as UCS 3C1.

STAGE 2 TRANSFER

UCS 3C1 and 3C2: During Stage 2 transfer the forward wing tank transfer pumps are energized and the transfer isolation valve is scheduled open to allow fuel to flow into both fuselage groups simultaneously (Figure 1.43). Stage 2 transfer is terminated when both forward wing tanks have been declared empty for >20 seconds.

MANUAL TRANSFER

CAUTION

WHEN THE FUEL TRANSFER SWITCH IS SELECTED TO ENABLE MANUAL TRANSFER FUNCTIONS ARE AVAILABLE FOR SELECTION. HOWEVER, UPON SELECTION OF ANY OF THE FUEL TRANSFER SK THE PILOT MUST ADHERE TO FCS FAILURE LIMITS.

Manual override of the automatic transfer system is made possible by selecting the transfer commit switch to the ENABLE position and selecting the appropriate SK on the MHDD/FUEL format. The SK selections allow the following options to be selected:

Selective Transfer: This selection causes the transfer valve not related to the selected group to shut and the transfer isolate valve to open(if closed) , resulting in all the fuel which is being transferred passing to the selected group (Figure 1.44).

Transfer Override: The override selection increments the sequenced transfer process to the next or further stage. Available options are displayed on a 'drop out' menu.

Tank Interconnect: The interconnect selection connects the front and rear collector tanks, via a motorized ball valve, to allow equalization of the fuselage groups contents.

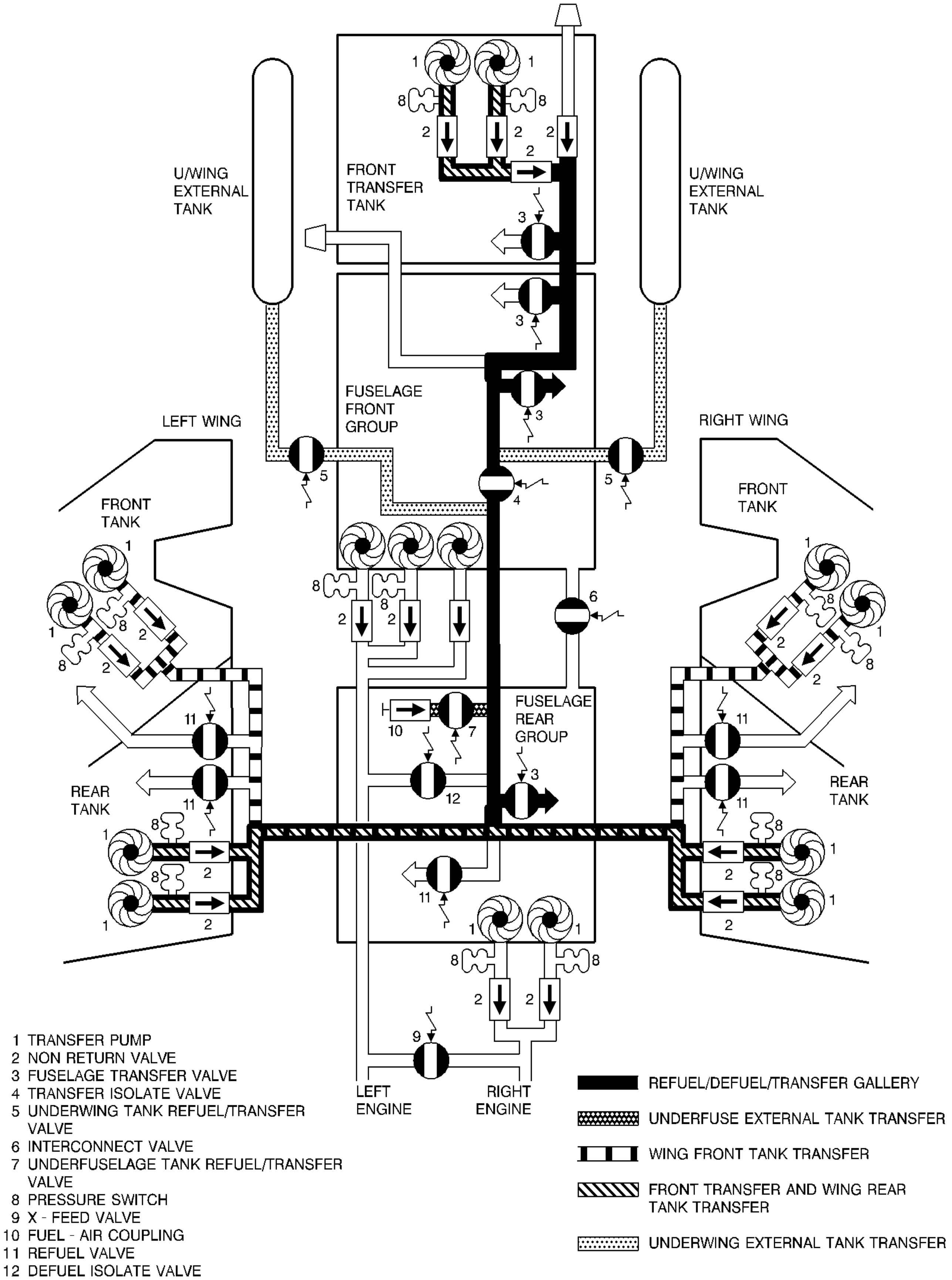


Figure 1.41 - Fuel Transfer System

Figure 1.42 - MHDD/FUEL Stage 1 Transfer (UCS 3C1)

Figure 1.43 - MHDD/FUEL Stage 2 Transfer (UCS 3C1 and 3C2)

Figure 1.44 - MHDD/FUEL Selective Transfer

FUEL PRESSURIZATION AND VENT SYSTEM

The pressurization and venting system Figure 1.45 performs the following tasks:

- Maintains all fuel tanks at a safe pressure
- External tank fuel transfer/defueling
- Vents system to ambient (during AAR/defuel)
- Assists fuel delivery to the engines.

PRESSURIZATION

Pressurized air is supplied to the system from two separate sources; ram air and bleed air. Ram air is ducted from a ram air inlet at the base of the fin leading edge to a vent package. Bleed air is supplied directly from the engines and is subjected to two stages of pressure reduction. Tappings from each stage allow the bleed air to be supplied at two separate pressures, one for general pressurization and a higher one for external tank transfer.

VENTING

During air-to-air refueling, ground refueling and defueling, all fuel tanks are automatically vented to atmosphere via a vent bypass valve. Excess pressure is vented to atmosphere through the vent package. At times other than refuel/defuel the fuel tanks are protected from over/under pressure by an inward and two outward vent valves located in the vent package. The tank venting system utilizes the pressurization system pipelines wing, fuselage and external tanks. ANFV are installed to ensure that fuel does not flow between groups during aircraft maneuvers and that any amount of spilled fuel is reduced to small quantities.

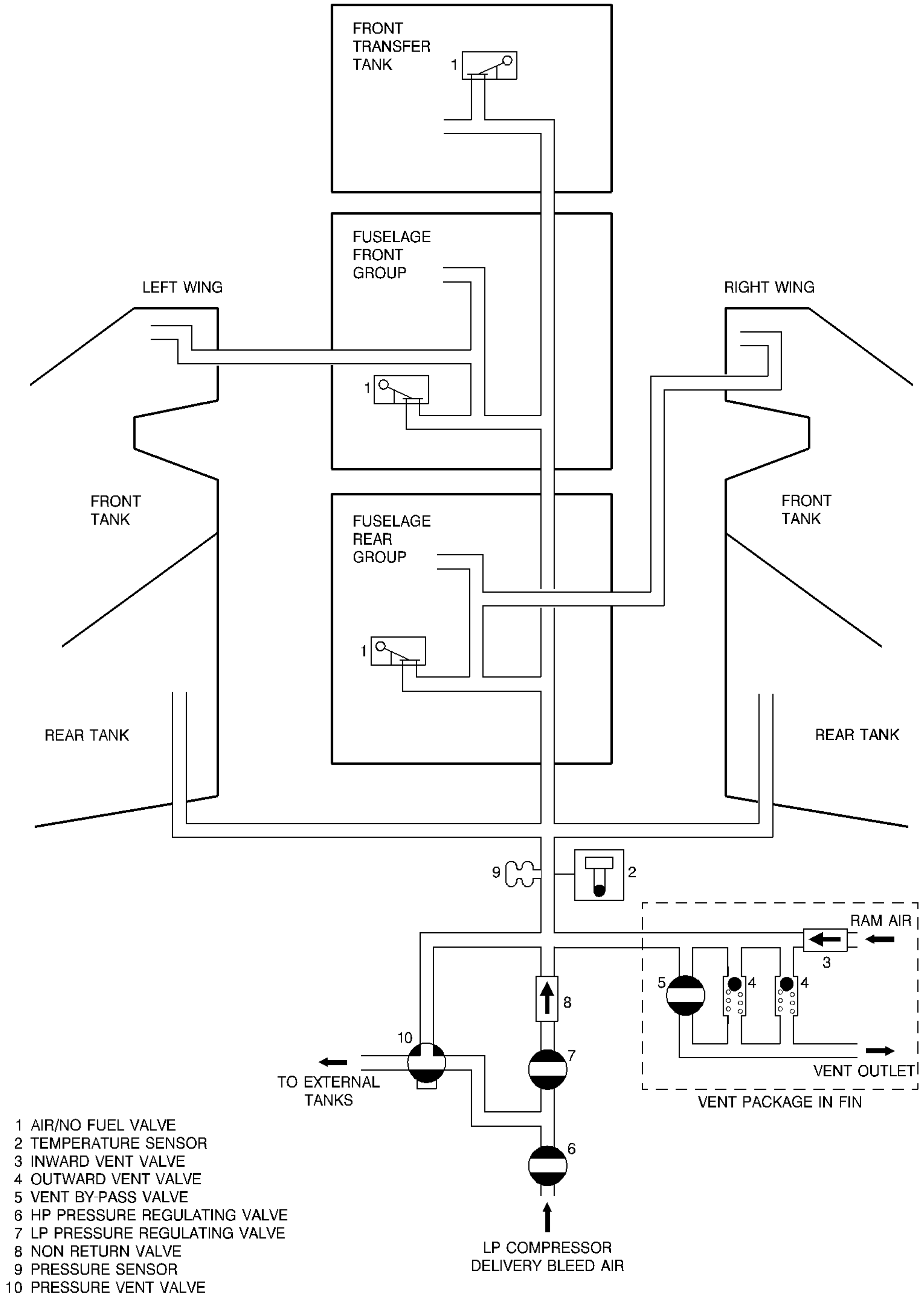


Figure 1.45 - Fuel Pressurization and Vent System

FUEL COOLING SYSTEM

The fuel/oil cooling system is designed to maintain the aircraft's hydraulic oil, AC generator and SPS gearbox lubricating oils below their maximum interface temperature, without exceeding the maximum fuel interface temperature of 95 °C at the engines.

The fuel used for cooling is tapped off the engine feed line downstream of the crossfeed valve and is recirculated through a FCOC. This consists of three heat exchangers in one unit which separately cool hydraulic, generator and gearbox oils.

The heated fuel is then cooled by passing ram air through the air cooled fuel cooler ACFC which is mounted in a duct on the underside of the aircraft. The cooled fuel returns to the collector tank through a restrictor which suppresses boiling, where it mixes with the contents under action of the boost pump impellers.

Fuel is also supplied to cool the DECU via a tapping off the engine fuel supply lines between the LP COCK and the engine.

ENGINE FUEL SUPPLY SYSTEM

The engine fuel supply system (Figure 1.46) provides each engine with its own independent fuel supply via separate engine feed lines. The left engine is supplied with fuel from the forward fuel tank groups and the right engine from the rear fuel tank groups.

Fuel is supplied to the engines under pressure developed by two AC boost pumps which are located in the collector tank of each group. The boost pumps are controlled by the L and R BOOST PUMP switches on the front cockpit right console. In the event of a single boost pump failure, which would be detected by a pressure switch located at the outlet of each pump, a failure indication would be shown on the MHDD/FUEL format. If a double pump failure occurs, a red FUEL P caption is displayed on the DWP. A non return valve, downstream of the pump, prevents fuel flow through the failed pump.

An emergency DC fuel pump is located in the forward group collector tank and supplies a limited amount of pressurized fuel to the left engine and the left fuel recirculation line automatically in the unlikely event of a total AC failure. The DC fuel pump switch is located on the right console and is set to AUTO before flight. If required, the engine supply systems can be interconnected through a crossfeed valve which is controlled by the XFEED NORM/OPEN switch on the right console. This enables a single engine to be supplied from both fuel groups or both engines to be supplied from one group.

Fuel flows to each engine through a LP cock which is controlled by the applicable LP COCK switch.
The APU is supplied with fuel from the forward group collector tank by gravity flow and is controlled by the APU SOV. The SOV is controlled by the APU control unit.

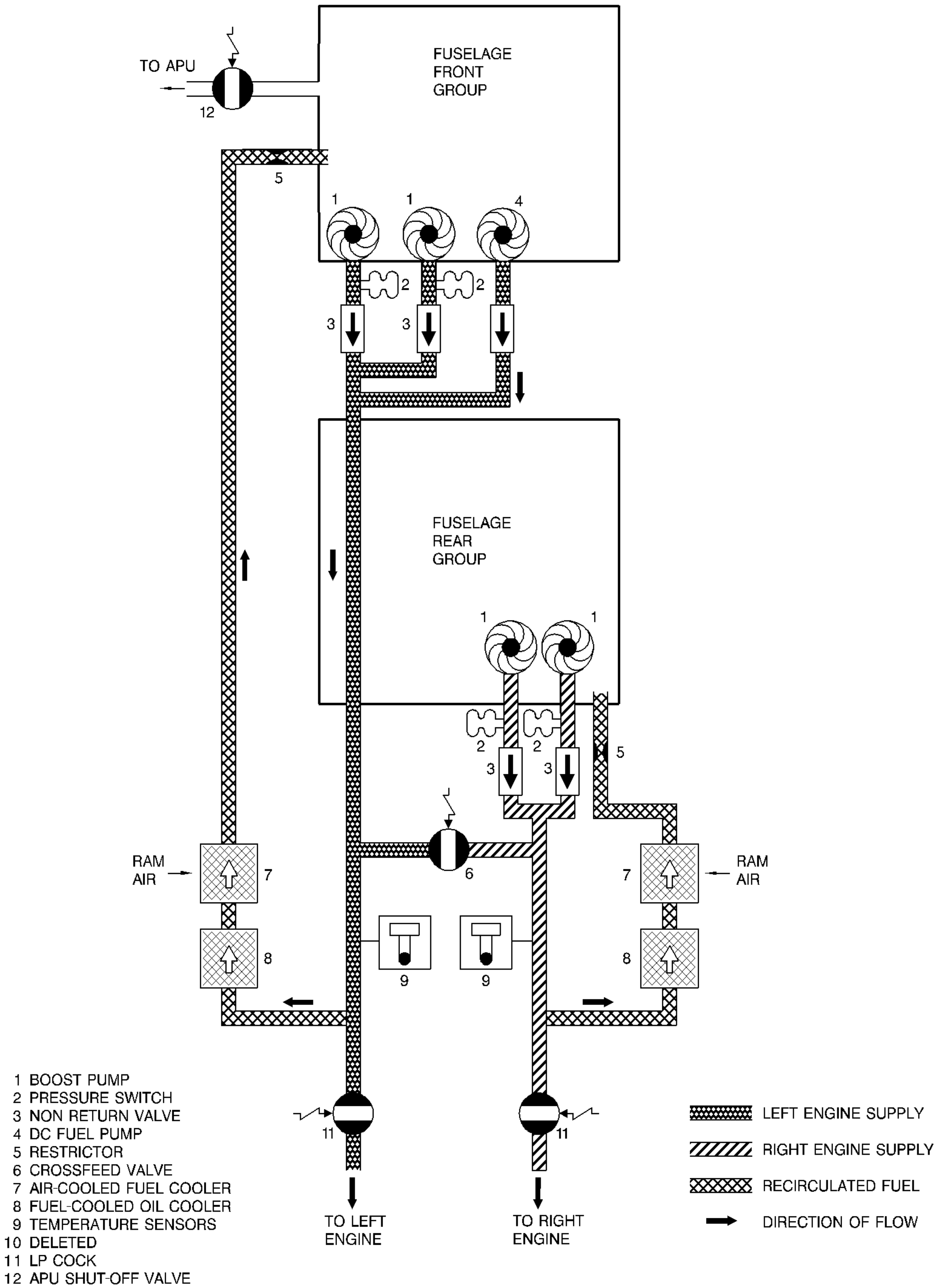
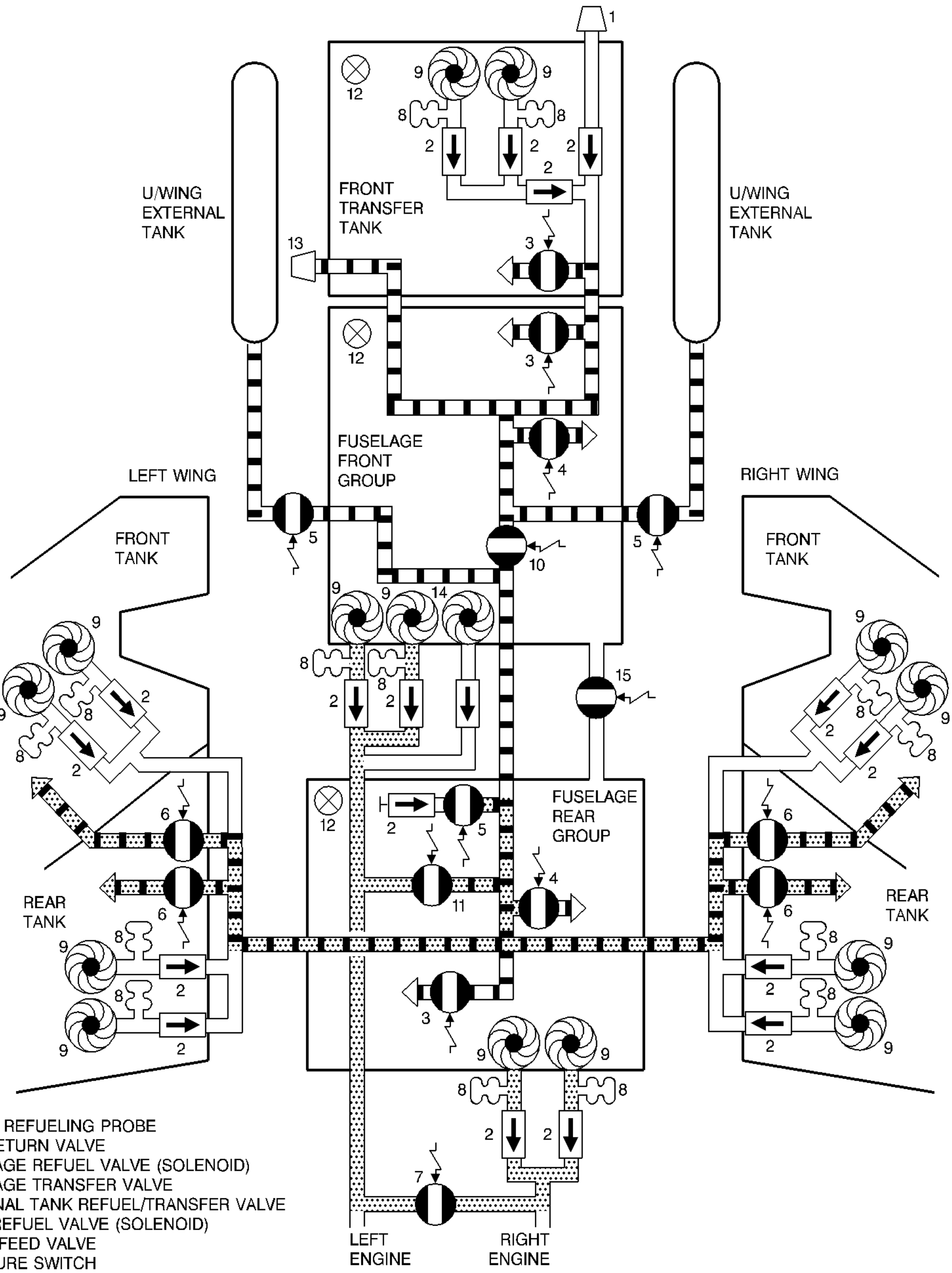


Figure 1.46 - Engine and APU Fuel Supply System

GROUND REFUELING AND DEFUELING

Pressure refueling is carried out using a single point refuel/defuel valve (Figure 1.47 and Figure 1.48) located on the left side of the center fuselage. The refueling procedure is controlled and monitored from the MDP and all selected tanks are refueled simultaneously. Fuel flow is controlled by the UCS in response to commands from the MDP. High level sensors provide fuel level data to the UCS which closes the associated refuel valve when each tank or group is full. The refueling procedure is normally terminated automatically by the UCS, but can be interrupted or terminated at any time by pressing any key on the MDP.

In the event of pressure refueling not being available, filler caps in each fuselage tank group, forward tank group and external tank enable the aircraft to be refueled by gravity. The wing tanks have no filler caps but can be refueled from the fuselage groups via the boost pumps and defuel isolate valve which allows pressurized fuel into the normal refuel gallery.



1 FLIGHT REFUELING PROBE
2 NON RETURN VALVE
3 FUSELAGE REFUEL VALVE (SOLENOID)
4 FUSELAGE TRANSFER VALVE
5 EXTERNAL TANK REFUEL/TRANSFER VALVE
6 WING REFUEL VALVE (SOLENOID)
7 CROSSFEED VALVE
8 PRESSURE SWITCH
9 BOOST PUMP
10 TRANSFER ISOLATE VALVE
11 DEFUEL ISOLATE VALVE
12 GRAVITY FILLER CAP
13 SINGLE POINT REFUEL/DEFUEL VALVE
14 DC PUMP
15 INTERCONNECT VALVE

Figure 1.47 - Refuel System

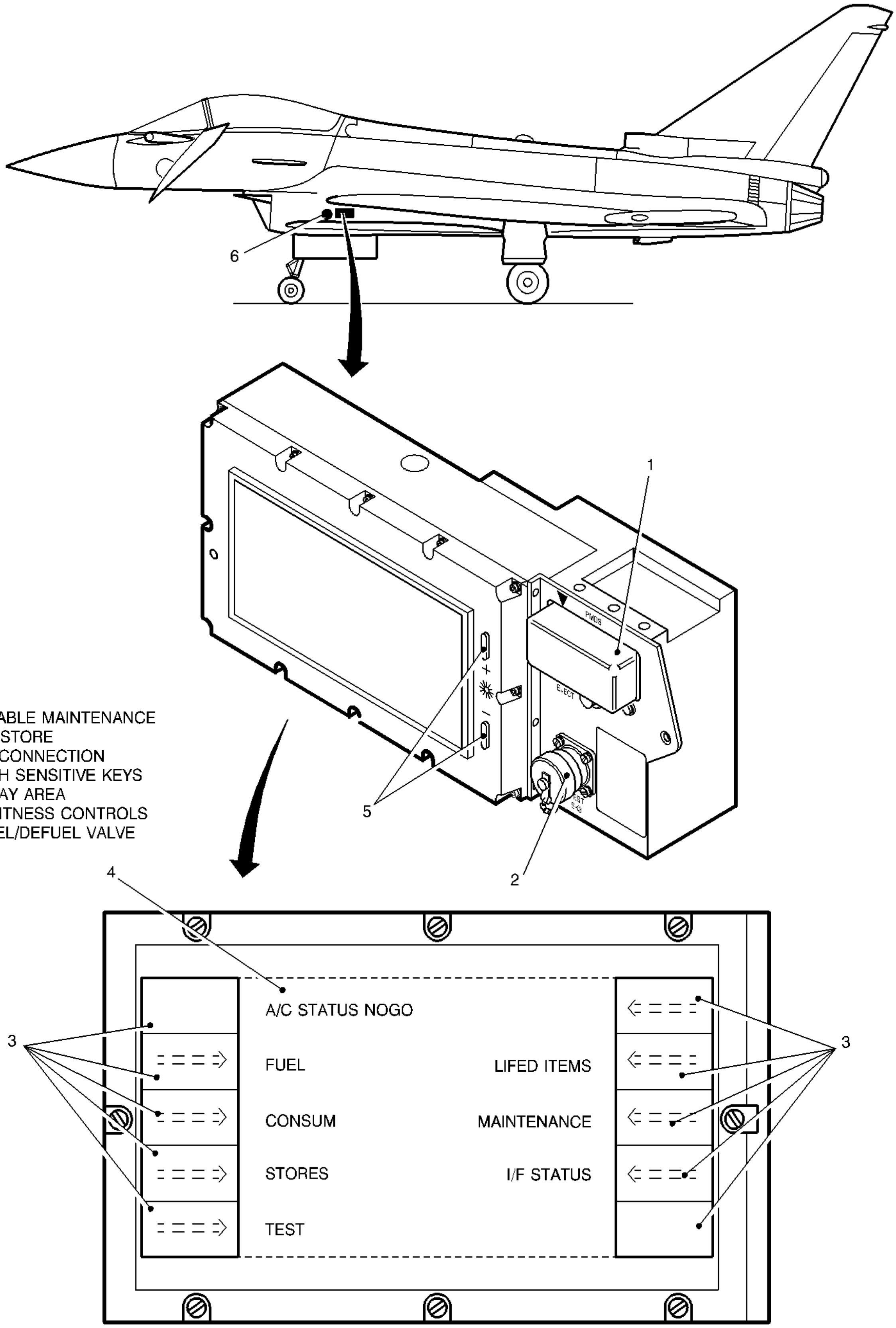


Figure 1.48 - Maintenance Data Panel

AIR-TO-AIR REFUELING

The aircraft is equipped for AAR through an extendible probe located in a compartment in the right front fuselage. The probe, when retracted, is covered by a door which, when closed, is flush with the fuselage.
The probe is extended and retracted hydraulically via the left hydraulic utility system and maintained in position by a mechanical lock. An indicator, marked PROB UNLK, and the DWP IFR caption are illuminated whenever the probe is unlocked. Normal extension time for the probe is between 5 and 20 seconds.
If a failure of the left utility hydraulic system occurs, operation of the probe is enabled by setting the FUEL PROBE switch to EMGY OUT and the probe actuator is supplied from the right hydraulic system. Following selection of the FUEL PROBE switch to EMGY OUT the probe cannot be retracted if the left hydraulic system is depressurized. Emergency fuel probe extension time is normally under 30 seconds.

AIR-TO-AIR REFUELLING CONTROL

The status of the AAR system is displayed on the MHDD/FUEL format. A SK enables one of up to three refueling options (depending on tank fit) to be selected from a 'drop out' menu. Two SK labeled REFU/STOP and REFU/STRT, enable the pilot to start, stop and restart the procedure if required. After the AAR probe has been selected out, a RDY caption will be displayed and the REFU STRT SK comes on provided the fuel system is serviceable. If the PROB UNLK indicator is off, contact can be made with the tanker aircraft drogue. Selecting the flight refueling probe out:

- Depressurizes the vent system to allow maximum fuel flow rates and lowest tank pressures in the event of a failure in the fuel system during refuel.
- Closes the fuselage transfer valves, transfer pumps stop (normal transfer inhibited).

Before and during contact with the tanker alternative refueling configurations can be selected using the REFU SK (detailed in AAR Refueling Sequence Table).

AAR Refueling Sequence

Option	Sequence
TOT	1 All internal tanks 2 Externals (when first forward wing tank is full).
INT	All internals
SIM	All internals (and externals if fitted) simultaneously

If no external tanks are installed, the first option will not be available. It is not necessary to select REFU/STRT before fuel can be taken on board. When contact is established with the drogue of the tanker aircraft, the refueling procedure is automatically started.
The procedure will normally stop when the high level sensors in the selected tanks sense full, indicated by the COMP caption on the MHDD/FUEL format, or if contact with the tanker aircraft is broken. The refueling procedure can be interrupted at any time by pressing the REFU/STOP SK and restarted by pressing the REFU/STRT SK.

FUEL SYSTEM CONTROLS AND INDICATORS

DEDICATED CONTROLS

The dedicated controls and indicators (see Figure 1.49) are as follows:

LOW PRESSURE COCK SWITCHES

Coverguarded two-position bi-stable toggle switches enable the left and right LP COCKs to be opened and shut. Selection of the controls between their OPEN and SHUT states will also enable and disable the igniter circuit of their associated engine. Inadvertent closure of the LP COCKs is prevented by coverguards which must be raised before the switch can selected to the SHUT position.

BOOST PUMP SWITCHES

Two position, bi-stable toggle switches which enable the boost pumps to be switched on and off. Inadvertent selection of OFF is prevented by locking the switch in the forward position such that the switch top must be lifted prior to selection aft.

DC FUEL PUMP SWITCH

A two-position, bi-stable toggle switch which enables the DC fuel pump to operate automatically under conditions of total AC power failure, or to be switched off. The switch is locked in both positions such that the switch top must be lifted before the switch setting can be changed.

CROSSFEED SWITCH

A two-position, bi-stable toggle switch which is used to open and close the fuel crossfeed valve. Inadvertent selection is prevented by locking the switch in both positions such that the switch top must be lifted before the switch setting can be changed.

REFUELLING PROBE SWITCH

A three position, tri-stable toggle switch which is locked in all three positions is used to extend and retract the refueling probe. The switch enables normal extension and retraction and an emergency extension option. Normal extension is achieved by setting the switch to the OUT position which requires the switch top to be lifted. An additional lift is required to select the EMGY OUT setting.

REFUELLING PROBE UNLOCKED INDICATORS

Indicators marked PROB UNLK, located under the right MHDD in both cockpits, illuminates when the refueling probe is travelling.

FUEL TRANSFER COMMIT SWITCH (DA7 ONLY)

A three position, tri-stable toggle switch which locks in all three positions to prevent inadvertent selection. This control enables one of three fuel transfer options to be selected - NORM, ENABLE and STOP/ RESET. The switch top must be lifted before the setting can be changed. The NORM setting enables the fuel transfer stages to be sequenced automatically. The ENABLE setting differs from the NORM setting as it allows the automatic sequence to be overridden by selection of manual fuel transfer soft keys on the MHDD/FUEL format. Upon reselection of NORM the automatic transfer sequence will resume at the earliest possible stage. The STOP/RESET setting suspends all fuel transfer, however on reselection of NORM fuel transfer will resume at the earliest available stage in the automatic transfer sequence.

FUEL TRANSFER COMMIT SWITCH (DA5 ONLY)

A two position, bi-stable toggle switch which locks in both positions to prevent inadvertent selection. This control enables one of two fuel transfer options to be selected - INHIBIT and ENABLE. The switch top must be lifted before the setting can be changed. The INHIBIT setting allows the fuel transfer stages to be sequenced automatically. The ENABLE setting differs from the INHIBIT setting as it allows the automatic sequence to be overridden by selection of manual fuel transfer soft keys on the MHDD/FUEL format. Upon reselection of INHIBIT the automatic transfer sequence will resume at the earliest possible stage.

REVERSIONARY/GUH DISPLAYS

Three, 4-digit indicators, labeled FWD, REAR and TOTAL on the front and rear HUP provide a reversionary display of the forward and rear fuselage fuel groups and total fuel contents of the aircraft in kg.

MHDD FORMATS

MHDD/FUEL FORMAT

The status of the complete fuel system is displayed on the MHDD fuel format which can be selected for display on any MHDD by pressing the FUEL SK. The display soft keys (Figure 1.50 and Table) also enable:

- Control of the AAR sequence
- Manual transfer options to be selected.

When the format is displayed, the FUEL caption is highlighted and the captions on the remaining SK are illuminated. The MHDD/FUEL format provides information on fuel tank contents, fuel transfer, fuel pumps and AAR. A digital readout of the mass of fuel in each tank (in kg) along with the total fuel contents of the aircraft is presented on the MHDD/FUEL format. Fuel in the tanks is also displayed pictorially using colored infill which alter in proportion to the quantity of fuel in the tank. Fuel system warning captions are available and, if displayed, are accompanied by flashing attention getters and voice warning messages.

MHDD/AUTOCUE FORMAT

Fuel system related MHDD/ACUE prompts and their meaning are presented in Table.

MHDD/ACUE Fuel System Related Prompts and Meanings

PROMPT	MEANING
RIGHT LP COCK	Appropriate LP Cock switch is in the SHUT position. Prompt occults when LP Cock switch is set to OPEN.
LEFT LP COCK	
XFEED	XFEED control is in the OPEN position. Prompt occults when XFEED control set to NORM.
FUEL PROBE	AAR probe switch is in the OUT or EMGY OUT position. Prompt occults when the AAR switch is selected to IN
RIGHT BOOST PUMP	Appropriate Boost Pump switch is set to OFF. Prompt occults when appropriate control is set to the BOOST PUMP position.
LEFT BOOST PUMP	

HEAD UP DISPLAY SYMBOLOGY

Indication that a manual transfer option is currently in use is indicated by the text string "FUEL XFER".

NOTE

The text string "FUEL XFER" is also presented on the selected group C MHDD format when a manual transfer option is in operation.

MANUAL DATA ENTRY

The Miscellaneous (MISC) subsystem of the MDE facility allows four fuel 'Bingo' levels to be defined which, when attained, generate one of four pre-defined CAT 4 warning messages. For information of MDE operation refer to Miscellaneous MDE and X-Y Functions pag. 329.

DEDICATED WARNINGS

Warnings associated with the fuel system are presented on the DWP see Table:

Warnings

DWP	VOICE	MEANING
L FUEL P	LEFT FUEL PRESSURE	Left feedline low fuel pressure
R FUEL P	RIGHT FUEL PRESSURE	Right feedline low fuel pressure
FUEL	FUEL LOW	One or both main groups < 375 kg
FUEL VLV	FUEL VALVE	Air-to-air refueling failure
L FUEL T*	LEFT FUEL TEMP	Left fuel overtemperature
R FUEL T*	RIGHT FUEL TEMP	Right fuel overtemperature
L FUEL C	LEFT FUEL COMPUTER	Left fuel computer failure
R FUEL C	RIGHT FUEL COMPUTER	Right fuel computer failure
IFR	IFR PROBE	Refueling probe lock failure
VENT	FUEL VENT	Vent pressure/temperature warning
XFER	FUEL TRANSFER	Fuel transfer failure
*Two triggers are provided from the fuel system. A CAT 3 warning is generated by the lower temp trigger (86°C); a CAT 2 warning is generated by the higher temp trigger (93°C).		

(Continued)

Warnings **(Continued)**

NO CAPTION - VOICE ONLY		
CAT4	WING TANK EMPTY	Wing tank empty
CAT4	CENTER TANK EMPTY	Under fuselage tank empty
CAT4	BINGO 1	Bingo fuel state 1 remaining
CAT4	BINGO 2	Bingo fuel state 2 remaining
CAT4	BINGO 3	Bingo fuel state 3 remaining
CAT4	BINGO 4	Bingo fuel state 4 remaining

MHDD/FUEL Format Display Symbology

Refer to Figure 1.50 Item No.	Description
1	Air-to-Air refuelling status - RDY (ready) or COMP (complete).
2	Air-to-Air refuelling probe symbol (shown when probe is deployed).
3	Forward tank group showing low fuel warning (<375 kg) (white figures on amber background) and boost pumps failed (red infill).
4	Refuel/transfer lines (shows tanks currently transferring or those tanks being refuelled).
5	Underfuselage external tank.
6	Aft wing tank and transfer pumps (white infill if pumps are running).
7	Rear fuselage tank group and boost pumps (white infill if pumps running).
8	CG warning - longitudinal fuel imbalance (shows rear heavy) (white text on red background).
9	Fuel low pressure warning (white text on amber background).
10	Low pressure fuel cock (shown open). Amber infill and horizontal bar indicate commanded shut state. Red infill indicates valve failure.
11	Fuel crossfeed valve (shown open). Symbology removed when crossfeed valve is shut.
12	Digital readout indicating actual fuel temp from -40°C to +125°C. An amber infill corresponds to the CAT 3 warning (fuel temp ≥86°C); a red infill corresponds to a CAT 2 warning (fuel temp ≥93°C).
13	Engine feed line (low pressure shown by amber dashes).
14	Underwing external tank (occults when tank not fitted).
15	Forward wing tank and transfer pumps.
16	Selector prompt (shows selection recommended to restore fuel balance).
17	Selective transfer indicator (currently showing XFER REAR selected - all transferable fuel transferred to rear group).
18	Spine tank and transfer pumps.
19	Total fuel contents readout.

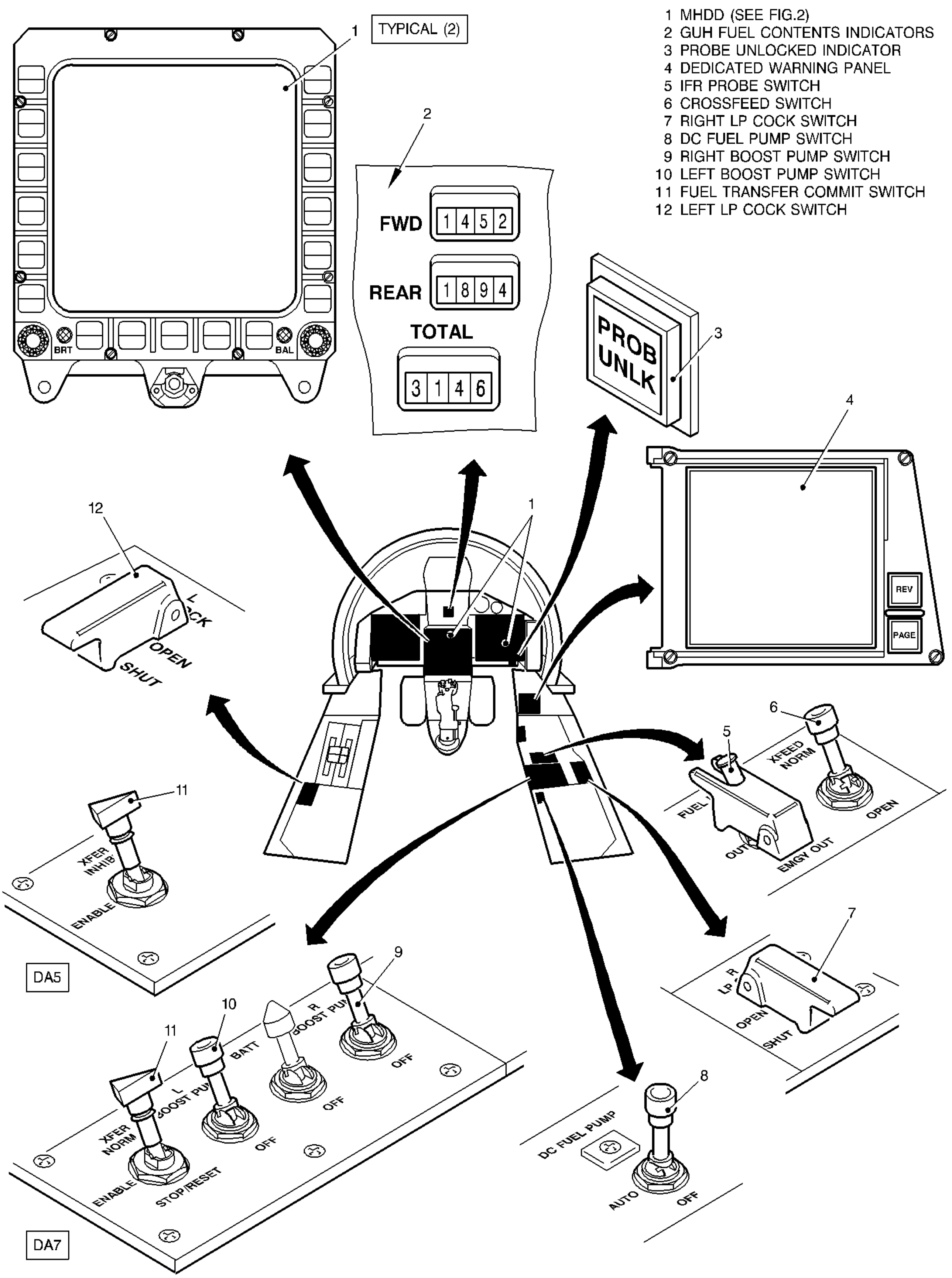


Figure 1.49 - Fuel System Controls and Indicators

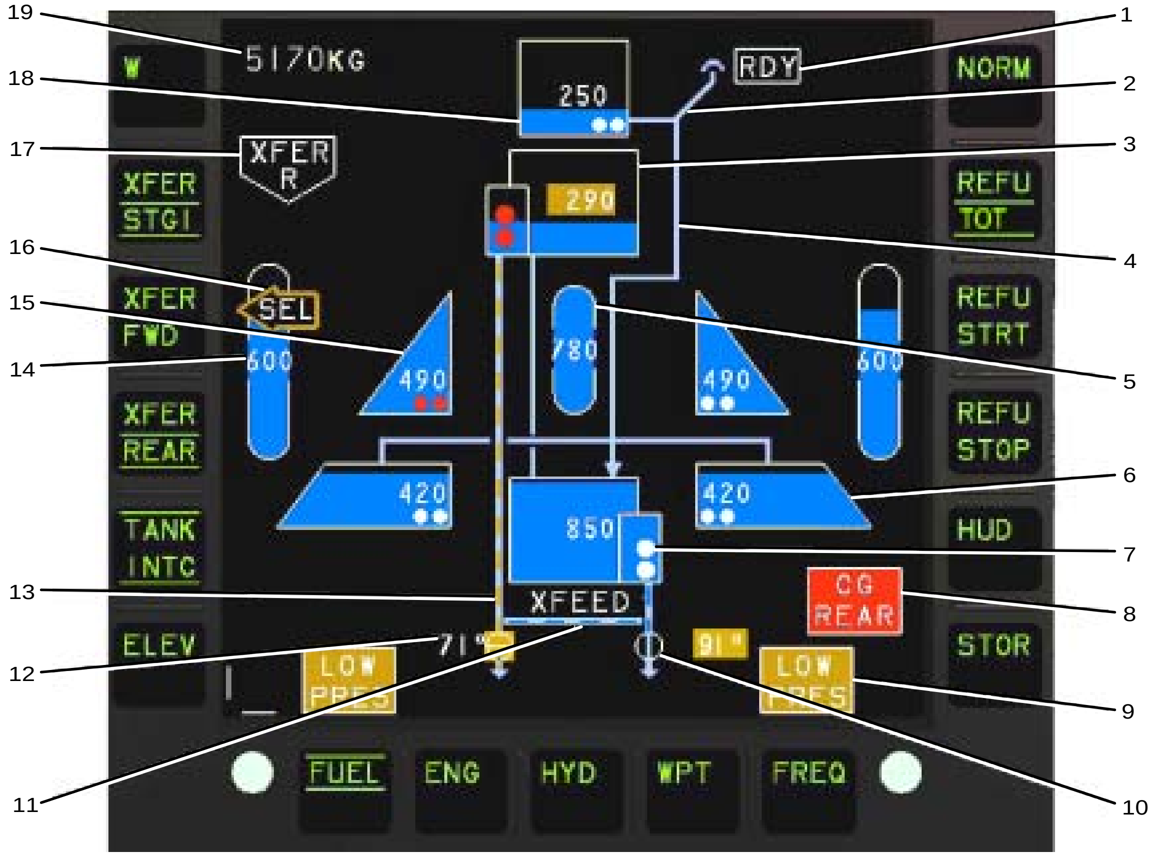


Figure 1.50 - MHDD Fuel Format Displays and Controls

FUEL MASSES

Fuel Tank Contents

TANK GROUP	GROUP TOTAL (USABLE) (KG)
Fuselage forward	950
Fuselage rear	890
Forward transfer	950
Wing forward	494 (x 2)
Wing rear	494 (x 2)
Underwing (1000 l x 2)	1560
Underfuselage (1000 l)	780
TOTALS:	
Internal fuel only	4756
Internal + 2 external (1000 l)	6316
Internal + 3 external (1000 l)	7096

NOTE

Usable fuel capacities are calculated at a specific gravity of 0.78.

ELECTRICAL POWER SUPPLY SYSTEM

ELECTRICAL POWER SYSTEM

The Electrical Power Generating System (EPGS) Figure 1.51 provides a 115/200 Vrms, 400 Hz, 3-phase, 4-wire AC supply and a 28 V DC supply to meet the demand of the aircraft.

The system has been designed to minimize the risk of total power loss by using a high level of redundancy and system partitioning.

Electrical power is distributed automatically under the control of the Electrical Management System (EMS), via busbars, bus tie contactors (BTC) and generator contactors (GC).

Two 30/45 kVA AC integrated drive generators (IDG), mounted on and driven by their respective accessory gearbox, provide the AC power supply for the EPGS. AC power is distributed to the relevant aircraft systems via two normally independent AC busbars. The AC busbars are also connected to TRU, which provide a 28V DC output to supply the essential and non-essential DC busbars. A single IDG is able to supply both the AC and DC systems in the event of a single IDG failure; the normally independent busbars linked by a BTC under control of the EMS.

Two gearbox driven 26V DC generators provide a reversionary power supply to the DC system in the event of failures arising in the main electrical generating system, thereby safeguarding the aircraft systems integrity.

A nominal 22.8V, 25 Ah Nickel Cadmium battery provides a supply for an APU start, essential loads under emergency conditions and power for limited ground servicing.

An APU generator, mounted on and driven by the APU, provides limited electrical power for ground operations.

External AC and DC power receptacles allow ground power unit supplies to be connected to the aircraft for ground operations.

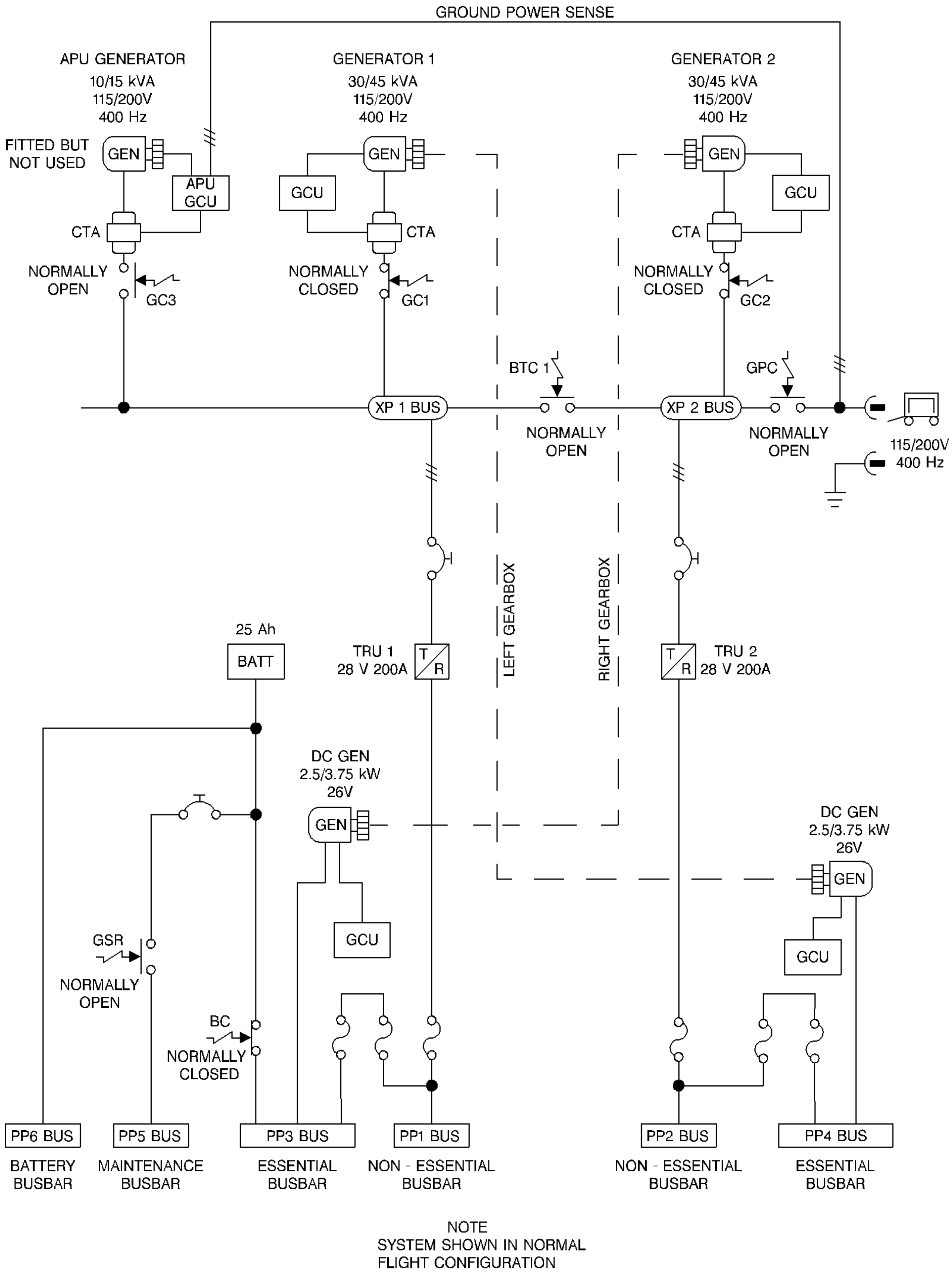


Figure 1.51 - Electrical Power System

ELECTRICAL SYSTEM CONTROLS AND INDICATORS

DEDICATED CONTROLS

BATTERY MASTER SWITCH

A toggle switch, labeled BATT/OFF Figure 1.52 , located on the right console, enables all systems connected to the aircraft left DC channel to be supplied with a nominal 22.8V DC power supply from the battery, provided there is no output from the TRU or DC generators.

GENERATOR CONTROL SWITCHES

Two, 2-position toggle switches, labeled GEN L/R - ON-OFF/RESET Figure 1.52 , located on the right console, manually control the connection/ disconnection of the integrated drive generator (IDG) to the electrical power system. If a generator goes off line selection to the OFF/RESET position, followed by an ON selection will reconnect the IDG if it is serviceable.

MHDD/AUTOCUE FORMAT

During ground procedures, if the battery master switch is selected OFF, the MHDD/ACUE format will prompt the pilot to select the battery master switch to the BATT position. The prompt consists of the text string “BATTERY MASTER”. The prompt will occult when the battery master switch is selected to the BATT position.

DEDICATED WARNINGS

Information on electrical system failures is displayed on the dedicated warnings panel (DWP) and the discrete audio warnings generation panel (DAWG), Figure 1.52. If a failure occurs such that it causes the warnings system to enter its reversionary mode of operation, a number of dedicated hardwired GUH electrical warnings remain supported. The following captions and associated voice warnings are presented to the pilot:

Warnings

DWP	VOICE	MEANING
ESS DC	ESSENTIAL DC	Total DC generation failure (GUH)
AC	DOUBLE AC	Double AC failure (GUH)
ELEC 2	DAWG ‘red’ tone	Electrical level 2 failure (loss of power to busbars)
DTRU	DAWG ‘amber’ tone	Double TRU failure
ELEC 1	DAWG ‘amber’ tone	Electrical level 1 failure (loss of redundancy)
L GEN	DAWG ‘amber’ tone	Left IDG fail
R GEN	DAWG ‘amber’ tone	Right IDG fail

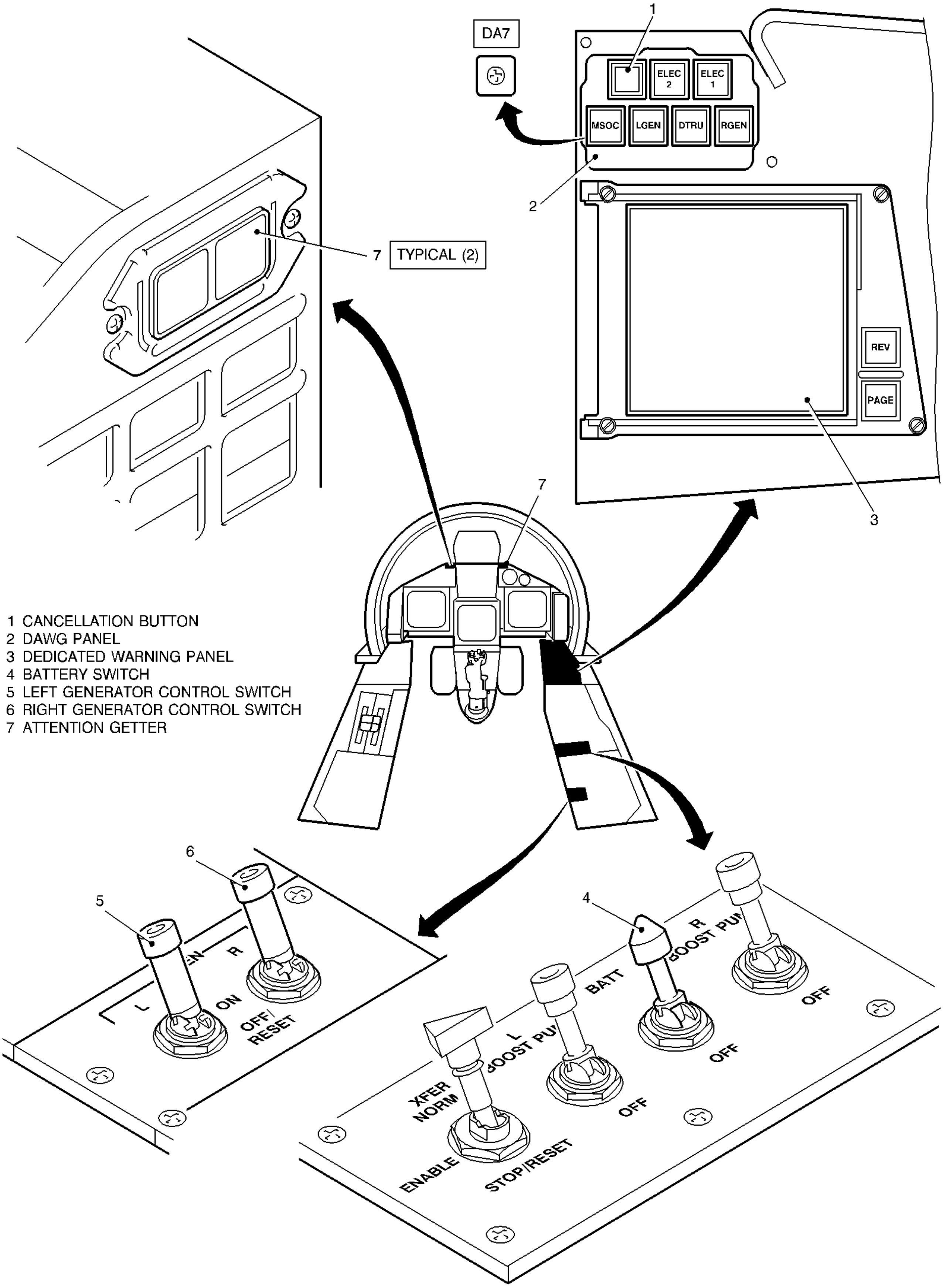


Figure 1.52 - Electrical System Controls and Indicators

AC POWER SUPPLY AND DISTRIBUTION

After initial switch setting during pre-flight checks operation of the AC system is controlled autonomously through the generator control units (GCU). Pilot intervention is only required in the event of certain aircraft malfunctions (see Section 3, Electrical System Failures).

NORMAL OPERATION

The AC busbars are supplied by two channels normally operating in parallel. In normal operation the No. 1 (left) integrated drive generator (IDG) is connected to AC busbar XP1 and the No 2 (right) IDG is connected to AC busbar XP2. The generated power is supplied to busbars, via the generator contactor (GC). The busbars of the AC channels, which under normal operating conditions are electrically isolated from each other, enable the AC power to be distributed to the aircraft's electrical equipment/systems. In the event of the loss of one engine, both IDG can be maintained 'on-line' using an airdrive system which drives the dead gearbox via an air turbine motor using bleed air from the live engine. While the aircraft is on the ground APU bleed air may be used to drive the accessory gearboxes and therefore the IDG.

Each IDG is controlled and monitored by a separate GCU. The GCU associated with each IDG provide regulation, generator contact control and protection against undervoltage/overvoltage, under/over frequency and over current/differential current for the AC and DC channels. A current transformer assembly (CTA) enables the GCU to provide overcurrent and differential current sensing. The IDG is equipped with an integrated drive arrangement which ensures that the output is of constant voltage and constant frequency for variable gearbox speeds. The IDG are fitted with a driveshaft incorporating a shear neck which protects the gearbox in the event of IDG mechanical failure. They are lubricated and cooled by oil which passes through a fuel cooled oil cooler in order to maintain normal operating temperatures.

NOTE

The APU generator is installed but is not electrically connected at this standard.

An APU mounted generator is provided to supply AC power for ground operations. Electrical power becomes available as soon as the APU achieves steady state running, provided an externally mounted 3-position toggle switch, located adjacent to the aircraft battery, is enabled. The power rating of the APU generator is:

- 10 kVA continuous load
- 15 kVA for 2 hours
- 20 kVA for 5 seconds.

The output of the APU generator is connected to XP1 via GC3, under control of the APU GCU, and to XP2 via a bus tie contactor (BTC 1) under control of the ESM.

An external 3 phase AC power supply can be connected to the aircraft for use during ground servicing and preparation for flight. Power from this source is connected to XP2 via the GPC, under control of the APU GCU, and to XP1 via BTC 1, controlled via the ESM.

A summary of user equipment bus bar allocation/ circuit breaker rating and numbering is contained in the following reports:

- BAe-WPM-R-EFA-PWR-00448, EF2000 Circuit Breaker Listing DA1
- BAe-WPM-R-EFA-PWR-00448, EF2000 Circuit Breaker Listing DA2
- BAe-WPM-R-EFA-PWR-00653, EF2000 Circuit Breaker Listing DA5
- BAe-WPM-R-EFA-PWR-00654, EF2000 Circuit Breaker Listing DA7.

ABNORMAL OPERATION

In the event of a single IDG failure in flight busbars XP1 and XP2 may be interconnected through BTC 1, under command of the IDG GCU. If, however, the IDG fails due to an earth fault, a ‘lockout’ circuit prevents BTC 1 from closing, thereby isolating the unserviceable busbar.

DC POWER SUPPLY AND DISTRIBUTION

After initial switch setting during pre-flight checks operation of the EPGS is controlled autonomously through the GCU. Pilot intervention is only required in the event of certain aircraft malfunctions (see Section 3, Electrical System Failures).

NORMAL OPERATION

The 28V DC power supply is derived from AC busbars XP1 and XP2 through TRU1 and TRU2 respectively. TRU1 supplies non-essential bus bar PP1 directly and essential busbar PP3 indirectly via BTC 4. TRU2 supplies non-essential bus bar PP2 directly and essential busbar PP4 indirectly via BTC 2. A 25 Ah battery provides emergency power for use in the air (engine relight) and power for limited ground use and APU starting. The aircraft battery is connected directly to:

- PP3 via the Battery Contactor (BC) controlled by the battery master switch.
- Maintenance busbar (PP5) via the Ground Service Relay (GSR) which is controlled by the MDP switch and enabling refuelling and limited ground testing.
- Battery busbar (PP6). During normal operation the battery is charged from TRU1 via essential busbar PP3.

A summary of user equipment bus bar allocation/ circuit breaker rating and numbering is contained in the following reports:

- BAe-WPM-R-EFA-PWR-00653, EF2000 Circuit Breaker Listing DA5
- BAe-WPM-R-EFA-PWR-00654, EF2000 Circuit Breaker Listing DA7.

ABNORMAL OPERATION

The requirement calls for the contactors of the DC system (BTC 2, 3 and 4) to be opened or closed under command of the GCU to maintain supplies to DC busbars during minor fault conditions or to protect essential busbar(s) in more serious failure cases. At this standard, however, the DC system is only protected by fuses which isolate parts of the DC system in the event of a busbar short circuit to earth.

NOTE

> The left gearbox driven DC generator is connected to the right DC channel. Similarly the right gearbox driven DC generator is connected to the left DC channel. In the event of a total failure of the DC generating system, the battery is able to supply emergency DC power via busbar PP3 for approximately 7 minutes.

In the event of failures arising in the main electrical generating system resulting in the voltage at the point of regulation falling below 26V DC, two DC generators, each located on and driven by their respective gearboxes, ensure that 26V DC is present at their associated essential busbar immediately. This ensures that there is no interruption of the supply to the essential busbars and associated systems thereby safeguarding the aircraft systems integrity.

HYDRAULIC POWER SUPPLY SYSTEM

Two separate hydraulics systems (Figure 1.53) are supplied from two independently driven hydraulic pumps each mounted on an engine driven, aircraft mounted, accessory gearbox. Each system is supplied with hydraulic fluid from a separate reservoir. The accessory gearboxes are either driven by the relevant air turbine starter motor (ATS/M) fitted on the gearbox, or directly by the respective engine via a PTO-shaft. ATS/M operation is achieved either by the APU, a pneumatic ground cart or the a/c engines in case of cross bleed.

Each hydraulic system is divided into a Flight Control Pressure circuit and a Utility Pressure circuit. The control systems are individually protected by isolation valves which will automatically close in the event of an external leakage, when the reservoir fluid level drops below 3.5 ltr.

The hydraulic systems provide power to the primary and secondary flight control actuators and to the utility subsystems.

LEFT/RIGHT SPS COMPUTER

The SPS computers form a component part of the utilities control system (UCS) and provide an interface with the UCS data bus and the hydraulics system. Two identical and interchangeable SPS computers are installed for performing control, monitoring and test functions of the hydraulics system and other associated sub-systems. The SPS computers incorporate Built-In Test (IBIT and CBIT) facilities for preflight checkout, first line diagnostic check and inflight monitoring. Status and monitoring data are transmitted via the UCS data bus to the MHDDs, the DWP, the MDP and to the Integrated Monitoring and Recording System (IMRS).

Electrical power to the two SPS computers is supplied by the left and right essential bus bars PP3 and PP4. For ground maintenance functions, alternative supply directly from the battery supported maintenance bus is available.

HYDRAULIC SYSTEM - SPS CONTROL

The SPS computers control and monitor the complete hydraulic power generation system and provide all necessary discrete analogue and data bus signals for control, monitoring and display. Inputs to the SPS computers interface with active transducers which provide information on hydraulic system pressure, - fluid level, - temperature, - differential pressure, - flow and gearbox speed. Electrical elements of the control circiuts, e.g. switches, relay and valves are monitored for correct operation. Outputs provide discrete signals to the control elements (utilities isolation valves, hydraulic depressurization valves). Information is sent on the data bus to the cockpit displays (MHDDs, DWP) and to the MDP for recording of maintenance data and indicating status of the hydraulic system.

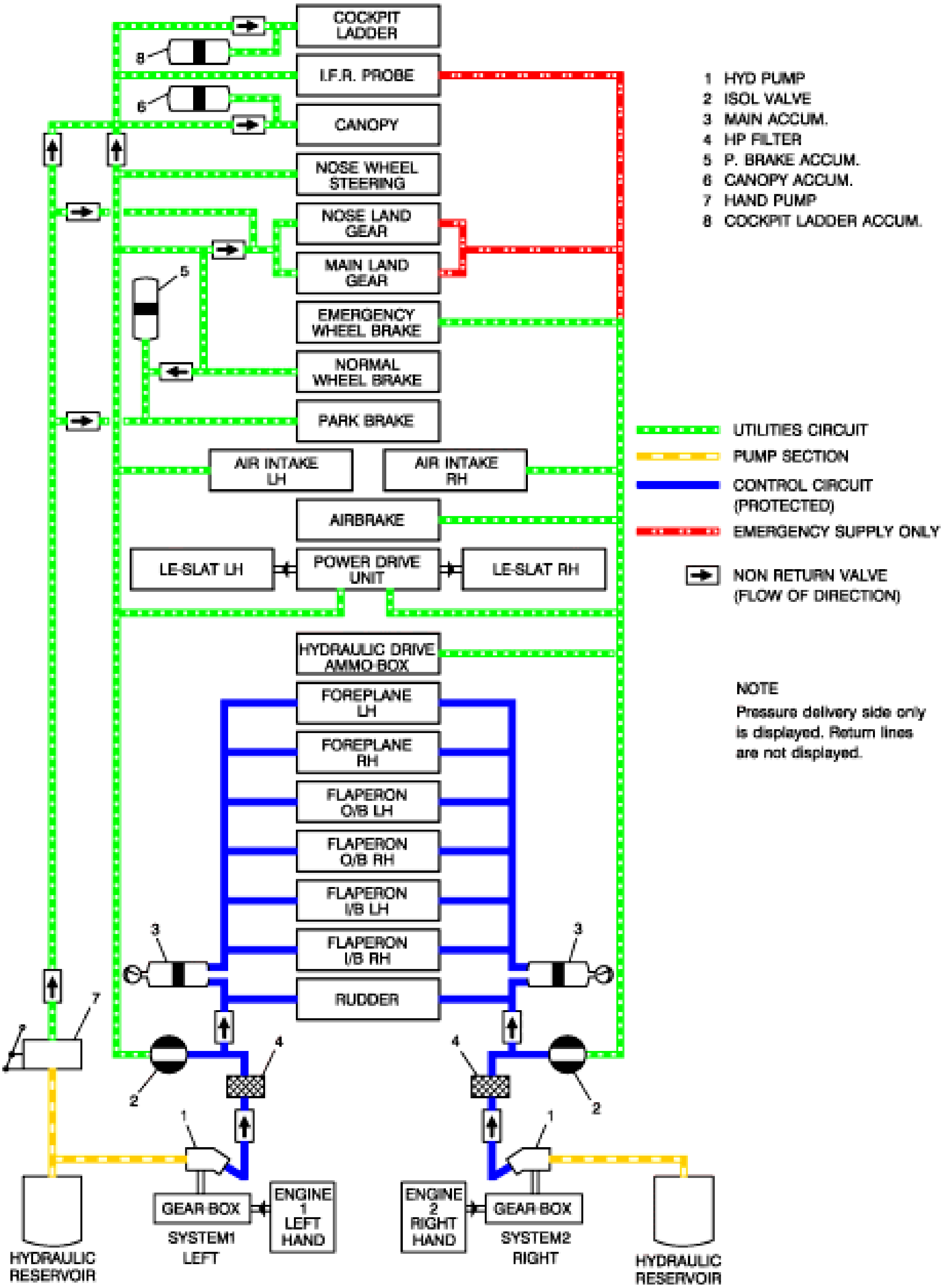


Figure 1.53 - Schematic of the Hydraulic System

HYDRAULIC SYSTEM - MAIN COMPONENTS

The hydraulic system provides power to the primary and secondary flight control actuators and to the utility subsystems. Included are the following main components:

HYDRAULIC FLUID RESERVOIRS

Two reservoirs, one for each system, are located in the rear fuselage. Each reservoir has a maximum hydraulic fluid capacity of 14 litres in the low pressure area and is pressurized to approx. 280 bar (28 000 KPa) at the high pressure port. Each reservoir incorporates a fluid level transducer, a medium level switch (for CFW), a low level switch (for utility isolation interlock override), an overboard pressure relief valve, a manual and an automatic bleed valve.

HYDRAULIC PUMPS

Each constant pressure variable delivery pump incorporates a solenoid operated depressurizing valve which is automatically controlled by the SPS computers to reduce gearbox drag torque during engine start. During engine start cycle the hydraulic pump is automatically depressurized (90 bar). When the valve is deenergized the system pressure is maintained at approx. 280 +/-3.5 bar at zero flow and 260 bar min. at max flow. For maintenance purpose the valve can be operated via SKs on the MDP.

NOTE

> Hardwired, dedicated interlocks associated with hydraulic pump depressurization function allow only one hydraulic pump to be depressurized at any one time.

HYDRAULIC ACCUMULATORS

The main accumulator in each control system smooths out pressure surges from the pump and produces the flow response necessary for satisfactory operation of the flight controls. These accumulators also supplement pump flow during extreme demands. They also provide hydraulic power for a limited control capability to assist safe pilot ejection following a double hydraulic power generation failure (Catastrophic warning). The available time span for safe pilot ejection depends on FCS flow demand.

The left system comprises also a canopy accumulator, a parking brake accumulator and a cockpit ladder accumulator for on ground operation of the canopy, the parking brake and the mechanical locking and unlocking of the ladder after engines shut down. The accumulators are charged with helium respectively. Information on gas pressure in the canopy respectively main hydraulic system accumulator is indicated on the MDP.

ISOLATING VALVES

NOTE

> The L/R <UTIL P> warning is displayed when the UTIL pressure falls below 140 bar.

The electrically operated UTIL ISOL valves are automatically controlled to the closed position by reservoir level (< 3,5 ltr) information via the SPS computers. The improved hard-wired safety interlock system allows, after occurance of a double UTILS failure, the closure of both UTIL ISOL valves at the same time. Manual operation is also possible.
Refer to Hydraulic System Controls and Indicators pag. 128.

HYDRAULIC COOLING

Each system is provided with a Fuel Cooled Oil Cooler (FCOC) installed in the low pressure return line to the reservoir. Incorporated in the FCOC is a bypass-valve which is open when the hydraulic fluid is below 50 to 60 deg C to improve hydraulic fluid warm up characteristics.

HAND PUMP

A hand operated pump is provided in the left system for recharging the park brake-, canopy- and cockpit ladder accumulators. The pump is located in the left accessory gearbox compartement and is operated by a detachable handle. The hand pump is also used to provide on ground operation of the flight refuelling probe and rigging of the landing gear.

HYDRAULIC SUPPLY

The hydraulic system (Hydraulic supply Table) provides hydraulic power to operate the following flight controls and utilities:

Hydraulic Supply

LEFT SYSTEM	RIGHT SYSTEM
Flight Control System - L/H & R/H foreplanes - L/H & R/H I/B & O/B flaperons - Rudder	Flight Control System - L/H & R/H foreplanes - L/H & R/H I/B & O/B flaperons - Rudder
Utilities System - L/H LEAS - L/H air intake cowl - Normal wheel brake - Main landing gear - Nose landing gear - Park brake - Canopy - Nose wheel steering - Air to Air refuelling probe - On board cockpit ladder	Utilities System - R/H LEAS - R/H air intake cowl - Emergency wheel brake - Main landing gear - emergency extension - Nose landing gear - emergency extension - Airbrake - Air to Air refuelling probe - emergency extension - Linkless ammunition box drive

HYDRAULIC SYSTEM CONTROLS AND INDICATORS

A combination of dedicated switches and displays achieve:

– Monitoring of the hydraulic system by a combination of built-in monitoring hardware and SPS computer monitoring software.

– Control of the hydraulic system by dedicated switches and/or computer software, and

– Indication of the hydraulic system monitor and maintenance information by the MHDDs, DWP and MDP.

DEDICATED SWITCHES AND DISPLAYS

HYDRAULIC DEPRESSURIZATION SWITCHES

Two three position latch-toggle switches marked HYD - L & R - ON/AUTO/OFF, each controlling the depressurization valve on one hydraulic pump, are located on the right console.
Their functions are as listed below:

ON With ON selected the system is always pressurized. Possible SW induced failures have no influence.

AUTO Upon selection of this position the hydraulic depressurization pump is operating automatically under the control of the SPS computer. On ground, AUTO selected, the system is depressurized below 50% SPS gear box speed to assist engine start.

OFF With OFF selected the pump is depressurized. A safety inter lock prevents a system being depressurized if the opposite system pressure is low.

HYDRAULIC SYSTEM STATUS DISPLAYS

Pressure and temperature transducers provide analogue signals to the SPS computers which form part of the UCS. The SPS computers process specific data for MHDD display.

Information of specific hydraulic system failures is displayed on the Dedicated Warning Panel (DWP). Related DWP captions are presented either as CAT 2 (red), CAT 3 (amber) or CAT C (catastrophic) warnings.

The DWP warnings and associated audios, except the HYD TOT (CAT C-GUH), are suppressed on ground during engine start-up cycle and engines shut down when below 58% gearbox speed.

MHDD HYDRAULIC FORMAT DISPLAY

The hydraulics format gives a diagrammatic presentation of the hydraulic system. It provides a digital readout and an analogue indication of various physical parameters. Symbology is used to present the UTIL valve status. Red infills are used to indicate warning or failure conditions. Amber is used to indicate abnormal conditions. Green lines indicate correct or satisfactory conditions.

Refer to MHDD - Formats (Colored MHDD format) in the front of the FM.

MHDD CONTROL

There is no automatic display of the MHDD/HYD format in any phase of flight modes (POF). Selection of the MHDD soft key (SK) labelled HYD enables to display the actual status of the left and right hand hydraulic systems, when required.
When selected the SK HYD legend is boxed. Pressing the key again reverts the display to the previous (default) format.

MHDD HYDRAULICS FORMAT/SK CONTROL

When the MHDD/HYD format is selected, SKs for operation (excluding BLANK ones) are as follows:

– Bottom line: FUEL, ENG, HYD (boxed), WPT and FREQ

– Left side from top: W, BLANK, BLANK, AUTO/MAN (AUTO boxed), BLANK, ELEV

– Right side from top: NORM, Blank, AUTO/MAN (AUTO boxed), HUD, STOR

UTILITIES ISOLATION VALVE OPERATION

NOTE

When AUTO is selected (boxed) the SKs OPEN/CLSD are not available.

Normal operation (default) for both left and right Utilities Isolation valves (UIV) would be to be open and the respective softkeys (SK) to display AUTO/MAN with AUTO being boxed. In addition AUTO is displayed next to the UIV symbol for each system.
AUTO mode selected and following specific failure scenarios for the SPS computer to close both UIVs with the appropriate indications on the HYD format and associated warnings.
It is also possible to select either one or both UIV to MAN by selection of the respective SK. MAN would be boxed on selection and MAN displayed on the format next to the UIV. Selection of MAN will then display the SK (s) legend OPEN/CLSD with OPEN boxed.

NOTE

It is not possible to manually select both UIV to the CLSDed position.

If subsequently to a MAN selection the SK OPEN/CLSD is operated, the selected UIV will close (CLSD boxed) and MAN is displayed next to the respective UIV. This will have the effect that the OPEN/CLSD and AUTO/MAN SKs of the remaining UIV will occult, i.e. these SKs are no longer available for selection. The open system will revert to AUTO with AUTO displayed next to the UIV. If an actual UTILS failure occurs (external leakage), this system will be commanded closed by the SPS. In this event the system will automatically open the opposite UIV if this system was set to closed and if it is deemed adequately “healthy”. This will also apply if the closure of the first system was induced by an erroneous software fault.
For Mode and/or Command Change of the UIVs, refer to Figure 1.54.

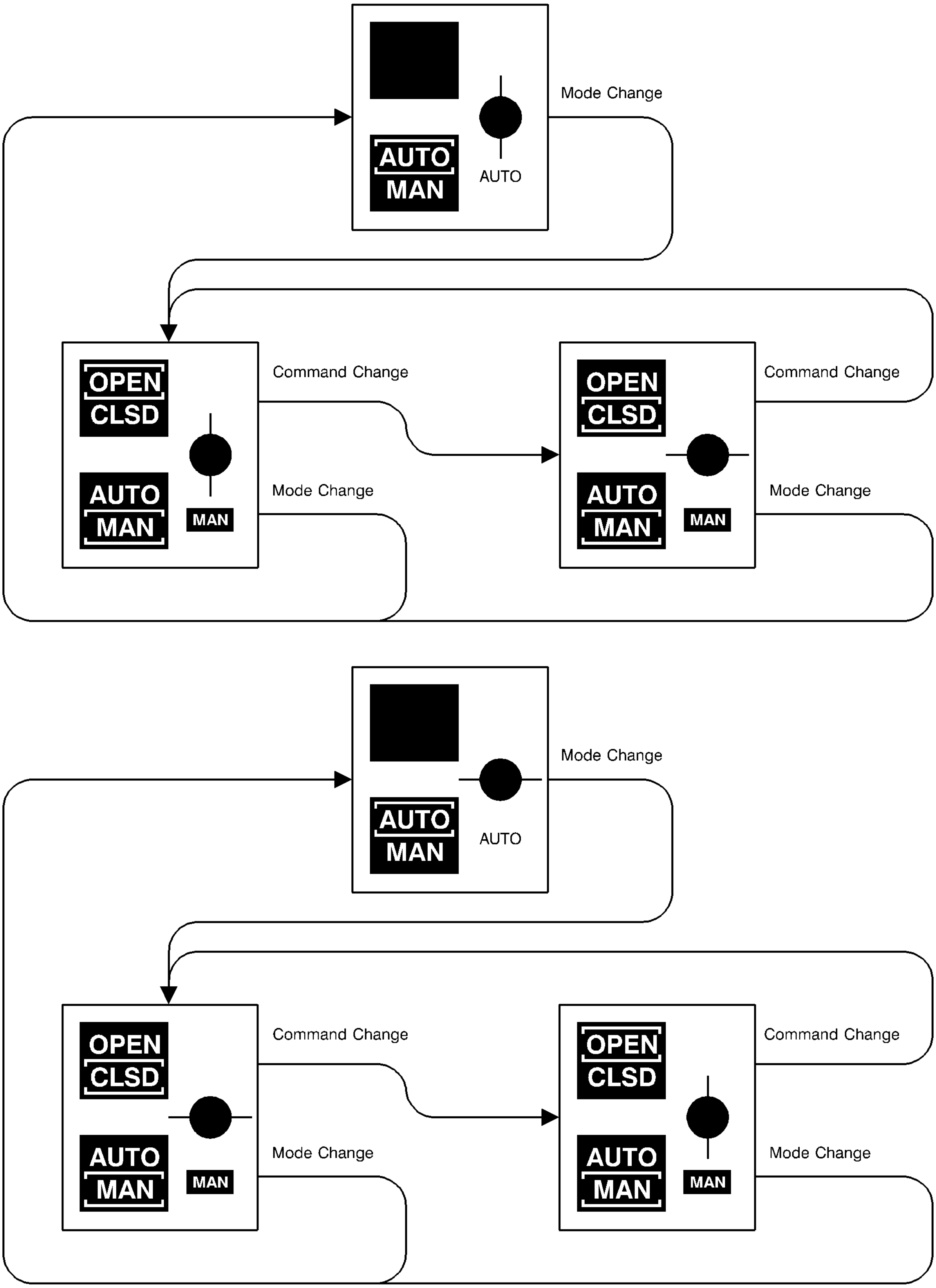


Figure 1.54 - MHDD/HYD Format-SK Moding (AvSP3)

DWP & MHDD/W INDICATION

The following CAT C, CAT 2 and/or CAT 3 warning captions are displayed on the DWP and the MHDD/W format (if available) following specific failure conditions:

- **HYD TOT** indicating the total loss of hydraulics (NORM & GUH)
- **L CONT P** or **R CONT P** indicating the loss of hydraulic system pressure/fluid.
- **L UTIL P** or **R UTIL P** indicating the loss of utilities pressure/fluid
- **L HYD A** or **R HYD A** indicating excessive air in hydraulics (GND only)

LANDING GEAR SYSTEM

The landing gear system is divided into the following subsystems:

– Landing gear functional system (extension and retraction system, sequencing and indication system, struts, tires, wheels and landing gear computer).
– Steering control system
– Brake control system
– Brake chute system
– Auxiliary deceleration system (HOOK)

The landing gear (LG) is a tricycle type, with one nose gear and two wing mounted main gears. The main landing gear (MLG) and the nose landing gear (NLG) consist of telescopic, oleo-pneumatic, two stage shock struts, each having a single wheel. The main wheels are equipped with a brake assembly. The activation part of the nosewheel steering system forms part of the nose gear leg.

Normal extension and retraction of the landing gear is electrically controlled and hydraulically operated by the left utility hydraulic system. An emergency lowering system is included, which is operated by the right utility hydraulic system in connection with a mechanically triggered sequencing valve for the MLG.

Nose and main landing gear bays are closed and locked by hydraulic operated doors. Down locks, uplocks, door locks and struts are equipped with proximity sensors which are linked to the landing gear computer (LGC).

The nosewheel steering is electrically controlled and hydraulically operated by FCS command via the flight control computers (FCCs).

The brake system has duplex hydraulic supply with integrated skid control systems in both, normal and emergency modes. An independent park brake system, hydraulically operated by electrical selection and an additional cooling fan are part of the system.

Indications/information of systems status and warnings are provided via HUD, MHDD, DWP and by audio voice warning.

LANDING GEAR CONTROL

The landing gear system is controlled and monitored by the landing gear computer (LGC), which provides also an interface to the utilities control system (UCS).

The LGC consists of two fully separated systems for control and monitoring of the normal and the emergency landing gear operation. The left system (system 1) is connected to the essential DC busbar PP3, while the right system (system 2) is connected to the essential DC busbar PP4. This ensures optimum mechanical and electrical separation of both systems.

The LGC performs control, interfacing, monitoring and test functions for the landing gear system, brake and anti skid system, the arrestor hook system and brake parachute system. This includes:

– LG sequencing
– LG indications
– Weight on wheel
– LG emergency lowering
– Brake and anti-skid monitoring function
– Park brake and arrestor hook monitoring function.

MAIN/NOSE GEAR

MAIN GEAR

The wing mounted main landing gears retract inboard into the wing root and center fuselage. A hydraulically operated wheel brake and a wheel speed transducer are mounted inside each wheel axle of the main landing gears.

During retraction and lowering the integrated telescopic strut with its oleo pneumatic strut shock absorbers are mechanically controlled to shorten the gear lengths during retraction.

Hydromechanical uplocks hold the main gears in the retracted position. Upon down selection, hydraulic pressure of more than 105 bar will release the uplocks again. In the down position, the main gears will lock mechanically without assistance from the hydraulic systems. Unlocking will be initiated by hydraulic pressure.

Each main gear bay is closed by two doors, one fuselage mounted part of the door operated by a separate hydraulic jack, and one wing mounted part of the door which is mechanically linked to the gear. Doors operation is automatically sequenced by the position of the main gears. The left and right main landing gear doors and the doorlocks are operated hydraulically.

Electrical proximity sensors indicate gears uplock and downlock, doors open and closed position, and weight of wheel (WOW) condition on each shock absorber. An independent sensor provides the down and locked position under emergency conditions. The sensors are connected to the landing gear computer (LGC) and energized when the landing gear computer is powered up. A BIT (CBIT and IBIT) integrated in the LGC monitors all sensor junctions.

NOSE GEAR

The nose gear is part of the tricycle landing gear system. The single wheel retracts backwards into the nosegear bay. The nose gear is equipped with a functional unit comprising nosewheel steering selector and motor, shimmy damper, servo valves and various other sensors.

The telescopic strut has an integrated two stage, oleo pneumatic shock absorber.

Prior retraction of the nose gear, the wheel must be centered by a mechanical centering device. It operates after the strut is fully extended, the NWS has automatically disconnected and the wheel is within 20 degrees from the centered position.

In the retracted position, the nose gear is stored in the nose gear bay and locked by hydromechanical uplocks. Upon selection the uplock will unlock by hydraulic pressure for normal and emergency extension.

In the down position, the nose gear is locked by a telescopic locking stay containing a locking mechanism which will hold the NLG in a centered position when extended. The mechanism is unlocked hydraulically.

A hydraulic jack is operating the NLG door to the open and closed position. The door is kept to the open position by hydraulic pressure maintained in the actuator. Two hydromechanical actuated doorlocks hold the NLG door in the closed position, if the NLG is up and locked. The locks are released by hydraulic pressure for normal and emergency extension.

The door actuation and unlocking is sequenced automatically with the NLG leg actuation.

Proximity sensors indicate NLG uplock/downlock, closed, locked and open position of the NLG door, extended condition of the shock absorber and the centering of the nose wheel. Each sensor is connected to the landing gear Computer (LGC). A BIT (IBIT and CBIT) integrated into the LGC monitors all sensor functions.

The following shows a summary of relevant technical data and/or operational limitations:

LANDING GEAR SYSTEM LIMITATIONS

The information provided is incomplete and part of the relevant AWFL. If differences exist to a specific AWFL, the AWFL has an overriding function.

Landing gear lowering speed (landing gear lever and EMGY gear switch)	max. 290 KDAS
Landing gear holding limit	max. 320 KDAS
Landing gear retraction speed	max. 290 KDAS
Main/nose landing gear extension time	5 sec at 200 KDAS
Main/nose landing gear emergency extension time	10 sec at 200 KDAS
Main/nose landing gear retraction time	5 sec, a/c clean 275 KDAS, 1g
Hydraulic supply pressure (normal and emergency)	280 bar
Electrical supply	28 V DC

LANDING GEAR EMERGENCY SYSTEM

The emergency lowering system is supplied by the right utility hydraulic system (system 2) and is independent of the normal system.

The changeover from the left to the right utility system is initiated via a cockpit selectable emergency gear control switch (EMGY GEAR). When the switch is selected to the DOWN position, irrespective of the position of the LG selector lever, pressure is routed to the combined gear and door selector valve which is hardwired to the emergency gear control switch in the cockpit, thus bypassing the landing gear computer (LGC). Monitoring of the hardwired circuit for switch position and failure indication via the LGC is still available.

With EMGY GEAR selected to DOWN, the combined selector valve supplies pressure first to the MLG- and NLG door and gear systems. At a MLG door opening angle of 50 degrees, a sequencing valve (located in the right main wheel bay) will be mechanically triggered by the MLG door jacks and opens the supply line to the main gear uplocks and main gear jacks. Sequencing of the NLG leg will be made after full opening of the NLG door via an integrator in the NLG uplock.

Gear and door actuators, as well as gear uplock and doorlock actuators are equipped with shuttle valves to permit changeover from the left hydraulic system (normal lowering) to the right hydraulic system (emergency lowering).

NOTE

LDG EMGY extension dumps about 3.5 liter of fluid from the right system reservoir (system 2) into the left system (system 1). This fluid is irreversible lost in system 2.

If the landing gear is supplied from the right utility hydraulic system, due to loss of the left utility system, nosewheel steering will not be available. Brakes and anti-skid, control and monitoring is available through the landing gear computer.

The landing gear systems have simplex electrical redundancy. Control and monitoring of the left and right hydraulic systems are separated within the landinggearcomputer.

WHEEL BRAKE SYSTEM

Each main landing gear wheel is equipped with an electronically controlled and hydraulically operated carbon brake.

Brake pressure is supplied by the left utility hydraulic system for normal operation and by the right utility hydraulic system for back-up (emergency) operation.

The changeover from the left to the right utility hydraulic system is either achieved by manual selection of a cockpit controlled two position switch, or automatically, in case of left system failure (detected by CBIT or IBIT).

An anti-skid control system is integrated in both the normal and the emergency wheel brake systems.

An electrical integrated cooling fan, which is operated by wheel speed, brake pressure and WOW inputs, is also controlled by the landing gear computer (LGC) and keeps wheel brake temperatures low.

Pilot demanded brake pedal pressure is controlled independently by the left and right brake pedal transducers (PDU). The transducers convert pilot brake pedal inputs into two redundant electrical isolated signals. These signals are routed to the LGC which in turn provides overall independent control and monitor of the landing gear system.

The hydraulic pressure to the brakes from either hydraulic system is controlled by two brake and anti-skid control manifolds according to LGC demand.

A brake shut off valve is included in both left and right hydraulic systems to isolate each system from the relevant failed system when required.

When airborne, the LGC closes both shut off valves, thus brake pressure cannot be applied at touchdown to the wheel brakes. The relevant shut off valve (normally for the left system) will open after touchdown by weight on wheels and by a wheel spin-up signal, allowing braking of the main wheels. When airborne, an automatic braking function of the main wheels decellerates the wheels during retraction from 170 Kts to 0 Kts within 1.0 sec. Thereafter the brakes are released again.

NOTE

Loss of LGC processors results in shut off of the servo valve control, which will be depowered to a safe condition. Normal and/or emergency braking is possible, however anti skid function is lost. Control and monitoring of brake pressure applications is lost as well.

Normal and emergency maximum supply brake pressure is 280 bar.

PARK BRAKE

A park brake, electrically selected via a cockpit switch and hydraulically operated by the left hydraulic system, operates to both wheel brakes. With ON selected and aircraft weight on wheels, max pressure (280 bar) to the left and right wheel brakes are applied.

The park brake accumulator for brake operation on ground after engine shutdown is charged with nitrogen and the pressure (70 bar) is indicated on the MDP. A hand pump for charging both, canopy and parking brake accumulators is provided for the left hydraulic system.

ANTI SKID SYSTEM

The aircraft wheel brake system is equipped with an electronically controlled and electro-hydraulically operated anti-skid system. The system is part of the brake and anti-skid control equipment comprising the landing gear computer (LGC) with inputs from wheel speed transducers, pedal transducers, brake and anti-skid manifolds, servo and shut off valves. The system is designed to give individual wheel skid control operation.

The system provides the following functions in both modes (normal and emergency) of operation:

– Touchdown protection
– Brake and anti-skid proportional control
– Failure detection
– Locked wheel protection

The system is energized and automatically tested by a built-in test (CBIT) function when the gear is down or via MDP BIT (IBIT) initiation. Only a failure of both brake systems (normal and emergency) or both anti-skid systems during IBIT or CBIT will induce a Cat 3 DWP caption (A SKID).

The anti-skid system is controlled, monitored and tested by the LGC and is available in the normal and emergency mode of wheel brake operation. For this purpose the LGC consists of two fully separate systems.

The LGC is receiving electrical signals, proportional to the main wheel rotation speed from two identical duplex wheel speed transducers. The computer detects changes in wheel decelleration and reduces fluid pressure to the servo valves via a combined brake and anti-skid control manifold. For normal operation, the LGC is controlling and monitoring a brake and anti skid control manifold which comprises all valves for normal brake and anti-skid function:

– An electro-hydraulically controlled brake pressure servo valve ensuring anti skid control.
– A wheel brake shuttle valve for normal and parking brake operation.
– A cockpit controlled electrical shut off valve connecting the wheel brake and anti-skid system to the left hydraulic system.

For emergency operation, the LGC is controlling and monitoring a separate brake and anti-skid control manifold which comprises all valves necessary for emergency brake and anti-skid function:

– An electro hydraulically controlled brake pressure servo valve ensuring brake and anti-skid control.
– A cockpit controlled electrical shut-off valve connecting the wheel brake and anti-skid system to the right hydraulic system.

The anti skid system is inoperative at ground speeds of less than 9 Kt.

LANDING GEAR SYSTEM CONTROLS AND INDICATORS

LANDING GEAR SELECTOR LEVER

The landing gear (LG) selector lever is on the left quarter panel and comprises a straight control shaft, which incorporates an integral uplock sleeve control and a circular handle, incorporating a red display source for gear and door unsafe conditions.

The gear selector lever determines the landing gear position UP or DOWN, marked on the panel surface.

– Selection of UP initiates the retraction command. When selected UP, the lever is mechanically locked. Normal selection of the LG selector lever to UP is only possible when weight off wheels is signalled to the LGC.
– Selection of DOWN initiates the extension command. To select DOWN, it is necessary to operate the selector uplock sleeve control first. This sleeve lock must be withdrawn from its detent to unlock the gear selector lever.

NOTE

The current landing gear equipment and LGC inhibits the function of landing gear retraction on the ground.

A dark grey, miniature circular, momentary pushbutton positioned above the selector lever, enables to override the mechanical lock and select the landing gear handle to UP. However, due to the missing 'nosewheel centered` signal to the LGC the gear will not retract.

EMERGENCY GEAR CONTROL

The emergency gear (EMGY GEAR) coverguarded, three position toggle switch is located on the forward left hand console. The three positions are labelled RSET, NORM, DOWN, marked on the panel surface.

– With NORM selected, the landing gear is under control of the LG selector lever.
– With DOWN selected the landing gear extends regardless of the LG selector lever position. After a LG emergency DOWN selection, normal UP operation is inhibited unless RSET has been selected.
– The RSET function, which is springloaded to the NORM position, is only operative with the landing gear lever in the DOWN position.

LANDING GEAR DISPLAY

Indication of landing gear position is provided on the left quarter panel by the the landing gear selector switch and the Head-Up Panel (HUD).

LANDING GEAR STATUS DISPLAY

Three identical green indicators on the left quarter panel are illuminated when the respective gear leg (sequence: left, nose, right) attains the down and locked position. At all other times (including the transition phase) those lights are occulted.
While the landing gear is in transit, the integral red LG lever LEDs in the LG selector lever knob indicate unlocking or transit of the gear doors and legs or gear(s) and/or door(s) not locked.
The landing gear selector indications on the LH quarter panel are driven from the lighting controller according to outputs provided by the LGC.

HEAD UP DISPLAY

Individual indications for each landing gear leg position (left, nose, right) are displayed on the right bottom of the HUD-PDU. The HUD display is driven from the Character and Symbol Generator (CSG) according to the signals provided by the LGC.

Depending on the LDG position state, the indications are as follows:

UP	UP	UP
-X-	-X-	-X-
D	D	D

- UP indicates respective gear uplocked and door closed.
- The bar indicates respective gear leg or door position unsafe.
- A X breaks the bar as long as the gear legs/ doors are in transit.
- D indicates repective door fully open and gear downlocked.

The landing gear HUD display is occulted 10 sec. after weight is off the nosewheel.
In the event that conflicting information for the LDG DOWN status (safe for landing)is provided it is recommended that the pilot should take the best information from all sources, i.e. if one indication shows good and the other shows false, then the good status from any source should be used.

CONFLICTING GEAR INDICATIONS

There is a possibility that the LDG status information of the landing gear lever , the left quarter panel (LQP) and the HUD may present conflicting information.

The left quarter panel indications are sourced from LGC 2 and in the event of either an open loop circuit between the LGC and the LQP or of a failure of the related system 2 downlock proximity sensor then the associated green indication will fail to illuminate.

The HUD is sourced from system 1 and system 2 which by design provides the best available information to the CSG for subsequent display onto the HUD. In the event of system 1 total failure, no HUD indication will be available. In the event of a system 1 proximity sensor failure, the HUD indication will be available and consistent with system 2 LG selector/LQP indication.

The following table shows the indications that would be provided for the normal failure free case, for a failure of the nose gear sensor in LGC system 1, and for the same failure in LGC system 2:

SYSTEM 1 STATUS	SYSTEM 2 STATUS	LDG LEVER INDICATION	LQP INDICATIONS	HUD INDICATIONS
D D D	D D D	Blank	G G G	D D D
D X D	D D D	Blank	G G G	D D D
D D D	D X D	Red	G Blank G	D D D

LANDING GEAR WARNINGS

Landing gear audio warnings are triggered in all POF except GND.

- GEAR TRAVEL (CAT4): If gear DOWN and speed exceeding 290 KDAS, but less than 320 KDAS.
- LANDING GEAR (CAT1): Gear not lowered below 180 KDAS, 500 ft (RAD ALT) and both throttle levers below 85% Max Dry
- GEAR LIMIT (CAT1): Gear down limit speed exceeding 320 KDAS.

BRAKE AND ANTI SKID CONTROLS

Cockpit control of either brake/anti skid system is provided by a two position, bistable toggle switch, labelled EMGY BRK, NORM-REV on the left hand quarter panel.

- With NORM selected, the brakes operate on the left hydraulic system as long as no failure condition is detected. If the left system fails (detected by CBIT or IBIT) the LGC automatically selects the right utility hydraulic system. Individual anti-skid protection is provided.
- With REV selected, the brakes operate on the right utility hydraulic system (emergency brake system). Individual anti-skid protection is provided.

BRAKE AND ANTI-SKID DISPLAY

System indications are given externally, on the MDP and on the MHDD/ACUE format.

EXTERNAL

Brake wear indicator, two on each side on the inner side of the left and right brake unit, protrude above the face of the unit and give information of the brakes status.
Tire pressure gages are installed on each main- and on the nosewheel. Pressure readout is from 0 to 450

psi. Normal pressure for the main tires is 24.0 bar, and 16.2 bar for the nose tire.

MHDD

On power up the MHDD/ACUE format will be automatically displayed on the LMHDD. The MHDD/ ACUE format is occulted with weight off wheels and therefore not available in-flight.

The MHDD/ACUE format does not displays brake related status indication, such as brake pressures or indication of the system in use. However, if there is a failure in one of the two brake systems, the MHDD/ ACUE displays a BRAKE NOGO caption and in addition either:

- Brake System 1 fail, or
- Brake System 2 fail.

DWP

A failure of both brake systems will trigger the following DWP warning captions:

- **BRK FAIL** GND & APPR/LDG
- **BRK FAIL** T/O
- **A/SKID** APPR/LDG
- **A/SKID** GND, T/O

PARK BRAKE SYSTEM

MHDD/ACUE

When the PARK BRK OFF-ON toggle switch is selected to ON with WOWs both brakes will be applied independently of the anti-skid function.

To support the pilot during power up the MHDD/ ACUE will prompt to select the Park Brake. This prompt is given if the PARK BRK is OFF prior to engine start. For power down the PARK BRK must also be set to ON.

PARK BRAKE WARNINGS

A CAT 1 <PARK BRAKE> voice warning, associated by flashing AG, is provided when:

- T/O: Park brake selected ON and both throttles above 75% Max Dry.
- APPROACH/LDG: Park brake selected ON and LDG DOWN selected.

AUXILIARY DECELERATION SYSTEM

BRAKE CHUTE SYSTEM

The brake chute system provides additional aircraft deceleration to that provided by the wheel brakes, reducing the landing roll and decreasing tyre and brake wear.

The brake chute system consists of a main chute and a drogue chute packed in a fabric bag and stowed in a compartment in the aft fuselage at the base of the rudder (between the two end turbine nozzles). The compartment is equipped with a door, spring-loaded to the open position.

The drogue chute is spring loaded to assist its deployment into the airstream. It is released by opening the door through the action of a two-position handle in the cockpit.

A riser with a strop fitting connects the brake chute to the brake chute lock and release unit on the aircraft.

The brake chute lock and release unit holds the chute strop fitting safely in position during flight by means of twin spring loaded jaws independent of the main lock jaws. The latter are normally in the open position.

In case of inadvertent chute deployment (by an action other than movement of the brake chute handle) the twin spring loaded jaws are not able to withstand the loads caused by the parachute, and the chute strop fitting is released with no structural damage to the aircraft.

A break link is provided in the brake chute linkage, to protect the fuselage structure from excessive loads imposed by brake chute deployment at high speeds.

BRAKE CHUTE HANDLE

The brake chute handle, located outboard of the left glareshield (see Figure 1.55), controls the operation of the brake chute. On pulling the handle, electrical power is supplied to the brake chute lock and release unit in order to close and lock the main lock jaws and to open the chute door. As the chute door opens, the drogue chute spring is released and ejects the drogue chute into the airstream. Wind action on the drogue chute pulls the brake chute free of the deployment bag and clear of the aircraft.

Pushing the handle to the forward position removes the electrical supply from the brake chute lock and release unit. This opens the main lock jaws and allows the chute loads to separate the chute from the aircraft.

To prevent inadvertent operation, the handle is equipped with a locking device that locks the handle in both positions. The locking device is operated by a locking lever, which unlocks the handle when is pulled.

NOTE

> The both sides of the lever must be pulled at the same time in order to unlock the brake chute handle.

CHUTE WARNING

Information of brake chute system failure is displayed on the dedicated warning panel (DWP). The following caption is presented:

CHUTE (CAT 3 - amber) Indicates an electrical failure in the brake chute system. The system may fail to function when it is operated.

The DWP caption is accompanied by attention getters and the "chute fail" voice warning message.

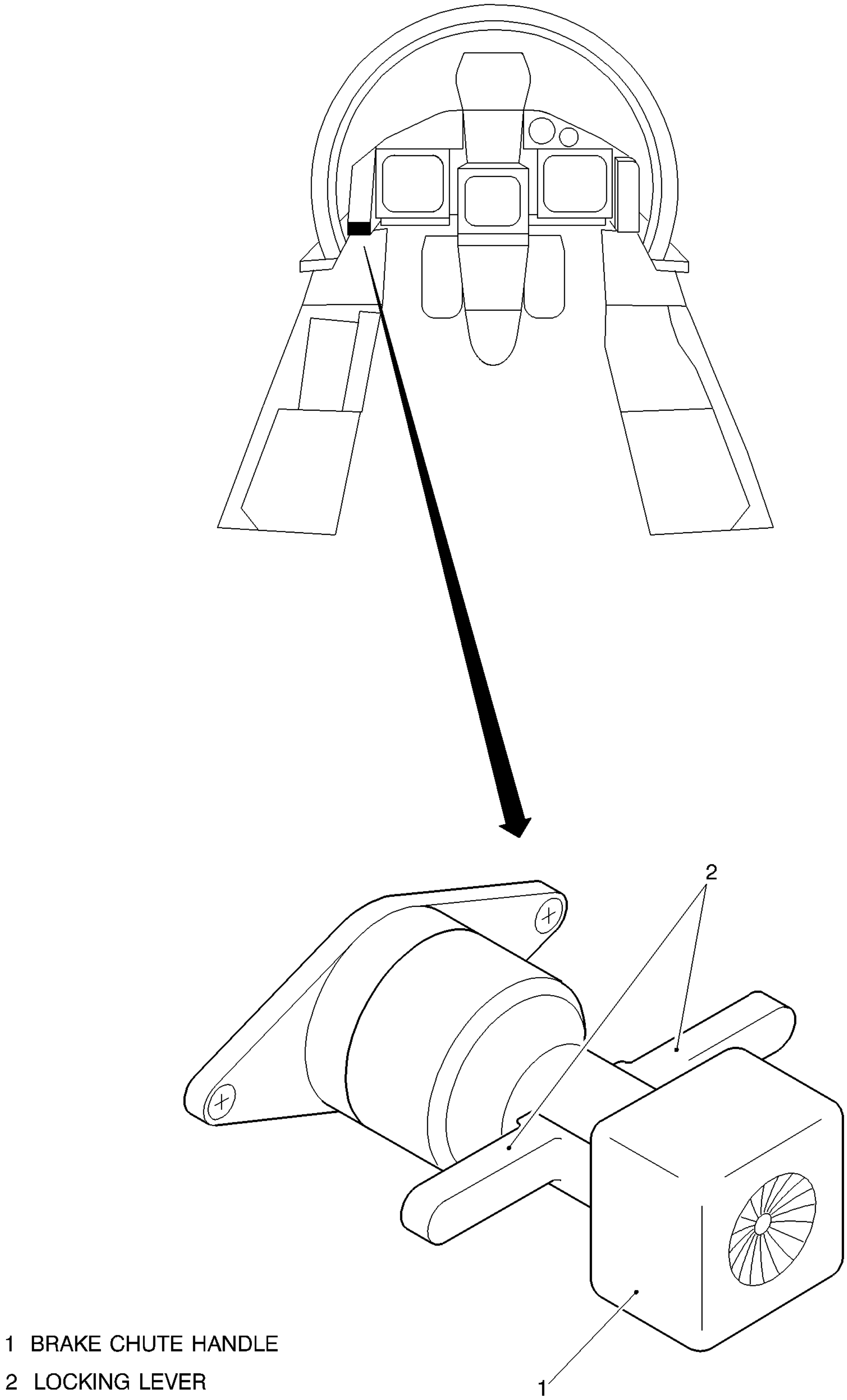


Figure 1.55 - Brake Chute System - Cockpit Control

ARRESTER HOOK SYSTEM

The arrester hook system can be used to decelerate the aircraft to a stop by engaging an arrester cable in a rejected takeoff or emergency landing situation.

The arrester hook system consists of a shock absorber, an arrester hook uplock and release unit, and the hook with its arm.

The arrester hook is electrically controlled. It extends by gravity and an oleopneumatic shock absorber, and is retracted manually by the ground crew.

The arrester hook release pushbutton controls the extension of the arrester hook. When the pushbutton is pressed, electrical power is applied to the uplock unit to release the arrester hook. The arrester hook assembly is forced down by the combined action of the shock absorber force and the hook weight.

The uplock unit includes a microswitch which detects the arrester hook status and puts the pushbutton light on when the arrester hook is not up and locked. The microswitch signal is also used by the utilities control system (UCS) to generate a warning on the dedicated warning panel. If the hook is not stowed and locked and the arrester hook release pushbutton has not been pressed, the HOOK DWN caption will come on.

If an electrical failure is detected in the arrester hook system, the HOOK caption will come on. This indicates that the hook may fail to function.

To prevent inadvertent unlocking during servicing and when the aircraft is parked, a ground safety pin is provided for insertion in the hook shoe. The ground safety pin must be removed prior to flight.

ARRESTER HOOK RELEASE PUSHBUTTON/ INDICATOR

The illuminated pushbutton, labeled HOOK, is on the left quarter panel and is protected by a concentric raised guard. The guard is black and yellow striped.

When the pushbutton is pressed, electrical power is applied to the uplock unit to release the arrester hook. The pushbutton is always illuminated when the arrester hook is not stowed and locked.

ARRESTER HOOK WARNINGS

Information of arrester hook system failures are displayed on the dedicated warning panel (DWP). The following captions are presented:

HOOK DWN (CAT 2 - red - during takeoff, CAT 3 - amber in any other phase of the flight) Indicates that the arrester hook is not stowed and locked without having pressed the arrester hook release pushbutton.

HOOK (CAT 3 - amber) Indicates an electrical failure in the arrester hook system. The system may fail to function when it is operated.

In addition to a DWP caption, the arrester hook failures are accompanied by attention getters and voice warning messages.

FLIGHT CONTROL SYSTEM

The Flight Control System (FCS) is designed as a quadruplex digital fly-by-wire system with no facility for reversion to mechanical controls.
The FCS is designed to:

- Provide air data and other information both internal and from the digital engine control unit (DECUs) to all aircraft systems via the avionics system (AVS) and utilities system (UCS) buses, in particular, provide the data to the primary cockpit displays and to the GUHI.
- Introduce compatibility with the EJ200 engine.
- Provide airdata system- (ADS), inertial measurement unit- (IMU) and engine data to AVS and UCS.
- Transmit FCS warnings via the AVS bus.
- Provide specific data to the integrated monitor and recording system (IMRS) IPU and to the Flight Test Instrumentation (FTI) system via dedicated unidirectional serial digital links.
- Provide a full test coverage Frequency Bias Input (FBI) facility to allow envelope expansion and air data calibration trials. The functions to be implemented are inputs at actuators only; bias, impulse and single frequency sweep.

The control surfaces through which the FCS acts upon the airframe are shown in Figure 1.56.

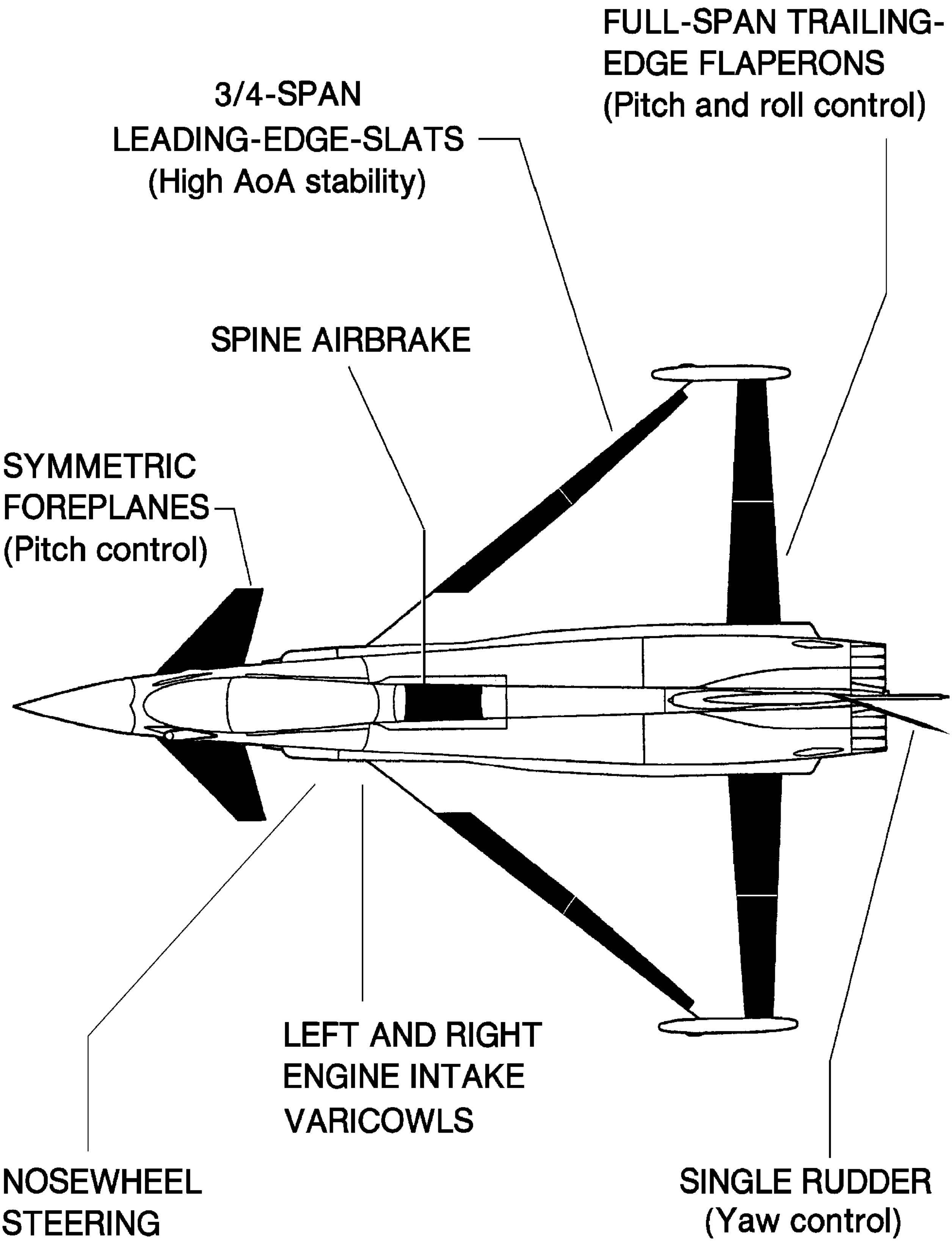


Figure 1.56 - Primary/Secondary Control Surfaces

EQUIPMENT INTEGRATION

ELECTRONIC EQUIPMENT

- 4 Flight Control Computers (FCC)
- 1 Inertial Measurement Unit (IMU)
- 4 Air Data Transducers (ADTs)
- 2 Digital Engine Control Units (DECUs, not FCS)

PILOT INCEPTORS (SSV/TSV)

- 1/2 Stick Sensor and Control Assembly (SSICA)
- 1/1 Pedal Sensor Unit (PDU), TWS 1 PSU
- 2/4 Throttle Boxes (not FCS)

PRIMARY FLIGHT CONTROL SURFACES

- Foreplane for pitch control and trimming
- I/B & O/B Flaperon; four trailing edge flaperons for pitch/roll control and trimming.
- Rudder to yaw control, trimming and automatic turn coordination.

SECONDARY FLIGHT CONTROL FUNCTIONS

- Leading Edge System (LEAS)
- Airbrake
- Left & Right Air Intake Cowls
- Nose Wheel Steering Control System.

INTEGRATION

The flight control system is implemented and integrated around a set of four identical and interchangeable, digital flight control computers (FCCs). Each FCC is controlling a lane of the system, including a STANAG 3910 bus, thus providing redundancy for all critical functions. Each FCC is also acting as a bus remote terminal, where two FCCs are interfacing with the avionics system bus (AVS) and the other two with the utilities control system bus (UCS).

Quadruplex electrical and duplex hydraulic redundancy is available for the primary actuators, incl. the LEAS, while the other secondary actuators have simplex electrical and hydraulic monitoring.

The air data system (ADS) comprises four ADT and DECU derived airdata as back up.

Electrical power is supplied to each FCC and IMU lane from two independent 28V DC protected bus bars, PP3 and PP4. The FCS is designed that the four lanes operate synchronously. This is achieved by synchronizing the digital channels between the FCCs. Refer to Figure 1.57.

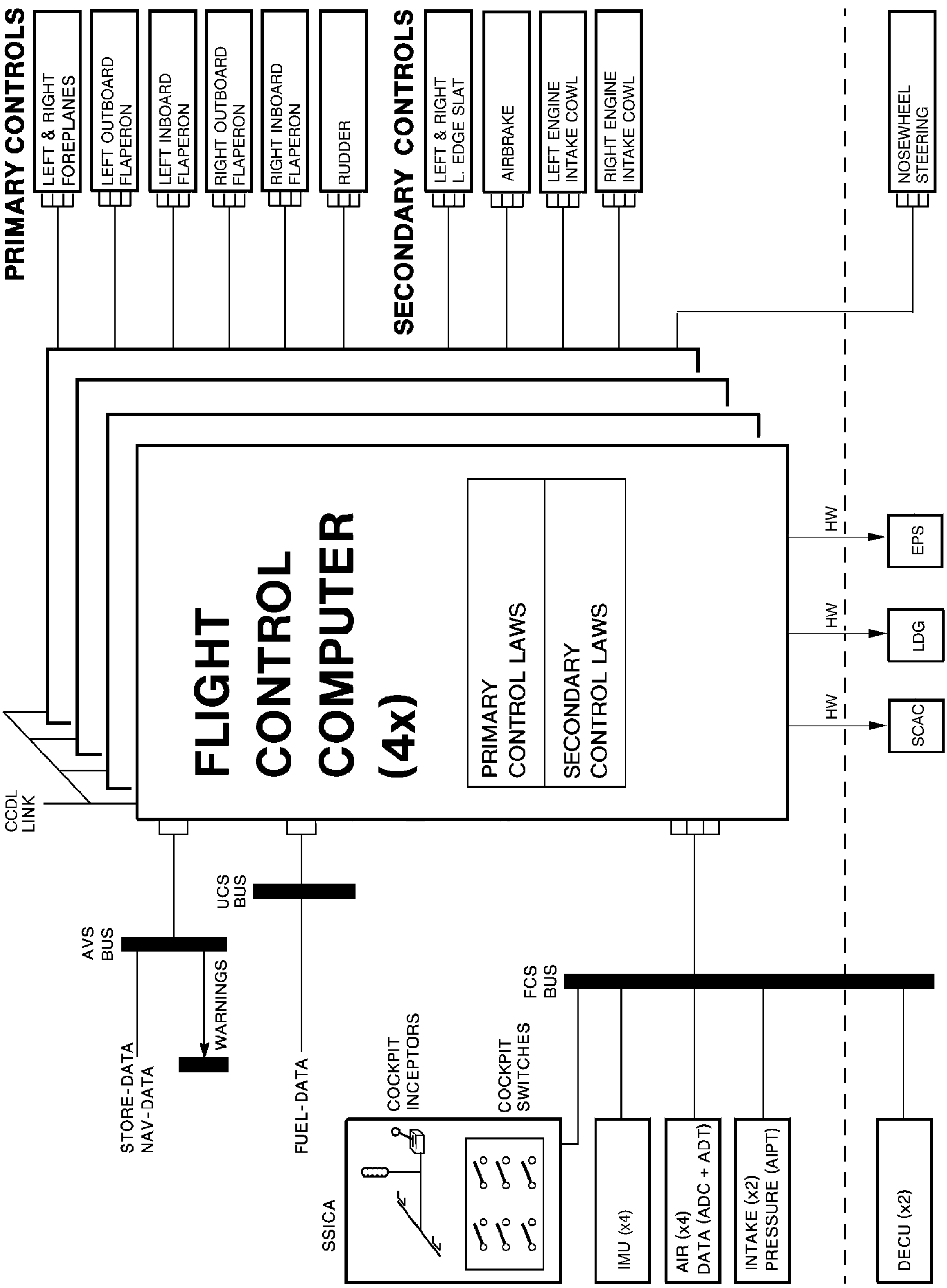


Figure 1.57 - FCS/FCC Integration

INERTIAL MEASUREMENT UNIT (IMU)

The IMU outputs are:

Aircraft motion (inertial sensed):

- Angular rates (pitch, roll and yaw rate)
- Accelerations (normal, lateral and longitudinal)

Aircraft Attitudes:

- Pitch angle
- Bank angle.

Calculated Data:

- True heading
- Estimated altitude and vertical velocity
- Estimated air data (TAS, incidence and sideslip)
- AOA and SS are inertial mixed and filtered with ADT values.

The IMU inputs are:

Latitude and True Heading (Nav data for alignment only)
Pressure Altitude, True Airspeed
Aerodynamic Incidence and Sideslip
FCS Status and Command Words.

FCS PH3R1 FUNCTIONS

The following functions are implemented:

- Operative leading edge.
- Full FCS mode & Automatic Reversionary FCS mode.
- Approach trim schedule (FP +2° LEAS 0°)
- NWS with minimum turn circle (+/- 48°)
- Carefree maneuver, all axes, to the PH3 loading targets CG symmetric configuration.
- Carefree A/B operation.
- AOA and g protection with landing gear down.
- Intake cowl supersonic scheduling to production standard.
- Store scheduling from SCAC sufficient for external tank carriage and A/A external stores (excluding TMC).
- Mass estimator, requiring availability of fuel/ store sensing signals.
- Inclusion of inertial AOA and SS information from IMU Air Data Estimator.
- Incorporation of IMU attitude signals to the primary control laws.
- Optimized roll/pitch combined handling at extreme roll pilot command.
- Flight path hold down to 200 KEAS (= KDAS), LDG DOWN.
- Auto-roll Trim including bank hold and heading hold wings leveler.
- Pitch/roll prioritization: Automatic reduction of roll rate if flap reaches saturation; prioritize pitch response over roll response, but guarantees a minimum roll rate.
- Lift dump fully automatic with mass scheduling.
- Lift dump auto-cancelled with NWS in low speed mode (high gain). Foreplanes are moved to DUMP position on 2nd engine shut down.
- Autothrottle.

FCS PH3R1 CONTROL LAW FUNCTIONAL PERFORMANCE

STABILITY AUGMENTATION

The FCC provides aircraft stabilization in all three axis, including automatic scheduling for fuel and store loading.

FCS PRIMARY LAWS

The primary control laws are designed to provide a manoeuvre command system using a hybrid pitch rate (q demand)/AOA command/g demand control system.

MANEUVER RESPONSE

The aircraft is fully self trimming in pitch and roll. positive and negative AOA/g protection is provided with LDG UP and DOWN, and carefree handling (CFH) is provided with LDG UP.

CONTROL OF AERODYNAMIC CONFIGURATION

The trim angle values for foreplane, leading edge surfaces and flaperons will be programmed to achieve an optimum compromise between performance and maneuverability (Figure 1.58).

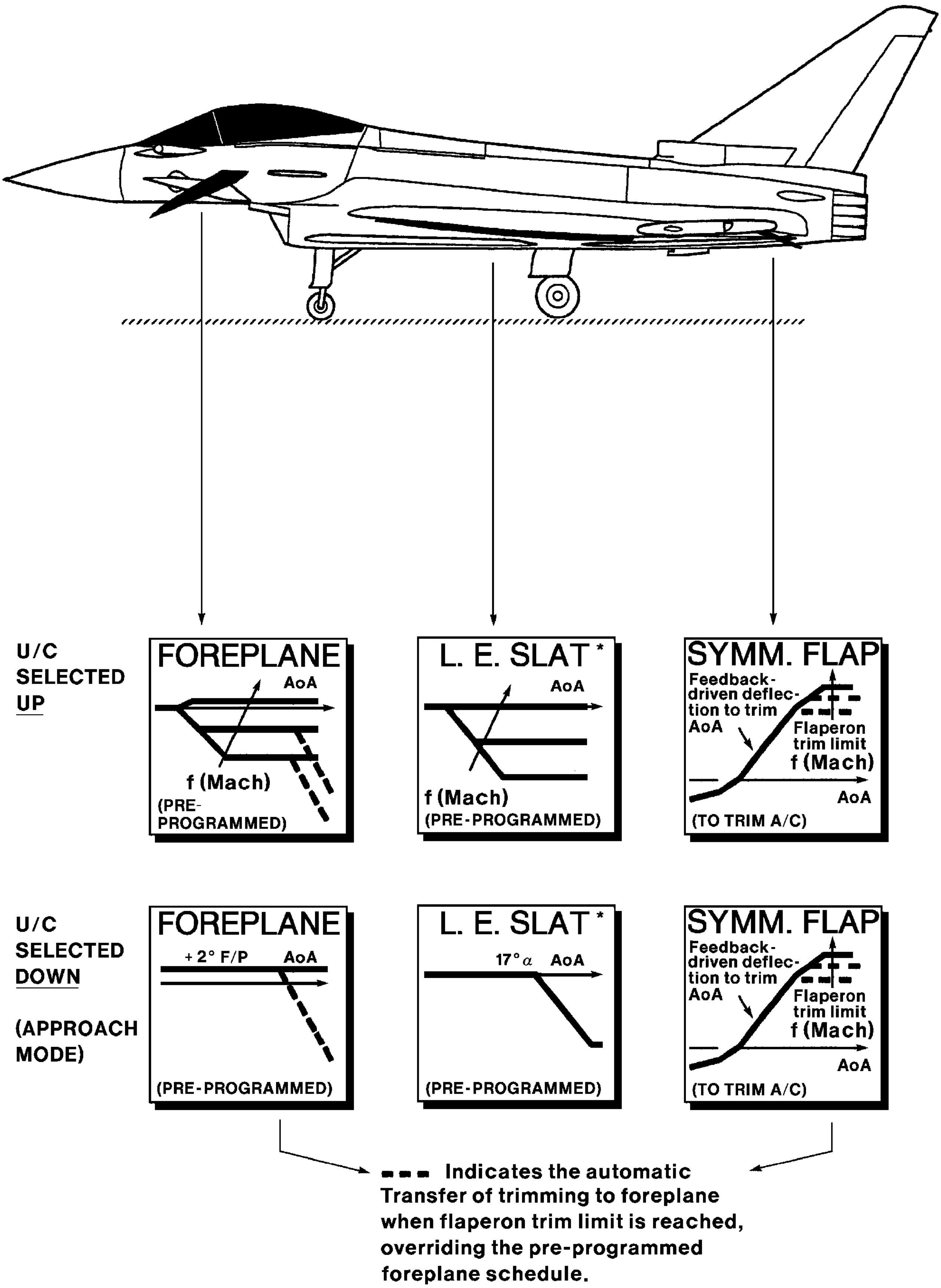


Figure 1.58 - Aerodynamic Control

EMERGENCY G OVERRIDE

An override capability of the maximum positive g is provided, but only cleared for special flight test activities.

AUTOMATIC FAILURE HANDLING

The automatic reversion to Reversionary Control Laws (REV LAWS) in the event of critical failures is provided. The FCS REV Laws are engaged following 2nd or 3rd failures of Ps, Pt, alpha and beta and IMU attitudes.
in the event of other failure cases, e.g.:

- loss of fuel data
- loss of store data
- LEAS failure
- Loss of NWS
- Airbrake failure

as indicated by the warning system, pilot observed procedures are provided in the FCC.

TWIN SEAT VERSION (TSV)

The twin seater control laws in general are identical.

FOREPLANE

Two identical foreplanes - also known as canards - are located left and right side of the foreward fuselage and are part of the primary flight control surfaces.
The foreplane are part of the primary actuators and provide a high degree of redundancy (electrically quadruplex, hydraulically duplex) and allow failures in single channels with consquential performance reduction but no complete loss of function.
The foreplanes are used for pitch control in subsonic range, supersonically in trimmed position. The foreplanes are symmetrically commanded but independently controlled. Depending on flight or ground conditions the foreplanes move up to 60 degree leading edge down, and up to 20 degree leading edge up.

FLAPERONS

Two pairs of inboard and outboard flaperons fitted to the trailing edge of the wings are part of the primary flight control surfaces.
The flaperons are used for pitch and roll control. Pitch control is achieved by symmetric operation, while roll control is achieved by differential movement of the flaperons. Automatically scheduling is provided according to the stores and mass control law functions.
The flaperons are part of the primary actuators and provide a high degree of redundancy (electrically quadruplex, hydraulically duplex) and allow failures in single channels with consquential performance reduction but no complete loss of function.

Maximum control surface movement of the inboard and outboard flaperons is 20 deg trailing edge up and 30 deg trailing edge down.

RUDDER

The rudder is a single surface which is controlled through pilot commands from the pedal sensor unit (PSU) via the SSICA. Since augmentation of aircraft lateral stability is required, including flight envelope regions where the lateral axis is aerodynamically unstable, the control laws stabilize the aircraft via sensor feedback signals.

The rudder is part of the primary actuators and provides a high degree of redundancy (electrically quadruplex, hydraulically duplex) and allows failures in single channels with consquential performance reduction but no complete. The maximum control rudder movement is 30 degrees left and right. Failure of one hydraulic system will lead to a reduced hinge moment.oss of function.

The rudder pedals are also used to generate brake and nose wheel steering signals.

LEADING EDGE SYSTEM

The leading edge system (LES) is installed in the center fuselage and wing and comprises one inner and one outer slat on each half of the wing running on tracks. It is part of the secondary control surfaces and is supplied by both utility hydraulic systems. The slats are operating synchronously between 0 deg (UP) and -19.5 deg (DOWN).

The leading edge slats are electrically controlled and hydromechanically operated and monitored by all four FCCs. Each of the two slat motors (one left, one right) receives power from one utility hydraulic system. Both motors are controlled from a tandem control valve which is driven from a Direct Drive Motor (DDM).

CONTROL LAWS

Slats position is computed as a function of air data AOA and Mach number. The slats operate automatically with no provision for manual control. Electrical feedback linkages associated with the slats actuators and the FCCs cause the slats to stop whenever the appropriate slat position is reached. To prevent excessive wear on the LES the control laws include an artificial hysteresis function which provides commands to the output only when the disparity between required and actual position exceeds a threshold.

CONTROL LAW SCHEDULE

The Control Laws contain open loop schedules for all of the secondary control surfaces (airbrake, LEAS, intake cowl). These are defined to satisfy the following criteria:

– Achieve maximum performance from the aircraft
– Maintain adequate control powers
– Keep basic aircraft stability within acceptable limits
– Avoid loading problems.

With the landing gear in the DOWN position the SLATS are locked in at and below 17° AOA.

SLATS ASYMMETRIC PROTECTION

The slats on both wings are monitored through an asymmetry detection in the FCCs to identify any significant difference in the position between left and right surfaces. A surface monitor prevents asymmetry difference greater than 3 degrees streamwise, corresponding to 4.6 deg. hinge wise, causing the system to lock the slats at the present positions.
The SLATS will continue to operate under the following conditions:

– Any single electrical failure will allow full operation.
– Any single hydraulic failure will allow operation but with reduecd load performance.

In the event of any single mechanical failure, i.e. drive shaft breaking, the slats will be locked to a fail/ safe position at the position of the asymmetry and remain inoperative.

DWP

Frozen SLATS is considered as critical and will therefore raise the DWP <SLATS> warning and the high Integrety DWP <REV ENV> warning.

NOSEWHEEL STEERING

The nosewheel steering (NWS) allows the pilot to follow a desired taxi pattern in response to rudder pedal inputs. The NWS is scheduled automatically in response to a combination of airspeed, aircraft groundspeed from LINS and wheel speeds from the landing gear computer.
The NWS is powered by the Left Utility Control System (UCS) and controlled and monitored by the FCS.

NWS CONCEPT

The FCS controls the NWS by determination of the NWS state. This process distinguishes between:

– Pre-Take-Off/Landing
– Airborne/Approach, and
– Free Caster State.

NOSEWHEEL AUTHORITY SCHEDULING

The nosewheel is scheduled as a function of airspeed with deflection decreasing with increasing speed. When no failure exists, the nosewheel authority blend from low speed (+/- 43°) to a mid-speed schedule (+/- 28°) between 20 to 30 kts, and the blend to the high speed schedule occurs between 60 to 90 kts. The changeover from low-speed to mid-speed is also dependent on throttle position, i.e. advancing both throttles out of the idle position will result in an instantaneous switch-over to high speed mode. (Figure 1.59)

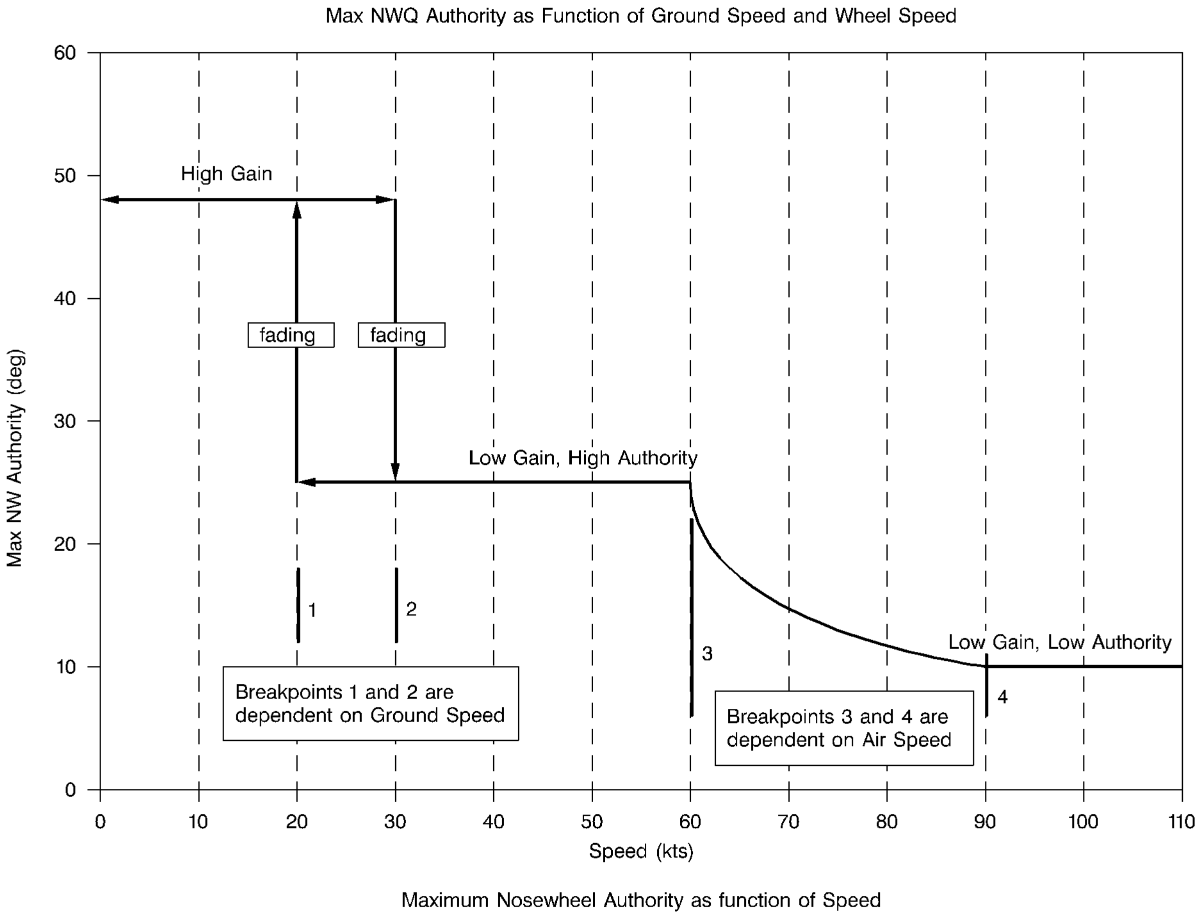


Figure 1.59 - Nosewheel Authority Schedule

PRE-TAKE-OFF/LANDING

The NWS may be engaged manually, if required via the TOT/NWS/RESET indicator push button. NWS may be disengaged via the ICO switch. When engaged, the NWS legend on the TOT/NWS button is illuminated. Manual NWS disconnect via the ICO will cause the NWS legend to flash and the DWP warning caption to be triggered.

If the system is serviceable but disengaged, pressing the TOT/NWS button will reengage the NWS, displaying a steady lit NWS legend on the TOT/NWS button and will occult the DWP warning caption.

To avoid abrupt NWS inputs during the blend from the low speed to the medium speed setting when both throttles are advanced for takeoff, a hysteresis has been added to prevent oscillations if the throttle is set to the break point where the moding takes place. The changeover during deceleration from high speed (+/-10°) to medium speed (+/-28°) is accomplished when at least one throttle lever position is reduced below the break point of the moding.

AIRBORNE/APPROACH

Once weight is off the wheels sensed, i.e. when airborne, the NWS is disengaged . When the landing gear is selected down, ICO will disengage the NWS and prevent automatic NWS engagement on landing. The NWS can be re-engaged by pressing the TOT/NWS push button, allowing automatic engagement on landing.

FREE CASTER MODE

In the case of a confirmed NWS failure the NWS will enter the free caster mode, whereby directional control may only be accomplished through the use of individual brake pedal inputs.

NWS INDICATIONS

FCS RSET

NWS engagement is indicated by:

- Occulting of the DWP NWS warning caption
- Illumination of the NWS legend on the TOT/ NWS push-button (NWS low speed), or
- Slow flashing of the NWS legend on the TOT/ NWS push-button
- Occulting of the NWS indicator on the ACUE format.

NWS disengagement is indicated by:

- Display of the NWS DWP warning caption.
- Flashing of the NWS legend on the TOT/NWS push-button (if NWS is possible to engage via TOT reset)
- Extinguishing the NWS legend on the TOT/ NWS push-button (if NWS is not possible to engage due to NWS position range exceeding)
- Setting the NWS engaged indicator on the ACUE format.

DWP

In the case of a NWS failure condition, a CAT 2 NWS or CAT 3 NWS (NAV POF only), DWP warning is triggered. ICO will also trigger the NWS warning caption.

AIR INTAKE COWLS

Two air intake cowls, one on each engine intake are hinged at the lower lip of the air intake ducts. The left air intake cowl is powered through the left utility hydraulics circuit and simplex controlled by FCC 3 and monitored by FCC 1. The right intake cowl is powered through the right utility hydraulics circuit and simplex controlled by FCC 2 and monitored by FCC 4.

CONTROL LAWS

The Air Intake (varicowl) control law provide both an automatic and manual mode of varicowl control (MAN MODE for DA1/2/3/5 only). This standard of automatic control mode provides control of the varicowl position:

- For engine ground running.
- At low speed and subsonic high incidence flying as a function of Mach number and incidence.
- During cruise at subsonic and supersonic speeds as a function of Mach number and total temperature.

The default mode of the cowl control on entry into FRS is AUTO.

AUTOMATIC MODE

The automatic cowl schedule is shown in Figure 1.60.

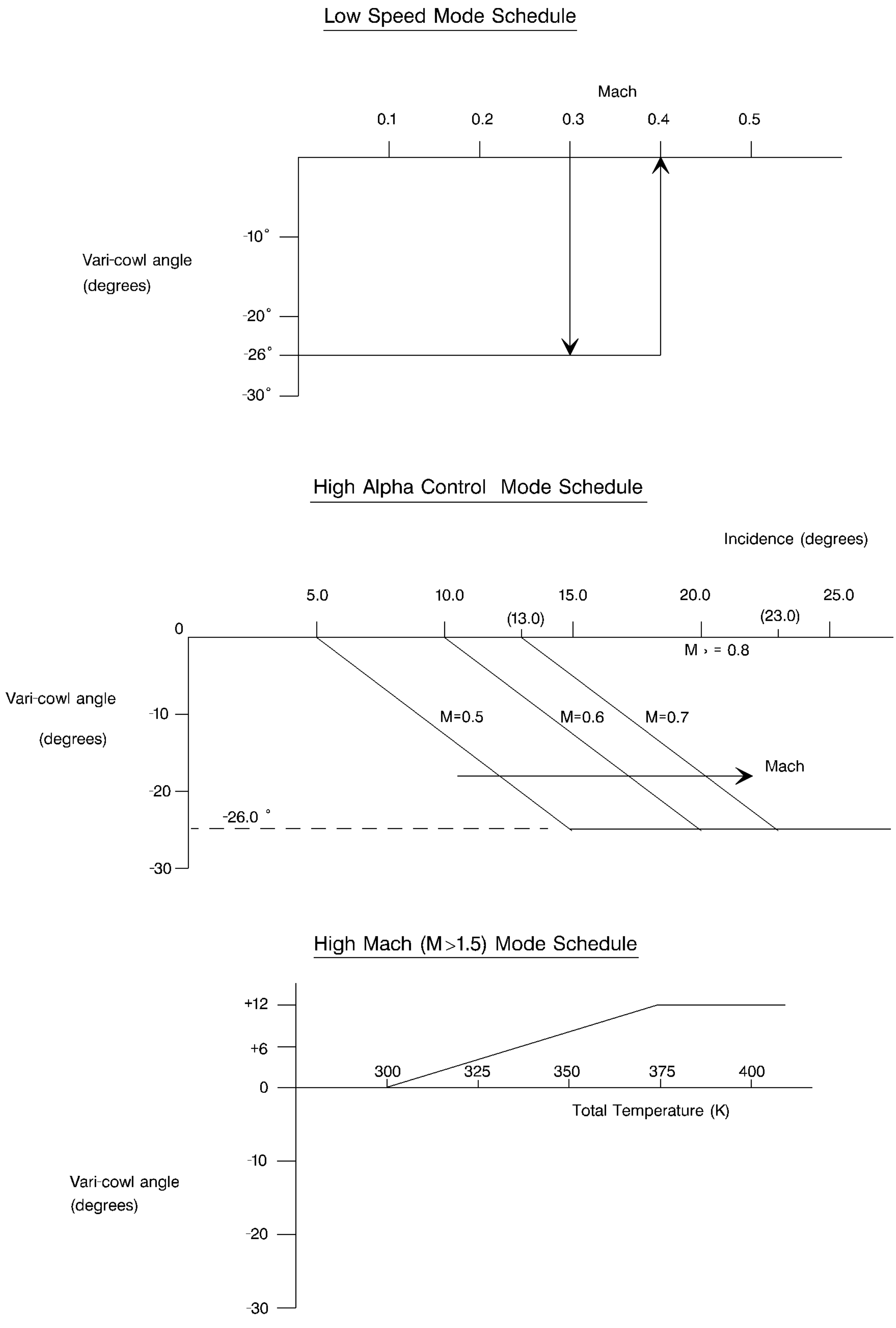


Figure 1.60 - Automatic Cowl Schedule

EMERGENCY INTAKE SWITCH

In order to provide a back-up mode to the intake cowl automatic control system, the cockpit is equipped with an emergency intake cowl opening system controlled by an emergency INTAKE open switch. Operation of the switch allows one or both intakes to be opened in the event of a failure condition as follows:

– When the switch is in AUTO position, the cowls are under automatic control.
– With one or both HYD/UTILS systems depressurized and with the emergency INTAKE switch held in the OPEN position, the appropriate intake (s) will be selected to OPEN. If the cowls have been automatically set to + 12° (above 1.5 M) at the time of failure, the cowls still can be opened to the required setting (-26°) for landing.

MANUAL OPERATION (DA1/2/3/5)

NOTE

The left and right MAN intake cowl facilities shall never be engaged both at the same time.

The MHDD displays the cowl position derived from a single point. If it fails, the wrong indications may be given and lead to close both cowls, generating a double engine flameout.

The manual control mode is operated from the cockpit and allows independent operation of left and right varicowls. With the cowl in the AUTO mode and no failure present, pressing the AUTO/MAN push button causes the cowl control to enter the MAN mode. The system will revert to the automatic mode when MAN is deselected or when a failure in the left or the right actuator loop or a failure of the enable switch is present. Transition from automatic control to manual control is instantaneous, whereas a fade-in of 5 sec. is provided from manual to automatic control. There is also an inching capability provided allowing the pilot to obtain the exact cowl position required. The manual control mode has authority limits defined as a function of Mach Number. A change to the manual mode is only possible when no failure of the enable switch exists or no actuator loop failure of the left and right cowl is present and MAN control is selected (button legend lit).

DEDICATED COCKPIT CONTROL

Intake Emergency Control switch (left console), refer to Flight Control System Controls and Indicators pag. 155.

MHDD

COWL position is indicated on the MHDD/ENG format.

DWP

A failure of the automatic cowl control is indicated on the DWP by a CAT 2 or a CAT 3, depending on POF, <L COWL> or <R COWL> warning caption. For more details refer to Air Intake Cowl Failures.

AIRBRAKE

The airbrake is installed on the upper surface of the fuselage just behind the cockpit. It is electrically controlled and hydraulically operated by the right utilities hydraulic system.
Airbrake actuation is controlled by FCC 4 and monitored by FCC 2.

CONTROL LAWS

Inputs into the airbrake position schedule are air data, angle-of-attack, measured, predicted and derived load factor and the airbrake activation signal. For the LDG DOWN AOA is the only input to the authority schedule. With the LDG in the DOWN position the airbrake is allowed to stay out to a higher command compared to normal low speed flight with LDG UP.
Output is the demanded, amplitude and rate-limited airbrake position signal to the actuator. A further element affected is present in the rudder/pedal path. In this path the demanded sideslip is calculated and the max sideslip authorities are scheduled with the airbrake selected in or out.

AIRBRAKE POSITION SCHEDULE

The aerodynamic airbrake position limit is scheduled as shown in Figure 1.61. An hysteresis and rate limit is applied to AOA to prevent cycling of the airbrake. The authority is cut down immediately with increasing alpha. There is a difference in the schedule for high and low Mach number. One authority signal is based on angle-of-attack and Mach number. A second authority signal is calculated from the max and min load factor (Nz).

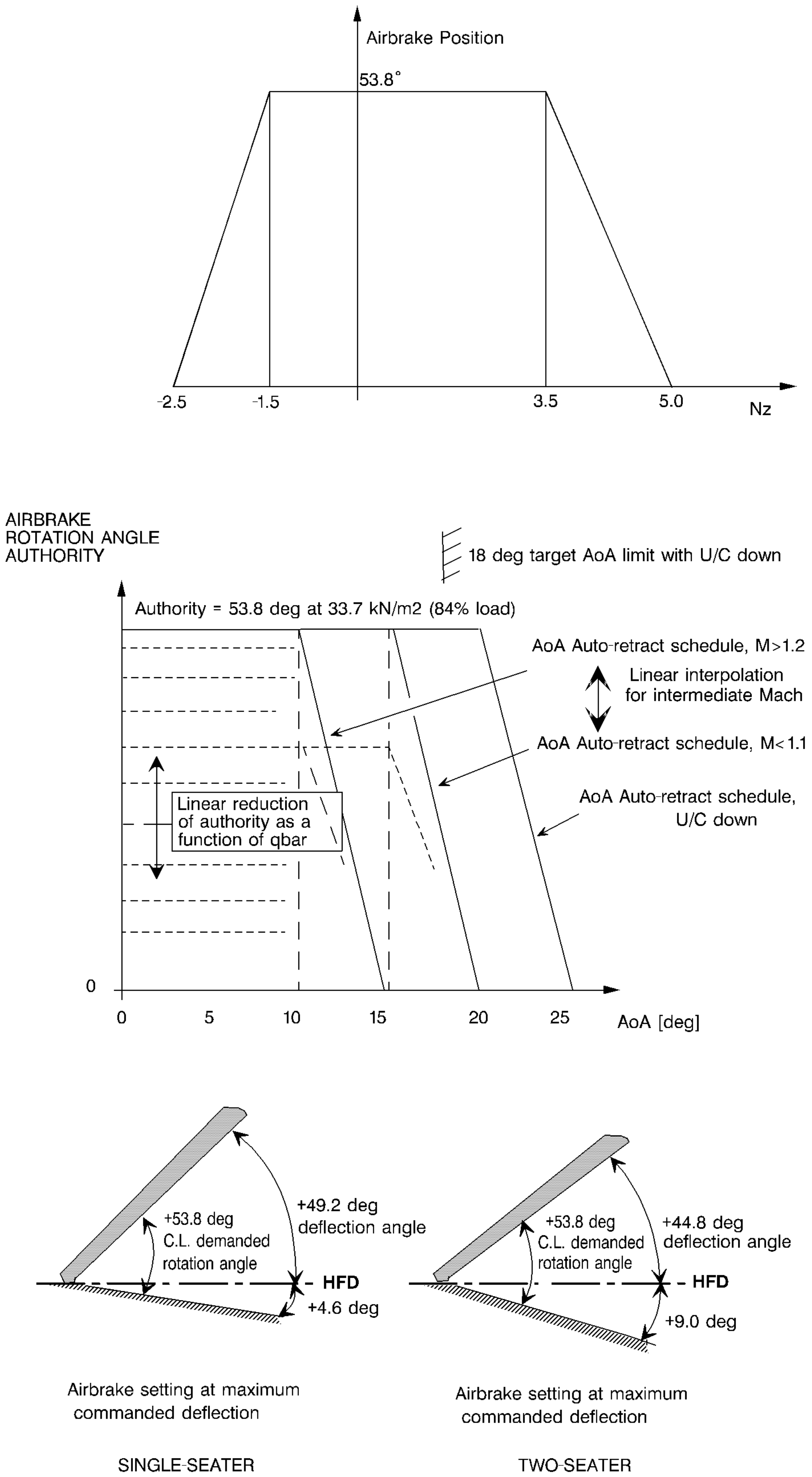


Figure 1.61 - Airbrake Schedule

The scheduling provides protection for speeds or load factors in excess of the A/B out schedule, but it also automatically retracts the airbrake if the nominal flight envelope limits are exceeded.

There are only two positions to be commanded: Fully in and fully out. The airbrake activation signal commanded by the pilot will result in either extend the airbrake, in accordance with the control law schedule, or to fully retract it. Note that the cockpit button is a spring-loaded switch. If the button is released the switch jumps back to default. In default the signal is ZERO and therefore holds the previously demanded airbrake position (fully in or fully out). No intermediate airbrake position is desired.

If the A/C passes through the scheduling limits with airbrake out and the maximum position is therefore automatically changed or the airbrake is even fully retracted, then the previously commanded airbrake status (Airbrake out) is stored and automatically restored if the flight condition allows for it.

HYDRAULIC PROTECTION MODE

For high alpha trials two further modes become necessary to protect the A/C. A hydraulic protection mode (in the case of engine flame out) will decrease the required hydraulic power by limiting primary control actuator rates and freezing the secondary control surface actuators.

The airbrake will be frozen if entering the hydraulic protection mode. If the hydraulic protection mode is quit the airbrake is reset to ZERO (fully in).

Any selection of the airbrake switch made is cancelling the previous command independent of the flight condition or the A/C (and airbrake) mode.

SPIN RECOVERY MODE

The spin recovery mode will be activated if the A/C needs to be recovered from a spin by using the spin recovery chute. The spin recovery mode provides a direct link to the primary control surfaces and runs all secondary control surface actuators to their default position. The pitch integrator is initialized to ZERO for the time the spin recovery mode is engaged. Note that this mode will not be available in the production aircraft.

The airbrake will be fully retracted in the spin recovery mode.

CONTROLS AND INDICATORS

AIRBRAKE SWITCH

The airbrake is controlled via a three position sprung to center selector mounted on the throttle top.

HUD

When selected to out, the airbrake position is indicated in the HUD by a green symbol above the aircraft symbol. It is steady when airbrake is deployed and will occult when the airbrake is fully retracted in.

DWP

A BRAKE

– If triggered by a detected failure the airbrake will be commanded to in either by hydraulic pressure or aerodynamic load.
– If triggered by a <L UTIL P> failure, a manual selection to IN is required for airspeeds above 250 KDAS.

TRIM SYSTEM

The aircraft is trimmed automatically within the control laws, or manually through dedicated cockpit switches located on the stick or the left console.

GENERAL FUNCTIONALITY

In pitch and roll the aircraft is trimmed automatically from within the control laws for most of the flight envelope. A parallel manual trim function is also provided via the stick top trim switch whenever this function is enabled by setting the TRIM/DA switch to the TRIM position.
In the yaw axis, manual trimming only of the rudder is available via a switch mounted on the left console. Manual trim authorities are speed scheduled. Trim inputs are not additive to normal stick and pedal control authorities limits. Thus, use of the trims cannot be used to augment the stick and pedal control power.

NOTE

– At FCS PH3R1 and 1a+ the AP function is not available, hence the default setting of the TRIM/DA switch should be TRIM (aft).
– Similarly, the trim button on the stick is configured to accept manual trim inputs only.

USE ON THE GROUND

Following engagement of the FCS, manual trimming in all three axis is available provided the throttles are at idle. Moving any trims away from neutral will cause the TOT indicator in the FCS RSET push-button to flash at a slow rate. Pressing the FCS RSET button will reset all trims to neutral and cause the TOT legend to become steady (checking of the manual trim function during start up is not essential for flight safety). If either throttle is moved above idle, manual trimming is disabled and all trims are set to the takeoff position (neutral) and maintained there until weight comes off the nose wheel during takeoff.

USE IN FLIGHT

PITCH AXIS

In pitch, the aircraft self-trims to zero pitch rate at center stick throughout the speed envelope below 17° AOA. Above 17° AOA, nose down static stability is progressively introduce via AOA feedback. manual pitch trim is active only below speeds of 186 KDAS and can be used to cancel the static stability effect for AOAs up to the value corresponding to 25% aft stick. At slower speeds, increasing amount of aft stick are required to maintain zero pitch rate with full back stick being required at limiting AOA. manual trim inputs are automatically cancelled when the speed increases above 186 KDAS.

ROLL AXIS

In the roll axis, the aircraft is self-trimming via an Auto Roll Trim (ART) function at all speeds down to 150 KDAS below which the ART function is disabled. The ART is active in the maneuver envelope +/- 60° pitch/bank between + 15° and - 5° AOA whenever the roll stick and rudder pedals are centered. outside this envelope, the last good auto trim offset value is retained for use in the roll command path. The trim settings applied by the ART are fully compensated for normal g effects. The lateral trim offsets required to balance asymmetric stores are fed directly into the ART system via the control laws using stores data supplied by the ACS.
There are three sub-modes contained within the ART as follows:

- Bank Angle Hold: This operates between 7° and 60° of bank and maintains constant bank angle.
- Wings leveller Mode: This operates at bank angles of less than 7° and will cause the aircraft to roll very gently towards 0° bank angle.
- Fly Straight Mode: This mode works as a pseudo-heading hold mode. It will cause the aircraft to fly in a straight line by applying a small amount of bank to offset lateral CG asymmetries provided the aircraft is trimmed out directional. Directional mis-trimming will cause the aircraft to fly excessively wing down.

Manual roll trimming is available throughout the flight envelope and may be used tom assist the ART particularly in emergency situations involving extreme lateral cg positions or flight with an engine shut down. The manual roll trim system is limited in authority to 40% of full roll stick. Any out of trim manual roll trim inputs will be washed out by the ART system.

YAW TRIM

The yaw trim system has a manual mode only. It operates directly on the rudder angle command path. The authority is set to nominal 70 % of pedal authority. The yaw trim authority is faded to zero between 1.7 M and 1.8 M in order to prevent interference with the primary control laws directional stability augmentation.

FLIGHT CONTROL SYSTEM CONTROLS AND INDICATORS

NOTE

> The control switches may have different locations in the various SS cockpits.

Control and monitoring of the FCS is achieved by a combination of dedicated controls, switches and displays.

DEDICATED CONTROLS, SWITCHES AND INDICATORS

CONTROLS

The controls comprise the pilots stick, rudder pedals, FCS related control switches, push-buttons and indicators.

CONTROL STICK

The pilot has full authority in pitch and roll by applying small stick displacements. The pitch stick travel contains an override region whereby the stick may be pulled through an aft detent (20% additional aft) to give additional emergency pitch control authority.

PITCH AND ROLL TRIM BUTTON

The pitch and roll trim button is a standard simplex 5 position (up/down, left/right, center) toggle button, spring biased to center, which drives integrators in the flight control computers (FCCs).

INSTINCTIVE CUT OUT SWITCH

The ICO disconnects the NWS, FBI and the Autothrottle (AT) and Autopilot (AP), when applicable.

AUTOPILOT ENGAGE/DISENGAGE PUSHBUTTON

NOTE

At FCS PH2B/2 the AP function is omitted.

The button is also used to inhibited the CG warner, when required, and/or for Frequency Bias and Impulse function (FBI).

THROTTLES

The throttles are used to interface with the DECU (Digital Electronic Control Unit) but also to provide various interfaces with other FCS controlled systems.

AUTOTHROTTLE ENGAGE/DISENGAGE PUSHBUTTON

NOTE

At FCS PH2B/2 only the AT function is available.

The button is located on the upper side of the right throttle.

AIRBRAKE CONTROL SWITCH

A two position spring to center toggle switch located on the right throttle. Momentary actuation of the airbrake switch selects the airbrake to a fully in and locked position (switch forward) or to the out position (switch rearward) determined by AoA, Mach and airspeed at the time of selection.

RUDDER PEDALS

The rudder pedals are used for demand to the rudder via the FCCs, to kick off drift on landing, for demand to the nosewheel steering when the weight on nosewheel signal is present, or for braking purposes. Rudder deflections are intentionally minimized. The rudder pedals can be adjusted by a pedal adjust handle.

PEDESTAL PANEL

Disorientation Recovery Function (DRF) button is covered by a safety guard and not cleared for use.

LEFT CONSOLE

FCS RSET

CAUTION

IF THE COVER GUARD OF THE FCS TEST BUTTON IS LEFT IN THE OPEN (UP) POSITION, THE FCS RSET BUTTON FUNCTION IS DISABLED.

The FCS RSET control selector/indicator is a momentary square push button that enable a number of FCS functions to be performed. The quadruplex button is labelled FCS RSET (panel marking) and NWS-T/O (split indicator). The split legends NWS and/or T/O illuminate by integral sources as appropriate.

LEFT AND RIGHT INTAKE MANUAL/AUTOMATIC CONTROL (DA1/2/3/5)

NOTE

Operation of the MAN VARICOWL(s) below 0.35 M is prohibited.

The two coverguarded, momentary action, squared push-buttons illuminate if MAN is selected and enable the manual control of the left, respectively the right intake varicowl. A second selection reverts the cowl(s) back to automatic control.

LEFT AND RIGHT INTAKE VARICOWL MANUAL CONTROL (DA1/2/3/5)

The two three position toggle switches labelled INTAKE VARICOWL L and R OPEN-CLOSE, located on the left rear console provide manual control of the left and/or right air intake cowls. Manual control allows selection over the full range of cowl movement (+12° to -26°) but with maximum opening limited to that of the low AOA setting of the automatic schedule.

After entry into FRS the system initializes with the automatic mode. A change to the manual mode is only possible when no failure of the enable switch signal and no actuator loop failure of the left and right cowl is present and MAN control is selected (button legend lit). The system will revert to the automatic mode when MAN is deselected or when a failure in the left or the right actuator loop or a failure of the enable switch is present.

CONFIGURATION CONTROL OVERRIDE SELECTOR

Moding selections of the CONFIG OVRD are as follows:

- With the coverguard closed any selection of store group is inhibited.
- With the coverguard open, manual selection of any store group (A, B or C) is possible.
- With the coverguard closed again the last selected configuration will permanently be used and this will be permanently indicated by illuminating the relevant store group.

If a new group is selected this is immediately indicated by the illumination of the relevant group. The selection is also immediately available within the control laws.

YAW TRIM SWITCH

Toggling the trim switch to the left or right increments the yaw trim via an integrator.

FCS TEST PUSHBUTTON/INDICATOR

CAUTION

- THE FCS TEST COVERGUARD MUST NOT BE OPENED UNLESS:
  - THE AMC IS INITIATED
  - A REPEAT PFC IS INITIATED (FOR ENGINE SHUT DOWN).

A quadruplex coverguarded test push-button providing an integral amber BIT and associated bars (box) illumination. After power switch on the FCS automatically initiates the power up BIT (PBIT) which lasts appr. 60 seconds, during which the BIT legend and the bars on the FCS TEST button are lit.

INTAKE EMERGENCY CONTROL SWITCH

The coverguarded, two position (AUTO/OPEN), spring biased to AUTO switch, if manually selected to the OPEN position allows the respective or both cowl surface(s) to move downwards (OPEN) as long as the switch is held to the OPEN position. In the absence of a detected failure the switch has no overriding function.

PITCH AND ROLL TRIM CUT OUT CONTROL

The two position, bi-stable toggle switch, when set to CANCEL, enables to cancel all previous applied manual trim inputs in pitch, roll and yaw on the ground and in flight. The cancelled signals will gradually fade to the datum position within 2 seconds.

LIFT DUMP SWITCH

A two position, bi-stable switch which is locked in the forward position (LIFT) and must be unlocked prior to aft (DUMP).

No cockpit indication is provided of the actual switch selection. The pilot must visually confirm switch selection and/or the position of the control surfaces on the ground (foreplanes).

REVERSIONARY FCS LAWS SELECTOR

The FCS provides full control law and reversionary control laws. The full mode is the normal mode for the control laws upon entry into FRS, with either automatic or manual degradation.

The push-button, labelled REV FCS, is used to manually select the pilot selectable reversionary mode (PSR) and/or to indicate reversion to the automatic FCS REV failure mode or the manually selected reversionary mode.

DISPLAYS

The FCS functions and warnings can be monitored and are displayed on the HUD, MHDDs, the Get-U-Home instruments (GUH) and the DWP.

HUD

FCS derived information, computed in the four FCCs are displayed in the HUD PDU. These include:

- Baro altitude and barometric pressure setting, airspeed i.e. KDAS/M and vertical velocity.
- Airbrake position (green symbol).
- Landing gear state (D, U and/or X).

MHDD

FCS PH2B/2 related data are presented on the following MHDD formats:

MHDD AUTOCUE (ACUE) FORMAT

The MHDD/ACUE format provides BIT sequence and indications as prompts. However, as a consequence of the relatively low integrity of the Displays and Controls subsystem, the pilot can not rely on the MHDD/ACUE format for essential FCS status indications. Evidence is provided by telemetries.

MHDD ENGINE FORMAT (ENG)

The position of the left and right intake cowl (INT) is indicated.

FLIGHT CONTROL SYSTEM BUILT IN TEST

The Flight Control System (FCS) incorporates extensive Built In Test (BIT) facilities to accomplish failure detection and failure isolation. The BIT thus indicates functional equipment performance or failure modes to determine the operational readiness and to evaluate the status of the FCS.

The FCS BIT functions are part of the aircraft Integrated Test System (ITS). The FCS BIT includes:

- Initiated Built-In-Test (IBIT), and
- Continuous Built-In-Test (CBIT)

BIT OPERATIONAL MODES

The FCS BIT comprises two modes, namely the Initiated BIT (IBIT) to detect failures on ground and during preflight check and the Continuous BIT (CBIT) for in flight assessment.

In the TWS aircraft all IBIT moding pilot interactions can only be performed from the front cockpit (FCS TEST/BIT button only in front cockpit). The progress and results of the IBIT functions are displayed as status indications on the MHDD/ACUE format and by the TOT/NWS/RESET button.

INITIATED BIT (IBIT)

The on ground FCS checks are performed by the IBIT function to enable the pilot to assess autonomously the operational level of the FCS before takeoff down to module level. Adequate interlocks are provided to ensure IBIT operation on ground only.

The IBIT is divided into three operational levels:

- Pre-Flight Check (PFC)
- Actuator Movement Check (AMC)
- First Line Check (FLC)

PRE-FLIGHT CHECK (PFC)

The PFC includes:

- Automatic PFC on all FCCs
- Determines the status of the overall FCS by checking the IBIT status of other FCS LRIs.
- Performs full FCS configuration check
- Checks IMU harmonization data and course alignment status
- Records all FITs
- Generates a maintenance message for each FIT bit.
- Generates PFC status indications on the MHDD/ACUE format and other cockpit indicators, e.g. TOT button.

The PFC will run automatically when the a/c is powered up (BATT on), or can be re-run by the pilot (Repeat PFC) provided the engines are not running yet and a previous PFC failure has been detected.

ACTUATOR MAINTENANCE CHECK (AMC)

After the successful completion of the PFC, the AMC can be initiated by pressing the FCS TEST button, provided hydraulic power is available. The AMC involves the physical movement of all primary and secondary actuators, except the NWS, and is selectable by the pilot via the FCS TEST/BIT button. Selection is only possible after a PFC/R-PFC GO and with both hydraulic systems available. It consists of:

- Actuator movement checks on all primary actuators.
- Actuator movement checks on LEAS, AB and L & R COWL.
- FIT recording.
- Generates maintenance messages.

Entry into AMC is inhibited when the FCS has entered Fight Resident Software (FRS). Status indications are displayed on the MHDD/ACUE format, on the FCS TEST button and on the FCS RSET button.

If the ACT is interrupted by means of the ICO, the FCS puts the actuators in a safe mode. A repeat ACT following ICO interruption is possible. Following AMC abort the BIT illumination legend flashes and pressing the BIT button will return the system to the IBIT mode select where AMC can be repeated.

If the ACT is terminated due to hydraulic power failure or finished with a GO or NOGO the IBIT mode (PFC GO) is automatically entered again, and the FCS readiness to enter FRS will be dependent only from the ACT result.

FIRST LINE CHECK (FLC)

The FLC will perform more comprehensive tests of the FCS LRIs and also provide the facility for data upload. The FLC can be initiated after PFC or AMC via dedicated MHDD soft keys or via dedicated ground equipment (ATE).

NOTE

In the current FCS PH3R1 the FLC runs only via ATE. The relevant ACUE information is also not yet available.

IN FLIGHT CONTINUOUS BIT (CBIT)

The CBIT function will be performed automatically and continuously whenever the FCS in flight software is active. FCS related failures will be indicated on the DWP.

FCS STATUS INDICATIONS

The related BIT indications are summarized at Table.

FCS RSET BUTTON	FCS TEST/BIT BUTTON	CONDITION	MHDD/ACUE INDICATION
OFF	BIT lit BARS lit	BATT switch ON	FCS NOT READY PRE-FLIGHT BIT IN-PROGRESS
OFF	BIT lit BARS flash	PFC FAIL R-PFC selectable	FCS NOGO PRE-FLIGHT BIT AVAILABLE
OFF	OFF	PFC pass HYD not available	FCS NOT READY
T/O legend flash (Note 1)	BIT lit	PFC and/or ACT pass HYD available	FCS READY
OFF	BIT lit BARS lit	ACT selected via FCS TEST button	ACTUATOR BIT AVAILABLE FCS NOT READY ACTUATOR BIT IN PROGRESS
OFF	BIT lit	ACT fail ACT re-selectable	FCS NOGO ACTUATOR BIT AVAILABLE
T/O lit NWS flash	OFF	FRS entered via FCS RSET button	EMPTY
T/O lit NWS lit	BIT lit	SEL MODE available from FRS (no motion & no engines running)	PRE-FLIGHT BIT AVAILABLE
OFF	BIT lit BARS LIT	AUTOMATIC R_PFC ON ENTRY IN SEL MODE	FCS not READY PRE-FLIGHT BIT IN PROGRESS
OFF	BIT lit BARS flash	PFC fail R-PFC selectable	FCS NOGO PRE-FLIGHT BIT AVAILABLE
OFF	OFF	POWER DOWN	EMPTY

Note 1:

– The readiness of the ACS system does not influence the FCS Normal Mode availability, but the a/c is prohibitrd to fly without the check passed (<FCS MASS> warning is triggered on entry into FRS).

– For this Phase FRS can be entered without IMU fine alignment complete (only course alignment complete). The IMU fine alignment uncompleted does not influence the Normal Mode availability but as a consequence the True Heading is not available. If the fine alignment is ongoing this is indicated by the fast flashing of the TOT legend. The TOT legend will flash slowly when fine alignment is complete.

FCS MODING

WEIGHT ON WHEELS (WOW)

This process uses LDG controlled relays to determine the a/c weight on wheels state. There is only one relay per gear strut/wheel.

Under no failure condition the in air/on ground state of the system is altered according to the nosewheel state (transition to in air/FLT) and nosewheel and mainwheel states (transition to on ground). In the case of nosewheel failures, e.g. jammed on nosewheel or nosewheel signal failures pitch rate or main wheels are used to set the system into the air state (FLT-LATCHED). If this occurs, the transition to ground from the FLT-LATCHED state only occurs based on mainwheel and alpha (AOA).

For redundancy purpose the FCS Pitch Rate from the IMU and the FCS AOA data from the ADS provide additionally improved integrity/detection of failures.

The WOW function in general detects:

– Nose wheel flight latched.
– Nose wheel jammed on the ground.
– Single main wheel failures.
– Incorrect LDG lever position indication.

GROUND

In the ground mode, which includes takeoff run until lift-off, landing roll with lift reduction and taxi, the pilot has direct link to:

– Foreplane and symmetric/differential flaperons by use of the stick.
– The rudder and the nosewheel steering by use of the rudder pedals.

On ground, at low a/c speeds the gains in the control law demands to all primary surfaces are reduced to prevent unnecessary activity of surfaces induced by sensor feedback signals when the aircraft operates on bumpy run or taxiways.

Airdata displayed, such as AOA, KDAS/M is set to a valid default value until a speed of 50 KDAS has been reached. From 60 to appr. 80 KDAS the pitch damper signal is fading in.

TRANSITION FROM GROUND TO AIRBORNE

After entering FRS and normal LDG hard wired relay operation, the a/c is considered on the ground as long as the WONW relay is set to “TRUE”. As soon as the WONW signal is set to “FALSE” transition into air is initiated.

In the case of additional failure detection, i.e. the NWS relay has failed on transition to air:

– IMU pitch rate plus AOA data are used, or
– Both main LDG WOW are detected “FALSE”, i.e. off the ground.

AIRBORNE

After rotation the weight off the nose wheel initiates and activates the transition sequence to the airborne mode. The fade in is 3 sec. After transition to the airborne mode, maneuver demand control law is active. In addition, the landing gear lever signals LDG up or LDG down FCS mode.

TRANSITION FROM IN AIR TO ON GROUND

The transition from the in flight status to the ground status is governed by WONW plus at least one WOMW.

In the case of additional failure detection, i.e. the NWS relay has failed and the nose wheel was set to flight latched (NWS legend on the FCS RSET button flashes), then:

– Both WOMW must be “TRUE” and AOA data from ADS must be available.

If FCS AOA data are not healthy:

– then exit from flight latched is not possible and the DWP NWS warning is set.

LIFT DUMP

The LIFT/DUMP function provides the ability to reverse the direction of the lift force which generates increased drag and extra load on the mainwheels to aid braking performance. This is achieved by driving the control surfaces into a DUMP position, i.e. flaperons upwards and foreplane leading edge downwards, scheduled via a Lift Dump control law mode.

Moding of the LIFT/DUMP is fully automatic with no requirement for a dedicated switch operation by the pilot. Foreplanes and flaperons are scheduled with airspeed to assist in decelerating the aircraft. The moding includes also mass scheduling to ensure that Lift Dump operation is within Lift Dump cleared limits. During low speed taxi, Lift Dump is automatically not engaged to ensure that no foreplane reflection of the landing lights occur. At engine shut down Lift Dump is engaged (DUMP) to ensure that the foreplanes are parked in a position that does not interfere with the ladder.

The moding is as follows:

– With at least one throttle above idle or NW off the ground or NWS high speed mode engaged (+/- 10°) or the a/c mass above landing gear limit, the automatic Lift Dump function is inactive, i.e. not engaged, and TOT is automatically set.
– With both throttles at idle, NW low speed mode (+/- 43°) active, the a/c mass below landing gear

limit and above taxi speed the automatic Lift Dump is active, i.e. engaged.
- At engine shut down automatic Lift Dump is engaged in order to assist actuator parking.
- During automatic Lift Dump, pilots stick input commands are still active and will override the flaperons deflections.

The lift reduction (DUMP setting) consists of the following stages (Figure 1.62) :

- Pre-set of -25 deg foreplane and an increasing negative flap deflection as airspeed reduces.
- An additional super imposed airspeed/ deceleration scheduled negative flap deflection to a level where flap induced pitch up is balanced by the pitch down provided by brake torque.
- Foreplane rotated from -25 deg to -60 deg below 90 KDAS (max drag).

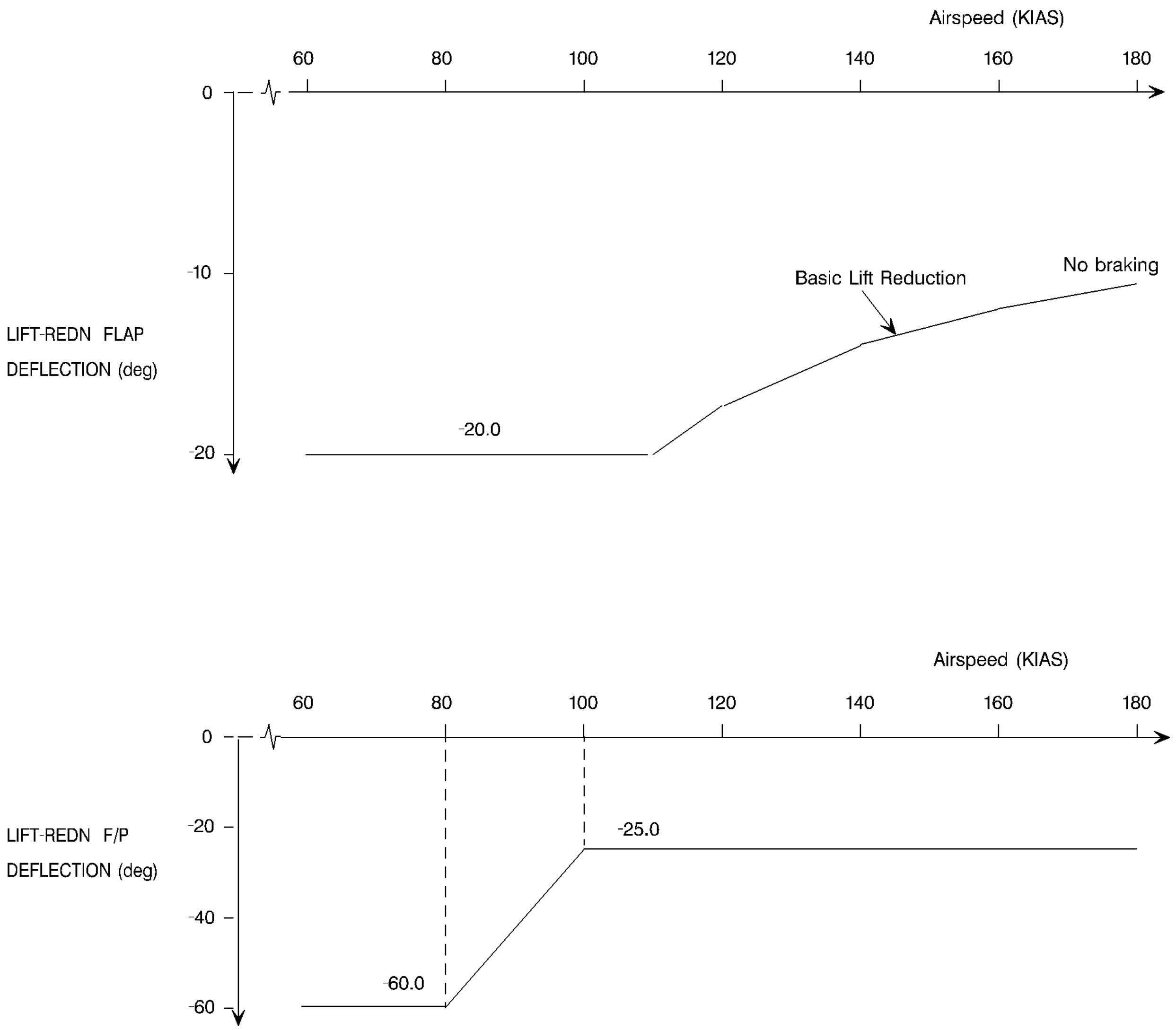


Figure 1.62 - Lift/Dump Schedule

There is no indication to the pilot as to whether the DUMP mode is engaged other than the control surfaces.

PROPULSION

Information of the left and right throttle positions is provided to the left and right EJ200 DECU and to the landing gear and fuel management subsystems. The left DECU is connected to FCC1 & 3 while the right DECU is connected to FCC 2 & 4.

Throttle position is routed from the SSICA interface to the LGC and FCS interfaces and in addition to the left and right DECU interfaces. On ground this routing is dependent on successful IBIT completion.

A throttle follow up function is implemented.

To establish the correct data transfer between the FCCs and the DECUs via the FCS bus, a certain sequence of events must take place as follows:

- FCS PFC takes 20 seconds from FCS power up, during this period no transfer of data between DECU and FCS is performed.
- When the throttles are moved from HP SHUT to IDLE or above, the DECU is commanded to be powered (hardwired signal from throttle box to relevant DECU).
- The DECU needs approximately 2.5 seconds from DECU power up to perform its initialization and IBIT operation. During this period no transfer of data between DECU and FCS is performed.
- Once the correct data bus communication is established, the DECU enters normal operation and data transfer can start.
- Airdata calculations will commence when the aircraft is airborne , or both NH are indication above 50 % NH.

The DECU is powered up when:

- The left and/or the right throttle levers are moved from HP SHUT to IDLE or above, or
- The aircraft is airborne.

The DECU is commanded to shut down, when:

- The left and/or the right throttle levers are moved from IDLE or above to HP SHUT, and
- Engine run down is detected below 50% NH, and
- The aircraft is on the ground (WOW).

COCKPIT SWITCH MODING

FCS RSET BUTTON

Following successful completion of PFC or ACT respectively, entering FRS is only possible from the front cockpit by pressing the FCS RSET button. Simultaneously NWS and TOT are engaged and indicated in both cockpits.

Subsequent operation of this control from either cockpit is possible, however the function is dependent on “who has control”.

Operation of the FCS RSET button causes the FCS to enter flight resident software (FRS), to engage the NWS and to set the takeoff trim (TOT). This is indicated by a low flashing (0.5 Hz) of the NWS, provided LINS is set to NAV mode, and T/O legend steady lit. The control surfaces are normally set to their datum trim position. The NWS will engage if the nosewheel is within 46.8 deg of the centered position, which represents actuator limit.

Under certain FCS failure conditions, the FCS may be reset to a normal failure free state using the FCS RSET button. A reset is only possible if the failure return to a failure free state; in this case the <FCS 1> warning will be accompanied by the <FCS RSET> warning.

NOSEWHEEL STEERING (NWS)

This process initiates and executes the moding to engage and disengage the NWS. The moding comprises basically two main modes, namely:

- NWS Pre-Take Off/Landing, and
- NWS Airborne/Approach.

The following inputs determine the NWS moding:

- System gain, i.e. low speed mode (+/- 43°), medium speed mode (+/- 28°) or high speed mode (+/- 10°) are based on wheel speed, IN velocities and groundspeed. In all cases the NWS legend on the FCS RSET button is steady lit.
- If wheel speed or IN velocity are greater than a certain threshold, or if both throttles are set out of the idle position near to MAX DRY, the NWS will enter high speed mode (+/- 10°).
- If wheel speed and IN velocity are less than a certain threshold (in general taxi sped) and if any throttle is set less than a defined position near MAX DRY, the NWS enters the low speed mode (+/- 43°). This mode is set by default if wheel speed or IN velocity are invalid.
- During low speed taxi NWS low speed mode (+/- 43°) will be indicated by the LIFT DUMP mode not being engaged, i.e. corresponding zero deflection of the foreplanes.
- In the case of a NWS failure the NWS will fade to zero by mechanical means and control law demand.
- When airborne, i.e. no weight on nosewheel, the NWS will be disengaged and the NWS legend extinguishes. With weight on the nosewheel again the NWS legend will be lit again.

- With the LDG selected DOWN (airborne) operation of the ICO cause the NWS to disengage, the NWS legend to flash, and the DWP <NWS> is raised. Pressing the FCS RSET button will reset the NWS legend, reset the <NWS> warning and re-engage NWS on the ground.
- If ICO is selected and the LDG is then selected UP, the NWS legends will cease to flash and the DWP <NWS> warning will extinguish. When LDG is selected DOWN again, ICO is remembered, the NWS legend continues to flash and the DWP <NWS> warning is raised again.
- The free caster mode is entered when NWS CBIT failures are detected. NWS will be disengaged, NWS legend is extinguished and the DWP <NWS> warning is displayed.

TAKEOFF TRIM (TOT)

This process provides the moding necessary to:

- Provide visual indication of the trim offset status on the ground,
- Allow to reset all trim offsets via the FCS RSET button on the ground,
- Automatic reset of all trim offsets if at least one throttle is advanced above IDLE on the ground.

WEIGHT OFF THE NOSEWHEEL

With weight off the nosewheel the TOT legend is extinguished. Pressing the FCS RSET button will have no affect on trim.

WEIGHT ON NOSEWHEEL (WONW)

Upon entering FRS or when in FRS and either throttle is advanced above IDLE the control surfaces are set to the TOT position, indicated by the TOT legend steady lit. The NWS will engage. Manual trim inputs are ignored as long as at least one throttle is out of the idle position.

With both throttles at idle pressing the TOT button will reset the trims, if applicable, to the TOT position. The TOT position (Take Off Trim) can be manually offset in pitch, roll and yaw causing the T/O legend to flash if the trim offsets are > 0.25 deg of the TOT position. A reset to the datum (T/O steady lit) position is achieved either by:

- Pressing the FCS RSET, or
- Advancing at least one throttle out of the IDLE position.
- Manually re-trimming of all axis to within the TOT threshold of +/- 25°.

DATUM ADJUST TRIM SWITCH

The DATUM ADJUST/TRIM switch can be used in two modes as follows:

- The DATUM ADJUST mode is used for inputting datum values for the AP Altitude Acquire and Heading Acquire mode.
- The TRIM mode for making manual pitch and roll inputs to the FCS control laws.

The mode used by the stick top Trim switch is determined by the position of the DATUM ADJUST/ TRIM switch. The normal position of the switch is in the DA position (forward). The TRIM (aft) position is used occasionally when manual trim inputs to the primary control laws need to be made. The switch is time monitored, i.e. the moding provides a monitoring function of the yaw trim switch and the dual purpose stick mounted Trim/AP datum adjust switch, and also provides the resultant trim cancel moding function.
Depending on the switch position the moding controls whether a primary control law input for pitch or roll trim shall be made, or an AP heading or altitude datum entry shall be done via the stick top pitch/roll trim button. The logic of Table applies.

DATUM ADJUST/TRIM SWITCH POSITION	AP STATE	FUNCTION AVAILABLE	PITCH/ROLL TRIM FUNCTION
DATUM ADJUST	engaged	AP datum adjust	Disabled
DATUM ADJUST	not engaged	AP datum adjust	Disabled
TRIM	engaged	No function	Disabled
TRIM	not engaged	Pitch/Roll Trim	Enabled

STORE CONFIGURATION SETTING

NOTE

At FCS FPSP1a store group A is set by default on power up.

Store group A uses data from Fuel (mass) and the SCAC of the cleared configuration. Store group A will only be accepted if the initial store data warnings, <SCAC> and/or <FCS MASS> are not set. However, if SCAC fails the data will be set to a safe default position within store group A.

The store configuration selection logic allows to override the Fuel/SCAC derived signals using the CONFIG OVRIDE selector switch according to Table. CONFIG A, B or C can only be manually selected with the cover guard open (up). With the cover guard open any of the three selections A, B or C will select the particular store configuration for the control laws. The relevant button is lit, all others are off. The store group illumination is available in the front and the rear cockpit.

Functionality of CONFIG OVRIDE Switch

CONFIG SETTING	STORE GROUP	FUNCTIONALITY
A	1	Fully automatic scheduling. All Fuel/ Store interface signals function as designed.
B	2	All Fuel/Store interface signals are fixed at values representing a/c configuration in CL Store Group 1 at 14 ton.
C	2	All Fuel/Store interface signals are fixed at values representing a/c configuration in CL Store Group 2 at 16 ton.

BARO PRESSURE SETTING

The BARO pressure moding function (BPM) is handled via the left glareshield (LGS) utilizing a toggle switch. The toggle switch (up/down) on the LGS selects the baro pressure values in 1 mb or 5 mb steps upwards and downwards depending on the input selection time. The toggle switch is only available in the front cockpit, but all displays are available in both cockpits. The actual selected baro pressure is displayed by AVS D & C on the LGS via a four digit number in millibars and is also presented on the HUD. The selected baro pressure value is supplied to the airdata process, which delivers the corrected baro altitude. The corrected baro altitude is then displayed to the HUD and the GUH instrument altimeter on the RGS.

The baro pressure pilot selection signals as well as the “ringback” illuminations are routed via CIU and AVS bus to FCC1 and FCC2 and additionally via RGS and USC bus to FCC3 and FCC4 in order to cover a single source failure. In the case of such a failure the baro pressure moding automatically reverts to the valid remaining source, AVS or UCS, and temporary sets the <BARO SET> warning. In the case of a double source failure the standard pressure is set to the last good value and the <BARO SET> warning is permanently raised. refer also to .

The BPM runs in normal FCS mode as follows:

– On a/c power up the BPM is automatically set to standard pressure 1013.
– The pressure can then be altered via the toggle switch in increments of either 1 mb or 5 mb upwards or downwards depending on the input selection time. The selected baro pressure range is 850 mb to 1070 mb.
– The standard pressure of 1013 can be set by the non-spring-centered left position of the toggle switch. If the control is set back from the standard selected position to the center position the BPM sets the last value which has been entered previously.
– Control inputs (up/down) in excess of 23 seconds will trigger the <BARO SET> warning and restore the last valid baro pressure setting. The control will fail and no further adjustments are possible.

LANDING GEAR

FCS moding, i.e. landing gear UP or landing gear DOWN, is purely dependent on the landing gear lever position.

The main differences between the control laws LDG UP or LDG DOWN are:

– With the LDG DOWN the longitudinal control system provides reduced g/AOA limits compared with LDG UP.
– With the LDG DOWN the maximum roll rate is reduced and rudder pedal authority is increased.

When the FCS control laws switch from landing gear down to landing gear up laws, the roll rate command gain is increased (and vice versa).
The landing gear DOWN control law mode has the following features:

– Carefree handling is not available; however, an AOA (25°) and g (+4/-0) limiter is available. Roll authority is 80 deg/s.
– Pitch handling is pure pitch rate demand (Q), with AOA feedbacks suppressed to minimize turbulence response.
– Sideslip feedback is suppressed at approach AOA's to minimize turbulence response.
– Foreplane is pre-set to a + 2 deg position, increasing available lift and drag.
– Leading edge slat is fully retracted (0°) within the normal approach AOA range (below 17 deg).
– The low speed artificial static stability is set to its full approach phase level.
– Minimized out of trim on takeoff, with the static stability function cancelled when accelerating to avoid the requirement to re-trim on climb out.

FCS OPERATIONAL MODES

FULL OPERATING MODE

The FCS full mode includes:

– Valid AOA and SS signals including Total temperature (TT)
– Valid attitude data from IMU-FCC moding (IMU/LINS)
– Valid Mass/Store data automatic for Store Group A.

HANDLING FEATURES SUBSONIC

– Uniform takeoff response over a range of masses and throttle settings, controlled by airdata scheduled ground mode authorities.
– L/G down pitch rate demand mode with AOA and g limiting function. Roll authority of 180 deg/sec.
– Improved lift/increased drag in the approach phase. Airbrake is fully available within the normal approach AOA.
– Carefree (up to 0.85 M) with L/G up; loads limits with unrestricted use of stick and rudder > 150 KDAS. The A/B will auto retract outside the airbrake envelope.
– Pitch response transitions to agile for large command inputs.
– Max. g limited to 90%/84% (8.1g/7.25g).
– Max. roll rated 200 deg/s at low AOA/g above 250 KDAS.
– Above 25° AOA rudder is suppressed.

TRANSONIC/SUPERSONIC

– Carefree operation in sub- and supersonic area. Cleared limits are pilot observed.
– Use of ADS α/β supersonically

COMMAND AUTHORITY

– Max allowable g (neg & pos) and max AOA overshoot in the subsonic envelope.
– Max roll rate up to 215 deg/sec.
– Max AOA overshoot in subsonic envelope.

MANEUVER DEMAND

– Transition in the 300 KDAS region from g-demand limiting at high speed to AOA demand limiting at lower speed.
– Stick center is q demand at all speeds.

USE OF ADS ALPHA AND BETA

– Used for feedback control and actuator trim scheduling.
– FF-IMU/ADE mixed alpha/beta used for CLAWS.

REVERSIONARY OPERATING MODE (AUTOMATIC DEGRADATION)

The control laws are automatically set to the FCS Reversionary mode via the Airdata System (ADS), if alpha and beta cannot be delivered with the defined accuracy, i.e.:

– An ADT 2nd failure confirmed, ADE is running for further 9 seconds.
– IMU attitude (ADE) 2nd failure, LINS will be back up for 2 minutes.

The REV mode automatically substitutes ADS AOA (α) with derived α when ADS signal fail. The achieved schedule is less accurate since α is estimated rather than measured. ADT derived AOA (α) and sideslip (ß) cockpit displays on GUH are lost and the CAT 2 warnings <FCS REV> and <REV ENV> are displayed. In the event of ADT sensed AoA and sideslip failure the IMU can only provide autonomous AOA & SS for a very limited period of time. Therefore the control laws will revert to reversionary operation after a short period of time.

ADT SECOND FAILED REV MODE

In this mode:

– Alpha and Beta are invalid, AOA display is lost.
– Attitude data are valid.
– Mass & Store data are valid (Store Group A)

IMU ATTITUDES (ADE) FAILED REV MODE

In this mode:

- Alpha and Beta are valid, AOA is displayed.
- Attitude data are valid.
- Mass & Store data are valid (Store Group A)

GENERAL HANDLING

- Similar to the full FCS system mode
- No carefree handling (clearance)
- Handling in general is departure resistant within subsonic envelope
- Envelope is limited with regard to g/AOA.

MANEUVER DEMAND

- Alpha demand mode is substituted by a g (Nz) demand in REV mode
- Fade of Q-demand at stick center to g (Nz) demand at full authorities.

AOA AND SS

AOA and SS are not used within the control laws.

SPECIAL MODING FEATURES

IN FLIGHT REFUELING (IFR)

Upon selection of the IFR probe to out the FCS automatically configures to the IFR mode where the control responses have been optimized for the IFR task. In addition, the air data is no longer sourced from ADTs, but from the DECU 5th source in order to avoid the potential effects of loss or damage to one or more ADTs as a result of contact with the hose or basket.

These control laws have historically been termed “Reversionary” as they are also scheduled when certain failures exist within the FCS or the Air Data System. The normal envelope associated with IFR/ Reversionary laws is 2g/20° alpha. There is a difference in the cleared flight envelope for IFR mode and Reversionary mode. If the FCS degrades to reversionary laws as a result of failure (s) an FCS REV and REV ENV warning are generated and the FCC limitations apply. With IFR probe extended a limited envelope has been cleared which includes an RTB if the probe is stuck out.

NOTE

Following a <L UTIL P> failure condition with the probe selected to OUT, the FUEL PROBE switch must be selected to EMGY OUT to lock the probe again.

AOA & SS

When the IFR Probe is deployed the control laws are automatically set into the FCS Reversionary mode for which AOA and SS are not required. With the retraction of the IFR Probe, IFR mode is cancelled and the control laws return to full FCS laws.

PRESSURES

The corrected, consolidated and rate limited DECU Pt and Ps are used to produce the airdata parameters when the IFR Probe is deployed.

On approach to the tanker a very restrictive rate limiting is applied to DECU Pt in order to protect against disturbance which are possible in the event of the drogue passing in front of the engine intake.

With the retraction of the IFR Probe or when the IFR switch is set to IN, IFR mode is cancelled and the control laws return to full FCS laws, i.e. ADTs for air data.

IFR COCKPIT INDICATIONS

Following selection of the PSR (FCS pilot selectable reversionary mode) both the <FCS REV> and the <REV ENV> DWP warning captions are displayed. When the probe is selected to OUT, the <REV ENV> warning caption occults.

After retraction of the fuel probe to IN, both, the <FCS REV> and the <REV ENV> warning captions are illuminated again until the PSR mode has been manually de-selected, at which time the FCS reverts to full laws.

AUTOTHROTTLE SYSTEM

AUTOTHROTTLE FUNCTIONS

The FCS PH3R1 (+) Control Laws (CL) provide the following AT functions:

- Mach Acquire and Hold
- DAS Acquire and Hold.

In both modes, the AT either holds the current speed value (in Mach or DAS) or acquires and then holds a pilot-inserted speed datum.

With weight-on-wheels the AT is disengaged and the speed acquisition datum deleted if previously indicated although Mach/DAS selection is retained.

AUTOTHROTTLE OPERATION

ENGAGEMENT CRITERIA

The AT can be engaged in any flight condition by a short press (< 1 second) on the AT engage button (Figure 1.63). Engagement is not possible with:

- Aircraft weight on wheels
- Throttle lever asymmetry of more than 20 mm.

If no mode is pre-selected on engagement the AT will automatically engage in the following modes:

- Altitude below 10 000 ft: DAS Mode
- Altitude above 10 000 ft: MACH Mode

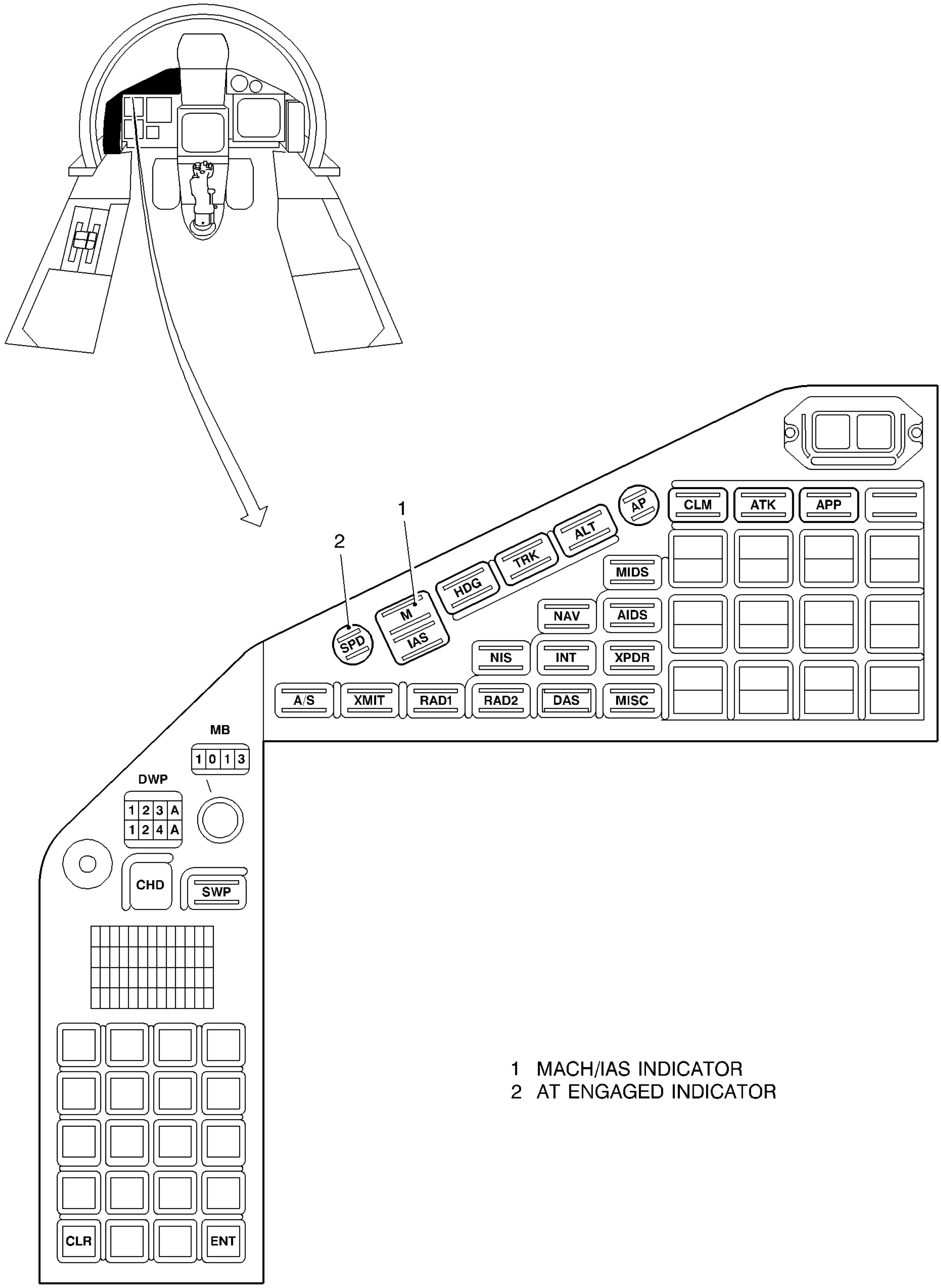
DISENGAGEMENT CRITERIA

The AT will disengage if:

- Short press (< 1 second) on the AT engage button
- Throttle override more than 15 mm
- Throttle asymmetry more than 20 mm
- ICO
- Aircraft weight on wheels.

INDICATIONS

Autothrottle engaged is indicated on the Left Hand Glareshield (LHGS), split AP and AT indicator button (Figure 1.64). When the AT is disengaged the indicator illumination is occulted.



1 MACH/IAS INDICATOR
2 AT ENGAGED INDICATOR

Figure 1.63 - Autothrottle Engage/Disengage Button

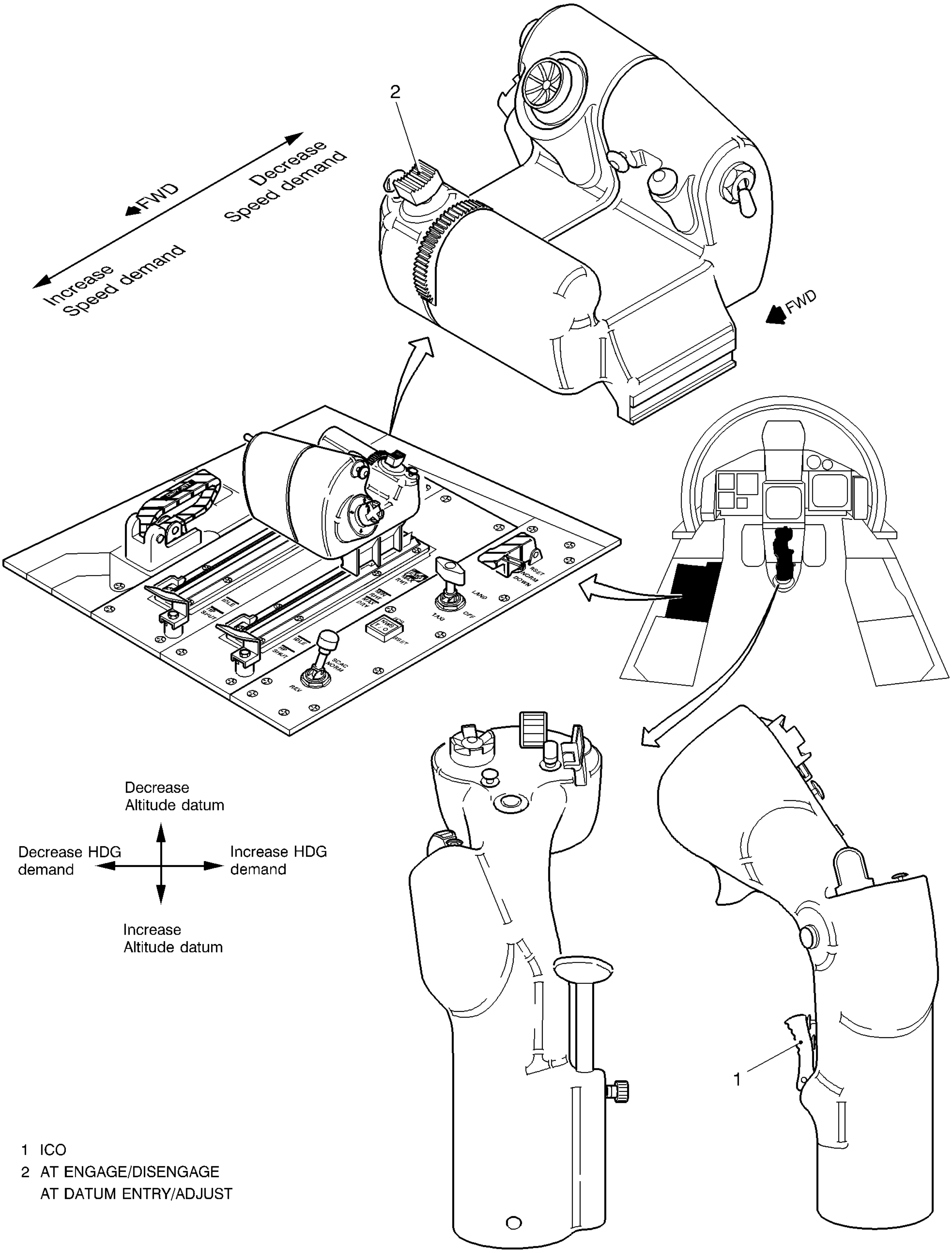


Figure 1.64 - Autopilot/Autothrottle Engage/Disengage Indicator

DATUM SETTING

DAS DATUM INPUT

The AT datum setting button increments or decrements the DAS reference datum between 110 kt and 276 kt using the following law:

– AT button pressed less than 0.4 seconds: increase/decrease by 1 kt
– AT button pressed more than 0.4 seconds: increase/decrease by 10 kt every 0.2 seconds continuous

MACH DATUM INPUT

The AT datum setting increments or decrements the Mach reference datum between 0.18 and 2.0 Mach using the following law:

– AT button pressed less than 0.4 seconds: increase/decrease by 0.01 Mach
– AT button pressed more than 0.4 seconds: increase/decrease by 0.05 Mach every 0.2 seconds continuous

If no datum is set and no mode is selected, AT will automatically select:

– DAS mode if altitude is below 10 000 ft
– MACH mode if altitude is above 10 000 ft

With the datum value starting from the current MACH/DAS.
If a datum is already entered, subsequent DA inputs will adjust the value.

DATUM CANCELLATION

The datum is deleted if:

– AT is disengaged
– No engagement within 120 seconds after datum set (time-out inhibited with weight on wheels)
– ICO.

INDICATIONS

MACH or DAS datum is displayed in the HUD.

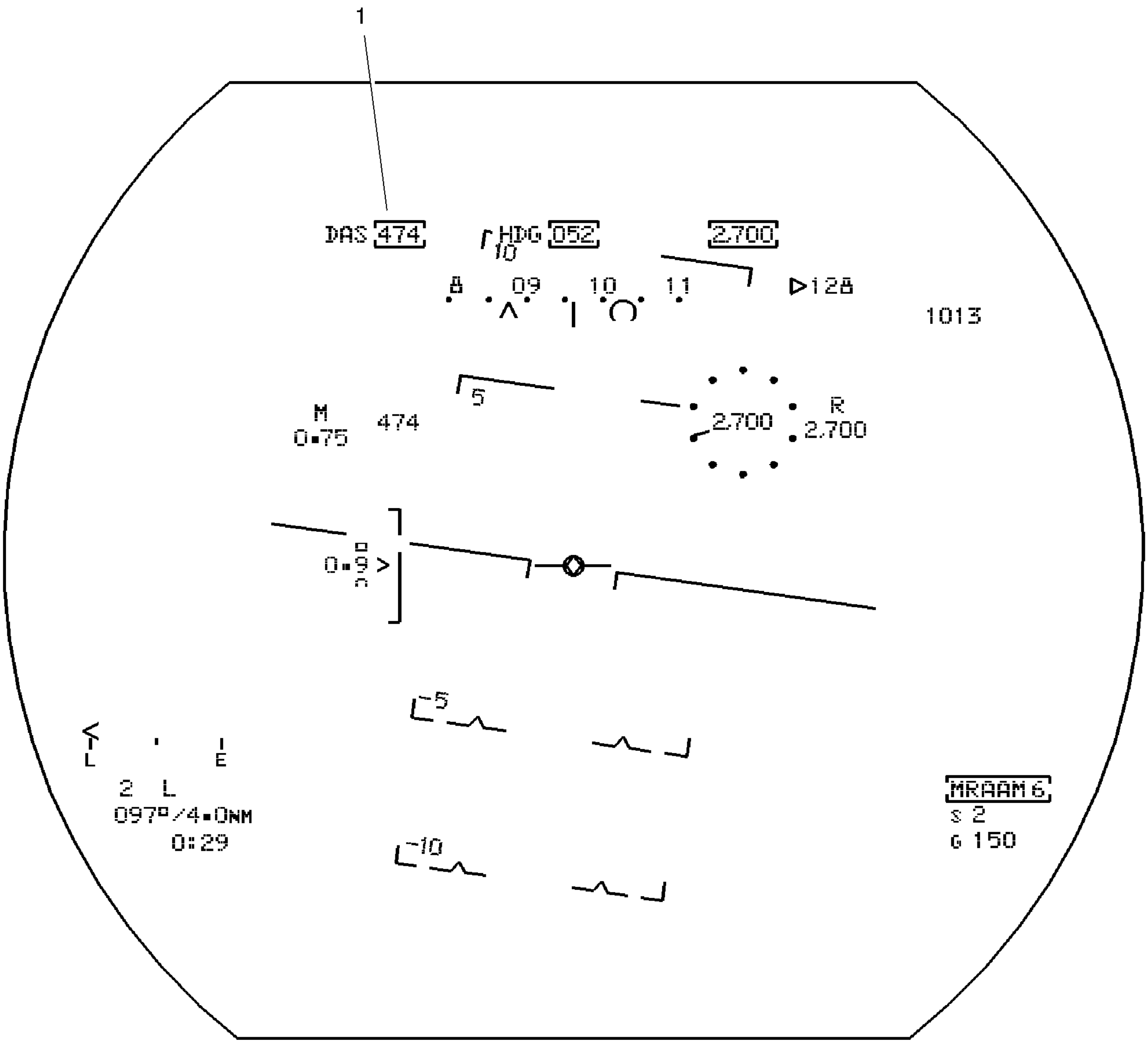
MODES OF OPERATION

AT HOLD AND ACQUIRE MODES

Whenever the AT is engaged, it will acquire and hold the current airspeed or the pre-set datum. AT will indicate hold as soon as the current speed is within 5 kt/0.01 Mach or 2% of the datum, whichever is larger. If any disturbance (maneuvering or wind) increases the speed error above this threshold the AT will indicate acquisition again.

HUD INDICATIONS

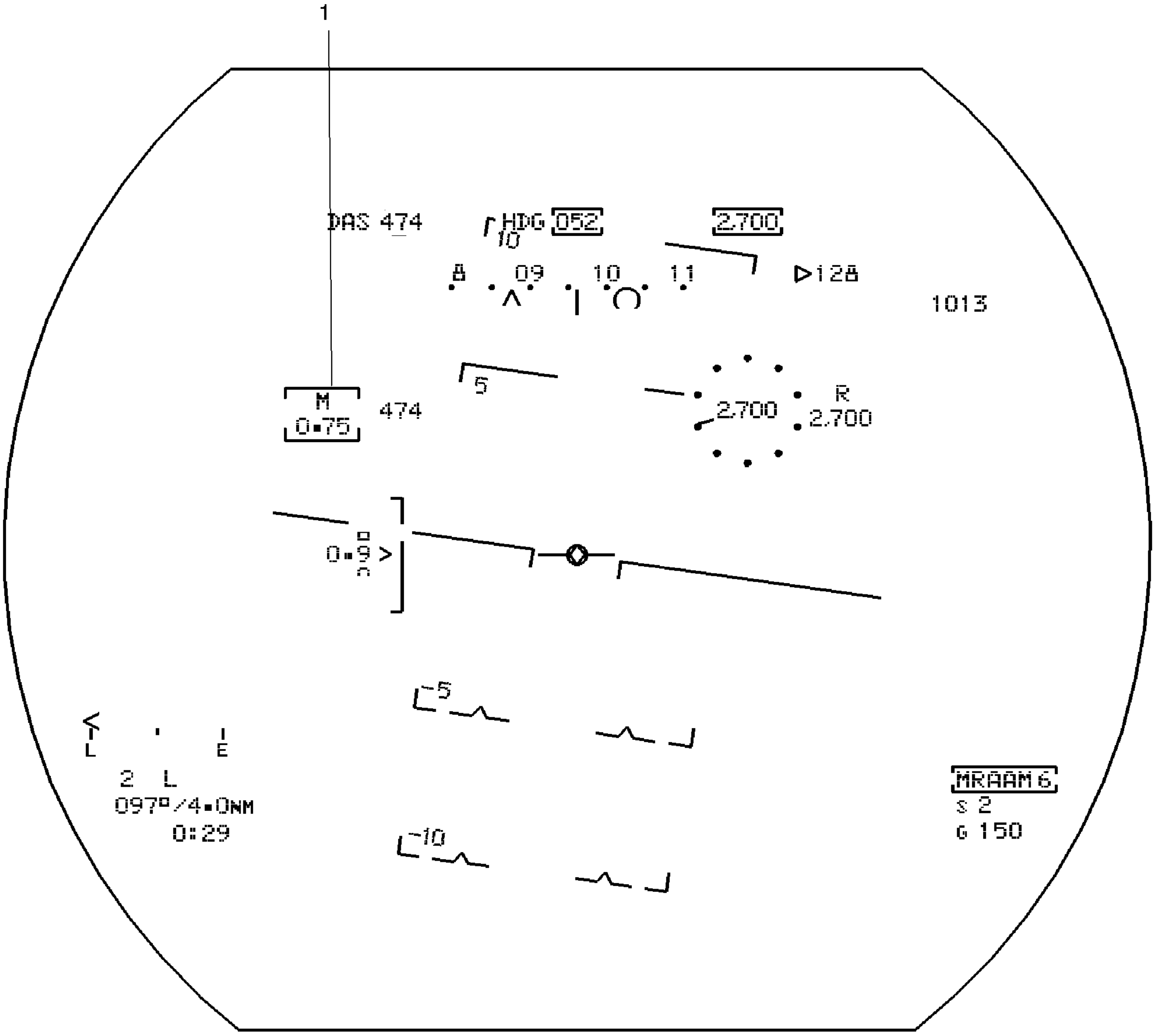
AT Acquire: Mach or DAS datum boxed (Figure 1.65)
AT Hold: Current Mach or DAS value boxed (Figure 1.66).



AT ACQUIRE MODE:

1 AT DAS (or Mach) Acquisition Datum Speed

Figure 1.65 - HUD-DAS Datum Indication



AT HOLD MODE:

1 AT DAS Held Indication
- DAS, when IAS selected (LGS)
- MACH, when M selected (LGS)

Figure 1.66 - HUD-MACH Datum Indication

SELECTION OF REHEAT

The AT has no authority to select reheat automatically. In case reheat is necessary, the reheat request voice warning will be triggered and allows to manually select reheat without disengaging the AT. It is also possible to pre-empt the reheat selection whenever the throttle levers are at Max Dry without disengaging the AT. AT then resumes normal operation in the reheat range and will revert to the dry range automatically when needed.

MODE SELECTION

The AT modes of operation can be toggles by a long press (> 1 sec). When AT is not engaged, the toggle sequence is:

– BLANK
– MACH
– DAS
– BLANK......

and a datum will be deleted.

When AT is engaged there is no BLANK mode anymore, therefore the toggle sequence is:

– MACH
– DAS
– MACH....

and a datum will be converted to the respective unit (DAS or Mach) using the current Mach/DAS ratio.

AUTOTHROTTLE WARNINGS

There are three warnings associated to the AT:

Voice Warning	DWP Warning	System Action
Select Reheat (CAT 4)	None	if no response within 15 seconds, the warning will repeat every 15 seconds while still required
Autothrottle (CAT 4)	None	AT is disengaged
Autothrottle Fail	**A/THROT**	Autothrottle disconnect

AUTOTHROTTLE TWIN SEAT

All AT relevant controls are duplicated in the rear cockpit and available when a cockpit is “in command”.

The instructor pilot may temporarily take throttle control away from the students cockpit by the following means:

– Press AT engage button and keep it depressed.
– Adjust throttle setting.
– Return throttle control by releasing the AT engage/disengage button.

The AT will be disengaged by this procedure if it was engaged.

NOTE

Failure of the AT button before/during this operation will prevent throttle override/return throttle control from being accessed by the student cockpit.

If the difference between the commanded and the actual throttle position is greater than 36 mm, the AT follow-up function will be cancelled. This mismatch will trigger the <THROT LK> and the <A THROT> DWP warning captions.

An internal failure of the throttle box in either cockpit will fail the AT function and also trigger the <THROT LK> and the <A THROT> DWP warning captions.

NOTE

Once the AT function is cancelled, AT it is lost and cannot be reset, even if throttles are brought back within tolerance.

AIRDATA SYSTEM

The Air Data System (ADS) forms part of the quadruplex FCS. Its function is to provide airdata of sufficient accuracy and integrity to meet the requirements of the FCS, AVS and UCS.

The ADS comprises four Air Data Transducer (ADTs), an Inertial Measurement Unit (IMU) and the Digital Engine Control Unit (DECU).

AIR DATA TRANSDUCERS (ADTS)

The four ADTs, located on the lower part of the nosecone, are the primary sensors for the measurement of quadruplex (fail op/fail op) air data for Ps and Pt, and the measurement of triplex (fail op/fail safe) air data α (AoA) and β (SS).

AOA & SS (FIGURE 1.67)

Triplex α and β are provided by the ADTs. The two upper probes both provide an α each and the 3rd is produced by combining the two lower probes. Similarily, the two lower probes both provide a β each and the 3rd is provided by combining the two upper ones. To ensure that the long term accuracy of IMU estimated AoA and SS does not degrade in the presence of wind, the IMU is slaved to the consolidated ADT α and β.

PRESSURES (FIGURE 1.67)

The ADTs produce quadruplex Pt and Ps data which are corrected to compensate for the aircraft/airframe induced airflow disturbances around the nosecone. Pt and Ps are then consolidated to ensure that the accuracy is protected against all ADT first failure scenario. Although consolidated DECU Pt and Ps data is being produced, it is not used in this mode. IMU estimated Ps and Pt are produced, but not used at this standard.

INERTIAL MEASUREMENT UNIT (IMU)

The IMU provides the ADS with inertial α (AoA) and β (SS). Consolidated ADT AoA and ADT SS is being mixed with the IMU inertial AoA and SS. The mixing is performed in the IMU by the Air Data Estimator (ADE). In addition the IMU produces estimated Baro Alt and TAS, however these data are not used at this standard (Figure 1.67).

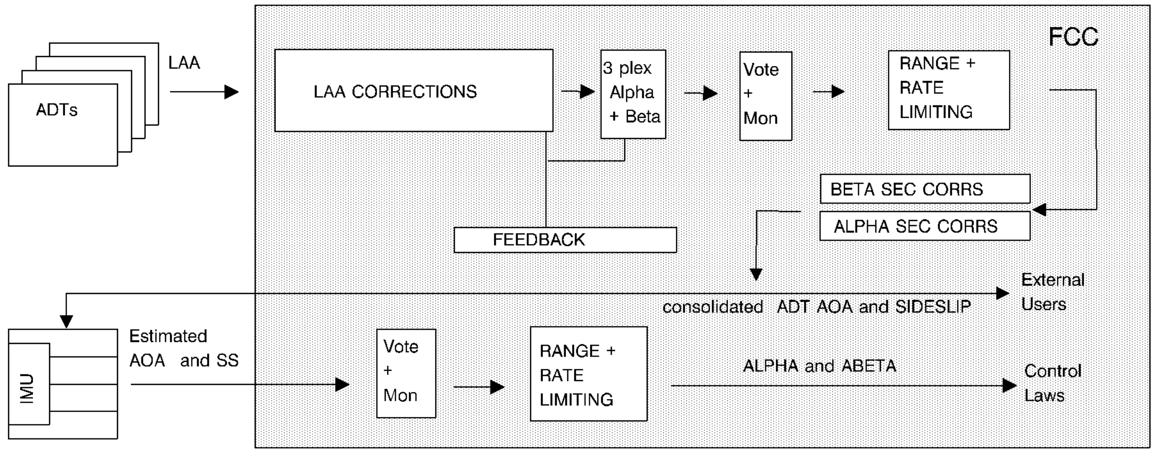
DIGITAL ENGINE CONTROL UNIT (DECU)

The DECU provides the ADS with quadruplex Mass Flow, Total Temperature (Tt), Ps, Pt and Mach number (Figure 1.67). When performing AAR the DECU provides quadruplex Pt and Ps (5th source) for all DAs. For DA4 to DA7 the DECU also provides 5th source following failure of ADT derived data.

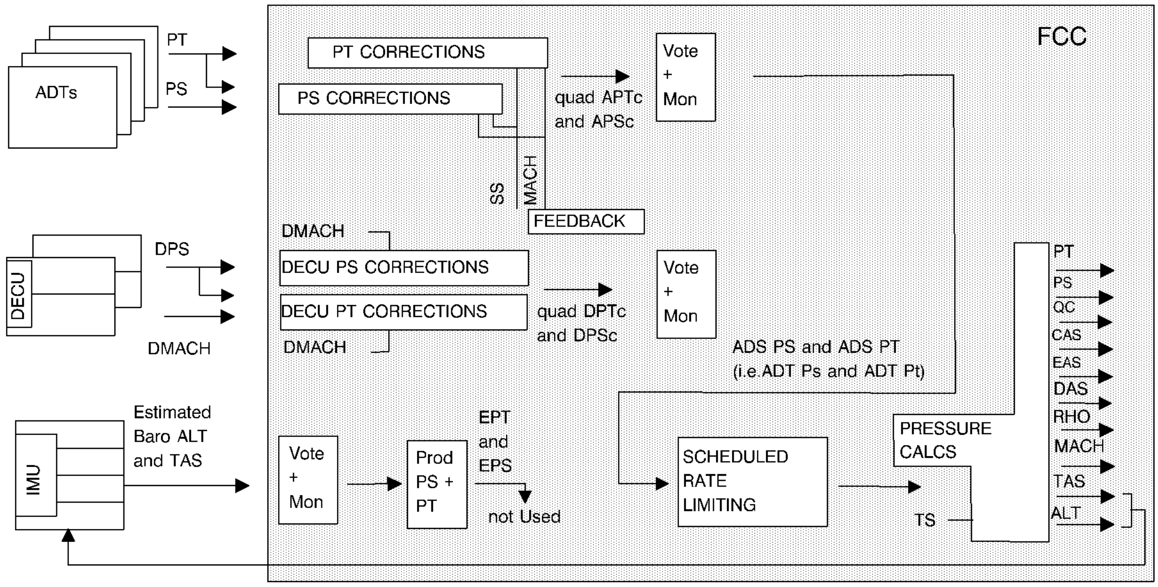
AIRCRAFT VARIATIONS (FIGURE 1.68)

DA1 to DA3 are fitted with an Air Data Computer (ADC) and a noseboom. GUH pressure data (5th source) is sourced from ADCs. If AAR is being performed fifth source is provided by the DECU.

AOA/SS:



Pt/Ps:



Key
APT: ADT Total Pressure
APS: ADT Static Pressure
DPT: DECU Total Pressure
DPS: DECU Static Pressure

EPT: Estimated Total Pressure
EPS: Estimated Static Pressure
c: corrected
v: voted (consolidated)

Figure 1.67 - ADS Design AOA/SS & Pt/Ps

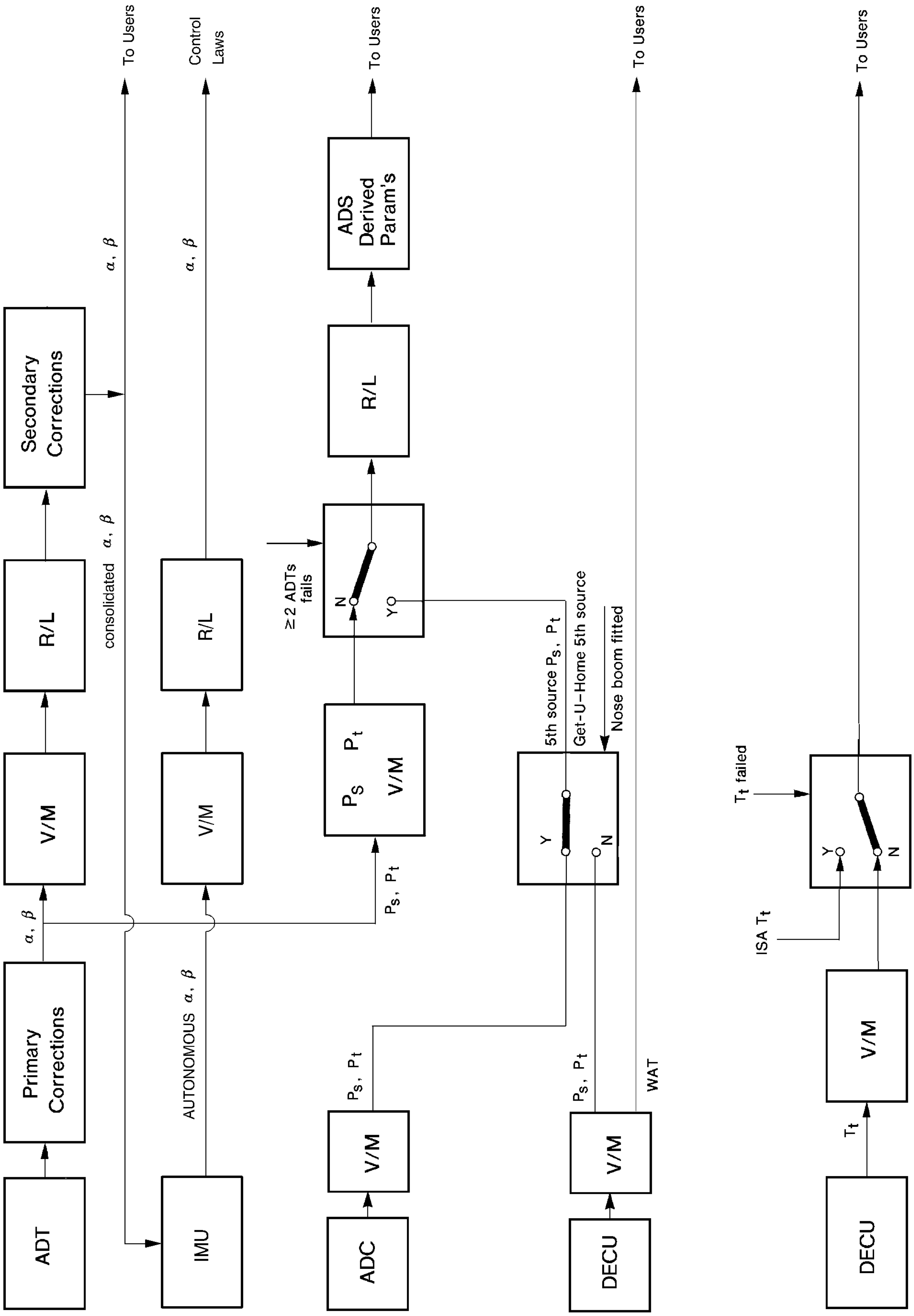


Figure 1.68 - ADS Design AOA/SS & Pt/Ps

ADS ACCURACY

For (in) accuracy of the airdata provided refer to and to the relevant AWFL Document.

MODES OF OPERATION

At FCS PH2B/2 the Air Data System operates in the modes as detailled in Weight on Wheels (WOW) pag. 160.

Summary of Pressure Sources Used

	NORMAL MODE	AAR MODE	OUTPUT
ADS PRESSURE SOURCE	ADTs	DECU	DAS, ALT, VSI, Mach
ADS AOA & SS SOURCE	ADTs & IMU	ADTs & IMU	Mixed AOA & SS

AIR DATA SYSTEM CONTROLS AND INDICATORS

All data are supplied automatically to the FCS, via the FCCs. Therefore only limited control can be achieved by dedicated switches in the cockpit.

DEDICATED CONTROLS

FCS RSET CONTROL

The FCS RSET control button is also used to reset first failures within the ADS.

FCS REV

The FCS REV push-button can be used to fly the aircraft in a pilot selectable reversionary (PSR) FCS mode.

BAROMETRIC SETTING

The BARO-SET toggle switch on the LGS allows to set a required QNH either by selecting momentary UP or DOWN, or set the switch to the LEFT position when quick standard setting (1013) is required.

NOTE

The quick standard setting (1013) by pushing the switch to the left position is omitted, i.e. this setting is presently not available.

Operation of the BARO toggle switch, either UP or DOWN, in excess of 23 sec. will fail the baro set facility and set the <BARO-SET warning on the DWP.

DISPLAY AND INDICATIONS

Monitoring of FCCs computed air data is achieved by a combination of dedicated Instruments and displays, e.g. MHDD, HUD, GUH and FTI.

MHDD

The MHDD/ACUE format enables to monitor the progress and results of the FCS Power up BIT (PBIT) and the CBIT.

HUD & GUH INSTRUMENTS

Various air data will be displayed on the HUD and the RGS (GUH).

ACCURACY OF DISPLAYED AIR DATA

NOTE

For HUD, MHDD and RGS displayed data errors, ADS failure free or following a 1st or 2nd failure refer to the PDM and to the AWFL.

Under the circumstances of partial or complete failure of some elements of the ADS, the accuracy of the cockpit displays of the FCS based flight data can be reduced. The relevant parameters are:

- AOA
- Airspeed
- Barometric altitude, and
- Mach number

The main problem areas for the pilot are cockpit readouts of AOA, airspeed and altitude for landing.

The FCS control laws are designed to absorb the full range of possible errors so handling behavior remains sound.

WARNINGS

Depending on the failure case the following ADS failure warnings will be triggered:

- AIRDATA confirmed 1st failures of ADT data, or failure of 5th source, or one or more ADC failures, or ADT/ADC transient failures.
- FCS REV with or without REV ENV and GUH AOA occulted, two or more confirmed failures of ADT.

– **FCS REV** with or without **REV ENV** GUH AOA available, ADE 1st or 2nd failure conditions or mass flow failures.

– **FCS 1** one or more confirmed TT failure, or 1st mass flow failure.

– **BAROSET** failure of the UCS or AVS sourced data.

FLIGHT TEST INTRUMENTATION

Depending of the Flt Test task, some aircraft, comprise additional FTI instruments such as an AOA indicator and a side slip indicator (normally on top of the left and right glare shield).

CANOPY

The canopy comprises a single stretched acrylic transparency mounted in an aluminium frame and hinged at the rear. The canopy is opened and closed hydraulically and can be operated from inside or outside the cockpit. An antimist system is provided to keep the transparency clear. In the event of an emergency, the canopy can be jettisoned.

CANOPY/WINDSCREEN SEALING

A continuous inflatable rubber seal is installed along the canopy edge members and arches to form an airtight seal between the canopy and the windscreen arch and the canopy and the aircraft structure.

The seal is inflated by precooled air supplied from the environmental control system (ECS) through a non-return valve, a pressure reducing/relief valve and an inflation/deflation valve. A lever, on the canopy torque tube behind the ejection seat, opens/ closes the inflation/deflation valve to actuate the supply of air to the seal when the canopy is locked/ unlocked. When the aircraft is on the ground and the ECS is not in operation, a reservoir bottle will supply the air for the canopy seal inflation.

The reservoir bottle can be pressurized to supply air to inflate the canopy seal by the ECS or, alternatively, by the charge connection on the ground.

NORMAL OPERATION

The canopy is opened and closed hydraulically. A hydraulic actuator is located at the rear of the canopy on the avionic bay roof and is supplied from the No 1 hydraulic system. When the canopy is fully closed, two microswitches (mounted on the canopy frame adjacent to the front arch) are tripped and activate the electrical lock/unlock actuator. The actuator drives the canopy locking mechanism (consisting of two shoot bolts and four hooks) via a torque tube and linkage assembly. The actuator also operates a hydraulic plunger operated check valve and canopy seal inflation/deflation valve and locks the torque tube.

The canopy is unlocked and opened by setting the switch momentarily to OPEN. This energizes the electric actuator fitted to the torque tube, which rotates, releasing the hooks and withdrawing the shootbolts which unlock the canopy and at the same time deflates the canopy seal and releases the hydraulic plunger operated check valve. This provides a signal to the hydraulic system to raise the canopy until an actuator mounted limit switch (microswitch) is operated (canopy fully open), or a momentary CLOSE selection is made which will stop the canopy from opening further.

Canopy lock status is provided to the UCS by hardwired inputs to the UCS front computer, which in turn provides indications to the pilot if the canopy is not locked via the MHDD/Autocue format (on ground) or via the DWP and attention getters (with weight-off-wheels). In addition the dedicated Canopy Unlocked Indicator provides an indication of the canopy status

If the canopy accumulator is fully pressurized, it provides sufficient pressure for a minimum of three open/close operations. If the pressure is not sufficient the canopy can be opened and the accumulator can be pressurized by using the hydraulic system hand pump.

If electrical power is not available on battery busbar (PP6), the canopy cannot be opened either using the internal or external operating switches. An external canopy unlock handle unlocks the canopy and operation of the jackhead release cable enables the canopy to be raised manually.

Microswitches located within the canopy system provide canopy lock status via hardwired inputs to the UCS Front Computer. If the canopy is not locked outputs from the UCS are used to display indications on the MHDD/Autocue format (GND POF) and to provide a DWP warning and attention getter (when both throttles >40% NH). In addition, a dedicated Canopy Unlocked Indicator, hardwired directly from canopy system microswitches, provides canopy locked/unlocked status (all POF).

CANOPY SYSTEM CONTROLS AND INDICATORS

INTERNAL CANOPY OPERATING SWITCH

NOTE

> Operation of the internal switch is inhibited when the aircraft mass is off the undercarriage landing gear.

A three-position toggle switch is located on the windscreen arch support frame below the right cockpit sill, Figure 1.69. The switch is labeled CNPY OPEN-CLOSE and spring-loaded to the center (off) position, it controls the raise/lower and lock/unlock function of the canopy. When set momentarily to OPEN and released, the canopy will open fully, but can be stopped in any intermediate position by momentarily selecting CLOSE. To close the canopy, the switch is set and held in the CLOSE position. Canopy closing can be stopped in any intermediate position by releasing the switch, thus reducing the risk of injury to aircrew and ground crew. A warning horn is activated and sounds whenever CLOSE is selected.

EXTERNAL CANOPY OPERATING SWITCH

An external canopy operating switch labeled CLOSE-OPEN, is located behind a panel (Figure 1.70). The switch is guarded in the center (off) position and when operated, the switch provides a parallel control function to the internal operating switch.

CANOPY UNLOCKED INDICATOR

The canopy status is displayed on the canopy unlocked indicator marked CNPY located beneath the left MHDD on DA1 and on the right console of DA2 , DA3, DA5 and DA7, refer to Figure 1.69.

CANOPY JACK HEAD RELEASE CABLE (EXTERNAL ONLY)

In an emergency, with no hydraulic or electrical power available, the canopy can be released, if time permits, by operating the external canopy unlock handle and the canopy jack head release cable. The jack head release operating handle is located behind a panel situated toward the left rear of the canopy, refer to Figure 1.70. Once the external canopy unlock handle and the canopy jack head release is operated, the canopy can be manually lifted allowing the aircrew to egress.

CANOPY JETTISON SYSTEM

The canopy can be jettisoned automatically as part of the ejection sequence, or manually by operation of an internal or external handle. The internal handle, marked CNPY JETT, is located on the left console and a telltale tie is installed on the handle which, if intact, indicates that the handle has not been operated. The external handle is located on the side of the left engine intake.

The canopy jettison system consists of a canopy jettison initiator, two canopy emergency unlock cylinders, a canopy jack disconnect piston unit and two canopy jettison rocket motors. The rocket motors are located on the front end of each canopy edge member. Two cartridges are installed in the canopy jettison initiator, one in each canopy emergency unlock cylinder and one in each rocket motor. The rocket motor cartridges are integral with the rocket motor.

WARNING

THE CANOPY JETTISON SYSTEM IS A POTENTIAL SOURCE OF DANGER. ACCIDENTAL OPERATION MAY CAUSE FATAL INJURIES. A SAFETY PIN IS INSTALLED TO SECURE THE SYSTEM ON COMPLETION OF FLIGHT.

The cartridges in the jettison initiator are fired, either by integral firing pin operated by gases generated from the ejection seat cartridges (dual input), or by firing pins operated by cables when either jettison handle is pulled. Gases generated by the left and right initiator cartridges are simultaneously routed through pipes and trombone units to the left and right canopy emergency unlock cylinders respectively and the canopy jack disconnect piston unit. The gases initiate the cartridges in the unlock cylinders which unlock the canopy and provide gas signals to initiate the rocket motors. Gas is routed from each canopy emergency unlock cylinder to both rocket motors to make sure that the sequence continues in the event of a failure of one unlock cylinder or one initiator cartridge. The canopy jack disconnect piston unit acts upon the canopy jackhead release unit to free the canopy from its operating mechanism. The rocket motors force the canopy upwards. When the hinge pins release, the canopy separates from the aircraft.

A safety pin is inserted in the canopy jettison initiator when the aircraft is on the ground to make the canopy jettison system ‘safe for parking and servicing’. Figure 1.71 shows a schematic diagram of the canopy jettison system.

WARNING

FOLLOWING LOSS OR JETTISON OF THE CANOPY, RECOVER THE AIRCRAFT AS QUICKLY AS POSSIBLE TO A MAXIMUM ALTITUDE OF 10 000 FT AND TO A SPEED LESS THAN 200KDAS.

Should the canopy fail to jettison during the ejection sequence and the canopy has remained locked, canopy breakers installed on the headbox of the ejection seat will fracture the transparency providing an exit path for the ejection seat.

The external jettison handle, located on the left side of the engine air intake, enables the canopy to be jettisoned for ground rescue operations.

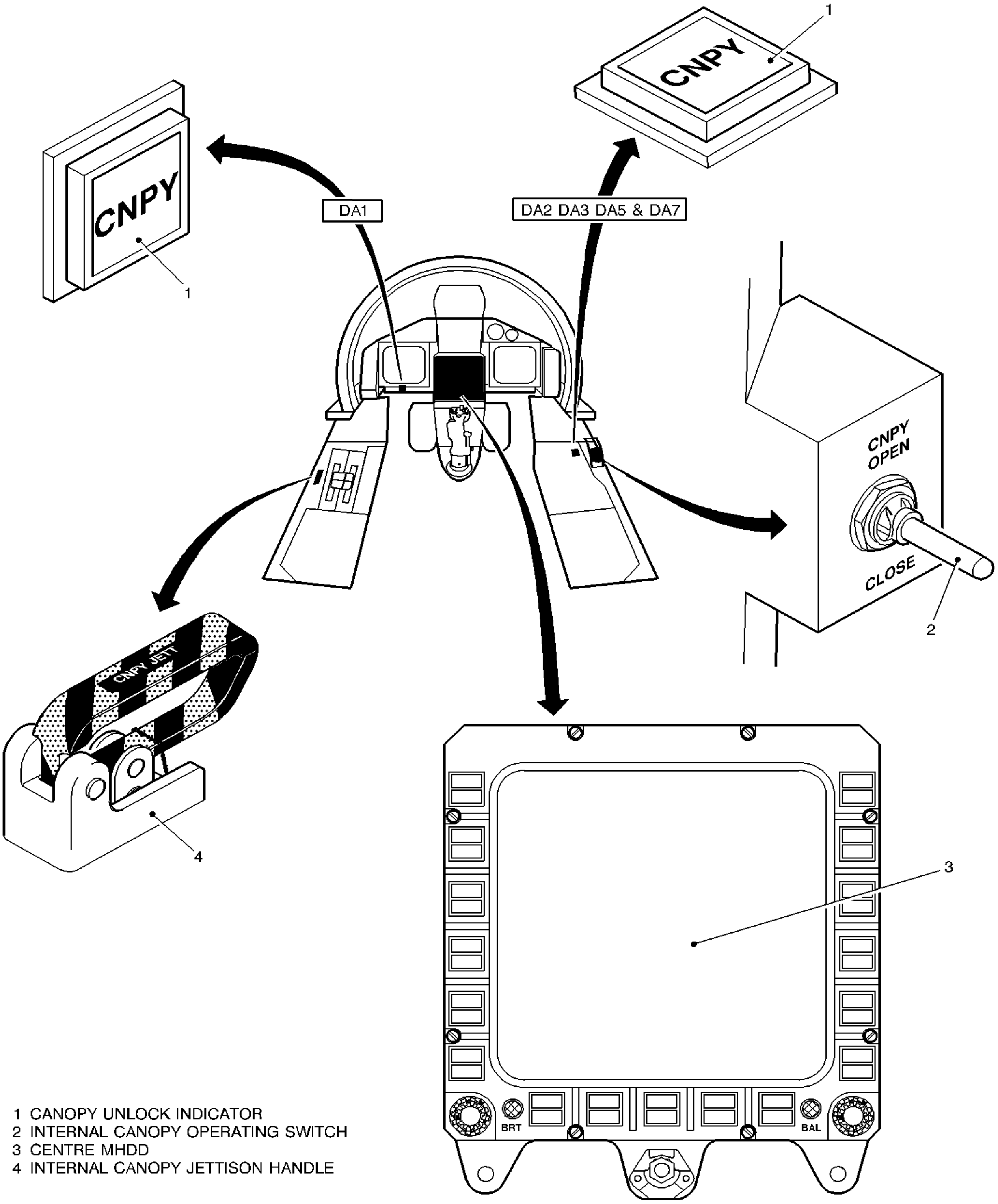


Figure 1.69 - Canopy System Controls and Indications (internal)

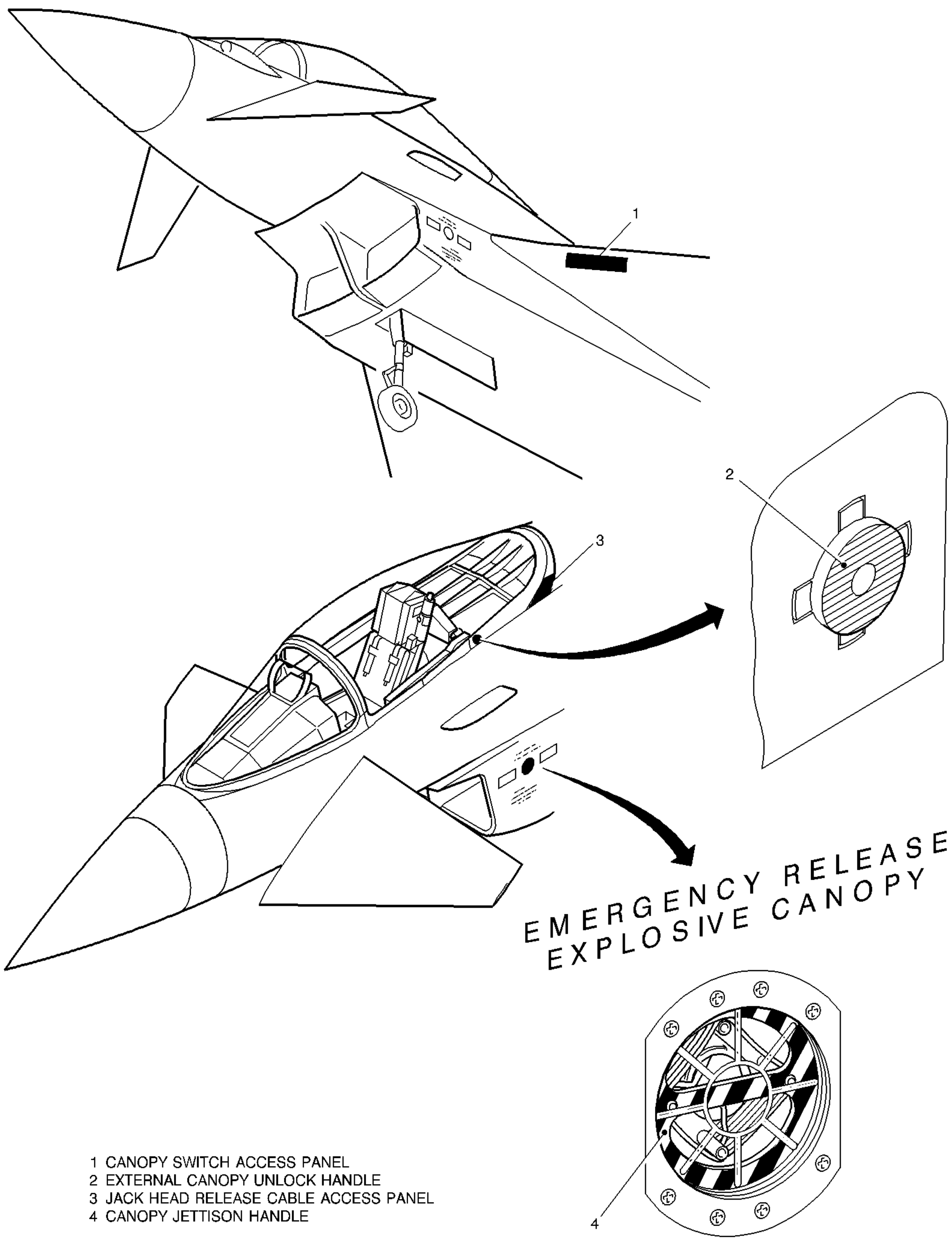
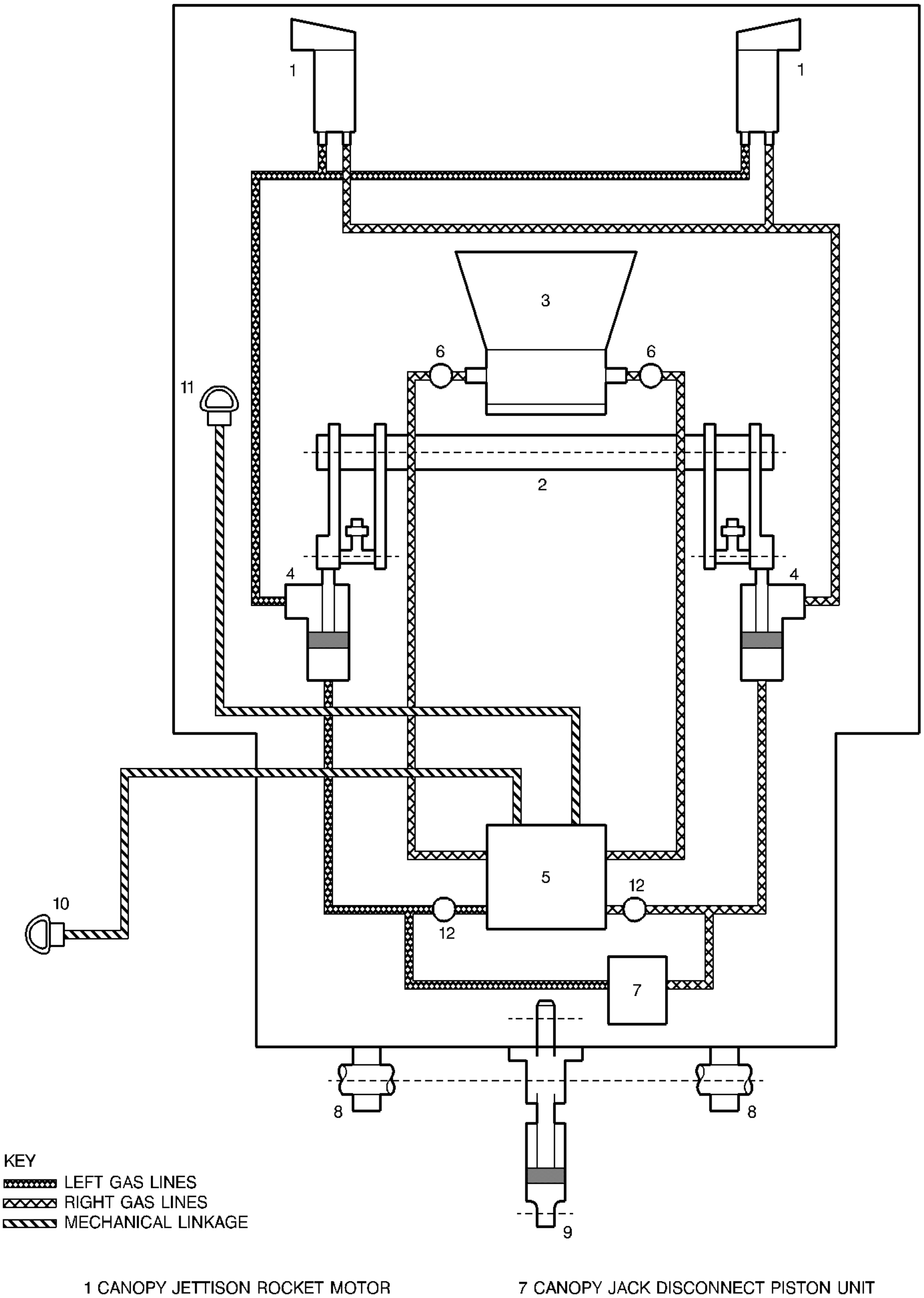


Figure 1.70 - Canopy System Controls (external)



1 CANOPY JETTISON ROCKET MOTOR
2 CANOPY LOCK/UNLOCK MECHANISM
3 EJECTION SEAT
4 CANOPY EMERGENCY UNLOCK CYLINDER
5 CANOPY JETTISON INITIATOR
6 QUICK RELEASE DISCONNECT
7 CANOPY JACK DISCONNECT PISTON UNIT
8 CANOPY HINGE INCORPORATING SHEAR PINS
9 CANOPY JACK
10 CANOPY JETTISON EXTERNAL HANDLE
11 CANOPY JETTISON INTERNAL HANDLE
12 TROMBONE UNIT

Figure 1.71 - Canopy Jettison System - Schematic

ESCAPE SYSTEM

The Escape System provides a means of safe escape from zero altitude to 55 000 ft and from 0 to 600 KCAS or Mach 2.0, whichever is the lower. Within the escape envelope the system provides safe escape for occupants sat at the design eye height and in straight and level flight, outside these conditions there is an increasing risk of injury to aircrew. The safe terrain clearance limits are define in Minimum Ejection Heights pag. 199.

Safe ejection or jettison of the canopy can only be assured if the canopy is down and locked on initiation of the system via the ejection seat, or jettison of the canopy via the internal or external handles.

The aircraft is equipped with a Martin Baker Mk16A ejection seat linked into a canopy jettison system. The ejection sequence begins when the seat firing handle is pulled causing the canopy to jettison and the seat to be ejected after a pre-set time delay.

Canopy jettison malfunctions will not interfere with the seats firing. If the canopy jettison system fails, the seats will eject through the canopy.Through canopy ejection operation has yet to be evaluated and therefore survivable ejection through the canopy cannot be assured.

EJECTION SEAT

WARNING

THE EJECTION SEATS ARE A POTENTIAL SOURCE OF DANGER AND ACCIDENTAL OPERATION MAY CAUSE FATAL INJURIES. ON COMPLETION OF FLIGHT, THE SEAT SAFE/ARMED HANDLE MUST BE ROTATED TO THE SAFE POSITION TO MAKE SURE THAT THE SEAT IS IN THE ‘SAFE FOR PARKING’ CONDITION.

The Mk 16A ejection seat (see Figure 1.72 and Figure 1.73) is an electronically-controlled, cartridge-operated seat providing safe escape within the safe escape envelope defined in the Escape System General Description. On twin seat aircraft the front and rear seats have some minor differences but are essentially similar.

After ejection the seat is initially stabilized by three aerodynamic surfaces, two which deploy from opposite sides of the seat pan and one mounted on the parachute headbox. At high speeds and/or high altitudes (above approximately 17 000 ft) a drogue bridle system is deployed, which further stabilizes and slows down the seat, followed by the automatic deployment of the personal parachute and separation of the occupant from the seat. Timing of all events after rocket motor initiation is controlled by the electronic sequencer, which uses altitude and airspeed information to select the correct mode of operation.

As the sequencer uses continuous sensing, there are no fixed timings for drogue release, parachute deployment and man/seat separation. During the sensing 'window', the sequencer determines the earliest possible safe parachute deployment times. A backup system for seat/man separation is provided in the event of the electronic system failure.

During descent, the personal survival pack (PSP) releases automatically on the lowering line if the automatic deployment unit (ADU) is set to AUTO. When landing in water, the liferaft will automatically inflate upon immersion of the PSP.

The Ejection Seat is cleared for safe escape within the following range of aircrew boarding mass, that is, the aircrew dressed weight.

– Minimum boarding mass 65.1 kg (143.5 lb)
– Maximum boarding mass 114.8 kg (253 lb)

EJECTION GUNS

The seat is ejected by action of gas pressure developed inside the two telescopic ejection guns when the ejection gun cartridge is fired. As the ejection guns reach the end of their stroke an underseat rocket motor is fired to sustain the thrust of the ejection guns to carry the seat to a height sufficient to allow the personal parachute to deploy.

SEAT PAN ASSEMBLY

The seat pan assembly accommodates a personal survival pack, a personal equipment connector (PEC), a harness reel, a combined snubber and guillotine unit (CSGU) the aerodynamic surface deployment unit (ASDU) and the seat operating controls. A seat firing handle in the centre of the front cross-beam is connected to the sears of two firing units in a double breech under the seat pan. Gas pipes from the double breech connect to other mechanisms on the seat pan and on the main beams. The seat pan has sticker clips to improve man/seat separation. A contoured back in the seat pan provides comfort and correct posture for the seat occupant. The underseat rocket motor (USRM) is bolted to the underside of the seat pan and the harness reel is bolted horizontally to the gun structure. A liquid suit connector assembly (LSCA) is provided on the right side of the seat pan.

UNDERSEAT ROCKET MOTOR

The underseat rocket motor (USRM) is attached to the underside of the seat pan. The USRM contains solid fuel propellent a gas-operated igniter cartridge and incorporates a pair of efflux nozzles at each end of the rocket body motor. The front and rear seat motors have the efflux nozzles set at different angles, providing diverging trajectories after ejection to avoid the possibility of collision between the two seats.

The USRM igniter cartridge is initiated by gas from the dual multi-purpose initiators at the end of the ejection gun stroke. The thrust of the USRM supplements the thrust of the ejection guns to carry the seat to a height sufficient to allow safe ejection.

AERODYNAMIC SURFACES

There are three aerodynamic surfaces; two lower surfaces mounted on opposite sides of the seat pan and operated simultaneously, and an upper surface mounted on the parachute headbox. The two lower surfaces stabilize the seat in yaw and pitch and the upper surface stabilizes in pitch only.

An aerodynamic surface deployment unit (ASDU) deploys the two lower aerodynamic surfaces to stabilize the seat initially, particularly during high speed ejection. The ASDU is made up of the two lower aerodynamic surfaces, and a single cylinder containing two opposed pistons and incorporating a central gas input. Gas pressure from the multi-purpose initiators (MPI) fires the ASDU cartridge, gas from which extends the pistons to deploy the lower aerodynamic surfaces at 44 degrees to the seat pan when the pistons are fully extended. The upper aerodynamic surface is deployed by gas pressure from the left MPI only.

MULTI-PURPOSE INITIATORS

The multi-purpose initiators (MPI) and their corresponding cartridges are positioned on the bottom collar of each ejection gun. Each MPI is mechanically initiated towards the end of ejection gun stroke by a trip on the ejection gun inner piston which causes a spring-loaded firing pin to strike a percussion-operated cartridge. The left and right MPI operate parallel gas systems and are completely independent of each other, providing an alternative if one of the MPI should fail.

When the seat is initiated, gas from the ejection gun cartridge forces the outer cylinders of the guns to rise and the MPI are tripped towards the end of the gun stroke. Gas from the two MPI cartridges initiates the following units independently of each other.

LEFT MPI

The left MPI initiates left pitot deployment, the left start switch, upper and lower aerodynamic surface deployment, the barostatic time release unit and the underseat rocket motor.

RIGHT MPI

The right MPI initiates right pitot deployment, the right start switch, lower aerodynamic surface deployment and the underseat rocket motor.

HEADBOX DEPLOYMENT SYSTEM

The headbox deployment unit (HBDU) forms part of the top cross-beam manifold assembly. Operation of the HBDU is controlled by the electronic sequencer which fires the initiation cartridge housed within the top cross-beam assembly. The HBDU consists of an outer body with two telescopic pistons which extend when gas pressure is applied. When the HBDU cartridge is initiated, the pistons extend and the personal parachute is deployed, with the rigging lines emerging first and then the canopy. This method of deploying the parachute reduces the parachute canopy opening shock load on the occupant. A small auxiliary drogue parachute is attached to the headbox by a strop and the crown of the drogue is connected to the crown of the personal parachute with a break tie. As the auxiliary parachute becomes taut, the break tie securing it to the crown of the personal parachute breaks and releases the headbox from the personal parachute. This arrangement prevents possible collision between the headbox and the ejectee.

DROGUE AND BRIDLE SYSTEM

If selected by the sequencer, the drogue and bridle assembly slows down and stabilizes the ejection seat after deployment of the aerodynamic surfaces and before deployment of the personal parachute. Three legs, one upper and two lower, and a bridle strop make up the bridle assembly. The three legs are joined at one point by a link and terminate at the opposite ends in spool fittings which are secured in three drogue bridle release units; one in the top cross-beam and one in the bottom of each gun outer cylinder. The drogue bridle strop attaches to one end of an H-link connector. The drogue is a 1.45m ribbon drogue which is attached to the other end of the H-link to attach the drogue to the bridle system. The drogue is pressure-packed in a canister which sits above the drogue deployment unit (DDU) behind the headbox. The drogue canister is environmentally sealed and is propelled from the seat by the DDU during the ejection sequence. The three bridle release units are operated by gas pressure from a bridle release cartridge at the appropriate time in the ejection sequence except in the 'low speed, low altitude' mode, when the drogue is not deployed and therefore not released. In the 'low altitude, high speed' and 'high altitude' modes, the drogue canister is propelled from the seat while the bridle legs remain locked to the seat until unlocked by gas pressure from the bridle release cartridge.

DROGUE DEPLOYMENT UNIT

The drogue deployment unit (DDU) is an integral part of the seat top cross-beam manifold assembly. The unit consists of an outer body with two telescopic pistons which extend during the ejection sequence to eject the drogue canister clear of the seat and rapidly deploy the drogue.

ELECTRONIC SEQUENCING SYSTEM

The electronic sequencing system consists of an electronic sequencer, two thermal batteries, two pitot assemblies incorporating start switch assemblies, and the associated wiring.

ELECTRONIC SEQUENCER

The electronic sequencer is connected by pipes to the pitot assemblies and by electrical wiring to the thermal batteries, the sequencer start switches and the electrically-operated cartridges. The functions of the sequencer are to measure altitude and airspeed at the moment of ejection, identify the correct recovery sequence and provide the necessary output signals to enable the recovery sequence to be implemented.

THERMAL BATTERIES

To provide system redundancy, the two thermal batteries are initiated independently by gas pressure from the two seat initiator cartridges or, in the event of a command ejection, from the aircraft command sequencing system.

PITOT ASSEMBLIES

The two pitot assemblies incorporate deployable pitot heads and the sequencer start switches. During normal flight, the pitots are stowed close to the sides of the headrest. The pitot heads are deployed during ejection by gas pressure from the multi-purpose initiators. When deployed, the pitot heads supply dynamic pressure inputs to the electronic sequencer. Static (base) pressure is supplied from a void inside the sequencer. The sequencer start switches inside the pitot assemblies supply a start signal to the sequencer at the correct time in the ejection sequence. The left and right pitot assemblies are completely independent of each other, providing redundancy to the pitot deployment system. The right pitot is deployed by gas from the right multi-purpose initiator and the left pitot is deployed by gas from the left multi-purpose initiator. A backup system is provided in the event of electronic system failure.

AUXILIARY OXYGEN SYSTEM

The auxiliary oxygen system interfaces with the aircraft breathing gas system. If there is a breathing gas supply failure, the auxiliary oxygen system automatically senses the pressure drop and switches to the auxiliary oxygen cylinder. The seat occupant also retains the option to change from one system to the other. Manual operation of the auxiliary oxygen system is provided by operating the emergency oxygen handle.

PERSONAL EQUIPMENT CONNECTOR

A personal equipment connector (PEC) on the left side of the seat pan, provides single action connection and disconnection of the occupant's mic/tel and personal supplies before and after flight respectively. It is disconnected automatically during the ejection sequence. The PEC consists of a seat portion, an aircraft portion and a man portion.

SEAT PORTION

The seat portion provides connection of the man portion on its upper face and the aircraft portion on its lower face. It is attached to the seat pan and is coupled to the oxygen regulator. A metal dust cover is provided to protect the seat portion when the man portion is removed. The time when the seat portion is not covered by either the man portion or the dust cover must be kept to a minimum.

AIRCRAFT PORTION

The aircraft portion connects the communications system and anti-g supply from the aircraft to the seat. It is held on the lower face of the seat portion by a lever-operated latch which is linked by static cable to the cockpit floor so that the aircraft portion (complete with mic/tel services) disconnects automatically during the ejection sequence.

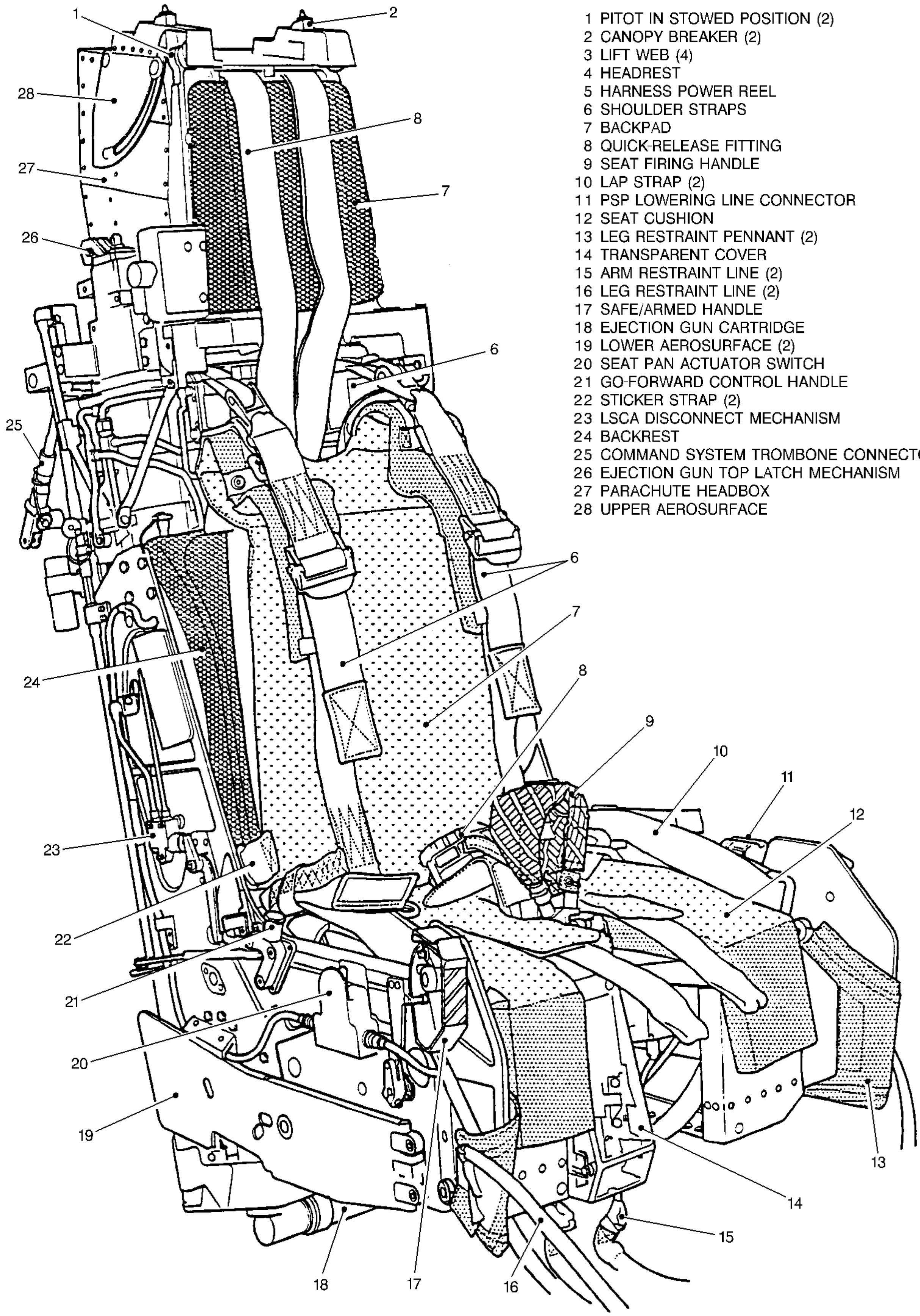
MAN PORTION

The man portion is connected to the top face of the PEC seat portion and has oxygen, anti-g and mic/tel services connected to it. The man portion is fitted in position on the seat portion during strapping-in and is manually disconnected at egress. The pilot connects the oxygen hose to the oxygen mask hose and the mic/tel to the helmet mic/tel and disconnects these services before normal egress. The man portion is released manually by pulling up its latch handle after pressing a thumb catch on the handle and released automatically during the ejection sequence by a linkage from the harness release system. If the automatic system fails the man portion is released by the operation of the PEC lanyard.

COMMAND FIRING SYSTEM (TWIN SEAT AIRCRAFT ONLY)

The aircraft is fitted with a combined canopy jettison and command ejection system. Selection is by a combined command mode selector/rear seat inhibitor in the rear cockpit. Command ejection is available in three different modes, as follows:

- SOLO. Ejection initiation by the front seat occupant jettisons the canopy immediately and the seat is ejected after a short delay. The rear seat is not ejected.
- BOTH. Ejection initiation by the occupant of either seat jettisons the canopy immediately, followed after a short delay by the rear seat and then after a further short delay, by the front seat, in that order. The delays make sure of safe separation between each of the ejected seats and the canopy.
- FRONT. This mode provides two alternatives:
    - FRONT SEAT INITIATES. Ejection initiation by the occupant of the front seat jettisons the canopy immediately, followed after a short delay by the rear seat and then, after a further short delay, by the front seat, in that order. The delays make sure of safe separation between each of the ejected seats and the canopy.
    - REAR SEAT INITIATES. Ejection initiation by the occupant of the rear seat jettisons the canopy immediately, followed after a short delay by the rear seat only. The front seat may be ejected independently later, if required.



1 PITOT IN STOWED POSITION (2)
2 CANOPY BREAKER (2)
3 LIFT WEB (4)
4 HEADREST
5 HARNESS POWER REEL
6 SHOULDER STRAPS
7 BACKPAD
8 QUICK-RELEASE FITTING
9 SEAT FIRING HANDLE
10 LAP STRAP (2)
11 PSP LOWERING LINE CONNECTOR
12 SEAT CUSHION
13 LEG RESTRAINT PENNANT (2)
14 TRANSPARENT COVER
15 ARM RESTRAINT LINE (2)
16 LEG RESTRAINT LINE (2)
17 SAFE/ARMED HANDLE
18 EJECTION GUN CARTRIDGE
19 LOWER AEROSURFACE (2)
20 SEAT PAN ACTUATOR SWITCH
21 GO-FORWARD CONTROL HANDLE
22 STICKER STRAP (2)
23 LSCA DISCONNECT MECHANISM
24 BACKREST
25 COMMAND SYSTEM TROMBONE CONNECTOR (2)
26 EJECTION GUN TOP LATCH MECHANISM
27 PARACHUTE HEADBOX
28 UPPER AEROSURFACE

Figure 1.72 - Ejection Seat Equipped (Right side)

1 SEAT SAFE/ARMED HANDLE
2 ACTUATOR CONTROL SWITCH
3 GO-FORWARD LEVER
4 SEAT FIRING HANDLE
5 OXYGEN CONTROL LEVER
6 PERSONAL SURVIVAL PACK CONNECTOR
7 PERSONAL EQUIPMENT CONNECTOR
8 SAFETY PIN (FITTED)

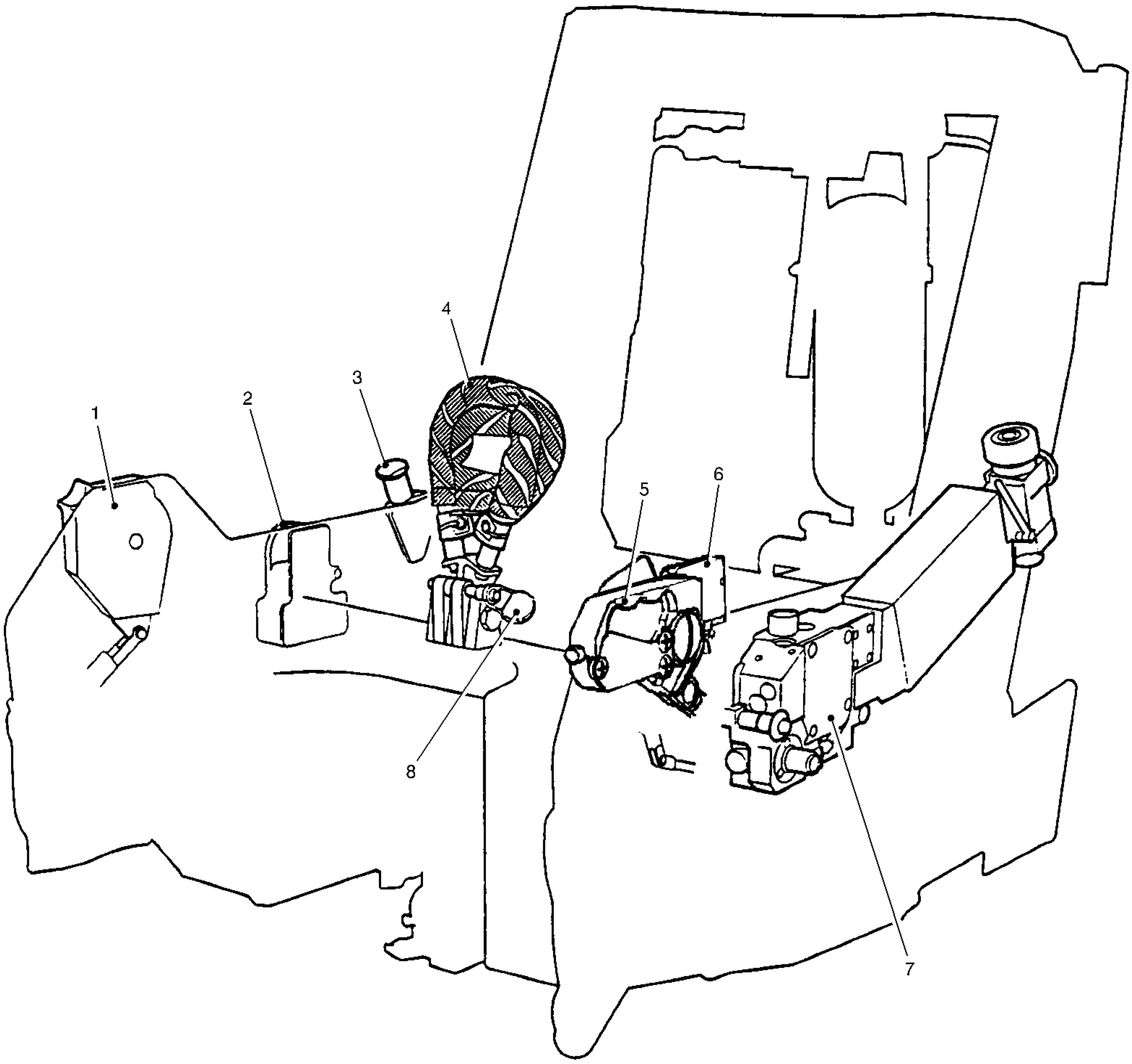


Figure 1.73 - Ejection Seat Equipped (Left side)

PARACHUTE AND COMBINED HARNESS

The combined parachute and seat harness consists of the following items.

PARACHUTE ASSEMBLY

The parachute assembly consists of the parachute canopy, the head box and the harness.

PARACHUTE CANOPY

The personnel parachute is a GQ Type 5000, which has a 6.5m Aeroconical canopy. The canopy fabric is capable of withstanding the loads imposed upon it during high speed ejections. The parachute is steerable via two lines, providing control over the canopy's direction of flight. With the canopy inflated, pulling down a hand loop at the end of the appropriate steering line will turn the parachute in that direction. Water deflation pockets on the canopy assist rapid deflation of the canopy after landing in water.

The canopy has four panels of different colors which can be used as camouflage or a location aid for rescue.

HEADBOX

The headbox is attached to the upper seat structure and contains a GQ Type 5000 parachute with a 6.5m diameter canopy and a small Irvin auxiliary parachute (559mm diameter) which is attached to a bracket inside the headbox. During the ejection sequence, the headbox is deployed by the Headbox Deployment Unit (HBDU). The personnel parachute emerges, rigging lines first, from the bottom of the parachute headbox and pulls out the auxiliary parachute, which slows down the empty headbox and prevents it colliding with the ejectee. The parachute canopy is attached to a combined parachute and seat harness. A headpad is fitted to the seat structure in the front of the headbox.

HARNESS

The combined parachute and seat harness attaches the occupant to the parachute, via the lift webs forming part of the harness, and to the seat by lugs on the harness engaging in upper and lower harness locks on the seat. Quick-release fittings on the harness connect to the arrowhead connectors on the single-handed release strap attaching the PSP to the harness. The combined harness is attached to the occupant by means of a quick-release box mounted on a negative-g strap which is locked in an aperture on the seat pan floor by a gas-operated lock on the top of the seat firing breech under the seat pan.

NEGATIVE-G RESTRAINT

Negative-g restraint is provided by a negative-g strap incorporating an AML quick-release fitting (QRF) at its upper end and a lug at its lower end, and a V-strap. The V-strap has two D-rings stitched into its upper end and one at its lower end. When installed on the seat, the lug on the negative-g strap is passed through the D-ring on the lower end of the V-strap before being inserted into the gas-operated lock on the top of the seat firing breech under the seat pan. The harness crotch straps are passed through the V-strap upper D-rings.

The QRF on the negative-g strap is a four-point AML fitting. The two lower points are for connecting the arm restraint lines and the two upper points are for connecting the two shoulder harness lugs, which are passed through the loops on the upper ends of the crotch straps before being plugged into the QRF.

LEG RESTRAINT SYSTEM

The passive leg restraint system restrains the occupants legs close to the front face of the seat pan and prevents the legs flailing during the ejection sequence. The system consists of two leg restraint lines, two cockpit tunnel recesses and one combined snubber and guillotine unit (CSGU) on the front of the seat pan. When strapping-in, the occupant places his legs into the tunnels where the leg lines were stowed by the groundcrew when the seat was installed. The leg lines are supported in the cockpit tunnels by horseshoe shaped metal clips which allow easy leg line extraction upon ejection. Each leg restraint line, which incorporates a section of tear webbing at the lower end, is routed around the cockpit leg tunnel and then to the CSGU on the front of the seat pan. The lines pass down through the CSGU and are anchored to brackets on the cockpit floor. A shaped webbing panel attached to the seat pan improves leg capture during ejection. The tear webbing in the lines increases the efficiency of the leg restraint by slowing down the speed of the snubbing action and increasing the leg capture envelope. During ejection, inertia causes the occupant's legs to rotate backwards on to the calf supports as the seat moves upwards. The lines are extracted from their tunnel recesses and drawn tight as the seat moves further upwards. The shaped webbing panels capture the legs, the tear webbing separates at about 500lbf and the lines are freed from the cockpit floor, leaving the legs fully restrained with some surplus line protruding from beneath the seat. On man/seat separation, gas from the harness release system operates the guillotines in the CSGU to cut the leg restraint lines.

ARM RESTRAINT SYSTEM

The arm restraint system (ARS) restrains the occupants arms and prevents arm flailing, particularly during high speed ejection. The system consists of two arm restraint lines and the same CSGU as used for the leg restraint system. Tear webbing in the lower end of the arm restraint lines serves the same purpose as previously described for that of the leg restraint lines and slows down the snubbing action to increase the arm capture envelope. The upper ends of the arm restraint lines terminate in sliders which are held in position on the QRB by two spring plates. The lower ends are attached to brackets on the cockpit floor. The lines are fed through the same CSGU as the leg restraint lines. When strapping-in, the occupant connects the restraint line lug on each arm of the flying clothing into the lower two slots in the QRB by first passing each lug through the slider on the end of the arm restraint lines attached to the seat, the two sliders having been fitted to the QRB during seat installation. As the seat travels upwards during ejection, initial tension on the lines causes the arm restraint line sliders attached to the QRB to be pulled from the QRB plate housing down towards the seat pan front cross beam. The rings on the arm lines are drawn down from the shoulder towards the wrist through the Velcro material attached to the flying clothing. When the arm restraint lines have been drawn down so that the sliders come up against the seat pan front cross beam, further movement of the lines is prevented. The lines become taut and tear the webbing separates, freeing the lines from the cockpit floor brackets. The arms are then restrained. At man/seat separation, gas from the harness release system operates the guillotines in the CSGU to cut the arm restraint lines.

SHOULDER HARNESS REEL

The cartridge-operated shoulder harness reel is fitted horizontally to the ejection gun.The harness reel ensures that the seat occupant is brought to, and locked in, the correct posture during ejection. The unit allows the seat occupant to lean forward and twist around in the seat for maximum visibility but restrains forward movement in the event of rapid strap extension due to excessive deceleration. The seat shoulder harness is connected by roller fittings to two harness reel straps, which are attached at one end to individual harness locks and at the other to spring-loaded spools around which the straps are wound. For normal flight operations, the go-forward control lever on the right side of the seat pan is the forward (free) position and the harness reel straps are free to extend and retract as the occupant moves in the seat. Should the occupant wish, however, the go-forward control lever can be moved to the rear (locked) position, which allows the harness reel straps to retract but prevents them extending.

When ejection is initiated, gas pressure from the seat firing breech under the seat pan fires the harness reel cartridge which provides the necessary gas pressure to power the harness reel. The harness reel straps are wound in, pulling the occupants shoulders back into the seat. During the pull-back sequence, the harness reel is automatically put into a locked position, allowing only strap retraction and preventing forward movement in the unlikely event of pressure loss.

EJECTION SEQUENCE

Pulling the seat firing handle removes the sears from the two firing units in the double breech on the underside of the seat pan, firing the two cartridges.

OPERATION

Gas from the left cartridge passes to:

– Activate the auxiliary oxygen system.
– The electrical and encrypto-erase connectors to disconnect them.
– The canopy jettison through the left quick-disconnect to jettison the canopy.
– The left thermal battery.
– The left time-delay mechanism in the dual timer on the ejection gun cartridge.
– The harness reel to pull the occupant back into the correct position for ejection.

Gas from the right cartridge passes to:

– Activate the auxiliary oxygen system.
– The electrical and encrypto-erase connectors to disconnect them.
– The canopy jettison through the right quick-disconnect to jettison the canopy.
– The right thermal battery.
– The right time-delay mechanism in the dual timer on the ejection gun cartridge.
– The harness reel to pull the occupant back into the correct position for ejection.

After either of the time-delays on the ejection gun cartridge has run out, the firing pin is released and initiates the cartridge. The gas pressure developed by the ejection cartridge causes the bottom latches to lock, the top latches to unlock and the ejection gun assembly to rise. As the seat rises up the guide tubes:

– The PEC aircraft portion is disconnected.
– The leg and arm restraint lines tighten to restrain the occupants arms and legs. When these lines become taut, the tear webbing separates from the anchorage points on the aircraft floor and

the legs and arms are restrained by the combined snubber and guillotine unit.

After approximately 0.75m of ejection gun travel, the left and right multi-purpose initiators (MPI) are tripped.

The left MPI provides gas pressure to:

- Ignite the underseat rocket motor to sustain the upward thrust of the ejection guns and carry the seat clear of the aircraft.
- Initiate the cartridge of the aerodynamic surface deployment unit under the seat pan to deploy the lower aerodynamic surfaces which help to stabilize the seat in conjunction with the upper aerodynamic surface, particularly in a high speed ejection.
- Deploy the upper aerodynamic surface on the parachute headbox.
- Open the left start switch and deploy the left pitot.
- Trip the time-delay mechanism in the barostatic back-up unit.

The right MPI provides gas pressure to:

- Ignite the underseat rocket motor to sustain the upward thrust of the ejection guns to carry the seat clear of the aircraft.
- Initiate the cartridge of the aerodynamic surface deployment unit under the seat pan to deploy the lower aerodynamic surfaces which help to stabilize the seat in conjunction with the upper aerodynamic surface, particularly in a high speed ejection.
- Open the right start switch and deploy the right pitot.

ELECTRONIC SEQUENCER TIMING

Electronic sequencer timing begins when the start switches open. Mode selection is dependent upon altitude and airspeed parameters, but because the sequencer uses continuous sensing, there are no fixed timings for drogue release, parachute deployment and the man/seat separation. During the sensing ‘window’, the sequencer determines the earliest possible safe parachute deployment time.

IMMEDIATE MODE (LOW SPEED, LOW/MEDIUM ALTITUDE)

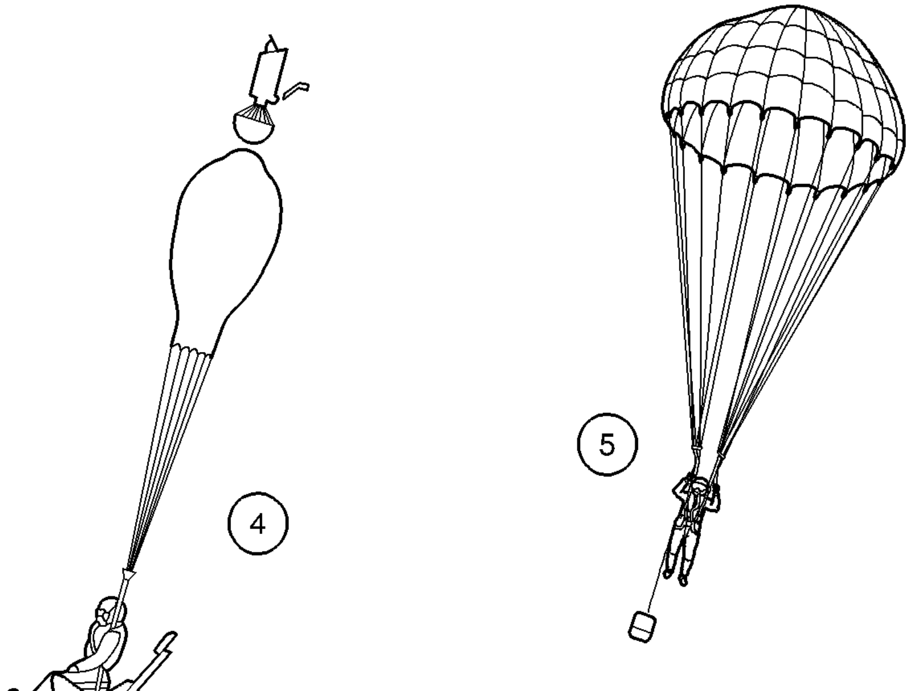
In this mode (Refer to Figure 1.74), the drogue is not deployed or released, the parachute headbox is deployed at the earliest practicable opportunity to place the occupant on to the parachute and the harness release system operates to free the occupant from the seat. The occupant is momentarily held in the seat by sticker straps.

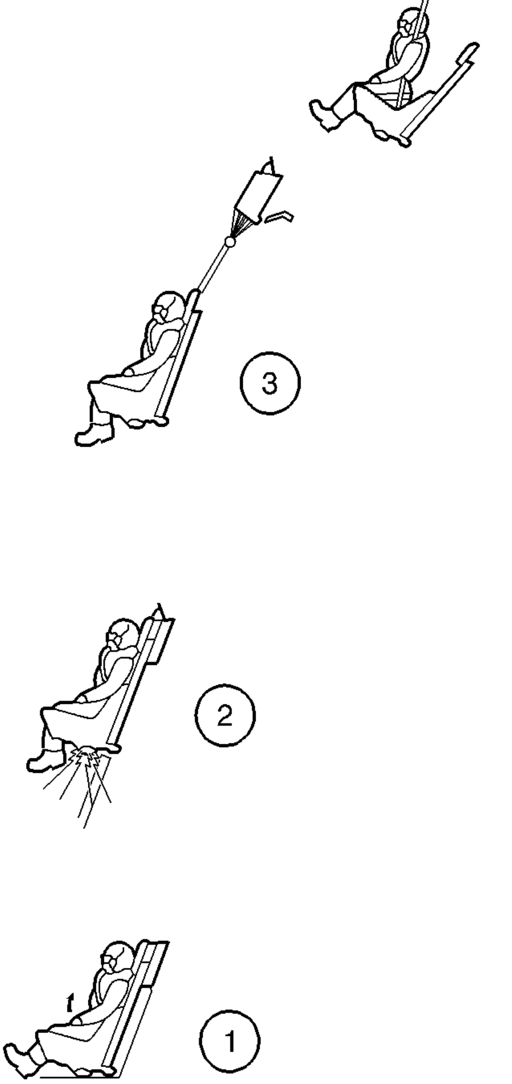
LOW DROGUE MODE (MEDIUM/HIGH SPEED, LOW/MEDIUM ALTITUDE)

In this mode (Refer to Figure 1.75), the drogue deployment unit fires to deploy the drogue. As soon as the sequencer senses that the airspeed is below a given limit the drogue bridle and drogue are released, the parachute headbox is deployed to place the occupant on to the parachute, and the harness release system operates to free the occupant from the seat. The occupant is momentarily held in the seat by sticker straps.

HIGH DROGUE MODE (ANY SPEED/HIGH ALTITUDE)

In this mode (see Figure 1.76), the drogue deployment unit fires to deploy the drogue and the drogue bridle remains connected until the seat has descended to 16 400 ft (5000m). This arrangement prevents prolonged exposure to low temperature and rarefied air and enables the occupant to ride down in the seat as quickly as possible, controlled by the drogue and supplied with oxygen, to a more tolerable altitude. When the seat has descended to 16 400 ft (5000m), the drogue bridle and drogue are released the parachute deployed and the harness release system operates to free the occupant from the seat. The occupant is momentarily held in the seat by the sticker straps.





1 A) SEAT FIRING HANDLE PULLED
B) HARNESS REEL RETRACTS SHOULDER STRAPS
C) EMERGENCY OXYGEN ACTIVATED
D) AGVSS INITIATED (ASP VARIANT ONLY)
E) ELECTRICAL CONNECTOR DISCONNECTED
F) ENCRYPTO-ERASE CONNECTOR DISCONNECTED
*G) CANOPY JETTISON AND SEQUENCE SYSTEM INITIATED
H) THERMAL BATTERIES ACTIVATED AND SQUENCER POWERED UP
J) EJECTION GUN TIME DELAYS INITIATED
K) EJECTION GUNS INITIATED AFTER DELAY
L) EJECTION GUN TOP LATCHES DISENGAGE
M) EJECTION GUN BOTTOM LATCHES ENGAGE
N) SEAT BEGINS TO MOVE UP GUIDE TUBES

* SEQUENCE SYSTEM TWIN SEAT AIRCRAFT ONLY

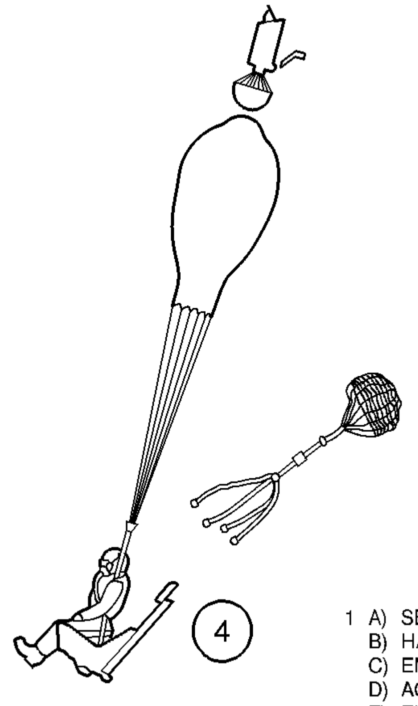
2 A) SERVICES DISCONNECT
B) LEG AND ARM RESTRAINTS OPERATE
C) MULTI-PURPOSE INITIATORS FIRE
D) END OF EJECTION GUN STROKE
E) UNDERSEAT ROCKET MOTOR FIRES
F) UPPER AND LOWER AERODYNAMIC SURFACES DEPLOYED
G) PITOTS DEPLOY
H) BAROSTATIC BACK-UP UNIT INITIALISED
J) START SWITCHES OPEN TO BEGIN SEQUENCER OPERATION

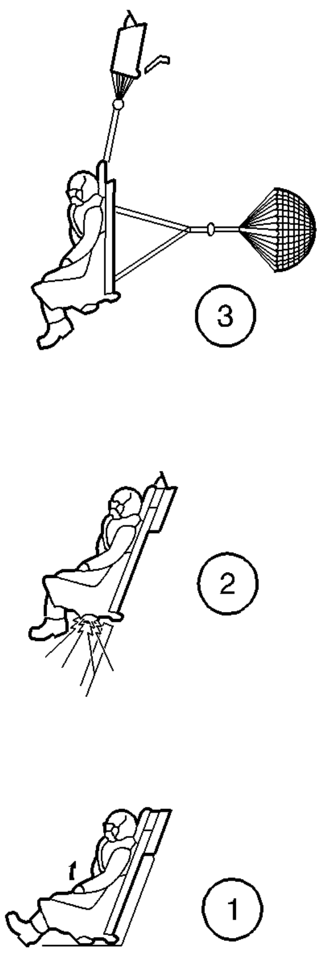
3 A) SEQUENCER SENSES LOW SPEED AND LOW ALTITUDE
B) SEQUENCER SELECTS IMMEDIATE MODE
C) HEADBOX DEPLOYMENT UNIT OPERATES

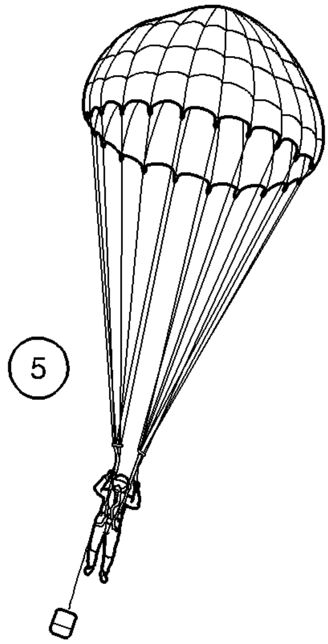
4 A) PARACHUTE DEPLOYS AND BEGINS INFLATION
B) HARNESS LOCKS AND PEC/LSCA MAN PORTIONS RELEASED
C) INFLATED PARACHUTE PULLS OCCUPANT FROM SEAT
D) PERSONAL LOCATOR BEACON ACTIVATED
E) PSP RETAINED
F) HEADBOX CLEARS EJECTION PATH USING AUXILIARY DROGUE

5 A) PILOT DESCENDS ON PARACHUTE
B) PSP AUTOMATICALLY LOWERED AFTER 4 SECONDS

Figure 1.74 - Ejection Sequence-Immediate mode (low altitude, low speed)







1 A) SEAT FIRING HANDLE PULLED
   B) HARNESS REEL RETRACTS SHOULDER STRAPS
   C) EMERGENCY OXYGEN ACTIVATED
   D) AGVSS INITIATED (ASP VARIANT ONLY)
   E) ELECTRICAL CONNECTOR DISCONNECTED
   F) ENCRYPTO-ERASE CONNECTOR DISCONNECTED
   *G) CANOPY JETTISON AND SEQUENCE SYSTEM INITIATED
   H) THERMAL BATTERIES ACTIVATED AND SQUENCER POWERED UP
   J) EJECTION GUN TIME DELAYS INITIATED
   K) EJECTION GUNS INITIATED AFTER DELAY
   L) EJECTION GUN TOP LATCHES DISENGAGE
   M) EJECTION GUN BOTTOM LATCHES ENGAGE
   N) SEAT BEGINS TO MOVE UP GUIDE TUBES

* SEQUENCE SYSTEM TWIN SEAT AIRCRAFT ONLY

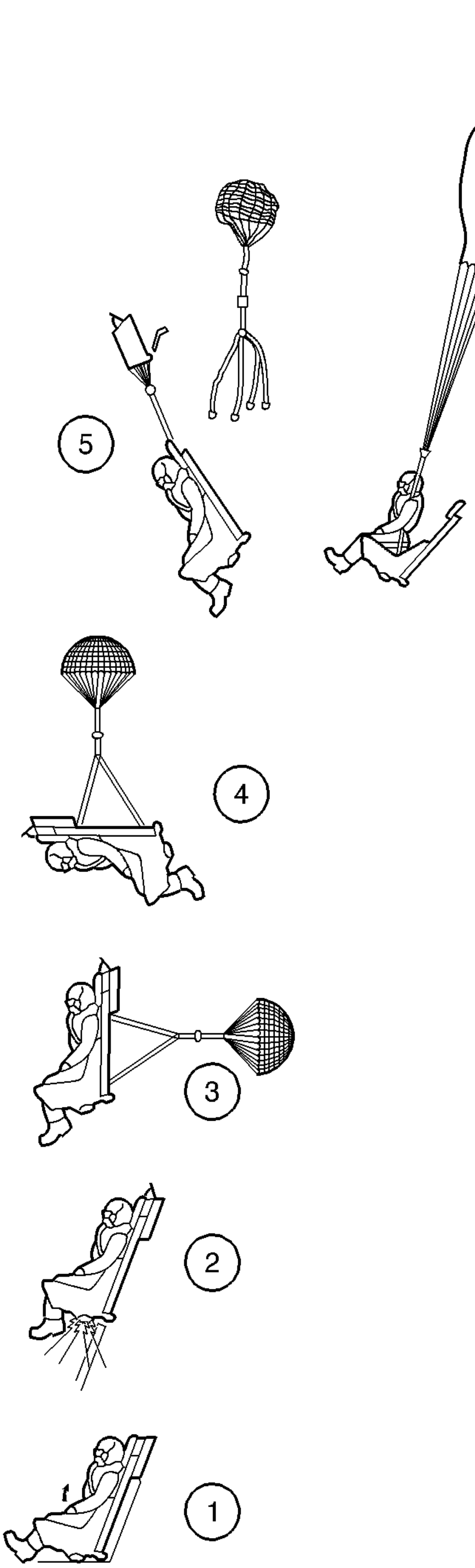
2 A) SERVICES DISCONNECT
   B) LEG AND ARM RESTRAINTS OPERATE
   C) MULTI PURPOSE INITIATORS FIRE
   D) END OF EJECTION GUN STROKE
   E) UNDERSEAT ROCKET MOTOR FIRES
   F) UPPER AND LOWER AERODYNAMIC SURFACES DEPLOYED
   G) PITOTS DEPLOY
   H) BAROSTATIC BACK-UP UNIT INITIALISED
   J) START SWITCHES OPEN TO BEGIN SEQUENCER OPERATION

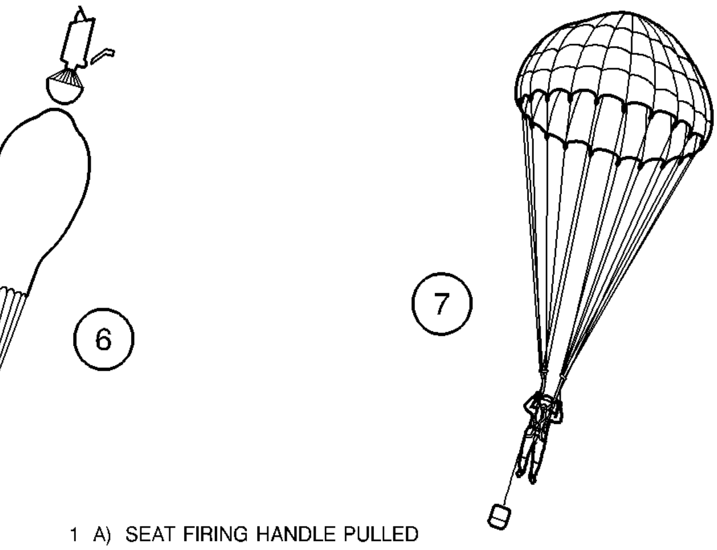
3 A) SEQUENCER SENSES HIGH SPEED AND LOW ALTITUDE
   B) SEQUENCER SELECTS DROGUE MODE
   C) DROGUE DEPLOYMENT UNIT OPERATES
   D) SEQUENCER RESTARTS ENVIROMENTAL SENSING AFTER DELAY
   E) HEADBOX DEPLOYMENT UNIT OPERATES WHEN SPEED SUFFICIENTLT REDUCED

4 A) DROGUE AND BRIDLE RELEASED
   B) PARACHUTE DEPLOYS AND BEGINS INFLATION
   C) HARNESS LOCKS AND PEC/LSCA MAN PORTIONS RELEASED
   D) INFLATED PARACHUTE PULLS OCCUPANT FROM SEAT
   E) PERSONAL LOCATOR BEACON ACTIVATED
   F) PSP RETAINED
   G) HEADBOX CLEARS EJECTION PATH USING AUXILIARY DROGUE

5 A) PILOT DESCENDS ON PARACHUTE
   B) PSP AUTOMATICALLY LOWERED AFTER 4 SECONDS

Figure 1.75 - Low drogue mode (low altitude, high speed)





1 A) SEAT FIRING HANDLE PULLED
B) HARNESS REEL RETRACTS SHOULDER STRAPS
C) EMERGENCY OXYGEN ACTIVATED
D) AGVSS INITIATED (ASP VARIANT ONLY)
E) ELECTRICAL CONNECTOR DISCONNECTED
F) ENCRYPTO-ERASE CONNECTOR DISCONNECTED
*G) CANOPY JETTISON AND SEQUENCE SYSTEM INITIATED
H) THERMAL BATTERIES ACTIVATED AND SQUENCER POWERED UP
J) EJECTION GUN TIME DELAYS INITIATED
K) EJECTION GUNS INITIATED AFTER DELAY
L) EJECTION GUN TOP LATCHES DISENGAGE
M) EJECTION GUN BOTTOM LATCHES ENGAGE
N) SEAT BEGINS TO MOVE UP GUIDE TUBES

* SEQUENCE SYSTEM TWIN SEAT AIRCRAFT ONLY

2 A) SERVICES DISCONNECT
B) LEG AND ARM RESTRAINTS OPERATE
C) MULTI-PURPOSE INITIATORS FIRE
D) END OF EJECTION GUN STROKE
E) UNDERSEAT ROCKET MOTOR FIRES
F) UPPER AND LOWER AERODYNAMIC SURFACES DEPLOYED
G) PITOTS DEPLOY
H) BAROSTATIC BACK-UP UNIT INITIALISED
J) START SWITCHES OPEN TO BEGIN SEQUENCER OPERATION

3 A) SEQUENCER SENSES HIGH ALTITUDE (ANY SPEED)
B) SEQUENCER SELECTS HIGH DROGUE MODE
C) DROGUE DEPLOYMENT UNIT OPERATES
D) DROGUE STABILISES AND DECELERATES SEAT
E) EMERGENCY OXYGEN SUPPLY CONTINUED

4 A) SEAT DESCENDS, STABILISED BY DROGUE
B) SEQUENCER CONTINUES TO SENSE ALTITUDE
C) EMERGENCY OXYGEN SUPPLY CONTINUED

5 A) SEQUENCER SENSES PARACHUTE DEPLOYMENT ALTITUDE
B) DROGUE AND BRIDLE RELEASED
C) HEADBOX DEPLOYMENT UNIT OPERATES

6 A) PARACHUTE DEPLOYS AND BEGINS INFLATION
B) HARNESS LOCKS AND PEC/LSCA MAN PORTIONS RELEASED
C) INFLATED PARACHUTE PULLS OCCUPANT FROM SEAT
D) PERSONAL LOCATOR BEACON ACTIVATED
E) PSP RETAINED
F) HEADBOX CLEARS EJECTION PATH USING AUXILIARY DROGUE

7 A) PILOT DESCENDS ON PARACHUTE
B) PSP AUTOMATICALLY LOWERED AFTER 4 SECONDS

Figure 1.76 - High drogue mode (high altitude, any speed)

ESCAPE SYSTEM CONTROLS AND INDICATORS

EJECTION SEAT CONTROLS (MK 16A)

Operation of the ejection seat is enabled by the following controls (Refer to Figure 1.77):

ARMED/SAFE/EGRESS HANDLE

The seat ARMED/SAFE/EGRESS handle is used to make the seat safe when the aircraft is on the ground and is also used for manual and emergency egress on the ground. The handle is on the right side of the seat pan and is in clear view of both ground crew and aircrew. Inside the handle is a lever which operates against a spring-loaded plunger to positively lock the handle in the ARMED, SAFE or EGRESS positions. Always ensure that the handle has latched into the selected position by rocking the handle backwards and forwards with the inner lever released. When the handle is in the SAFE or EGRESS positions, a mechanical interlock prevents the seat firing handle being accidentally pulled from its housing.

When the ARMED/SAFE/EGRESS handle is in the SAFE position, the seat is safe and the visible portion of the handle is colored white and engraved SAFE in black. With the ARMED/SAFE/EGRESS handle in the ARMED position, the seat is armed and the visible portion of the handle is colored red and white and engraved ARMED in black. The EGRESS portion of the handle is colored yellow with the word EGRESS engraved in black.

For manual and emergency egress, the ARMED/SAFE/EGRESS handle is rotated beyond the SAFE position and locked into the EGRESS position. When the handle is in the EGRESS position, the word EGRESS lines up with a yellow marker on the thigh guard. Locking the handle into the EGRESS position releases the jacket arrowhead connector from the PSP lowering line connector on the left side of the seat pan. Alternatively, the ARMED/SAFE/EGRESS handle can be selected to SAFE and the PSP lowering line arrowhead connector released by operating the manual release on the connector.

SEAT FIRING HANDLE

The seat firing handle is a black and yellow flexible loop at the front of the seat pan and is connected by a linkage to a double breech under the seat pan. When the handle is pulled, it removes the sears from the two firing units in the breech to fire two cartridges which start the ejection sequence. A mechanical interlock between the ARMED/SAFE/EGRESS handle and the seat firing handle prevents the seat firing handle being pulled when the ARMED/SAFE/EGRESS handle is in the SAFE or EGRESS positions.

SEAT HEIGHT ACTUATOR SWITCH

The seat height actuator switch is a three position switch located on the right side of the seat pan. The switch is spring loaded to the centre (OFF) position. The switch is moved rearward to raise the seat pan and forward to lower the seat pan. To avoid overheating, the switch should not be operated for more than one minute in any eight minute period.

PERSONAL SURVIVAL PACK CONNECTOR

The personal survival pack (PSP) connection forms part of the lowering line assembly and is located in a clip on the left side of the seat pan. The connector forms the interface between the seat occupant and the PSP via the lowering line. During manual and emergency egress on the ground, operation of the SAFE/ARMED/EGRESS handle to the EGRESS position will release the jacket arrowhead connector from the PSP connector in its clip. During the ejection sequence, at the seat/man separation point, the PSP connector is pulled from its clip on the seat pan but remains connected to the jacket and the lowering line.

HARNESS GO-FORWARD LEVER

The harness go-forward lever is positioned on the right side of the seat pan behind the actuator switch. In the forward (free) position, it allows the occupant to move forward and twist round in the seat. If the straps extract rapidly because of sudden deceleration with lever in this position, the HPRU locks and prevents further extraction until the load on the straps is released. With the lever in the rear (locked) position, the straps will retract but not extend.

EMERGENCY OXYGEN HANDLE

The Emergency Oxygen Handle is a black and yellow lever located on the left seat pan thigh guard. Emergency oxygen is selected by rotating the lever towards the pilot. At the end of lever travel a button at the forward end of the lever will extend to indicate full selection and lock the lever in position.

The button must be depressed to allow deselection of the handle. At the fully deselected position the handle clicks into the locked position.

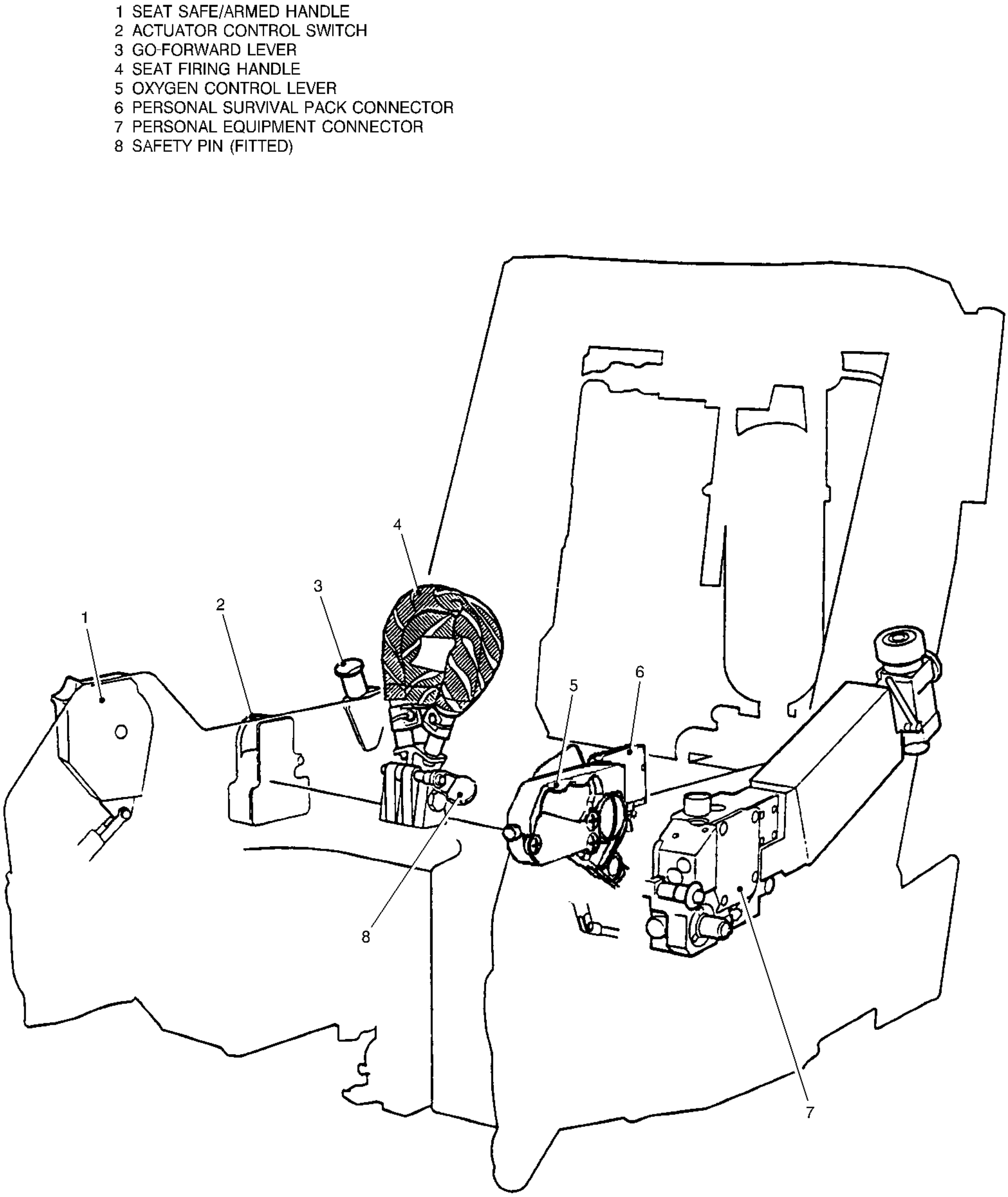


Figure 1.77 - Operating controls

MINIMUM EJECTION HEIGHTS

The minimum ejection heights shown in Figure 1.78 and Figure 1.79 are from ejection gun initiation and exclude the seat time delays.

The data presented applies to ISA sea level atmospheric conditions. Altitude effects on seat performance require that terrain clearance must be increased by 2% for every 100 ft above sea level.

The data does not directly take into account the underseat rocket motor (USRM) divergence effects on safe terrain clearances. This is addressed by use of bank angle correction value selected from the chart at Figure 1.78. This value is added to or subtracted from the actual bank angle, dependent on which direction the bank angle is acting in relation to the USRM divergence direction. Thus, if right bank is initiated and the URSM provides divergence to the left, then the correction angle is subtracted from the bank angle.

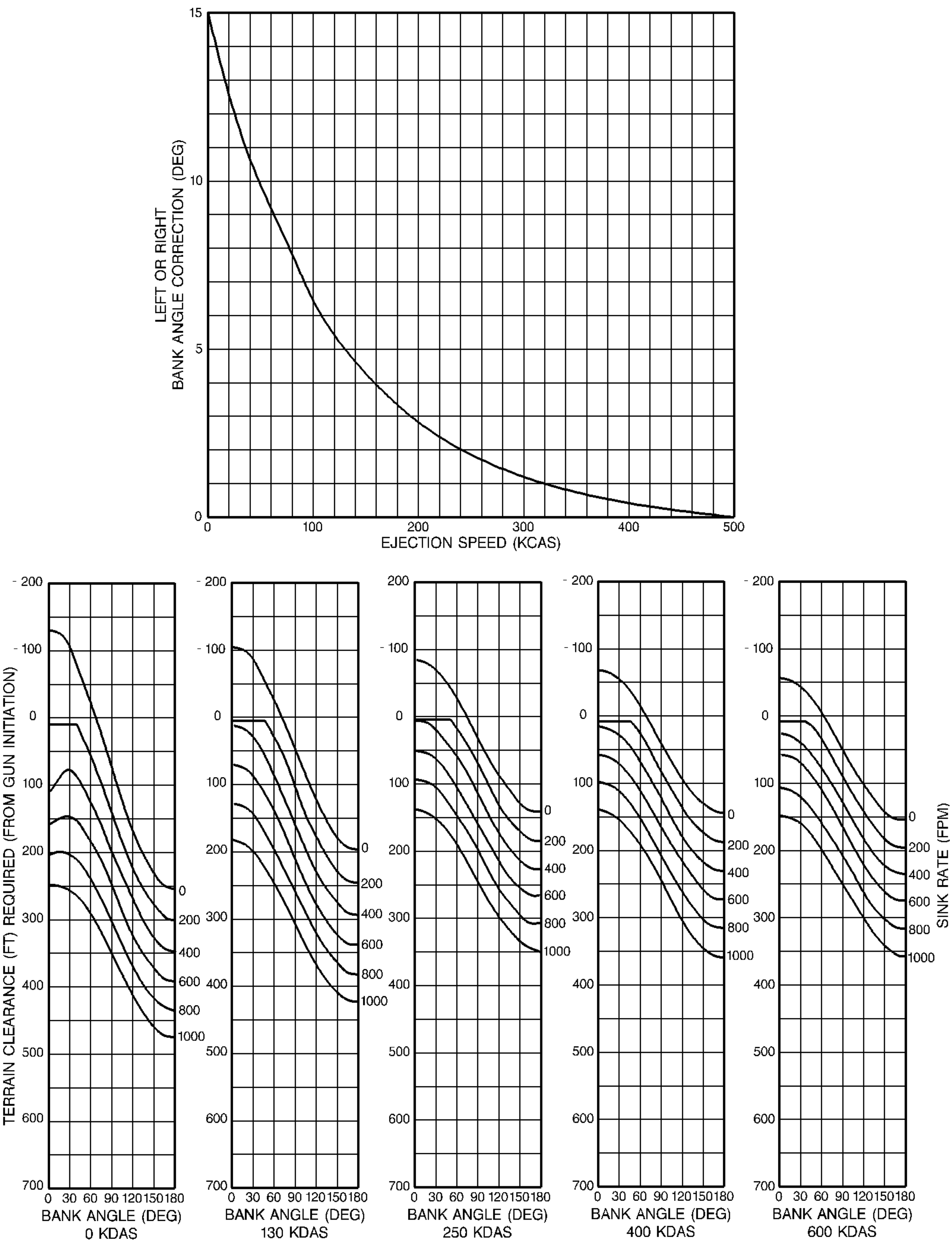


Figure 1.78 - Terrain clearance/sink rate

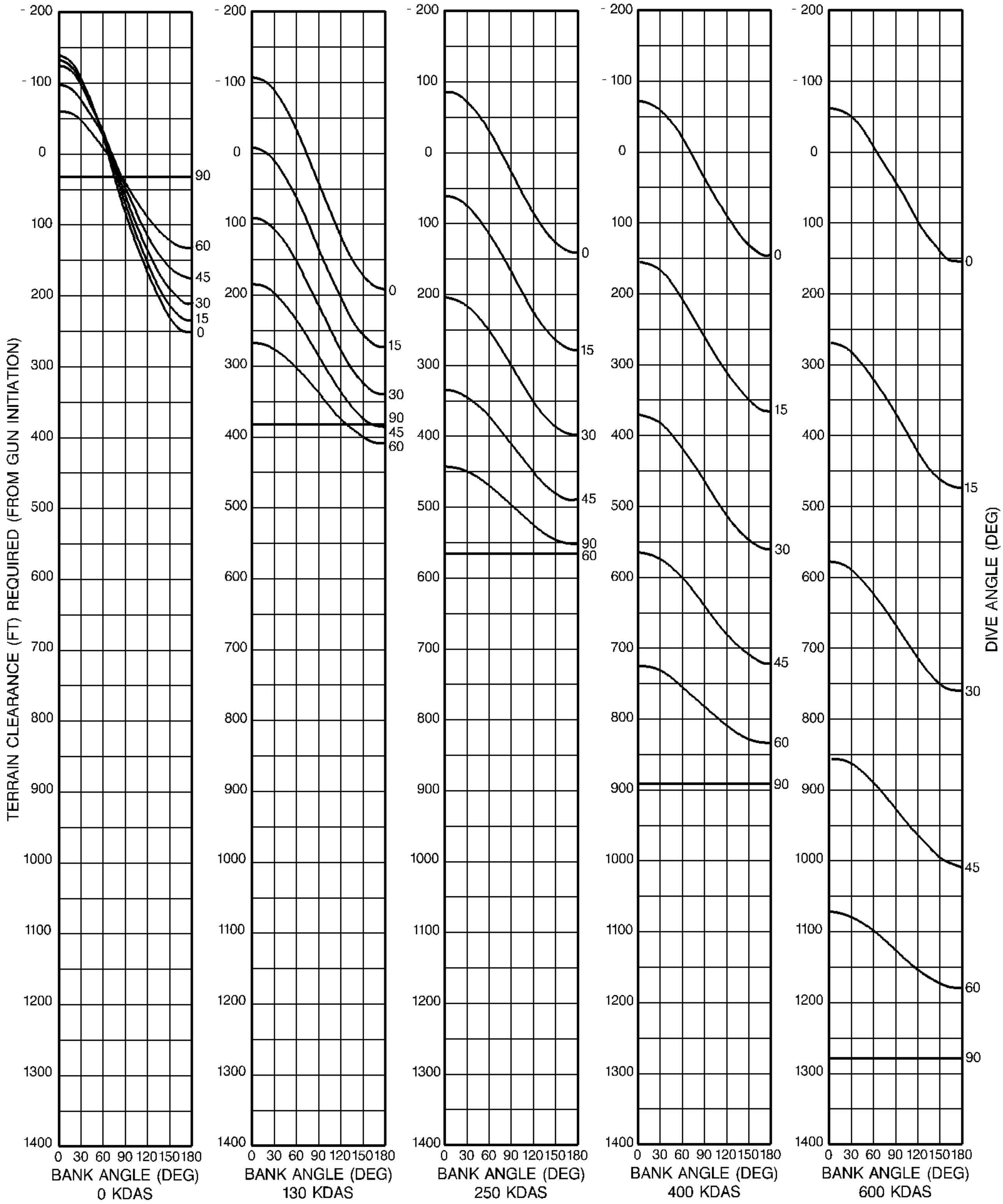


Figure 1.79 - Terrain clearance/dive angle

AIRCREW EQUIPMENT ASSEMBLY

The Aircrew Equipment Assembly (AEA) system consists of garments and man mounted equipment, and interfaces with other aircraft systems to allow the aircrew to operate the aircraft effectively throughout the operating envelope. Additionally the AEA provides protection during escape and enhances the probability of survival prior to and during rescue. The AEA comprises both standard Government Furnished Equipment (GFE) and Eurofighter specific equipment.

Only those items that are appropriate to the mission need to be selected from the Eurofighter AEA. The Eurofighter AEA system differs from previous equipment in that each AEA function is performed by a distinct layer of garments.

AIRCREW EQUIPMENT ASSEMBLY SYSTEM

The Eurofighter AEA system is divided into two sub-systems, the Head Equipment Assembly (HEA) and flight clothing (including and associated equipment).

HEAD EQUIPMENT ASSEMBLY

The major components of the HEA are:

- Helmet
- Face mask
- Communications lead.

HELMET

The helmet provides head impact and ocular protection. In addition the helmet provides fitting adjustment and supports the face mask and earphones.

FACE MASK

The face mask is attached to the helmet via bayonet fittings. The face mask attachment tension is manually adjustable and also has a quick release capability. The face mask also provides a voice activated microphone.

COMMUNICATIONS LEAD

The communications lead, for the earphones and facemask microphone, connects between the inner helmet and the Aircrew Services Package (ASP), aircrew portion.

FLIGHT CLOTHING

There are three categories of flying clothes:

- Inner layer
- Intermediate layers
- Outer layer.

INNER LAYER

The inner layer consists of under wear. This layer provides basic thermal protection and enhances comfort by absorbing sweat.

INTERMEDIATE LAYERS

The intermediate layer comprises a number of garments, some of which may be worn over others as follows:

Thermal Protection Garments (TPG): TPG are optional and are worn as the next layer over the underwear. There are three types:

- Shortie: This is a thermal coverall type garment with short sleeves and short legs.
- Longie: This is a thermal coverall type garment with long sleeves and long legs.
- Combie: This is a thermal coverall type garment long sleeves, long legs and an extra thick vest section.

Immersion Protection Garment (IPG) (UK & GE only): The IPG is an optional one piece garment, which includes socks. The garment fabric is double layer nomex with a third, middle layer of Gore-Tex water proofing. The socks are made of a Gore-Tex stretch material and the upper arms incorporate cotton ventile patches to prevent ballooning and 'shrink wrapping' during rapid changes in pressure. The IPG has pockets, water tight neck and wrist seals, and a urination zip. A water tight breakout for the Liquid Conditioning Garment (LCG) hoses is also provided although the LCG is currently only available on DA6. The breakout must be plugged in cases where a LCG is not worn. There are two types of IPG which are identical in all respects except for the way they fasten, these are:

- Horseshoe zip: The closure zip goes from the front torso, behind the neck and then back to the front torso.
- Cross chest zip (UK only): The closure zip is situated diagonally across the chest.

Interim IPG (UK only): This is the standard RAF `Mk1 immersion suit inner'.

Liquid Conditioning Garment (LCG) (SP only): The LCG is a short sleeved vest containing capillary tubes, which circulate conditioned fluid to control body temperature. The LCG is connected via a quick release connector to the Intermediate Hose Assembly (IHA), which in turn connects to the seat mounted Liquid Suit Connector Assembly (LSCA).

Light Weight Coverall (LWC): The LWC is a one-piece garment of Nomex fabric, which may be worn as an outer garment on the ground and as an intermediate layer in flight.

OUTER LAYER

The major components of the outer layer are :

- Flight jacket
- Full coverage anti-G trousers (FCAGT)
- Integrated boots
- GFE boots
- Gloves.

Flight Jacket: The flight jacket consists of a long sleeved carrier waistcoat, which incorporates an inflatable chest counter pressure bladder (CCPB) and a life preserver assembly (LPA). The CCPB assists breathing during pressure breathing with G (PBG), and pressure breathing with altitude (PBA). The CCPB applies pressure on the chest to counteract the outward pressure due to the pressurized breathing gas. The LPA consists of an inflatable life preserver and an automatic inflation unit, which can also be manually activated. This is stowed in a pouch around the neck. The breathing gas hose assembly, (BGHA), is considered part of the flight jacket assembly. The BGHA has a compensated dump valve (CDV), which regulates the pressure applied by the CCPB. The sleeves have arm restraints, which prevent arm flailing during ejection. Sleeve pockets are provided to stow the arm restraint lines when they are not in use. The waistcoat portion of the flight jacket has pockets for the stowage of survival aids. The main closure zipper closes downwards to prevent it riding down during ejection.

Full Coverage Anti-G Trousers (FCAGT): The FCAGT contain bladders, which apply pressure over the lower abdomen and legs, excluding the crotch and buttocks. The FCAGT are supplied with air via a connection from the Aircrew Services Package (ASP) and are available in two types:

- Zippered: These are closed by zips down the inside of each leg.
- Step-in: These have no zips and are donned like normal trousers.

Integrated Boots: The integrated boots are flying boots which have inflatable bladders built into them to apply pressure to the feet. The boots have connectors to the FCAGT.

GFE Boots: GFE boots are flying boots without inflatable bladders.

Gloves: These are flying gloves.

FLIGHT OPERATING PROCEDURES

No part of the AEA should be removed during flight and the blast visor should always be in the down position. This ensures safety in the event of sudden emergency such as loss of cabin pressure or requirement to eject. Only specific actions such as the Valsalva maneuver or to clear the nasal passage, should both visors be raised and/or the mask be released.

SCHEDULES

When selecting AEA for a mission, refer to Figure 1.80, Figure 1.81 and the AEA equipment items from Table .

AEA Items

SUMMER	WINTER	DESCRIPTION	PART NO.
X		CP39 AEA CFE Land Schedules (Winter / Summer)	
	X	CP39 AEA CFE Land Schedules Winter / Sea Schedule	
H1	H1	Gentex TLSS Helmet	96D9435
			(or TLSS 1812)
H1	H1	Gentex TLSS Mask	96D9436
			(or TLSS 1786)
A	A	Interim Head Assembly with MQR	MP2700/2 to MP2704/2 (alpha)
H2	H2	Mask without AMT	P type 12-2848W000
			Q Type 12-2846W000

(Continued)

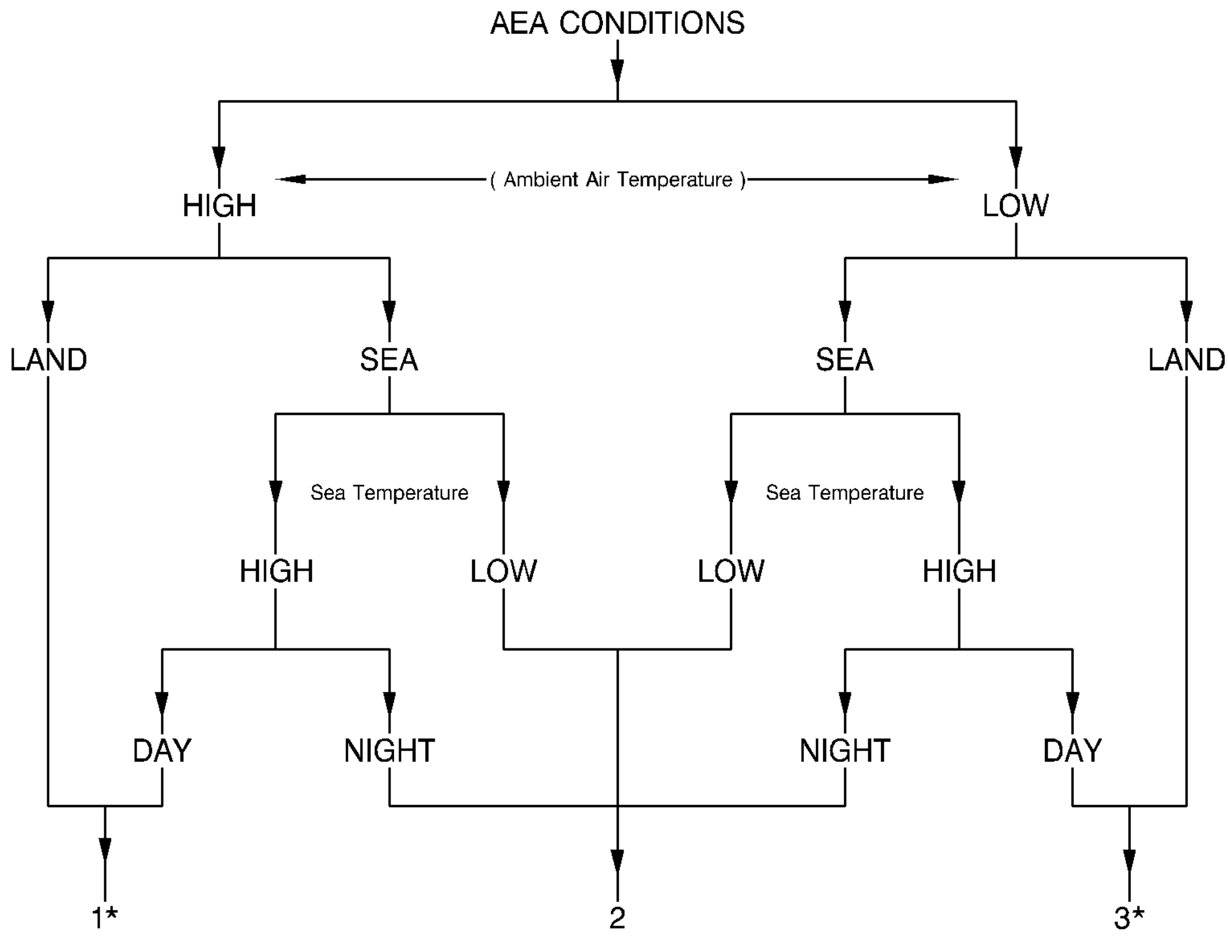
AEA Items (Continued)

SUMMER	WINTER	DESCRIPTION	PART NO.
P	P	Kneeboard without pocket (Right handed)	LG 6634R-01-00
P	P	Kneeboard with pocket (Right handed)	LG 6635R-01-00
A	A	Arm restraint lines (pair)	LG 6445-01-01 to -08
A1	A1	Integrated flight jacket	LG 6622-01-01 to -18
A1	A1	Full coverage anti-G trousers	LG 6615-01-01 to -12
A	I1	Coverall Lightweight	LG 6511-01-01 to -12
-	I1	Immersion protection garment (interim)	8475-99-721228 to 236
			& 22c/4272/79
-	A2	Immersion protection garment	LG 6614-01-01 to -18
-	A2	Immersion protection garment	LG 6615-01-01 to -18
O	A3	Thermal protection garment - Longie	LG 6390-01-01 to -06
O	A3	Thermal protection garment - Shortie	LG 6391-01-01 to -03
O	A3	Thermal protection garment - Combie	LG 6510-01-01 to -03

Key:	
A	Item must be worn as part of correct schedule. This applies to items identified with an A followed by a number e.g. A1.
A1	These items must always be worn as a matched pair, combination with other EF AEA flight jacket or G-trousers is not allowed.
A2	Either of these garments may be worn.
A3	These garments are selected individually or in combination to suit the prevailing conditions. The combination of the thermal protection garments, a longie and a shortie, and the immersion protection garments meets the survival requirements for 6 hours in water at 2°C.
O	These garments may be worn underneath the lightweight coverall or IPG.
H1	The Gentex TLSS helmet and mask are allowed as an alternative to the other helmet listed. However, use of this equipment introduces aircraft speed and altitude restrictions which are detailed in the Airworthiness Flight Limitations (AWFL).
H2	This mask may only be worn for use with non-PBG regulators
I1	The use of these two items with a coverall outside the immersion garment are an allowable alternative to the part no. LG 6614 or LG 6615
P	The use of a kneeboard is at the discretion of the aircrew.

The GFE items may be selected from the drawings listed below:

- RDJ9590014 - GFE Flt Schedule - MK 16 Seat GE
- RDJ9590015 - GFE Flt Schedule - MK 16 Seat IT
- RDJ9590016 - GFE Flt Schedule - MK 16 Seat SP
- RDJ9590017 - GFE Flt Schedule - MK 16 Seat UK.



1 - Summer Land/Sea (as required)
2 - Winter Sea
3 - Winter Land * Winter Sea Schedule is an acceptable alternative. Guidance should be taken from Figure 2.

Figure 1.80 - Selection of Aircrew Clothing

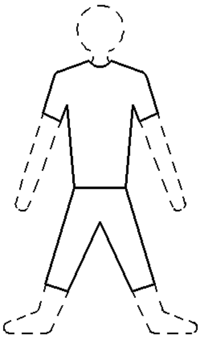
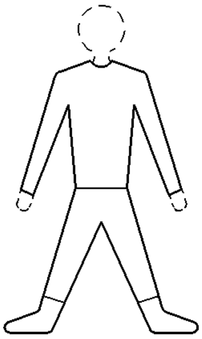
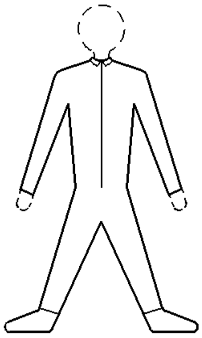
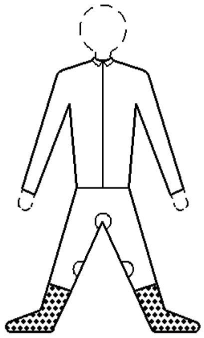
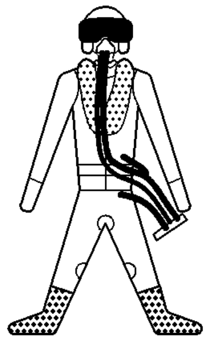
DONNING SEQUENCE / AEA SCHEDULE	1 	2 	3 	4 	5 
SUMMER LAND	LONG JOHNS VEST (optional) LCG (optional)	SOCKS SHIRT SHORTIE (optional) LONGIE (optional) COMBIE (optional)	LIGHTWEIGHT COVERALL	INTEGRATED BOOTS or BOOTS FCAGT KNEEBOARD (optional)	FLIGHT JACKET SPECTACLES (optional) GLOVES WATCH HEAD ASSEMBLY
SUMMER SEA	LONG JOHNS VEST (optional) LCG (optional)	SOCKS SHIRT SHORTIE (optional) LONGIE (optional) COMBIE (optional)	IMMERSON PROTECTION GARMENT	INTEGRATED BOOTS or BOOTS FCAGT KNEEBOARD (optional)	FLIGHT JACKET SPECTACLES (optional) GLOVES WATCH HEAD ASSEMBLY
WINTER LAND	LONG JOHNS VEST LCG (optional	SOCKS AT LEAST ONE OF THE FOLLOWING: SHIRT SHORTIE LONGIE COMBIE	LIGHTWEIGHT COVERALL	INTEGRATED BOOTS or BOOTS FCAGT KNEEBOARD (optional)	FLIGHT JACKET SPECTACLES (optional) GLOVES WATCH HEAD ASSEMBLY
WINTER SEA	LONG JOHNS VEST LCG (optional)	SOCKS AT LEAST ONE OF THE FOLLOWING: SHIRT SHORTIE LONGIE COMBIE	IMMERSON PROTECTION GARMENT	INTEGRATED BOOTS or BOOTS FCAGT KNEEBOARD (optional)	FLIGHT JACKET SPECTACLES (optional) GLOVES WATCH HEAD ASSEMBLY

Figure 1.81 - Donning Stages

ENVIRONMENTAL CONTROL SYSTEM (ECS)

The environmental control system (ECS) uses bleed air from the engines to provide conditioned air and pressurization for the cabin and cooling air for the avionics and general equipment (see Figure 1.82). The ECS also provides precooled air for the following subsystems:

– Canopy seal inflation
– Transparency antimist/demist
– Molecular sieve oxygen generation (MSOG)
– Anti-g

BLEED AIR SYSTEM

The bleed air for the ECS is taken from the 5th stage of each engine HP compressor through the engine bleed shut-off valves (EBSOVs). A check valve in each line prevents reverse flow from one engine to the other. The bleed air lines are combined and routed to the precooler via:

– a variable pressure regulator and shut-off valve (VPRSOV) or,
– a molecular sieve oxygen concentrator pressure regulator and shut-off valve (MSOC PRSOV).

The temperature of the precooler bleed air output is regulated by the precooler bypass valve. The precooler is ram air cooled in flight. Below 200 kt in flight or when on the ground, the precooler ejector SOV supplies bleed air to induce coolant flow through the precooler. The position of each SOV and the bypass valve is controlled and monitored by the front computer.

There is a leak detection loop installed between the EBSOVs and the precooler. The leak detection loop is monitored by the front computer. If a hot air leak is detected the front computer closes both EBSOV. If an EBSOV fails to close the corresponding L (or R) ECS LK warning is activated.

On the ground, in alert operation, the air for the ECS is supplied by the secondary power system (SPS).

The bleed air flow rate is controlled by varying the output of the VPRSOV. A venturi in the main ECS pipe limits the maximum flow for any regulator setting.

AIR CONDITIONING SYSTEM

The precooled bleed air is supplied to the air conditioning system through the environmental control system shut-off valve (ECS SOV).

The precooled air from the ECS SOV passes through the temperature control valve (TCV) into the cold air unit (CAU) compressor. The air is cooled in the intercooler and the regenerative heat exchanger. The turbine inlet water extractor (TIWE) removes most of the free water before the air enters the CAU turbine. The CAU turbine output air temperature is regulated by the position of the TCV.

The ECS SOV and the TCV are controlled and monitored by the front computer. The TCV routes the bleed air to the CAU and/or to the CAU bypass line.

The CAU turbine air output passes through the liquid/air and MSOC heat exchanger and into the main water extractor. The main water extractor removes most of the remaining condensed water.

In flight the intercooler is ram air cooled. Below 200 kt in flight or when on the ground, the intercooler ejector SOV supplies bleed air to induce coolant flow through the intercooler. The intercooler ejector SOV is controlled and monitored by the front computer.

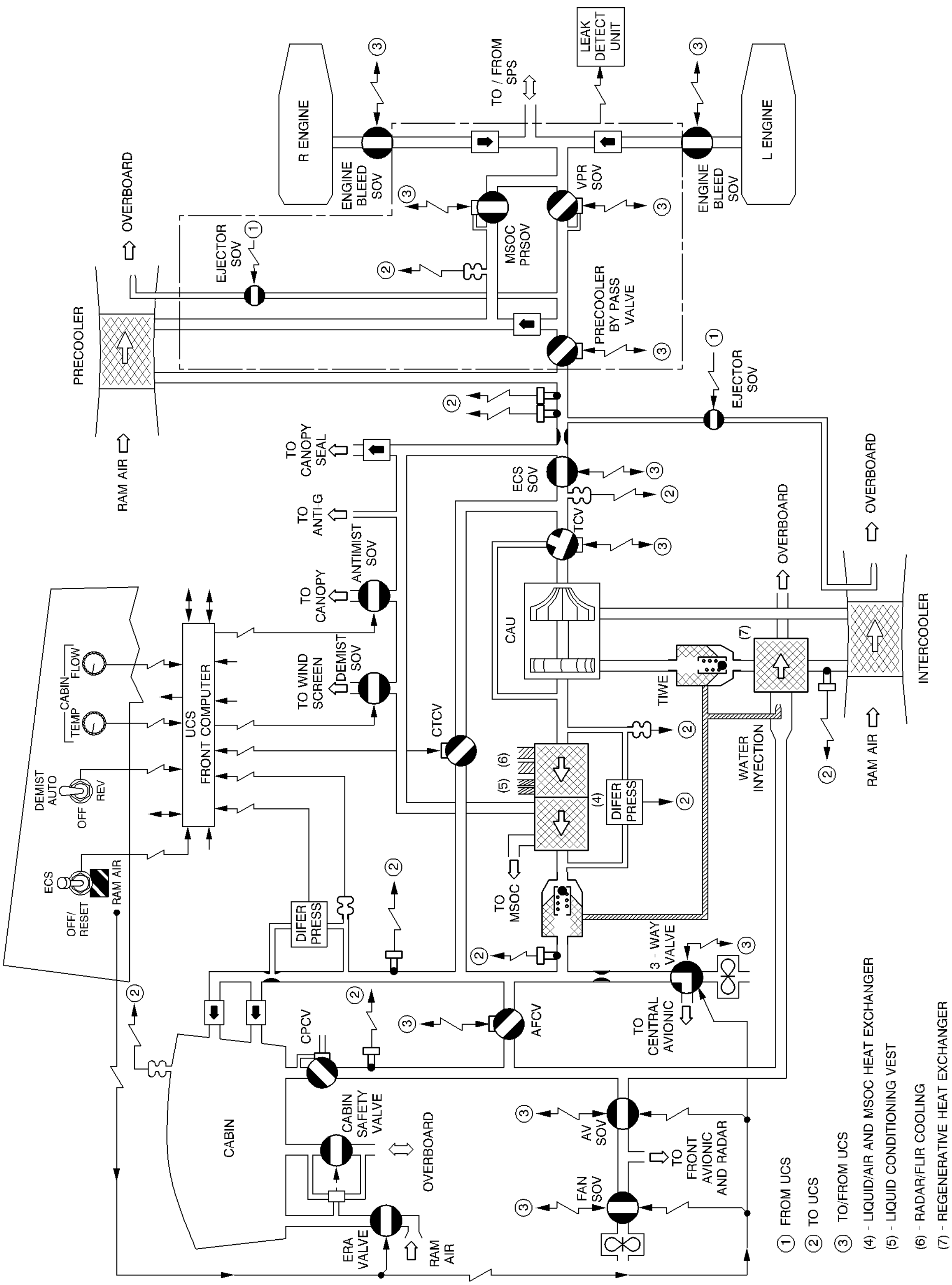


Figure 1.82 - Environmental Control System - Functional Schematic

ENVIRONMENTAL CONTROL SYSTEM MODES OF OPERATION

ALERT OPERATION

The air is supplied from the SPS. The air is conditioned by the air conditioning system to provide cabin air conditioning.

The avionic cooling air is from the front and center cooling fans. The AVSOV is closed and the fan SOV is open. The front cooling fan air is routed to the front avionic and the radar bays. The 3-way valve is "open-to-fan" and routes the center cooling fan air to the center avionic bay.

Service lines supply air to the MSOC, the canopy seal, the antimist/demist and the anti-g subsystems

The ejector SOVs are open connecting the bleed air to the ejectors to induce coolant flow through the precooler and the intercooler heat exchangers.

TAXI, TAKEOFF AND LANDING

The ECS operation in this mode is as described for the alert mode but the bleed air is supplied from the engines.

NORMAL FLIGHT

The air is supplied from the engines to the ECS system. The air is conditioned by the air conditioning system to provide:

– cabin air conditioning
– front avionic and radar bays cooling
– center avionic bay cooling.

The AVSOV is open, the fan SOV is closed, the 3-way valve is "open-to-ECS" and, the front and center cooling fans are off.

The service lines supply air to the MSOC, the canopy seal, the antimist/demist and the anti-g subsystems.

The ejectors SOV are closed.

ECS FAILURE IN FLIGHT

In case of ECS failure (with the exception a of hot air leak) the VPRSOV and the ECS SOV will close and the MSOC PRSOV will open. The engine bleed air is routed through the MSOC PRSOV and the precooler to the MSOC service line to provide breathing gas to the pilot.

The service lines supply air to the anti-g and canopy seal subsystems.

The antimist/demist SOVs are closed and, the subsystem is inhibited to save the air for the MSOC.

The cabin air conditioning is with ram air through pilot selection of the ECS switch to RAM AIR.

The avionic cooling air is from the front and center cooling fans, as described for the alert mode.

FLIGHT IN TRANSIENT CONDITIONS

If an engine fails during normal flight, bleed air is taken from the "live" engine and ducted to run the gearbox of the non-operating engine via the SPS. The ECS controlling software instructs the VPRSOV and the ECS SOV to close and the MSOC pressure regulator to open, to maintain the supply of breathing gas to the pilot.

If the situation described above is maintained for a short time (2 minutes), after which, the normal ECS operation is not recovered, a warning of ECS failure is generated, and the ECS goes into the functional situation described in "ECS failure in flight".

ECS FAILURE IN FLIGHT CAUSED BY HOT AIR LEAKAGE

In case of a hot air leakage the EBSOV of each engine is closed. There is no bleed air.

The cabin air conditioning and the avionic cooling is as described in "ECS failure in flight".

There is no air available through the services lines to any subsystem, including the MSOC supply.

PRESSURIZATION SYSTEM

The pressurization system provides pressure control for the cabin.

The cabin pressurization is provided by controlling the overflow of conditioned air from the cabin through the cabin pressure control valve (CPCV). The control of the pressure schedule (see Figure 1.83) by the CPCV is automatic.

In the case of CPCV failure or if the cabin pressure goes to sub-atmospheric condition, the cabin safety valve (CSV) prevents the cabin differential pressure from exceeding the maximum established limits. The CSV can inward relief and outward relief. The CSV opens to inward relief for a low differential pressure and to outboard relief for excessive differential pressure.

The UCS generates the cabin low pressure (CABIN LP) or the cabin high pressure (CABIN HP) warning via the dedicated warning panel to indicate system malfunction to the pilot.

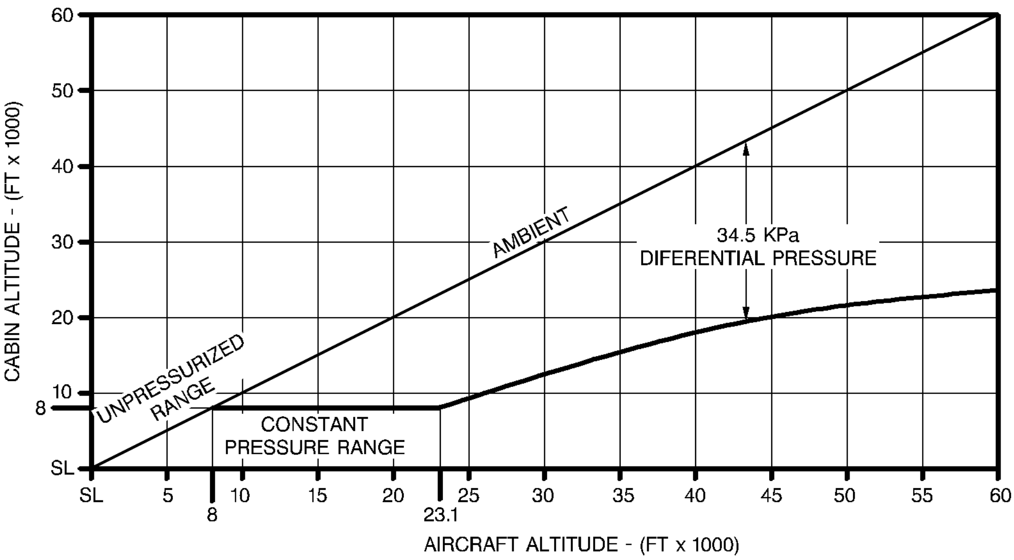


Figure 1.83 - Cabin Pressure Schedule

CABIN AIR SUPPLY SYSTEM

The cabin air supply system receives conditioned air from the air conditioning system. The air is distributed to the cabin by means of a distributed set of ducts and vents.

The airflow supplied is controlled by the front computer via the utilities control system (UCS). This receives signals from different sensors and from the pilot requirements by means of the cabin airflow control.

The UCS acts on the airflow control valve (AFCV) to regulate the airflow which enters the cabin.

The pilot selects the airflow with the cabin airflow control. The UCS evaluates the difference between the current flow and the new selected flow and commands the AFCV to open or close to achieve the requested cockpit flow demand.

The temperature of the cabin mass air flow is controlled by the cabin temperature control valve (CTCV) in the air conditioning system bypass line. The CTCV controls the amount of hot air that is mixed with the cold air output of the MSOC and liquid/air heat exchanger.

The pilot can change the temperature with the cabin temperature control. The front computer monitors the cabin inlet and outlet temperature to command the CTCV to open or close. Thus giving the requested temperature by varying the position of the CTCV.

When the ECS SOV is closed, due to an ECS failure, the pilot must open the ERA valve to ventilate the cabin. The ERA valve is opened when the ECS switch is set to RAM AIR. When the ERA valve opens, it pneumatically opens the cabin safety valve (CSV). The cabin is ventilated by ram air and is unpressurized.

AVIONIC AIR SUPPLY SYSTEM

The avionic air supply system cools the equipment installed in the center avionic, the front avionic and the radar bays. This equipment are cooled with air from the air conditioning system or, on the ground and for a emergency operation with air from two cooling fans.

During normal flight operation, with the ECS switch at ECS:

- The avionic shut-off valve (AVSOV) routes cooling air to the front avionic and the radar bays. The 3-way valve routes cooling air to the center avionic bay. The fan SOV is closed and the two cooling fans are off.
- The center avionic bay is cooled by cooling air from the cold air unit (CAU).
- The front avionic and the radar bays are cooled by a mixture of cabin air and cooling air from the CAU.

During ground operation with the ECS switch at ECS or RAM AIR:

- the AVSOV closes
- the fan SOV opens and switches on the front cooling fan
- the 3-way valve changes over and switches on the center cooling fan
- the two cooling fans provide the cooling air for the avionic and general equipment.

In flight, when a component malfuntion or failures are detected the pilot must selects the emergency operation cooling mode by positioning the ECS switch to RAM AIR. If the pilot selects ram air in flight the AVSOV, the fan SOV and the 3-way valve are positioned as in the ground case, and the two cooling fans are switched on. If any fan fails to operate the UCS generates the FAN warning via the dedicated warning panel.

If the aircraft is on ground, the air speed is below 100 Kt, or both engines rpm are below 60% then the control software of the UCS changes the three-way valve position, closes the AVSOV, opens the fan SOV and switches on the two cooling fans. In this case the equipment is cooled by external air supplied from the fans.

There is a warning horn to alert the ground crew if any fan is not running when the aircraft is electrically powered.

AVIONIC LIQUID COOLING SYSTEM

The avionic liquid cooling system is a closed circuit which removes the heat generated by the radar and FLIR unit and dissipates it to the conditioned air supply via the liquid/air and MSOC heat exchanger (see Figure 1.84).

A pump, controlled by the UCS front computer, is used to circulate the coolant liquid around the circuit. From the pump outlet, the liquid passes through the liquid/air and MSOC heat exchanger and then through the radar/FLIR. After cooling the radar/FLIR it passes through the liquid reservoir before reaching the pump inlet. The reservoir controls the coolant pressure at pump inlet and accommodates expansion of the liquid.

If a blockage occurs within the radar and the radar/FLIR inlet pressure rises above a preset level, the liquid by-pass valve opens. A second liquid relief valve is positioned upstream of the pump. This will dump excess coolant liquid overboard, protecting against overfilling when using the ground trolley or a failure of the reservoir expansion mechanism.

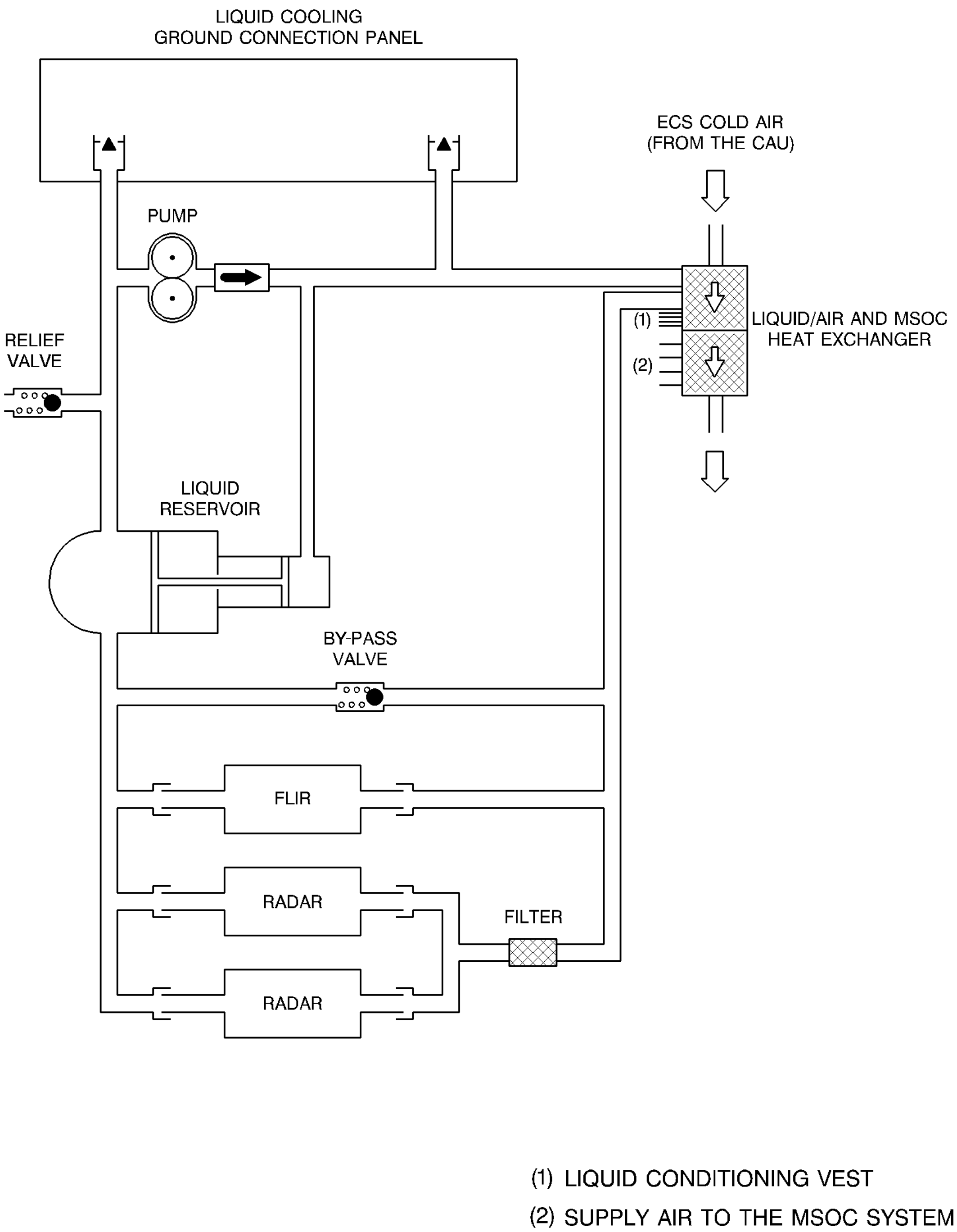


Figure 1.84 - Avionic Liquid Cooling System - Schematic Diagram

There are ground connections at either side of the pump for cooling the radar/FLIR at ground without engines or SPS running. A microswitch in the ground connection causes the aircraft pump to be electrically isolated when the ground cooling trolley is connected. The ground connections are also used to refilling the system.

ANTIMIST/DEMIST SYSTEM

The windscreen demist facility and the canopy antimist facility are by a pneumatic antimist/demist system, and the windscreen antimist is by an electrical antimist system.

PNEUMATIC ANTIMIST/DEMIST SYSTEM

The antimist/demist system receives precooled bleed air from the ECS system, then delivers it to the canopy and windscreen.
The precooled bleed air is divided into two lines, one line supplies air to the canopy antimist facility and the other line supplies air to the windscreen demist facility.
The antimist flow passes through the antimist SOV to supply air to the canopy transparency. When selected, flow is controlled automatically to maintain the inner surface of the canopy at a temperature above the dew point temperature, and so prevents the formation of condensation.
The demist facility, which has to be selected, provides a means of demisting the windscreen in the case of failure of the electrical antimist system. The demist flow passes through the demist SOV. With the demist SOV open, a large quantity of air flows over the windscreen surfaces.
The pneumatic antimist/demist system is controlled by the demist switch located on the right console (in front cockpit, on twin seat aircraft).

ELECTRICALANTIMIST SYSTEM

The windscreen antimist is by means of electrically heated elements controlled by a control unit.
The control unit controls the application of electrical power to the windscreen heating elements and automatically maintains the windscreen temperature at a required level to prevents mist formation in flight. The temperature is monitored by three sensors, when these sensors detect different temperatures the highest value is used. The system is activated by the windscreen heater switch located on the systems gangbar at the rear of the right console (in front cockpit, on twin seat aircraft).

WINDSCREEN HEATER SWITCH

A two position toggle switch labeled W/S HTR - OFF, controls the operation of the windscreen heating system. When the switch is in the W/S HTR position, the windscreen heating elements are energized under control of the windscreen control unit. The windscreen heating is deenergized, by a hardwired interlock, when the demist switch is set to REV.

WINDSCREEN WARNING

Information of windscreen heating failure is displayed on the dedicated warning panel (DWP).
The following caption is presented:
WINDSCRN (CAT 3 - amber) Indicates a failure of the windscreen heating system.
The DWP caption is accompanied by attention getters and the "windscreen heater fail" voice warning message.

EMERGENCY RAM AIR

The emergency ram air system provides ram air for the cabin conditioning and avionics cooling in the case of an ECS failure.
By positioning the ECS switch in the RAM AIR position the ERA valve and the cabin safety valve, which are pneumatically linked, are opened. The airflow comes into the cabin through a ram air scoop mounted on the left side of the aircraft skin. Additionally, the avionics SOV is closed, the fan SOV is opened and the three-way valve is positioned to permit the airflow from the fan to the center avionic bay. The fans are switched on, consequently the center avionic bay and the front avionic and the radar bays are conditioned by air from the fans.
The flight is limited to the emergency ram air envelope (see Figure 1.85).

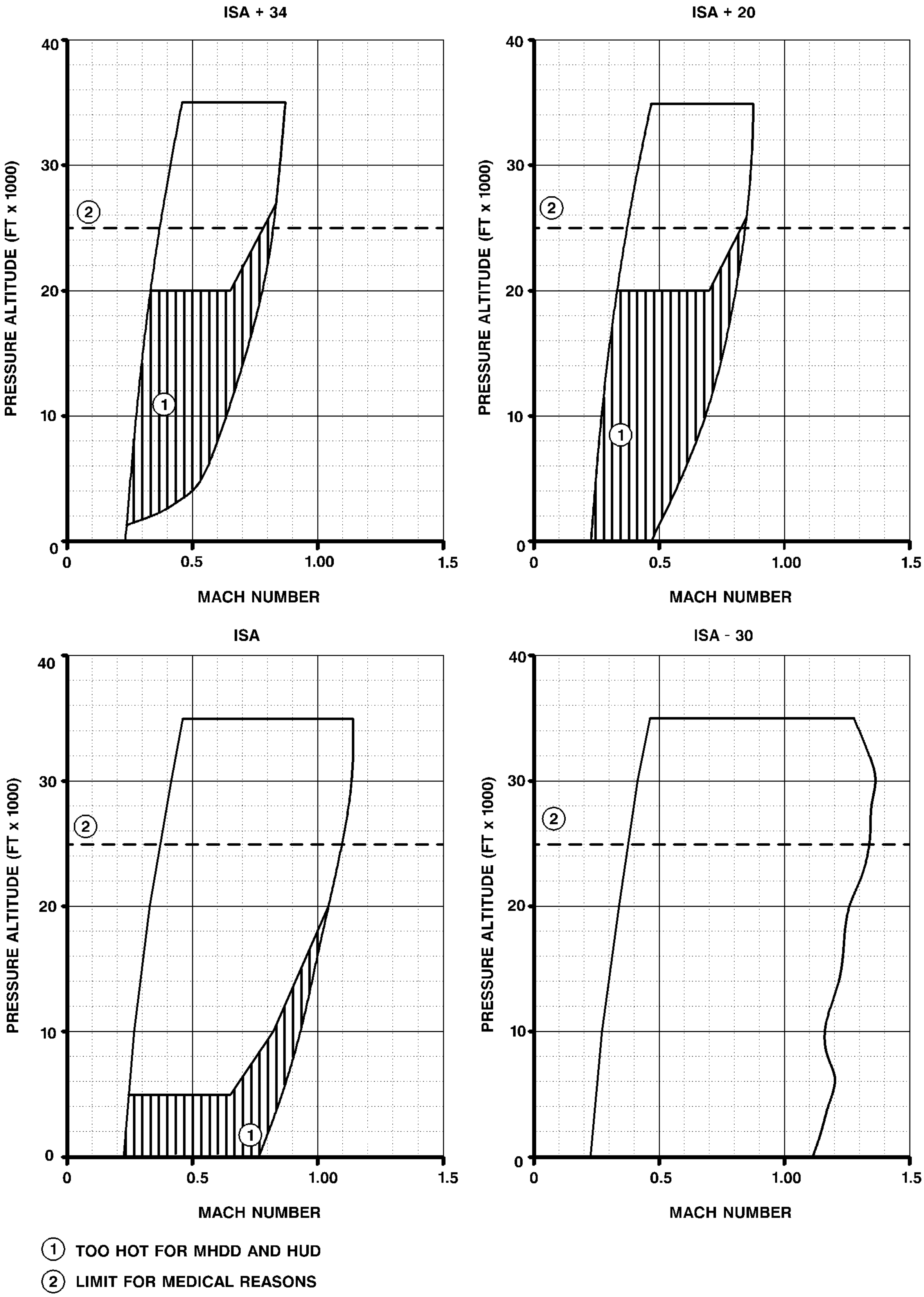


Figure 1.85 - Emergency Ram Air Envelope

ANTI-G SYSTEM

The anti-G system takes precooled air from the ECS and inflates and pressurizes the anti-G full coverage trousers, to provide protection against the G-effects.

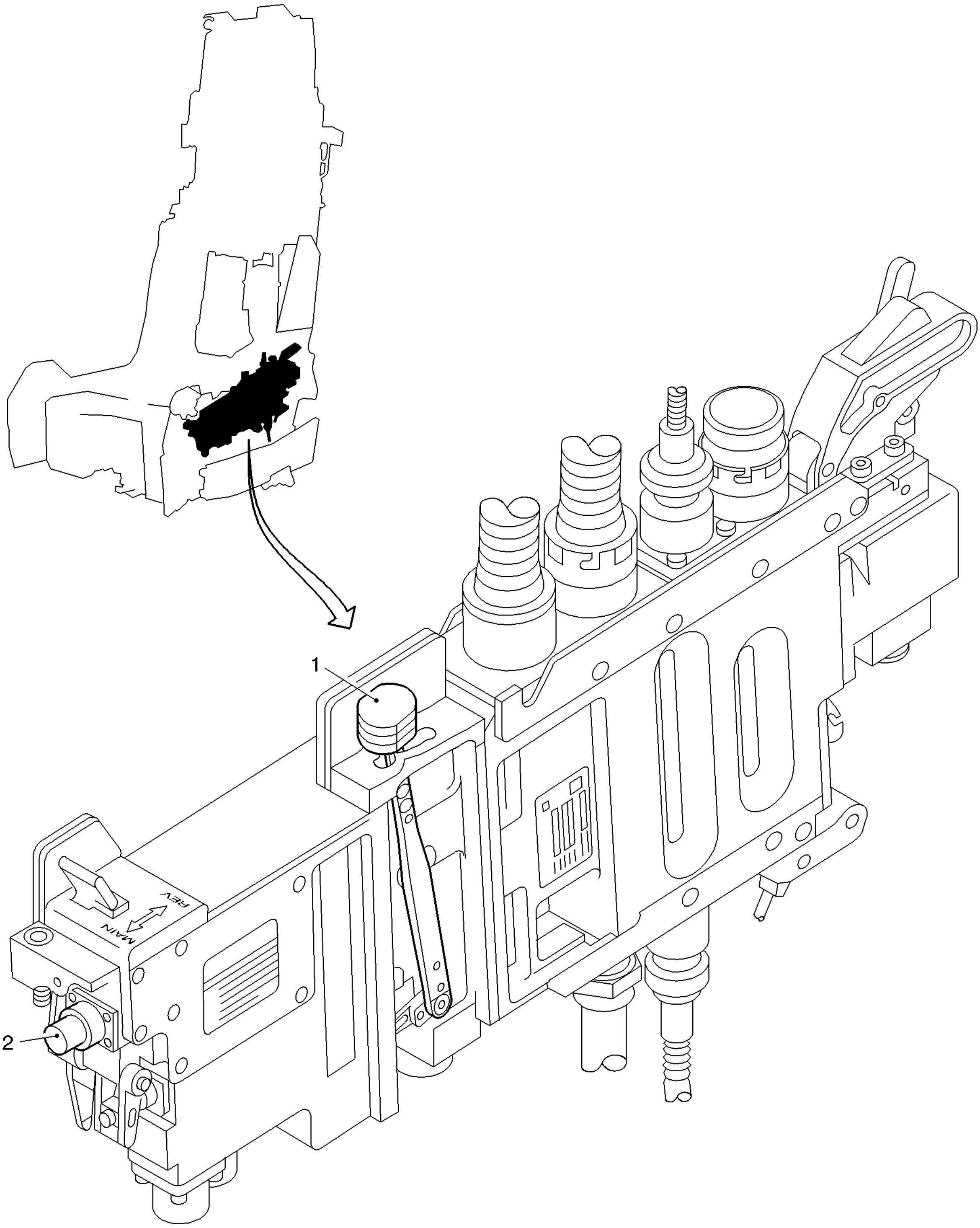
The anti-G system consists of an anti-G valve mounted within the aircrew service package, on the left side of the seat pan. The anti-G valve opens at a loading in excess of 2G to permit anti-G full coverage trousers inflation. The G-trousers pressure varies linearly with G.
The G-valve outlet pressure is also connected to the breathing gas regulator. The regulator then provides positive pressure breathing with G. The regulator, in response to the G pressure, provides elevated mask, tube and chest counter pressure bladder pressure proportional to the G-trousers pressure.
The anti-G valve is fitted with a manual ON/OFF lever, and incorporates a press-to-test facility.

ANTI-G VALVE CONTROL

A two position lever (1, Figure 1.86), operable in a forward and rear positions with a detent at each position, controls the anti-G valve. In the forward position (ON) the anti-G trousers pressure is controlled automatically and varies in accordance with the G level. In the aft position (OFF) the anti-G valve inlet is isolated to inhibit the trousers pressurization, and the current trousers pressure is reduced (vent) to a minimum.

ANTI-G VALVE PRESS-TO-TEST BUTTON

Pre-flight checks of the anti-G valve, including pressure breathing with G, are with the anti-G valve press-to-test button (2, Figure 1.86). When the button is pressed the anti-G trousers pressure increases, which also generates a corresponding breathing pressure increase.



1 ON/OFF CONTROL LEVER
2 PRESS-TO TEST BUTTON

Figure 1.86 - Anti-G System - Controls

ICE DETECTION

The ice detection system initiates the ICE warning (CAT 3) via the DWP when icing conditions are encountered and an ice accretion has occurred on the ice detector sensing probe.

ICE WARNING

Information of icing conditions is displayed on the DWP. The following caption is presented:
ICE (CAT 3 - amber) Indicates that icing conditions have been encountered in the engines air intakes.
The DWP caption is accompanied by attention getters and the "icing" voice warning message.

OPERATION IN ICING CONDITIONS

Flight operations in icing conditions are not cleared. If icing conditions are encountered, the aircraft has to be accelerated to ice free speed as defined in Figure 1.87. The line A is the initial speed to be attained. If ice is not cleared from the airframe or other areas within 2 minutes then line B has to be attained, this speed has to be maintained for 2 minutes to ensure that the airframe is free of ice.

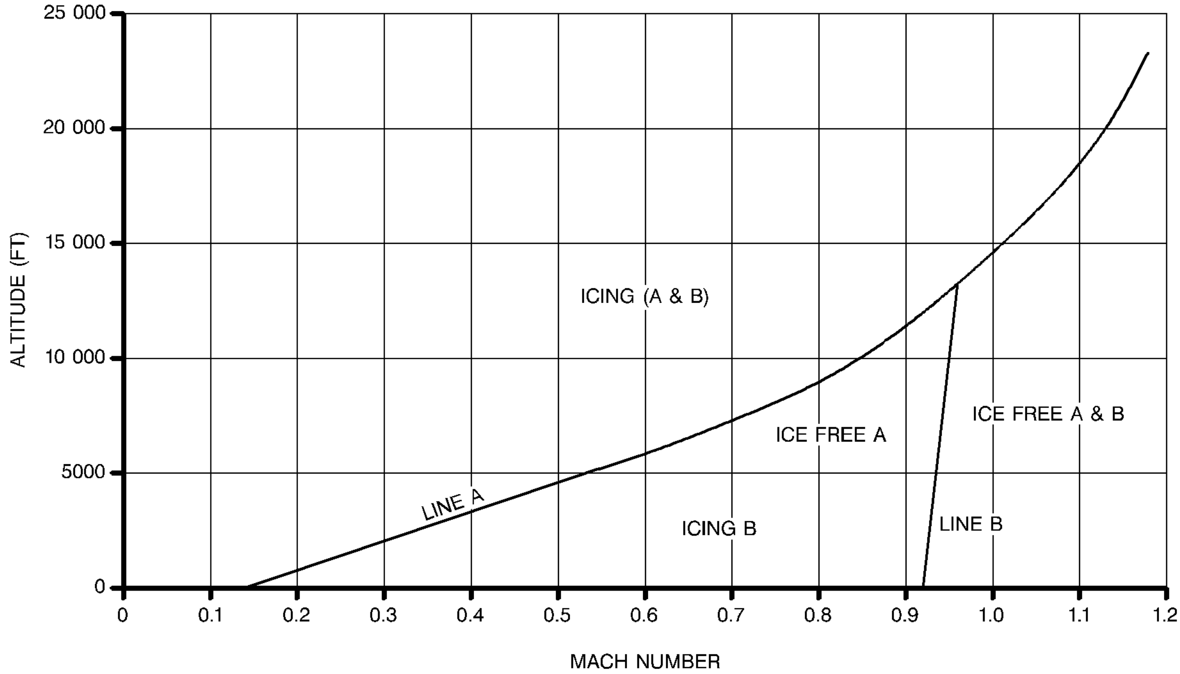


Figure 1.87 - Ice Free Speed

ENVIRONMENTAL CONTROL SYSTEM CONTROLS AND INDICATORS

ECS SWITCH

A three position tri-stable toggle switch (1, Figure 1.88) labeled ECS - OFF/RESET - RAM AIR, controls the operation modes of the ECS as follows:
ECS The ECS operates normally under UCS software control.
OFF/RESET The ECS does not operate. The UCS software of the ECS is reset. In this position the following functions of the ECS are retained.

– The anti-g supply
– The canopy seal supply
– The MSOG supply.

RAM AIR The normal operation of the ECS is disabled. The cabin is depressurized. The ERA valve is opened to supply air to the cabin. In addition, the front and center avionics fans supply cooling air to the avionics equipment. In this position the following functions of the ECS are retained:

– The anti-g supply
– The canopy seal supply
– The MSOG supply.

The switch is locked in the centre (OFF/RESET) and aft (RAM AIR) positions, and must be unlocked prior to selection of the aft or forward positions respectively.

DEMIST SWITCH

A three position tri-stable toggle switch (2, Figure 1.88) labeled DEMIST AUTO - OFF - REV, controls the antimist/demist as follows:
AUTO Normal selection. The canopy antimist facility operates normally under software control to prevent transparency misting. A flow of partially conditioned engine bleed air is supplied over the inside of the canopy via the antimist SOV. This function is unavailable if the ECS master switch is not selected to the ECS position.
OFF No antimist/demist. The antimist SOV is closed.
REV A continual (reversionary) flow of partially conditioned engine bleed air is supplied over the inside of the canopy and windscreen via the demist SOV and antimist SOV. The windscreen heater is deenergized by a hardwired interlock.

CABIN TEMPERATURE CONTROL

A circular rotary control (3, Figure 1.88) labeled CABIN TEMP controls the air temperature of the cabin.

Clockwise rotation increases the selected temperature of air flowing into the cabin, via the ECS vents. Anticlockwise rotation decreases this temperature level.

CABIN AIRFLOW CONTROL

A circular rotary control (4, Figure 1.88) labeled CABIN FLOW controls the volumetric rate of airflow into the cabin.

Clockwise rotation increases the selected volumetric rate of air flowing into the cabin, via the ECS vents. Anticlockwise rotation decreases this flow rate level.

ECS WARNINGS

Information of ECS failures are displayed on the dedicated warning panel (DWP). The following captions are presented:

ECS (CAT 3 - amber) Indicates the loss of cabin and avionic conditioning with engine bleed air. This warning is also generated when; the fans are operating when not required, or, the ECS switch is in the off position when the aircraft is electrically powered.

If the warning is due to a hot leak, which has been isolated by the UCS closing the engine bleed SOVs, there is no air supply to either subsystems. If the warning is not caused by a hot leak, the air supply to the MSOG, anti-g and canopy seal subsystems remains.

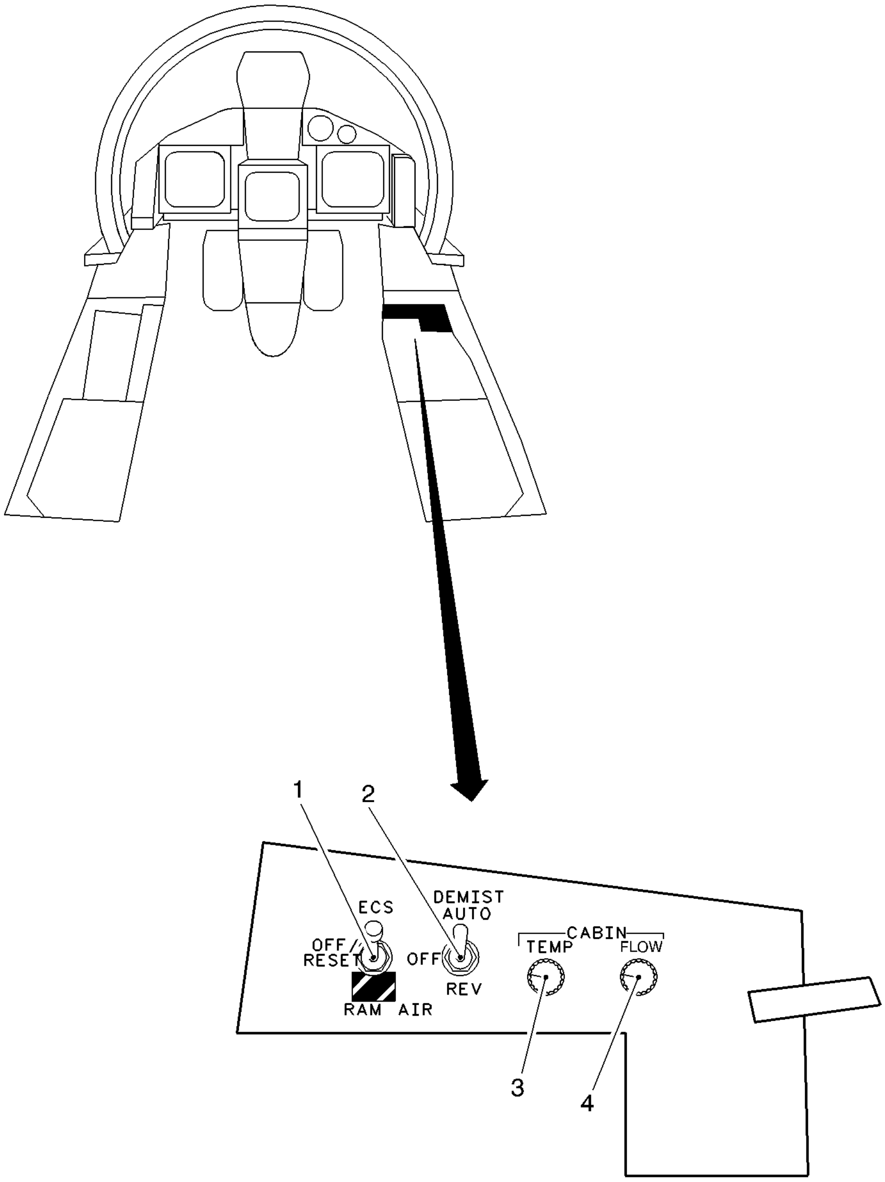
FAN (CAT 2 - red) Indicates a loss of reversionary/ ground conditioning to the avionics. Any of the avionic cooling fans is inoperative whenever are required to function.

L (or R) ECS LK (CAT 2 - red) Indicates a hot air leak in the rear fuselage "V" bay together with a failure to close the corresponding engine bleed SOV.

CABIN LP (CAT 3 - amber) Indicates a cabin pressurization failure. The cabin pressure altitude is above 26 000 feet.

CABIN HP (CAT 3 - amber) Indicates that the cabin differential pressure is higher than 45 KPa, due to failures of the CPCV and the cabin safety valve.

In addition to a DWP caption, the ECS failures are accompanied by attention getters and voice warning messages.



1 ECS SWITCH
2 DEMIST SWITCH
3 CABIN TEMPERATURE CONTROL
4 CABIN AIRFLOW CONTROL

NOTE: ON TWO SEAT AIRCRAFT THE CONTROLS ARE ONLY IN THE FRONT COCKPIT

Figure 1.88 - ECS - Controls

OXYGEN SYSTEM

The oxygen system consists of two subsystems:

– The molecular sieve oxygen generation (MSOG)
– The auxiliary oxygen subsystem.

The MSOG subsystem takes air from the ECS and produces breathing gas at the required oxygen concentration. The auxiliary oxygen subsystem provides an auxiliary supply of 100% oxygen.

The MSOG gas is routed to a pneumatic changeover valve located within the aircrew service package (ASP), mounted on the left hand side of the seat pan (See Figure 1.89). Then the gas is routed to the mask and chest counter-pressure garment, through a brathing oxygen regulator unit and a personal equipment connector (both in the ASP). The auxiliary oxygen is also routed to the changeover valve. The changeover valve is normally biased to the MSOG supply but when the auxiliary oxygen is selected, due to its higher delibery pressure, this valve is biased to provided 100% oxygen to the breathing oxygen regulator.

Within the auxiliary oxygen bottle head there is a valve for selection of the auxiliary oxygen supply. The utility control system (UCS) selects/deselects the auxiliary supply automatically as required as an auxiliary back-up to the MSOG. An aneroid, set to operate at 25 000 ft, selects the auxiliary oxygen supply in the event of a cabin decompression with or without a UCS failure (for altitudes between 25 000 ft and 35 000 ft, the UCS can override the aneroid selection if the MSOG is serviceable).

The breathing oxygen regulator unit is a duplex demand type regulator:

– The main regulator delivers breathing gas at a nominal safety pressure (0.375 kPa) at all times.
– The reversionary regulator delivers breathing gas at twice the pressure of the main regulator (0.75 kPa) at all times.

The oxygen regulator selector on the upper face of the regulator assembly (see Figure 1.90) enables the pilot to select which regulator is coupled to the system.

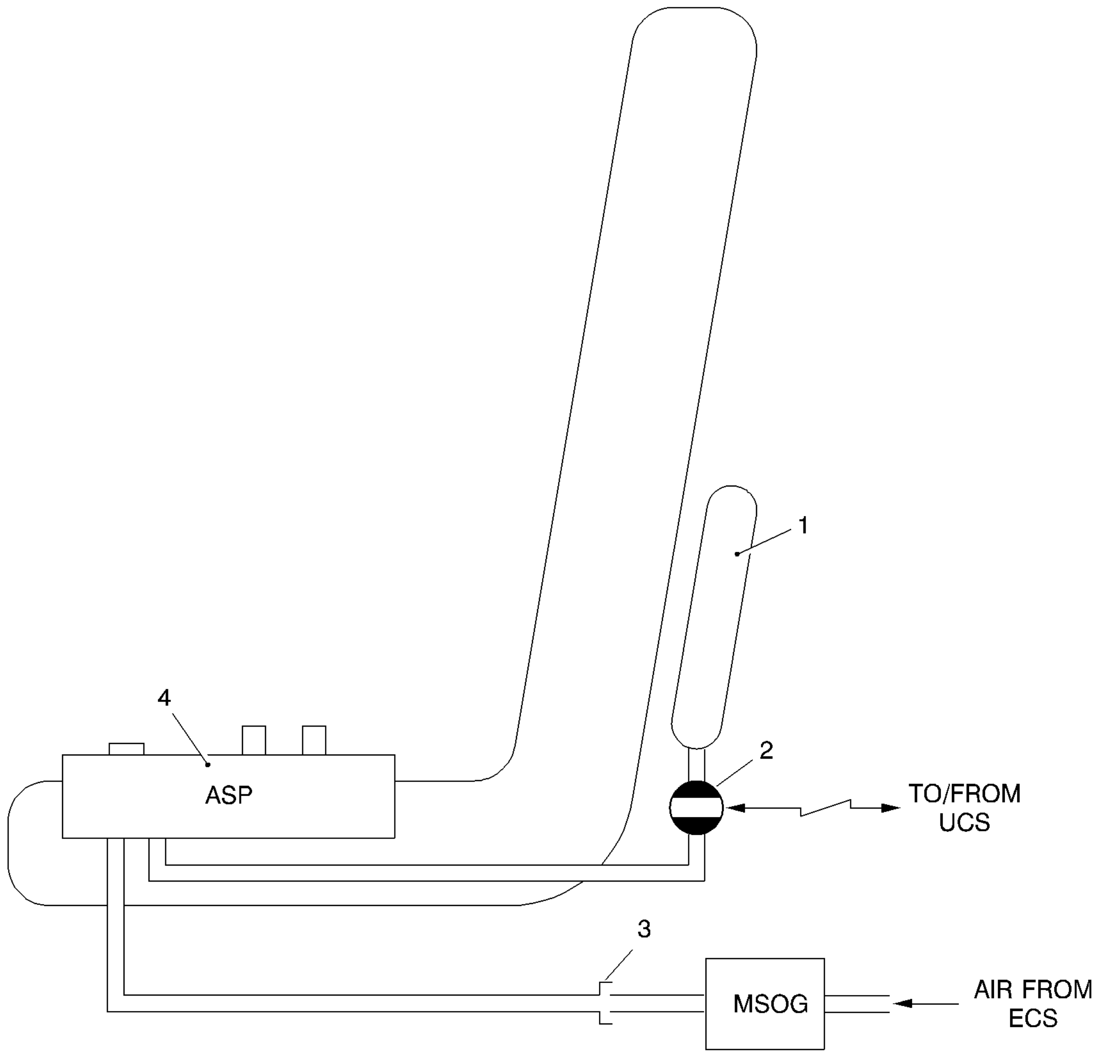
A G-suit pressure signal is supplied to the regulator in order to provide the pilot with pressure breathing with G to increase relaxed G tolerance.

To allow the ejection seat to leave the aircraft unhindered, a quick release coupling is fitted between the MSOG and the ASP.

OXYGEN REGULATOR SELECTOR

A two-position control (see Figure 1.90), labeled MAIN - REV, controls the selection of the oxygen regulator coupled to the oxygen supply system as follows:

MAIN	The main regulator is selected. On demand, breathing gas is supplied at a pressure of 0.375 kPa.
REV	The reversionary regulator is selected. On demand, breathing gas is supplied at a pressure of 0.75 kPa.



1 AUXILIARY OXYGEN BOTTLE (AOB)
2 AUXILIARY OXYGEN BOTTLE HEAD
3 QUICK DISCONNECT
4 AIRCREW SERVICE PACKAGE (ASP)

Figure 1.89 - Oxygen System - Schematic

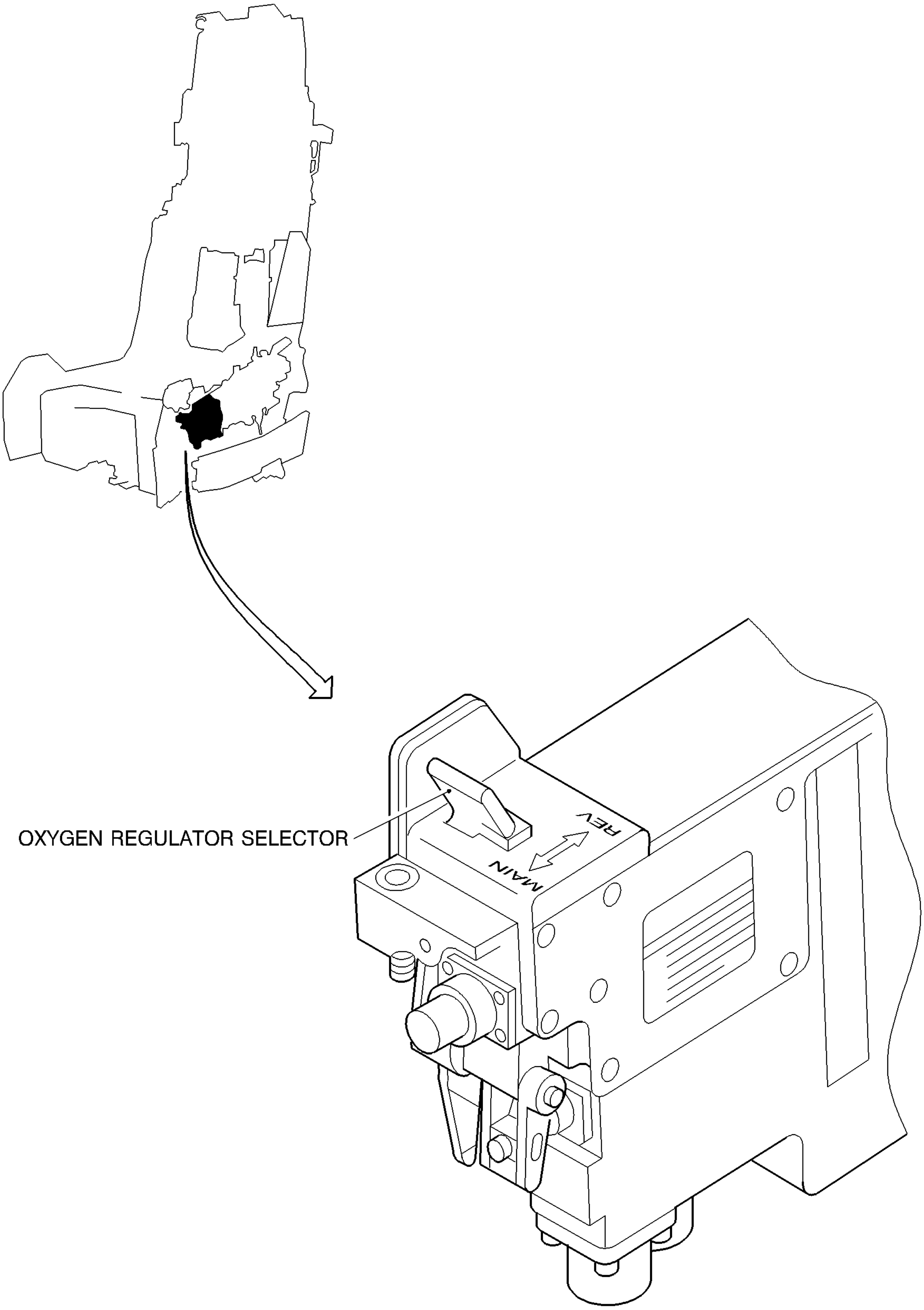


Figure 1.90 - Oxygen Regulator Selector

MOLECULAR SIEVE OXYGEN GENERATION

The MSOG system provides the main source of breathing gas for the pilot at the required oxygen concentration and flow rate.

The MSOG system takes air from the environmental control system (ECS) and, responds to the cabin altitude to produce breathing gas of the correct oxygen concentration for that cabin altitude (see Figure 1.91).

The air from the ECS passes through a water separator and a pressure reducing valve (PRV) to reduce the water content and the pressure to a suitable level. A plenum chamber reduces variations in the flow through the water separator and PRV.

The air then passes to the molecular sieve oxygen concentrator (MSOC), where an appropriate amount of nitrogen is removed to provide breathing gas of a suitable oxygen concentration. The MSOC also reduces engine bleed air contaminants to an acceptable level.

The MSOC is regulated to produce the appropriate oxygen concentration, by means of a closed loop control process, involving an oxygen monitor and an electronic control unit (ECU). The oxygen monitor produces a signal of oxygen partial pressure by comparing a sample of the breathing gas with the ECS air (reference air). A tapping into the cabin allows the partial pressure to be sensed relative to the cabin. The ECU receives the partial pressure signal from the oxygen monitor and, controls the cycle time of the MSOC to produce breathing gas at the correct oxygen concentration.

The MSOC gas passes through an outlet filter to the aircrew service package. The outlet filter acts as a constraint on particulate matter emanating from the MSOC.

The oxygen monitor contains a second partial pressure sensor separate from that used for control. The sensor produces a warning signal when the oxygen partial pressure falls below warning limits. The warning signal, via the ECU, is hardwired to the cockpit to illuminate the MSOC warning indicator. This signal is also supplied to the UCS front computer to select the auxiliary oxygen supply. The UCS senses the position of the AOB head valve and:

- If the AOB head valve has moved to the auxiliary oxygen supply position, produces the MSOC warning via the DWP, or
- If the AOB head valve has not moved to the auxiliary oxygen supply position, produces the OXY warning via the DWP.

In order to test the warning prior to flight, a IBIT valve is included. On the command of the UCS IBIT, the valve cuts off the supply of MSOC gas to the oxygen monitor. If it is functioning correctly the oxygen monitor produces the warning signal. The UCS monitors the warning signal and controls the test.

MSOC WARNING

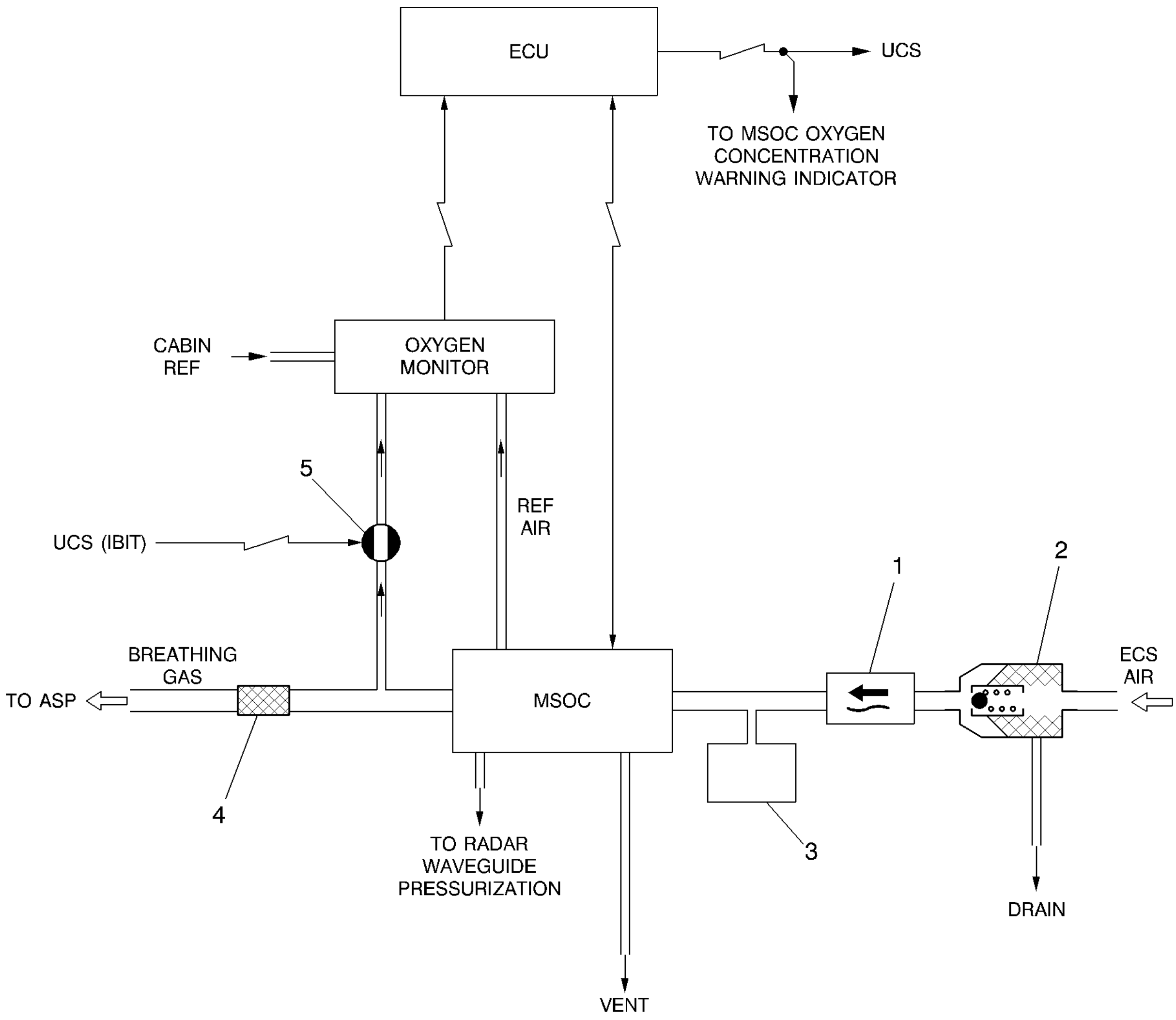
On the DWP, the following caption is presented:

MSOC (CAT 3 - amber) Indicates that the breathing gas supply is not provided by the MSOG system. The oxygen supply is from the auxiliary oxygen bottle.

The MSOC caption is accompanied by attention getters and the "MSOC off" voice warning message.

MSOC WARNING INDICATOR

The MSOC (red) warning indicator is an illuminated caption located above the DWP, on the right quarter panel. Illumination of the caption, accompanied with the "oxygen" voice warning message, indicates a fall of the oxygen partial pressure below the fixed warning limits due to a failure in the MSOG system. The voice warning message can be cancelled by pressing the warning indicator.



1 PRESSURE REDUCING VALVE (PRV)
2 WATER SEPARATOR
3 PLENUM CHAMBER
4 OUTLET FILTER
5 IBIT VALVE

Figure 1.91 - MSOG System - Functional Schematic

AUXILIARY OXYGEN SYSTEM

The auxiliary oxygen supply is provided by a 200 liters gaseous oxygen bottle mounted on the back of the seat (70 liters are allocated as emergency on ejection).

The auxiliary supply is activated by opening a valve on the head bottle :

- Automatically on ejection
- Manually by pulling the auxiliary oxygen selector handle located on the left side of the seat pan
- Automatically by UCS, when there is a failure in the MSOG system.
- Automatically by aneroid, when the cabin altitude is above 25 000 ft.

When there is not a UCS or an aneroid selection, the manual selection of auxiliary oxygen supply can be manually deselected. The UCS selection of the auxiliary oxygen supply is inhibited when the aircraft is on ground.

The selection of the reversionary regulator is automatic when the auxiliary oxygen supply is manually selected or upon ejection selection.

Pressure and temperature sensors fitted to the auxiliary oxygen bottle (AOB) enable the UCS to calculate the contents of the bottle. This indication is displayed in cockpit via the multi-function head down display (MHDD), only when the bottle is in use.

The bottle may be recharged in situ. The charging point is located on the head of the bottle.

AUXILIARY OXYGEN SELECTOR HANDLE

A black and yellow striped handle (Figure 1.92) located on the left side of the seat pan, allows to select the auxiliary oxygen supply in case of MSOG system failure.

OXYGEN WARNING

The UCS generates the OXY (CAT 2 in NAV and COMB, CAT 3 in GND, TAKEOFF and APP/LDG) warning when:

- Auxiliary oxygen supply selected (UCS or manual) and the UCS does not detect that the AOB head valve has moved to the auxiliary oxygen supply position
- Failure of AOB valve position monitor (can not guarantee breathing gas source)
- The AOB contents is at or below 70 liters
- Auxiliary oxygen supply selected and AOB contents unknown (therefore assumed empty).

The OXY caption is accompanied by attention getters and the "oxygen" voice warning message.

NOTE

If the reversionary GUH mode is selected, the OXY warning is CAT 2 in all POF.

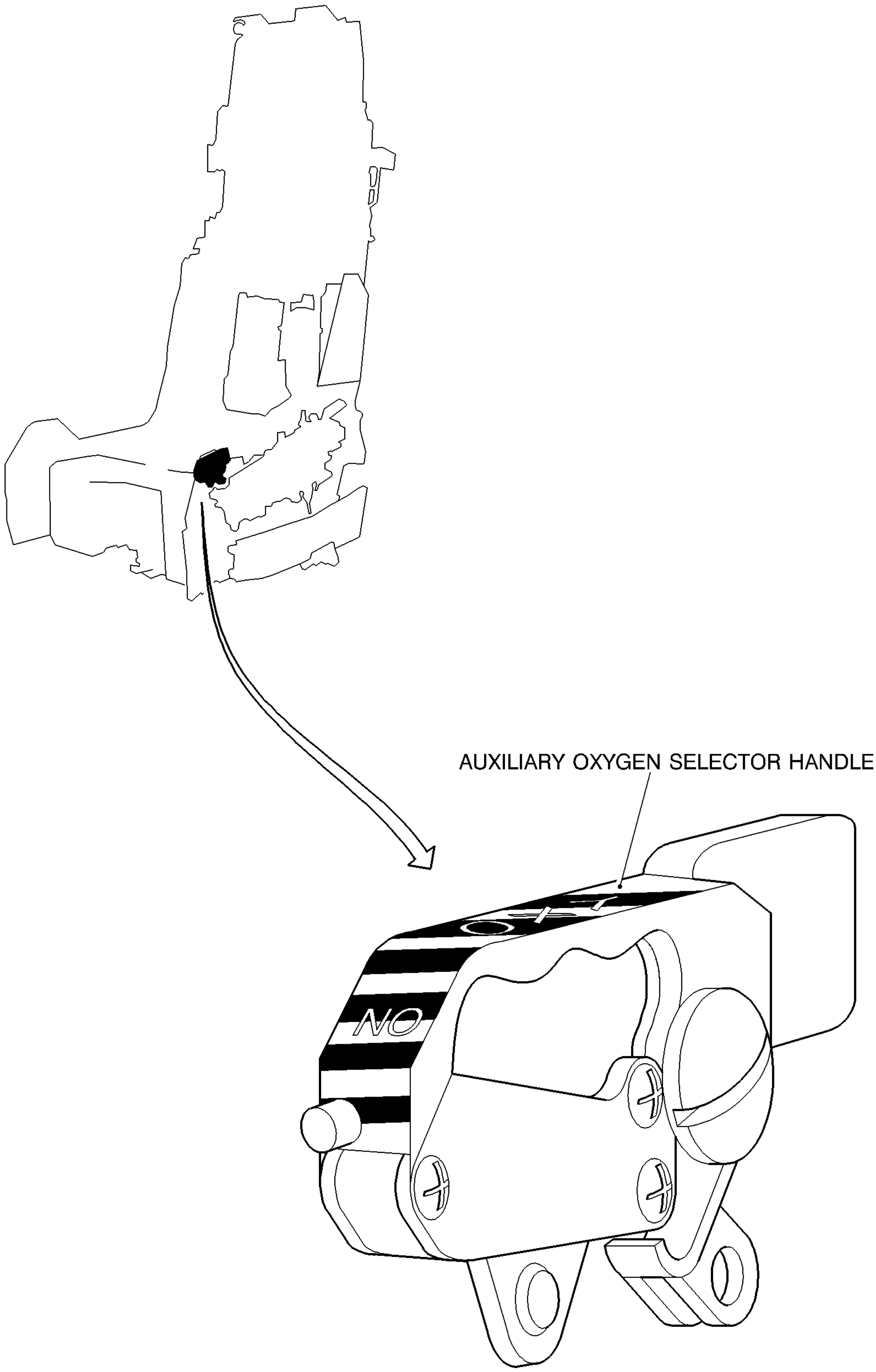


Figure 1.92 - Auxiliary Oxygen Selector Handle

LIGHTING SYSTEM

The lighting system is divided into external and internal lights.

EXTERNAL LIGHTING

The external lights consist of the following:

– Navigation lights
– Anti-collision lights
– Landing and taxi light.

NAVIGATION LIGHTS

The navigation lights consist of a red light mounted centrally on the left wing tip pod, a green light mounted centrally on the right wing tip pod and a white light on the trailing edge of the upper fin. The three lights are controlled by a three-position switch (Figure 1.93), labeled NAV - BRT/DIM/OFF which is located on the right console.

ANTI COLLISION LIGHTS

Two high intensity strobe lights, installed on the upper and lower surface of the fuselage, are controlled by a switch (Figure 1.93) on the right console labeled A COLL - WHITE/OFF.

LANDING/TAXI LIGHT

A single combined landing and taxi light is installed on the left main landing gear door. The light incorporates two halogen bulbs and is controlled by a three position switch located on the left console (Figure 1.93) labeled LAND/OFF/TAXI. Power to the lights is only available when the landing gear lever is in the down position.

INTERNAL LIGHTING

Illumination of the main cockpit displays, instrument panels and consoles is provided by electroluminescent panels, floodlights and illuminated pushbutton switches and indicators.

The internal lighting system maintains adequate display visibility within the cockpit, throughout the full operational ambient illumination range, with minimum pilot intervention. In addition, a reversionary capability is provided, allowing a limited amount of cockpit lighting to be available under certain failure conditions.

Power and control to the internal lighting is provided by a lighting controller in conjunction with ambient light sensors and lighting controls.

LIGHTING CONTROLLER

The lighting controller comprises a power control unit to control cockpit lighting and display brilliance and a lighting computer to control:

– Glareshields.
– Multifunction head-down displays (MHDD).
– Quarter panels.
– Warning panels.
– HUD control panel.

NOTE

● The HUD is autonomous with respect to lighting control.

The controller receives inputs from the internal lighting controls and the MHDD offset controls, located on the right console, and a number of light sensors located in various parts of the cockpit.

AMBIENT LIGHT SENSORS

The ambient light sensors provide inputs to the autobrightness lighting computer for the MHDD. There are two light sensors in each MHDD, two in the pilot's display unit (PDU) of the head-up display (HUD) and one on each side of the left and right glareshields.

COCKPIT LIGHTING CONTROLS

Cockpit lighting is controlled as follows:

LIGHTING MODE SELECT SWITCH

The Lighting Mode Select Switch (LMSS) is a three position toggle switch labelled DAY, DUSK and REV which is used in conjunction with the Reversionary Lights switch (Rev Lights), refer to Figure 1.93. In normal use the LMSS will be set to either DAY or DUSK (dependent upon ambient light conditions), and the Rev Lights switch to NORM.

In daylight to dusk conditions, the LMSS will normally be set to DAY and the Rev Lights switch set to NORM. With this configuration the brightness of the cockpit display suite is automatically adjusted via the Lighting Controller (LC) according to the measured ambient illumination. Additionally the pilot has:

– limited control over the CRT brightness of the MHDDs via the MHDD Manual Offset Control.
– limited control over the brightness of the HUD-PDU via the BRT control on the HUD-CP.
– control of the floodlights via the FWD and CONSL controls situated on the right forward console.
– no control over zone lighting.

In night, dusk or low light conditions the LMSS will normally be set to DUSK and the Rev Lights switch to NORM. With this configuration the brightness of the display suite can be manually adjusted via the LC according to pilot preference. The pilot also has control over zone lighting via the zone dimmer switches situated on the right consoles of each cockpit.
REV mode is selected when there is a fault associated with the normal cockpit display and lighting controls. In this situation selecting either DAY, DUSK or NIGHT on the Reversionary Lights Switch will set the cockpit lighting to appropriate pre-determined levels.

REVERSIONARY LIGHTS SWITCH

The Reversionary Lights switch (Rev Lights) is a five position rotary switch labelled NORM (two positions)/DAY/DUSK/NIGHT, and is used in conjunction with the Lighting Mode Select Switch. Both switches are supplied via dedicated circuit breakers such that, in the event of an electrical or mechanical failure in the lighting mode select circuit, there is a means of controlling the brightness of at least one of the two groups of instruments listed below:

Group 1

- HUD (Control Panel and Pilots Display Unit)
- Right hand glareshield (GUH instruments)
- DWP (GUH warnings)

Group 2

- Lighting controller
- MHDDs
- Right hand glare shield
- Left hand glare shield
- DAWG and TSDB

Each group is capable of providing essential flight information.
Following a failure such that the brightness of the display suite renders the information illegible, essential flight information can be recovered on the Group 1 instruments by setting the Rev Lights switch to DAY, DUSK or NIGHT as required. Depending upon the failure mode, the Group 2 instruments may also be recovered by setting the LMSS to REV. With the LMSS to REV the Rev Lights switch will control the brightness of both Groups 1 and 2. In this configuration the pilot has no control over the brightness of the MHDD displays or zone dimmer controls, but does have control over flood lighting and the brightness of the HUD-PCU.

ZONE DIMMER CONTROLS

A set of three rotary controls located on the right consoles (Figure 1.93), labeled GL SHIELD/DISP/CONSL, allow manual adjustment of display lighting levels when the LMSS is set to DUSK.
Rotating the individual controls, increases or decreases the lighting levels as required of displays and panels as follows:

- GL SHIELD controls the lighting levels of the displays located on the left and right glareshields and the HUD control panel.
- DISP controls the lighting levels of the MHDD, the displays on the left and right quarter panels and the pedestal panel, the dedicated warning panel and fire buttons.
- CONSL controls the lighting levels of the left and right consoles.

FLOODLIGHT CONTROLS

A set of two rotary controls located on the right consoles (Figure 1.93), labeled FLOOD - FWD/CONSL enable the forward panels (MHDD, pedestal and quarter panels) and the left and right consoles to be illuminated. A general low level of illumination in the cockpit is also provided when external ambient light conditions are inadequate.

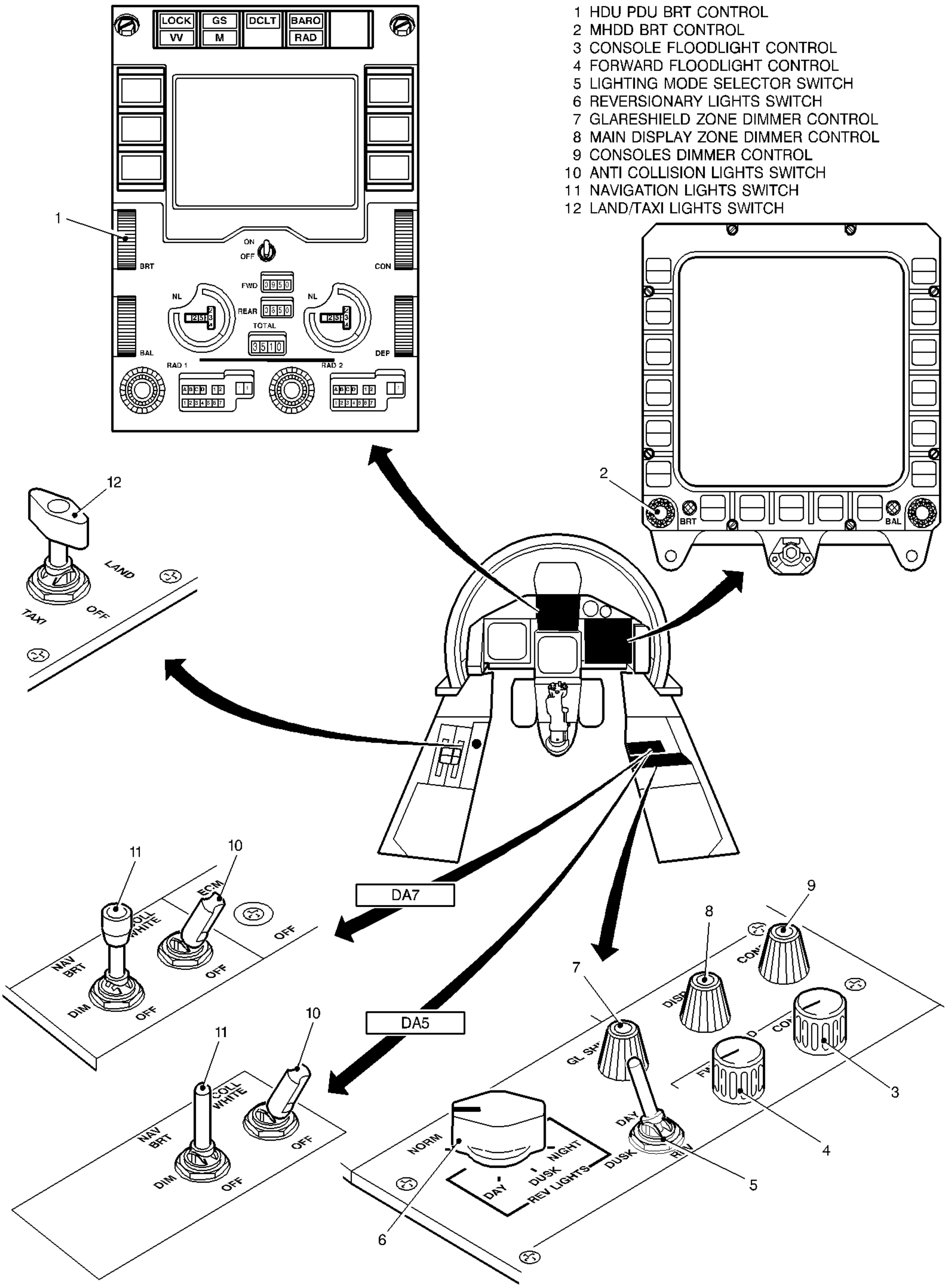


Figure 1.93 - Internal and External Lighting Controls

AVIONICS SYSTEM INTEGRATION

The aircraft's integrated system structure uses multiple, dual redundant databus networks that can sustain systems failure and/or battle damage. Data transfer is achieved using STANAG 3838 and STANAG 3910 databus networks, video and synchronization links and dedicated data links. Figure 1.94 provides an overview of the databus architecture for the aircraft's avionic system.
The avionic system consists of seven subsystems as follows:

- Displays and Controls (D and C).
- Navigation (NAV).
- Integrated monitoring and recording system (IMRS).
- Communications (COMMS).
- Armament control system (ACS).
- Attack and Identification (A and I).
- Defensive Aids (DASS).

The controlling software is stored within the line replaceable items (LRI) in each subsystem. For more information on system software, refer to System Software/Mission Data Loading pag. 244.

DISPLAYS AND CONTROLS SUBSYSTEM

Figure 1.95 shows the interfaces between the LRI within the displays and controls subsystem. These LRI are as follows:

- Head-up display (HUD).
- HUD video camera.
- Multifunction head-down displays (MHDD).
- Left glareshields (LGS).
- Right glareshields (RGS), including get-u-home (GUH) instruments.
- Cockpit interface units (CIU).
- Computer symbol generators (CSG).
- Lighting controllers (LC).
- Dedicated warning panels (DWP).
- Ground proximity warning system (GPWS).
- Digital map generators (DMG).
- Stick top controllers.
- Throttle top controllers.
- Reversionary instruments.

The LRI are interconnected by the cockpit databus, the avionic databus, the utility control system (UCS) databus, video and synchronization links, dedicated links and dedicated data links. The primary functions of the display and controls subsystem are to provide:

- The necessary dedicated displays and control functions for the avionic system.
- HUD and MHDD display and moding functions.
- The display indications for the DWP and the attention getters.
- A manual data entry facility.
- Cockpit lighting control functions.
- Limited system status information during ground procedures.
- A GUH mode of operation.

NAVIGATION SUBSYSTEM

Figure 1.96 shows the connections between the LRI within the navigation subsystem. These LRI are as follows:

- Navigation computer (NC).
- Laser inertial navigation system (LINS).
- Global Positioning System Unit (GPSU).
- Radar altimeter (RAD ALT).
- Interim tactical air navigation (TACAN).

The LRI are interconnected via the avionics databus and dedicated links. The primary functions of the navigation subsystem are to provide:

- Primary dead reckoning (DR) navigation using the output of the LINS.
- Navigation steering information (e.g. planned route and waypoints information).
- Navigation parameters (e.g. climb-dive angle, magnetic heading, track, wind speed and direction etc.) from the available navigation data.
- On-top-fixing function.
- Range and bearing to a selected TACAN ground station.
- Height information based on calculations from the RAD ALT. A low height warning is also provided by the navigation computer.
- Automatic cross monitoring by comparing LINS bank, inclination and vertical velocity information with FCS bank, inclination and vertical velocity information. The LINS data is declared invalid if any of the specified limits are exceeded.

NOTE

Cross monitoring of LINS data with FCS sourced data is available from AVS SP3C/12.

- Automatic cross monitoring by comparing LINS northings, eastings and velocity with similar data sourced from the GPS system. The LINS data is declared invalid if disparity beyond specified limits occurs.

NOTE

Cross monitoring of LINS data with GPS sourced data is available from AVS SP3C/12.

IMRS SUBSYSTEM

Figure 1.97 shows the connections between the LRI within the IMRS subsystem. These LRI are as follows:

- Interface processing unit (IPU).
- Crash survivable memory unit (CSMU).
- Sensor and signal conditioning units (SSCU).
- Video/voice recorder (VVR).
- Bulk storage device (BSD).
- Maintenance data panel/portable maintenance data store (MDP/PMDS).
- Mission data loader and recorder/portable data store (MDLR/PDS).

The LRI are interconnected via the avionics databus, the attack databus, the UCS databus and dedicated links. The primary functions of the IMRS subsystem are to provide:

- A crash recording facility which collates and records data to support accident/incident investigations.
- Maintenance data to support post flight fault diagnosis.
- Structural health data to enable airframe fatigue damage to be calculated.
- Engine usage and conditioning monitoring to enable engine life consumption to be calculated.
- Stores configuration data loading facility.
- Avionics initiated built-in-test request handling.
- Avionics LRI configuration checking facility to compare the expected MDP/PMDS loaded configuration against the actual aircraft configuration.
- A facility to upload Single Mission Data (SMD).
- A facility to record all head down primary video displays, the head up scene as viewed through the HUD, pilot's headset audio (including audio warnings) and pilot initiated event markers.

COMMUNICATION SUBSYSTEM

Figure 1.98 shows the connections between the LRI within the communications subsystem. These LRI are as follows:

- Communications and audio management unit (CAMU).
- V/UHF transceiver 1.
- V/UHF transceiver 2.
- Combined fin tip antenna.
- Lower antenna.

The CAMU, V/UHF transceivers 1 and 2 are interconnected by dedicated links. Each LRI is also connected to the avionic databus. The primary functions of the communications subsystem are to provide:

- Voice communications (clear and secure).
- Audio tones and voice warnings.
- A direct voice input (DVI) facility where the crew members can execute certain avionic commands by voice inputs. System functionality is currently limited to command recognition only, however, positive feedback is provided via the displays and controls subsystem to confirm that commands have recognized.
- A multiple information and distribution system (MIDS) which provides a high capacity digital information distribution system that enables cryptographically secure and jam resistant information transfer amongst dispersed and mobile platforms in real time. The system also provides a TACAN function.

ACS SUBSYSTEM

Figure 1.99 shows the interconnections between the LRI within the ACS subsystem. These LRI are as follows:

- Safety critical armament controller (SCAC).
- Non-safety critical armament controller (NSCAC).
- Gun control junction box (GCJB).
- Armament safety break contactors (ASBC).
- Distribution unit (DU).
- Fuselage station unit (FSU).
- Inboard station unit (wing) (ISU).
- Center station unit (wing) (CSU).
- Outboard station unit (wing) (OSU).
- Integrated tip stub unit (ITSU).

The LRI of the ACS system are interconnected by the weapons databus and dedicated links. The system communicates with the rest of the avionic systems via the SCAC and NSCAC which are connected to the attack databus. The armament subsystem is connected by dedicated links to the master armament safety switch (MASS) and the selective and emergency jettison switches. The primary functions of the armament subsystem are to enable:

- Loading and validation of stores configuration.
- Selection, arming, launching and jettison of missiles.
- Gun firing.
- Release, fuzing and jettison of stores.
- Jettison of external fuel tanks.
- Air-to-air weapon training.

ATTACK AND IDENTIFICATION SUBSYSTEM

NOTE

No radar installed on DA1, 2 and 3.

The attack and identification subsystem comprises the following:

- Air interception radar (AIR)
- Forward looking infra red (FLIR) sensor
- IFF interrogator (INT)
- IFF transponder (XPDR).

The LRI of the attack and identification system are interconnected via the attack and avionic databusses and dedicated links (refer Figure 1.100). The primary functions of the attack and identification system are to enable:

- Detection and tracking of airborne targets via AIR.
- Presentation of FLIR video (DA7 only).
- A radar ground mapping capability.
- A transponder capability for self-identification to friendly interrogating aircraft and ground stations via:
  - Mode 1
  - Mode 2 (from AVS 3C)
  - Mode 3A
  - Mode 4 (from AVS 3C)
  - Mode C
  - Mode S.
- An interrogator capability (from SP3 C 12) to identify other platforms via the following modes:
  - Mode 1
  - Mode 2
  - Mode 3A
  - Mode 4
  - Mode C.
- Status and configuration sensing for the attack and identification LRI.

The attack computer performs height conversion functions for the transponder system as well as databus control functions.

DEFENSIVE AIDS SUBSYSTEM

The defensive aids subsystem comprises a defensive aids computer (DAC). This is connected via the defensive aids and the attack databusses and dedicated links. The function of the DAC is to enable radio frequency inter-operability and stealth control of all transmitters and receivers.

DATABUS START-UP PROCEDURE

When electrical power becomes available, the aircraft systems and the LRI perform their own power-up built-in test (PBIT). Detected failures in LRI with associated warnings are indicated on the DWP, refer to Dedicated Warning Panels. Databus operations are initiated and the primary and secondary bus controllers (BC) check each other for normal operation. Completion of the PBIT is indicated on the MHDD/ACUE format.

DATABUS OPERATIONS

A simple databus system consists of a bus controller (BC) and remote terminals (RT), with both the BC and RT located within the individual LRI connected to the associated databus.The BC controls overall operation of the system, initiates all data transfers (BC to RT, RT to BC and RT to RT transfers) and allocates time to each RT within the overall system time. The BC and RT are connected to the databus by coupling stubs.The above system is duplicated within the aircraft databus configuration. Each databus comprises two individually connected busses; bus A and bus B. There are two BC; a primary and secondary (each BC is located within a different LRI attached to the databus). Table indicates the primary and secondary bus controllers for the various avionic system databusses. Each LRI has a dual redundant RT linked to bus A and to bus B.

Databus Primary and Secondary Bus Controllers

DATABUS	PRIMARY BC	SECONDARY BC
Avionic	Navigation Computer	Navigation Computer
Attack	Attack Computer	Attack Computer
Cockpit	CIU 1	CIU 2
Weapons	NSCAC (primary)	NSCAC (secondary)
Defensive Aids	DAC	ECM/ESM Processor

Only one BC is active at any one time, but the secondary BC can take control of the databus if the primary BC fails. Failure of the primary BC is detected by the secondary BC monitoring the databus for any lack of activity by the primary BC. The switching mechanism consists of a discrete connection between the BC. Only a total failure of an LRI will exclude it from the databus network and no single LRI failure will prevent the normal operation of the databus - this is known as the STANAG 3838 dual redundant bus system, refer to Figure 1.101. However where large amounts of data are required to be transmitted between LRI a STANAG 3910 bus system is used, refer to Figure 1.102.

The STANAG 3910 bus system comprises a wire databus and a fibre optic databus. During periods where only small quantities of data are being transferred the 3910 bus system uses the wire bus in the same way as a 3838 bus. However if a large transfer of data is required the 3910 bus system will use the wire bus for commands (e.g. addressing, polling) and the fibre optic bus for data transfers. Continuous built-in tests (CBIT) are performed within each LRI, in addition to a CBIT on the databus by the BC. If both lanes of the cockpit or avionics bus fail, or if both CIU or CSG fail, the DWP will automatically enter its reversionary mode.

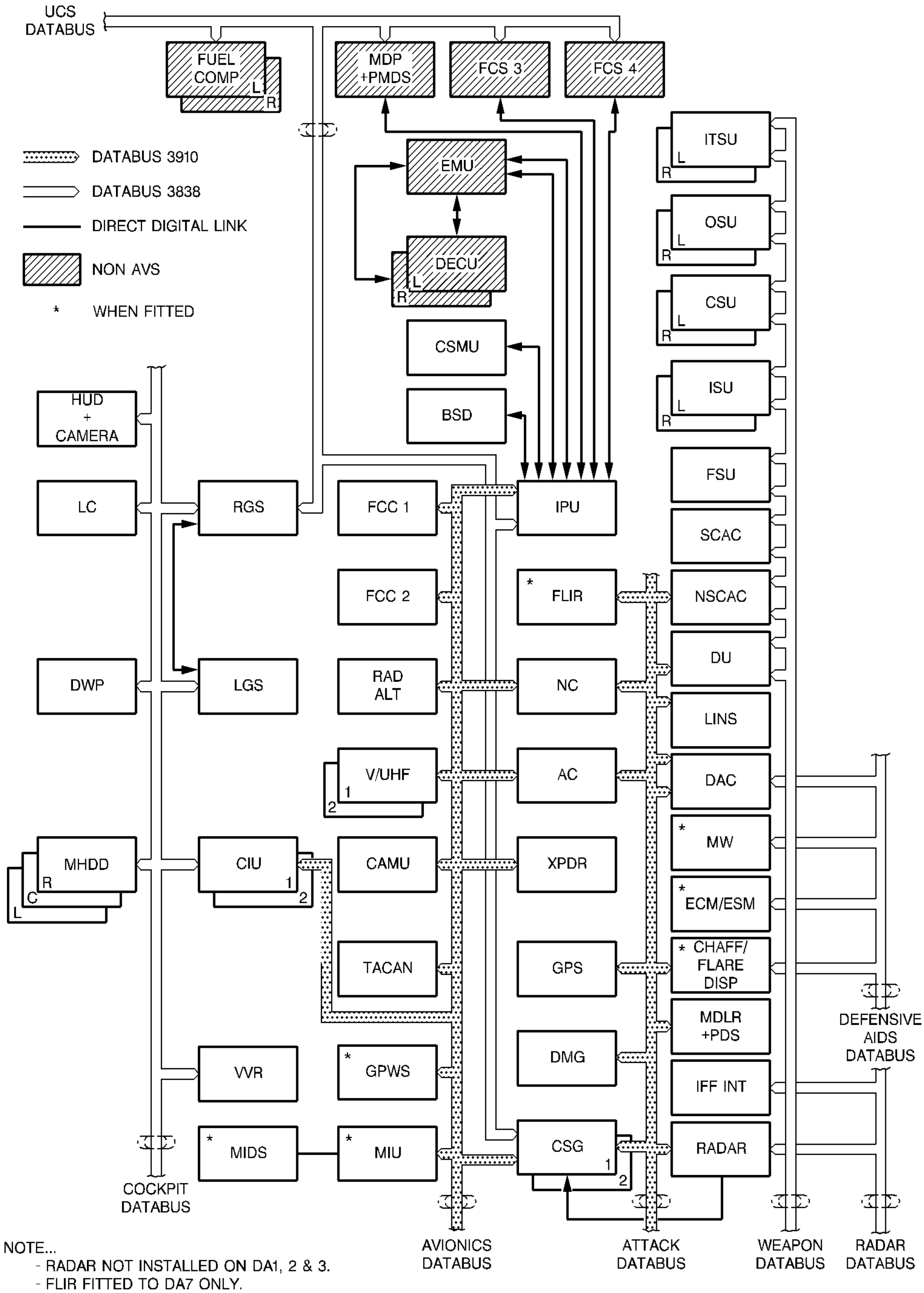
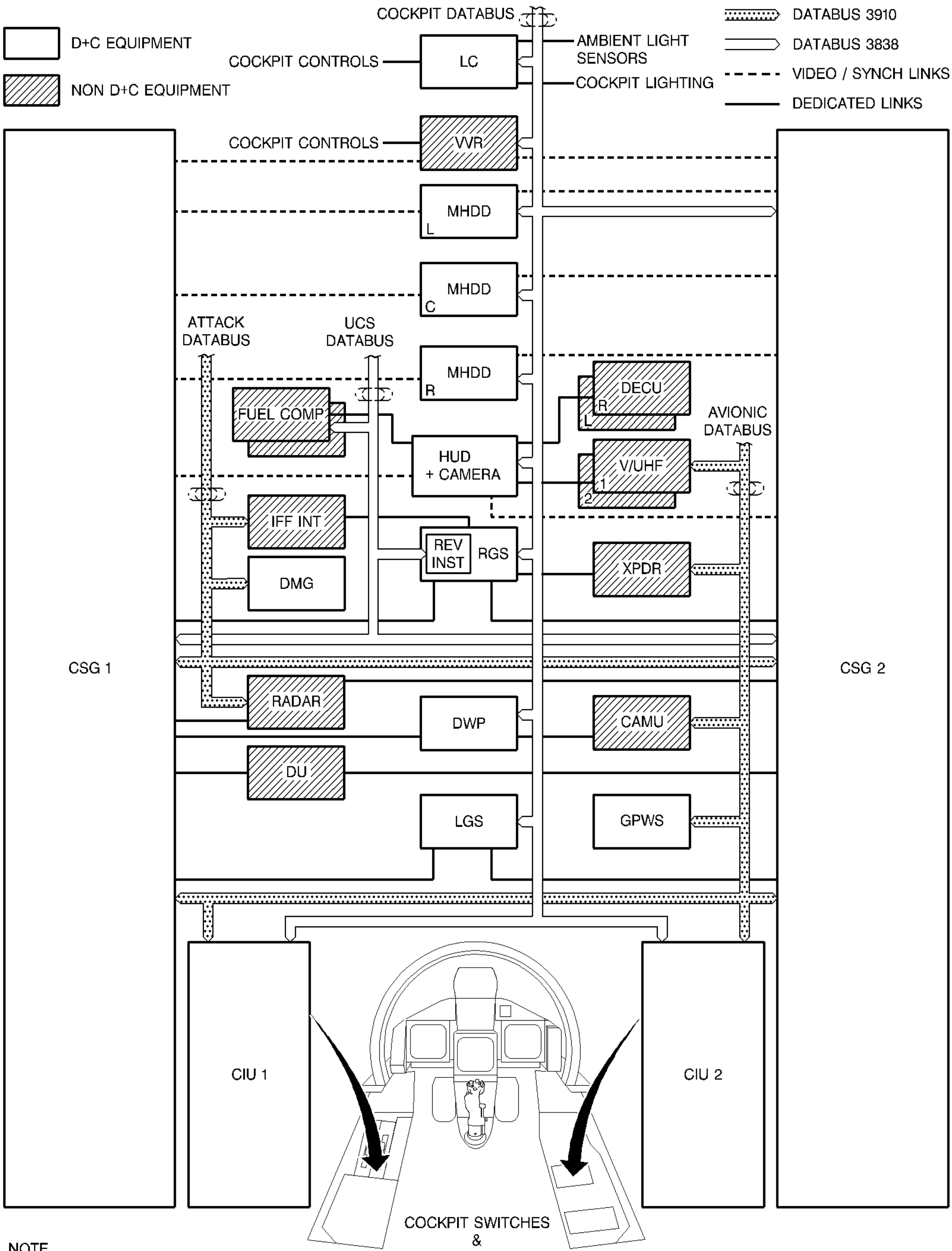


Figure 1.94 - Avionic System Bus Architecture



NOTE...
RADAR NOT INSTALLED ON DA1, 2 & 3.

Figure 1.95 - Displays and Controls Subsystem Architecture

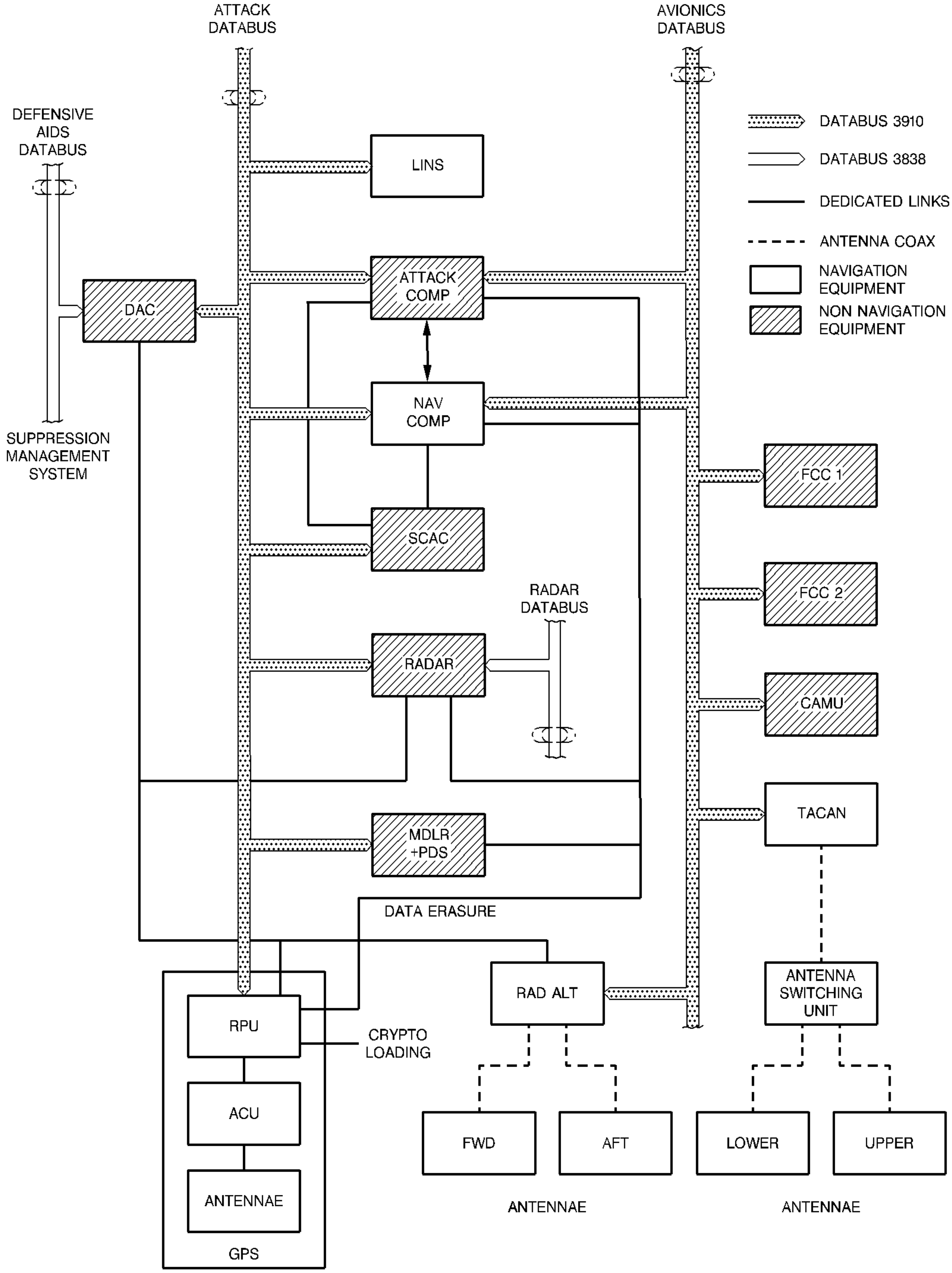


Figure 1.96 - Navigation Subsystem Architecture

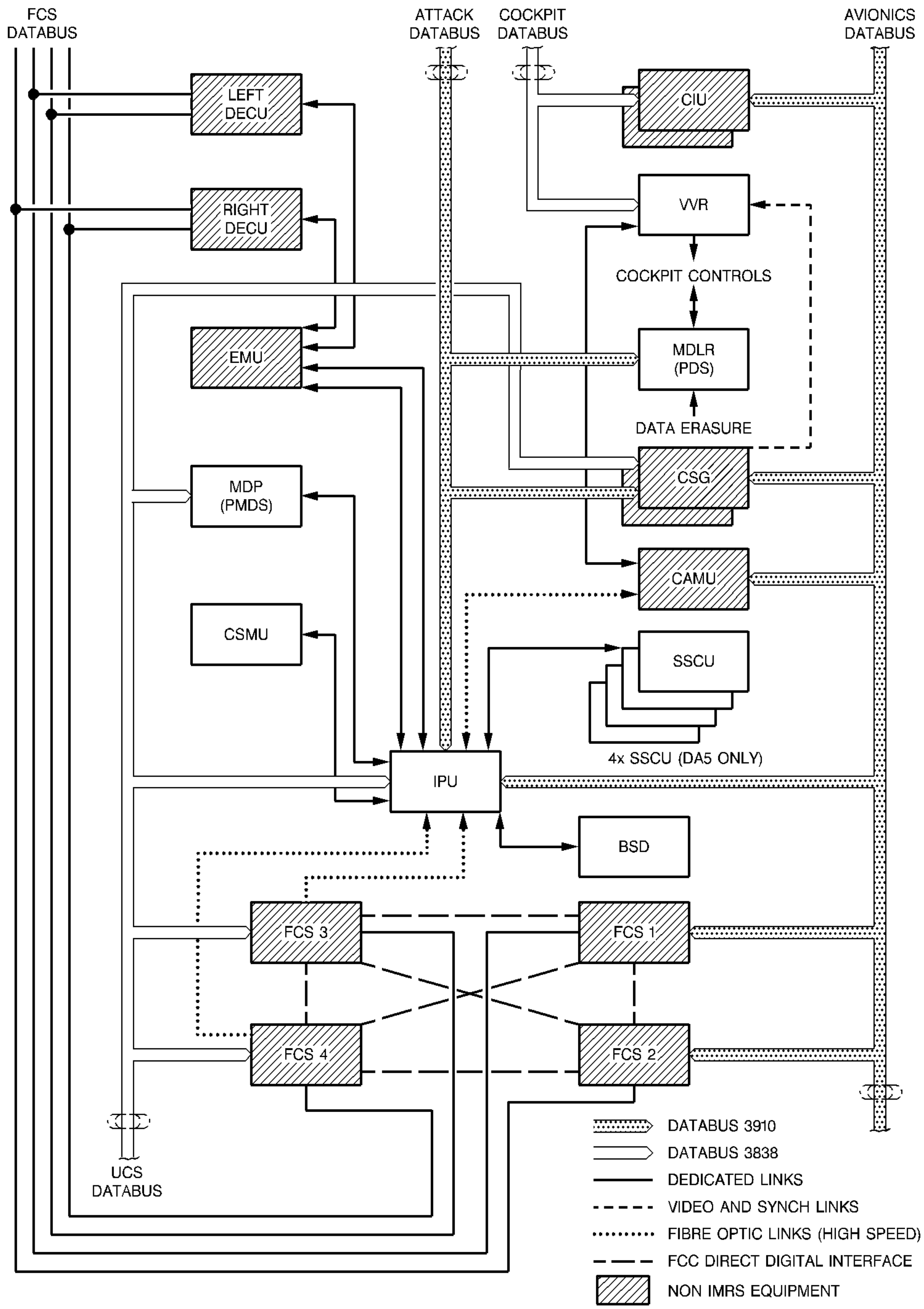


Figure 1.97 - Integrated Monitoring and Recording Subsystem Architecture

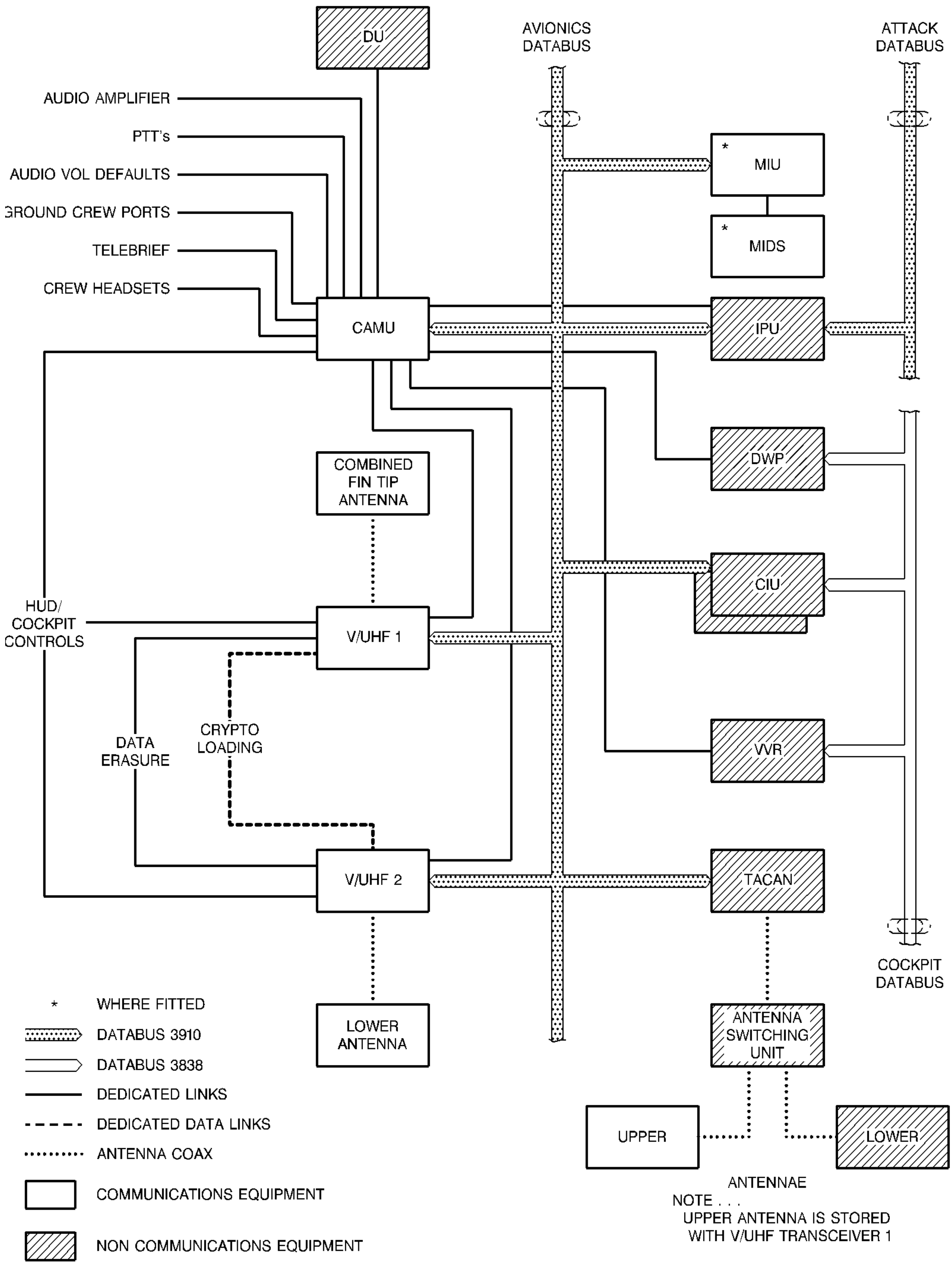


Figure 1.98 - Communications Subsystem Architecture

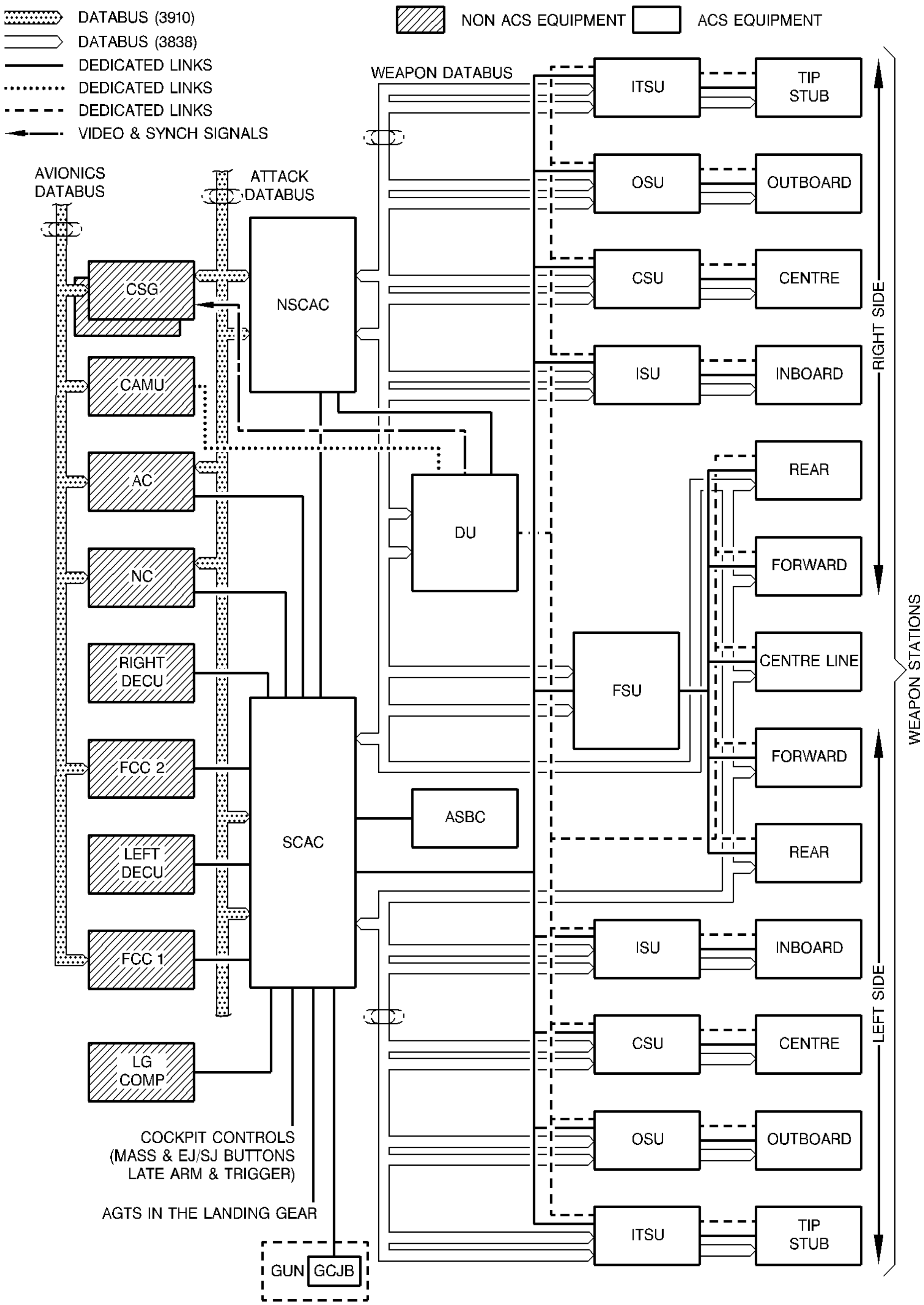


Figure 1.99 - Armament Control Subsystem Architecture

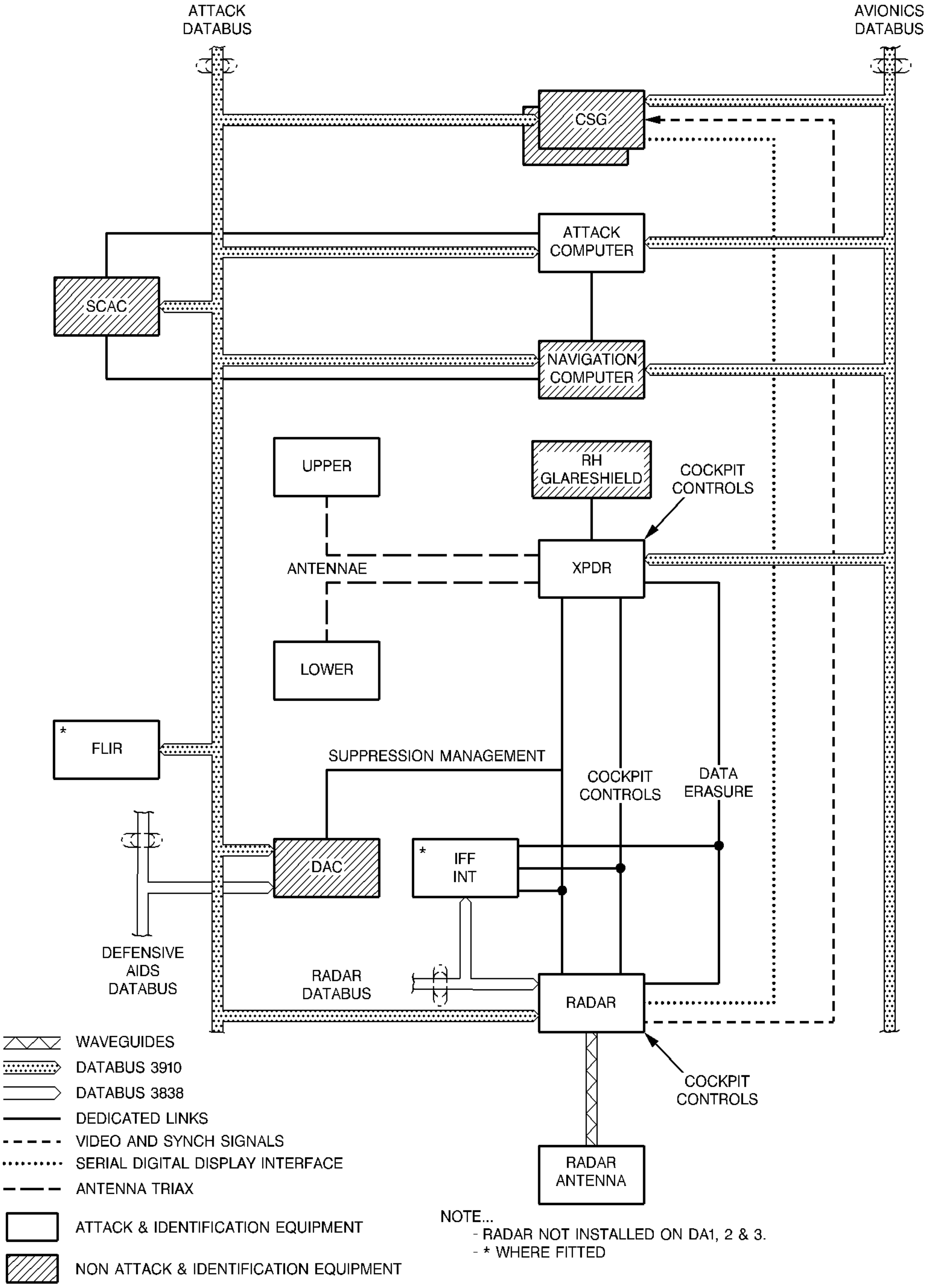


Figure 1.100 - Attack and Identification Subsystem Architecture

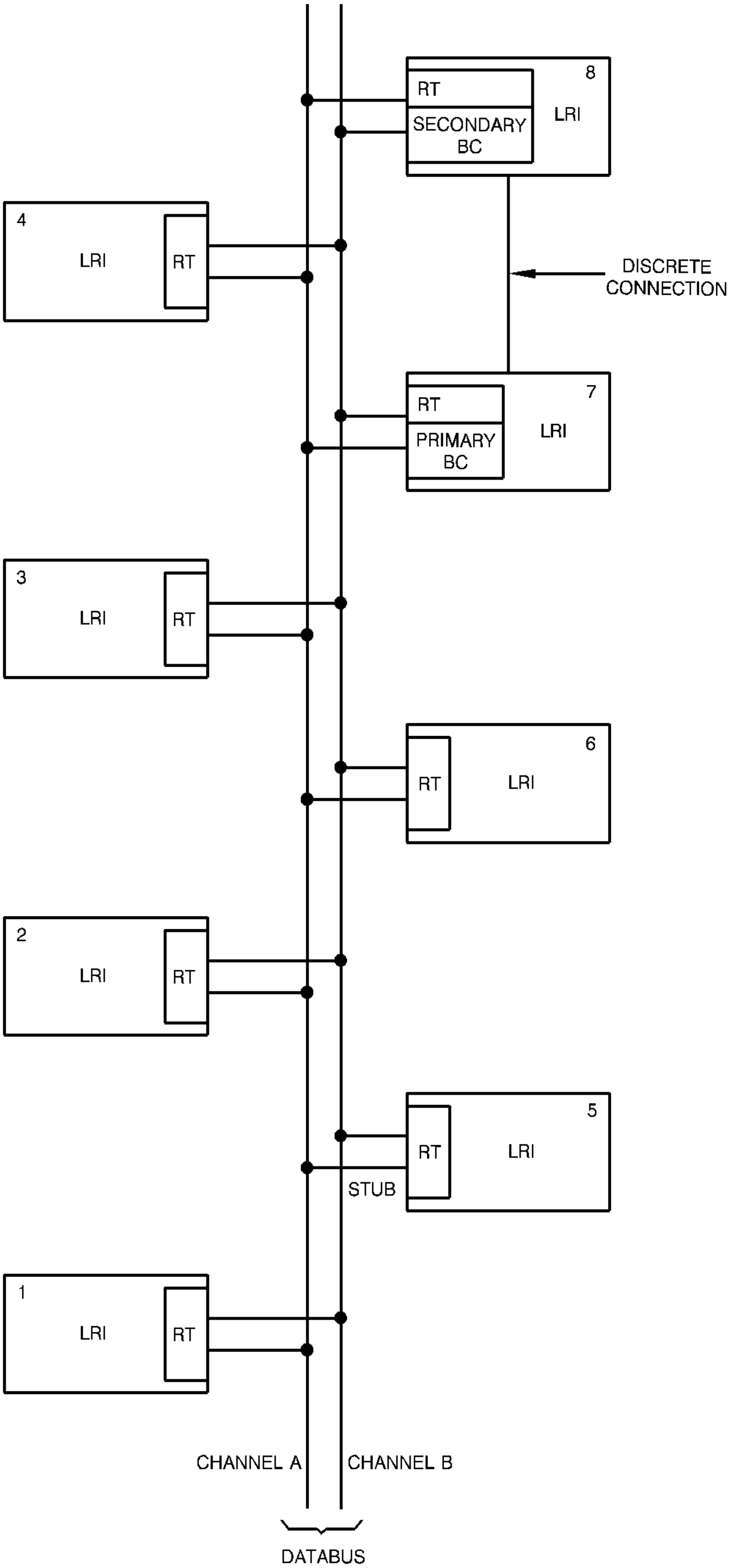


Figure 1.101 - Dual Redundant Databus Architecture (STANAG 3838)

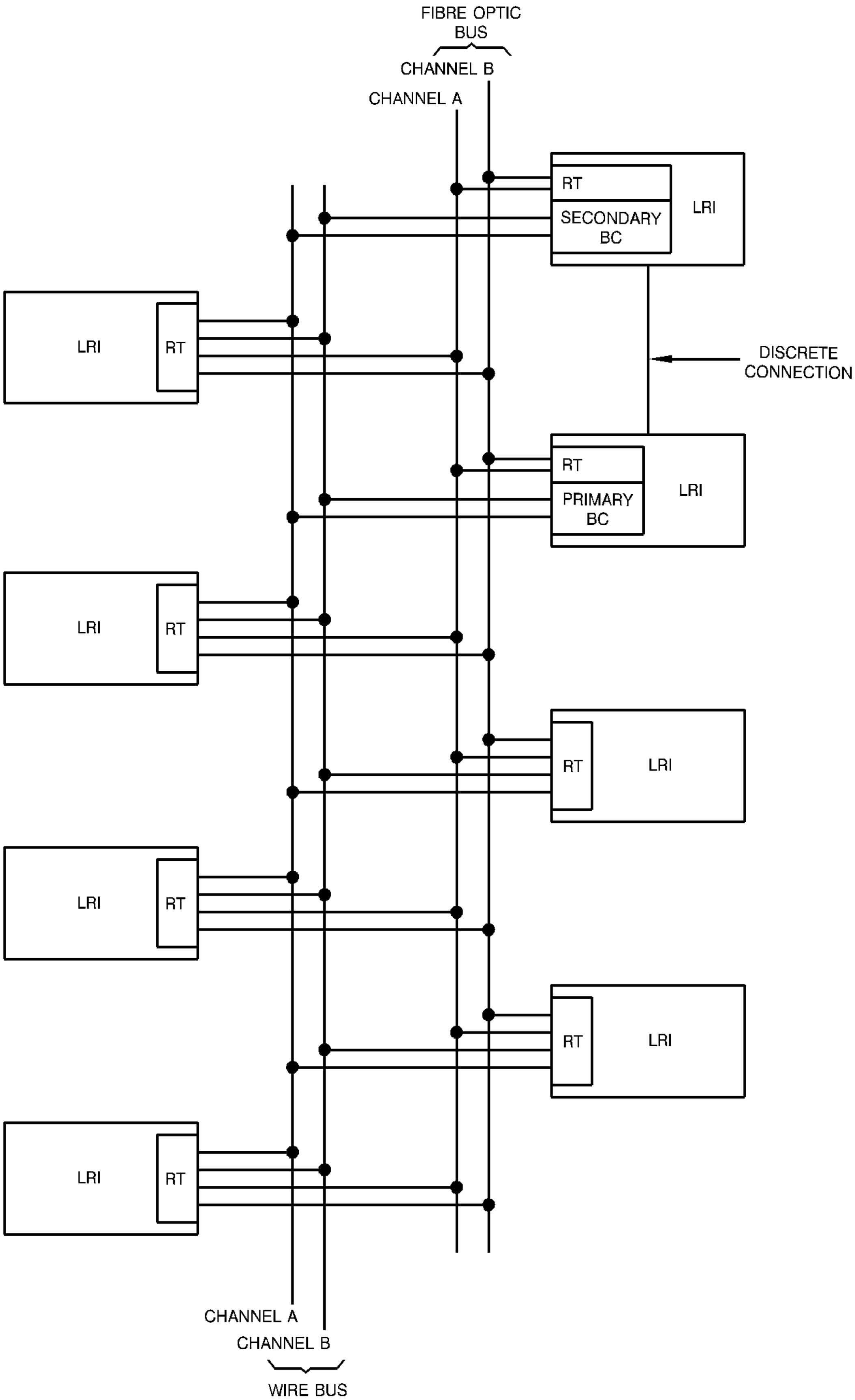


Figure 1.102 - Dual Redundant Databus Architecture (STANAG 3910)

SYSTEM SOFTWARE/MISSION DATA LOADING

Single mission data is entered into the aircraft immediately prior to take-off. It comprises data that is unique to a particular mission, and is entered via:

– the mission data loader/recorder (MDLR) via a portable data store (PDS)
– ground loading unit (GLU)
– manual data entry (MDE) facility.

For further details of data single mission data loading see Integrated Monitoring Test and Recording System and MDE/XY chapters associated with each avionic sub-system.

APPLICATION SOFTWARE

Application software affects the operational capability of the aircraft. It is loaded before flight, directly into individual line replaceable items (LRI) for systems management, and can only be updated on the ground. LRIs can contain more than one class of software.

Software is categorized depending on the potential hazard resulting from a software failure:

– Class 1 software is defined as having the potential to cause hazards with catastrophic/ critical severity.
– Class 2 software is defined as having the potential to cause hazards with marginal hazard severity or effects on mission success.
– Class 3 software is defined as having ground applications only.

Class 1 application software is loaded into the four flight control computers (FCC), digital engine control units (DECU), left and right fuel computers, landing gear computer, computer symbol generators (CSG) and safety critical armaments controller (SCAC).

Class 2 application software is loaded into the non-safety critical armaments controller (NSCAC), interface processor unit (IPU), radar, communication and audio management unit (CAMU), cockpit interface units (CIU), attack computer, lighting controller, navigation computer, engine monitoring unit (EMU), maintenance data panel (MDP), and left and right secondary power system (SPS) computers.

CONFIGURATION CHECKING

NOTE

If the actual aircraft LRI configuration changes it is necessary to update the configuration data within the IPU. This is achieved by loading new configuration data via the MDP/PMDS.

Upon power-up of the IPU and completion of the IPU PBIT the IPU performs a configuration check of actual aircraft LRI configuration against the expected aircraft LRI configuration. This is achieved by comparing LRI part number codes (hardware and software) contained within incoming maintenance data with the expected LRI part numbers which are held in non-volatile memory within the IPU. This data is originally loaded via the MDP/PMDS. Any disparity between actual configuration and expected configuration will be reported via the MDP (as a NOGO).

NAVIGATION SYSTEM

The prime purpose of the Navigation Subsystem is to enable the aircraft to be flown to a specified destination from a specified point of departure. To do this, the on-board sensors provide essential flight data (speed, direction, height, attitudes) and then supply this data to a dedicated computer for Navigation function computation.

The primary functions of Navigation Subsystem are based on:

– Inertial Navigation: the primary dead reckoning navigation is provided by LINS, and the secondary by FCS;
– that generates Navigation parameters: Best navigation data are produced by integrating the navigation aids (GPSU) or manual fixing (OTF) to refine the dead reckoning performance using Kalman Filter (KF).
  Navigation parameters to support track information, climb/dive angle, wind speed/ direction are generated from the Best available generation data when LINS modes are available.
– In case of LINS failure, best data are produced without Kalman Filter evaluation error.

The Navigation Subsystem includes the following equipment:

– Navigation Computer (NC). This dedicated computer uses data from the LINS and from the other system to compute Best Navigation Data and navigation steering parameters. If the LINS is invalid the FCS supplies the data.
– Laser Inertial Navigator System (LINS). This on-board sensor is the primary sensor for dead reckoning navigation. The LINS supplies prime attitude and heading data, position data, accelerations, velocities and body angular rates, magnetic Heading, magnetic variation and climb-dive angle.
– Global Positioning System Upgradable (GPSU). This on-board sensor provides climb and dive angle, present position, time and horizontal and vertical velocities for cross-monitoring with corresponding LINS data, displayed on MHDD HDHUD format and/or on HUD.
– Radar Altimeter (RA). This on-board sensor provides height above the earth's surface up to 5000 ft.
– Integrated Tactical Air Navigation (ITACAN) equipment. This equipment provides range and bearing to the selected ground TACAN station (Air-to-Ground) or to selected TACAN Airborne beacon (Air to Air) or range from another aircraft (Air-to-Air) which are displayed to the pilot on the MHDD Pilot Awareness (PA) format.

The Flight Control System (FCS) provides to the navigation system by IMU, 3-dimensional velocities and accelerations, aircraft attitude and air data (CAS, EAS, TAS, IMN, barometric height, vertical speed).

The navigation subsystem uses this correlated set of data to provide the following facilities:

– Precise calculation of present position (PP), and aircraft velocities vector.
– Steering to pre-defined waypoints.
– Calculation of all navigation parameters associated with pre-defined route.
– Supply of air data and navigation data to the weapons system to support track correlation and maintenance.
– Dynamic display of PP and track on map and tactical displays.
– High integrity head-up and head-down flight path displays.
– Reversionary navigation data on the get-you-home (GUH) displays.
– Position fixing for degraded navigation modes.

NAVIGATION FUNCTIONS AND NAVIGATION DATA GENERATION

The LINS data are used as primary dead reckoning navigation information.

The FCS is the secondary sensor for dead reckoning navigation information.

LINS and FCS data are used by navigation computer to generate the best navigation data at required accuracy and update rates.

The navigation computer mixes the sensors outputs through a Kalman Filter to provide consistently accurate outputs of all the necessary data required for the pilot's flight instrument displays and for navigation. The system is tolerant to failures, for example, if the LINS fails the system will continue to provide accurate navigation using mixed FCS and GPSU data.

Best Navigation Data output by Navigation Computer (NC) are sent to the users AVs and FCS systems and also used internally by the Navigation Computer for other Navigation functions (e.g. Steering, Rad/Alt inhibition, etc.). The following Best Navigation data are produced by the system:

– Best Present Position are continuously compared with GPSU Present Position. They are also used by the Kalman Filter (KF) to evaluate and update the present position error when a fix procedure has been performed by the pilot. On top fixing (Mode 3) is used to refine this information when considered necessary by the pilot. This information is displayed on the MHDD PA format.

– Best Velocities are: north, east and vertical velocities, are continuously compared with GPSU velocities.
  The Vertical velocity is displayed on the HUD and HDHUD format.
  The Ground Speed (GS) when selected will be displayed on HUD or MHDD HDHUD format.
– Best Attitudes and Attitudes Rates are compared with FCS attitudes. This information is displayed on the HUD and MHDD HDHUD format.
– Magnetic Heading Calculation. LINS, if valid, is the source of Magnetic Heading that, is displayed on the HUD, on the PA format and on the HDHUD format. The magnetic variation is deduced from the Best Present Position and the combined with the Best True Heading to produce the Best Magnetic Heading.
– Best Wind. Wind information is calculated by the system when LINS/FCS data are valid, otherwise Set Wind is set as Best Wind. During ground, take-off, approach and landing, the digital readout of the wind speed and direction is displayed on the PA format.
  If PDS set-wind-data have been loaded via GLU/MDLR, then the NC will provides as set wind those data according to the current baro altitude.
– Best Height. This is the height measured by Radar Altimeter (up to 5000 ft) and displayed on the HUD PDU and on the HDHUD format. The Radar Altimeter supplies height above surface and the related validity signal. The Radar Altimeter does not supply height data if the pilot inhibits transmission by setting the Stand-by mode. Certain aircraft attitudes also inhibit transmission: bank and/or inclination rates exceeding +60 degrees/second lasting longer than 2 seconds or bank and/or inclination exceeding $\pm$ 60 degrees.
– ITACAN information. The range and bearing information are sent directly to the HSI format. The pilot sets the operating state, mode and channel of the ITACAN on MDEF.

CROSS MONITORING

Cross Monitoring Functions IN Bank, and in Inclination are compared with the FCS Bank and FCS Inclination. The IN Data are declared invalid if any of the above parameter exceeds the specified thresholds, and the pilot selects the Altitude Source select Key SRCE NAV on MHDD. Monitoring the angles generates the angle Monitor Status and in case of invalid data on the HUD and on the MHDD HDHUD format the notice MONITOR NOT AVAIL is displayed.
Moreover, Horizontal and Vertical Velocity data of the LINS and GPS are compared and the Velocity Monitor is declared to have tripped if the difference between any of the monitored parameters exceeds the specified thresholds. The Climb/Dive angle and Vertical Velocities provided by GPS are displayed on the MHDD HDHUD format, while the same data provided by LINS are displayed on the HUD.

NAVIGATION MODES

In the AVs SP3B2/10 configuration the Navigation Subsystem operates in the following mode only:

– Mode 1 : LINS + GPSU + NC-KF
– Mode 3 : LINS + Fixes (On-Top-Fix) + NC-KF;
– Mode 4 : LINS + GPSU without KF correction and On-Top-Fix;
– Mode 5 : LINS + Fixes without KF correction;
– Mode 6 : FCS + GPSU without On-Top-Fix;
– Mode 8 : FCS + Fixes without KF correction.

Auto/Manual NAV Mode Selection is available and when no Navigation mode is available the BEST NAV Mode is set to NO-MODE (i.e. on LHGS no information about NAV mode are available).

NOTE

Due to the low accuracy of Air Data from FCS, a possible degradation of LINS data may occur (FCS pressure altitude is an input to LINS). Therefore in case of discrepancy between LINS data displayed on HUD and GUH instruments data, the latter must be considered as valid.

MAGNETIC HEADING CALCULATION

The primary source of Best Magnetic Heading is NC. The magnetic variation is deduced from the Best Present Position and then combined with the Best True Heading to produce the Best Magnetic Heading and it is displayed on the MHDD PA/HDHUD Format and on the HUD.

LOW HEIGHT WARNING

A Warning is generated if the Best Height, measured by the Radar Altimeter, becomes lower than the Clearance Height set by the pilot on the RHGS "LOW HT", the Attention Getters and a voice warning message "Low Height" immediately warn the pilot of the danger.
In addition a pull-up indication is displayed on HUD and HDHUD format, shown by a flashing arrow which rotates about its center point such that it always points away from the ground. When the Best eight becomes > of +3% of CLEARANCE-HEIGHT, the Low Height Warning is reset.

Low height warning is calculated by NC during NAV and COMBAT PoF.
A delay of 15 seconds in the computing the low eight warning have been introduced during the transition between T/O and NAV POF or if NAV has been previously manually selected between Weight-On-Wheel to Weight-Off-Wheel transition.

NOTE

The low height warning must not be used as the sole indication of closure with terrain.

RADAR ALTIMETER TX INHIBITION

A signal is produced by Navigation Computer to inhibit Radar Altimeter transmission when attitudes or attitudes rates data exceed specified thresholds (provided by LINS or FCS).
The Radar Altimeter Tx Inhibition it is also possible via XMIT SSK on MDEF.

BUILT-IN TEST FUNCTION

The Navigation System incorporates extensive built in test (BIT) facilities to accomplish failure detection.
The Navigation System includes:

- Power-up Built-In-Test (PBIT);
- Continuous Built-In-Test (CBIT);
- Initiated Built-In-Test (IBIT), (not cleared for AVs SP3B2/10).

DEDICATED WARNING PANEL (DWP)

Information on specific Navigation system failures or abnormal conditions are displayed on the DWP and are the following:

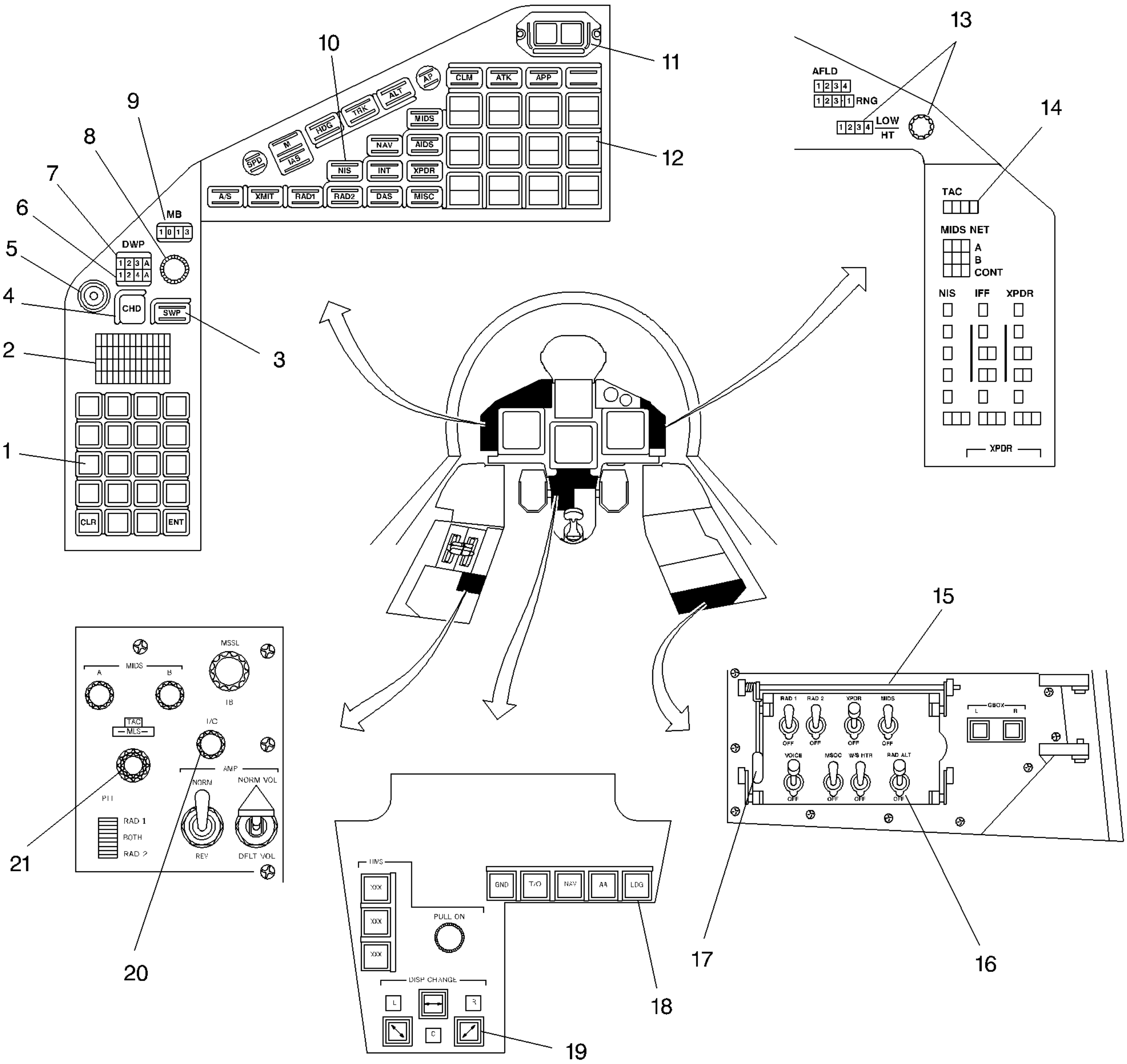
- "Low Height" - Warning Category 1 in NAV and COMBAT PoF and pull-up indication is displayed on HUD and HDHUD.
- "LINS" - Warning Category 3 in all PoF.
- "NAV CPTR" - Warning Category 3 in all PoF.
- "RAD ALT" - Warning Category 3 in all PoF.
- "TACAN" - Warning Category 3 in all PoF.
- "MON TRIP" - Warning Category 2 (Cat. 3 in GND PoF)

RECOVERY

The Recovery system runs automatically as continuous monitoring on all Remote Terminal (RT) and whenever an equipment (LRI) is in failure the pilot is alerted. The system recovery continuous to monitor the LRI in failure and if the origin of failure disappear for any reason, the LRI will come recovered.

NAVIGATION SUBSYSTEM CONTROLS AND DISPLAYS

The navigation information are obtained from the LINS, GPSU, Radar Altimeter, TACAN, Flight Control System and Air data which allow the navigation steering computation.
The navigation information are available in the cockpit to the pilots on the Multifunction Head Down Displays (MHDDs) with their associated soft keys, the Head Up Displays (HUD), the Manual Data Entry Facility (MDEF) and Get You Home (GUH) instruments.
The majority of system controls are available thought the MHDDs. The pilot's main interface with the avionics system for entering, reviewing, and altering data is the MDEF and associated keys and mode selectors, see Figure 1.103.



1 DATA ENTRY KEYBOARD
2 READOUT LINES (ROL)
3 SET WAYPOINT KEY
4 CHANGE DESTINATION KEY
5 WRITING TOGGLE MARKER SWITCH
6 NEXT DESTINATION WAYPOINT ROL
7 DESTINATION WAYPOINT ROL
8 BAROMETRIC PRESSURE SETTING CONTROL
9 BAROMETRIC PRESSURE SET DISPLAY
10 SUBSYSTEM KEYS (SSK)
11 ATTENTION GETTER
12 MODING KEYS
13 RADAR ALTIMETER HEIGHT SET CONTROL AND DISPLAY
14 TACAN DISPLAY
15 TACAN SWITCH
16 RADAR ALTIMETER TRANSMIT SWITCH
17 SYSTEM GANGBAR
18 PHASE OF FLIGHT SELECTOR/INDICATOR
19 MHDD DISPLAYS CHANGE CONTROLS
20 INTERCOM VOLUME CONTROL
21 TACAN AUDIO CONTROL

Figure 1.103 - Navigation Subsystem Controls and Displays

PILOT AWARENESS FORMAT

The Pilot Awareness (PA) format is the primary display for navigation waypoint position and route data. On PA format are displayed: waypoint number, TACAN range and bearing, time and distance to go (referred to next waypoint). The PA always displays the active route and its constituent waypoints and provides a very easy and simple monitor of Present Position (PP) against the desired route or track.

HUD

The Head Up Display present a variety of navigation information to steer the aircraft: Attitude, Heading (True or Magnetic), Track Index, Steering Bug, Altitude (Radar and Baro), Calibrated Airspeed, Mach/Ground Speed, Barometric Pressure Setting, Climb/Dive angle, Vertical Velocities, etc.

GET U HOME (GUH) NAVIGATION INSTRUMENTS

An independent set of instruments are provided to assist the pilot in recovering the aircraft in the event of the primary display failure.

BASE AIRFIELD DESIGNATOR CODE DISPLAY

The Base Airfield Designator Code Display, labeled AFLD, is located on the right glareshield and displays the airfields identifier.

The emergency airfields waypoints are loaded via GLU or PDS and stored in the navigation computer. The emergency airfields waypoints are not retained in memory on power down.

This information is purely for display purposes and there are no associated pilot procedures.

RANGE TO BASE AIRFIELD DISPLAY

The Range to Base Airfield Display, labeled RNG, is located on the right glareshield and displays the range of the airfield nearest to the aircraft present position.

MODES OF OPERATION

The Navigation System software runs within sequential branching structure in an interactive relationship with the pilot via the controls and displays. When power is applied, each equipment performs its own Power-Up BIT. After completion of this test the equipment sends a message to the IPU containing status, maintenance and configuration information required for recording and verification purposes.

LINS GROUND STATIC HARMONIZATION

The Navigation Computer provides pitch, roll and yaw correction to be applied inside LINS to compensate errors due to mounting installation.

UTC TIME MANAGEMENT

The NC will be able to manage UTC time according to LRI availability (GPSU and Radios), time figure of merit and weight-on-wheels. GPS is the primary source and Radio is the secondary source of UTC. The GPS UTC source is always set and is available on ground and in flight, while radio provides UTC time information only in flight.

NAVIGATION SYSTEM INITIALIZATION

Initialization of the navigation system is automatic once the required data has been loaded via PDS or GLU. If no PDS or GLU is available, the necessary data can be loaded manually via MDEF.

LINS ALIGNMENT INITIALIZATION

LINS alignment is handled by Navigation Computer in terms of Initial Position (IP), Alignment type, Rapid heading.

GPS INITIALIZATION

GPS initialization requires an approximate position. In normal operation, the GPS crypovariables are stored in volatile memory and a real time clock continues to maintain time when the GPS receiver is switched off.

CLEARANCE HEIGHT

The pilot must set the required clearance height for low height warning via the right hand glareshield.

BARO SETTING

As part of the initialization procedure the pilot must manually set the reference barometric pressure setting via the left hand glareshield.

WIND DATA

The navigation system automatically calculates the current wind using LINS (velocities, attitudes) and FCS data (TAS, alfa and beta. In case of not availability of FCS data, the last calculated wind will be maintained and the CNST soft key on MDE will be boxed.

In case of LINS failure, set wind will be provided and calculated wind will not be longer available. If pre-loaded wind data are available (via GLU/MDLR) then NC will provide those data as "set wind data" according to the current baro altitude provided by LINS or FCS (in case of LINS failure) and if a manual wind has not been entered by the pilot.

STORED WAYPOINTS

The Navigation Computer can store up to 200 waypoints divided as follows;

- from 190 to 175 - normal waypoints i.e. route, overfly,
- from 171 to 000 - normal waypoints i.e. route, overfly,
- from 191 to 200 - mark waypoints,
- 172 - 173 - 174 - in flight alignment waypoints.

The possible waypoints types are as follows:

- Route point: if in a route, the navigation system will turn before overflying the waypoint so as to capture the exact track between that waypoint and the next in the route.
- Overfly point: the navigation system will steer to overhead the waypoint before commencing a turn onto the next track.
- CAP point: a waypoint on which is based a racetrack CAP pattern. The CAP parameters are defined by PDS and/or MDEF.
- Landing point: is considered as overfly waypoint.
- Mark point: a position stored as a result of the pilot "marking" a point of interest in flight.
- Fuel point: a waypoint defined as the datum point for an air-to-air refuelling (AAR) towline, and/or as a fuel management point, i.e. a planned fuel at the waypoint is stored during mission planning and a prompt given to the pilot on reaching the reappoint, to assist monitoring of fuel usage (not cleared up to As Spa).

Each reappoint is defined with several parameters, known as attributes. The attributes are:

- Number: the reappoint number is stored in the navigation computer
- Position: defined in At/Long coordinates references
- Waypoint elevation (feet): waypoint elevation above mean sea level.
- Aircraft altitude: planned aircraft altitude above mean sea level at the waypoint, mostly used for CAP and AAR waypoints. This height is not used in the steering calculations.
- Planned Time of Arrival
- CAP pattern lenght. If a value is not defined by PDS input or pilot manual input, the system uses default leg lenght of 15 nm.
- CAP pattern direction: true track of the CAP “hot” leg.
- CAP pattern orientation: left or right racetrack: the system defaults to a left hand pattern.
- CAP pattern speed: planned IAS while on CAP. Unless defined otherwise by PDS or manually by the pilot, the system default speed is 360 KIAS.
- Description: an short description of the waypoint, e.g. Bridge. The description is loaded via PDS, cannot be edited by the pilot and is automatically deleted if the waypoint position is edited.
- Identifier: a three character code for the waypoint to simplify pilot recognition of the waypoint identity, e.g. CGY = Coningsby. The identifier is loaded via PDS, cannot be edited by the pilot and is automatically deleted if the waypoint position is edited by the pilot.

Not all waypoint types can use all attributes.

DELETING WAYPOINTS

Waypoint may be erased by use the DEL WP function. This routine is available whilst the aircraft is on the ground. Note that it is not possible to delete a waypoint from route store that is part of both Automatic or Manual route.
Also, it is not possible to remove the DWP from an active route but just modification is allowed; to do this, either in AUTO than MANUAL route, HOLD mode must be selected.

ROUTES

The Navigation system can contain 2 different routes for use by the pilot: AUTOmatic (loaded via: MDLR or GLU) and MANual (loaded via: MDLR or GLU; or created at any time by using MDEF, XY/PA format, or the XY cursor and Waypoint format). The routes are constructed from a series of waypoints stored within the navigation computer. Each route can contain up to 50 waypoints of various types dependent on the action required at any specific point in the route.

NOTE

To ensure sufficient space remains available in a route to permit the automatic addition a waypoints to a route, e.g. on selecting In Flight LINS Alignment, the system prevents loading of more than 47 waypoints into any route.

AUTO ROUTE

The AUTO route can be created both manually (via XY controller) or automatically (via GLU/MDLR loading). The AUTOmatic route can be amended by the pilot on the ground or in flight and is not deleted when overflown. It is also stored in the non-volatile memory of the Navigation Computer on aircraft power down and is therefore available on power-up unless overwritten by a new PDS-loaded planned route. The AUTO route is always selected as the default route for steering.

MANUAL ROUTE

The MANUAL route can be created both manually (via XY controller or MDEF) or automatically (via GLU/MDLR loading). The MANual route is selected by default for editing, so that all waypoints and route manipulation could be modified by the pilot using MDEF and/or XY and the MHDDs will normally affect the Manual route unless the pilot specifically chooses to modify the Auto route. A Manual route can be created, amended, or deleted by the pilot on the ground or in the air via MDEF. The Manual route is not retained on aircraft shut-down. On selection of the Manual route the first of its waypoints becomes destination waypoint and if the last of its waypoints is also included in the Auto route, the system automatically transfer to the AUTO route as that waypoint is reached.

NAVIGATION FIXING

Navigation Fixing can be performed automatically with GPS aid or manually with OTF. Normally, the navigation system automatically select and operate in Nav Mode 1 (LINS + GPS, integrated via a Kalman Filter) and no Navigation Fixing by the pilot is required.
If the GPS is not valid, the system will automatically revert to Nav Mode 3 (LINS + OTF “manual fixing”, integrated via Kalman Filter) or Mode 5 (LINS + OTF “manual fixing”, without Kalman Filter) where pilot fixing can be carried out to maintain system accuracy.
If the LINS is unavailable, the navigation system will use FCS data Nav Mode 6 (FCS + GPS), or Nav Mode 8 (FCS + manual fixing)
Three On-Top-Fixing modes are available:

– Mode 3: LINS + OTF with Kalman Filter correction
– Mode 5: LINS + OTF with last Kalman Filter correction
– Mode 8: FCS + OTF without Kalman Filter correction

Navigation Fixing is performed manually by the pilot. Manual fixing is accomplished by On Top Fix (OTF). During fixing, the Navigation system provides the necessary information to steer the aircraft to overfly the fix point before commencing a turn towards the next track.

LINS OTF KF

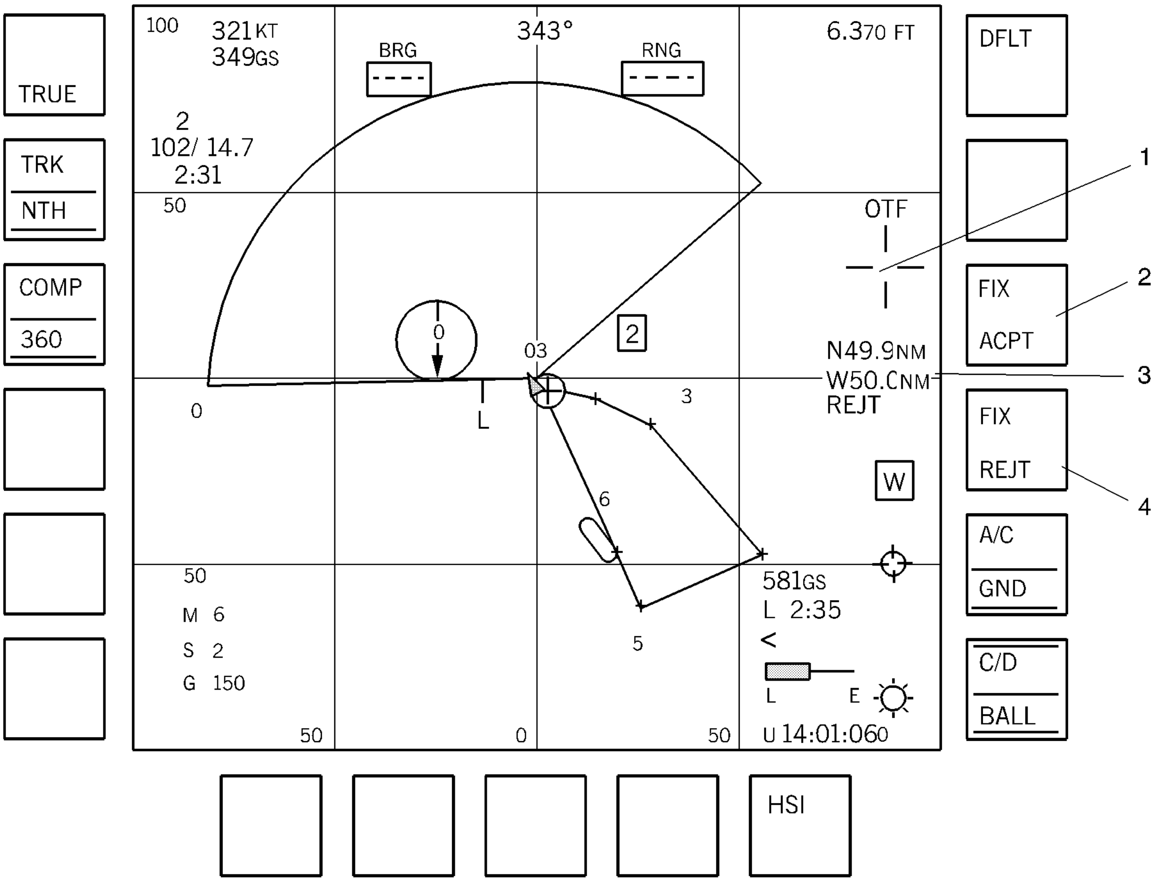
Upon pilot acceptation of position error, the Navigation Computer (NC) updates the Present Position with the position error evaluated by Navigation Computer Kalman Filter (KF). The system also displays a recommendation on acceptance or rejection, based on the magnitude of the error and the estimated positional error. If the pilot perform a Reject Fix then the system ignores the fix position error, in both cases, to change leg, pilot has to close fixing procedure (accepting or rejecting the "error" within 2 NM from the current DWP).

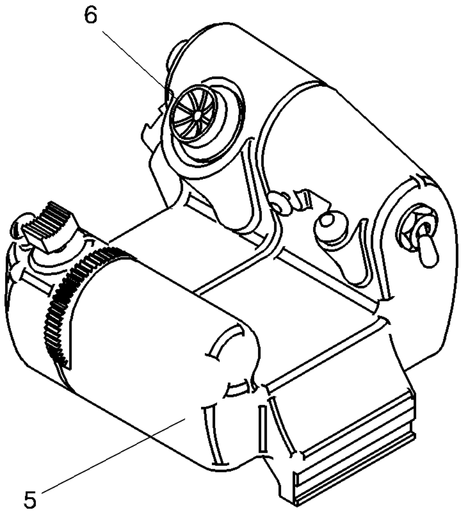
LINS OTF

Upon pilot acceptance of position error, the Navigation Computer updates the Present Position with the correction derived from the computation between real aircraft Present Position (PP) and measured PP sensed by the LINS.
When FCS OTF mode is engaged, best data computed by the Navigation Computer are based upon FCS data (CAS, accelerations, attitudes and heading) and upon the last calculated wind (currently frozen) before the loss of LINS. Due to the fact that real wind could change due to meteorological conditions and that, on the contrary, Navigation Computer is using the frozen wind in its algorithm to calculate aircraft velocity and position, this best data could be degraded. For this reason the pilot should use the FCS OTF mode with caution, and it is also recommended that OTF procedure be performed frequently.

HOW TO PERFORM AN OTF

The pilot enables On Top Fix mode by selecting the FIX/OTF soft key on the MHDD PA format. The OTF key then lights up. On selection, the XY cursor is located to the right side of the PA format and all other functions are inhibited. The pilot flies the aircraft over the fix point, and presses the XY insert when directly overhead. The north/south and east/west fix errors are then displayed on the PA format for the pilot to accept or reject as required, using ACPT or REJT soft keys on PA format, see Figure 1.104.





1 XY CURSOR
2 FIX ACPT SOFT KEY
3 KF EVALUATION
4 FIX REJT SOFT KEY
5 THROTTLE CONTROL TOP
6 FIX INSERT BUTTON

Figure 1.104 - Insert On Top Fix

The "Fix Error", is the difference between the navigation system present position based upon sensors availability, and the real waypoint position.

The "ACPT FIX" soft key on the MHDD PA format shall be pressed to accept the "Fix Error" and "best" position will be corrected. To reject the "Fix Error", the MHDD "REJT FIX" soft key shall be pressed.

On accepting or rejecting, the errors are cleared from the display, and the system automatically changes destination (the usual auto CHD function is inhibited while OTF is selected)

OTF mode may be cancelled before any fixing has occurred by pressing the FIX/OTF soft key.

NAVIGATION STEERING

The Navigation Steering calculation is provided for manual steering only. The system provides to the pilot some parameters to steer the aircraft along a route that is made up of a series of legs, where a leg is that part of a route flying between two successive waypoints.

On power up the AUTOmatic route is selected as the default route. The pilot can select between the Automatic route and Manual route both on the ground and during flight via MDE NAV sub-system.

After take-off (weight-off-wheels and phase of flight NAV) the steering data is displayed to the pilot to guides the aircraft to the destination waypoint (DWP). Direct Steering is the default steering mode, but the pilot can select Track steering if required, via the MDE NAV sub-system.

ROUTES

The navigation system can contain two different routes (Auto route and Manual route) for use by the pilot, both of which can be pre-planned and loaded via MDLR/GLU.

The Automatic Route will contain at least two waypoints as minimum since the first one identifies the airfield.

ROUTE TRANSITIONS (JOIN WAYPOINT)

The system will automatically transition from one route to the other under particular circumstances. If the system has been flying the Manual route and the last waypoint in this route is also a waypoint in the Auto route, then the system will automatically transition to flying the Auto route from that point onwards. If the pilot selects the Auto route whilst the Manual is being flown, or the system is in Steering Hold mode, then the system will return to the Auto route using the previously set DWP in that route as the new DWP.

ADDITIONAL ROUTE FUNCTIONS

Three extra functions are provided to improve navigation system flexibility. They are all selectable via the MDEF, in the NAV SSK and are the following:

– Change Direction: This function, selected by pressing the CHG DIR on moding key, reverses the selected route direction and allows the pilot to navigate back down the selected route. The route is completely reversed and the new route order is shown on the Waypoint List format, and is displayed on the PA format.
– CHD XXX: This facility is only available when there is a preceding waypoint in the route currently being flown that is available for selection. On pressing the CHD, the key moves the route sequence back one step, providing steering back to the previous waypoint but retaining the planned route sequence.
– New Track: With Track Acquire Steering engaged, it is possible to define a new planned track from PP to DWP, by selecting the NEW TRK moding key.
– Emergency Airfields: Following navigation computer PDS/GLU mission data loading the NC provides to the pilot (via FCS, D+C) Range and Bearing of the nearest emergency airfields available. This information is displayed on RHGS on reversionary instruments indicators.
– Delete Manual Route: A DEL MAN soft key is located on Moding key on MDEF, to allow the deletion of manual route, if it is previously created by the pilot.

STEERING LAWS

The possible Steering types are:

– DIRECT;
– TRACK ACQUIRE, which includes the following Steering modes: Route, Point To Point, Combat Air Patrol, Combat Air Patrol Acquire;
– HOLD
– NO-STEER

Depending on the steering type and mode selected, each leg of the navigation route can be divided into the following segments:

– TURN. It is used only in CAP steering mode and during this segment the steering bug will command to null the angle between the Actual track and the Command Track (Direct Track from the A/C PP and the current DWP);
– STRAIGHT. It is the first segment of the leg and it is being flown when the previous leg is over. The Command Track is defined as the track from the acquired waypoint to the DWP;
– DIRECT. It is defined only in PT-PT Steering mode and is engaged when the distance along

track is less than 5 Nm from the NWP. The steering bug will command to null the angle between the Actual track and the Command Track (Direct Track from the A/C PP and the current DWP);

– OVERFLY. It is initiated on completion of a Direct segment (i.e. when the distance along track is less or equal to 2 Nm) if a fix is not selected (i.e. the fix-over is TRUE). During this segment the Command Track is frozen to the last calculated Direct Track value and no longer updated.

DIRECT STEERING TYPE

Direct Steering is selected automatically (if DWP is available), when Weight off Wheels is detected or after over flying the last waypoint in the selected route or manually at any time or exceeding the threshold of ± 50 deg from the planned track and the related Key on LHGS DIR is boxed. In Direct steering mode the track directly from PP to current DWP is continuously updated while the leg is being flown and drawn in white on the PA format, see Figure 1.105.

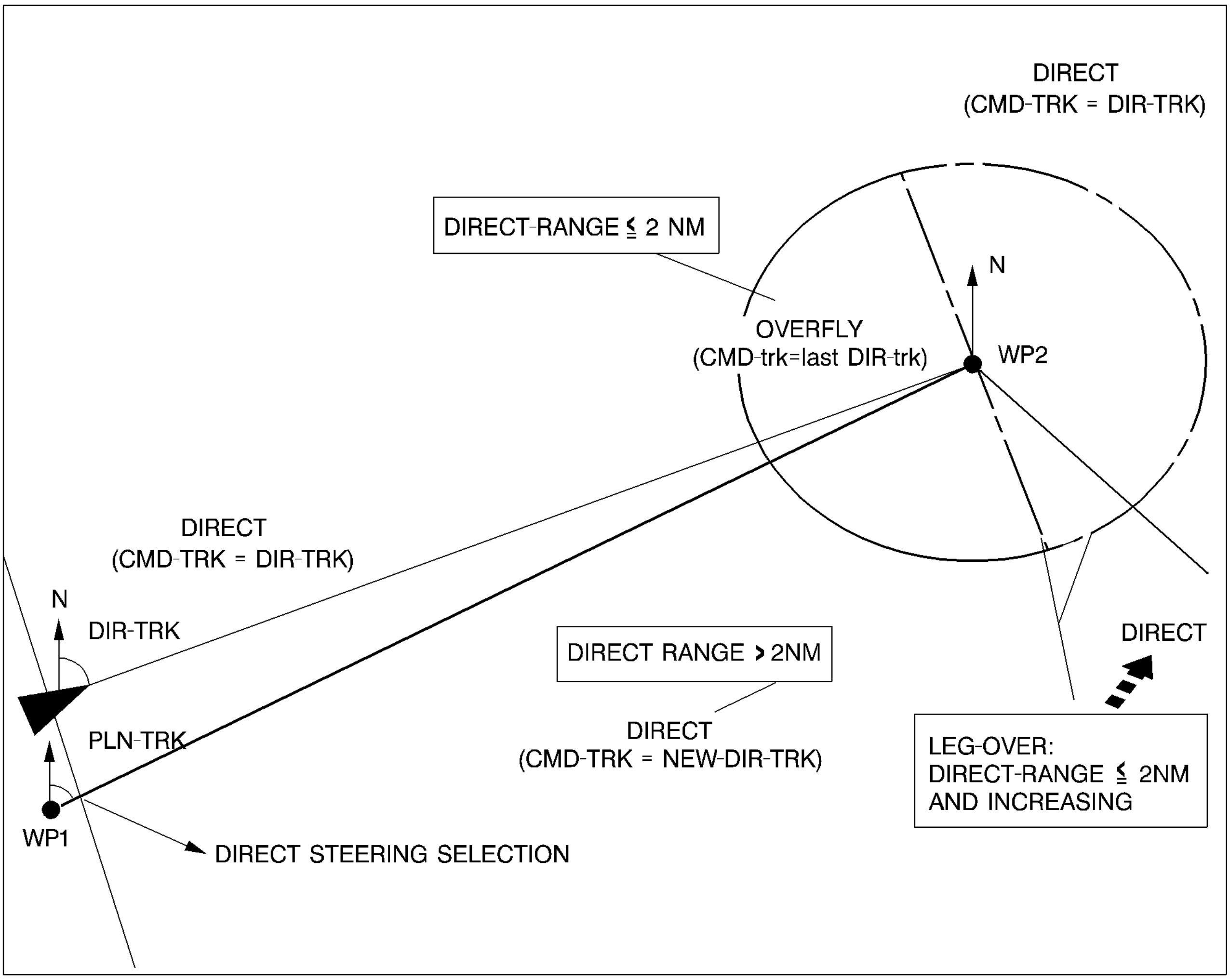


Figure 1.105 - Direct Steering Type

TRACK ACQUIRE STEERING TYPE

The Pilot can select Track Acquire Steering if required, via the TRK/DIR soft key on moding keys, highlighted by pressing TRK. In Track Acquire Steering type , steering information is presented to the pilot to enable optimum tracking and reacquisition of a Planned Track defined by the route and the steering mode engaged. The Track Acquire Steering has 4 different Steering-mode , Route, Point-To-Point, CAP-Acquire and CAP according to the WP type to be flown is Route, Overfly or CAP, see Figure 1.106 and Figure 1.107.

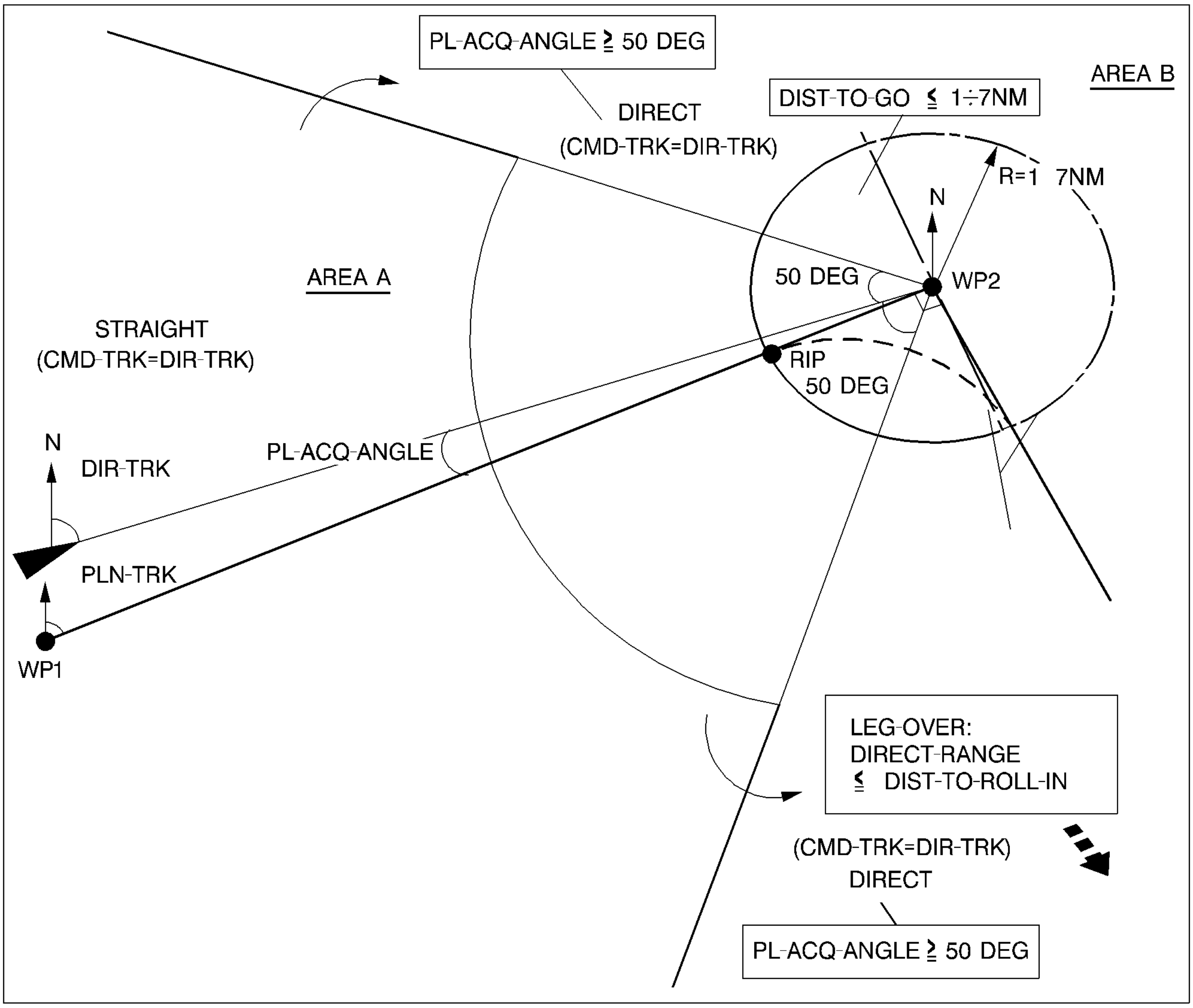


Figure 1.106 - Route Steering Mode

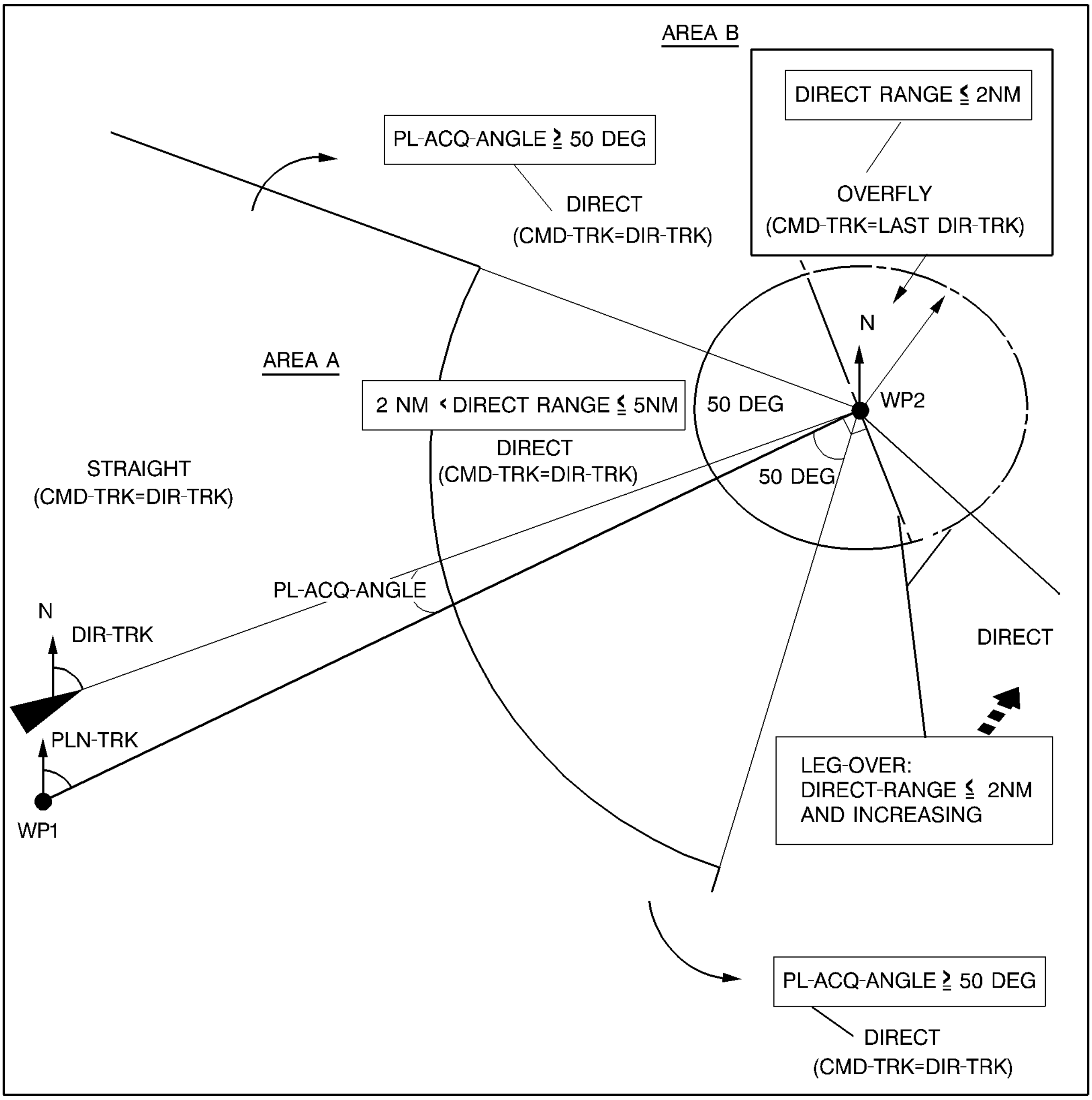


Figure 1.107 - Point To Point Steering Mode

ROUTE STEERING MODE

Steering information is provided such that a smooth transition from the current leg to the next is achieved without overflying the DWP. The point at which the transition is performed is named Roll-in-point and it is the point to which the TIME-TO GO and DIST-TO-GO are calculated.
The Route Steering mode is automatically entered when the DWP is a Route or a CAP waypoint.

POINT TO POINT STEERING MODE

Steering information is provided such that the DWP is overflown before the next leg is entered. This type is automatically entered when DWP is an overfly or Landing waypoint.

HOLD STEERING

The Command Track is frozen to the Best Actual Track at the Hold mode selection. Hold Steering mode can be selected:

– automatically at Take off (WOW transition) if the selected route does not contain any waypoint;
– manually at any time by selecting STR/HOLD moding key.

Deselecting HOLD, the system reverts to the previously engaged steering mode and Planned Track.

NO-STEER

When A/C is on GND and Weight OFF Wheels transition has not been detected Steering type will be set to No-steer and just NWP, NNWP, AUTO Route and MANUAL Route information is made available to the pilot.

COMBAT AIR PATROL (CAP) STEERING

The navigation system provides steering cues to assist the pilot in acquiring and maintaining position on a pre-defined CAP pattern. At all times, the HUD and PA format waypoint data blocks show range and bearing to CAP datum, and the PA format displays: the CAP pattern, the CAP datum and the planned CAP speed in knots
When approaching a DWP that has been defined as a CAP, the system provides the following different phase of navigation steering:

– CAP acquire steering: A CAP waypoint is treated initially as a route waypoint, and the navigation system therefore uses route steering, i.e. it will initiate a turn to capture the planned track away from the DWP (the CAP datum) before reaching the waypoint itself. The start point of the turn is calculated by the system, and varies according to aircraft position, groundspeed and the bank angle to be used, which itself varies as a function of airspeed. This means that, unless the aircraft is approaching the CAP datum on the same track as the planned outbound (hot) leg, the aircraft will not overfly the CAP datum on initial capture. Once the system has reached the turn in point, the system change the CAP steering. On PA format, a white direct track line is drawn between PP and the CAP datum until the turn-in point is reached.

  The CAP pattern is also always displayed. Once the system changes to CAP steering, the PA format shows the hot leg drawn in bright white.

– CAP steering: This provides steering cues to capture and maintain the planned CAP pattern, using capture laws similar to those used in Track Acquire steering.

  To allow flexibility in how the CAP pattern is flown (e.g. the pilot may wish to fly a very tight pattern for a low altitude visual CAP, or a slack pattern in IMC at high altitude) the navigation system continuously adjusts the size of the pattern in response to how the pilot maneuvers the aircraft. The Hot Leg (i.e. from the CAP datum, outbound on the CAP orientation track for the specified leg length) is always fixed. At the end of the hot leg (either overflown, or abeam), the steering bug will give a fly left or right command to carry out a left or right hand pattern as specified. Note the steering bug is in bank angle demand mode (as in normal track acquire steering) and if followed accurately will turn the aircraft using a bank angle defined by aircraft speed: this bank angle is also used in calculating the expected turn radius, and thus the size of the CAP pattern drawn on the PA format.

– Note that if the pilot has turned tighter than the nominal rate when turning from hot to cold leg, the system will automatically adjust the CAP pattern size, and display the actual pattern being flown on the PA format. The end of the cold leg is defined as when the aircraft passes abeam the CAP datum point. The steering bug then gives a turn command back towards the CAP datum: route steering is given to recapture the hot leg. This moding allows the pilot to fly the CAP pattern with whatever bank angle and maneuver rate he wishes, while still providing steering cues to capture and maintain the hot and cold legs, and with the PA format always displaying the size of the actual CAP pattern he is using.

– Off CAP Steering: If the aircraft flies outside an area defined by one hot leg legth all around the hot leg, CAP steering is disengaged and the system reverts to. CAP acquire steering to reposition the aircraft back onto the outbound hot leg.

The CAP steering described in the previous paragraph is inhibited when the aircraft diverges more than one CAP leg legth all around the hot leg. This will usually occur when the aircraft leaves CAP to investigate or engage a target of interest. When this occurs, the navigation system reverts to CAP acquire steering, i.e. the steering bug provides commands to steer back directly to the CAP datum, and will turn onto the beginning of the hot leg when is reaches to calculated turn in point. The only exception to this condition is when the fighter is within a narrow cone extending from the CAP datum symmetrically about the hot leg. If the fighter is within this cone (for example, the pilot has extended beyond the end of the hot leg to investigate a track, and then turned back towards datum) then the system will instead provide steering direct back to the CAP datum. On approaching the datum, instead of attempting a route steering turn back onto the hot leg before reaching the datum (which it cannot achieve because the aircraft is too close to the hot leg outbound track), the system will continue to steer to overhead the datum and will then fly a teardrop turn back onto the hot leg. If the aircraft moves from being within the cone to outside the cone, then the route steering mode will automatically be entered.

AUTOMATIC DESTINATION WAYPOINT CHANGE

Automatic change destination occurs for Direct Steering when the direct-range is ≤ 2 and increasing and a fixing procedure is not in progress (on the MHDD FIX OTF key is not boxed).

If Track Steering is selected and Steering mode is Point to Point, change leg will occur when Direct-Range ≤ 2 NM and increasing.

If Track Steering is selected and Steering mode is Route, change leg will occur when Direct-Range ≤ Dist-To-Roll-in.

If a fixing procedure is in progress (on the MHDD FIX OTF key is boxed) the leg completion will occur upon fix error acceptance/rejection with Direct-Range ≤ 2 NM and increasing. Steering to the fix waypoint will continue to be provided, after overflying the fix waypoint, until the fix procedure is completed.

Automatic change destination does not occur on achieving a CAP waypoint or a Fuel waypoint, these waypoints remain as DWP until the pilot manually selects CHD.

MANUAL DESTINATION WAYPOINT CHANGE

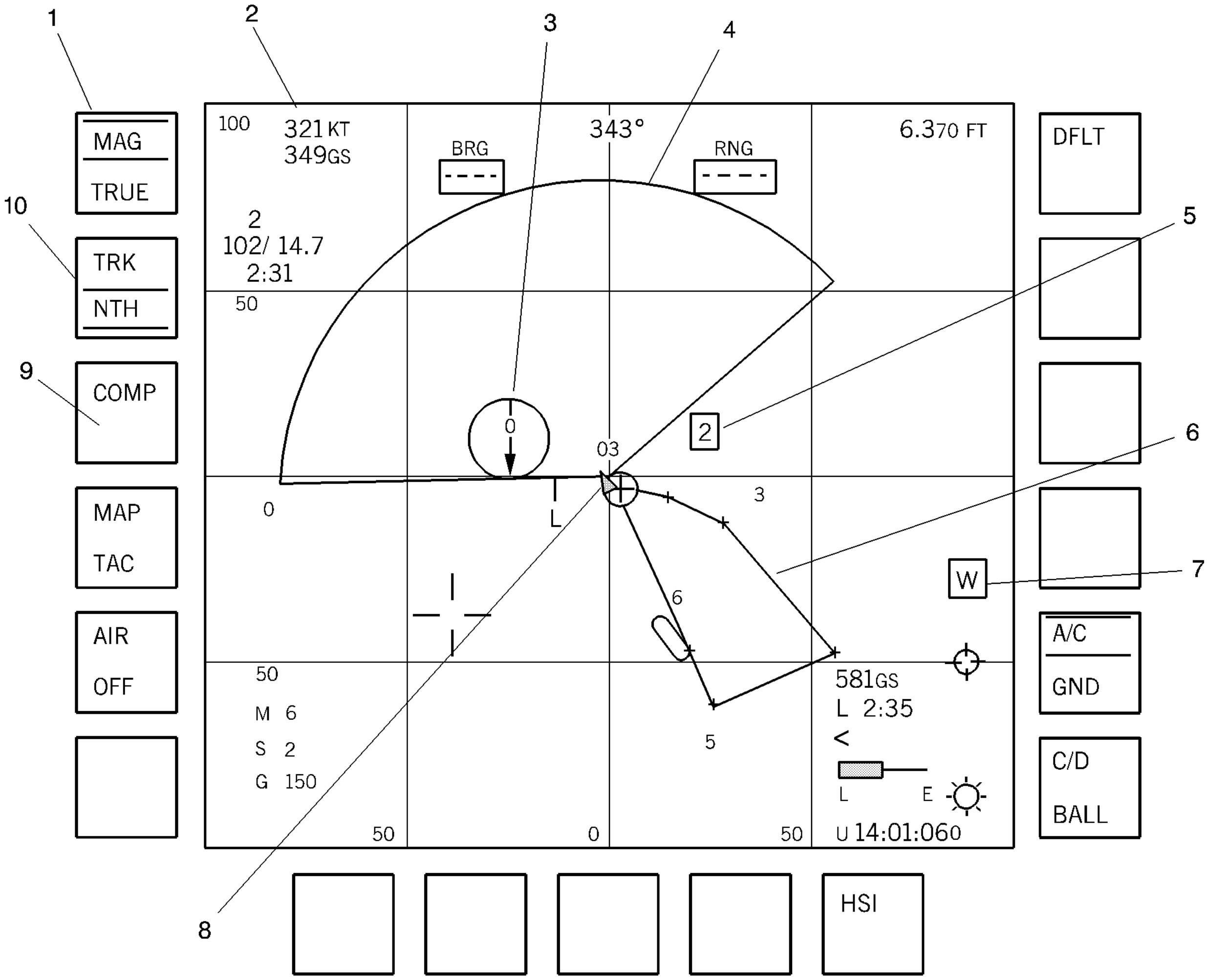
A manual facility is provided, via CHD button on MDEF, to enable the pilot to skip forward the current DWP.
In Track Acquire Steering, following the change destination facility, the new Planned Track is the leg of the selected route connecting the previous DWP to the new DWP.
In Direct, following change destination facility, steering information will be referred from the PP to the DWP continuously updated.
In Hold Steering, a selection of change destination will result in re-selection of the previously selected steering mode with no change to the current DWP.

NAVIGATION FORMAT DISPLAYS

The navigation format displays enable the pilot to monitor the status of the complete navigation system and moreover present a variety of navigation information to steer the aircraft during the flight. The status and the navigation information is displayed on the MHDD PA format, on the Head-Down Head Up Display (HDHUD) format and on the HUD.

MHDD PILOT AWARENESS FORMAT

The MHDD Pilot Awareness (PA) format, see Figure 1.108, can be displayed to the pilot in all phases of flight (PoF).

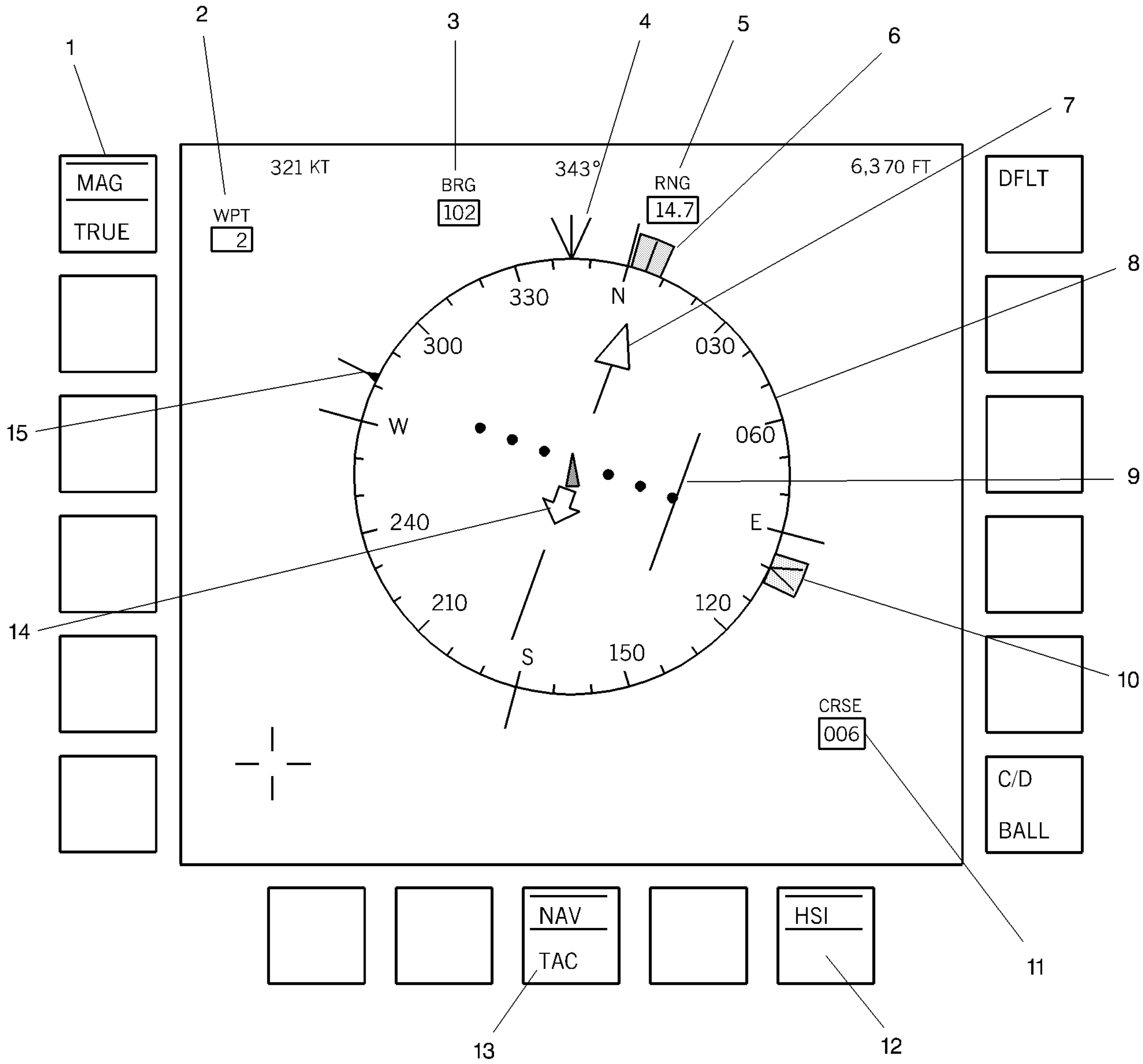


1 MAGNETIC TRUE SELECT KEY
2 CURRENT DISPLAYED AIR SPEED/GROUND SPEED
3 WIND SPEED AND DIRECTION
4 COMPASS ROSE
5 CURRENT DESTINATION WAYPOINT
6 CURRENT AUTOROUTE LEGS
7 WINDOW ON THE WORLD ICON
8 TRIANGLE TO INDICATE SELF PP
9 COMPASS SOFT KEY
10 TRACK UP/NORTH UP SOFT KEY

Figure 1.108 - Pilot Awareness Format

The PA and WPT format is the main displays for navigation waypoint position and route data.
A waypoint block is shown on the PA Format, displaying waypoint number, range and bearing and distance to go/time to go to the next waypoint and TACAN range and bearing.
The TACAN channel number and mode are displayed also on the Dedicated Readout Panel (DRP) on the right glareshield.
The selected route is displayed, with associated waypoints, with the current leg shows in white and the remainder of the route in green. In Direct steering, the current leg shown direct track from PP to DWP, while in Track Acquire steering it shows the planned track between the previous and destination waypoints. The PA always displays the active route and its constituent waypoints and provides a very easy and simple monitor of Present Position (PP) against the desired route or track.
A "zoom" function is provided on the PA format, allowing the pilot to rapidly select an expanded area of the main display. Zoom is selected by a XY insert, pressed for more than 1 second, on the required point. Zoom is cancelled by a short XY insert on a black space.
The PA format also provides the basic Navigation display setting functions:

– Compass Rose - A compass rose is superimposed on the PA format to provide heading reference. Either a 360°, partial (120°) rose or none can be displayed by COMP soft key on PA format.
  Magnetic/True Orientation - All heading references on the HUD and MHDDs can be set to either true or magnetic orientation by pressing the MAG/TRUE soft key on the PA. The default orientation on power-up is "Magnetic". Note that if the HSI is selected with TACAN as the HSI navigation data source, the aircraft heading references are automatically set to Magnetic.
– Horizontal Situation Indicator (HSI) - A conventional HSI type display presentation is provided, selected by HSI soft key on PA format, see Figure 1.109.



1 MAGNETIC/TRUE SOFT KEY
2 DESTINATION WAYPOINT
3 DIGITAL BEARING DISPLAY
4 LUBBER LINE WITH CURRENT TRACK SYMBOL "V" SUPERIMPOSED
5 DIGITAL RANGE DISPLAY
6 HEADING BUG
7 COURSE POINTER
8 COMPASS ROSE
9 LATERAL DEVIATION BAR
10 TAIL OF THE DIRECT POINTER
11 DIGITAL COURSE DISPLAY
12 HSI SELECT KEY
13 NAV/TAC SOFT KEY, NAV SELECTED
14 TO/FROM FLAG
15 POINTER-DIRECT BEARING TO WAYPOINT (NAV) OR BEACON (TAC)

Figure 1.109 - HSI format

WAYPOINT FORMAT

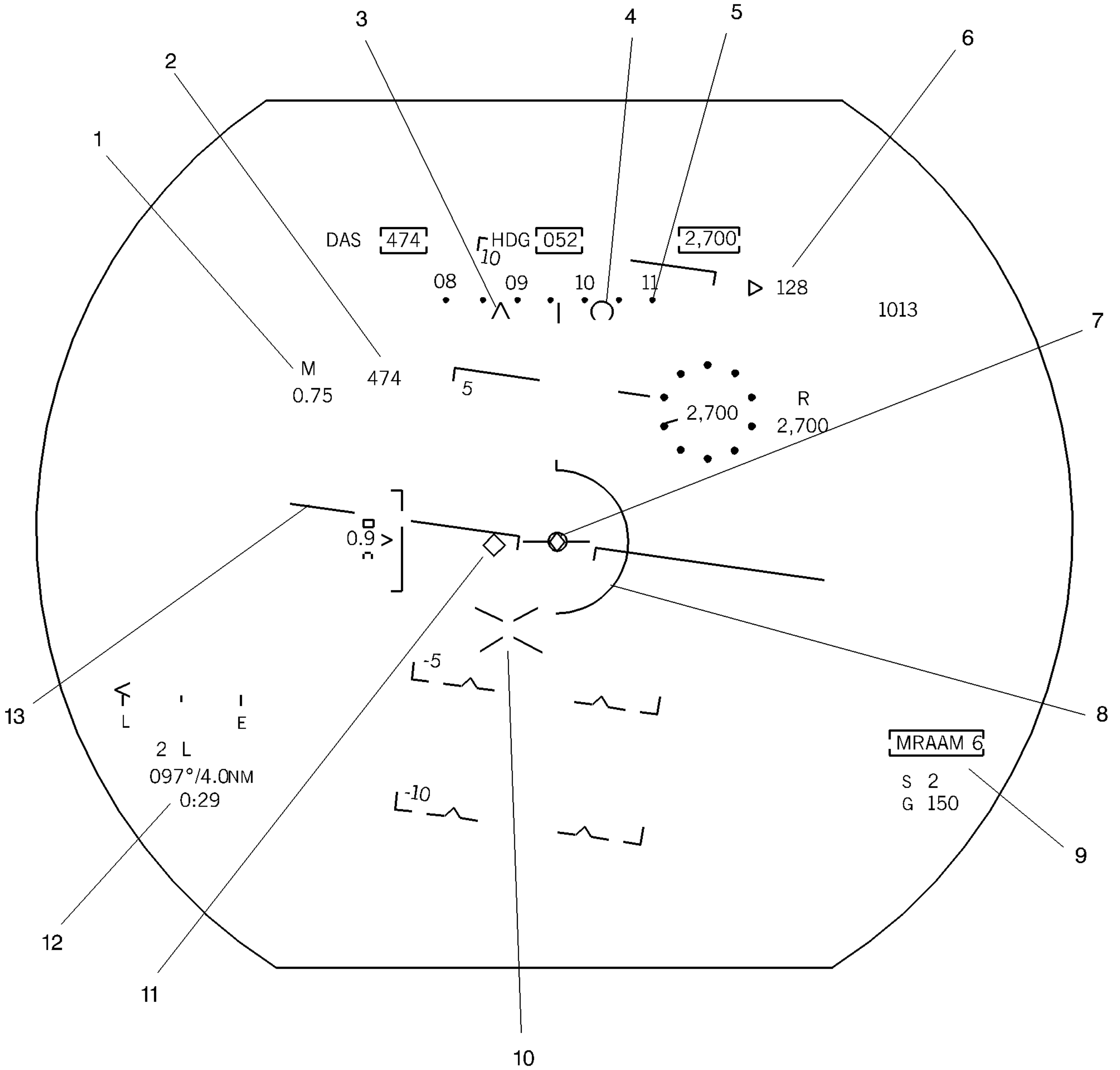
The Waypoint format is selected via the WPT soft key, available on most RMHDD format. A typical waypoint list format is shown in Figure 1.110.
It provides a list of the waypoints within the Navigation system, listing then by number and detailing the waypoint type, identifier, a simple description, and if defined, planned time of arrival. An XY insert anywhere on the waypoint data line opens an expanded information box detailing waypoint number, lat/long, direct range and bearing to the waypoint from PP, waypoint elevation, and planned altitude (if defined). The Waypoint format also display the waypoints in the Auto or Manual routes. These show the route waypoints in order, the joining and destination waypoints for each route. The active route ROL shows the current route, with the current DWP highlighted in the first position in the ROL and also on the waypoint list.

HEAD UP DISPLAY (HUD)

The Head Up Display, see Figure 1.111, presents a variety of navigation information to steer the aircraft.

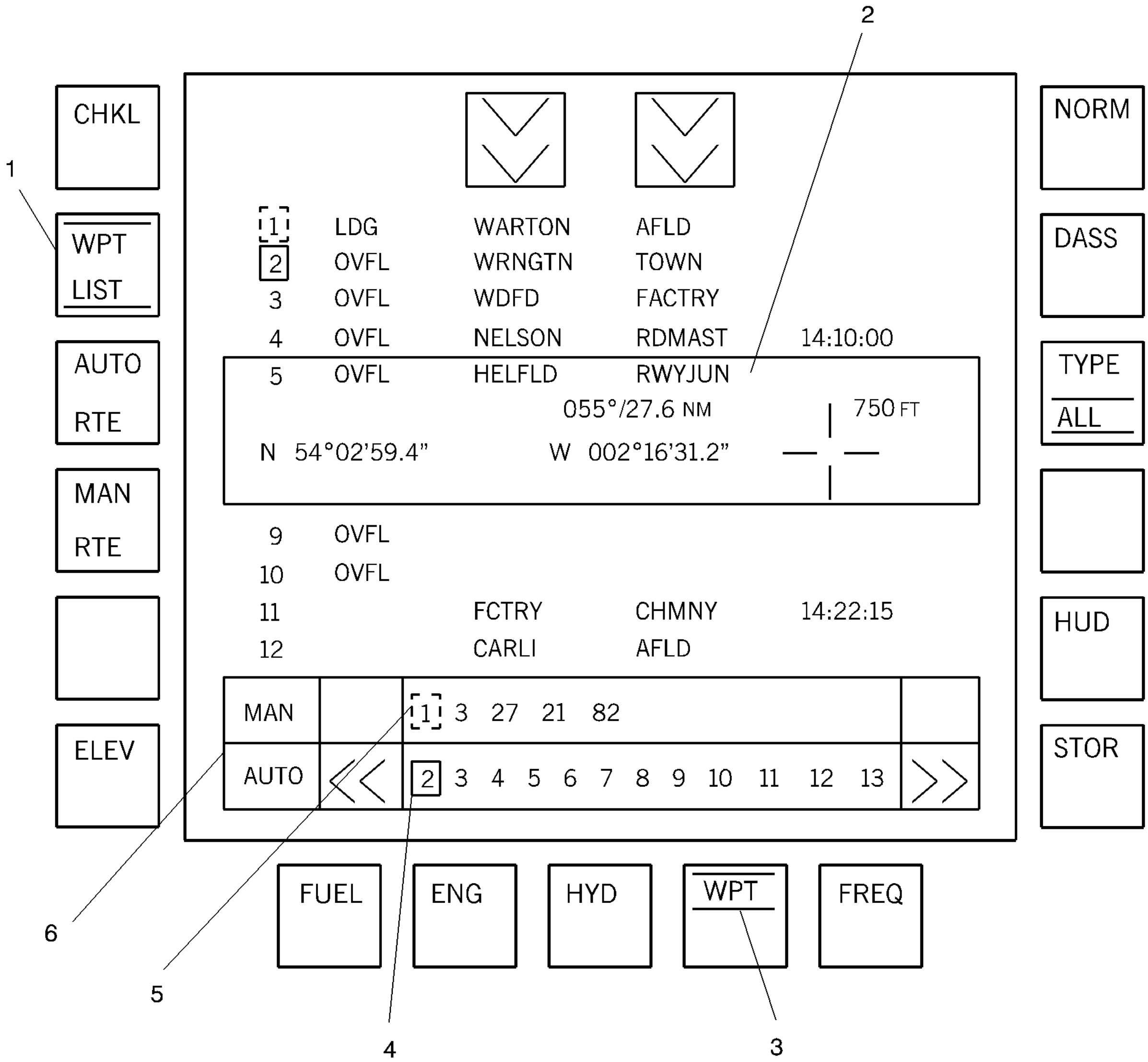
- The Navigation data block shown: waypoint number and type, direct range and bearing, time to go to overhead.
- Steering cue provides the required guidance to capture or maintain the required track.

In all phases, the Steering Cue command is limited by a simple schedule based on Calibrated Airspeed to ensure that the bank angle limit will allow maximum turning performance, avoiding an undesirable flight condition (e.g. buffet, stall, etc.).



1 MACH OR GROUND SPEED DISPLAY
2 DAS DISPLAYED
3 CURRENT TRACK
4 STEERING BUG
5 HEADING RIBBON
6 NEXT TRANCK AND DIRECTION OF TURN ARROW
7 AIRCRAFT SIMBOL
8 TIME TO-GO TO OVERFLY WAYPOINT
9 WEAPON STATUS BLOCK
10 WAYPOINT CROSS
11 VELOCITY VECTOR DIAMOND
12 WAYPOINT DATA BLOCK
13 ZERO DEGREE HORIZON BAR

Figure 1.110 - HUD Navigation Format



1 WPT LIST SOFT KEY
2 WAYPOINT EXPANDED INFORMATION BOX
3 WPT SOFT KEY
4 CURRENT DWP HIGHLIGHTED
5 NON-ACTIVE ROUTE JOIN WAYPOINT (JWP)
6 AUTO AND MANUAL ROUTE ROLS

Figure 1.111 - Waypoints Format with Extra Information

CLOSE NAVIGATION

Close Navigation phase is engaged when Time to go is ≤ 65 and include Time to go circle (counting down from 65 seconds), the waypoint cross (indicating the computed waypoint position in term of azimuth and elevation), an indication of the next planned track and the direction to turn to achieve it.

STEERING SELECTION

The pilot can select either route (AUTO/MAN route) for steering via the LHGS NAV SS key. The AUTO route is the default route (if available), if no other selection has been made, otherwise HOLD mode is engaged. On GND Pof just NWP and NNWP are initialized, if are part of a route.
Following Weight OFF Wheels transition the other steering parameters (Distance to go, Time to go steering mode, scheduled time enabled, etc.) are calculated as well. The system will automatically change from one DWP to the next one in the selected route according to the criteria of the Steering Law
When Track Acquire Steering is selected and DWP is OVERFLY the following segments will be engaged:

– Straight: It is the first segment of the leg and is initiated when the previous leg is over. The Command Track is defined as the Planned Track from the just acquired WP position to the NWP and will not be updated.
– Direct: is initiated after the Straight segment when Direct Range ≤ 5 NM or Planned Acquire Angle ≥ ± 50° (dependent upon the ratio between the Across Track Distance and the Distance Along Track). During the Direct segment the Command Track will be defined as the Direct Track from the A/C position to the NWP.
– Overfly: it is initiated after the Direct segment when Direct Range ≤ 2 NM. During the Overfly segment the Command Track is frozen to the last calculated Direct Track value and no longer updated.

When Track Acquire Steering is selected and DWP is ROUTE the following segment will be engaged:

– Straight: is the segment of the current leg unless the Planned Acquire Angle > ± 50 ° (dependent upon the ratio between the Across Track Distance and the Distance Along in this case DIRECT segment will be engaged.
  For the turn maneuver the pilot can choose between two different options:

  * Turn Radius Constant: in this option, the bank limit used for the computation of the RIP and required during the turn maneuver is that which achieves a constant turn radius of 2.5 NM. However, when the bank required for the constant turn radius is bigger than 60 ° or the altitude is greater than 20 000 ft, the turn radius will become variable and the RIP will be anticipated.
  * Turn Radius Variable: the bank angle limit demand depends on CAS and ranges from 30° to 60°. Therefore, the resulting turn radius of the maneuver for the new leg acquisition will vary with groundspeed and hence with altitude.

If Direct Steering is selected the following segments will be engaged:

– Direct: is the first segment of the leg. During the Direct segment the Command Track will be defined as the Direct Track from the A/C position to the NWP.
– Overfly: it is initiated after the Direct segment when Direct Range ≤ 2 NM. During the Overfly segment the Command Track is frozen to the last calculated Direct Track value and no longer updated.

In Direct Steering ROUTE Waypoint are considered OVERFLY Waypoint as well.

STEERING BUG CALCULATIONS

The steering azimuth commands to acquire and hold the planned track are calculated and displayed as a steering bug below the A/C heading ribbon as a displacement from the HUD azimuth centre line for manual steer of the pilot and on MHDD HD/HUD format. The steering bug provides azimuth guidance, based on calculation of a non-linear function of the error between the rate limited bank angle demand and the actual bank angle. The demanded bank angle is calculated according to an algorithm that takes into account FCS CAS data, align mode type, current phase of flight and steering type, with a limit value of 60°.
In order to acquire or reacquire the Command Track, the basic steering bug laws are:

– INTERCEPT phase, which aims to take the A/C to cross the Planned Track with a fixed value of 50°. The condition to entry in this law is the invalidity entry condition for the following two laws.
– ACQUIRE phase, which aims to direct the A/C into a nominally fixed bank angle turn such that the circular arc turn would be tangential to the Planned Track. The condition to entry in this law depends on a continually evaluated across track distance threshold value and the difference between the planned track angle and the A/C track angle.
– CAPTURE phase, which aims to direct and maintain the A/C onto the planned track. The

condition to entry in this law depends on a continually evaluated turn rate lesser than a demanded turn rate and the difference between the planned track angle and the A/C track angle.

REVERSIONARY NAVIGATION MODE

The navigation system automatically select the optimum Navigation Mode depending on the sensors available. The system is tolerant to failures. For example, if the LINS fails the system will continue to provide accurate navigation using mixed FCS and GPS data. If GPS data is unavailable, the system will use LINS only data, corrected by navigation computer. Manual fixing is also provided under failure condition.

The pilot may also manually select any Nav Mode, using the AIDS SSK and then select NAV MODE on Moding key. As well as in MDEF, the selected Nav Mode is indicated on the Autocue format and in the PP Extra Information box (selected by XY insert on the PP symbol) on the PA format.

In the existing configuration the Navigation System operates in six Nav Modes, in decreasing order of accuracy they are:

– Mode 1: LINS + GPS + KF (LINS GPS1 selected on Moding key, bars highlighted).
– Mode 3: LINS + OTF with KF Kalman Filter correction (LINS FIX1 selected on Moding key, bars highlighted).
– Mode 4: LINS +GPS (LINS GPS2 selected on Moding key, bars highlighted).
– Mode 5: LINS + OTF (LINS FIX2 selected on Moding key, bars highlighted).
– Mode 6: FCS + GPS (FCS GPS selected on Moding key, bars highlighted).
– Mode 8: FCS + OTF (FCS FIX selected on Moding key, bars highlighted).

Normally, the system will automatically select and operate in Nav Mode 1 “LINS GPS1” integrated via a Kalman Filter and no navigation system fixing by the pilot is required.

If the GPS is not valid (unhealty or NAV FOM greater than 4), “LINS GPS1” is frozen for a variable time depending upon LINS navigation integrity. In case GPS is lost, the system will automatically revert to Nav Mode 3 “LINS FIX1” where pilot fixing can be carried out to maintain system accuracy.

The LINS integrity is determined by comparison of LINS and GPS velocities in the NC, which produce the relevant Nav Mode in case the established thresholds are exceeded. When the GPS becomes not available , the integrity of the LINS data is checked against FCS attitudes only for 5 minutes.

Following LINS failure, Navigation Computer will engage secondary dead reckoning the navigation system will use attitude data from the Flight Control System (FCS) and the Nav Mode 6 “FCS GPS” will be automatically selected. If the GPS is not available, the navigation system revert on Nav Mode 8 “FCS FIX”.

If the Kalman Filter is lost or not calculated, “LINS GPS2” is engaged. In case of GPS failure the Navigation Computer will revert to Nav Mode 5 “LINS FIX 2”.

The pilot may select any navigation mode at any time using the “NAV MODE” function in the AIDS SSK, in according to the availabilitiy of sensors

Attitude and heading from the secondary dead reckoning sensor (FCS) are less accurate then those supplied by the LINS.

The Navigation System in the case of total failure includes a Get You Home(GUH) instruments.

LASER INERTIAL NAVIGATOR SYSTEM (LINS)

The main purpose of the Laser Inertial Navigator System (LINS) is to provide the primary source of information for navigation parameters:

– Present Position (LAT, LONG);
– True Heading;
– Magnetic Variation;
– Magnetic Heading;
– Bank;
– Inclination;
– Climb/Dive Angles;
– Velocities;
– Body Angular Rates;
– Baro-IN Altitude;
– Accelerations.

MODES OF OPERATIONS

The LINS sends/receives its output/input information by means of a dual redundant digital Data Bus. It operates as a Remote Terminal on the Attack Bus.

The LINS is activated as soon as AC and DC power are available. When the LINS is energized, it performs a Power-Up BIT (about 8 ÷ 10 sec). After successful completion of the Power-Up BIT, the LINS automatically enters the Normal Alignment mode (gyro-compass) using the required data have been loaded via PDS or GLU, or using the stored Present Position (PP), or PP inserted by pilot or GPS positions.

The LINS requires accurate initial position data, standard baro altitude from FCS to stabilize its vertical channel.

The LINS alignment status is displayed on the MHDD Autocue format and HUD, and is shown in

terms of the LINS position drift rate in nautical miles per hour (CEP) and time to go in alignment.
The displayed position drift rate decreases as the alignment progresses and when the specified acceptable performance level is attained a " LINS READY" caption is displayed on the Autocue format and HUD. When the Alignment is completed (with full performance i.e. 0.8 NM/h), the pilot can enter LINS in the Navigation mode by setting the relevant button NAV SEL on the MHDD, or automatically via aircraft movement, so that NC will engage LINS GPS 1.

NOTE

If the LINS is entered/commanded the NAV mode due to aircraft movement or manually entered by the pilot, with AVs SP3A onwards, is possible to refine the alignment performed previously, by pulling the Park Brake when LINS is in Navigate state.

ALIGNMENT MODES

The LINS performs an alignment procedure according to the type of alignment selected. Selection of a particular alignment mode is made either by an input from PDS or GLU which provides an automatic trigger to the system, or by a manual selection of an soft key on the Autocue format.
Three alignment modes are available on PoF “GND”:

– Normal/Full Gyrocompass Alignment;
– Memorized Heading Alignment;
– Rapid Heading Alignment (HUD);

In order to achieve alignment, LINS can execute Incremental Alignment, Restart and Refinement Alignment.

– Incremental Alignment;
– Alignment Restart;
– Alignment Refinement

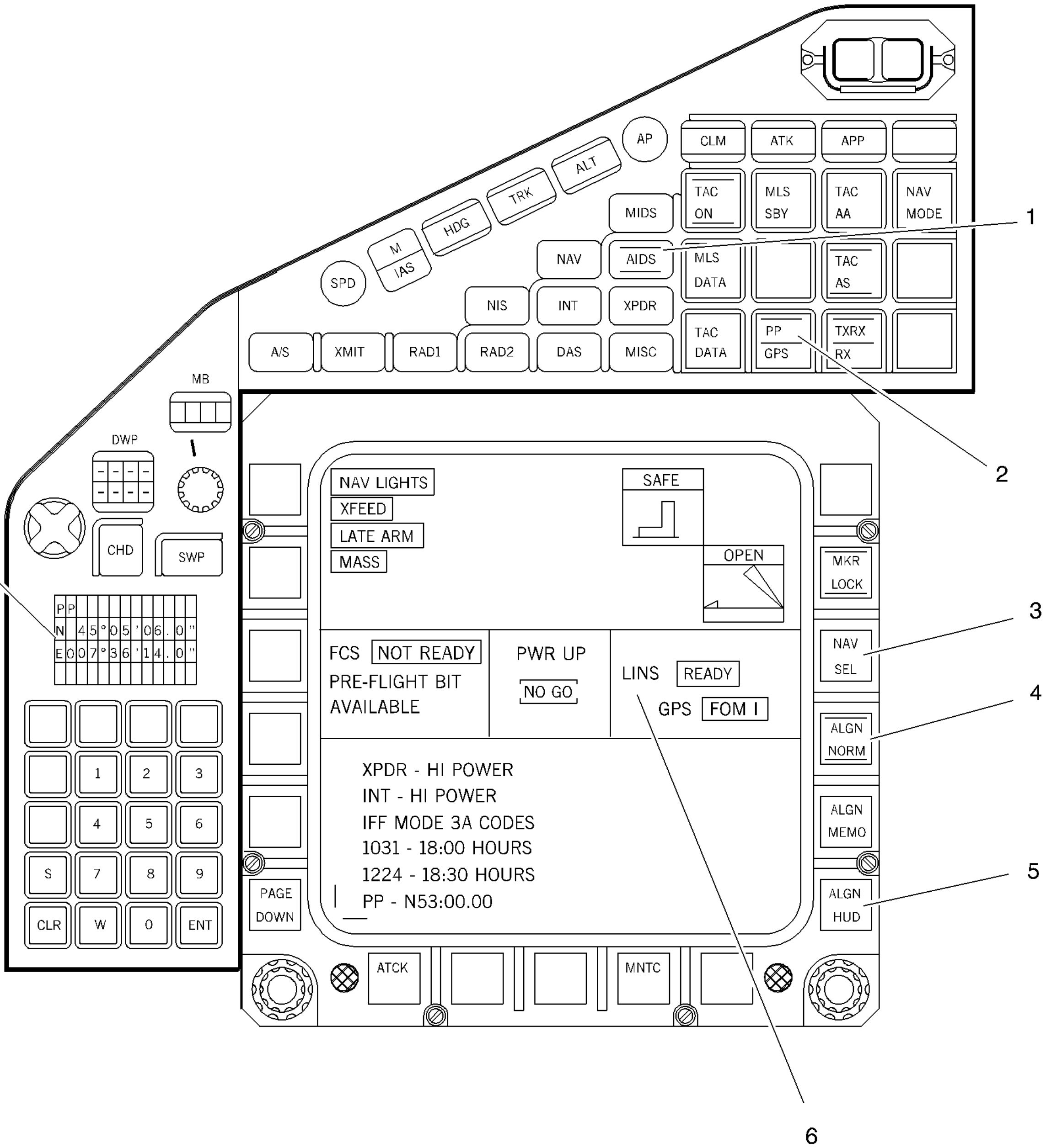
NORMAL/FULL GYROCOMPASS ALIGNMENT

The Normal Alignment mode is used when the reaction time is not critical. It is an automatic self-contained process to determine Local Vertical and Heading. The duration of this mode does not exceed 4 minutes. When the LINS is activated and the normal alignment is initiated, and the PDS or GLU data is unavailable, fails to load or the pilot wishes to alter the PDS position data then PP must be manually enter via the MDEF (AIDS - PP - keyboard). If the local PP is not entered, the LINS will use the last stored Present Position (PP) whose performance is assumed to be affected by an error. In this case, the Alignment Error on Autocue will be stopped at 4 NM/h, the output IN-Present Position-Dval will be set Invalid as a safety measure and the equipment will not be used for navigation purpose.
LINS needs the Standard Baro Altitude input valid from FCS in order to stabilize its vertical channel. If the Standard Baro Altitude becomes invalid for more than 5 minutes, LINS will declare invalid the vertical channel.
When the Standard Baro Altitude is valid again, LINS will reacquire its vertical channel after 90 sec.

NOTE

Each time a gyrocompass alignment is requested to the LINS, the Present Position must be entered by the pilot even if it is the same position on which the LINS is aligning, otherwise NAV ALIGN Status will not reach the value of 0.8 NM and lat/long will be set INVALID by the LINS.

The pilot can enter aircraft Present Position (PP) only with weight-on-wheels and Phase of Flight (PoF) GND.
During this procedure the Navigation System displays the data related to the LINS alignment phase on the MHDD Autocue format, see Figure 1.112.



1 AIDS SSK CONFIGURED TO ENTER PP
2 PP SOFT KEY
3 LINS NAV/ALIGN MODE SELECT KEY
4 ALIGN NORM SOFT KEY
5 HUD ALIGNMENT SOFT KEY
6 LINS STATUS
7 ROLS FOR PP DATA INPUT

Figure 1.112 - MHDD Autocue Format - LINS Alignment

Ensure that the "ALIGN" indication and "ALGN NORM" soft key is illuminated on the Autocue format is present. The Alignment error decreases as the alignment progresses and when the specified acceptable performance level is attained a "LINS READY" caption is displayed on MHDD and HUD. Within 240 seconds verify the "LINS READY" indication is present, the time is "0" and the "ALIGN" error is "0.8 NM/H", the LINS is ready to navigate. The LINS automatically enters NAVigate mode on aircraft movement or by pilot selection pressing the NAV SEL soft key.

MEMORIZED HEADING ALIGNMENT

Memorized heading alignment takes the last recorded values of present position and heading recorded prior to system shutdown and uses these stored values as the start points for a rapid gyrocompass alignment, taking approximately 30 seconds. This mode of alignment provides the specified performance if the following conditions are met:

- a full Gyrocompass Alignment has been performed before shut-down of the system;
- after Gyrocompass Alignment, a controlled Power-down has been performed without entering the LINS NAV mode;
- the aircraft has not been moved from the last OFF-Mode.

To perform memo HDG, press "ALGN-NORM" soft key on the Autocue format, or commanded via PDS/GLU. After 30 seconds "LINS READY" and "ALIGN" error "0.8" is displayed.

RAPID HEADING ALIGNMENT (HUD) ALIGNMENT

This alignment type requires an accurate PP and reference object bearing or coordinates provided by PDS/GLU to the system when the pilot initiates HUD alignment. The system aligns the platform to the true bearing of an object within the HUD FoV as datum for a rapid alignment.

Upon HUD alignment selection on MHDD Autocue format, the navigation computer provides to the LINS the current heading, derived from PP and bearing/coordinates of a reference point. Offset between reference point and the aircraft will be provided by placing XY marker (on HUD) on reference point and pressing the XY Controller.

After 30 seconds "LINS READY" and "ALIGN" error "0.8" is displayed.

REFINEMENT ALIGNMENT

Refinement Alignment occurs when an alignment is completed successfully (LINS error < 0.8 NM/h), LINS did not exceed 10 minutes of navigate state and/or a velocity of 50 knots. In this case pulling the PARK BRAKE, the alignment reentry will be performed to obtain the best possible alignment before take off.

INCREMENTAL ALIGNMENT

In case LINS, during alignment case, enters in navigate state (manually or by A/C movement) with time to NAV less than 150 sec., pulling PARK BRAKE will allow LINS exiting from Navigate state and continuing alignment from it has been stopped.

ALIGNMENT RESTART

LINS will be capable to perform a new alignment (full gyrocompass) without need of resetting the equipments via the circuit breakers (CBs). To do this the following procedure has to be followed:

- Before Take Off:

  1. PARK BRK in ON position
  2. LINS in navigate state, NAV SEL boxed on Autocue format
  3. Time to NAV is greater than 150 sec. , on HUD and HDHUD
  4. NAV SEL press on Autocue format
  5. Enter local Initial Position (IP) within 45 seconds
  6. LINS will align on the new IP just entered
  7. In case IP is not entered and GPS is available with FOM = 1, LINS will align, commanded by navigation computer, on GPS position.

- After Landing (Weight-On-Wheel has been detected) or Taxi Exceeding 50 kts of groundspeed:

  1. PARK BRK in ON position
  2. LINS in navigate state, NAV SEL boxed on Autocue format
  3. NAV SEL press on Autocue format
  4. Enter local Initial Position (IP) within 45 seconds
  5. LINS will align on the new IP just entered
  6. In case IP is not entered and GPS is available with FOM = 1, LINS will align, commanded by navigation computer, on GPS position.

FAILURE OF LINS

The pilot is immediately alerted by flashing Attention Getters and a flashing amber "LINS" caption on the DWP. An Attenson (cat. 3) and voice warning message "Inertial Nav" is also heard by the pilot in the headset.

In case of LINS failure the system will engage reversionary navigation modes FCS GPS or FCS FIX.

IN FLIGHT ALIGNMENT

This mode shall permit the to align during flight. The purpose of the In Flight Alignment is to Align the LINS outputs in order to achieve the full accuracy (1 NM/h CEP) during Navigation Mode.
In Flight Alignment shall be commanded only when Weight On Wheel is OFF.

NAVIGATION COMPUTER

The Navigation Computer (NC) uses data from the on-board sensors, to compute Best Navigation Data based on the NAV Mode available. The NAV Mode depends by the sensor health, data validity, the pilot manual selection can overwrite the automatic assignment. From these data the NC calculates navigation steering parameters and general navigation data.
The Navigation Computer (NC) shall have the purpose of managing and controlling Avionic and Attack Serial Digital buses (EFABUS), acting as primary Bus Controller for the Avionic databus (AVS) and as reversionary Bus Controller for the Attack databus.
In normal mode of operation, the NC performs the AVS bus LRIs Health monitor in order to provide information for bus LRIs NOGO generation, Master/ Slave management of redundant LRIs (CIU, CSG,SCAC, NSCAC), LRIs IBIT monitor and synchronize all the system databuses. When the NC operates in reversionary mode it performs also the ATK bus LRIs Health and IBIT monitoring.
If the NC fails as Bus Controller on the Avionic bus, the bus controlling functions are taken over by the Attack Computer. If the AC fails as Bus Controller on the Attack bus, the bus controlling functions are taken over by the Navigation Computer.
The Attack Computer (AC) and the Navigation Computer (NC) are identical from a hardware point of view, here in after called Attack/Navigation Computers (AC/NC).
The Navigation Computer is powered from the 115V AC XP2 busbar.

GLOBAL POSITIONING SYSTEM (GPS)

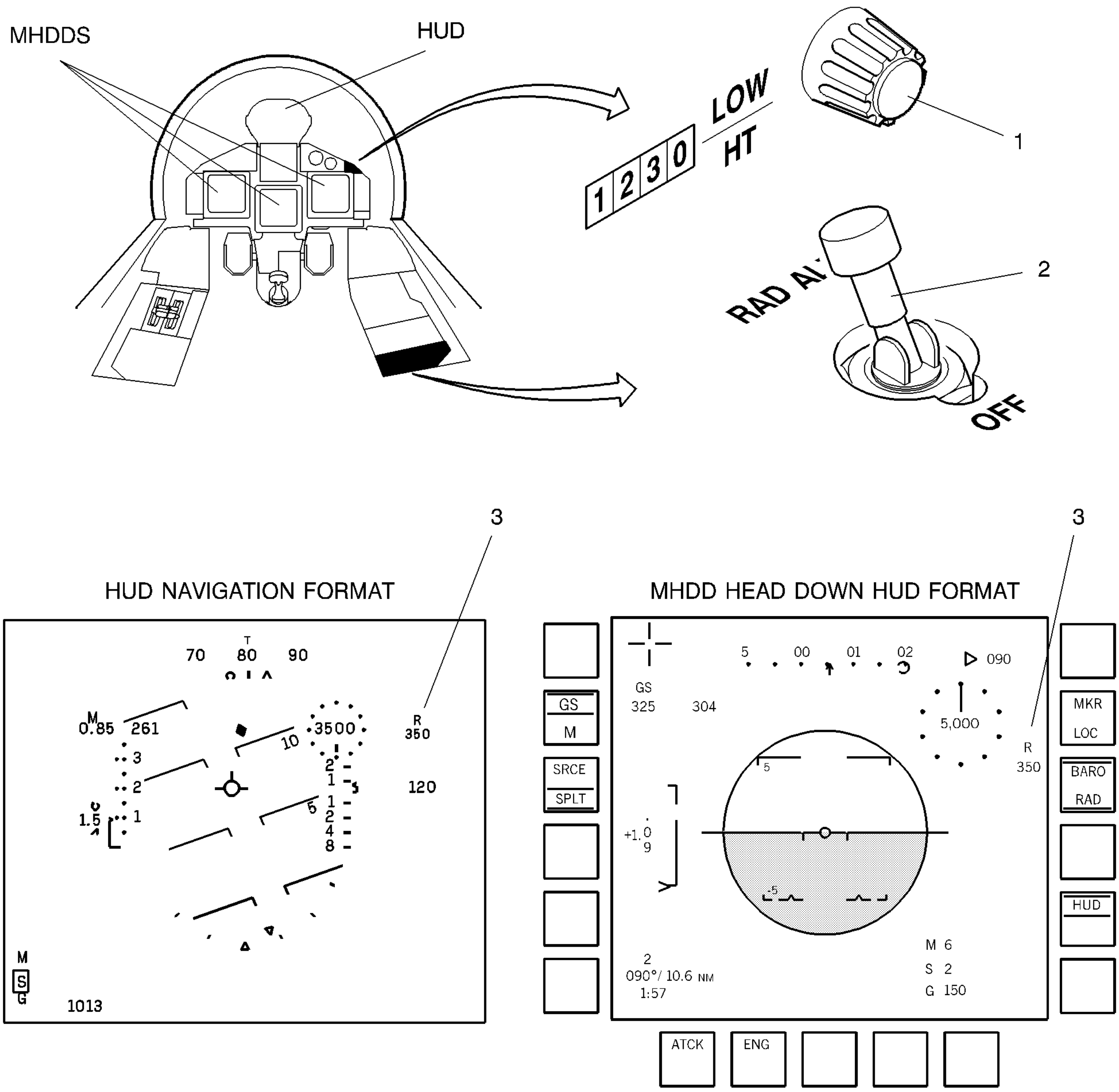
The main purpose of the Global Positioning System Upgradable (GPSU) is to provide the following navigation functions: Present Position, Altitude, Velocity (north, east and vertical), UTC Time and Climb and Dive angle.
The GPSU is capable to operate in adverse jamming and spoofing environments, its consists of Navigation System Unit (NSU), Antenna Electronic Unit (AEU), Antenna Set (AS, either ASS for single seater or AST for twin seater aircraft).
On power up, the NSU automatically perform a PBIT and the GPSU Navigate mode (NAV mode) is selected automatically whenever the initialisation mode has been completed.
The GPSU initialisation requires position. Lacking the GPSU initialization data the receiver uses the last stored data.
In normal operation, the GPSU criptovariables are stored in non-volatile memory and a real time clock continues to maintain time when the GPSU receiver is switched off. On power up, the GPSU will search for available satellites and establish tracking: knowledge of present position (PP) at start up speed up this search.
The GPSU external aiding data are provided from either or both the LINS as primary and FCS secondary aiding data, to enhance the GPS acquisition/re-acquisition performance.
The “NAV mode” entered when the initialization mode is completed, the GPSU will search for acquires and tracks the NAVSTAR GPS satellites signals so as to calculate from them and make available to the aircraft systems, present position (PP), Velocities UTC time and Climb/Dive Angle; the navigation solution to complete the satellite constellation tracking, will be achieved within 5 minutes. At all times on the ground, GPS Figure of Merit (FoM) is displayed on the MHDD Autocue format. With FoM that it corresponds to green colour between 1 and 4, the navigation system will use GPS data in calculating PP; if FoM that it corresponds to amber colour is more than 4, the GPSU is considered unreliable.
The GPSU is capable of tracking up to five satellites, but the precise carrier track is maintained on four satellites signals so as to calculate from them and make available to the aircraft systems, PP, Climb/ Dive Angle and Velocities.
The GPSU provide built-in test (BIT) facilities which are used to monitor AEU and NSU functions during flight and ground.
There are three types of BIT:

– Power-up BIT
– Continuous BIT
– Initiated BIT

In the event of a GPSU failure, in all PoF, the pilot is immediately alerted by Attention Getters and "GPS" caption amber flash on the DWP and an Attenson (CAT 3) and voice warning message "GPS" is heard by the pilot in the headset.

RADAR ALTIMETER (RA)

The Radar Altimeter (RA) system is integrated into the Navigation Subsystem. It consists of three Line Replaceable Items: a Transmitter/Receiver, a Transmitter Antenna and a Receiver Antenna. The function of the RA system is to measure, the local height between the aircraft and any type of terrain currently being overflown (built-up areas, desert, snow, sea, etc.) up to a maximum of 5000 ft. Height data is routed on the aircraft data bus and displayed to the pilot on the HUD and on the MHDD HDHUD format, see Figure 1.113.



1 RADAR ALTIMETER CLEARANCE HEIGHT SETTING CONTROL AND DISPLAY
2 RADAR ALTIMETER TRANSMISSION CONTROL SWITCH
3 RADAR ALTIMETER HEIGHT INDICATION

Figure 1.113 - Radar Altimeter Controls and Displays

NOTE

> The low height warning must not be used as the sole indication of closure with terrain.

In addition to the information presented to the pilot, the height calculated by the RA is also used as input data by the Navigation Computing system.

OPERATING MODES

The RA has two main operating modes: STAND-BY and TRANSMIT. In the STAND-BY mode, power is applied but transmission is inhibited. In the TRANSMIT mode, the full cycle of search, track and memory sub-modes (see below) are active. On power up, a power-up BIT is performed, following which the system goes into the STAND-BY Mode. When the Radar Altimeter Transmit receives a transmit command via the Data Bus, the Radar Altimeter equipment performs a subset of the start-up BIT. If no failures are detected and the aircraft is in the above mentioned operating limits the RA enters into TRANSMIT mode. The TRANSMIT mode has three sub-modes: search, track and memory. The system starts in "search" mode in order to acquire the initial lock, and subsequently goes to "track" mode automatically, providing perceived height above the surface. In the event of a temporary loss of lock, the last valid height is provided by the "memory" mode for up to 1 second. If the loss of lock persists for more than 1 second, the system reverts to the "search" mode again. To ensure correct operation in all flight conditions, transmitter power is varied as a function of the perceived height (also for stealth reason i.e. transmitter power is minimized depending on terrain return).

SELF-TEST FACILITY

The built-in test (BIT) facilities contained within the RA consist of software modules resident on the processor modules, and appropriate BIT circuitry to test and check the RA modules. These modules test the RA internal circuits to detect a failure, to identify its location.

There are three types of BIT:

- Power-up BIT
- Continuous BIT
- Initiated BIT

RADAR ALTIMETER CONTROLS AND INDICATIONS

RADAR ALTIMETER CLEARANCE HEIGHT SETTING CONTROL AND DISPLAY

Height clearance can be set using the RA Clearance Height setting control labelled "LOW HT" located on the right glareshield of the cockpit. When the aircraft descends below the selected clearance height, the warning facility activates a CAT1 audio/visual warning to the pilot, consisting of flashing Attention Getters accompanied by a voice warning message "Low Height". In addition a pull-up indication is displayed on HUD format. The selected value is displayed on a 4-digit display and can be increased by clockwise rotation or decreased by counterclockwise rotation of the LOW HT control. Three levels of resolution for RA height readout automatically provide greater precision by decreasing the interval between successive height steps as height above terrain decreases:

- 0 thru 200 ft: in increments of 10 ft
- 1000 thru 5000 ft: in increments of 100 ft

RADAR ALTIMETER TRANSMITTER SWITCH

The Radar Altimeter Transmitter Switch controls operation of the RA. It is labelled "RAD ALT / OFF" and is located towards the rear of the right hand console of front cockpit. The switch is physically protected in the OFF position in order to prevent accidental selection. The switch shaft must be pulled up before OFF can be selected. The switch functions are indicated below:

- RAD ALT (forward position). When selected, the RA operates and transmits normally
- OFF (rearward position). When selected, the RA does not transmit

The transmit inhibition of the RA it is also possible via XMIT SSK on MDEF and/or automatically via NC when attitudes or attitudes rates data exceed specified thresholds.
In this case the inhibition remains in force until the aircraft attitude returns within the limit.

PDU HUD NAVIGATION FORMAT

The Pilot Display Unit (PDU) on the cockpit, displays the local height between the aircraft and ground as measured by the Radar Altimeter.

MHDD HEAD DOWN HEAD UP DISPLAY (HDHUD) FORMAT

The Head Down Head Up Display (HDHUD) format enables the pilot to monitor the perceived height by the Radar Altimeter, displayed on the MHDDs.

FAILURE OF THE RADAR ALTIMETER

In the event of a Radar Altimeter failure the pilot is immediately alerted by Attention Getters and "RAD ALT" caption amber flash on the DWP and an Attenson (CAT 3) and voice warning message "Rad Alt" is heard by the pilot in the headset. The pilot must climb to a safe height above the local terrain and use the barometric altitude displayed on the HUD and MHDDs for any altitude (sea level related) information.
The CAT 1 audio/visual LOW HT warning facility "Low Height" is lost.
The CAT 4 audio Landing Gear not Lowered warning facility "Landing Gear" is lost.

TACAN

The tactical air navigation (TACAN) system is a radio navigational aid. The equipment consists of two antennas, a transmitter/receiver unit and an antenna switching unit. Control is via the manual data entry (MDE) facility. The locations of the transmitter/receiver unit, antenna switching unit and antennas are shown in Figure 1.114. The MDE facility is located on the left glareshield in the cockpit.
The TACAN equipment provides bearing and range information when operated in conjunction with a selected TACAN ground station. Bearing and range information is displayed on the MHDD/PA format. Bearing and range information, TACAN channel number, type and mode (Air-to-Surface or Air-to-Air) is displayed on the MHDD/HSI format. The currently selected TACAN channel number and type is displayed on the right glareshield flap.

TACAN SYSTEM CONTROLS AND INDICATIONS

The MIDS switch is used to operate the TACAN and is located on a switch panel, to the rear of the right console in the front cockpit. In the MIDS position the TACAN operates in Transmit/Receive mode. In the OFF position the TACAN operates in receive mode only. TACAN volume is adjusted using a rotary volume control located on the left console in both cockpits. For information on the controls/indicators and operation of the TACAN system, refer to Data Modules:

- Electronic Displays and Controls (MDE)
- Navigation MDE and X-Y Functions pag. 278.

A built-in test (BIT) is initiated upon the TACAN equipment on aircraft power-up and, following a 3 minute warm-up period, full TACAN performance is achieved. Failure of the system in flight, detected by continuous BIT, is indicated by the warning system, refer to Data Modules:

- Dedicated Warning Panel pag. 375.
- Visual/Audio Warnings pag. 377.

MODES OF OPERATION

The TACAN system has two modes of operation; receive mode and transmit/receive mode.

RECEIVE MODE

In the receive mode, the aircraft equipment uses the TACAN ground based transmissions to obtain bearing information only which is displayed on the MHDD/PA and MHDD/HSI formats.

TRANSMIT/RECEIVE MODE

In the transmit/receive mode, the TACAN transmits interrogation pulses, which are transponded by the selected TACAN beacon. The beacon may be under interrogation from a number of aircraft, causing simultaneous transmission of multiple replies. The aircraft receiver examines these replies and accepts only that reply which is relative to the transmitted pulses; the resulting bearing and range information is displayed on the MHDD/PA and MHDD/HSI formats.

ANTENNA SWITCHING

The antenna switching unit automatically selects the antenna receiving the strongest signal.

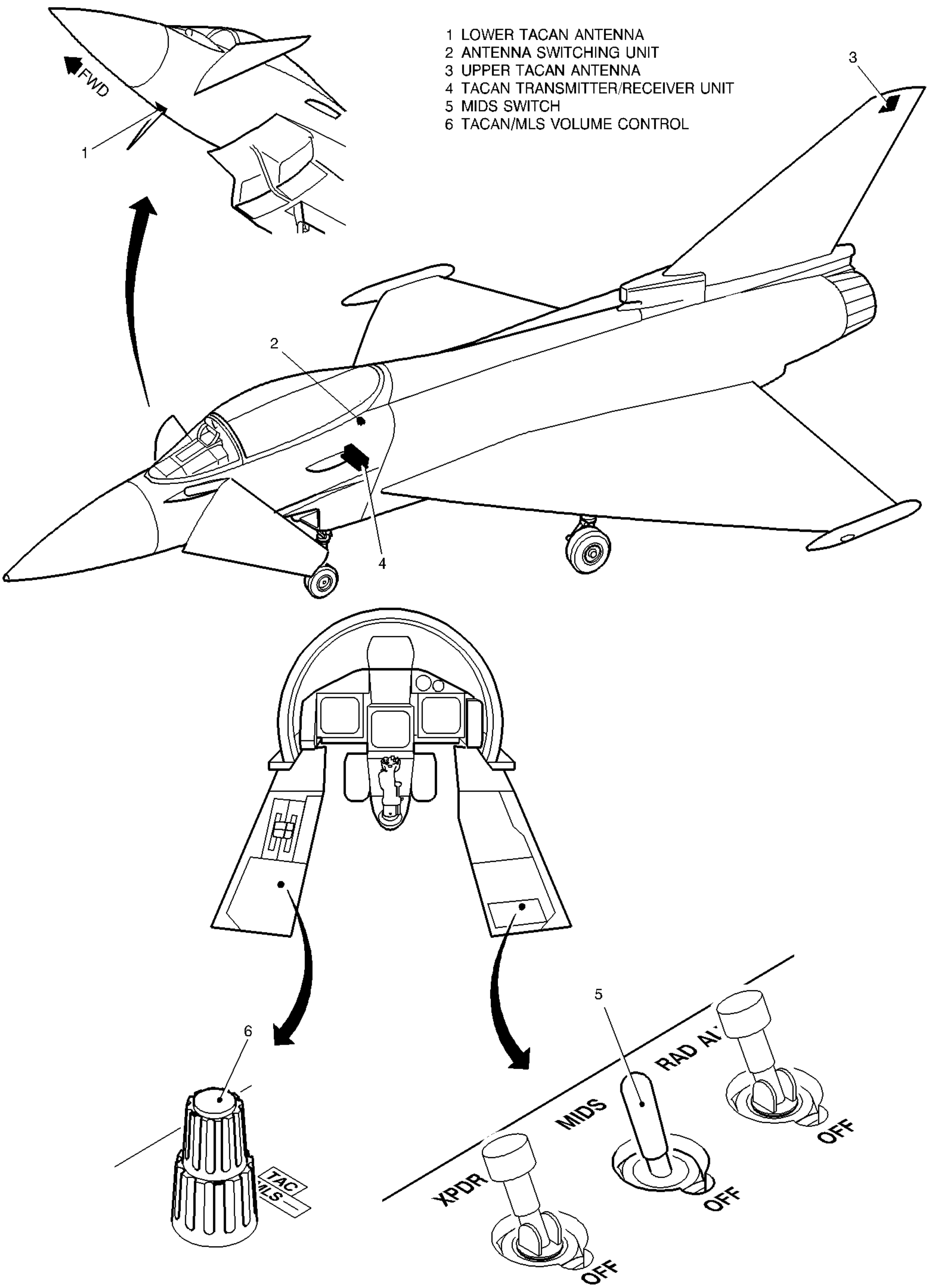


Figure 1.114 - TACAN Equipment

NAVIGATION MDE AND X-Y FUNCTIONS

The Manual Data Entry Facility (MDEF) allows data to be manually entered and manipulated within the aircraft avionics subsystems. The selections available within this facility which are relevant to the Navigation subsystem are grouped within the following MDEF subsystems:

– Navigation Aids (AIDS)
– Navigation (NAV)
– Set Waypoint (SWP)

In some instances the pilot has the option to enter and manipulate data in combination with the X-Y controller.

The X-Y controller may also be used in isolation to perform specific functions.

For information on the operation of the X-Y controller, refer to Electronic Displays and Controls - VTAS pag. 37 (for single seat aircraft), or (for twin seat aircraft).

NAVIGATION AIDS SUBSYSTEM

When selected the modes/data entry tasks of the Navigation Aids subsystem (AIDS SS) are displayed on the moding keys (Figure 1.115 shows the default selections) and the crew are able to perform the following tasks:

– View the current and/or input a new aircraft Present Position (Figure 1.116)
– Input Global Positioning System (GPS) initialization data (Figure 1.117)
– Initiate Laser Inertial Navigation System (LINS) alignment (Figure 1.118)
– Initiate LINS airborne alignment mode (Figure 1.119)
– Select the use of available navigation source data as opposed to using automatically selected best available data (Figure 1.120)
– Select the TACAN between on and standby, and select between TACAN Air-to-Air mode and TACAN Air-to-Surface mode (Figure 1.121)
– Input a new TACAN channel (Figure 1.122)
– Edit TACAN channel (Figure 1.123)
– Select to use TACAN in transmit/receive mode or receive mode only (Figure 1.124).

NAVIGATION SUBSYSTEM

When selected the modes/data entry tasks of the Navigation subsystem (NAV SS) are displayed on the moding keys (Figure 1.125 shows the default selections) and the crew are able to perform the following functions:

– Input Manual Wind data and select between system derived wind data and manually input wind data (Figure 1.126)
– Select between the Automatic and Manual routes (Figure 1.127)
– Create/edit the manual route, defining waypoints in either the Latitude/Longitude or the Geographical Reference Positioning systems (Figure 1.128, Figure 1.129, Figure 1.130, Figure 1.131)
– Delete the contents of the Manual route (Figure 1.132)
– Reverse the order of the route currently selected to be flown (Figure 1.133)
– Change destination so that the previous Destination Waypoint (DWP) becomes the current DWP (Figure 1.134)
– Select between track and direct steering (Figure 1.135)
– Maintain (Hold) current track (Figure 1.136)
– Define a new track from Present Position (PP) to the current DWP (Figure 1.137)

On selection of the NAV SS the MHDD/Waypoint (WPT) format is automatically presented on the Group C head (right MHDD, by default) and all paired waypoints and route lines that fall within the selected coverage area are shown on the MHDD/PA format.

SET WAYPOINT SUBSYSTEM

When selected the modes/data entry tasks of the Set Waypoint subsystem (SWP SS) are displayed on the moding keys (Figure 1.138 shows the default selections) and the crew are able to perform the following functions:

– Create new waypoints and edit existing waypoints (Figure 1.139)
– Delete waypoints (Figure 1.140)
– Create a MARK waypoint at present position (Figure 1.141)
– Draw a line from a waypoint on the PA format (Figure 1.142)
– Define a new Bullseye position (Figure 1.143)
– Edit Fighter Area of Responsibility (FAOR) information (Figure 1.144)

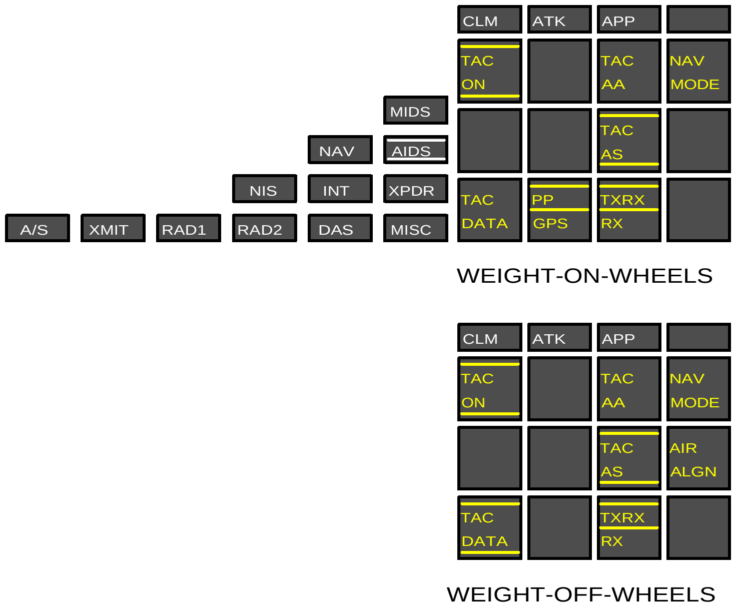
While the SWP SS is selected all paired waypoints in the PA area of coverage are displayed on the MHDD/PA format.

X-Y FUNCTIONALITY

The following functions are available via the X-Y controller:

– Page waypoints list (Figure 1.145)
– Display extra data on waypoints on the MHDD/WPT format (Figure 1.146)

- Copy waypoints (Figure 1.147)
- Move waypoints (Figure 1.148)
- Remove waypoints from the route ROL (Figure 1.149)
- Scroll route ROL (Figure 1.150)
- Reset route ROL (Figure 1.151)
- Select ‘Window-on-the-World’ (Figure 1.152)
- Change the range scale (Figure 1.153)
- Display extra data on waypoints on the MHDD/ PA format (Figure 1.154)
- Display the groundspeed indication (Figure 1.155)
- Display the time early/late error (Figure 1.156)
- Select between UTC time and Mission time (Figure 1.157)
- Perform an On-top fix (Figure 1.158)
- Display extra data on present position (Figure 1.159)
- Select the Bullseye grid for display (Figure 1.160)
- Select between Range, GEOREF and L/L grids and select between the two available DMG color palettes (Figure 1.161)
- Display a zoom picture (Figure 1.162).

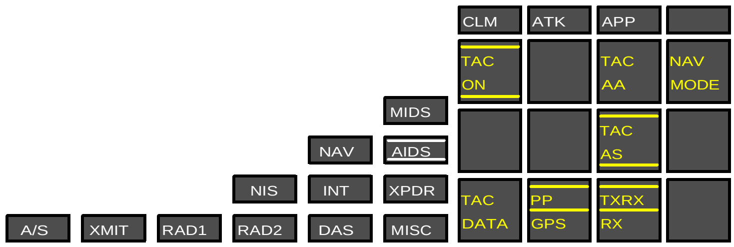


NOTE

1. THE **AIR ALGN** OPTION BECOMES AVAILABLE PROVIDED NAV POF IS ENTERED, WEIGHT-OFF-WHEELS AND GPS FOM IS LESS THAN OR EQUAL TO 4.

2. WHEN WEIGHT-OFF WHEELS THE **PP/GPS** OPTION IS OCCULTED.

Figure 1.115 - Navigation AIDS Subsystem Default Moding



PRESS THE **AIDS** SSK.

↓

PP IS SELECTED BY DEFAULT DURING THE LINS ALIGNMENT PROCEDURE.

↓

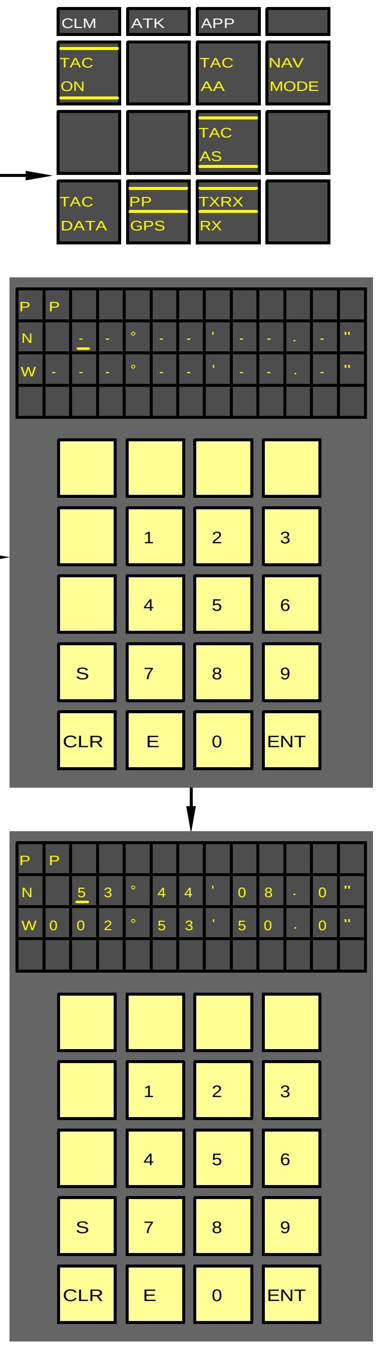
IF PP IS HELD IN NON VOLATILE MEMORY OR HAS BEEN LOADED VIA PDS, IT IS DISPLAYED IN THE ROL AND MAY BE EDITED VIA THE DEK.

↓

IF NO PRESENT POSITION DATA EXISTS IT MAY BE ENTERED VIA THE DEK.

↓

PRESS **ENT** TO CONFIRM NEW PP DATA.



NOTE

THE **PP** OPTION IS ONLY AVAILABLE IF THE FOLLOWING CONDITIONS ARE MET:

- WEIGHT-ON-WHEELS
- LINS IN ALIGNMENT MODE.

Figure 1.116 - Present Position Insertion

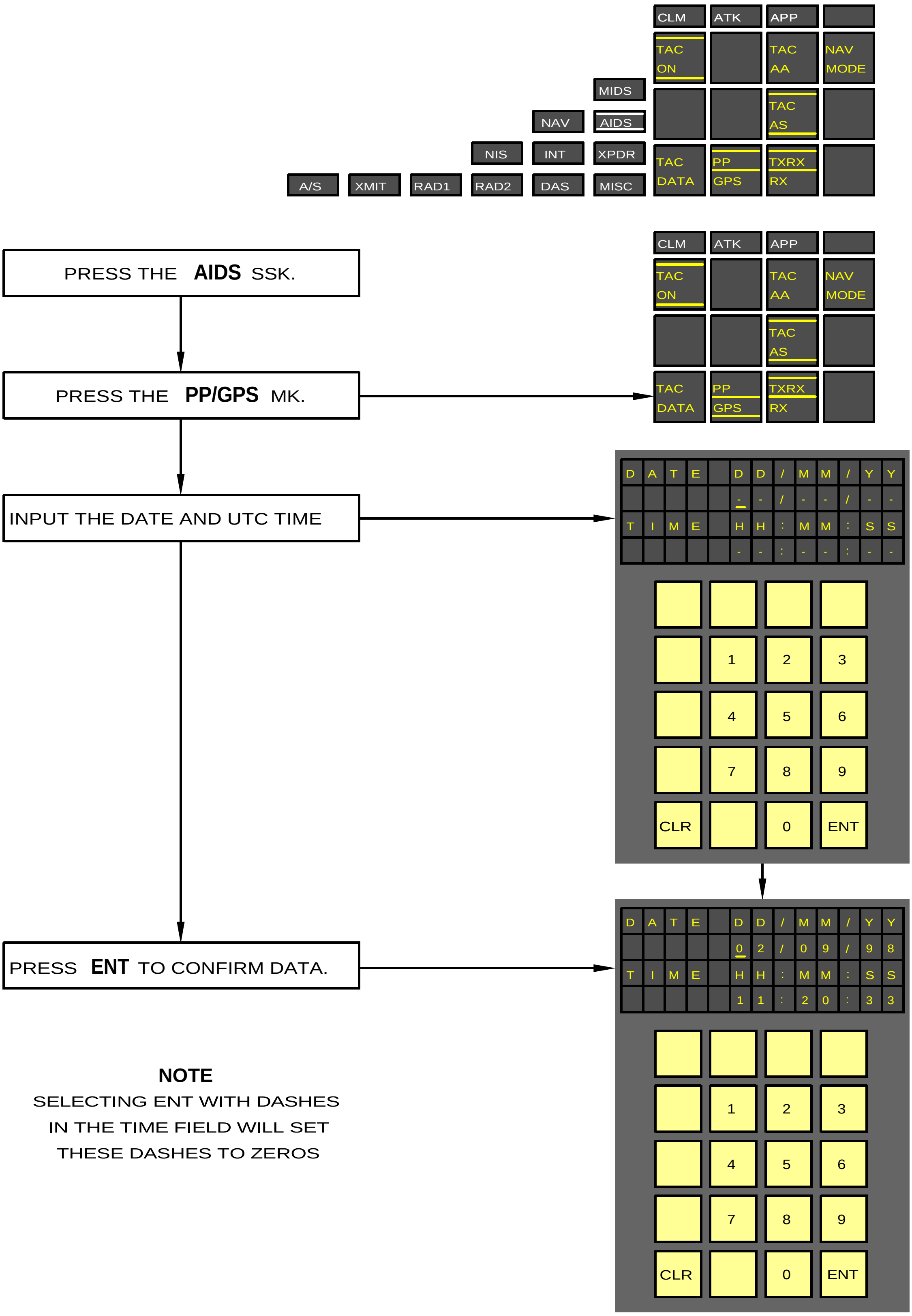


Figure 1.117 - GPS Initialization

POSITION THE AIRCRAFT AT A POINT ON THE AIRFIELD WHOSE CO-ORDINATES ARE KNOWN.

↓

ENTER PRESENT POSITION DATA IF NECESSARY (FIG 2).

↓

FROM THIS POSITION ORIENTATE THE AIRCRAFT SO THAT A LOCAL LANDMARK (WHOSE CO-ORDINATES OR BEARING (RELATIVE TO PP) ARE STORED IN THE SYSTEM) CAN BE SEEN WITHIN THE HUD FIELD OF VIEW.

↓

SELECT THE **ALGN HUD** SK ON THE **AUTO CUE** FORMAT. →

↓

A HEADING ALIGNMENT CROSS IS PRESENTED ON THE HUD.

↓

USING THE X-Y CONTROLLER SLEW HEADING ALIGNMENT CROSS TO OVERLAY THE LANDMARK AND PERFORM A SINGLE X-Y INSERT.

↓

TRUE HEADING IS CALCULATED BY THE SYSTEM AND USED TO ASSIST THE RAPID ALIGNMENT OF THE LINS.

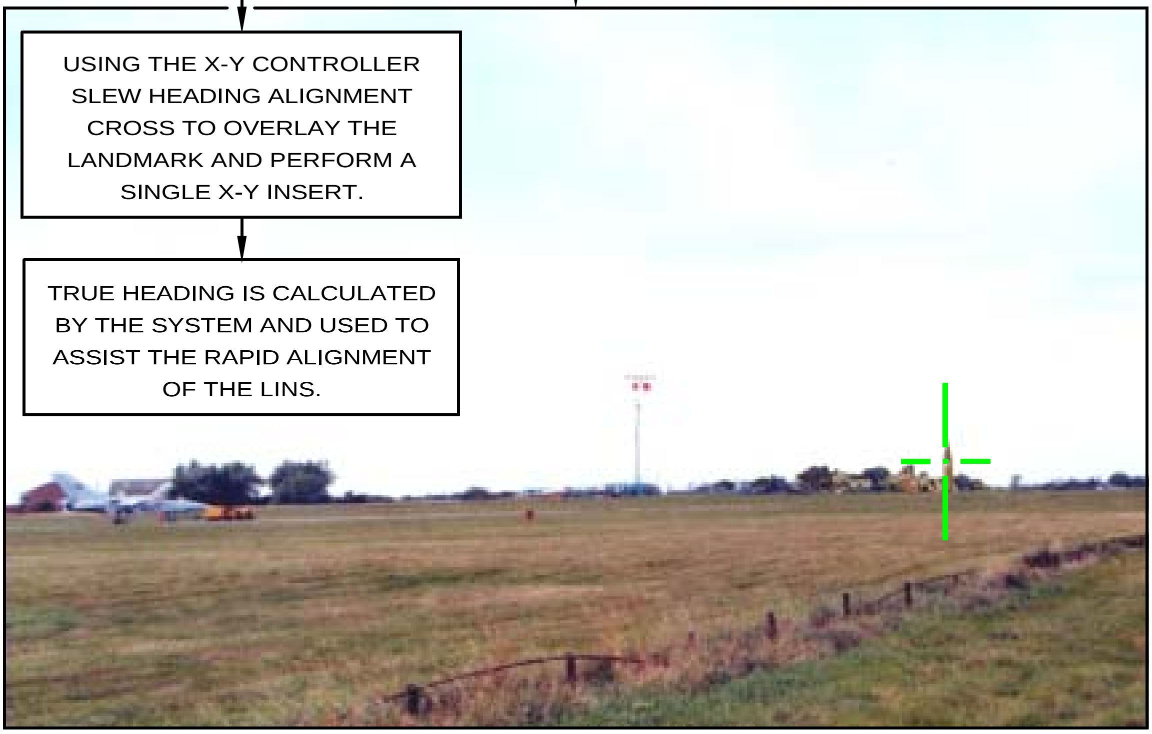
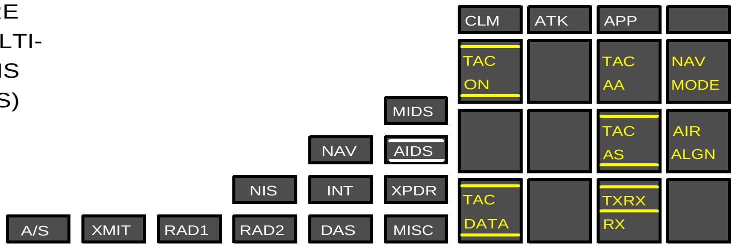


Figure 1.118 - LINS Rapid Alignment - HUD Optical Transfer

NOTE

PRIOR TO SELECTING IFA ENSURE THAT THE AIRCRAFT SPEED AND ALTITUDES ARE STABLE AND THERE IS SUFFICIENT TIME (ABOUT 10 MINS) AND SPACE TO COMPLETE IFA.



PRESS THE **AIR ALGN** MK.

A DIVERSIONARY ROUTE, CONSISTING OF 3 ROUTE WAYPOINTS (172, 173 AND 174), IS ENTERED INTO THE CURRENT ROUTE PRIOR TO DWP.

FLY THE DIVERSIONARY ROUTE AS ACCURATELY AS POSSIBLE WHILST MAINTAINING A CONSTANT GROUND SPEED (THE SAME VALUE THAT EXISTED AT IFA SELECTION).

LINS ALIGNMENT TIME-TO-GO (IN SECS) AND LINS ALIGNMENT LEVEL (IN NM/H) ARE DISPLAYED IN HUD/HDHUD.

'NAV READY' DISPLAYED IN HUD/HDHUD WHEN IFA COMPLETE. PILOT EXITS IFA MODE AND ENTERS NAV MODE BY DESELECTING **AIR ALGN** MK.

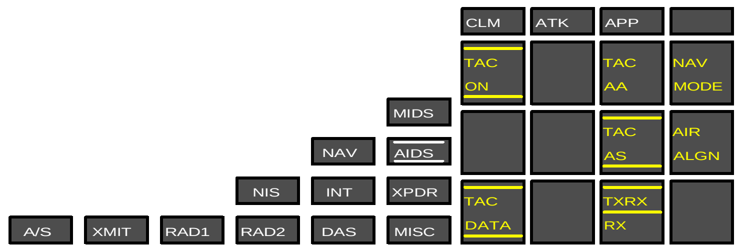
IF **AIR ALGN** IS DESELECTED BEFORE IFA HAS BEEN COMPLETED THERE WILL BE A DEGRADATION IN SYSTEM PERFORMANCE.

AIR ALGN MK ONLY AVAILABLE WHEN WEIGHT OFF WHEELS, NAV POF AND GPS FOM < 4.

NOTE

1. ONLY THE ALTERNATIVE ROUTE MAY BE EDITED DURING IFA.
2. IT IS NOT COMPULSORY TO FLY THE DIVERSIONARY ROUTE, BUT IFA WILL TAKE LONGER TO COMPLETE IF IT IS NOT.

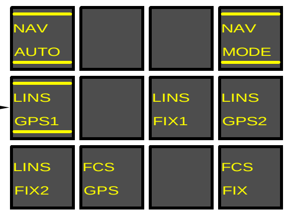
Figure 1.119 - LINS Airborne Alignment Mode



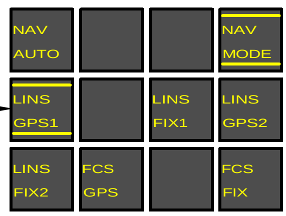
PRESS THE **AIDS** SSK.

MK AND ROL MODE TO DEFAULT AIDS CONDITION.

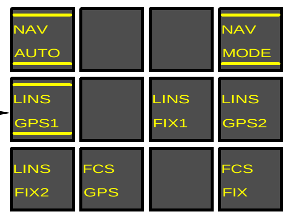
SELECT THE **NAV MODE** MK, MK MODE TO SHOW ALL AVAILABLE NAV OPTIONS. **NAV AUTO, NAV MODE** AND BEST AVAILABLE NAV MODE ARE SELECTED



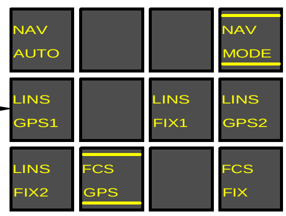
DESELECTION OF **NAV AUTO** WILL CAUSE THE SYSTEM TO REMAIN IN THE CURRENT NAV MODE AND WILL NO LONGER SELECT THE BEST AVAILABLE MODE AUTOMATICALLY.



RESELECTION OF **NAV AUTO** WILL AUTOMATICALLY SELECT THE BEST NAV SOURCE CURRENTLY AVAILABLE.



AN ALTERNATIVE NAV SOURCE CAN BE MANUALLY SELECTED AT ANY TIME BY PRESSING THE APPROPRIATE MK. **NAV AUTO** MODE WILL BE DESELECTED



NOTE

IF A MANUALLY SELECTED NAV MODE BECOMES UNAVAILABLE, THE NAV AUTO MODE WILL BE RE-ENGAGED CAUSING THE BEST AVAILABLE NAV SOURCE TO BE USED.

Figure 1.120 - Selection of Navigation Modes

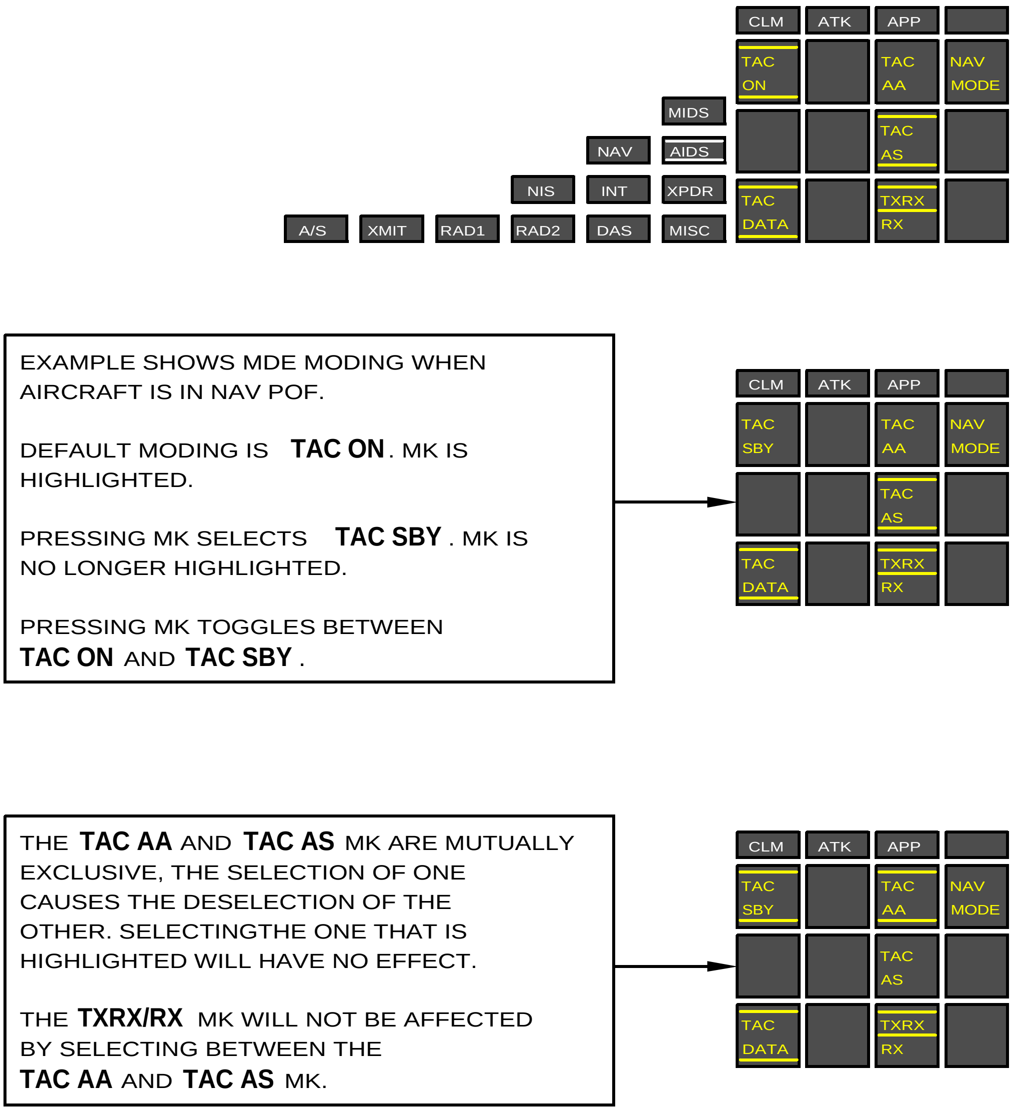
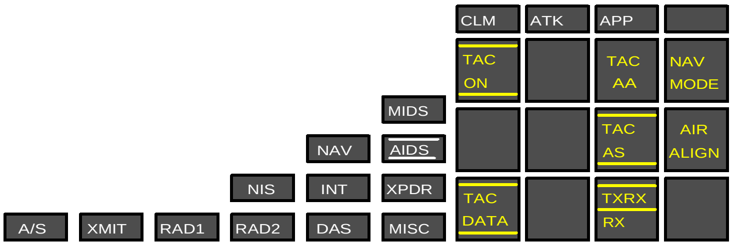
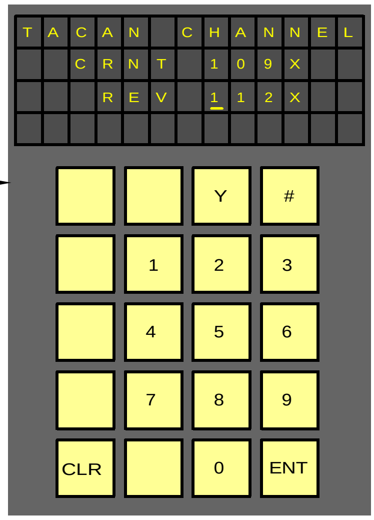


Figure 1.121 - Selecting Between TACAN ON/SBY and Between TAC AA/AS



TO UPDATE THE CURRENT TACAN CHANNEL OVERTYPE THE PREVIOUS TACAN CHANNEL NUMBER. THE PILOT CAN UPDATE THE X TO A Y ON ROL 3 BY SELECTING THE Y DEK - THIS UPDATES THE DEK TO X.



ON DEFINING THE FIRST CHARACTER THE **PREV** LEGEND CHANGES TO **NEW** AND THE 2ND AND 3RD CHARACTERS AUTOMATICALLY REVERT TO DASHES.

ENTER REMAINING TACAN DATA. SELECT **ENT** - THE ROLs BLINK OFF.

THE NEW TACAN NUMBER IS SENT TO THE SYSTEM TO BE USED AS THE CURRENT TACAN CHANNEL. THE LAST CURRENT TACAN CHANNEL NUMBER BECOMES THE PREVIOUS TACAN CHANNEL NUMBER.

Figure 1.122 - Edit TACAN Channel - Input New Channel

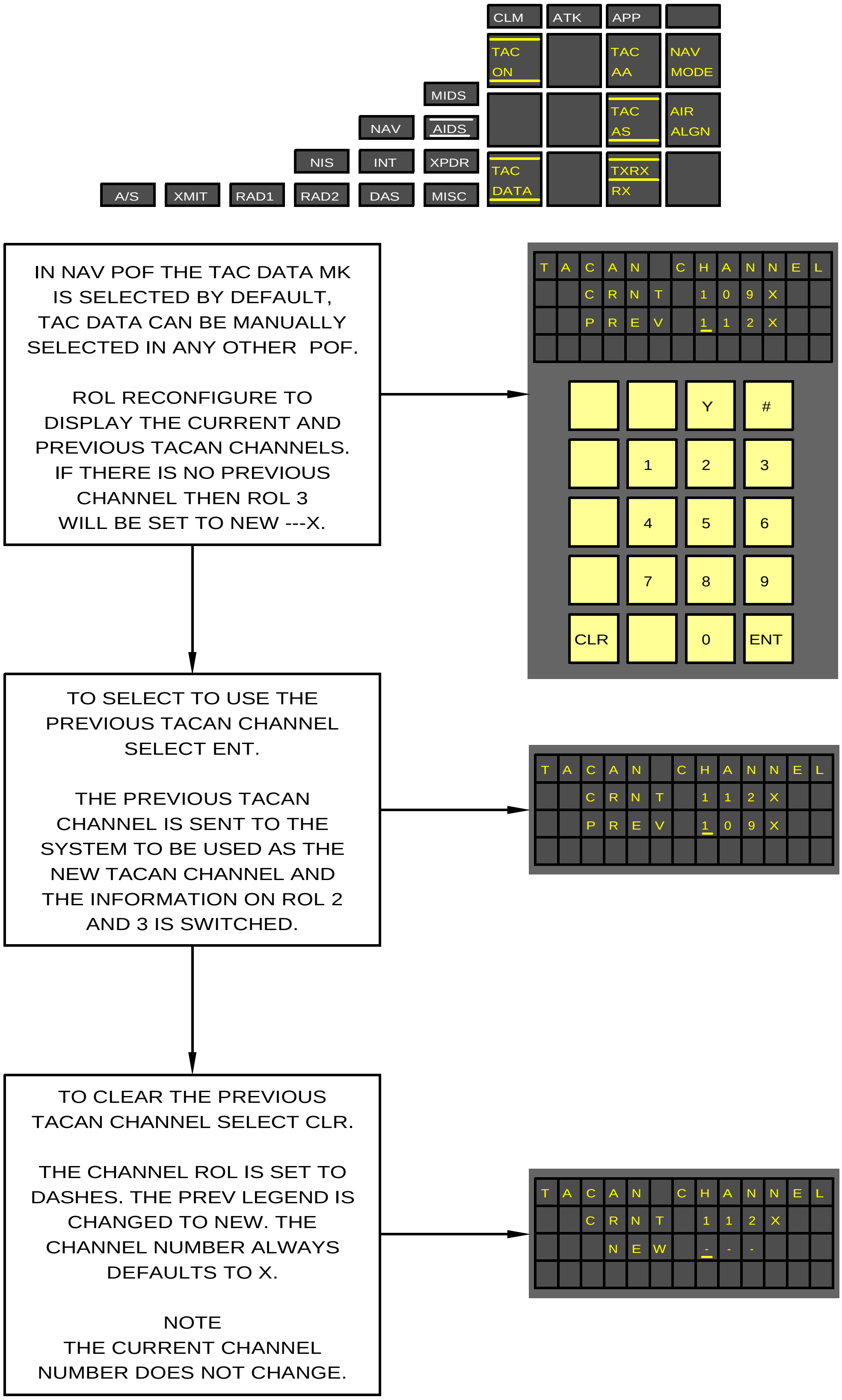
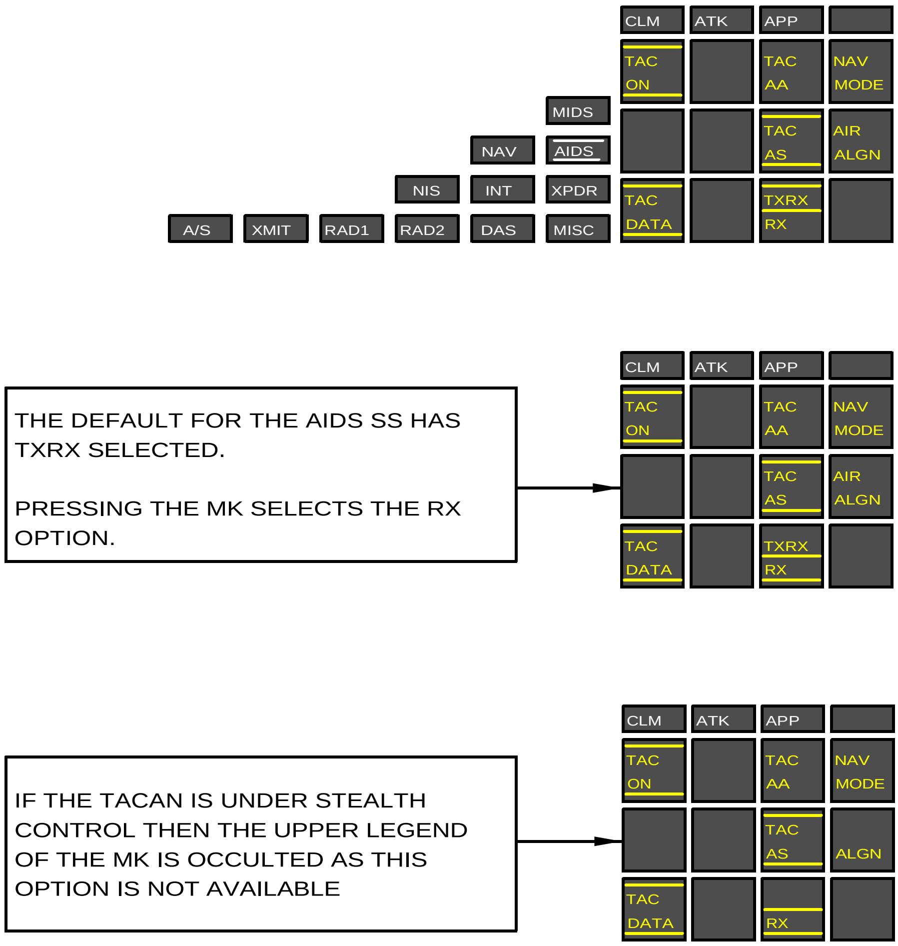


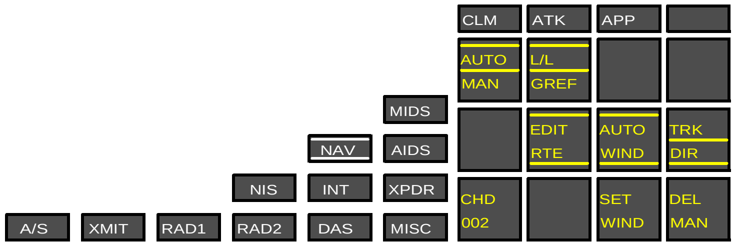
Figure 1.123 - Edit TACAN Channel - Select/Clear Previous



NOTE

AT SP3 THE TACAN OR MIDS TRANSMITTER CONTROL (LOCATED ON THE RIGHT CONSOLE, REAR PANEL) WILL NOT AFFECT THE MODING OF THE TX/RX MK ON THE MDE

Figure 1.124 - TACAN - Selecting Between TXRX and RX



GROUND STATE

PRESS THE **NAV** SSK.

AIR STATE

DEFAULT CONFIG:
- AUTO ROUTE
- ROUTE STEERING
- DIRECT STEERING
- LAT / LONG
- AUTO WIND
- EDIT ROUTE.

GROUND STATE

DEFAULT CONFIG:
- AUTO ROUTE
- DIRECT STEERING
- LAT / LONG
- AUTO WIND
- EDIT ROUTE.

AIR STATE

HIGHEST UNPAIRED WAYPOINT (FROM 164) IS PRESENTED ON THE ROL. IF THERE ARE NO UNPAIRED WAYPOINTS THE DEK AND ROL RECONFIGURE TO ALLOW THE PILOT TO ENTER A PAIRED WAYPOINT.

THE **WPT** FORMAT IS SELECTED BY DEFAULT.

X-Y CONTROLLER ENABLES:
- ROL SCROLLING
- ROL RESETS
- EXTRA WP DATA SELECTION
- ROUTE MANIPULATION
- REMOVAL OF WP NUMBERS
- RE-ORDER WP NUMBERS.

Figure 1.125 - Navigation Subsystem Default Moding

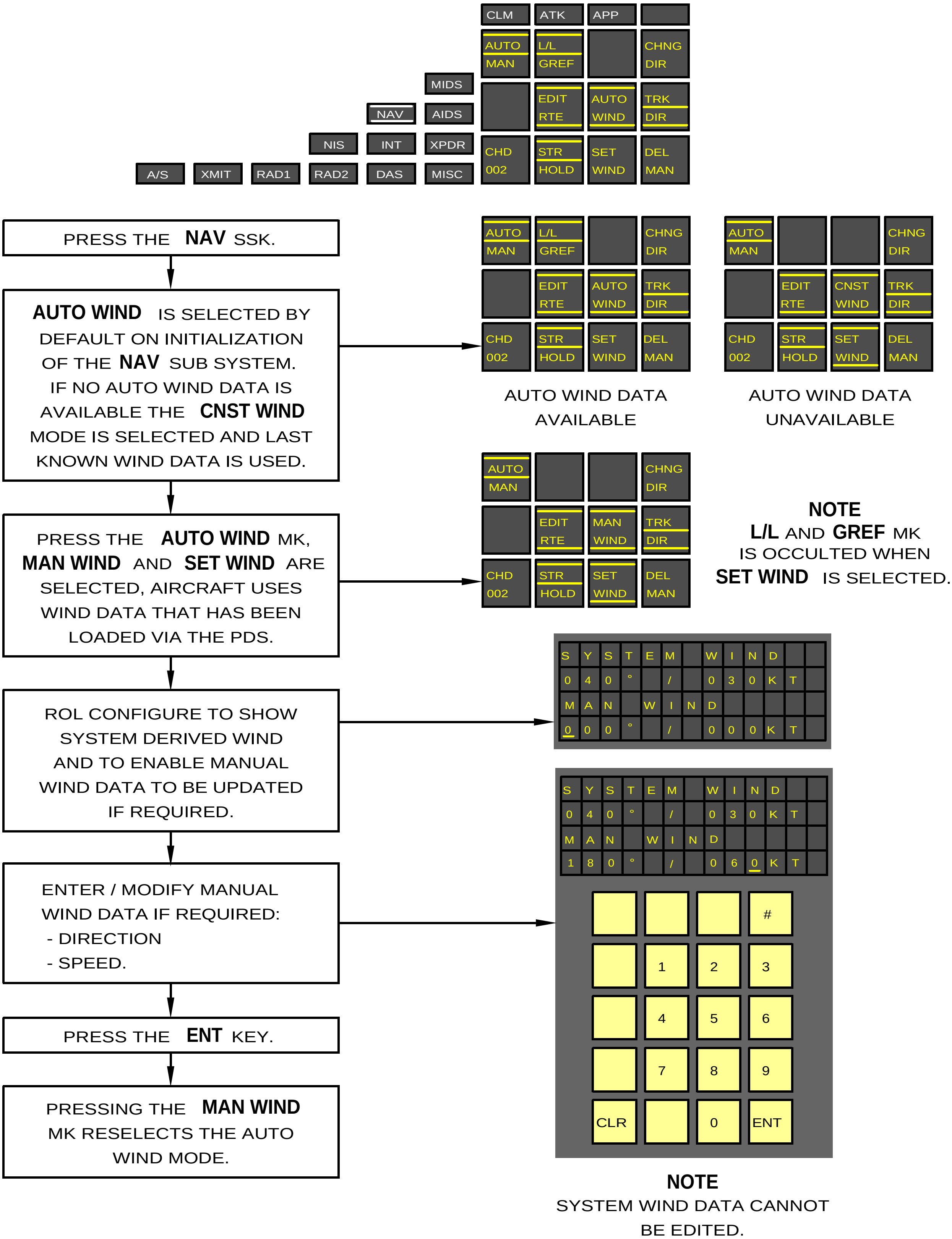


Figure 1.126 - Selection of Wind Modes

PRESS THE **NAV** SSK.

WPT FORMAT IS SHOWN BY DEFAULT ON RIGHT MHDD. PAGE CONTAINING DWP IS SHOWN BY DEFAULT.

SIMULTANEOUSLY ALL WAYPOINTS ARE SHOWN ON PA FORMAT (IF THEY FALL WITHIN AREA OF COVERAGE). BOTH THE AUTO AND MANUAL ROUTES ARE SHOWN (IF THEY EXIST). AUTO ROUTE IS SHOWN BY SOLID LINE, MAN ROUTE IS SHOWN BY DASHED LINE.

AUTO ROUTE IS SELECTED TO BE FLOWN BY DEFAULT ON INITIAL SELECTION OF **NAV** SSK. SYSTEM PROVIDES STEERING FOR AUTO ROUTE DWP (WP 2 IN THIS EXAMPLE).

ON DESELECTION OF WPT FORMAT THE PA FORMAT DISPLAYS ONLY THE ROUTE SYMBOLOGY OF THE SELECTED ROUTE AND THE JWP (164) OF THE ALTERNATE ROUTE. ALTERNATIVELY SPECIFIC TYPES OF WAYPOINTS MAY BE DISPLAYED BY SUCCESSIVE SELECTION OF THE **TYPE** SK ON THE WPT FORMAT (SEE FIG 31).

ON REACHING THE END OF THE AUTO RTE THE LAST WP REMAINS ENGAGED AS THE DWP AND STEERING INFORMATION CONTINUES TO BE PROVIDED FOR THIS WP (CONTINUED ON SHEET 2).

Figure 1.127 - Automatic and Manual Route Selection (Sheet 1 of 2)

PRESS THE **AUTO/MAN** MK TO SELECT MANUAL ROUTE.

MAN ROUTE IS DISPLAYED ON THE PA FORMAT. SYSTEM PROVIDES STEERING FOR MAN ROUTE DWP (164).

ON REACHING THE END OF THE MAN ROUTE:

IF THE LAST WP IN MAN RTE EXISTS IN AUTO RTE, THEN AUTO RTE IS AUTOMATICALLY SELECTED AND STEERING IS PROVIDED TO NEXT WP IN AUTO RTE.

IF THE LAST WP IN THE MAN RTE DOES NOT EXIST IN THE AUTO RTE, OR IF THE LAST WP IN THE MAN RTE IS ALSO THE LAST WP IN THE AUTO RTE, THEN MAN RTE REMAINS ENGAGED AND LAST WP REMAINS AS DWP.

ROUTE STEERING INFORMATION IS ALSO PROVIDED ON THE HSI FORMAT (A), HDHUD FORMAT (B) AND THE HUD (C).

A

B

C

Figure 1.127 - Automatic and Manual Route Selection (Sheet 2 of 2)

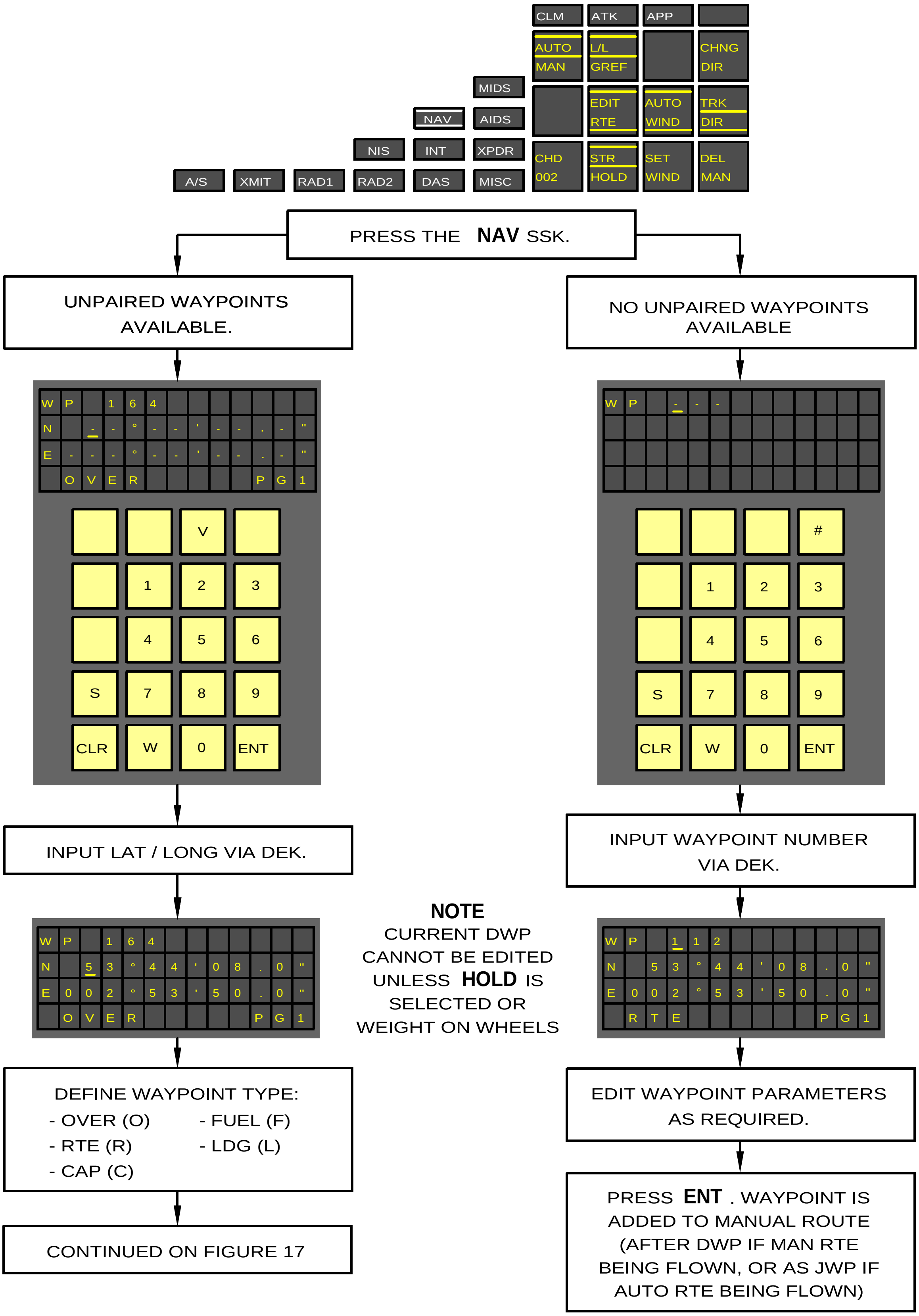


Figure 1.128 - Manual Route Creation Via MDEF (L/L)

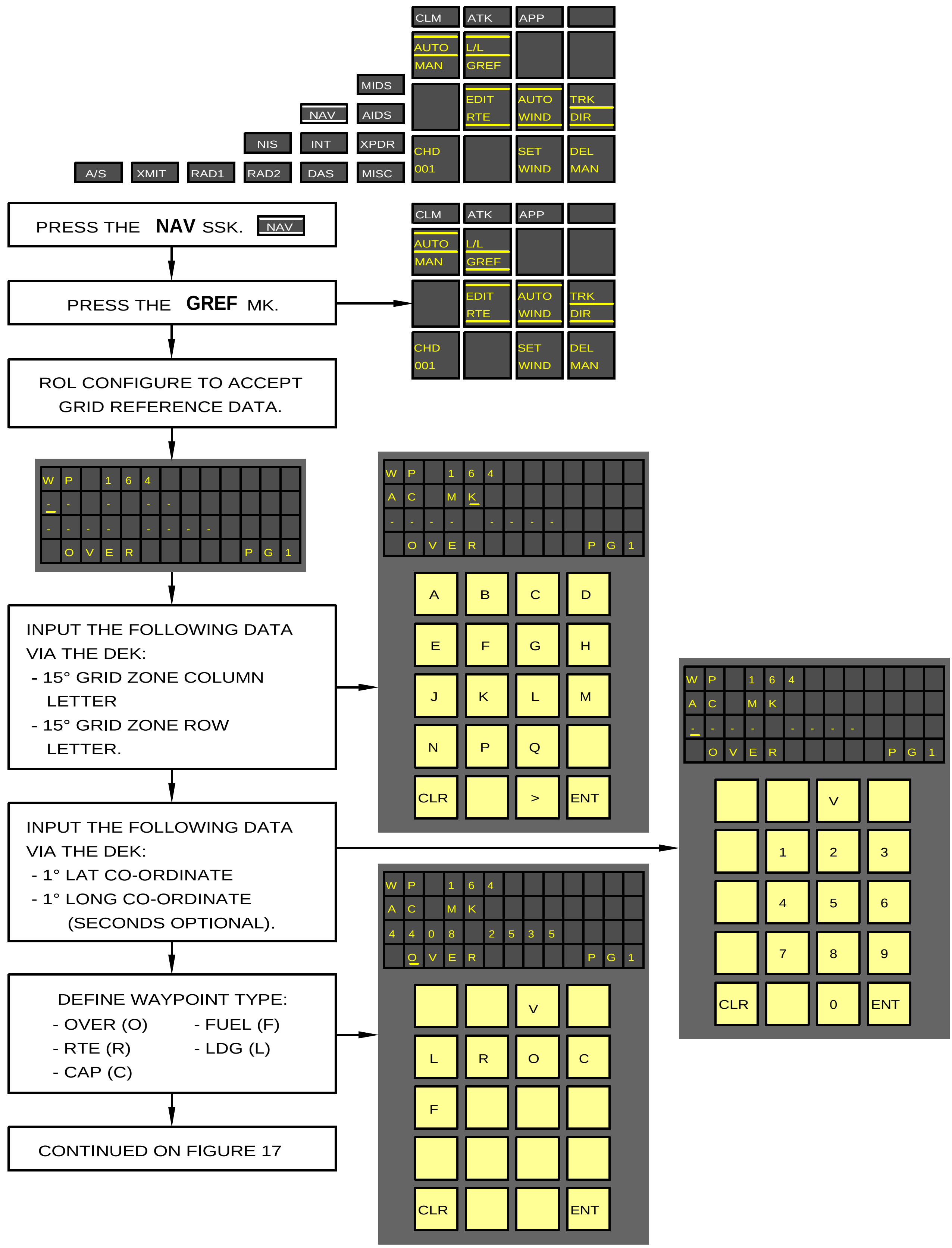


Figure 1.129 - Manual Route Creation Via MDEF (GEOREF)

PRESS THE NAV SSK. X-Y MARKER ANNOTATED WITH 'RTE'

UNPAIRED WAYPOINTS AVAILABLE

PERFORM AN X-Y INSERT ON THE **PA** FORMAT AT THE POSITION WHERE THE NEW WAYPOINT IS REQUIRED.

ROLS CONFIGURE TO SHOW THE LAT / LONG OF THE WAYPOINT.

EDIT AS REQUIRED. DEFINE WAYPOINT TYPE:

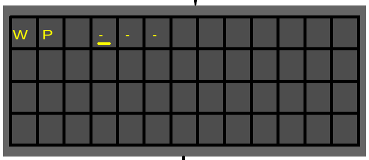
- OVER (O)
- FUEL (F)
- RTE (R)
- LDG (L)
- CAP (C)

NOTE
ANY DEK SELECTION CANCELS X-Y INVOLVEMENT WITH THE PROCEDURE

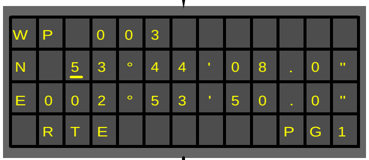
CONTINUED ON FIGURE 17.

X-Y HIGHLIGHTED AND L/L OF X-Y POSITION SHOWN.

NO UNPAIRED WAYPOINTS AVAILABLE



SELECT WAYPOINT FROM PA FORMAT BY PERFORMING A SINGLE X-Y INSERT OVER IT. EXTRA DATA BOX PRESENTED (SEE FIG 40).



IF NO EDITING IS REQUIRED A SECOND CONSECUTIVE X-Y INSERT ADDS THE WAYPOINT TO THE MANUAL ROUTE. HIGHLIGHT AND L/L BOX OCCULT.

Figure 1.130 - Manual Route Creation Using X-Y Controller

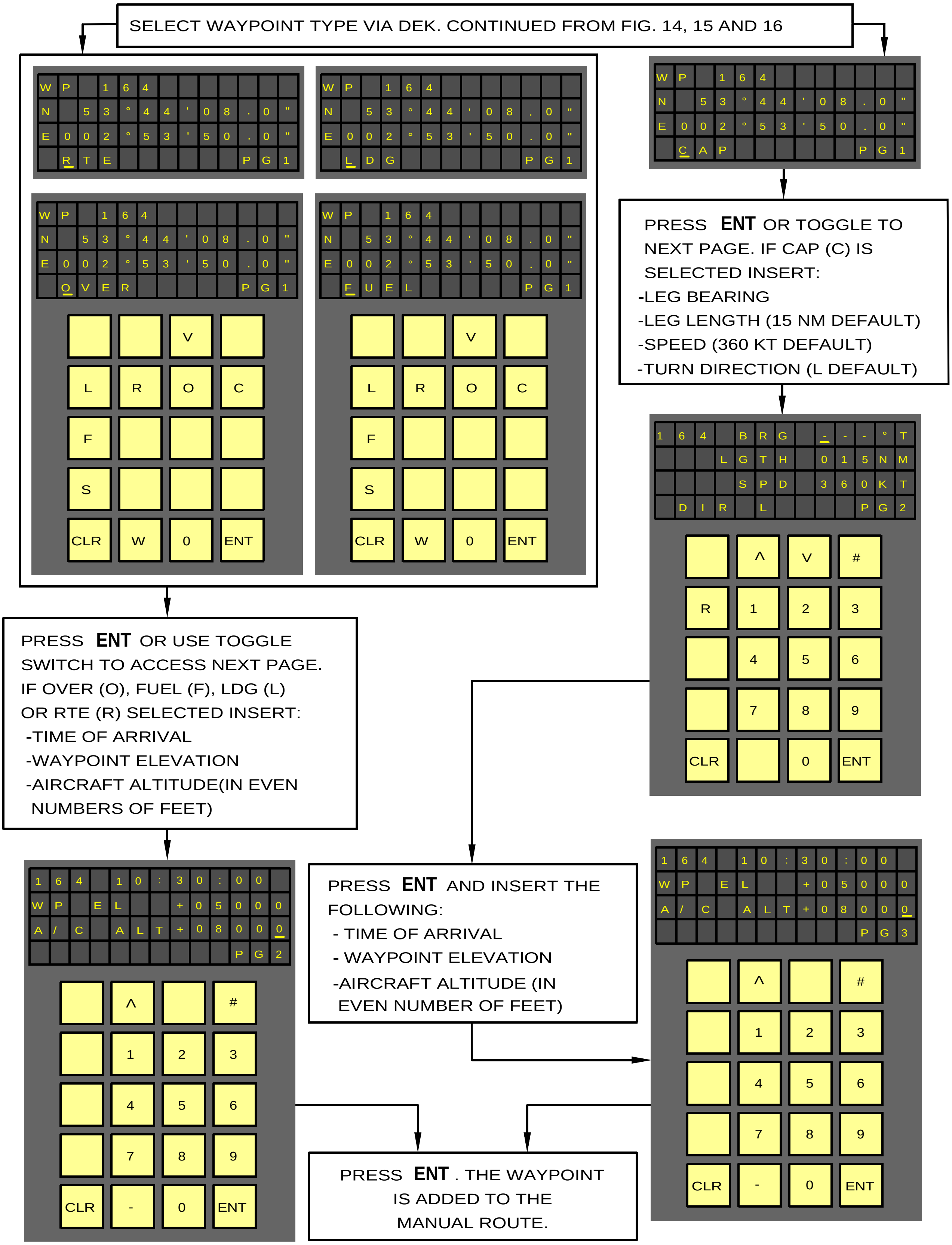


Figure 1.131 - Manual Route Creation - Entering Waypoint Parameters

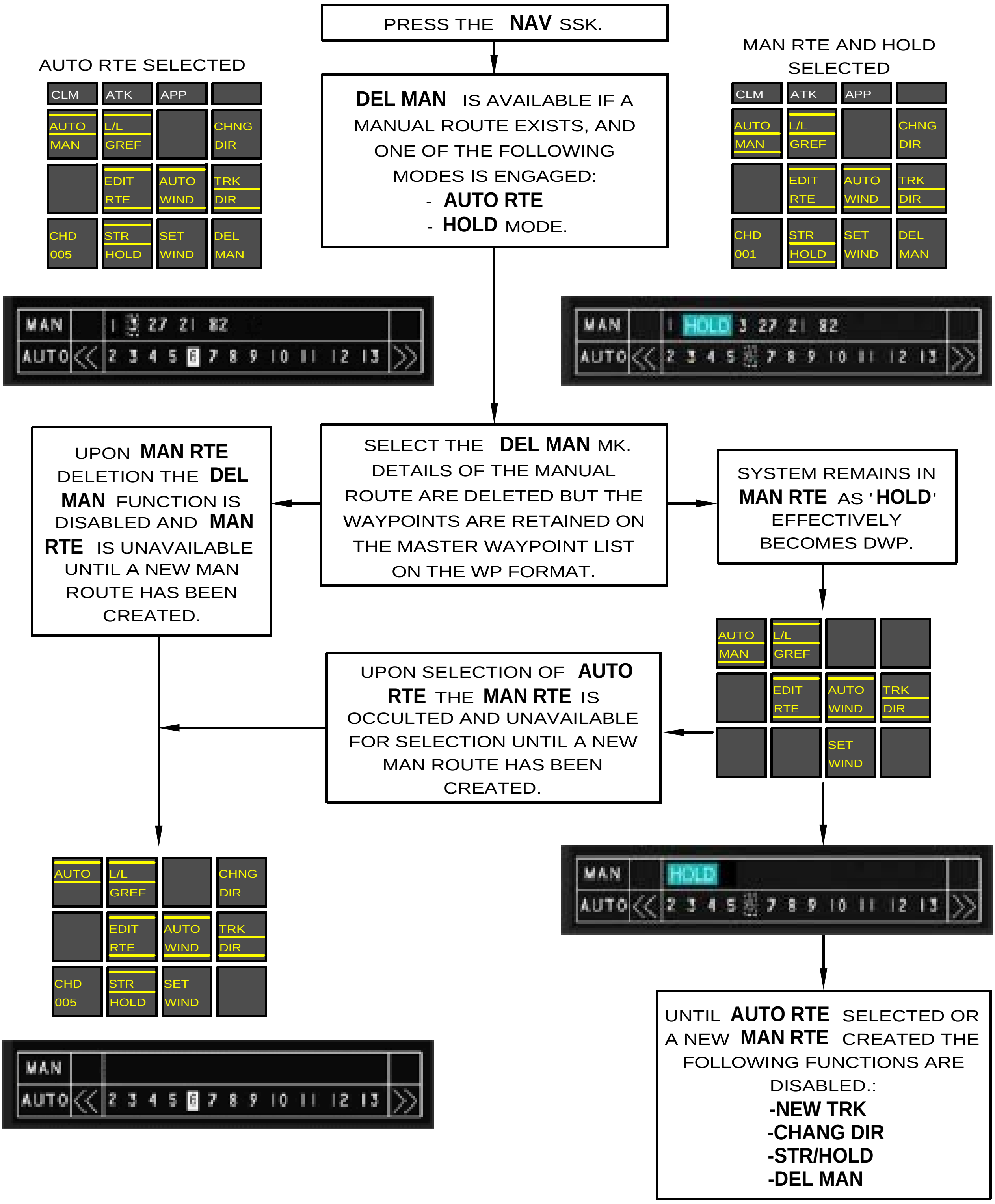
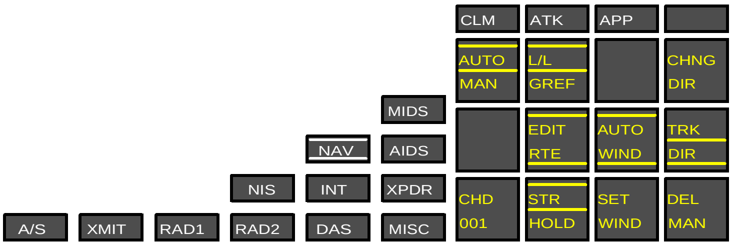


Figure 1.132 - Manual Route Deletion



PRESS THE **NAV** SSK.

SELECT AUTO OR MANUAL ROUTE AS NECESSARY

PRESS THE **CHNG DIR** MK. REMAINS UNBOXED

CURRENTLY SELECTED ROUTE IS REVERSED. STEERING IS PROVIDED TO THE PREVIOUS WAYPOINT, **HOLD** MODE IS DESELECTED IF ENGAGED.

REVERSED SEQUENCE

14 13 12 11 10 9 8 7 6 5 4 3 2 1

(WAYPOINT 1 BECOMES DESTINATION.)

Figure 1.133 - Route Reversal

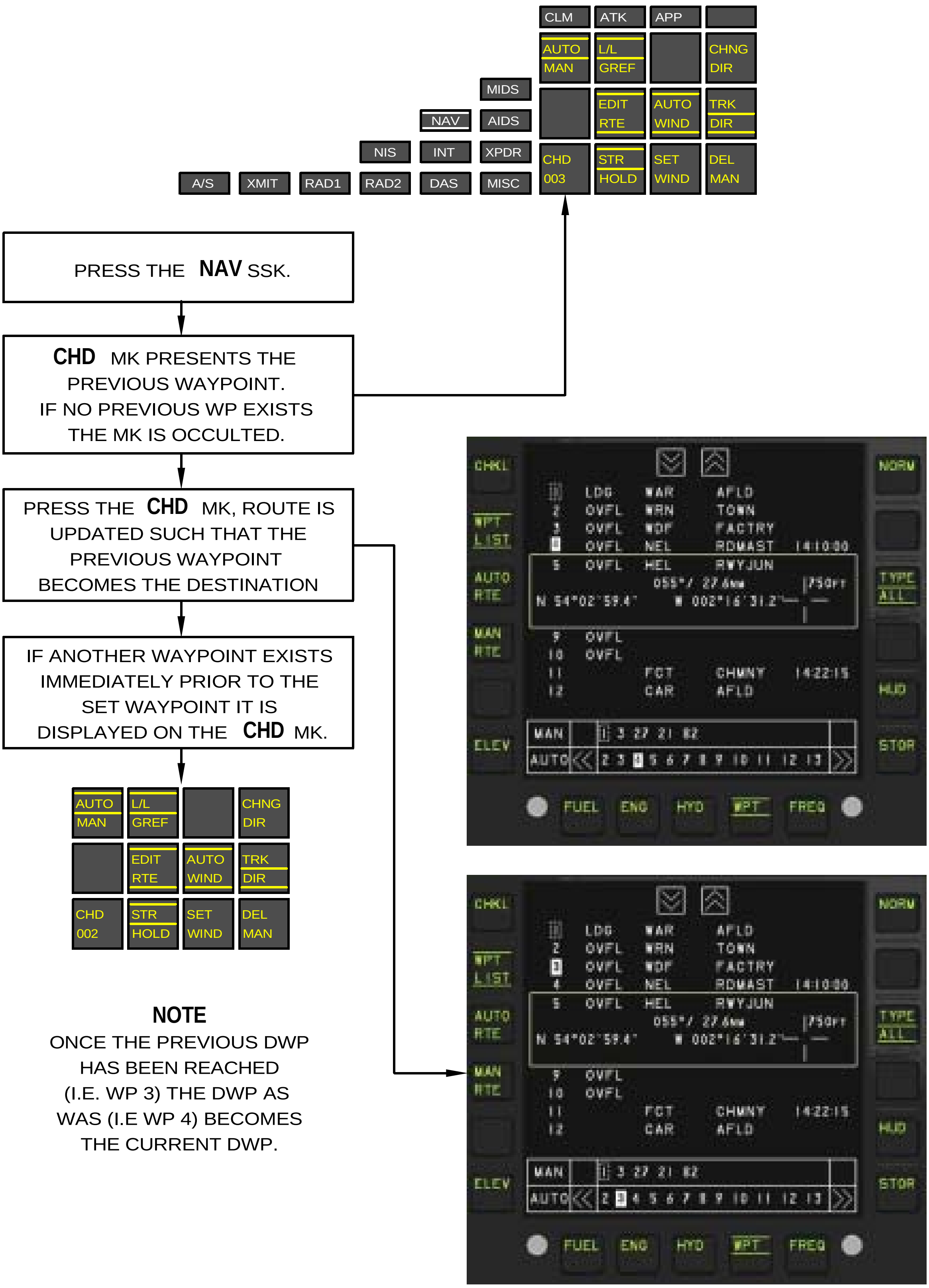


Figure 1.134 - Reverse Change Destination

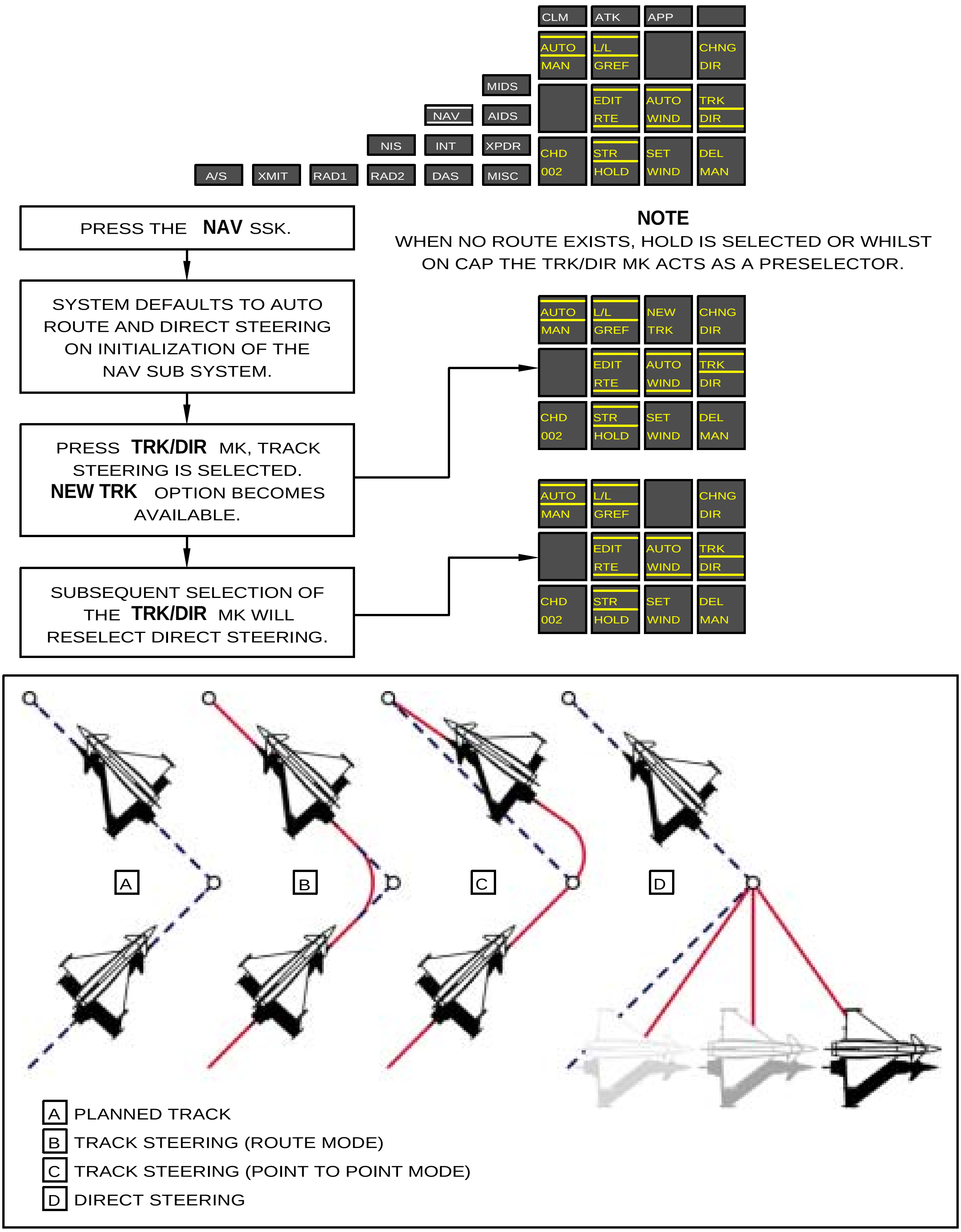
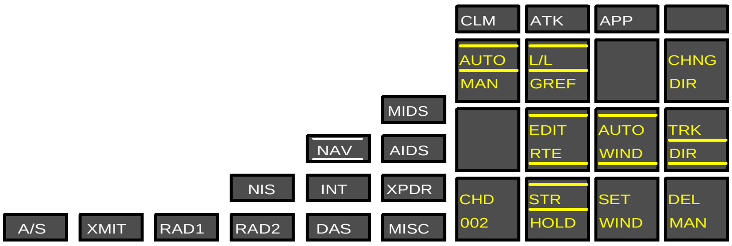


Figure 1.135 - Steering Mode Selection

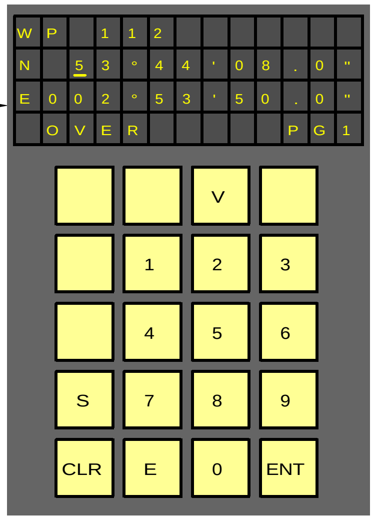


PRESS THE **NAV** SSK.

STR (STEER MODE) IS SELECTED BY DEFAULT ON INITIAL SELECTION OF THE NAV SUB SYSTEM.

PRESS **STR/HOLD** MK, STR IS DESELECTED AND **HOLD** MODE IS ENGAGED. STEERING INFORMATION IS PROVIDED TO MAINTAIN CURRENT TRACK. (**NEW TRACK** MODE IS DISABLED)

DEK AND ROL CONFIGURE TO ENABLE DESTINATION WAYPOINT TO BE MODIFIED IF REQUIRED.



SUBSEQUENT SELECTION OF THE **STR / HOLD** KEY WILL RESELECT STR AND REINSTATE ROUTE STEERING.

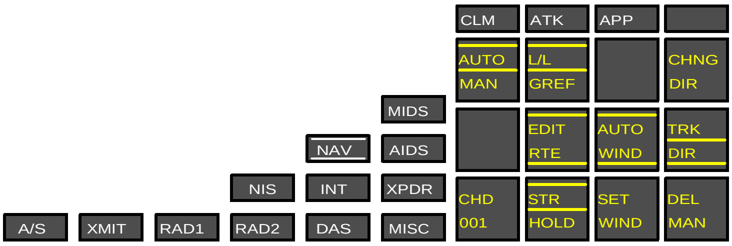
NOTE

THE **STR / HOLD** MK IS ONLY AVAILABLE IF THE FOLLOWING CONDITIONS EXIST:
- EXISTENCE OF A VALID DESTINATION
- WEIGHT-OFF-WHEELS.

NOTE

THIS IS THE ONLY METHOD OF MODIFYING THE DESTINATION WAYPOINT WHILST AIRBORNE.

Figure 1.136 - Route Suspension



PRESS THE **NAV** SSK NAV
DIR STEERING IS DEFAULT SELECTION. IN DIRECT STEERING THE TRACK LINE FROM PP TO DWP IS CONTINUALLY UPDATED.

WITH **TRK** MANUALLY SELECTED THE DIRECT TRACK LINE IS OCCULTED AND REPLACED BY THE PLANNED TRACK FOR THE CURRENT LEG.

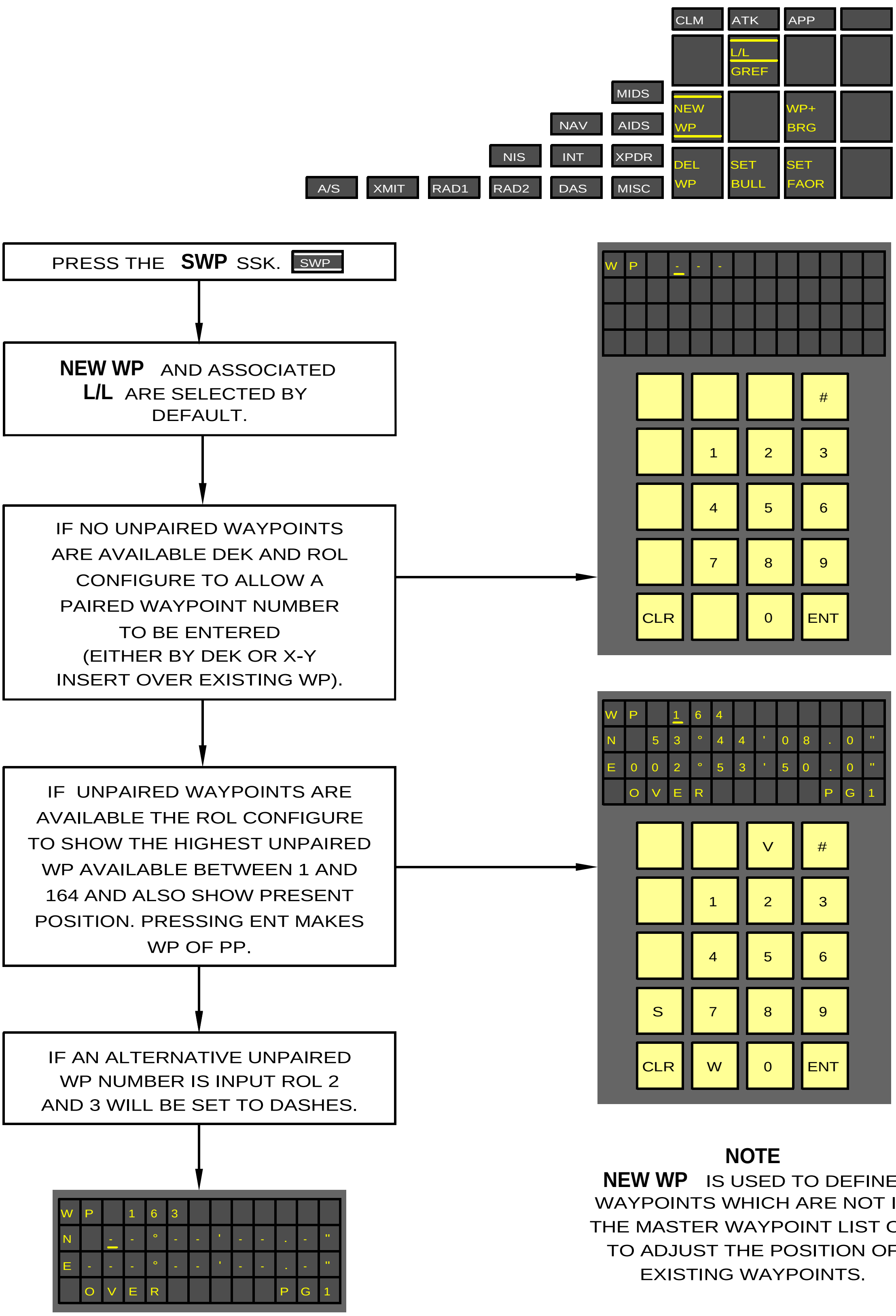
SELECT THE **NEW TRK** MK.

NAV SYSTEM CALCULATES A NEW TRACK FROM PRESENT POSITION (PP) TO DESTINATION WAYPOINT (DWP). A TRACK LINE IS DRAWN ON THE **PA** FORMAT FROM PP TO DWP.

NOTE

- THE **NEW TRK** MK IS NOT BOXED WHEN SELECTED.
- SUBSEQUENT SELECTIONS OF THE **NEW TRK** KEY WILL REPEAT THE FUNCTION AND WILL CANCEL THE PREVIOUS NEW TRACK LINE.

Figure 1.137 - New Track Moding



NOTE

NEW WP IS USED TO DEFINE WAYPOINTS WHICH ARE NOT IN THE MASTER WAYPOINT LIST OR TO ADJUST THE POSITION OF EXISTING WAYPOINTS.

Figure 1.138 - Set Waypoint Subsystem Default Moding

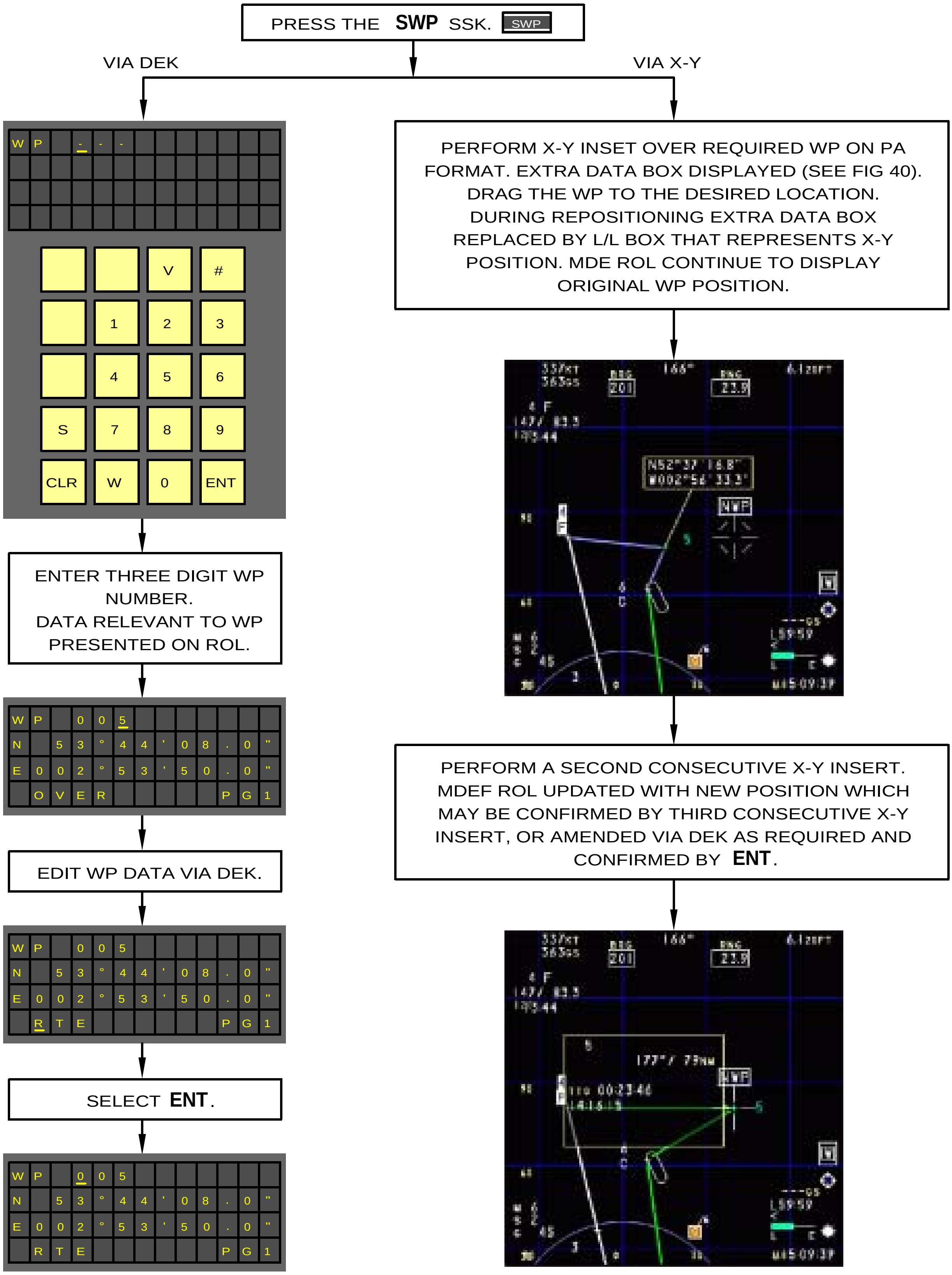
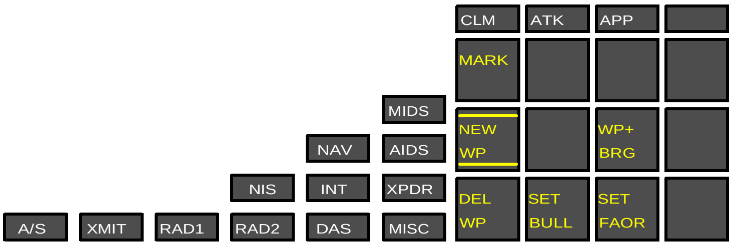
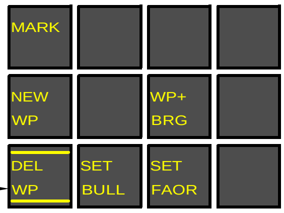


Figure 1.139 - Identify/Edit Paired Waypoint

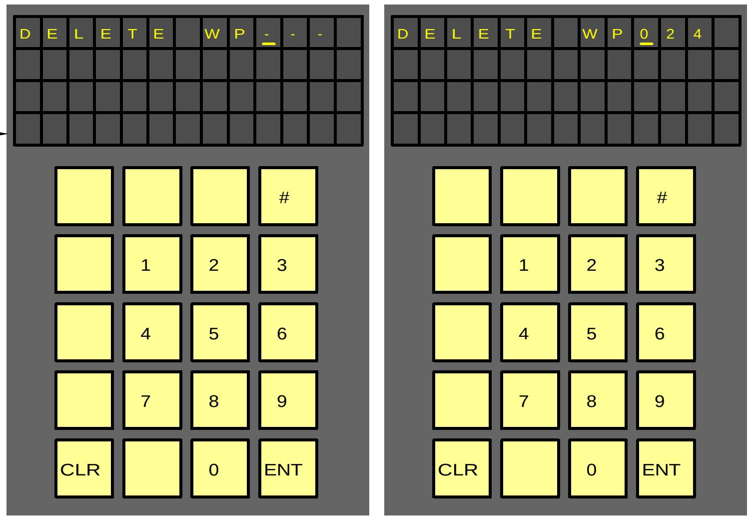


PRESS THE **SWP** SSK [SWP]

PRESS THE **DEL WP** MK:
- **NEW WP** MODE IS DESELECTED.
- ROL CONFIGURE TO ENABLE WAYPOINT NUMBER TO BE SELECTED.



INPUT THE NUMBER OF THE WAYPOINT TO BE DELETED OR SELECT THE REQUIRED WAYPOINT VIA THE **PA** FORMAT.



SELECT **ENT** OR PERFORM SECOND X-Y INSERT.

WAYPOINT IS DELETED AND ROL RECONFIGURED TO ENABLE THE DELETION OF ANOTHER WAYPOINT.

NOTE
THIS PROCEDURE CAN ONLY BE USED TO DELETE WAYPOINTS THAT ARE NOT IN A ROUTE.

IF WAYPOINTS IN A ROUTE ARE TO BE DELETED THEY MUST FIRST BE REMOVED FROM THE ROUTE (SEE FIG 35).

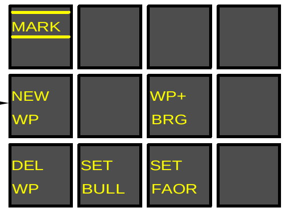
Figure 1.140 - Delete Waypoint Moding

NOTE

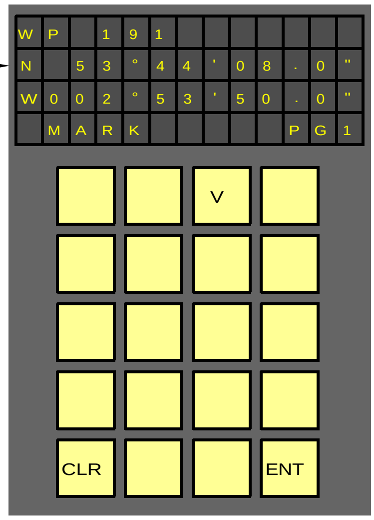
- THE **MARK** FUNCTION IS ONLY AVAILABLE WITH WEIGHT-OFF-WHEELS.
- MARK POINTS ARE ONLY DEFINED USING THE LAT / LONG POSITIONING SYSTEM (**L/L GREF** MK OCCULTED).
- THE SYSTEM ALLOWS UP TO 10 MARK POINTS TO BE DEFINED. NUMBERS 191 TO 200 ARE RESERVED FOR MARK POINTS.
- MARK POINTS MAY BE ADDED TO ROUTES. IF 10 MARK POINTS EXIST AND ARE INCLUDED IN A ROUTE THEN THE **MARK** MK IS OCCULTED UNTIL A MARK WP IS DELETED FROM THE ROUTE.

PRESS THE **SWP** SSK. SWP

SELECT THE **MARK** MK, A MARK POINT IS CREATED AT PRESENT POSITION.



PREVIOUSLY SELECTED DEK / ROL MODE IS DESELECTED AND THE ROL CONFIGURE TO SHOW THE POSITION OF THE MARK POINT FOR 5 SECONDS.



THE DEK ARE OCCULTED AND THE **ENT** AND **CLR** FUNCTIONS ARE DISABLED. THE NEXT AVAILABLE WAYPOINT NUMBER IN THE RANGE 191 TO 200 IS ALLOCATED TO THE NEW MARK POINT.

RESELECTION OF THE **MARK** MK WILL CREATE ANOTHER MARK POINT, WHICH WILL ADOPT THE NEXT WAYPOINT NUMBER IN THE RANGE. IF 200 WAS THE LAST MARK POINT, THE NEXT SELECTION WILL OVERWRITE THE DETAILS OF THE FIRST AVAILABLE MARK POINT IN THE RANGE 191 TO 200.

A SECOND PAGE OF MARK POINT PARAMETERS MAY BE VIEWED ON SUBSEQUENT SELECTIONS OF THE WP NUMBER (VIA **NEW WP** ETC). THE DATA CANNOT BE EDITED.

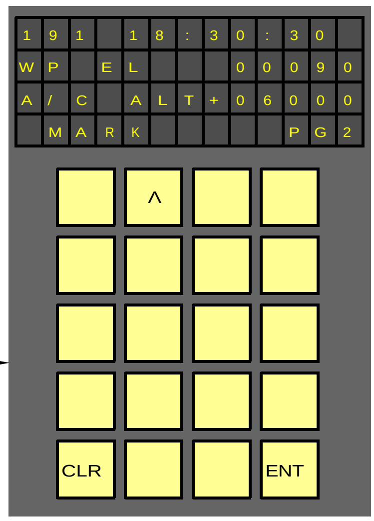


Figure 1.141 - Mark at Present Position

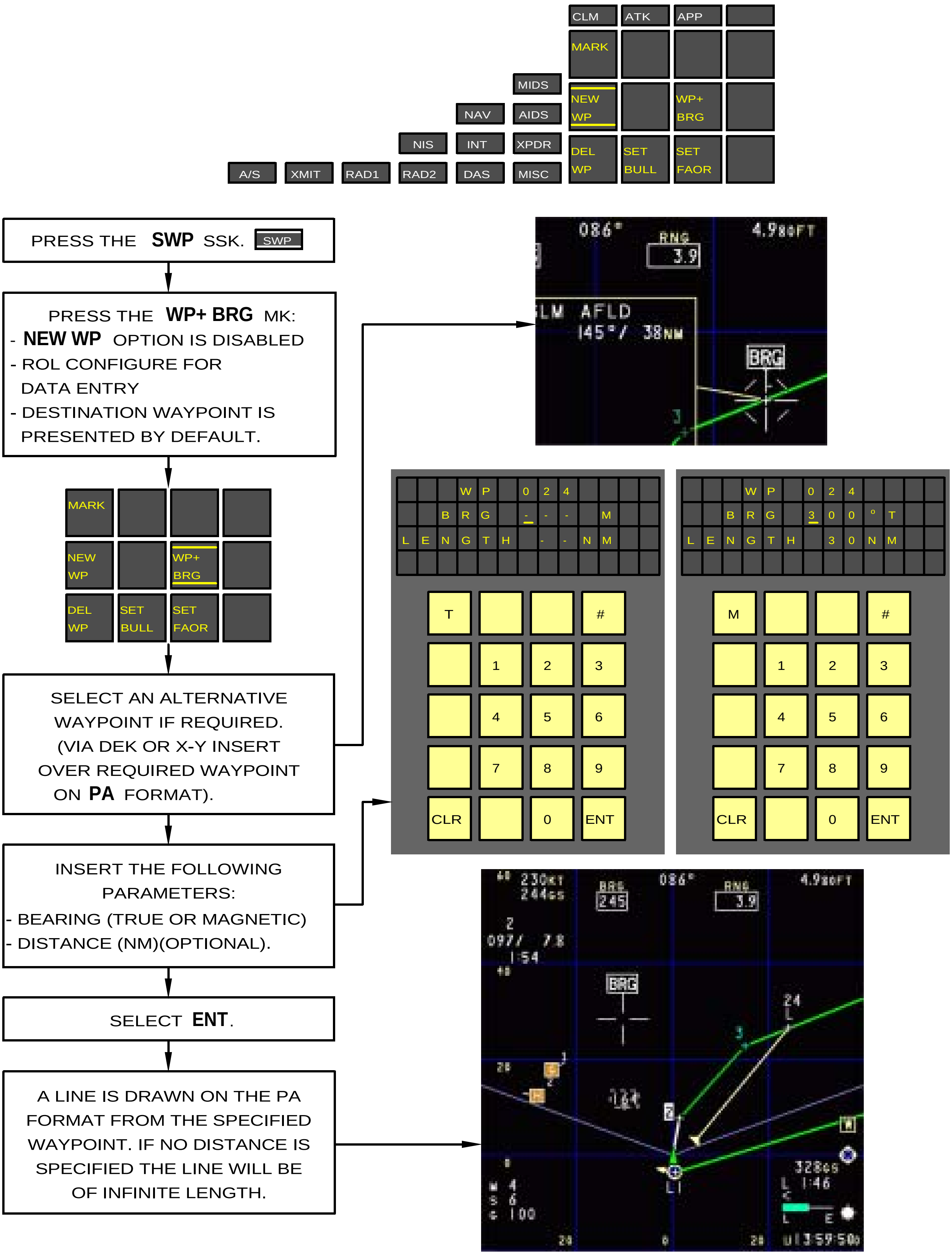


Figure 1.142 - Line From a Paired Waypoint

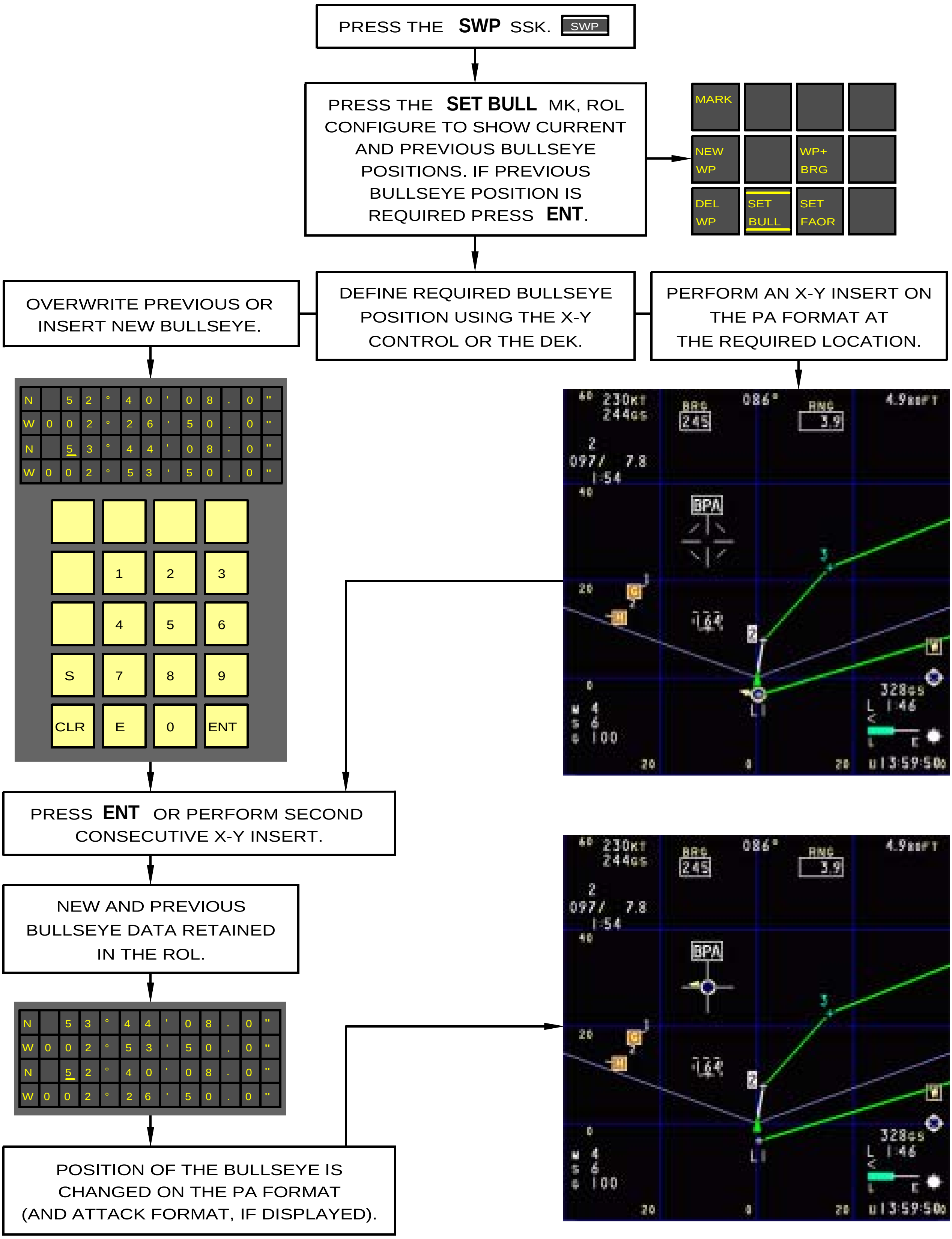


Figure 1.143 - Set Bullseye Position

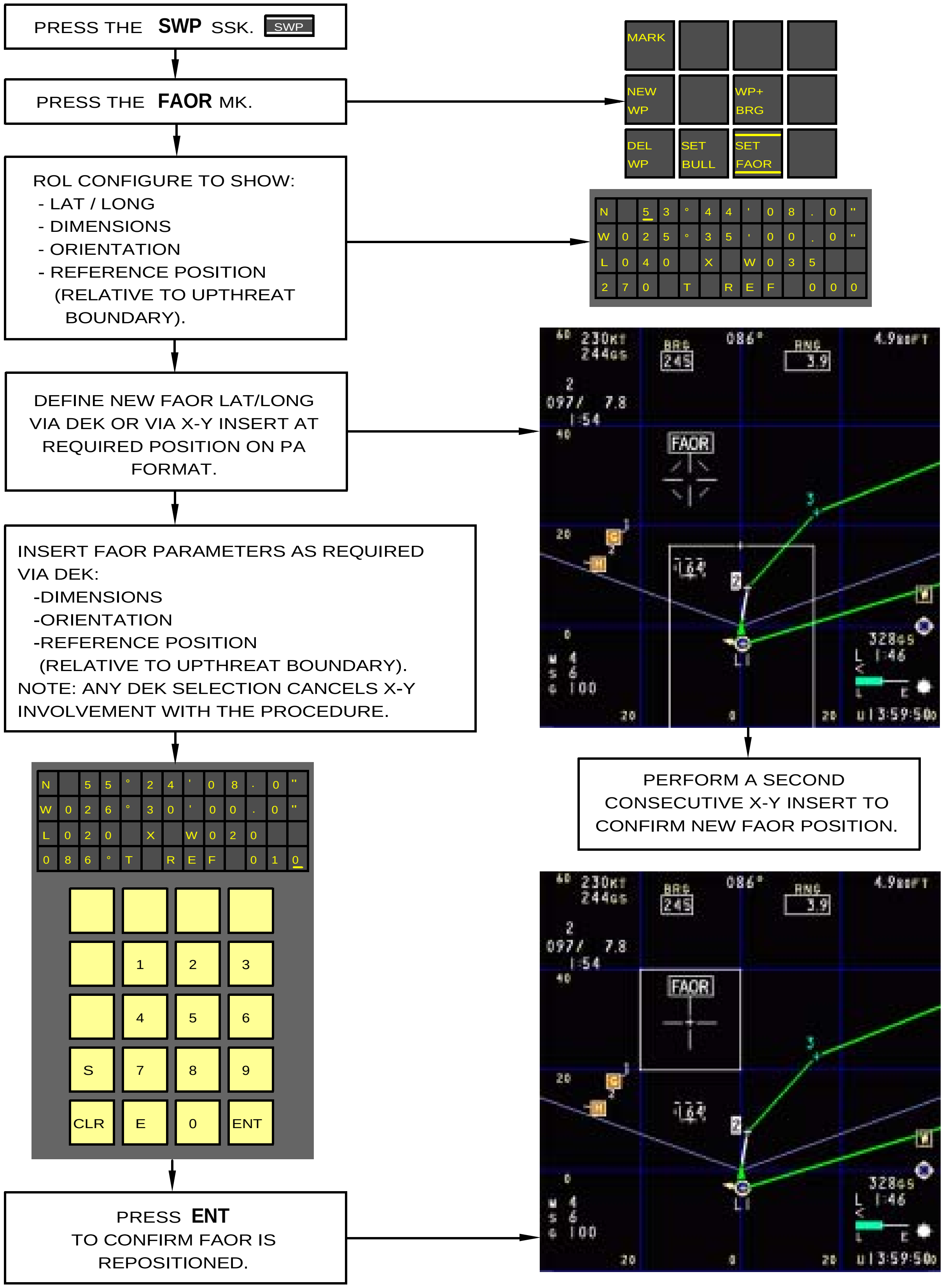


Figure 1.144 - Set FAOR Via DEK/X-Y

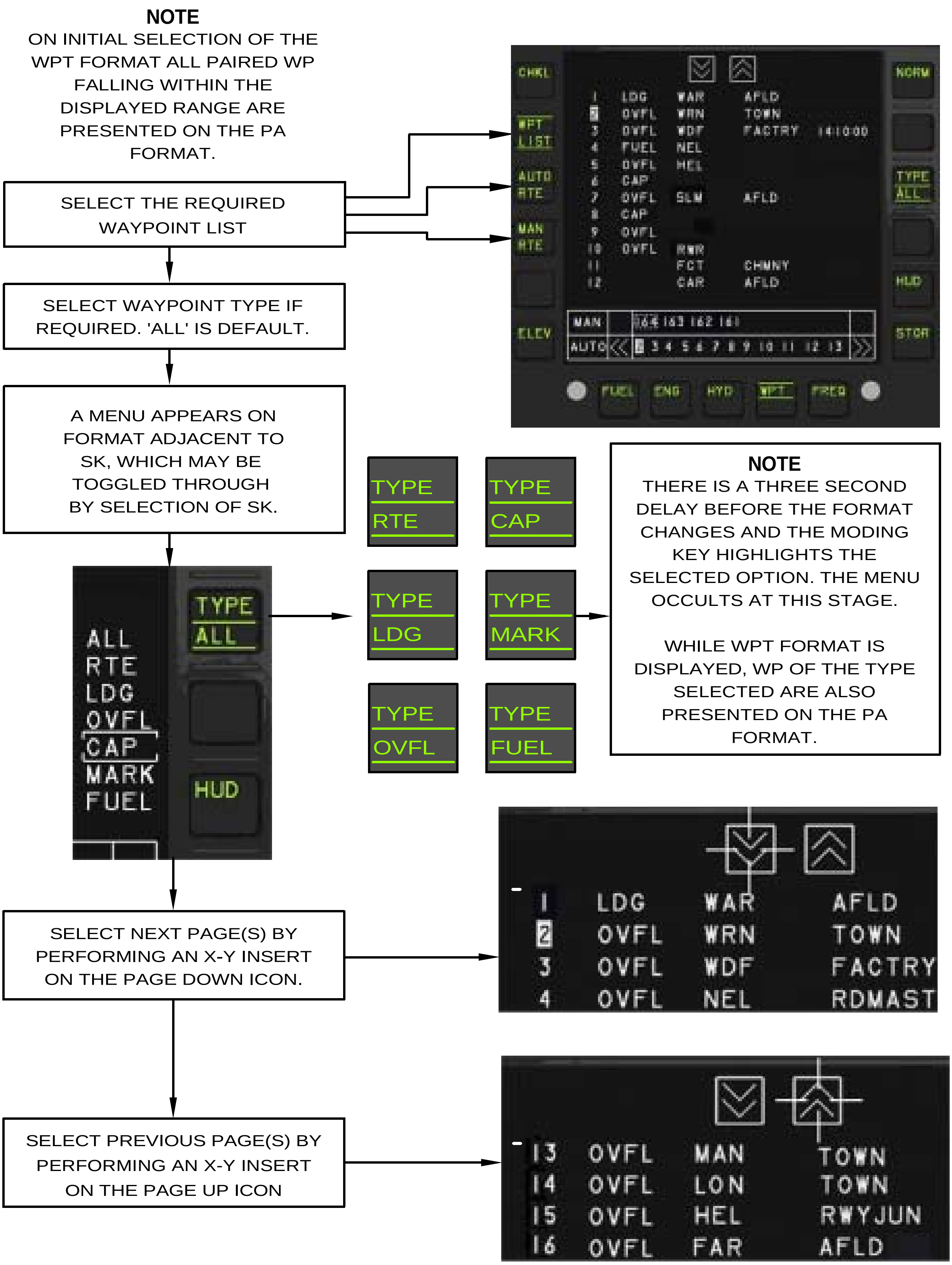


Figure 1.145 - Paging Waypoint Lists

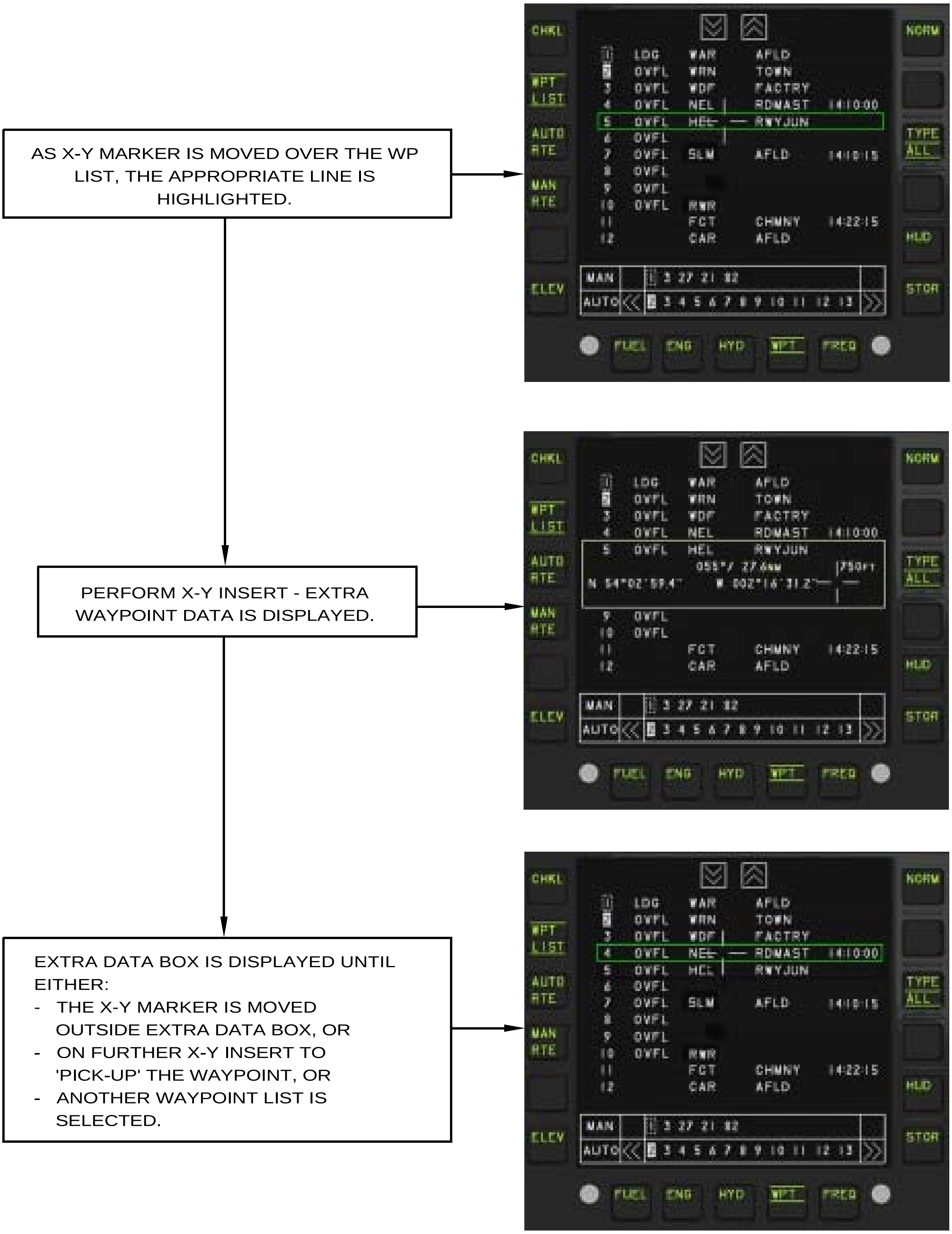


Figure 1.146 - Extra Data on Waypoints (WPT Format)

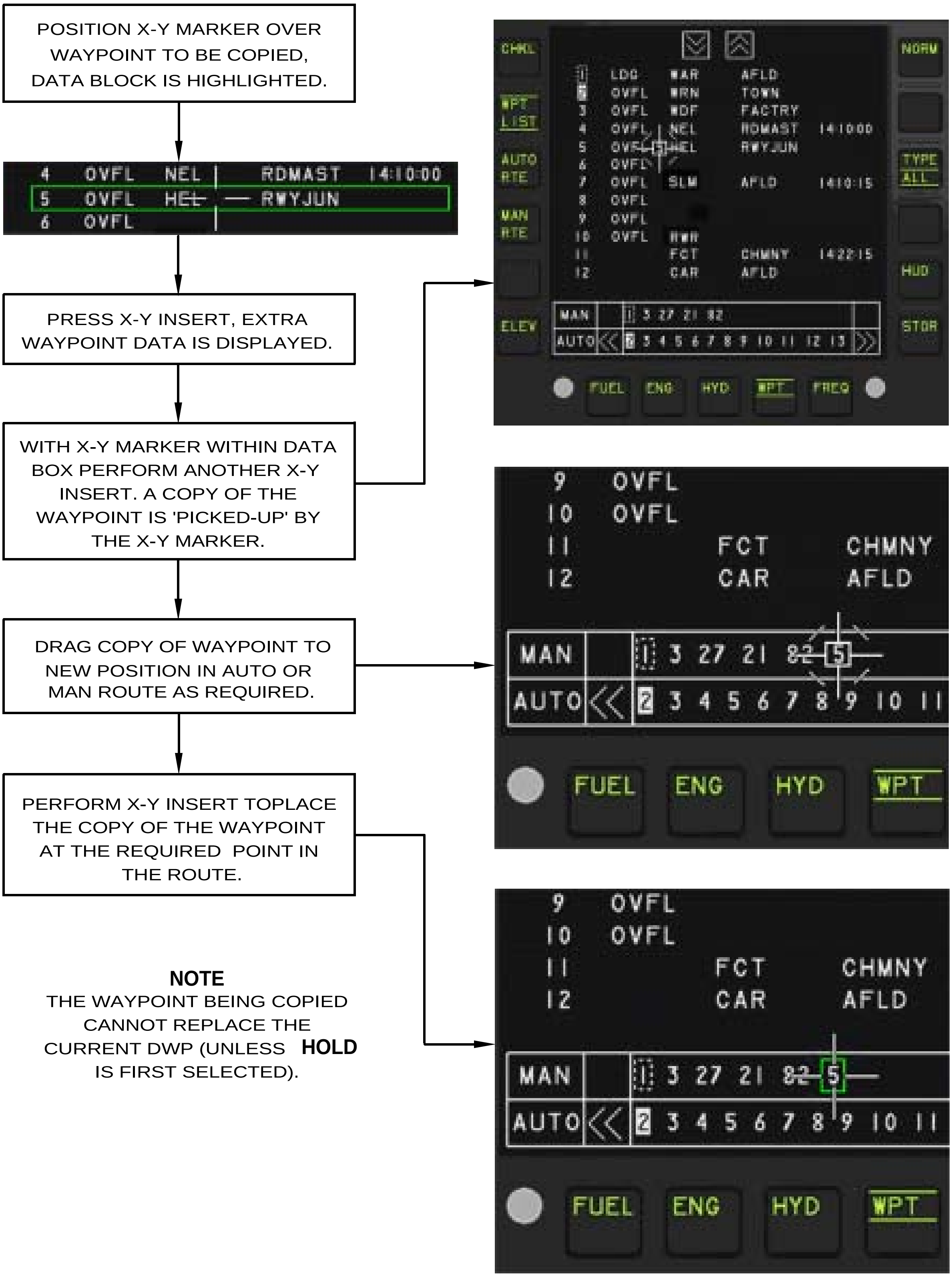


Figure 1.147 - Copying Waypoints

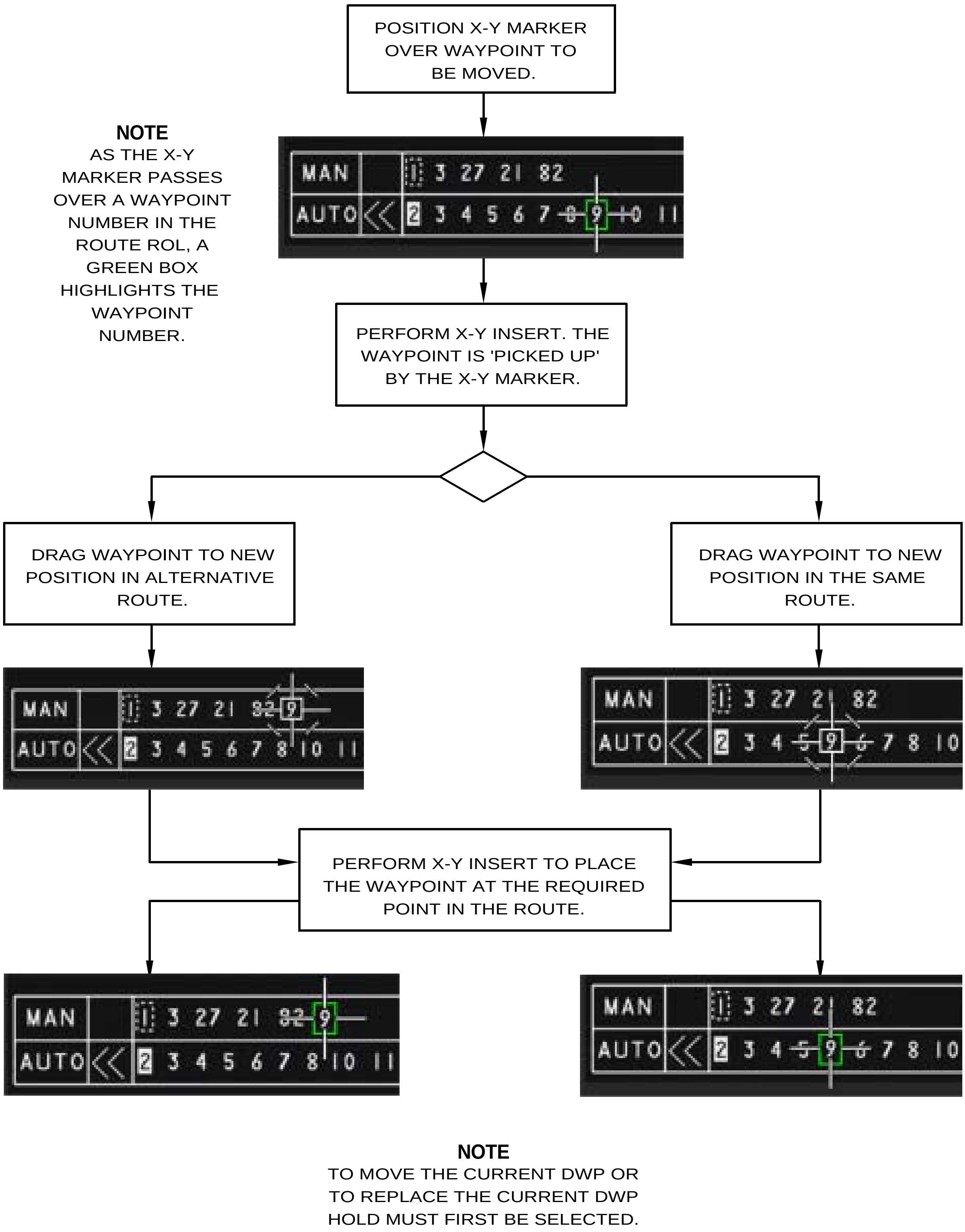


Figure 1.148 - Moving Waypoints

NOTE
THIS PROCEDURE ONLY REMOVES WAYPOINTS FROM THEIR RESPECTIVE ROUTES, THE WAYPOINTS ARE STILL RETAINED IN THE MASTER WAYPOINT LIST.

POSITION X-Y MARKER OVER WAYPOINT TO BE REMOVED.

PERFORM X-Y INSERT. THE WAYPOINT IS 'PICKED UP' BY THE X-Y MARKER.

DRAG WAYPOINT TO THE WAYPOINTS LIST.

PRESS X-Y INSERT TO RELEASE THE WAYPOINT.

NOTE
TO REMOVE THE CURRENT DWP **HOLD** MUST FIRST BE SELECTED.

Figure 1.149 - Removing Waypoints

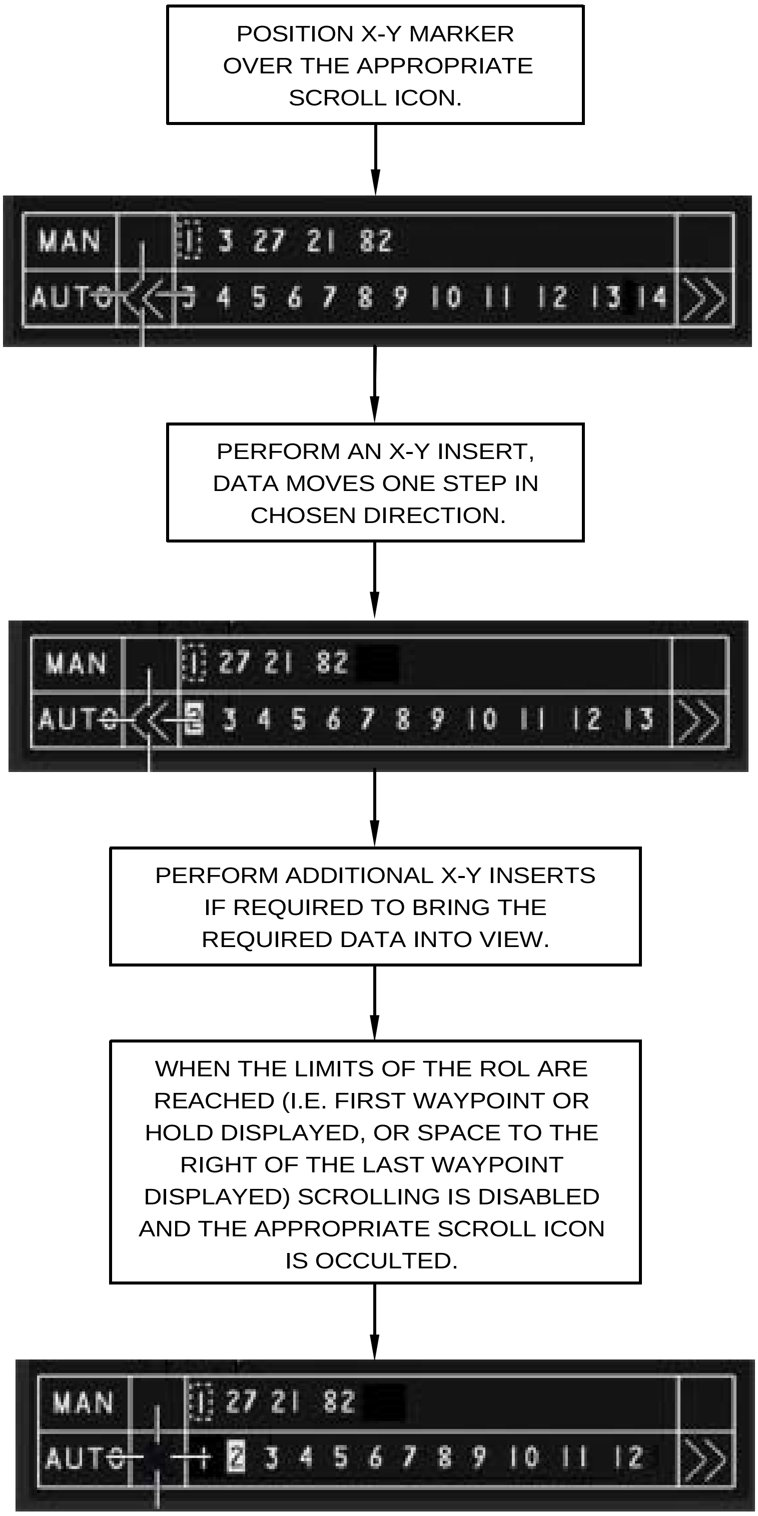


Figure 1.150 - Scrolling Route ROL

NOTE

THE FOLLOWING EXAMPLES SHOW THAT THE AUTO ROUTE CONTAINS ITS MAXIMUM ALLOWABLE NUMBER OF WAYPOINTS (50), I.E.

AUTO CHANGES TO **AUTO**

SIMILARLY, IF THE MAN ROUTE IS FULL

MAN CHANGES TO **MAN**

POSITION X-Y MARKER OVER THE APPROPRIATE RESET ICON.

PERFORM AN X-Y INSERT, DATA IN THE ROL IS CHANGED TO SHOW DWP IN THE LEFT HAND POSITION IF THE ROUTE IS BEING FLOWN, OR THE JWP IF THE ROUTE IS NOT BEING FLOWN.

Figure 1.151 - Resetting Route ROL

PERFORM X-Y INSERT OVER THE 'WINDOW 'ICON.

'WINDOW-ON-THE-WORLD' MODE IS ENGAGED.

THE X-Y MARKER:
- IS HIGHLIGHTED
- IS ANNOTATED WITH A 'W'
- JUMPS TO THE CENTER OF THE SCREEN.

THE **DFLT** SK REMODES TO EITHER **RTN PP** (IF A/C STABILIZED) OR **RTN DWP** (IF GND STABILIZED)

THE DISPLAYED AREA IS NOW SLAVED TO THE X-Y CONTROLLER.

SLEW THE DISPLAY UNTIL THE REQUIRED AREA IS IN VIEW.

PERFORM A FURTHER X-Y INSERT TO RELEASE THE WINDOW IN THE REQUIRED LOCATION AND TO CANCEL WINDOW-ON-THE-WORLD MODE.

DISPLAY CAN BE RETURNED TO THE PREVIOUSLY SELECTED MAP MODE BY SELECTION OF THE **RTN PP** SK (IF A/C STABILIZED) OR **RTN DWP** SK (IF GND STABILIZED).

Figure 1.152 - Window-On-The-World Selection

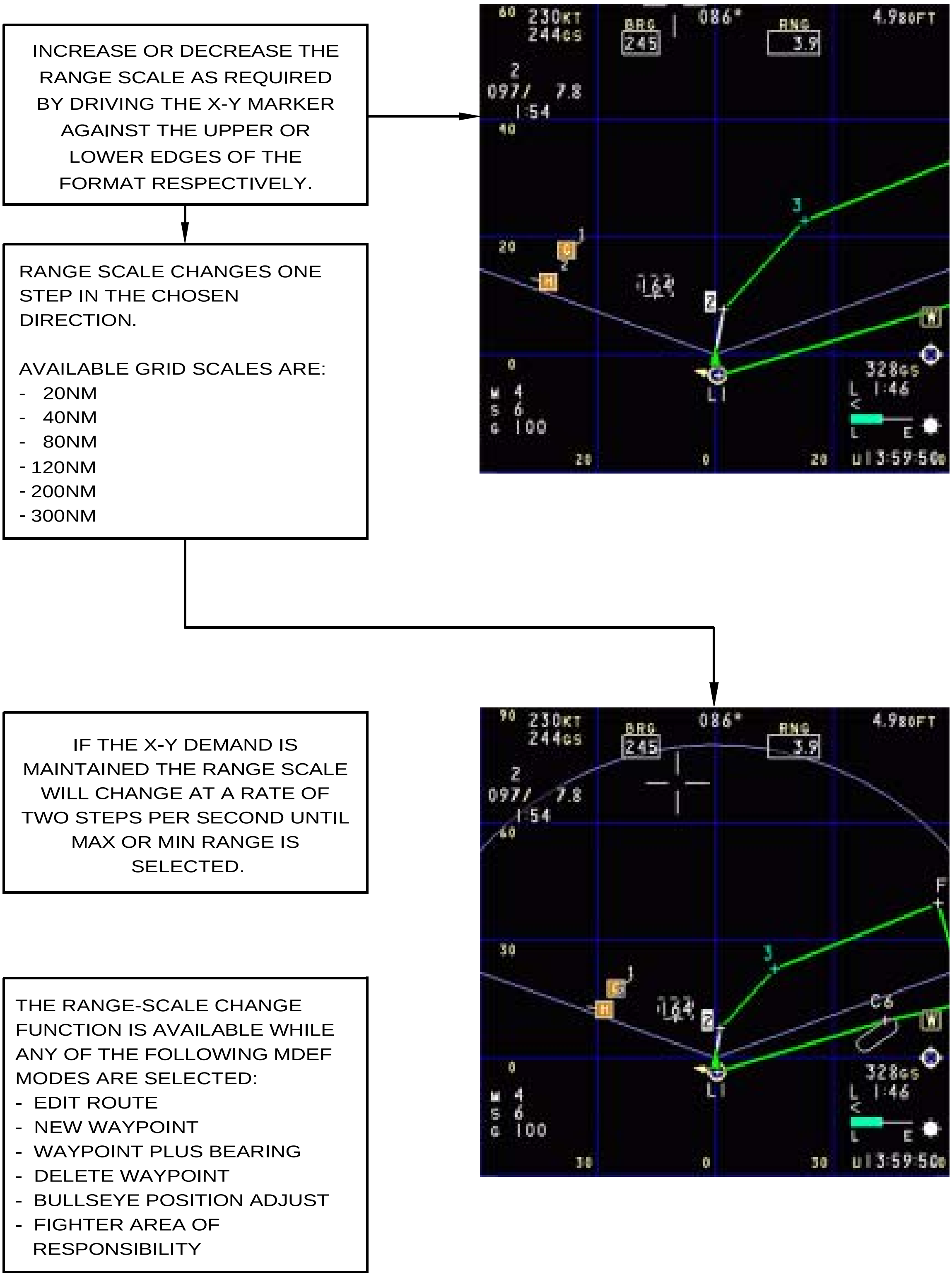


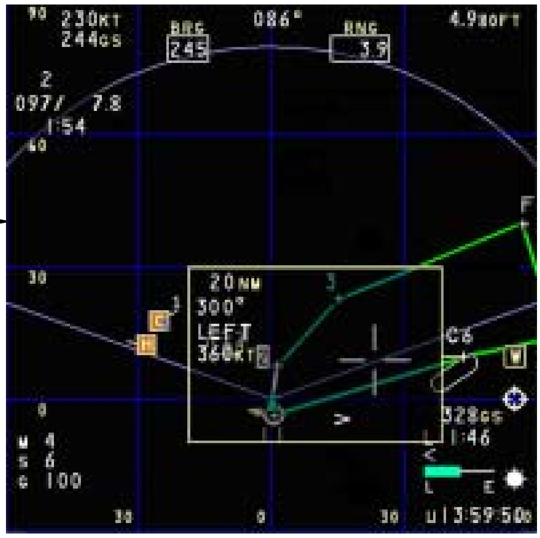
Figure 1.153 - Display Range-Scale

PERFORM A SINGLE X-Y INSERT OVER THE REQUIRED WAYPOINT.

EXTRA WAYPOINT DATA IS DISPLAYED AS FOLLOWS:
- WP NUMBER
- IDENTIFIER
- DESCRIPTION
- ELEVATION (TO NEAREST 10 FEET)
- BEARING
- RANGE (TO NEAREST NM)
- TIME TO WAYPOINT ALONG ROUTE
- PLANNED TIME OF ARRIVAL (IF DEFINED) OR TIME OF CREATION (MARK WP ONLY)
- PLANNED AIRCRAFT ALTITUDE AT WAYPOINT (IF DEFINED)

FOR CAP WAYPOINTS EXTRA INFORMATION IS PRESENTED ON TWO PAGES. '>' INDICATES SECOND PAGE AVAILABLE
THE FIRST PAGE PRESENTS THE FOLLOWING CAP PATTERN DATA:
- LENGTH
- ORIENTATION (OUTBOUND LEG)
- DIRECTION (LEFT OR RIGHT)
- SPEED

X-Y INSERT WITHIN THE BOX PRESENTS SECOND PAGE (AS ABOVE).



NOTE
EXTRA DATA BOX IS ALSO PRESENTED ON FIRST X-Y INSERT IN THE FOLLOWING MODES:
- NEW WAYPOINT (NWP)
- EDIT ROUTE (RTE)

EXTRA DATA BOX DISPLAYED FOR AS LONG AS X-Y REMAINS ON DWP
EXTRA DATA BOX OCCULTS:
- 3 SECS AFTER X-Y MARKER LEAVES SYMBOL AND X-Y MARKER IS NOT IN EXTRA INFORMATION BOX (AND THE BOX HAS MORE THAN ONE PAGE)
- ON SELECTION OF DFLT SK
- ON X-Y INSERT ON ANOTHER SYMBOL

Figure 1.154 - Extra Data on Waypoints (PA Format)

NOTE
GROUNDSPEED IS NOT SHOWN
BY DEFAULT ON POWER UP
UNLESS 'ON' IS DEFINED BY PSMK.

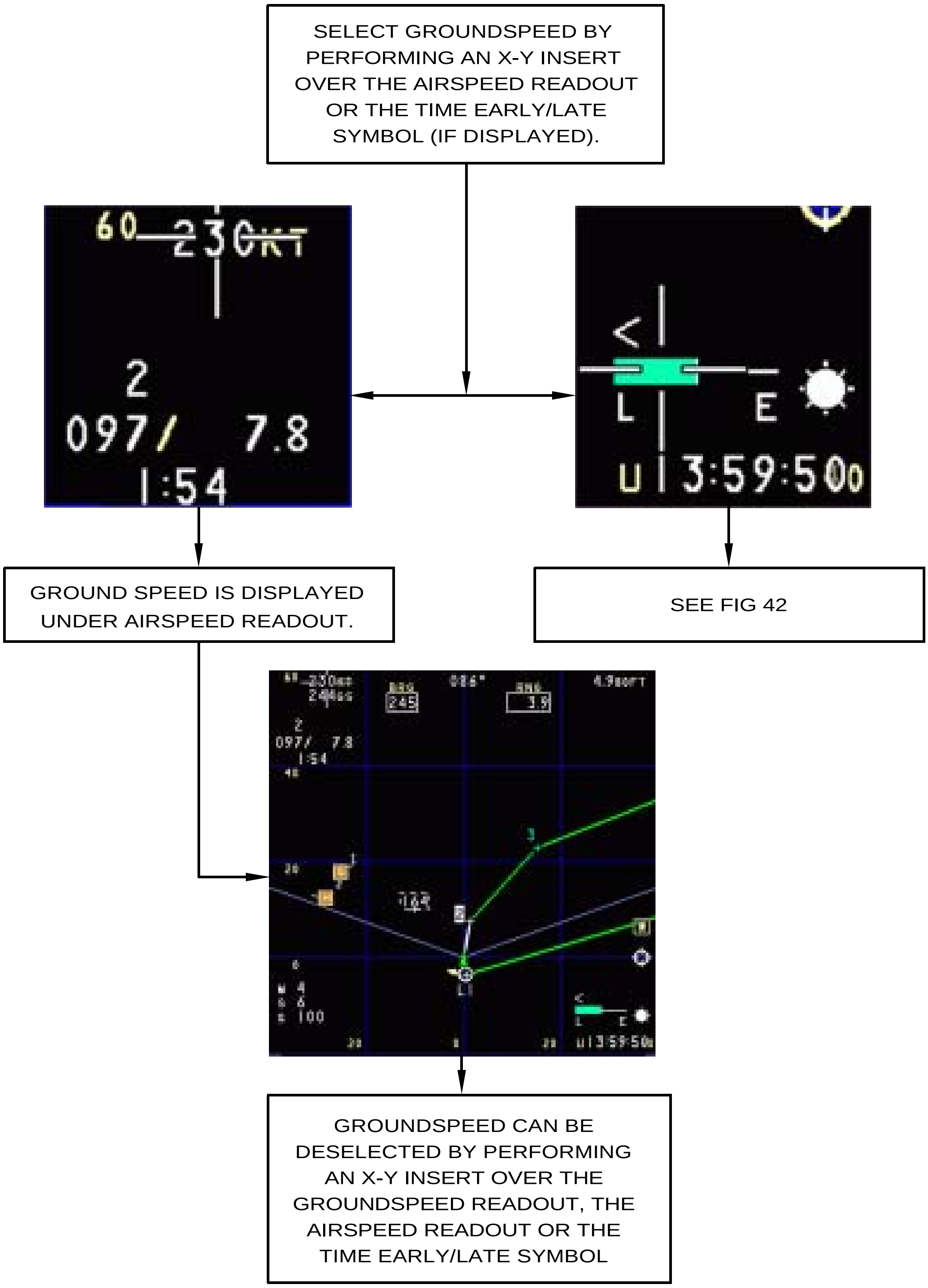


Figure 1.155 - Groundspeed Indication

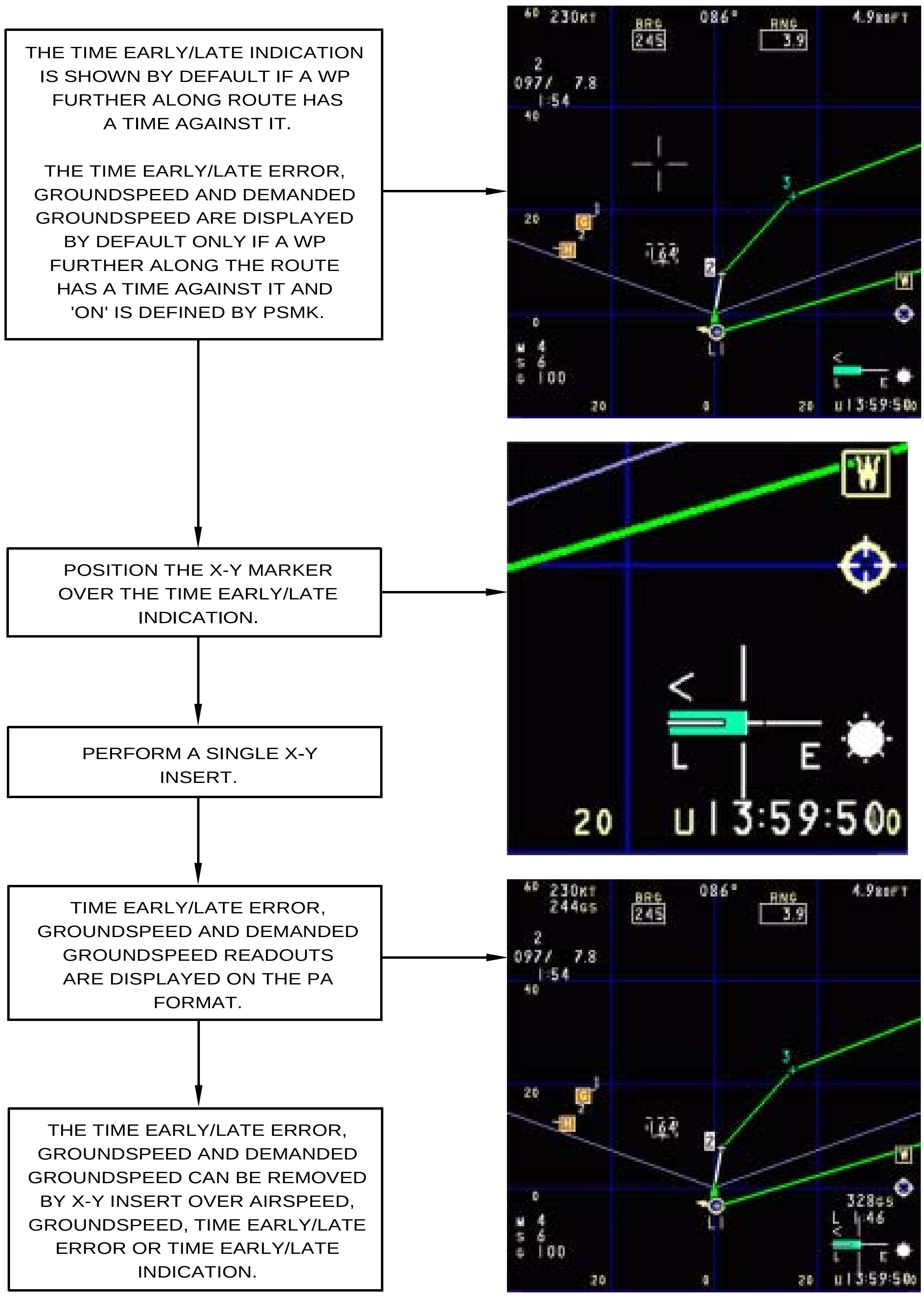


Figure 1.156 - Time Early/Late

POSITON X-Y MARKER OVER THE TIME DISPLAY.
TIME OF DAY (UTC TIME) DISPLAYED BY DEFAULT ON POWER UP.

PERFORM A SINGLE X-Y INSERT.

ALTERNATIVE (MISSION) TIME IS DISPLAYED.

NOTE
FIRST SELECTION ON GROUND WILL START/RESET MISSION TIME.

MISSION TIME, IF NOT MANUALLY STARTED, WILL START AUTOMATICALLY WITH WEIGHT-OFF-WHEELS.

Figure 1.157 - Time Reference Selection

THE **FIX OTF** SK IS ONLY PRESENTED IF A MODE THAT PERMITS OTF IS AVAILABLE, I.E. LINS+FIX (WITH KALMAN FILTER), LINS+FIX OR FCS+FIX, AND THE DWP IS AN OVERFLY, LANDING OR FUEL WP.

SELECT THE **FIX OTF** SK PRIOR TO ARRIVAL AT THE OVERFLY POINT. X-Y MARKER JUMPS TO THE FORMAT EDGE ADJCENT TO SK.

PERFORM AN X-Y INSERT WHEN OVER THE OVERFLY POINT.

SYSTEM DETERMINES THE ACCURACY OF THE FIX AND DISPLAYS AN ESTIMATE OF FIX ERROR AND RECOMMENDATION FOR ACCEPT OR REJECT.

MULTIPLE X-Y INSERTS MAY BE PERFORMED WITH A NEW ERROR AND ACCEPT OR REJECT RECOMMENDATIONS PRODUCED ON EACH OCCASION.

SELECT **FIX ACPT** OR **FIX REJT** SK AS REQUIRED.

IF **FIX ACPT** IS SELECTED THE NAVIGATION COMPUTER 'BEST' POSITION IS UPDATED WITH THE FIX POSITION.

IF **FIX REJT** IS SELECTED THE FIX ERROR IS REJECTED BY THE SYSTEM AND NO UPDATE OCCURS.

NOTE

OTF MODE IS DESELECTED BY

- PRESSING THE **FIX OTF** SK
- PRESSING THE **FIX ACPT** OR **FIX REJT** SK
- PRESSING THE **DFLT** SK
- PRESSING THE **MKR LOC** SK
- SELECTING SACQ, SRAAM SLAVED OR VISIDENT MODE
- SELECTING THE HSI FORMAT
- CHANGING THE DWP (AUTOMATICALLY OR BY THE PILOT ACTION).

Figure 1.158 - On-Top-Fixing

PERFORM AN X-Y INSERT
OVER THE PP SYMBOL.

EXTRA DATA ASSOCIATED WITH PP
IS DISPLAYED IN A BOX AS FOLLOWS:
- LATITUDE
- LONGITUDE
- GPWS FOM
- NAV SOURCE
- POSITIONAL ERROR
  (ESTIMATED)

BOX OCCULTS AUTOMATICALLY
3 SECS AFTER X-Y MARKER IS
MOVED AWAY FROM THE
PP SYMBOL.

Figure 1.159 - Extra Data on Present Position

NOTE
BULLSEYE ICON IS SHOWN BY DEFAULT IF SELECTED RECTANGULAR GRID SCALE IS 20NM OR GREATER AND A BULLSEYE HAS BEEN DEFINED.

PERFORM AN X-Y INSERT OVER THE BULLSEYE GRID ICON.

BULLSEYE GRID REPLACES RECTANGULAR GRID.

BULLSEYE GRID CENTERED ON BULLSEYE SYMBOL, ALLOWING PILOT TO REFER RANGES AND BEARINGS RELATIVE TO BULLSEYE.

BEARING AND RANGE OF PP FROM BULLSEYE REPLACES WAYPOINT DATA (TOP LEFT OF DISPLAY).

NORTH SOUTH LINE, TO AID ORIENTATION, REPLACES NORTH INDICATION ON BULLSEYE SYMBOL.

NOTE
WHEN THE RANGE OF PP FROM THE BULLSEYE POINT IS GREATER THAN 300NM, THE GRID IS OCCULTED.

RANGES AVAILABLE ARE 320, 200, 120, 80, 40, AND 20NM. RANGE SCALE MAY BE ALTERED BY X-Y 'BUMPING' (SEE FIG 39).

WHEN SELECTING BETWEEN THE BULLSEYE GRID AND THE RECTANGULAR GRID THE CURRENTLY SELECTED SCALE WILL BE CARRIED ACROSS FROM ONE GRID TO THE OTHER.

RESELECTION OF BULLSEYE GRID ICON OR SELECTION OF **DFLT** SK RETURNS DISPLAY TO RECTANGULAR RANGE GRID.

Figure 1.160 - Bullseye Grid Selection

PERFORM AN X-Y INSERT OVER THE GRID ICON TO TOGGLE THROUGH THE GRID TYPES. GRID ICON INDICATES GRID TYPE SELECTED
- 'R' INDICATES RANGE
- 'G' INDICATES GEOREF
- 'L' INDICATES LAT/LONG

DMG COLOR PALETTE SELECTION

X-Y INSERT OVER THE PALLETTE ICON TOGGLES BETWEEN THE TWO AVAILABLE COLOR PALETTES.

THE FIRST PALETTE OPTIMIZES THE DISPLAY FOR 'BEST MAP'

THE ALTERNATIVE PALETTE EFFECTIVELY DIMS THE DISPLAY TO 80% OF THE BRIGHTNESS OF THE OPTIMUM VALUE (THE VALUE MAY BE REDEFINED BY PSMK). THIS IS TO HELP DIFFERENTIATE THE OVERLYING SYMBOLOGY FROM THE UNDERLYING MAP WHEN CERTAIN TOPOGRAPHY IS DISPLAYED.

Figure 1.161 - Selecting Grid Options and DMG Color Palette

TO DISPLAY THE ZOOM PICTURE PERFORM A LONG X-Y INSERT ON A TRACK OR TARGET SYMBOL OR BLANK AREA OF THE FORMAT.

ONCE THE ZOOM PICTURE IS DISPLAYED THE X-Y RETURNS TO ITS DEFAULT STATE.

THE ZOOM PICTURE IS GROUND STABILIZED IF THE INSERT IS PERFORMED OVER A WAYPOINT OR BLANK AREA OF FORMAT (INDICATED BY THE 'GROUND' LEGEND BEING DISPLAYED).

THE ZOOM PICTURE IS TRACK STABILIZED IF THE INSERT WAS PERFORMED OVER A TRACK OR TARGET SYMBOL (INDICATED BY THE 'TRACK' LEGEND BEING DISPLAYED).

WHILST ZOOM IS SELECTED:
- THE A/C AND GND STABILIZATION SK IS NOT AVAILABLE FOR SELECTION
- WINDOW ON THE WORLD AND RANGE CHANGING ARE NOT AVAILABLE.

THE SCALE OF THE ZOOM WINDOW IS DICTATED BY THE PA SCALE WHEN ZOOM IS SELECTED AS FOLLOWS:

PA SCALE (NM)	ZOOM SCALE (NM)
3 - 5	3
10 - 20	5
40	10
80	20
200 - 120	40
320	80

ZOOM PICTURE MAY BE CANCELLED BY X-Y INSERT OVER ANY BLANK AREA INSIDE THE ZOOM PICTURE.

Figure 1.162 - Zoom Window

MISCELLANEOUS MDE AND X-Y FUNCTIONS

The Manual Data Entry Facility (MDEF) allows data to be manually entered or manipulated within the aircraft's avionics subsystems.
The Miscellaneous Subsystem is selected using the MISC Subsystem Key (SSK) located with the other MDEF SSK on the left glareshield (Figure 1.163 shows the default moding). Once selected, modes applicable to the MISC Subsystem can be selected by use of the moding keys. Data is able to be entered/manipulated via the Data Entry Keyboard (DEK) and Toggle Switch (TS).
Data relevant to the MISC SS is displayed on the Read Out Lines (ROL), the MHDD and the HUD.
Within the MISC SS the following functions are available:

- The stopwatch, which consists of two distinct modes:
  - Time elapsed (normal stopwatch or ‘count-up’ moding)
  - Count-down (of a variable time period)
- Bogus AMRAAM selection
- Lamps Test procedure
- Automatic Crypto Variable Suppression System
- Tracked Target Simulation
- Video Voice Recorder
- Fuel Bingo moding
- Ground Proximity Warning System

STOPWATCH COUNT-UP MODING

On initial selection of the MISC SS the CNTU MK is selected by default, the DEK and ROL configure accordingly and an indication of the stopwatch time is displayed on the HUD and HDHUD (Figure 1.164). In CNTU mode the pilot has several options:

- To start/restart the timer by selecting the STRT TIME control. Once selected the MK configure to enable the timer to be stopped (via the STOP TIME MK) or for the split time mode to be selected (via the SPLT TIME MK).
- To halt the time display while the timer continues to run by selecting the SPLT TIME control. When selected the MDEF ROL and HUD/HDHUD reconfigure to show both the split time and the elapsed time.
- To stop the timer (STOP TIME MK) and halt the time display to show the elapsed time only (the split time, if selected, is occulted). When selected the MK reconfigure to enable the timer to be restarted (STRT TIME MK) or reset to zero (RSET TIME MK).
- To reset the timer back to zero by selecting the RSET TIME MK. When selected the MDEF ROL and HUD/HDHUD readout are reset to zero time and the MK configure to enable the timer to be started.

Stopwatch elapsed time (and split time, if selected) are displayed on the MDEF ROL, HUD and HDHUD. To cancel the CNTU mode completely an alternative stopwatch mode must be selected, i.e. CNTD mode. If the CNTU mode is subsequently re-selected the timer is reset to zero.

STOPWATCH COUNTDOWN MODING

The CNTD MK is used when a standard countdown function is required (Figure 1.165). Once selected the MK reconfigure to show that the countdown mode has been selected and the ROL display dashes ready for a countdown time to be specified (dashes are also presented on the HUD and HDHUD). Once the time has been specified the pilot has several options:

- Start/restart the countdown clock by selecting the STRT TIME MK. Once selected the MK reconfigure so that the timer can be stopped or the split time mode can be selected. The ROL, and HUD/HDHUD show the elapsed countdown time.
- Halt the time display while the clock continues to run by selecting the SPLT TIME MK. The ROL and HUD/HDHUD show the split time and the elapsed time with the timer still running.
- Stop the countdown clock and halt the time display by selecting the STOP TIME MK. The ROL and HUD/HDHUD show the time at which the MK was selected and the MK reconfigure so that the timer can be restarted or reset.
- Reset the countdown time to the initial value previously entered when the stopwatch has been stopped before it has reached the end of the countdown period (via the RSET TIME MK). Selecting the STRT TIME MK starts the timer. Alternatively, the pilot can select the DEK CLR key, which sets the ROL to dashes to allow a new countdown time to be entered.

Once the stopwatch has completed the countdown, i.e. the ROL show ‘00:00:00’, the ROL automatically reconfigure to show the previously defined countdown value, and the MK reconfigure to allow the timer to be restarted. The ‘00:00:00’ indication on the HUD/HDHUD will also flash for 5 seconds at 2Hz before reconfiguring to show the specified start time. If any other MDEF timer modes are selected within the 5 seconds the HUD/HDHUD readout reconfigure to reflect the selected modes.

DISPLAY WATCH

The DISP WTCH MK is selected (boxed) by default when entering the MISC SS to indicate that a

stopwatch function is available and/or in use. When an alternative MK is selected from the MISC SS which has an associated DEK/ROL input (e.g. FUEL BNGO), then the DISP WTCH MK is unboxed and the stop-watch second level functions (STRT TIME, CNTU, CNTD etc.) are occulted. Subsequent selection of this control allows the stopwatch facilities to be re-accessed.
On deselection of the MISC SS (or the Display Watch Facility) the HUD/HDHUD stopwatch indication will still be presented if the timer is in the running, stopped or split time condition. However, if the timer is in the reset condition the HUD/HDHUD stopwatch indication will be occulted. On returning to the MISC SS (or reselecting the Display Watch Facility) the ROL reconfigure to display the CNTU stopwatch data, unless the CNTD mode had previously been selected and is running, stopped or split.

BOGUS AMRAAM

The BGUS AMR MK (Figure 1.166) is boxed by default on entering the MISC SS provided that bogus AMRAAM have been loaded into the Armament Control System (ACS) via the Maintenance Data Panel (MDP) or Portable Data Store (PDS) using the standard weapon package loading procedure. The ACS behaves in the same way as if the plane were armed. The BGUS AMR MK is occulted if bogus AMRAAM is not loaded or if any live weapons are fitted. The symbology displayed on the HUD and MHDD formats is the same as utilized for real weapons and the simulated decrement of weapons, as they are fired, are also indicated on the HUD/ MHDD.
Provided there are no ‘missiles’ in flight, pressing the BGUS AMR resets the AMRAAM configuration to its initial setting on take-off. The BGUS AMR MK will be occulted when one or more ‘missiles’ are in flight.
During bogus mode the FCS and Propulsion interfaces reflect the actual conditions existing on the aircraft, i.e. as a result of simulated firing no store station mass changes occur and no additional engine control is necessary.

LAMPS TEST

It is intended that the main users of the Lamps Test will be maintenance engineers who will use this facility during periodic aircraft servicing, or as directed by post flight reports of aircrew who have experienced or suspect display element failure. As a confidence check, however, it is also possible for aircrew to use the Lamps Test when the aircraft is stationary on the ground.
Two different types of lamps test are available - one to test the dedicated indicators and another to test the multifunction programmable displays. Dedicated indicators are indicators that show an unchanging caption or legend, but which may be highlighted in some way to show availability or selection. Multifunction displays refer to any area formed from matrices of LED and include both multifunction keys and alphanumeric display areas. Dedicated indicators are able to be tested in the traditional way, i.e. by means of simultaneous illumination across the entire cockpit. However, due to the large number of LED that are used in the multifunction displays, the simultaneous illumination of large blocks of LED would require the use of unacceptable levels of power, and would result in the production of excessive heat, leading in turn to display failures. Therefore blocks of LED are illuminated sequentially by means of software controlled test routines. To this end the LAMPS TEST MK selects a menu of lamps test options (Figure 1.167). A full menu is available with weight-on-wheels and provided the NH value for both engines is less than or equal to 70% NH. If these criteria are not met then the BULB TEST MK is the only option available. In twin seat aircraft the selection of the LAMP TEST in either cockpit initializes the same test in both cockpits simultaneously.

DEDICATED INDICATORS

The dedicated indicators are tested by depressing and holding the BULB TEST MK. The dedicated indicators are as follows:

– Front and rear cockpit; Attention getters (2 Hz flashing, inhibited in flight), DWP REV, DWP PAGE, POF indicators, arrestor hook (inhibited in flight), undercarriage (reds and greens, inhibited in flight).
– Front cockpit only; VVR record.

The level to which the indicators illuminate depends upon the level currently set by the Lighting Controller. On release of the MK the dedicated indicators return to their previous status. Dedicated indicators are available for test at any time.

While the bulb test is being performed the normal functioning of the attention getters and of the DWP is disabled and any incoming warning is queued for the display, although the voice warning will play as normal. When the BULB TEST MK is released the normal functioning of the attention getters and DWP is restored and the DWP displays any queued warning.

NOTE

- Some dedicated indicators are controlled by the Two State Dimmer Box (TSDB). These indicators are tested via a lamps test control, which is mounted on the forward right console on DA3 and DA4 or the rear left console on the other DA. Selection of this control illuminates the following dedicated lamps, if fitted:

  – LEFT/RIGHT FIRE *
  – APU RUN *
  – CANOPY *
  – PROBE UNLOCKED *
  – MSOC
  – SPIN PARACHUTE JETTISON
  – SPIN PARACHUTE STREAM/ GONE
  – SPIN WARNING
  – VOICE WARNING MUTE (DA2 ONLY, FOR SPIN TRIALS)
  – EPU RUN (DA2 ONLY)
  – EPU TEST BOX (DA2 ONLY)
  – AIRCRAFT YAW AND ROLL (FOR SPIN TRIALS).

- * Duplicated in the rear cockpit on twin seat aircraft.

- In addition, the following FCS indicators are excluded during a MDEF BULB TEST and/or console mounted lamps test, although these indicators may be tested by means of the FCS First Line Check (FLC) via the MHDD/ Maintenance Format:

  – FCS TAKEOVER CONTROL (TWIN SEAT ONLY) *
  – LIFT DUMP (REAR COCKPIT ONLY IN DA4 AND DA6)
  – REVERSIONARY FCS
  – FCS TEST BIT
  – FCS RESET (TOT AND NWS CAPTIONS) *
  – FCS CONFIGURATION OVERRIDE *
  – LEFT MANUAL INTAKE (DA1, 2 AND 3 ONLY)
  – RIGHT MANUAL INTAKE (DA1, 2 AND 3 ONLY).

* Duplicated in the rear cockpit on twin seat aircraft.

MULTIFUNCTION INDICATORS

For the purposes of testing the multifunction displays the cockpit is divided into eight separate functional areas, each possessing its own test routine. These areas are as follows:

– Left glareshield (LGS)
– HUD Control Panel (HUP)
– Right glareshield, including GUH displays (RGS)
– Right glareshield Flap (RGS FLAP)
– Left MHDD (MHDD L)
– Center MHDD (MHDD C)
– Right MHDD (MHDD R)
– Dedicated Warnings Panel (DED WP).

On selection of a MK that corresponds to a LED test routine the selected hardware performs a pre-defined test routine. A test routine cannot be interrupted once it has started and subsequent selection of the MK has no effect until the selected routine has finished. Once completed a routine may be re-instated. Any number of test routines can be selected simultaneously. On selection of a LED test routine the LED of that display are all occulted until illuminated as part of the test sequence.
If a Lamps Test was requested for each area in sequence then the total time for a full lamps test would take approximately 6 minutes.

LEFT GLARESHIELD

During the test routine the different areas of the LGS are illuminated in the following order:

– MDEF Data Entry Keyboard (DEK)
– MDEF Read Out Lines (ROL)
– Destination Waypoint Displays (DWP)
– Barometric Pressure Setting Facility (BARO SET)
– MDEF Subsystem Keyboard (SSK)
– Autopilot and Autothrottle Displays
– MDEF Moding Keyboard (MK).

During the test of the LGS all display elements not involved in the test sequence are occulted, apart from the Baro Set display and all engraved legends associated with the part of the LGS currently being tested. Consequently when the LGS routine is selected all the MDEF functions are temporarily disabled.
The total time for the test of the LGS is approximately 44 seconds.

HUD CONTROL PANEL

During the test routine the different areas of the HUP are illuminated in the following order:

– Left Multifunction Keys
– MIDS panel
– Right Multifunction Keys
– Left Engine Analogue and ROL displays
– Fuel ROL displays
– Right Engine Analogue and ROL displays

– Radio ROL displays.

The total time for the test of the HUP is approximately 24 seconds.

RIGHT GLAREHIELD

During the test routine the different areas of the RGS are illuminated in the following order:

– AOA Display
– Track Angle Error Display and Digital Heading Displays
– Airfield ID and Range to Destination Displays
– Airspeed Indicator Display
– Mach Indicator Display
– Vertical speed Indicator Display
– Altitude Indicator display.

If a test of the RGS is selected when the RGS flap is closed, the test will commence as normal but will terminate immediately after the completion of the illumination of the Airfield ID and Range to Destination displays.
The total time of the test of the RGS is approximately 34 seconds.

RIGHT GLARESHIELD FLAP

During the test routine the different areas of the RGS Flap are illuminated in the following order:

– Low Height Indicator Displays
– TACAN and MIDS Displays
– XPDR, IFF and NIS Displays.

The total time of the test of the RGS Flap is approximately 11 seconds.

MULTIFUNCTION HEAD DOWN DISPLAYS

Each MHDD is tested separately. When the routine commences any softkey captions that are displayed are occulted and the normal functioning of the softkeys is disabled.
During the test routine the different areas of the MHDD are illuminated in the following order:

– The six softkeys located on the left side of the MHDD
– The five softkeys located at the bottom of the MHDD
– The six softkeys located on the right side of the MHDD.

The total time for a test on each MHDD is approximately 62 seconds.

DEDICATED WARNING PANEL

When the routine commences any captions that are displayed are occulted.
At the start of the routine the normal functioning of the display panel itself is disabled for the entire duration of the test routine. The test of the display panel itself consists of the illumination of an entire block of red LED at the top of the display consisting of all the LED associated with a complete row of three warnings caption positions, including the caption boxes. The LED in this block are then extinguished and the LED in the next lower line are illuminated. This process is repeated until all the LED for the entire display have been illuminated. The sequence is repeated in exactly the same manner for the amber LED.
When the routine has finished the DWP returns to the state of display which was currently operative at the time the test was requested and the normal functioning is re-established.The total time for the test on the Dedicated Warning Panel is approximately 58 seconds.

TRACKED TARGET SIMULATION

Upon selection of the SIM TGT MK (Figure 1.168) the system generates a simulated target at 50 nm slant range from the host aircraft, 20° left of the host aircraft heading and at an altitude of 1000 ft below that of the host aircraft (with a minimum of 5000 ft above mean sea level). The target then ‘flies’ straight and level with a groundspeed of 400 kts on a reciprocal track to the host aircraft heading at initialization.
The mode can be manually deselected via a re-selection of the MK. Otherwise the mode automatically deselects 360 seconds after selection.

VIDEO VOICE RECORDER

The VVR MK allows the pilot to view the amount of elapsed time recorded, and an indication of the system status; either OFF, FAIL, STANDBY or RECORDING (Figure 1.169). The default state is SBY. The VVR can be set to record either manually (by selection of the VVR record switch on the right console) or automatically when any of the following conditions exist:

– On entering Combat POF
– Selection of Late Arm switch
– Trigger pressed to its first detent
– VISIDENT target less than 1 nm.

When all the automatic conditions have ceased the VVR enters the SBY state 15 seconds later unless the VVR is in manual mode. In this case the VVR continues to record until deselected by the pilot where upon it immediately enters the SBY state.

AUTOMATIC CRYPTO VARIABLE SUPPRESSION SYSTEM

The CRYP SUPP MK is used to mode the crypto variable warnings, i.e. voice warnings, DWP warnings and Autocue warnings (on ground only), between suppressed and unsuppressed (Figure 1.170).

The default setting at power-up is unsuppressed and crypto variable warnings are available. The unsuppressed state is indicated by the MK being unboxed.

Warnings are suppressed by selection of the MK, which is indicated by the MK being boxed. The suppression is automatically removed (MK becomes unboxed) and the warnings are shown if any of the following warnings occur:

– RAD1
– RAD2
– IFF - Transponder
– IFF - Interrogator.

The MK must be reselected for the suppression to be re-enabled.

If any crypto variables are loaded on power-up, then the suppression is removed and the MK is unboxed.

FUEL BINGO

Four fuel 'Bingo' levels may be defined which, when attained, generate one of four pre-defined CAT 4 warning messages. The fuel bingo levels may be defined via PDS load. If no data has been loaded then on selection of the FUEL BNGO MK the ROL will appear blank (Figure 1.171), with the exception of ROL 4 which displays the minimum landing fuel (200 kg). Fuel bingo levels may be entered manually. The last significant digit of each bingo variable is a fixed zero and cannot be altered by the pilot, i.e. fuel bingo levels can only be entered to the nearest 10 kg. Additionally, the validation check will fail if a bingo level is within 100 kg of another.

Bingo levels can be entered/modified in any order and there is no automatic re-ordering of bingo levels on the ROL as the pilot enters them, i.e. the bingo value in ROL 3 can be greater than that specified in ROL 2. In this case a 'BINGO 3' CAT 4 warning would be triggered before the 'BINGO 2' warning as 'BINGO 3' is the first achieved fuel state.

A bingo level can be specified with a value greater than the fuel contents of the aircraft. If this occurs there is no data checking process to highlight that the bingo level exceeds the current fuel state.

GPWS MODING

The GPWS is available in all POF. When the aircraft is initially powered-up the default setting is ON. The GPWS/PAGE MK indicates the GPWS ON/OFF state - ON is indicated by the GPWS legend being boxed, OFF indicated by the legend being unboxed (Figure 1.172).

Selection of the GPWS/PAGE MK remodes the moding keys such that the GPWS ON/OFF MK is presented. GPWS ON (boxed) will be displayed on initial power-up. Selection of the MK will select the GPWS to OFF (GPWS OFF displayed). With the GPWS selected to OFF all GPWS warnings and symbology are inhibited apart from the following:

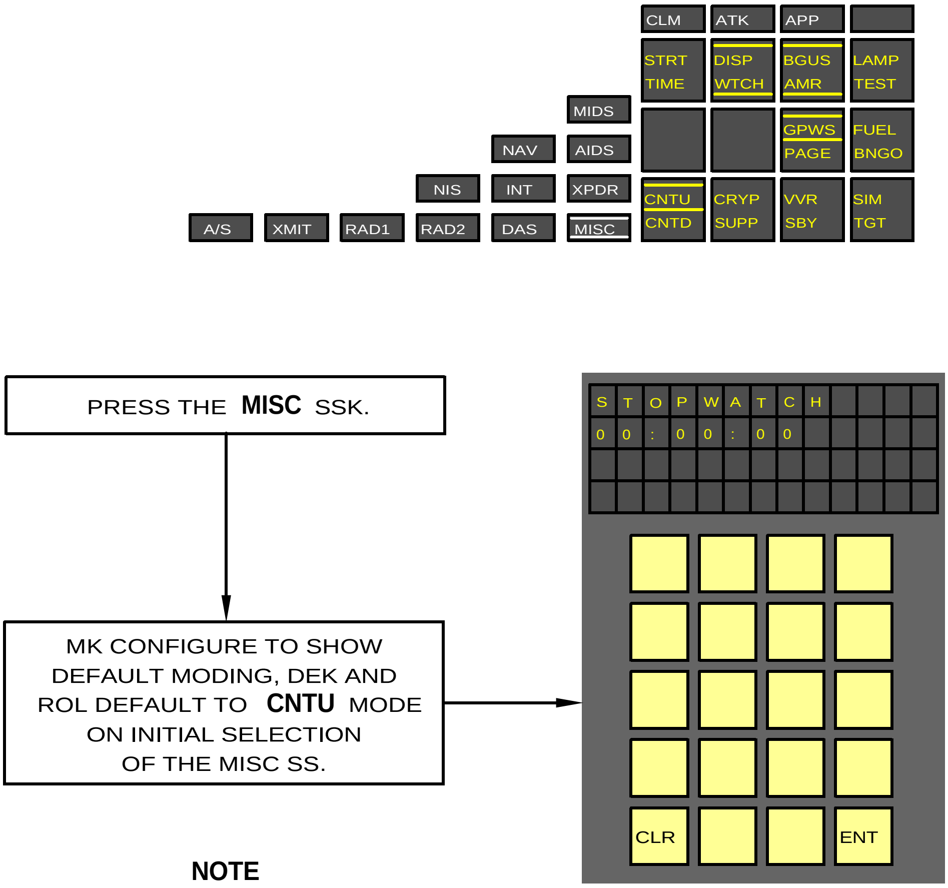
– The GPWS DWP warning and associated voice warning
– The MSD display on the MDEF and MHDD/ ACUE format
– The 'GPWS AVAIL' legend on the MHDD/PA format
– The height and position Figure of Merit (FOM) indications on the MHDD/PA format.

With the GPWS/PAGE MK selected, irrespective of whether the GPWS is ON or OFF, the ROL also configure to show the Minimum Separation Distance (MSD) that has been loaded via PDS. If no MSD has been loaded the ROL will show the default MSD of 50 ft.

NOTE

- The pilot does not have the facility to alter the MSD via the MDEF.

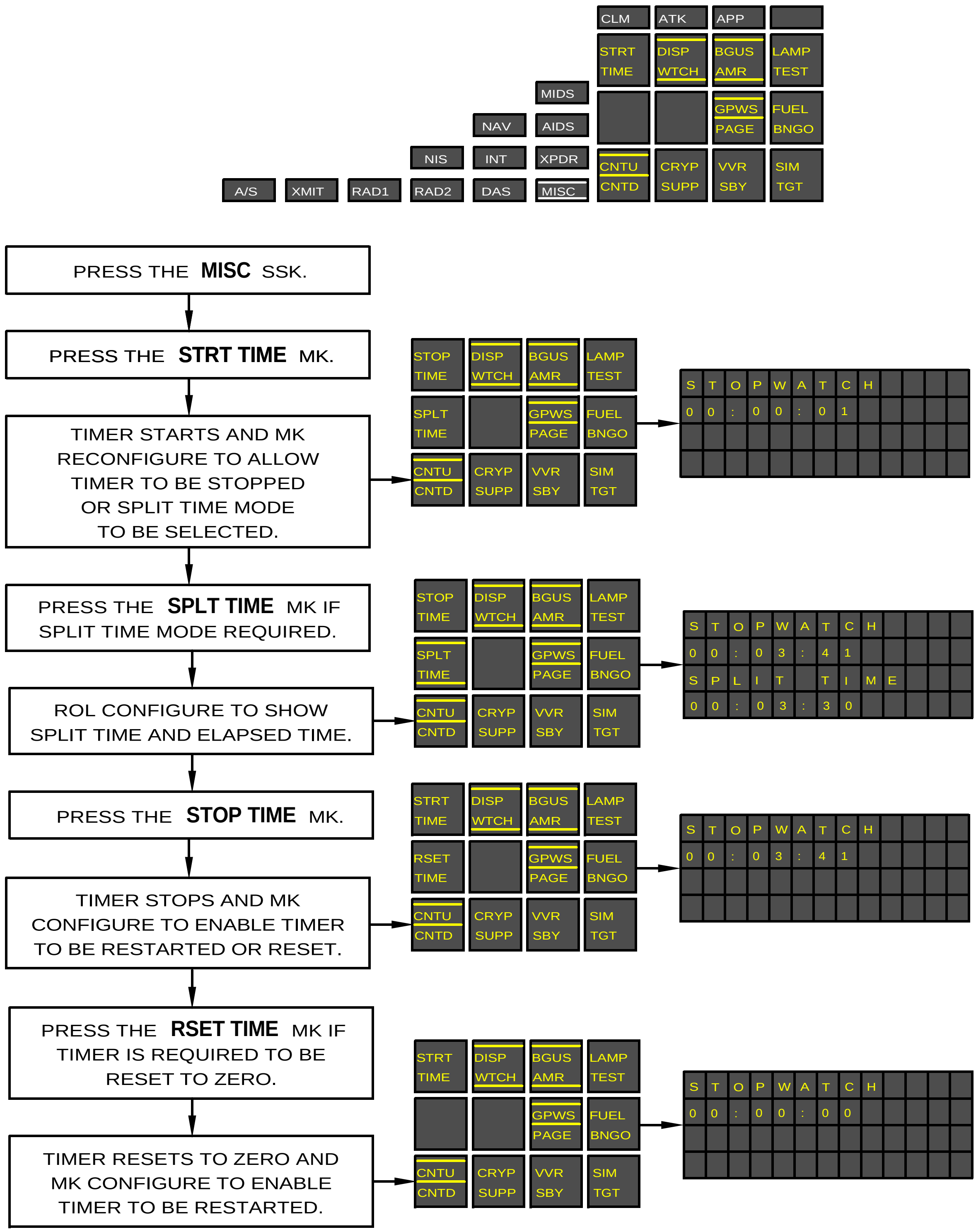
Reselecting the GPWS/PAGE MK displays the main MISC SS page.



NOTE

BGUS AMR MK IS ONLY PRESENTED WHEN LIVE WEAPONS ARE NOT FITTED AND BOGUS WEAPONS HAVE BEEN LOADED VIA THE MDP

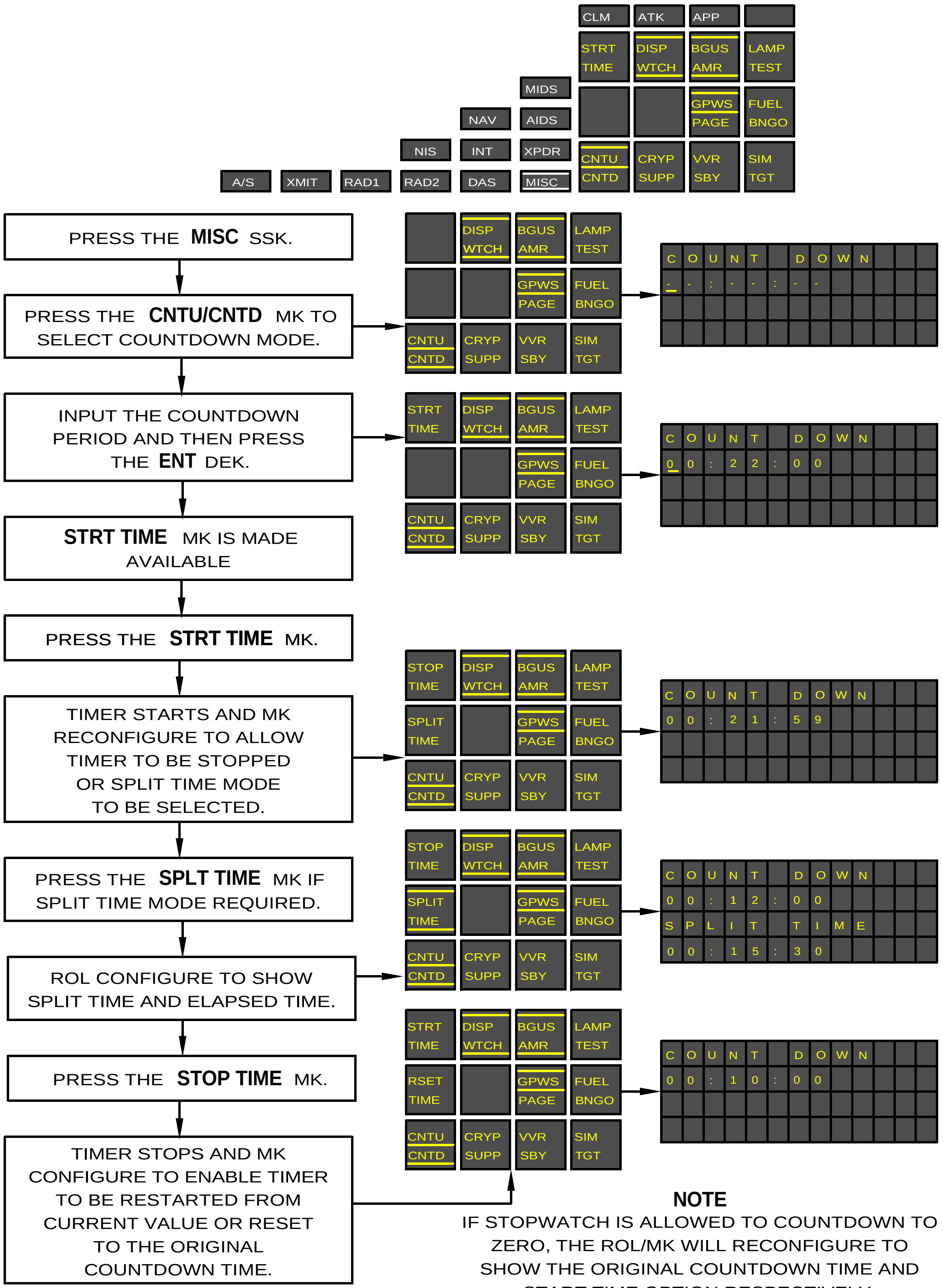
Figure 1.163 - Miscellaneous SS Default Moding



NOTE

STOPWATCH SPLIT TIME AND ELAPSED TIMES ARE ALSO DISPLAYED ON THE HUD.

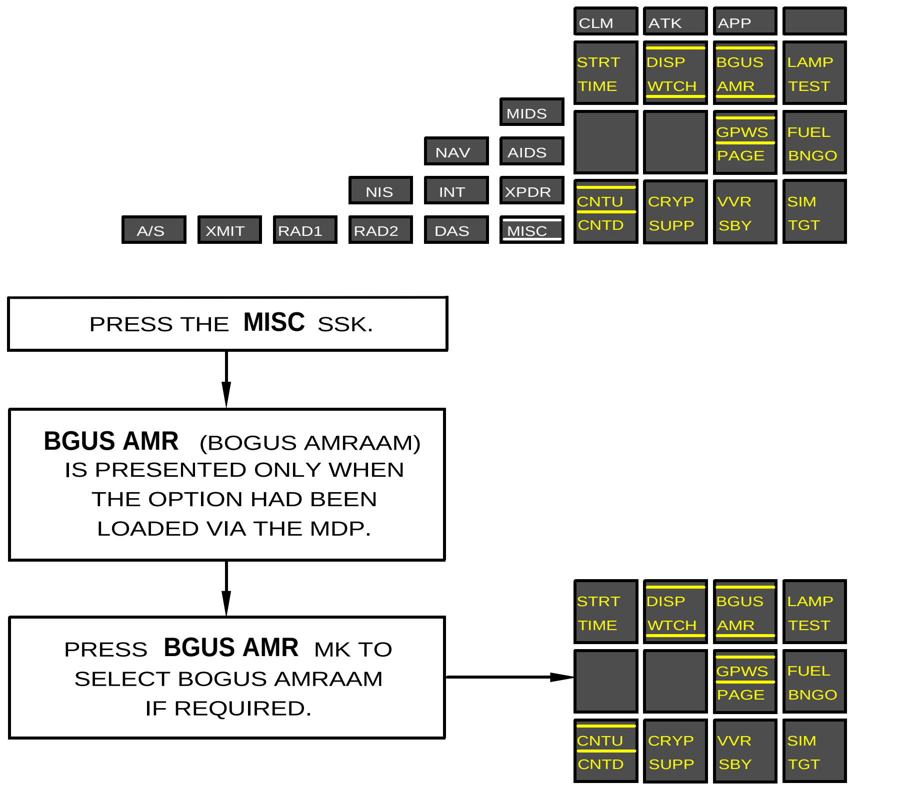
Figure 1.164 - Stopwatch - Count-Up Moding



NOTE

IF STOPWATCH IS ALLOWED TO COUNTDOWN TO ZERO, THE ROL/MK WILL RECONFIGURE TO SHOW THE ORIGINAL COUNTDOWN TIME AND START TIME OPTION RESPECTIVELY.

Figure 1.165 - Stopwatch - Countdown Moding



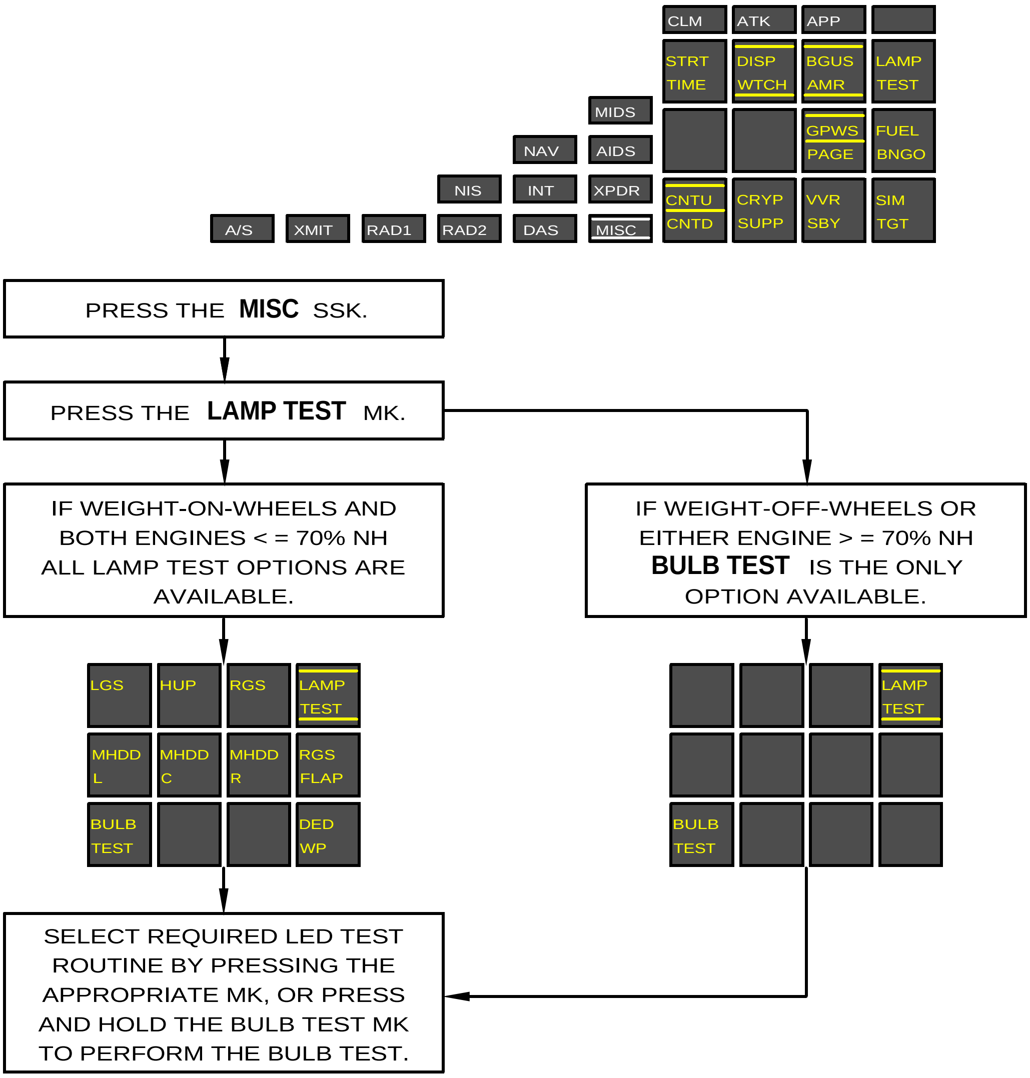
NOTE

THE PILOT MAY RESET THE AMRAAM TO THE INITIAL BOGUS STORES CONFIGURATION BY PRESSING THE **BGUS AMR** MK.

THE **BGUS AMR** MK OCCULTS WHEN ONE OR MORE 'MISSILES' ARE IN FLIGHT.

THERE IS NO DEK OR ROL MODING ASSOCIATED WITH BOGUS AMRAAM SELECTION.

Figure 1.166 - Bogus Weapons Moding



NOTE

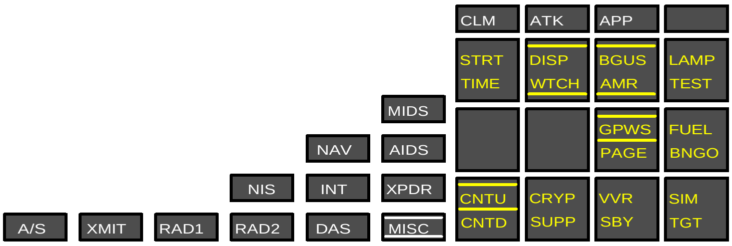
THE MK LEGENDS ARE NOT BOXED ON SELECTION (ONLY THE **LAMPS TEST** MK REMAINS BOXED WHILE SELECTED).

ONCE A ROUTINE HAS STARTED SUBSEQUENT SELECTION OF THE RELEVANT MK HAS NO EFFECT UNTIL THE SELECTED ROUTINE HAS FINISHED.

ANY NUMBER OF TEST ROUTINES CAN BE SELECTED SIMULTANEOUSLY.

IF THE LGS TEST ROUTINE IS SELECTED THE MDEF FUNCTIONS ARE TEMPORARILY DISABLED UNTIL THE ROUTINE IS COMPLETE.

Figure 1.167 - Lamps Test Procedure



PRESS THE **MISC** SSK.

PRESS THE **SIM TGT** MK.

A SIMULATED TARGET IS GENERATED WHICH EXHIBITS THE FOLLOWING CHARACTERISTICS WITH RESPECT TO THE HOST A/C:

- SLANT RANGE 50 NM
- AZIMUTH 20° (LEFT)
- ALTITUDE 1000 FT (BELOW)

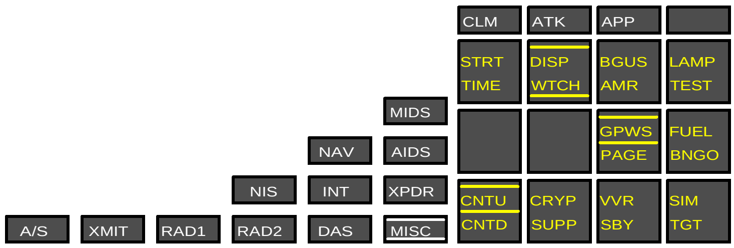
TARGET CONTINUES STRAIGHT AND LEVEL AT A GROUND SPEED OF 400 KT ON A RECIPROCAL TRACK TO THE HOST A/C AT INITIALISATION.

SUBSEQUENT SELECTION OF THE **SIM TGT** MK WILL DESELECT THE MODE.

NOTE

THE SIMULATED TRACKED TARGET MODE WILL AUTOMATICALLY DESELECT 360 SECONDS AFTER INITIALISATION.

Figure 1.168 - Simulated Tracked Target Moding



PRESS THE **MISC** SSK.

THE **VVR** MK SHOWS THE CURRENT STATE OF THE SYSTEM. DEFAULT STATE IS STBY. THE STATUS OF THE MK IS DEPENDENT ON THE FOLLOWING:

VVR OFF — WHEN THE UNIT IS IN THE OFF MODE.

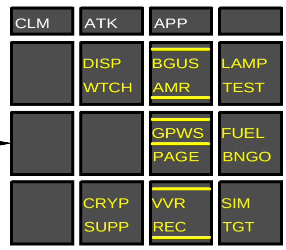
VVR STBY — WHEN THE VVR HAS A CASSETTE CORRECTLY INSERTED, PBIT HAS BEEN PASSED AND THE VVR IS READY TO RECORD

VVR REC — WHEN THE VVR IS RECORDING (EITHER IN MANUAL OR AUTO MODE)

VVR FAIL — WHEN THE UNIT HAS FAILED PBIT, CBIT OR IBIT.

ON SELECTION OF THE MK THE KEY BECOMES BOXED AND THE ROL DISPLAY THE ELAPSED RECORD TIME TO THE NEAREST MINUTE.

DESELECTION OF THE MK BLANKS THE ROL UNLESS THE STOP WATCH IS RUNNING, SPLIT OR STOPPED.



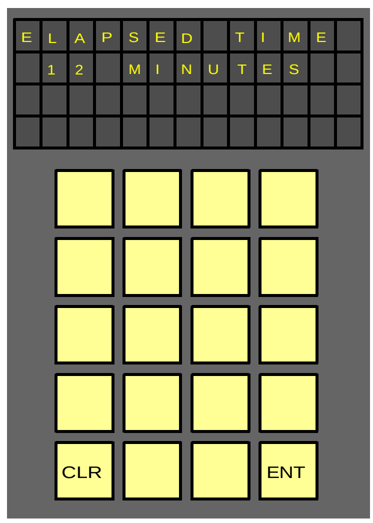
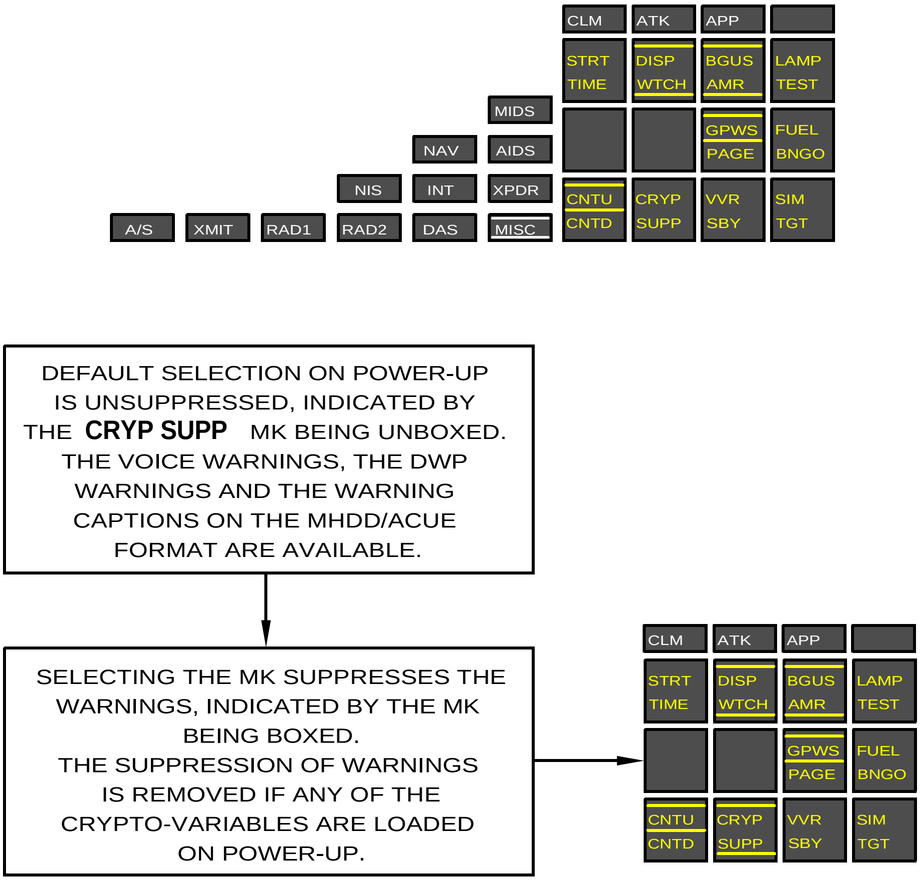


Figure 1.169 - Video Voice Recorder Moding



NOTE

IF ANY ONE OF THE FOLLOWING FOUR WARNINGS OCCUR, WITH SUPPRESSION ON, THE SUPPRESSION IS REMOVED AND THE WARNINGS SHOWN:
- RAD1
- RAD2
- IFF TRANSPONDER
- IFF INTERROGATOR

THE PILOT MUST RESELECT THE MK FOR THE SUPPRESSION TO BE RE-ENABLED.

Figure 1.170 - Automatic Crypto Variable Management System Moding

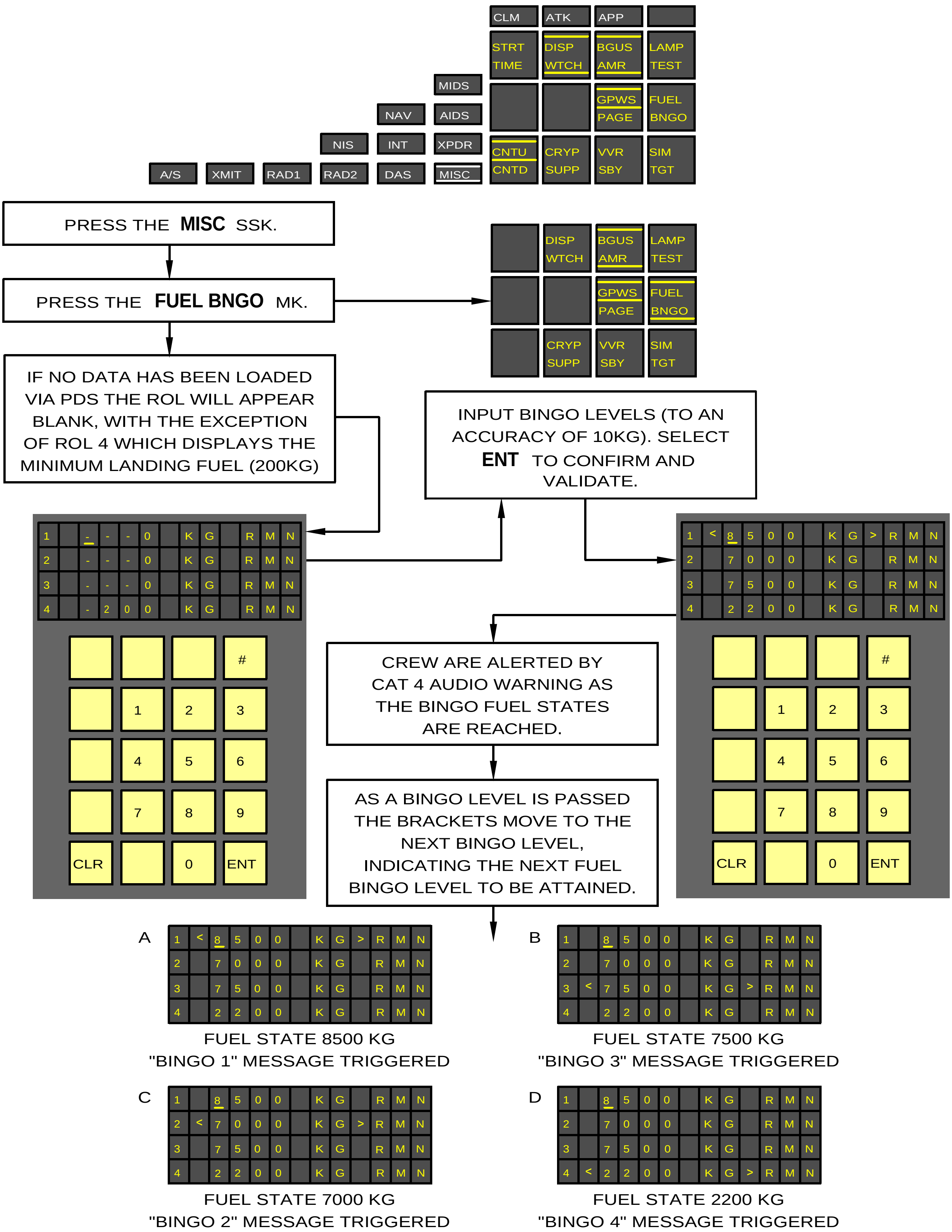
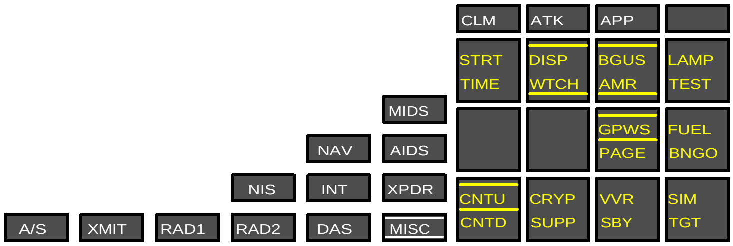
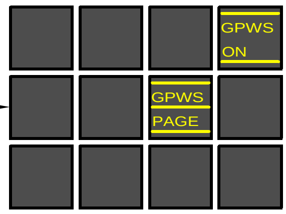


Figure 1.171 - Fuel Bingo Moding



PRESS THE MISC SSK.

GPWS IS AVAILABLE IN ALL POF. WHEN THE AIRCRAFT IS INITIALLY POWERED UP THE DEFAULT SETTING FOR THE GPWS IS ON, INDICATED BY THE GPWS LEGEND ON THE GPWS/PAGE MK BEING BOXED.

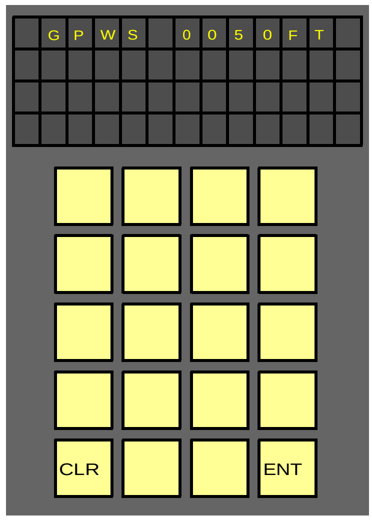


PILOT SELECTS THE GPWS SUB PAGE.

THE ROL DISPLAY THE CURRENT GPWS MSD HEIGHT.

THE MSD HEIGHT VALUE IS LOADED VIA PDS. IF NOT DEFINED, THEN A DEFAULT HEIGHT OF 50FT IS DISPLAYED.

RESELECTING THE GPWS PAGE MK DISPLAYS THE MAIN MISC SS PAGE.



SELECTION OF THE GPWS FUNCTION MK SELECTS THE FUNCTION TO OFF. ALL GPWS WARNINGS AND SYMBOLOGY ARE SUPPRESSED, APART FROM:

- THE GPWS FAIL WARNING AND DWP CAPTION.
- THE DISPLAY OF THE MSD ON THE MDEF ROL AND MHDD/ACUE FORMAT.
  THE GPWS AVAILABLE AND FOM INDICATIONS ON THE PA FORMAT.

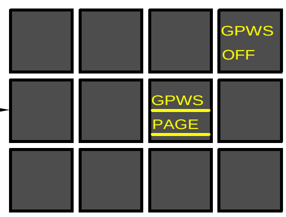


Figure 1.172 - GPWS Moding

COMMUNICATION EQUIPMENT

The communication system provides air-to-air and air-to-ground communications and audio management. The system consists of two identical and independent V/UHF transceivers, a lower V/UHF antenna, a fin tip combined antenna, the communications and audio management unit (CAMU) and their associated controls and indications.

The V/UHF transceivers provide transmission and reception of radio signals in all different combinations of clear/secure and fixed-frequency/ECCM modes. Supported ECCM modes are HaveQuick I/II and SATURN.

The communications and audio management unit (CAMU) performs the control and management of the aircraft communications and audio warning generation.

The fin tip combined antenna is installed at the top of the fin and it is connected to transceiver 1. This antenna transmits/receives UHF or VHF frequencies and D-band frequencies for TACAN.

The lower V/UHF antenna is installed at the lower center fuselage, just below the left air intake and it is connected to transceiver 2. This antenna transmits/receives only VHF or UHF frequencies.

V/UHF RADIO

Two identical and independent V/UHF transceivers are installed in the front air conditioned avionic bay. Both transceivers provide transmission and reception of radio signals in all different combinations of clear/secure and fixed-frequency/ECCM modes, operating in the following frequency bands and modulation:

In no ECCM Mode:

VHF	108.000 to 155.975 MHz (108.000 to 117.975 MHz receiver only)	AM
UHF	225.000 to 399.975 MHz	AM

In ECCM mode:

UHF	HQ I/HQ II	SATURN
225.000 to 399.975 MHz	AM	MSK

Each transceiver has 24 preset channels and 1 manual channel.

Each transceiver incorporates an independent guard receiver tuned to the frequencies 121.5 MHz or 243.0 MHz, depending on pilot selection, and independent of the frequency band in which the transceiver is operating.

Each transceiver is connected to a different antenna, the transceiver 1 is connected to the fin tip combined antenna and the transceiver 2 is connected to the lower V/UHF antenna.

Both transceivers are connected to the avionic data bus as remote terminals. A "crypto erase" signal is connected to each transceiver when the seat ejector control is operated.

Electrical power is supplied to the transceiver 1 from the essential DC bus bar PP3 and to the transceiver 2 from the nonessential DC bus bar PP2. The transmitter power output level is 20 W on normal power for fixed frequency and HQ modes, and 30 W for SATURN mode. The transceivers have BIT routines for equipment monitoring.

COMMUNICATION AND AUDIO MANAGEMENT UNIT (CAMU)

The communications and audio management unit (CAMU), installed in the front conditioned avionic bay, performs the control and management of the aircraft communication system. The CAMU has the following functions:

- Audio routing, mixing, matching, amplification and conditioning
- Audio interfacing from the two V/UHF transceivers, distribution unit (DU) and TACAN/MIDS (whichever is fitted)
- Audio interfacing to the two V/UHF transceivers, video voice recorder (VVR) and interface processor unit (IPU)
- Audio interfacing to/from the telebrief ground link
- Intercommunication between the pilot and ground crew
- Generation and control of voice message warnings, attentions and tones
- Communication system management and remoding
- Direct voice input.

The CAMU consists of independent functional modules interfacing each other. The functional modules are: the processor module, the audio communications module, two audio warning modules, the external data bus interface and a global memory shared by all modules.

The processor module enables the remaining functional modules.

Each audio communications module routes, mixes, matches, amplifies and conditions the communications. This module incorporates:

– two redundant and selectable amplifiers.
– the preset default volume levels for each audio signal
– the default PTT (radio 1 only).

The audio warning module generates the attentions and the voice warning messages and tones. This module consists of two identical warning generation modules each one capable of generate Get-U-Home (GUH) discrete warnings.

The CAMU audio output goes via the Discrete Audio Warning Generator (DAWG) to the pilots headset. This is to enable any discrete audio warning to be included in the audio output.

The pilot actions on CAMU functions are:

– PTT operation
– voice warning message suspension (VOICE OFF)
– audio amplifier selection
– audio volume selection for radio 1, 2, TACAN, MLS, MIDS voice channel A/B missile tone and intercom.
– default volume selection
– audio volume selection for the telebrief ground link.

COMMUNICATION CONTROLS AND INDICATORS

The communication equipment is operated by controls on the HUD control panel, the left hand glareshield, the rear left hand console, the rear right hand console (Gangbar) and the PTTs (on throttles and rear left hand console).

HUD CONTROL PANEL CONTROLS

The HUD control panel contains the radio 1 and radio 2 volume controls, the radio 1 and radio 2 channel selector knobs, and the radio 1 and radio 2 readout displays.

RADIO 1 AND RADIO 2 VOLUME CONTROLS

The radio 1 and radio 2 volume controls are circular rotary controls (4, Figure 1.173). Clockwise rotation increases the audio volume of the respective radio in the pilot headset. Counterclockwise rotation decreases the audio volume.

RADIO 1 AND RADIO 2 CHANNEL SELECTOR KNOBS

Each radio channel selector knob is concentrically installed with its respective radio volume control in a single control arrangement, but operates independently (5, Figure 1.173). The radio channel selector knob is smaller in diameter and protrudes out of the radio volume control. The radio channel selector knob has two positions: in and out.

In the "in" position, rotation of the knob selects a number of discrete positions. Clockwise rotation of the knob increases the selected radio channel number in steps of 1, from 1 to 25 (1 to 24, are preset channels, and 25 a manual channel). If channel 25 is set, further clockwise rotation selects 1, 2, 3 and so on. Counterclockwise rotation of the knob, decreases the selected channel in steps of 1.

When pulled to the "out" position, the knob selects the emergency frequency 243.0 MHz for transmission and reception.

RADIO 1 AND RADIO 2 READOUT DISPLAYS

Adjacent to its respective radio volume control and channel selector knob, the radio readout display (6, Figure 1.173) shows the following parameters:

A. Operating mode:

"CLR" for CLEAR mode
"SECR" for SECURE mode.

B. The readout shows:

"GU" for UHF guard receiver selected
"GV" for VHF guard receiver selected
"-U" for reception or transmission via the transceiver with the UHF guard receiver selected
"-V" for reception or transmission via the transceiver with the VHF guard receiver selected
" " for no guard receiver selected or emergency channel selected and no reception or transmission
"- "for reception via the transceiver without any guard receiver selected.

The symbols "- ", "-U" and "-V" remain displayed for 3 seconds after the end of the reception or transmission signal.

C. Selected channel number:

"1 to 24" for preset channel
"M" for manual channel 25
"G" for guard emergency select.

D. Frequency or ECCM net associated to the current channel selected (preset, manual or emergency):

###.### for a fixed frequency
HQ1 ### for a HaveQuick 1 net
HQ2 ### for a HaveQuick 2 net
SAT###A for a SATURN A net
SAT###B for a SATURN B net.

NOTE

digits identify the frequency or net.

LEFT HAND GLARESHIELD CONTROLS

The Manual Data Entry Facility (MDEF), on the left hand glareshield, contains the radio 1 and radio 2 subsystem keys (1 and 2, Figure 1.173) and the associated moding keys (3, Figure 1.173). Data relevant to the radio 1 and radio 2 subsystems is able to be displayed on the read out lines (9, Figure 1.173) and entered/edited via the data entry keyboard (8, Figure 1.173).

RADIO 1 AND RADIO 2 SUBSYSTEM KEYS

The radio 1 and radio 2 subsystem are identical in operation and are selected/deselected using the RAD1 or RAD2 subsystem keys (SSK).

ASSOCIATED MODING KEYS

Upon selection of the applicable SSK (RAD 1 or RAD 2 shows boxed) the following modes/data entry options are available on the moding keys (MK):

NRW/BRD	Controls reception over a broad or narrow band around the selected frequency (only in clear mode).
MAN/PSET	Allows the operating frequencies to be defined by the pilot for both manual and preset channels. Additionally, Havequick and Saturn modes and their associated net identifiers can be selected in place of a standard frequency via the data entry keyboard operation. It also allows the radio transmission to be preselected between clear and secure.
SQ ON/OFF	Deselects the automatic squelch facility, to assist in hearing weak signals at the expense of increased background noise (only in clear mode).
GRDU/GRDV	Selects the guard receiver to either the UHF or VHF guard frequency, or selects the receiver OFF.
NORM/LOW	Selects between NORMal and LOW transmitter power output, to reduce emission power and enhance stealth characteristics.
HAIL ON/OFF	Allows the pilot to select the Saturn Hail mode, through which a caller can attract the pilot attention that communication is required on a predefined frequency.
TX TIME	Allows the pilot to transmit his time (time of day, TOD) to a receiving platform. Different times may be used for radio 1 and radio 2. When this function is selected, the RX TIME function is occulted and not available for 5 seconds.
RX TIME	Allows the pilot to receive an operating time from another platform. When this function is selected, the TX TIME function is occulted and not available for 5 seconds.

The boxed moding keys correspond to the current channel selected on the radio channel selector. To alter this, press the corresponding moding key (the applicable caption will show boxed).

REAR LEFT HAND CONSOLE CONTROLS

The rear left hand console contains the duplicate PTT switch, the TACAN/MLS volume controls, the intercom volume control, the amplifier selector switch, the default volume selector switch and the missile audio/telebrief volume control.

DUPLICATE PTT SWITCH

The duplicate PTT switch has 3 positions, 2 momentary positions and a center-biased position. The switch is labeled RAD1 - OFF -RAD2 (18, Figure 1.173). The 3 positions are:

OFF	No transmission on radio 1 or radio 2. Pushed, transmission via radio 1 and radio 2 is enabled simultaneously for as long as the switch is held in this position.
RAD1	When held, transmit on radio 1
RAD2	When held, transmit on radio 2

NOTE

- When the Default Volume Selector switch is at the DFLT VOL position, transmission is restricted to radio 1 only.

TACAN/MLS VOLUME CONTROLS

These controls are coaxial, the center (top) control is for TACAN and the outer (bottom) control is for MLS (19, Figure 1.173). Clockwise rotation increases the audio level and counterclockwise rotation decreases this level.

INTERCOM VOLUME CONTROL

The intercom volume control is a rotary control labeled I/C (15, Figure 1.173). Clockwise rotation of this control increases the volume level of pilot audio and ground crew link audio. Similarly, counterclockwise rotation decreases this level.

AMPLIFIER SELECTOR SWITCH

The amplifier selector switch is a two-position toggle switch labeled NORM and REV (17, Figure 1.173). When placed to NORM, the audio signals received are transmitted from each radio to the headset via the CAMU audio module 1. In case of failure, the pilot may select the REV position in reversion to redirect radio reception to the headset via the CAMU audio module 2.

DEFAULT VOLUME SELECTOR SWITCH

The default volume selector switch is a two-position switch labeled NORM VOL and DFLT VOL (16, Figure 1.173). When placed to NORM VOL, the volume of each audio signal is controlled with inputs to the CAMU. When placed to DFLT VOL, the volume of each audio signal is the default level preset in the CAMU. Also, the default PTT is selected to restrict transmissions to radio 1 only. The individual volume control inputs to the CAMU have no effect. To prevent inadvertent selection, the pilot must pull the switch before placing it to the DFLT VOL position.

MISSILE AUDIO/TELEBRIEF VOLUME CONTROL

The missile audio/telebrief volume control is a rotary control labeled MSSL/TB (14, Figure 1.173).
On ground, clockwise rotation of this control increases the level of telebrief volume and counterclockwise rotation decreases this level. Pushing the control, transmission via the telebrief link is enabled for as long as the control is held in this position. The control is biased to the upper position.
In flight, clockwise rotation of this control increases the level of missile audio volume and counterclockwise rotation decreases this level.

REAR RIGHT HAND CONSOLE CONTROLS

The radio 1 and radio 2 transmit switches and the voice warning control switch are contained on the rear right hand console, inside the systems Gangbar.

RADIO 1 AND RADIO 2 TRANSMIT SWITCHES

The radio 1 and radio 2 transmit switches are two-position, toggles switches, labeled RAD1 (or RAD2) and OFF (10 & 11, Figure 1.173). When placed to RAD1 (or RAD2) position, transmission via its corresponding transceiver is available. When placed to OFF, transmission via its corresponding transceiver is disabled, reception is operative.

VOICE WARNING CONTROL SWITCH

The voice warning control switch is a two-position toggle switch, labeled VOICE and OFF (12, Figure 1.173). When placed to VOICE, the voice warning messages are made audible to the pilot from the CAMU and the Discrete Audio Warning Generator (DAWG). When placed to OFF, the warning messages (except the catastrophic warnings) are not audible. To prevent inadvertent operation of the switch, the pilot must pull the switch before placing it to the OFF position.

COMMUNICATIONS CONTROL SWITCH

The communication control switch is placed on the throttle top unit (21, Figure 1.173) and is a six-position toggle switch, spring biased to center position:

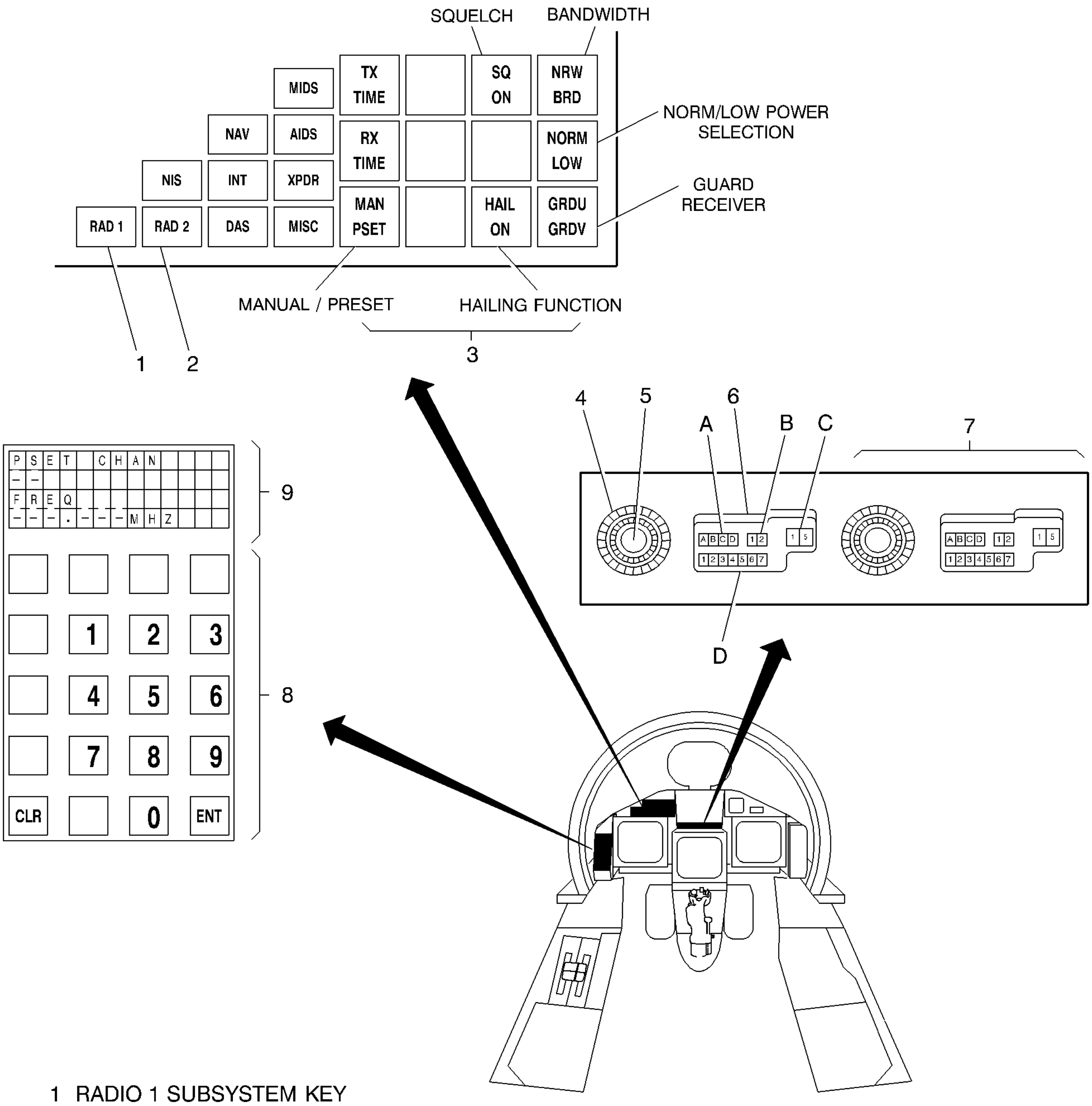
Forward	Transmission via radio 1 is enabled for as long as the switch is held in this position
Rearward	Transmission via radio 2 is enabled for as long as the switch is held in this position
Up	Voice warning suspended (VWS)
Down	Direct voice input (DVI) press to reconize
Center	Transmission via either transceiver is not influenced by this position
Center push	Transmission via radio 1 and radio 2 is enabled simultaneously for as long as the switch is held in this position.

NOTE

When the Default Volume Selector switch is at the DFLT VOL position, transmission is restricted to radio 1 only.

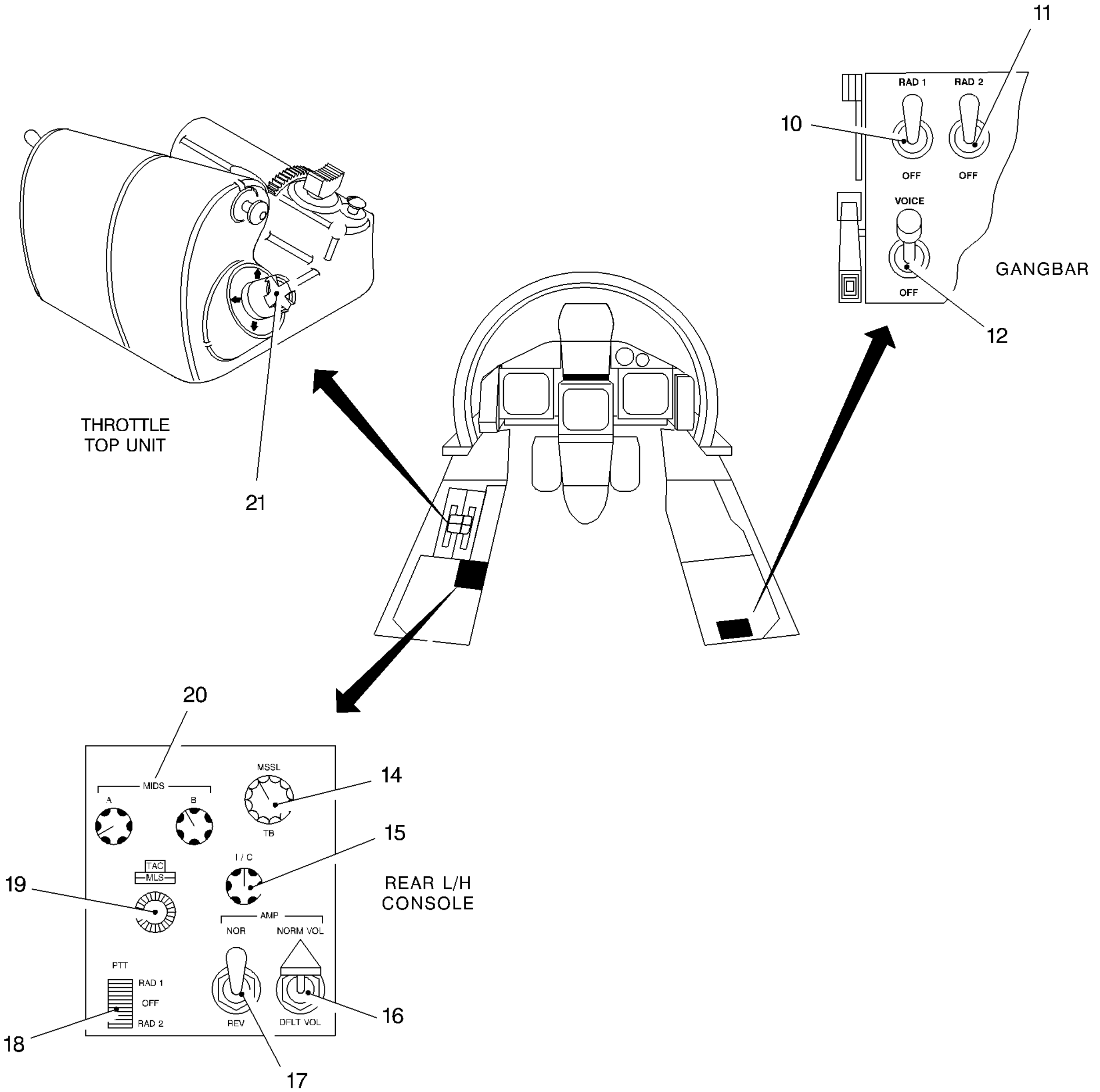
COMMUNICATIONS WARNING

Information of communications failure is displayed on the dedicated warning panel (DWP). The following caption is presented:
VOICE (CAT 3 - amber) Indicates a failure of the generation and control of voice message warnings, attentions and tones in the CAMU.
The DWP caption is accompanied with flashing attention getters.



1 RADIO 1 SUBSYSTEM KEY
2 RADIO 2 SUBSYSTEM KEY
3 MODING KEYS
4 RADIO 1 VOLUME CONTROL
5 RADIO 1 CHANNEL SELECTOR KNOB
6 RADIO 1 READOUT DISPLAY
A. OPERATING MODE
B. ENABLED GUARD MODE & TRANSMIT / RECEIVE
C. SELECTED CHANNEL DISPLAY
D. FREQUENCY ASSOCIATED TO THE SELECTED CHANNEL
7 SIMILAR TO ITEM 4 TO 6 FOR RADIO 2
8 DATA ENTRY KEYBOARD
9 READOUT LINES

Figure 1.173 - Communication System - Controls and Indications (Sheet 1 of 2)



10 RADIO 1 TRANSMIT SWITCH
11 RADIO 2 TRANSMIT SWITCH
12 VOICE WARNING CONTROL SWITCH
13 DELETED
14 MISSILE TONES & TELEBRIEF CONTROLS
15 INTERCOM VOLUME CONTROL
16 DEFAULT VOLUME SELECTOR SWITCH
17 AMPLIFIER SELECTOR SWITCH
18 DUPLICATE PTT SWITCH
19 TACAN & MLS VOLUME CONTROLS
20 MIDS A / B CONTROLS
21 COMMUNICATION CONTROL SWITCH

Figure 1.173 - Communication System - Controls and Indications (Sheet 2 of 2)

COMMUNICATION MDE AND X-Y FUNCTIONS

The Manual Data Entry Facility (MDEF) allows data to be manually entered or manipulated within the aircraft avionics subsystems. The subsystems available within this facility that are relevant to communications are:

– Radio 1 (RAD 1)
– Radio 2 (RAD 2).

Within the MDEF data relevant to the RAD 1 or RAD 2 subsystems is able to be displayed on the Read Out Lines (ROL) and entered/edited via the Data Entry Keyboard (DEK) and Toggle Switch (refer to Electronic Displays and Controls - MDE). The X-Y controller, located on the right throttle (refer to Electronic Displays and Controls - VTAS pag. 37 for single seat aircraft or for twin seat aircraft), may be used to browse the frequency channel lists that are presented on the MHDD/Radio Format.

Dedicated controls for selecting volume, channel and UHF emergency frequencies and dedicated radio readout displays for each radio are located on the HUP.

RADIO 1 AND RADIO 2 SUBSYSTEMS

The Radio 1 and 2 subsystems are identical in operation and are selected/deselected using the RAD 1 or RAD 2 subsystem keys (SSK) on the left glareshield. Upon selection, modes applicable to the subsystem are made available for selection by use of moding keys (MK) to the right of the SSK.

The radios are manually controlled by a combination of MDEF, dedicated controls and VTAS controls.

MDEF functionality with respect to the RAD 1 (2) SS is as follows:

– Enter and edit manual and preset channel information
– Select between clear and secure voice communications
– Select fixed frequency modes of operation
– Select ECCM modes of operation
– Receive and transmit time status
– Select Saturn 'HAIL' between on and off.
– Select between UHF and VHF guard receiver modes of operation.
– Select between narrow and broad bandwidths
– Select between normal and low power
– Override the automatic squelch facility.

X-Y functionality with respect to the RAD 1 (2) SS is as follows:

– Select between the Radio 1 and Radio 2 frequency channel lists
– Page through the Radio 1 and Radio 2 frequency channel lists.

MANUAL AND PRESET CHANNELS

The initial frequencies assigned to the 24 preset channels are loaded via the PDS. The initial frequency of the manual channel is set to the last stored value. The pilot may edit the frequency of any channel. The MAN/PSET MK allows the operating frequencies to be defined by the pilot for both the MAN and PSET channels. For the MAN channel the previous manual frequency is stored in memory and can be easily reselected to be used. Alternatively, a new MAN frequency can be specified.

EDITING MANUAL CHANNEL INFORMATION

On selection of the RAD 1 or RAD 2 SS the DEK, ROL and MK configure to the default moding (Figure 1.174). The ROL show the current MAN frequency on ROL 2 and the previous MAN frequency on ROL 4. To use the previous MAN frequency the pilot simply presses ENT (Figure 1.175). The previous MAN frequency is sent to the communication system to be used as the current MAN frequency, and the current MAN frequency as was now becomes the previous MAN frequency.

Alternatively the pilot may enter new channel information by altering the displayed previous frequency (Figure 1.176), selecting clear or secure (Figure 1.177) and, if secure, specifying the KOD number (Figure 1.176). Selecting ENT confirms the new MAN frequency as the current MAN frequency.

If a Havequick I or II network is to be entered the pilot must specify type I or II (type I is selected by default), enter the network channel number, select clear or secure and specify the KOD number, if applicable (Figure 1.178). If Havequick II is selected the pilot must also specify NATO or non-NATO hopsets. Selecting ENT confirms the new MAN frequency as the current MAN frequency.

If a Saturn network is to be entered (Figure 1.179) the pilot must specify the net channel number, net channel mode (A or B), clear or secure, KOD number (if applicable) and NATO or non-NATO hopsets. Selecting ENT confirms the new MAN frequency as the current MAN frequency.

Whenever any changes are made to the manual channel the channel information on the MHDD/ Radio format is updated. If the manual channel is currently in use then the changes are also reflected in the radio readout displays on the HUP.

SPECIFY/EDIT PRESET CHANNEL

On selection of the RAD 1 or RAD 2 SS and selecting the PSET mode via the MAN/PSET MK the MDEF, ROL and DEK reconfigure to show the details of the currently selected pre-set channel number (if a

PSET channel is selected on the HUP) and its associated frequency (see Figure 1.180). If a MAN channel or emergency frequency is currently selected on the HUP then the ROL configure to allow a PSET channel to be manually specified by the pilot. The pilot is then able to over-type the frequency associated with the pre-set channel with the required new frequency. Selecting ENT updates the communications system with the new data. In addition, the pre-set channel information on the MHDD/Radio format is updated. If the details of the preset channel currently in use are modified then the changes are also reflected in the radio readout displays on the HUP.

CLEAR AND SECURE VOICE COMMUNICATION

The pilot is able to select between clear and secure voice communications for both fixed frequency and frequency hopping ECCM modes of operation (Figure 1.177). Clear or secure communication is possible on all 24 preset channels and the manual channel. The availability of secure mode depends upon valid KOD cryptovariables. If valid KOD cryptovariables are not loaded then the option to define a channel as secure is unavailable.

The status of the clear/secure setting for the currently selected channel on each radio is permanently displayed on the HUP. The clear/ secure status of all channels is displayed on the MHDD/Radio format and for individual channels on the MDEF ROL. The default status for a channel is clear. Channels may be allocated secure status either on PDS load or by manual selection via the MDEF.

Selection of a secure channel automatically selects the broad bandwidth and switches the squelch filtering to ON.

ECCM MODES OF OPERATION

To aid communications in the ECM jamming environment Havequick I and II, and Saturn frequency hopping ECCM communications are available. Havequick II and Saturn are capable of using either NATO or non-NATO hopsets. These modes require an accurate UTC system time (Time of Day) and Word of Day (WOD) cryptovariables. If TOD and WOD are not available the ECCM modes are not available for selection. Selection of Saturn mode or Havequick I or II secure voice mode automatically selects broad bandwidth and switches the squelch filtering to ON.

TIME SYNCHRONIZATION

To ensure satisfactory operation of the ECCM modes the pilot has the means to receive (Figure 1.181) and transmit (Figure 1.182) an accurate update of time over the air. If the value of the system time supplied to the Radios degrades to a level which jeopardizes the correct operation of the ECCM modes, or if the system time becomes unavailable, then a CAT 3 'COMMS' warning is generated to prompt the pilot to obtain a time update.

CRYPTOVARIABLES

Cryptovariable codes are necessary for operation of the ECCM modes and for secure speech encryption and decryption. KOD cryptovariables are used for voice encryption and decryption. WOD cryptovariables are used for the ECCM functions. At AVS SP3, all Radio cryptovariables (six KOD and six WOD) are loaded via a fill gun. A KOD cryptovariable is stored for each channel and the initial allocation of a KOD number to individual channels is defined by the PDS channel information data. The pilot is able to alter the KOD assigned to a channel (Figure 1.177).

SATURN HAIL

Selection of Saturn enables the monitoring of a 'hail' frequency, provided that a hailing frequency has been loaded via PDS. A different hailing frequency is able to be loaded for each radio. The frequencies can only be entered by PDS load and cannot be altered by the pilot. The 'hail' facility is enabled by default, but the pilot is able to select 'hail on' or 'hail off' via the MDEF whilst in Saturn mode, or preselect 'hail off'/'hail on' prior to entering Saturn mode (Figure 1.183). If no hailing frequency has been loaded for either or both radios, then the HAIL ON/ OFF MK will be occulted for the respective radio(s).

GUARD RECEIVER MODE SELECTION

The pilot is able to individually set each Radio to receive on the guard UHF or VHF frequencies (Figure 1.184). The power up default setting is UHF. The guard monitoring function enables the pilot to monitor both guard frequencies simultaneously and is available in both the fixed frequency and ECCM modes. Manual selection between UHF, VHF and OFF is made via the MDEF GRDU/GRDV MK and the selection is shown on the radio readout display on the HUP.

TRANSMISSION/RECEPTION ON EMERGENCY FREQUENCIES

Selection of the UHF emergency frequency (243 MHz), by pulling the Radio 1 or Radio 2 channel selector knob to the out position, and whether transmitting or receiving on this frequency is indicated on the HUP radio readout display (Figure 1.184).

When the pilot deselects the UHF emergency frequency channel the radio reverts to the channel that was previously selected on the channel selector,

provided that the channel selector has not been rotated during emergency channel selection.
To transmit on the VHF emergency frequency (121.5 MHz) the pilot must enter this frequency into the manual channel, unless it has been previously been allocated to a preset channel.

SELECTING BANDWIDTH

To aid coherent communication the pilot is able to select between narrow and broad bandwidth depending on the bandwidth of the station with which he wishes to communicate (Figure 1.185). The default setting is narrow. Manual selection of bandwidth is only available in the fixed frequency clear voice and Havequick I and Havequick II clear voice modes. Broadband is automatically selected when in Havequick I or II secure, Saturn or fixed frequency secure modes and when in these modes the NRW/BRD MK is unavailable for selection. When the radio stops operating in these secure modes the system sets the bandwidth to its previously manually selected state and the MK becomes available for selection.

SELECTING TRANSMITTER POWER

Manual selection between high (normal) and low transmitter power is provided (Figure 1.186). High power is used for long range communications and low power typically for short range, stealth, when flying in high terrain, dense air traffic, in formation or other operational reasons. High (normal) power is the default.

SELECTING SQUELCH MODE

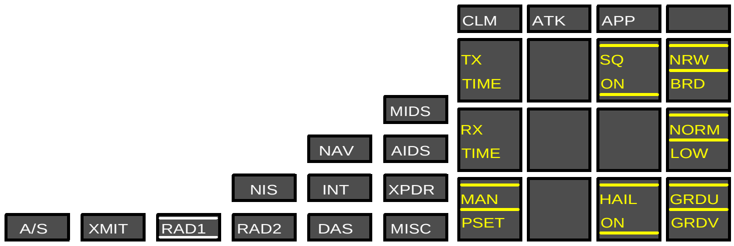
The squelch function rejects unwanted weak signals to improve message clarity (Figure 1.187). On power up the squelch function defaults to ON. The pilot is able to manually switch off the squelch function to amplify weak signals if required. Manual selection of the squelch function is only available in the fixed frequency clear voice and Havequick I and Havequick II clear voice modes. Squelch is automatically selected to ON when in Havequick I or II secure, Saturn or fixed frequency secure modes and when in these modes the SQ ON/OFF MK is unavailable for selection. When the radio stops operating in these secure modes the system sets the squelch function to its previously manually selected state and the MK becomes available for selection.

BROWSE RADIO LISTS

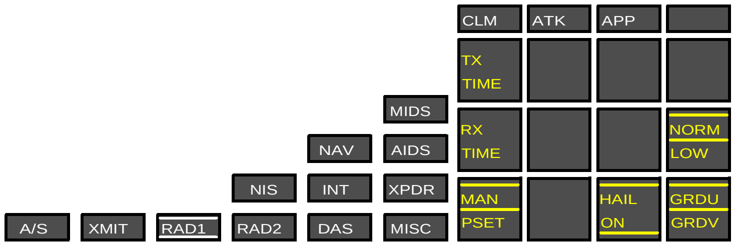
The majority of the radio channel information is displayed on the MHDD/Radio format (Figure 1.188). The format is available in all POF and is accessed by selection of the FREQ SK on the MHDD Group C head (right MHDD, by default). The format includes details of channel number, frequency or network identifier, station identifier, clear/secure status, current Key of Day (KOD) number for that channel (if secure) and whether Nato or non-Nato hopsets are selected in Havequick II or Saturn modes.
When the MHDD/Radio format is first selected it will display the page containing the channel currently selected on Radio 1. The pilot is able to use the X-Y controller to select for display the frequency channels lists for either Radio 1 or Radio 2 by performing an X-Y insert over the relevant RADIO channel icon. Alternatively he can select the RAD1/RAD2 SK. When the radio frequency channel list is changed, the X-Y marker is automatically re-positioned over the page change icon.
At any one time only half of the list of channels for the selected radio is displayed. The currently selected channel is highlighted by a green box. As the channel selector on the HUP is rotated the box moves to highlight the appropriate channel. If a channel is selected that is not currently on that page, the page featuring the channel will automatically be presented with the highlight box around the appropriate channel. The pilot may also page either the RADIO 1 or RADIO 2 channels lists to display the half of the list not currently shown by performing an X-Y insert over the page change icon. Alternatively he can select the PAGE UP or PAGE DOWN SK to achieve the same result.

PRESS THE **RAD1 (2)** SSK.

DEFAULT CONDITION WHERE CURRENTLY SELECTED CHANNEL IS CLEAR.



DEFAULT CONDITION WHERE CURRENTLY SELECTED CHANNEL IS SECURE.



ROL/DEK CONFIGURE TO ENABLE THE MANUAL CHANNEL TO BE MODIFIED. THE ROL CONTAIN THE FOLLOWING DATA:-

- CURRENT MANUAL FREQUENCY
- KOD AND HOPSET (IF APPLICABLE)
- CLEAR OR SECURE STATUS
- PREVIOUS MANUAL FREQUENCY (SET TO DASHES IF NO PREV FREQ IS DEFINED, I.E. AFTER POWER UP).

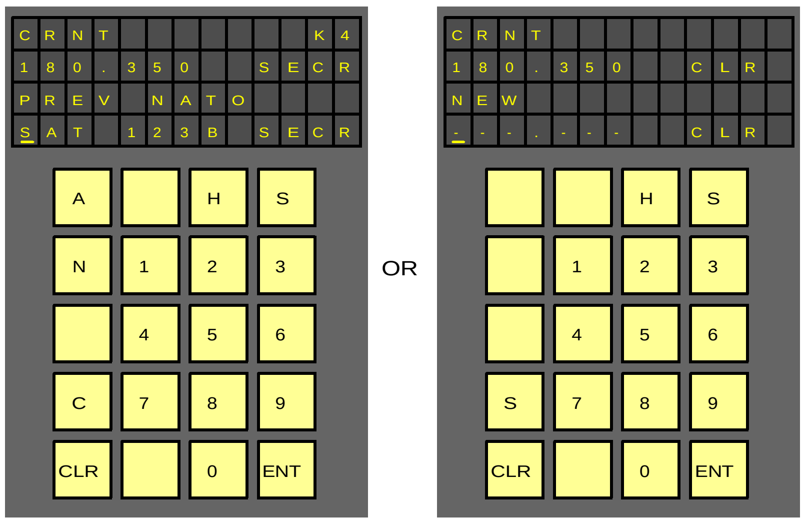


Figure 1.174 - Default Moding of the Radio 1 (2) Subsystem

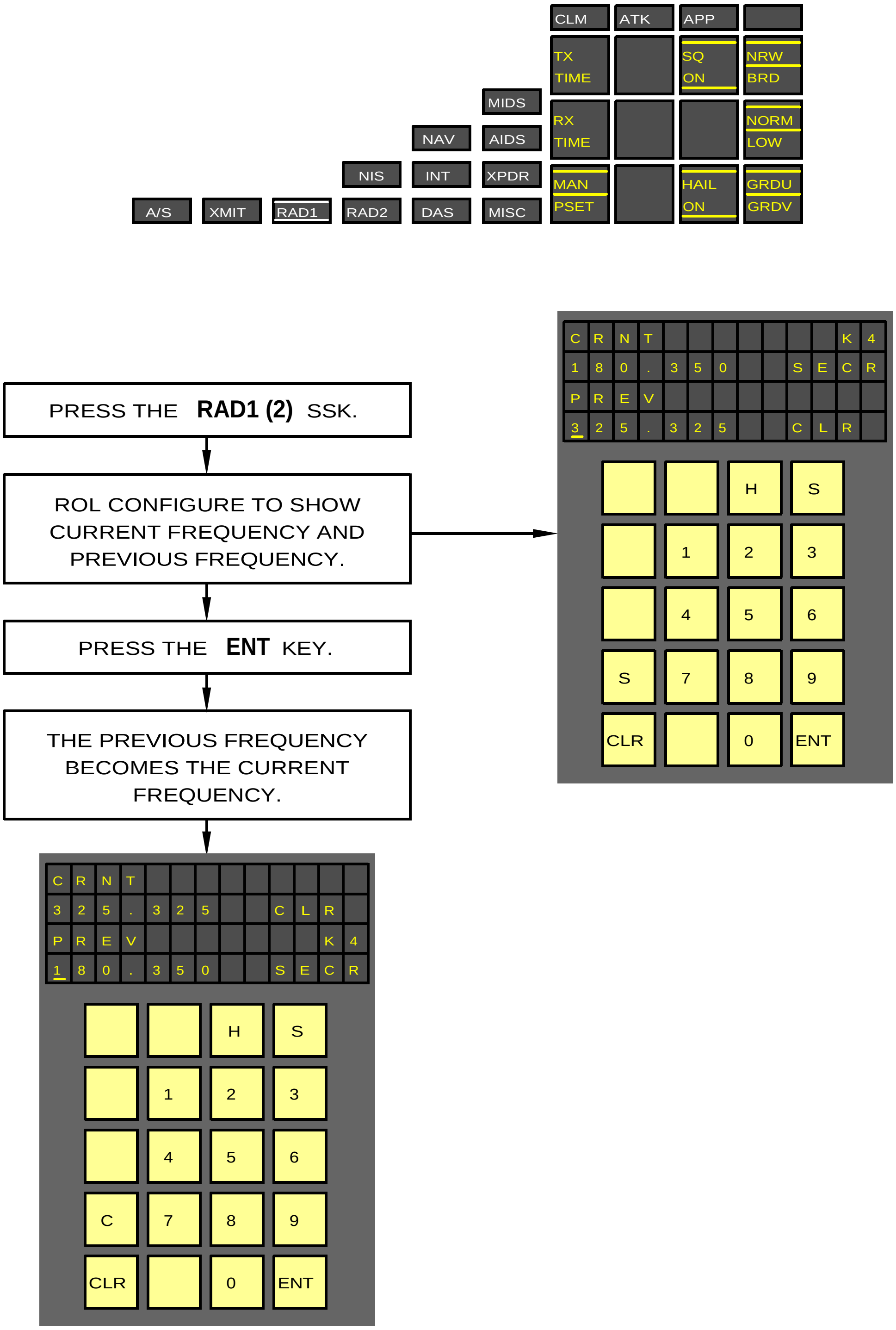
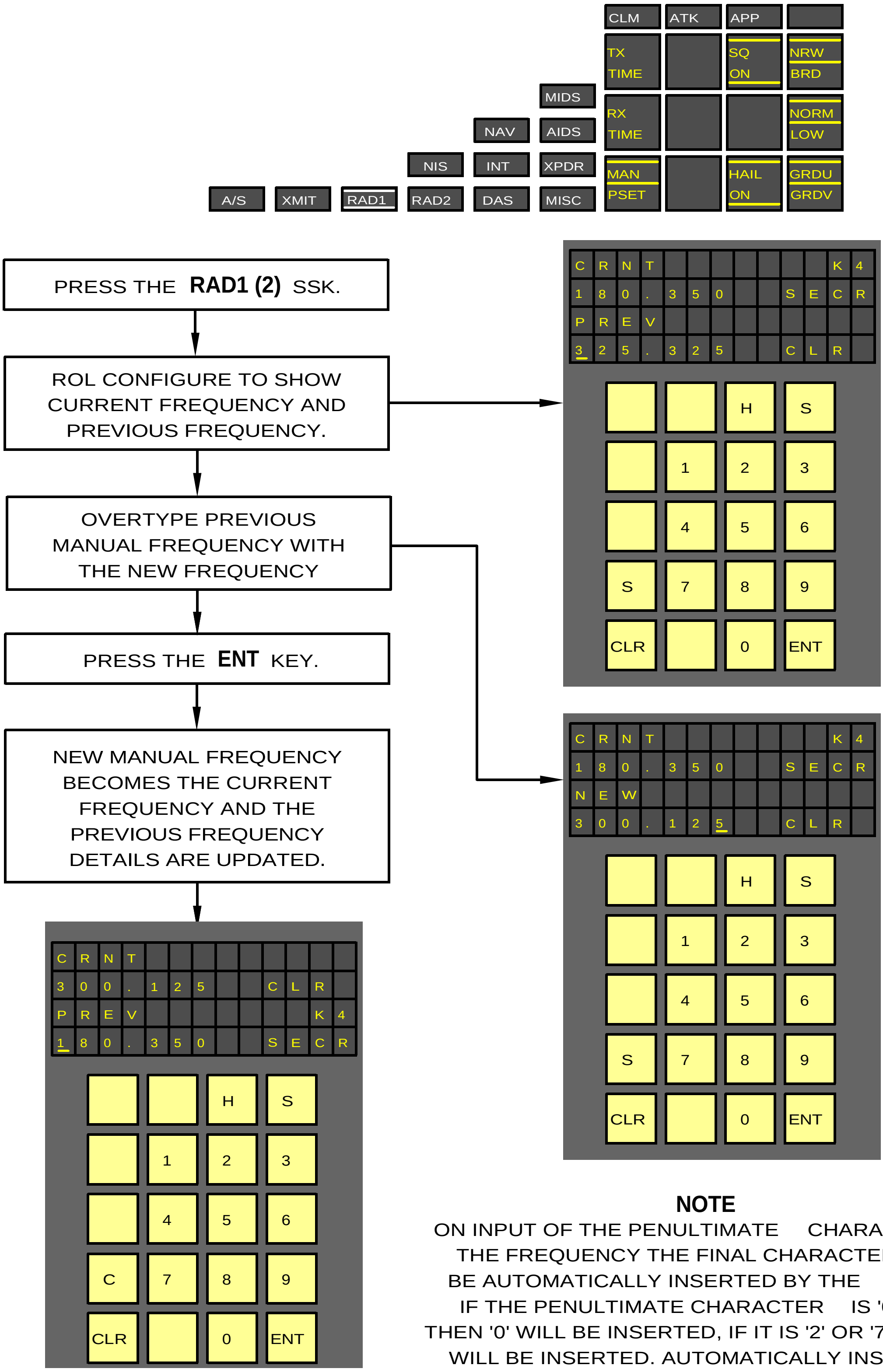


Figure 1.175 - Edit Manual Channel-Selecting Previous Frequency



NOTE

ON INPUT OF THE PENULTIMATE CHARACTER OF THE FREQUENCY THE FINAL CHARACTER MAY BE AUTOMATICALLY INSERTED BY THE SYSTEM. IF THE PENULTIMATE CHARACTER IS '0' OR '5' THEN '0' WILL BE INSERTED, IF IT IS '2' OR '7' THEN '5' WILL BE INSERTED. AUTOMATICALLY INSERTED CHARACTERS CAN BE OVERTYPED IF NECESSARY.

Figure 1.176 - Edit Manual Channel-Input New Frequency

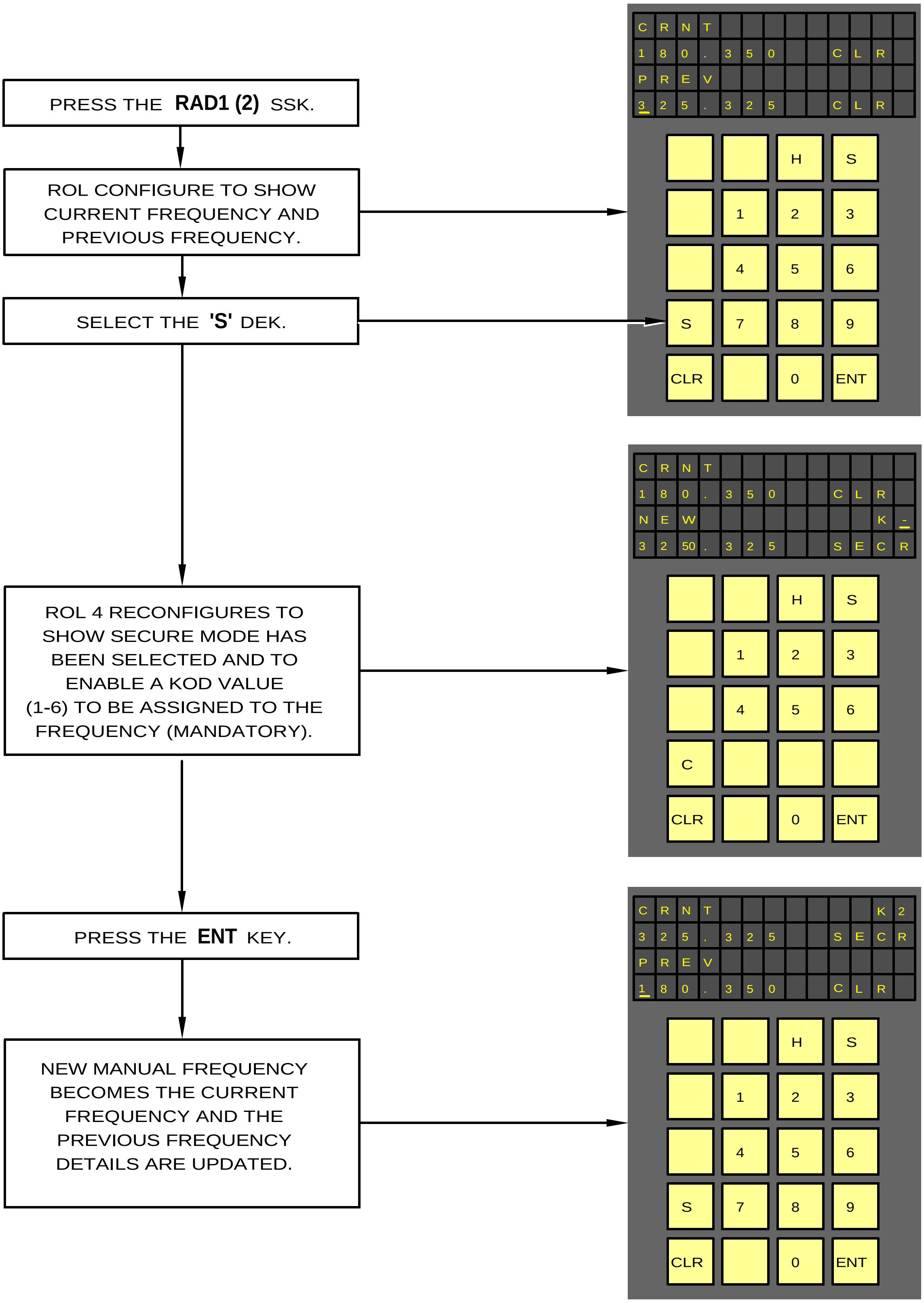


Figure 1.177 - Edit Manual Channel-Selecting Between Secure and Clear Modes/Inputting KOD Value

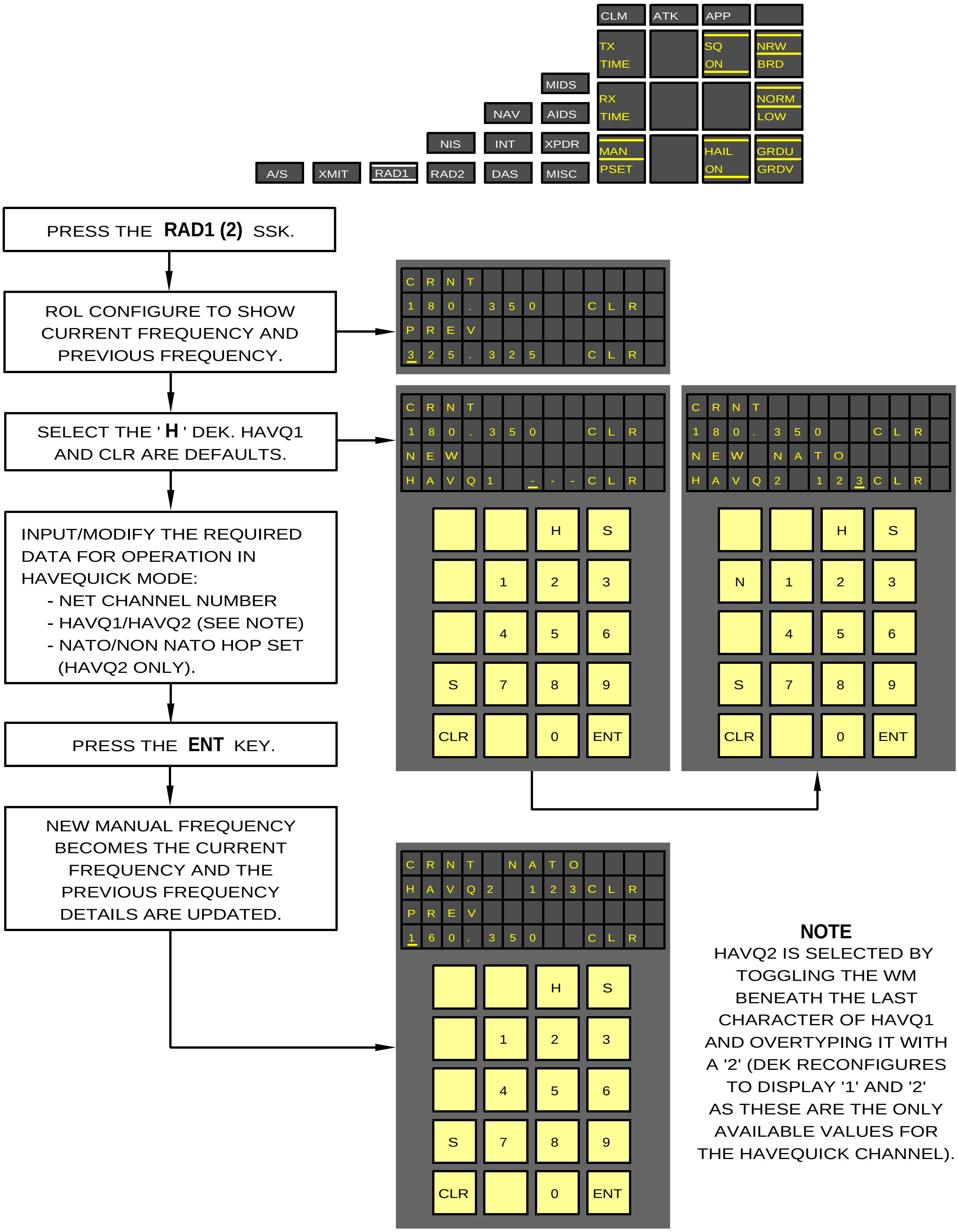


Figure 1.178 - Edit Manual Channel-Selecting Havequick

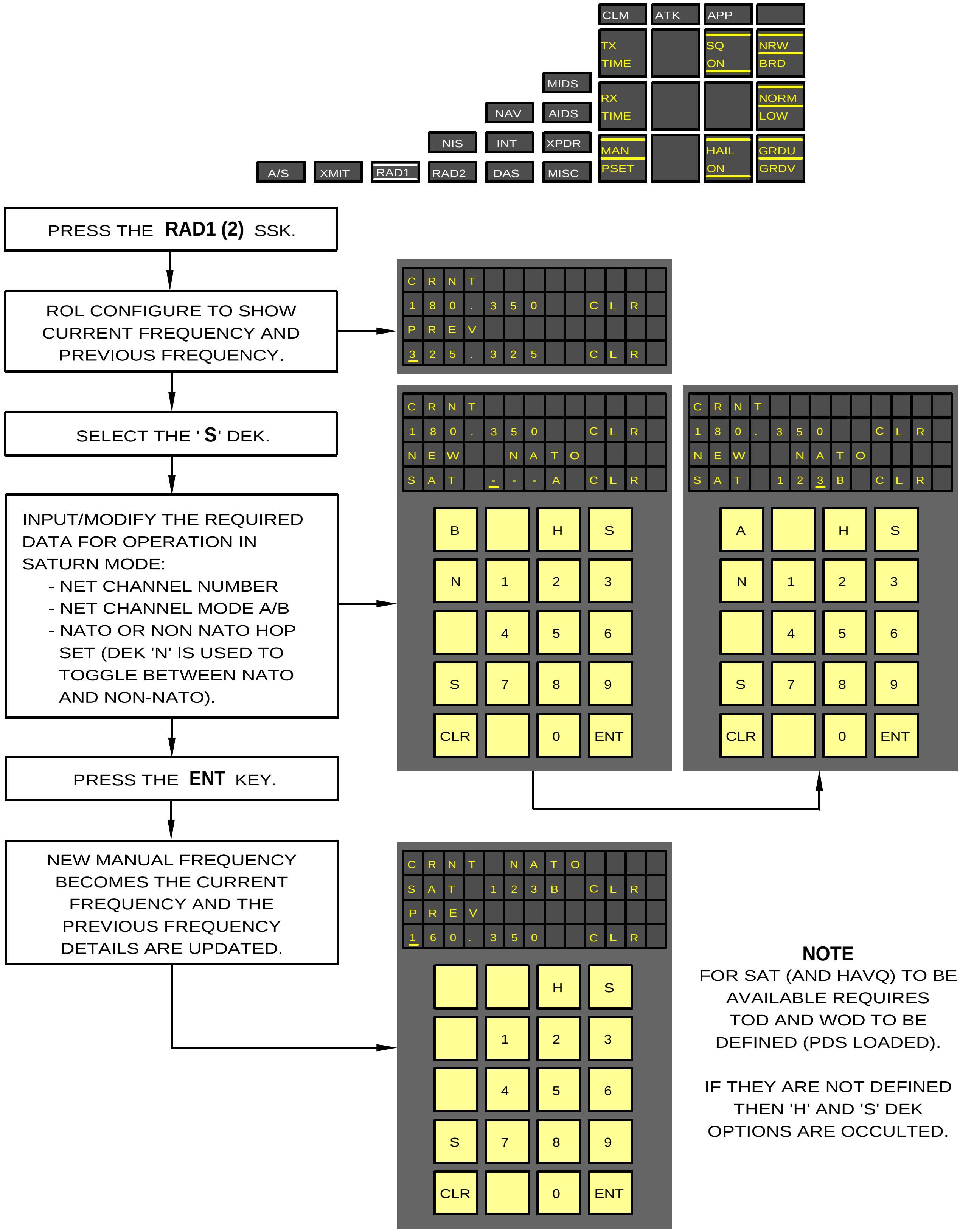


Figure 1.179 - Edit Manual Channel-Selecting Saturn

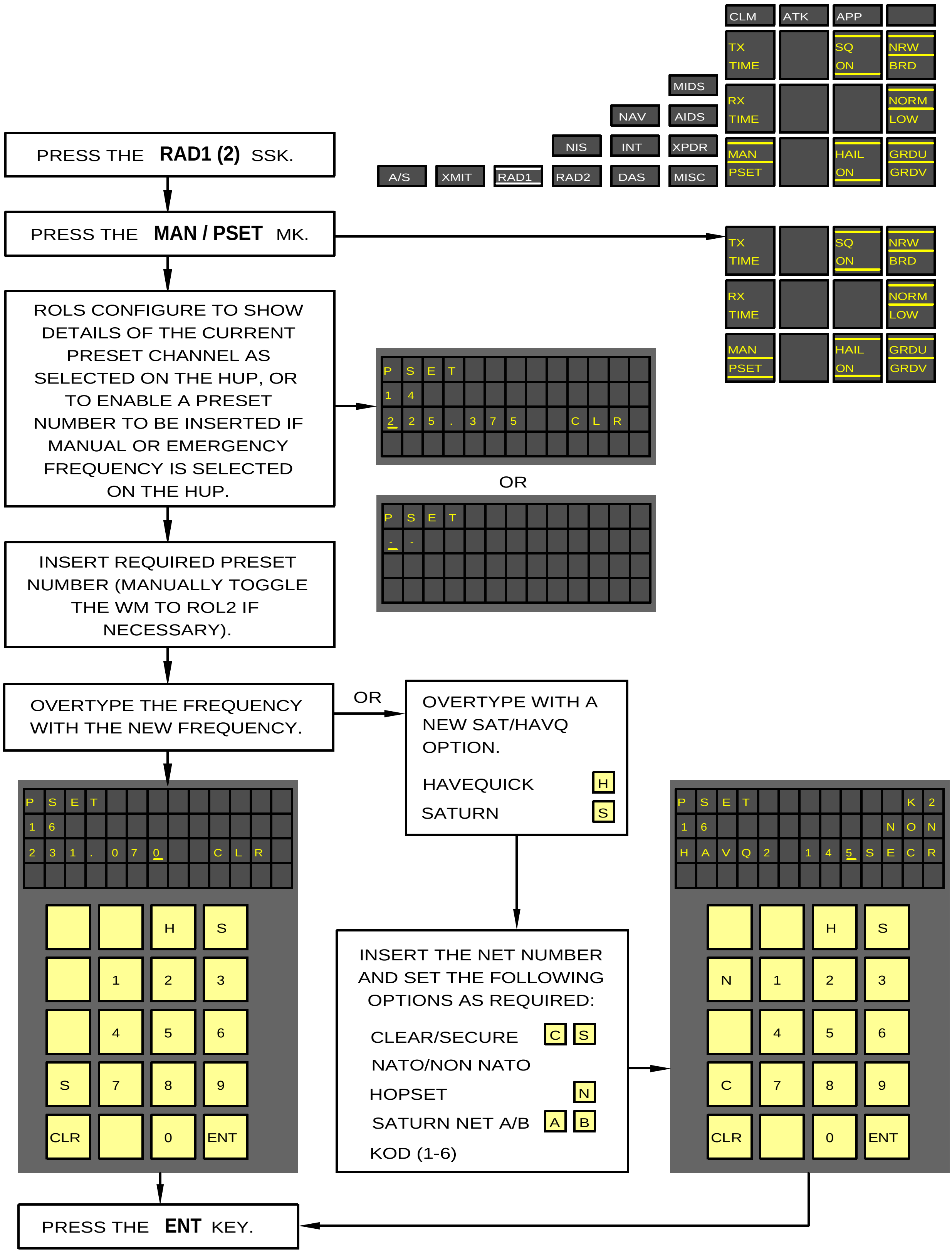
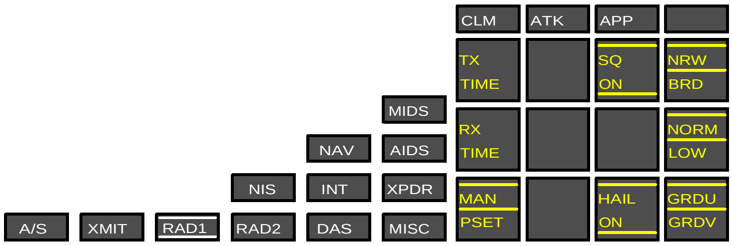


Figure 1.180 - Edit Preset Channel



PRESS THE **RAD1 (2)** SSK.

PRESS THE **RX TIME** MK.

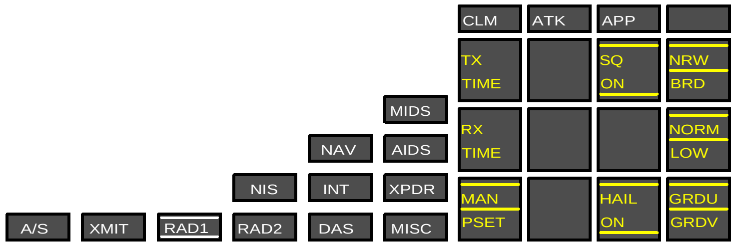
TX TIME MK OCCULTS.

RX TIME MODE REMAINS ENGAGED UNTIL A TIME SIGNAL IS RECEIVED OR THE MODE IS DESELECTED BY PRESSING THE **RX TIME** MK.

NOTE

RX TIME MODE WILL NOT BE SUSPENDED AUTOMATICALLY ON DESELECTION OF THE RADIO SUBSYSTEM.

Figure 1.181 - Receiving Time Mode



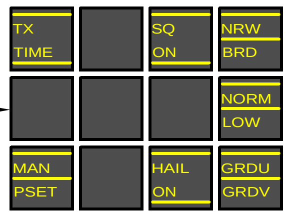
PRESS THE **RAD1 (2)** SSK.

↓

PRESS THE **TX TIME** MK.

↓

RX TIME MK OCCULTS. →

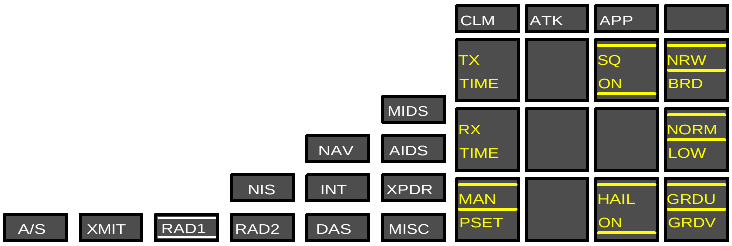


↓

SYSTEM TRANSMITS THE NET TIME OF DAY FOR 5 SECONDS AND THEN AUTOMATICALLY DESELECTS **TX TIME**. THE FUNCTION CAN BE SUSPENDED AT ANY TIME DURING THE 5 SECOND PERIOD BY PRESSING THE **TX TIME** MK.

↓

Figure 1.182 - Transmitting Time Mode



PRESS THE **RAD1 (2)** SSK.

SATURN HAIL MODE IS SELECTED BY DEFAULT.

CREW MEMBER(S) WILL BE ALERTED BY VOICE MESSAGE IF A SATURN HAIL TRANSMISSION IS RECEIVED PROVIDED THE RADIO IS OPERATING IN A SATURN ECCM MODE.

PRESS THE **HAIL ON** MK MK RECONFIGURES TO SHOW **HAIL OFF**.

SATURN HAIL MODE IS DESELECTED.

CREW MEMBER(S) WILL NOT BE ALERTED IF A SATURN HAIL TRANSMISSION IS RECEIVED.

SUBSEQUENT SELECTION OF THE **HAIL OFF** MK WILL RESELECT HAIL ON.

NOTE

THE HAIL ON MK WILL ONLY BE PRESENTED IF THE HAIL FREQUENCY IS LOADED VIA PDS.
THE HAILING FREQUENCY MAY NOT BE ALTERED/ENTERED BY THE PILOT.

Figure 1.183 - Selecting/Deselecting Saturn Hail

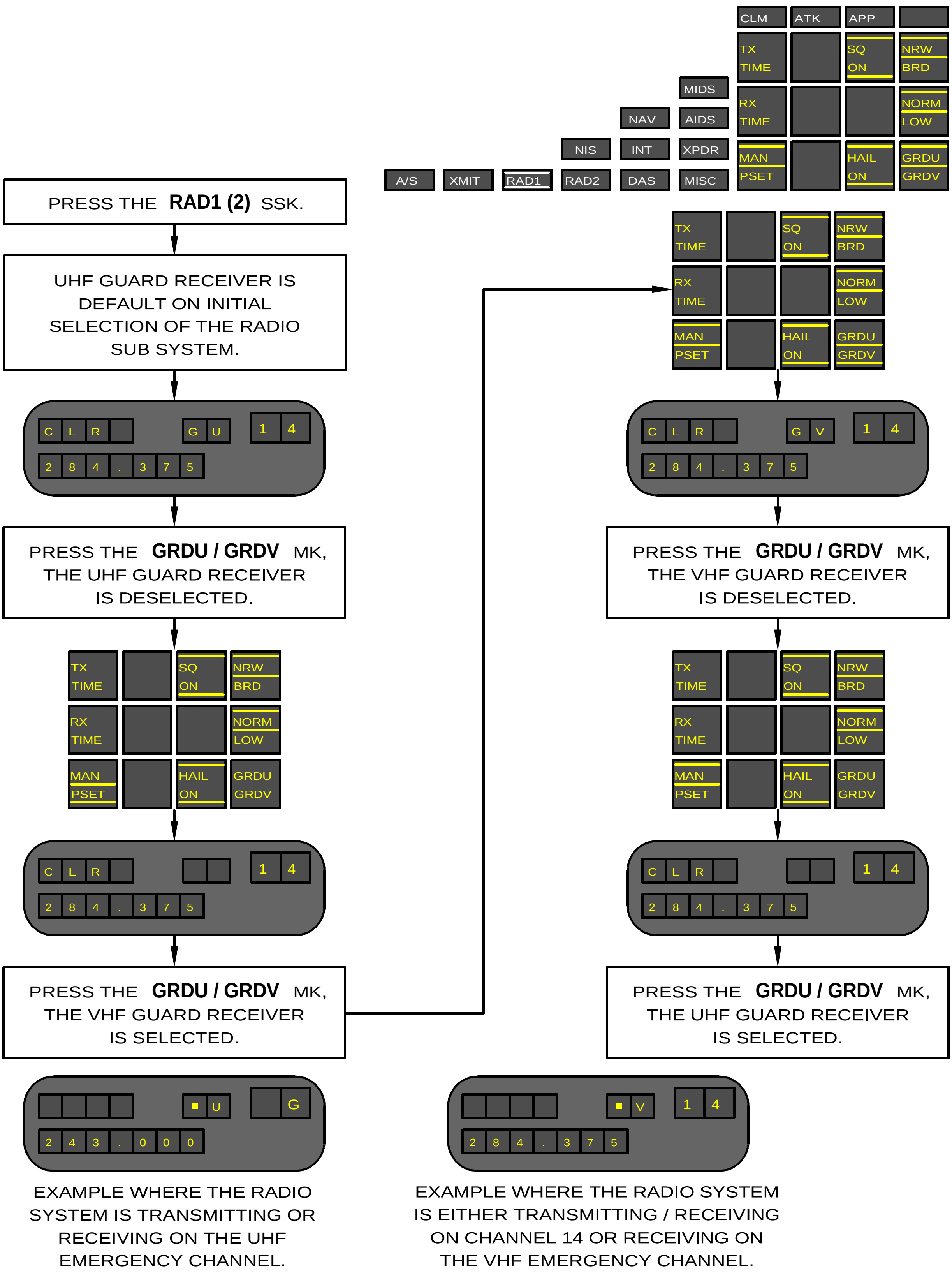
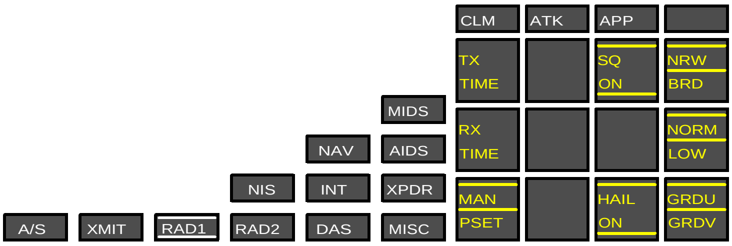


Figure 1.184 - Guard Receiver Mode Selection



PRESS THE **RAD1 (2)** SSK.

NARROW BANDWIDTH MODE IS SELECTED BY DEFAULT ON INITIAL SELECTION OF THE RADIO SUB SYSTEM.

PRESS THE **NRW/BRD** MK.

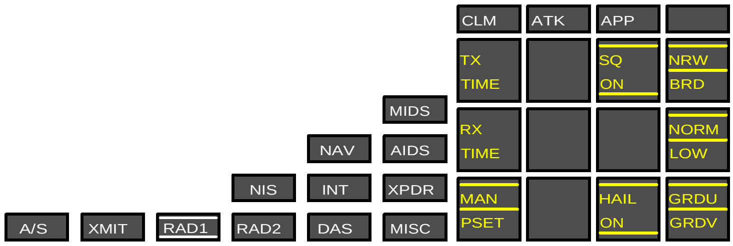
BROAD BAND MODE IS SELECTED

NARROW BANDWIDTH MODE CAN BE RESELECTED BY PRESSING THE **NRW/BRD** MK.

NOTE

THE **NRW/BRD** MK IS ONLY AVAILABLE FOR SELECTION IN HAVEQUICK CLEAR AND FIXED FREQUENCY CLEAR VOICE MODE (SATURN AND SECURE MODES REQUIRE BROAD BANDWIDTH ONLY).

Figure 1.185 - Selecting Bandwidth



PRESS THE **RAD1 (2)** SSK.

↓

NORMAL POWER MODE IS SELECTED BY DEFAULT ON INITIAL SELECTION OF THE RADIO SUB SYSTEM.

↓

PRESS THE **NORM/LOW** MK.

↓

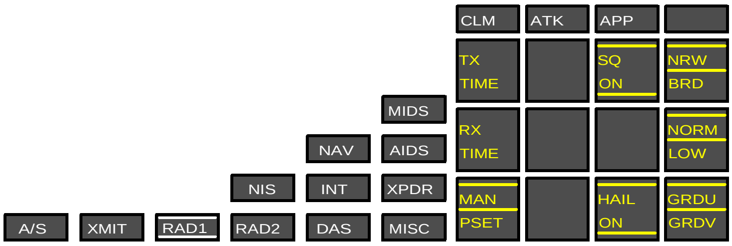
LOW POWER MODE IS SELECTED.

↓

↓

NORMAL POWER MODE CAN BE RESELECTED BY PRESSING THE **NORM/LOW** MK.

Figure 1.186 - Selecting Transmitter Power



PRESS THE **RAD1 (2)** SSK.

SQUELCH MODE IS SELECTED BY DEFAULT ON INITIAL SELECTION OF THE RADIO SUB SYSTEM.

PRESS THE **SQ ON** MK.

SQUELCH MODE IS DESELECTED AND THE MK RECONFIGURES TO SHOW **SQ OFF**.

SQUELCH MODE CAN BE RESELECTED BY PRESSING THE **SQ OFF** MK.

NOTE

THE **SQ ON/OFF** MK IS NOT PRESENTED IN CONJUNCTION WITH THE FOLLOWING SECURE RADIO OPTIONS:

- FIXED FREQUENCY SECURE
- HAVEQUICK SECURE
- SATURN

THESE OPTIONS AUTOMATICALLY SELECT SQUELCH TO ON.

Figure 1.187 - Selecting Squelch Mode

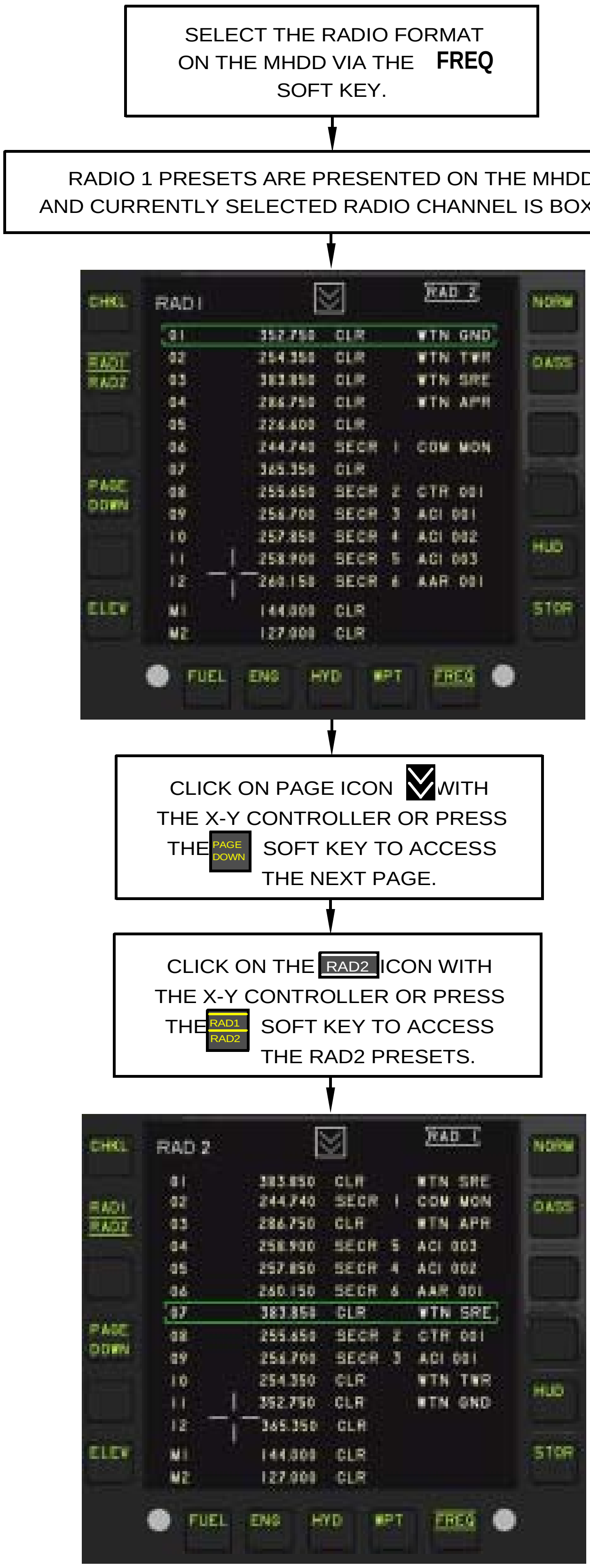


Figure 1.188 - Browse Radio Lists

AUDIO WARNING EQUIPMENT

Radio transmissions, warnings and attention getting sounds (attensons) are heard in the pilot's headset. The communications and audio management unit (CAMU) provides and controls these communications. When a warning situation occurs, the warning is sent to the CSG where it is categorized and prioritized, then transmitted to the pilot via the CAMU. If necessary, an attenson is also transmitted with the warning message. Audio warnings are also generated by the discrete audio warning generator (DAWG) in response to certain system failures on DA1, 2, 5, and 7.

VOICE WARNING SYSTEM MUTE CONTROL

CAUTION

USE OF THE VOICE WARNING CONTROL SWITCH FOR THE PURPOSE OF SILENCING WARNINGS IS NOT RECOMMENDED AS IT MAY REDUCE THE PILOTS AWARENESS OF A CAUTIONARY WARNING SITUATION.

The voice warning system mute control (DA2 only), Figure 1.189, is located underneath the right multifunction head down display. The control consists of a guarded button to prevent inadvertent operation. When the button is pressed, all audio warnings, except spin warnings, are muted; when pressed again, the audio warning system is activated. Voice warnings can also be suspended by selecting voice warning suspend (VWS) on the communication control switch, located on the right throttle top. If the VWS switch is pressed and released the suspended warning and all warnings of equal or lower priority are suspended for a period of 15s. However if the VWS switch is pressed and held for 15s then the suspended warning and all warnings of equal or lower priority are suspended for the duration of the switch operation. During VWS, warnings of higher priority than the currently suspended warnings are unaffected by VWS suspension. Catastrophic warnings cannot be suspended. Voice warning system will be inhibited if the voice warning control switch is set to OFF.

PRESS-TO-TRANSMIT (PTT)

There are three PTT controls located on the stick top controller, the right throttle top (communication control switch) and at the rear of the right console, Figure 1.189. Radio transmission causes transmission of audio warnings to be suspended. If a warning message has started to play, selecting the PTT control suspends the warning for the duration that PTT is selected; the warning continues upon deselection of the PTT control. If a warning occurs after the control is selected, the message plays immediately.

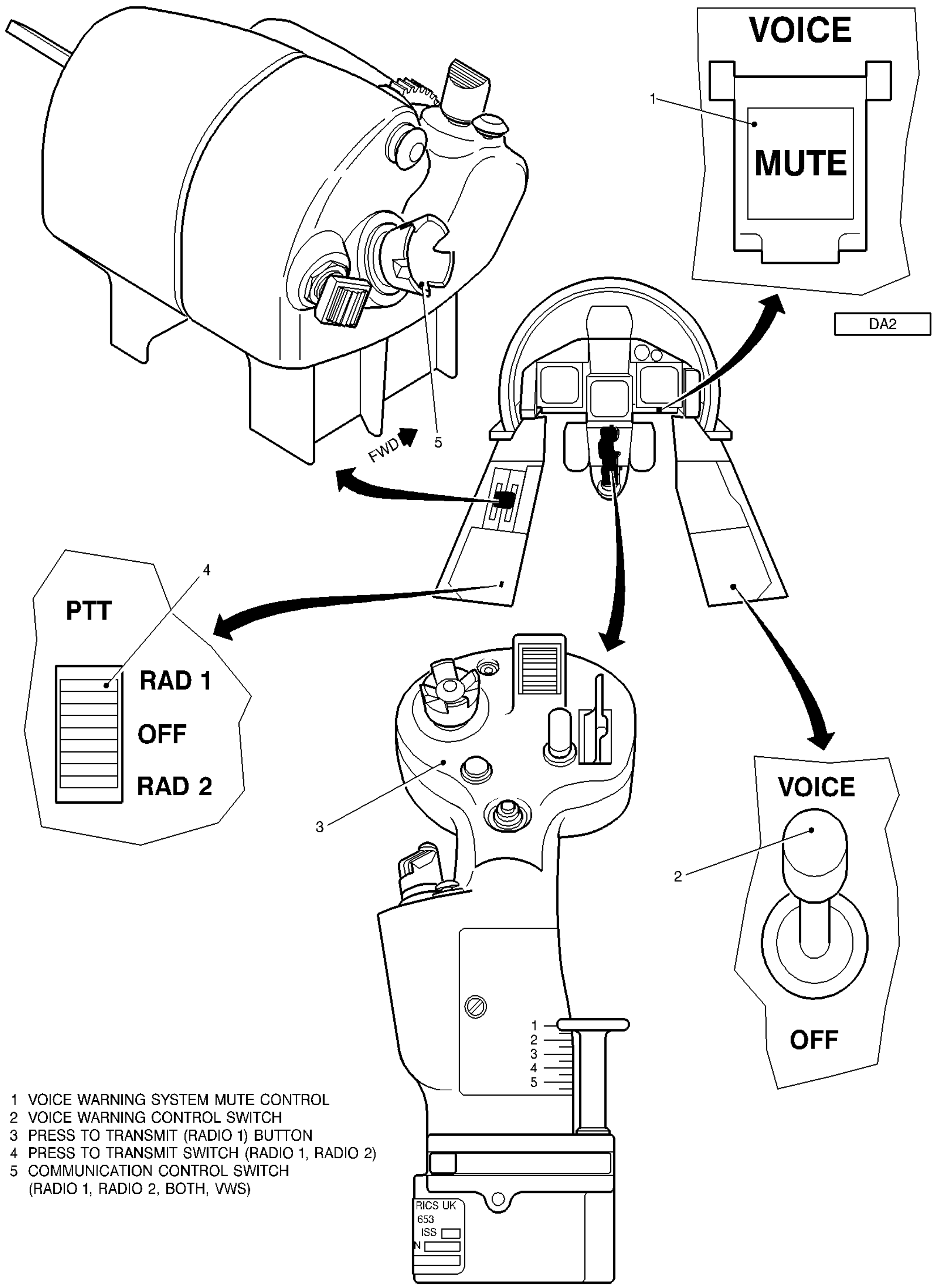


Figure 1.189 - Audio Warning Equipment

WARNINGS MANAGEMENT AND FAILURE ANALYSIS

Under normal operating conditions, all on-aircraft systems are subject to automatic status monitoring. Detection and display of faults/failures is automatic via the warnings system. Failure analysis is not possible on this aircraft. For information on monitoring, refer to Integrated Monitoring Test and Recording System pag. 386.

The warnings system gathers together all warnings, prioritizes them and presents them to the crewmember in an organized and consistent manner. The warnings are presented by some, or all of the following devices: flashing attention getters, an illuminated caption on the dedicated warning panel (DWP), an attention getting sound (attenson) and a voice warning. The aural components of the warning are generated by the communications and audio management unit (CAMU).

All warnings are either related to aircraft systems or are of a procedural nature and are assigned a category according to the phase-of-flight (POF) and are also prioritized within each category. The categories are Catastrophic, 1, 2, 3, 4 in descending order of priority. Warnings occurring simultaneously will be presented sequentially according to their category and prioritization.

During start-up/shutdown, most warnings are suppressed to prevent an array of warnings due to equipment or systems not being activated.

Warnings generated as a consequence of a primary fault condition are referred to as secondary warnings and they are presented on the DWP but do not trigger any other part of the warnings system.

CATASTROPHIC WARNINGS

A catastrophic failure is an event which makes it impossible for the aircraft to continue safe flight and handling. Immediate pilot action is advised which, under some circumstances, may be immediate ejection.

CATEGORY 1 WARNINGS

A category 1 warning is of a procedural nature and warns of a hazardous situation that requires immediate action.

Upon receipt of a category 1 warning, the attention getters flash and the voice warning message is heard. Pressing one of the attention getters accepts the warning; the attention getters stop flashing and, if it is a first play of the voice message the voice warning, is allowed to play in full and then ceases. For subsequent plays the message stops immediately. Figure 1.190 illustrates this sequence.

The voice warning message interrupts and mutes any incoming audio communications.

CATEGORY 2 WARNINGS

A category 2 warning is related to aircraft systems and warns of a primary failure that requires immediate action.

Upon receipt of a category 2 warning, the attention getters and the DWP red caption flash, and an attenson is heard which is followed by a voice warning message. By pressing one of the attention getters, the attention getters stop flashing and the flashing DWP red caption becomes steady. If it is the first play of the voice message it is allowed to play in full and then ceases. For subsequent plays it stops playing immediately. Figure 1.191 illustrates this sequence.

The attenson interrupts and mutes any incoming audio communications, the voice warning message operates in parallel with any incoming communications.

CATEGORY 3 WARNINGS

A category 3 warning is also related to aircraft systems and warn of a primary failure that requires attention.

Upon receipt of a category 3 warning the attention getters and the DWP amber caption flash. A voice warning message will commence as soon as the category 3 situation is detected. By pressing one of the attention getters the attention getters stop flashing and the flashing DWP amber caption becomes steady. If it is the first play of the voice message it is allowed to play in full and then ceases. For subsequent plays, it stops immediately. Figure 1.192 illustrates this sequence.

The voice warning message operates in parallel with any incoming audio communications.

CATEGORY 4 WARNINGS

A category 4 warning is procedural only and provides advice or information of a procedural nature.

Upon receipt of a category 4 warning a voice warning message is played twice and then stops. It can also be stopped by pressing one of the attention getters (even though they are not flashing/not active for this category of warning).

For a category 4 warning the warning system provides an information function; detail of the warning is provided by the voice warning message. The message operates in parallel with any incoming audio communications.

GET-U-HOME (GUH) WARNINGS

The GUH warnings are all category 2 and are presented to the pilot as described for other category 2 warnings.

HARDWIRED WARNINGS

A number of category 2 and category 3 warnings are handled by a hardwired warning system. These warnings are displayed on a number of indicators on the discrete audio warning generator (DAWG) panel, which is situated on the right quarter panel. If a warning is triggered the relevant indicator is illuminated and is accompanied by one of two audio warnings (in the headset) and a flashing pushbutton. The audio warnings ('red tone' for category 2 warnings and 'amber tone' for category 3 warnings) are cancelled by operating the flashing pushbutton. Aircraft equipped with an interim standard MSOC have an additional MSOC switch indicator. If an MSOC warning is triggered, its associated audio warning ('red tone') can be cancelled by pressing the MSOC switch/indicator.

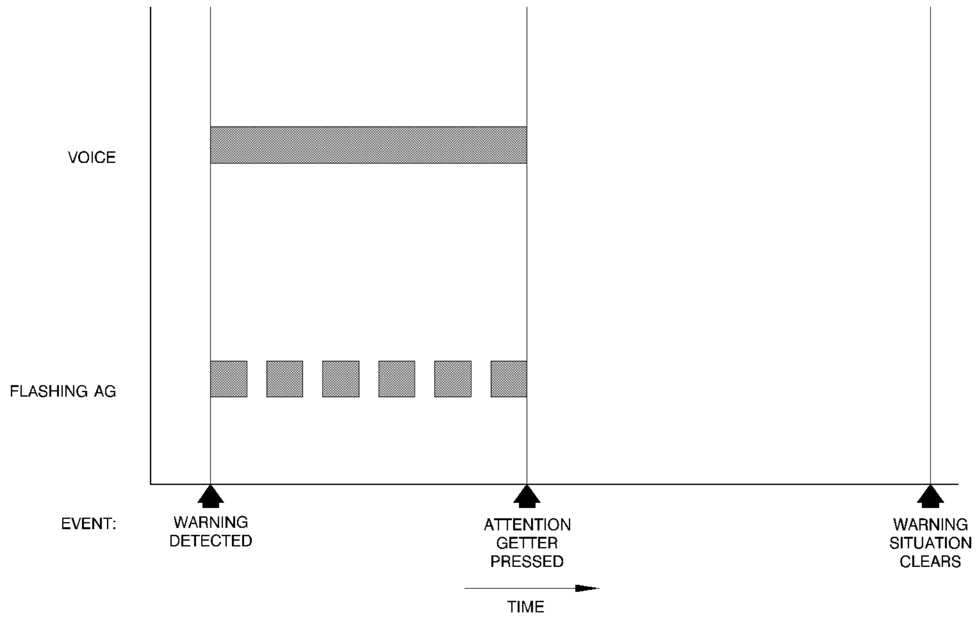


Figure 1.190 - Category 1 Warning Sequence

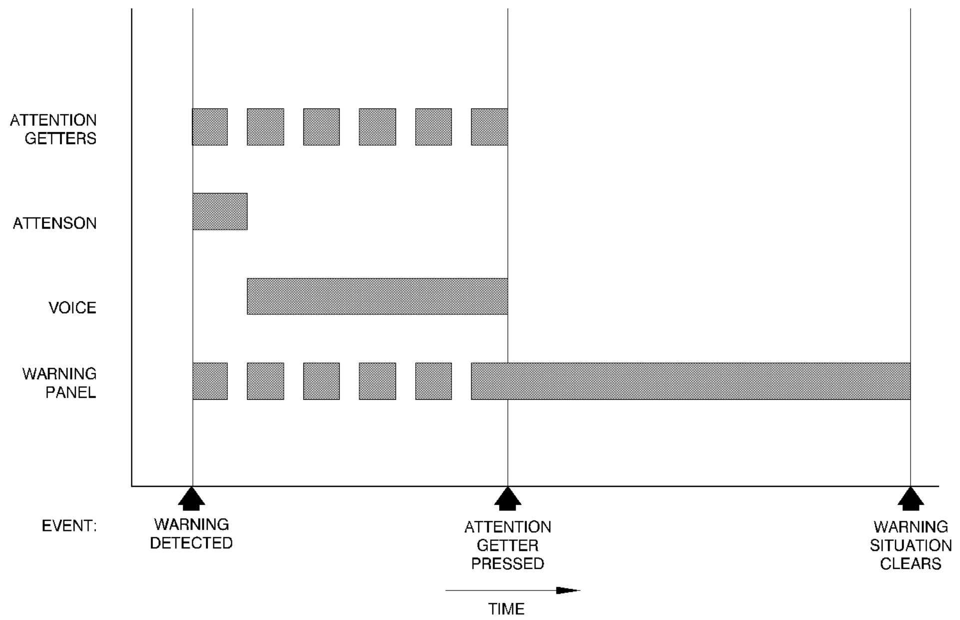


Figure 1.191 - Category 2 Warning Sequence

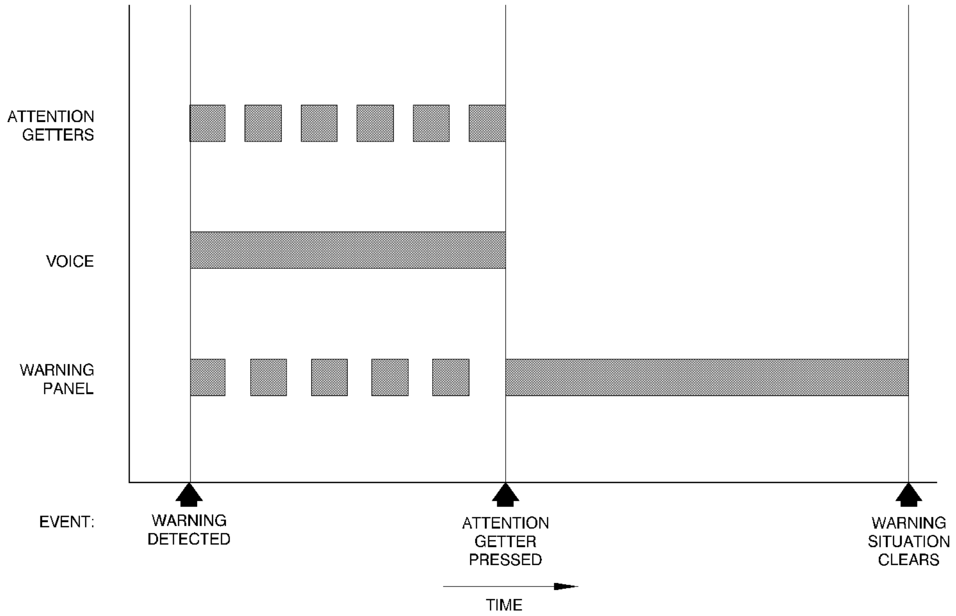


Figure 1.192 - Category 3 Warning Sequence

DEDICATED WARNING PANEL

The dedicated warning panel (DWP), Figure 1.193, is situated on the right quarter panel (twin seat aircraft are equipped with a DWP on the front and rear cockpit right quarter panels). The DWP consists of a reconfigurable, dot matrix type display capable of presenting 27 captions simultaneously, in three columns of nine. The bottom row of three is reserved for captions related to catastrophic warnings. Currently two are defined. Captions are presented in either red or amber depending on the classification, category 2 or 3 respectively. A primary warning flashes until acknowledged by the crewmember(s) (by pressing one of the attention getters). Secondary warnings are a consequence of primary warnings, and do not flash. When a warning has been acknowledged, the caption(s) remains visible until the warning situation clears.

The captions are presented in the order of priority, from the top to the bottom of the display. Captions associated with systems on the left of the aircraft are displayed on the left of the display. Similarly, captions associated with right systems are displayed on the right of the display. When a primary warning with associated secondary warnings is received, space will be made available on the DWP adjacent to the primary caption to display the secondary captions.

WARNING PANEL MODE SELECTOR/ INDICATOR

The warning panel mode pushbutton/indicator Figure 1.193, under normal circumstances, is available for selection at all times. This is indicated by illumination of the caption REV. Upon selection, status bars, above and below the caption, come on and the DWP enters a reversionary ‘get-u-home’ mode of operation. In addition to manual selection, reversionary mode is engaged automatically when the DWP loses one of its two power supplies, or the avionics data bus fails.

After a manual selection of the reversionary mode, further selection of the pushbutton causes the panel to revert back to the normal mode of operation. Upon successful de-selection, the status bars occult. If a detected failure has caused the panel to enter the reversionary mode, selection of the pushbutton has no effect. The normal mode of operation is re-engaged by the system if the fault condition clears.

WARNING PANEL PAGING SELECTOR/ INDICATOR

The warning panel paging pushbutton/indicator Figure 1.193 enables the pilot to scroll through 2 pages of warnings. If the number of warnings that have been triggered exceed two pages, captions for additional warnings are not displayed. The other elements of these additional warnings will however be provided (attention getters, attensons and voice warnings). When the first warning panel page becomes full, the caption PAGE is illuminated. Upon selection, the next page of warnings is displayed and status bars, above and below the caption, come on. Subsequent selection of the pushbutton displays the first page, and the status bars occult. While the PAGE caption is illuminated operation of the paging selector/indicator performs a DWP reset function. The reset function removes all blank/reserved spaces from the display to enable the display to be used more efficiently.

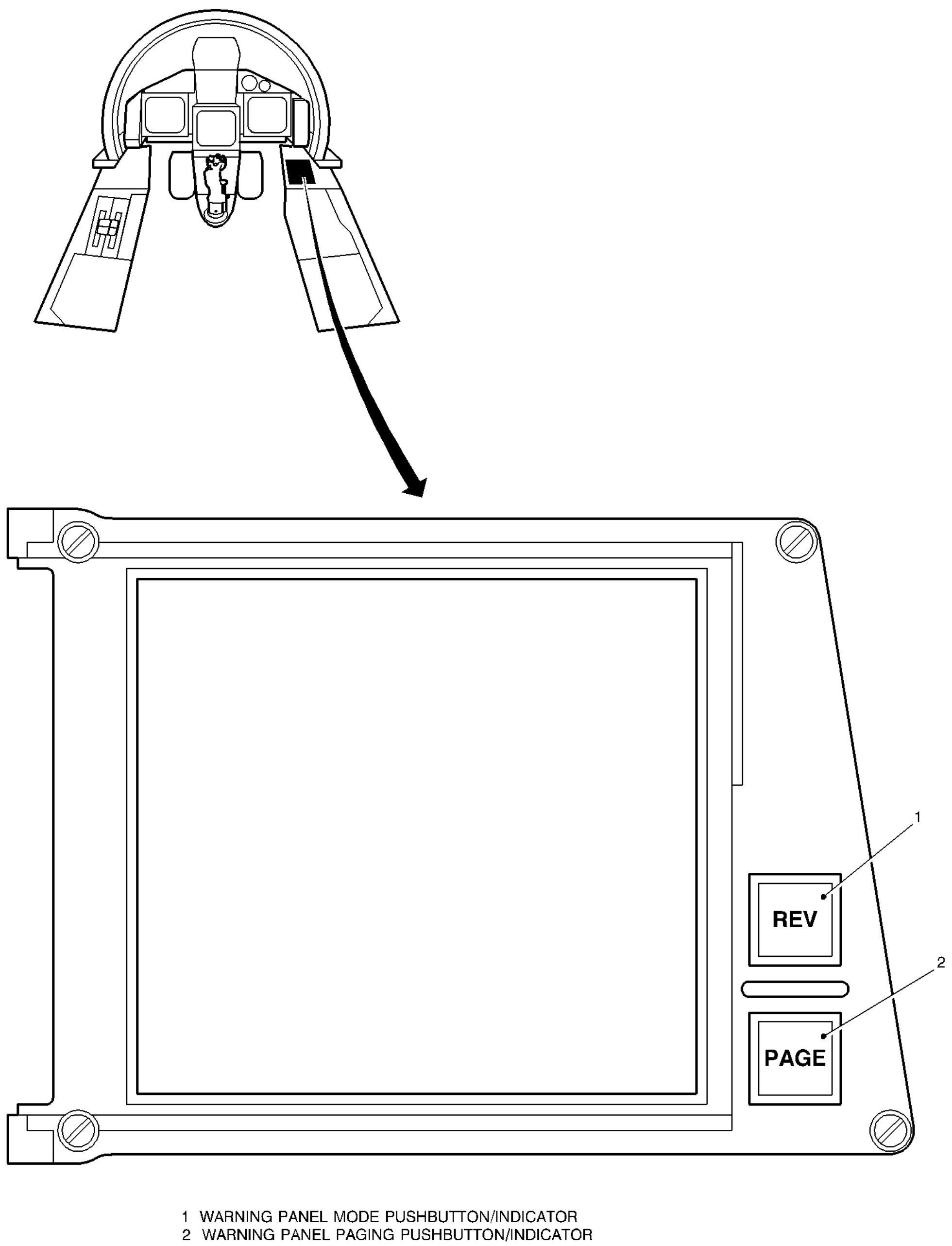


Figure 1.193 - Dedicated Warning Panel (DWP)

VISUAL/AUDIO WARNINGS

The aircraft warning system provides both visual and audio warnings to the pilot. The visual warnings are presented via the attention getters and the dedicated warning panel (DWP). The audio warnings are presented using attention getting sounds (attensons) and voice warning messages.

VISUAL WARNINGS

Two flashing red attention getters, located on the left and right coaming, inform the pilot of a warning situation. By pressing one of the attention getters, the warning is acknowledged and the flashing stops. The DWP presents a visual indication of all category 2 and 3 warnings (including catastrophic warnings). Upon receipt of a warning, the DWP caption will flash until acknowledged, after which it will remain steady. A warning which is the result of an indirect system failure will not flash. For further details of the DWP, refer to Dedicated Warning Panel pag. 375.

AUDIO WARNINGS

There are two forms of audio warnings; attensons and voice warning messages. Category 1, 3 and 4 warnings generate a voice warning message, but not an attenson. Category 2 warnings carry an attenson and a voice warning message. The voice warning message sounds until the warning is acknowledged. Category 4 warnings are sounded twice and then stop automatically.

CATASTROPHIC WARNINGS

This category of warning has the highest priority and is indicated by flashing attention getters, a dedicated caption on the DWP and a voice message that plays immediately, interrupting any other audio message. Currently, only two catastrophic warnings are defined, refer to Catastrophic Warnings Table.

Catastrophic Warnings

WARNING	CAPTION	VOICE WARNING MESSAGE
Double hydraulics failure	HYD TOT	Double hyd fail
Reduce envelope	REV ENV	Reversionary envelope

CATEGORY 1 WARNINGS

This category of warning is the next highest priority of warning and is indicated by the attention getters and a voice warning message. The message informs the pilot of the immediate action to be taken, and continues until the warning is acknowledged or the warning condition clears. Table is a list of category 1 voice warning messages.

Category 1 Voice Warning Messages

WARNING	VOICE WARNING MESSAGE
RAD ALT low height (NAV and COMB POF) *	Low height
Pull up (including GPWS)	Pull up
Auto pull up	Auto pull up
Mass not live (TAKE OFF POF) *	Mass not live
Gear not lowered in conjunction with: Airspeed < 180 kts Radar Altitude < 500 ft Both throttles < 70mm.	Landing gear
Gear down and speed exceeding 320 kts	Gear limit
Low speed	Speed low recover

(Continued)

Category 1 Voice Warning Messages (Continued)

WARNING	VOICE WARNING MESSAGE
Park brake (TAKE OFF and APP/LDG POF) Park brake to be triggered by: 1 Park brake engaged Weight-on-wheels Both throttles >65% NL, or Park brake engaged Weight-off-wheels Gear Down selected	Park brake
Missile detected left	Missile left
Missile detected right	Missile right
Missile detected rear	Missile rear

* Refer also to Table. These warnings may be Cat 4 warning messages depending upon POF.

CATEGORY 2 AND 3 WARNINGS

These two warning categories are the next highest priority of warning and are indicated by the attention getters, DWP caption, an attenson (CAT 2 warnings only) and a voice warning message. In the case of CAT 2 warnings the voice warning message follows the attenson and informs the pilot of the nature of the warning, continuing until the warning is acknowledged. In the case of CAT 3 warnings the voice message is played immediately the category 3 situation is detected. Certain category 2 and 3 warnings are indicated via dedicated captions on the discrete audio warning generator (DAWG) panel. These warnings are accompanied by one of two audio warnings (depending on the category) and a flashing push button located on the DAWG panel which enables the audio warning to be muted when operated. However if the MSOC warning is triggered its associated audio warning may only be cancelled by pressing the MSOC switch/indicator. The following Tables identify the category 2 and 3 warnings and includes the caption and voice/audio warning associated with them.

NOTE

Aircraft DA7 has a data-bus compatible MSOC. The MSOC warning will be displayed on the DWP, therefore DA7 does not have a dedicated MSOC switch/indicator fitted.

DAWG Category 2 and 3 Warnings

WARNING	CAPTION	AUDIO WARNING
Category 2		
DC generation failure level 2	ELEC 2	'Red' tone
MSOC failure	MSOC	'Red' tone
Category 3		
DC generation failure level 1	ELEC 1	'Amber' tone
Left AC generator failure	L GEN	'Amber' tone
Right AC generator failure	R GEN	'Amber' tone
Double TRU failure	D TRU	'Amber' tone

DWP Category 2 Warnings

WARNING	CAPTION	VOICE WARNING MESSAGE
Left engine oil low pressure	L OIL P	Left oil pressure
Right engine oil low pressure	R OIL P	Right oil pressure
Left engine performance	L ENG P	Left engine performance
Right engine performance	R ENG P	Right engine performance
Left reheat failure *	L RHEAT	Left reheat
Right reheat failure *	R RHEAT	Right reheat
Left engine flameout	L FLAME	Left engine flameout
Right engine flameout	R FLAME	Right engine flameout
No cooling to avionic LRI	FAN	ECS fan
Left uncontrolled hot gas leak	L ECS LK	Left ECS Leak
Right uncontrolled hot gas leak	R ECS LK	Right ECS Leak
Double AC generator failure (GUH only)	AC	Double AC
DC generation failure level 3 (GUH only)	ESS DC	Essential DC
DC generation failure level 2	ELEC 2	Electrical second fail
Left air turbine starter motor overspeed	L ATSM	Left air turbine
Right air turbine starter motor overspeed	R ATSM	Right air turbine
Left gearbox lubrication overtemperature	L GBOX T	Left gearbox temp
Right gearbox lubrication overtemperature	R GBOX T	Right gearbox temp
Left gearbox failure	L GBOX	Left gearbox
Right gearbox failure	R GBOX	Right gearbox
Left fuel low pressure	L FUEL P	Left fuel pressure
Right fuel low pressure	R FUEL P	Right fuel pressure
Left fuel overtemperature *	L FUEL T	Left fuel temp
Right fuel overtemperature *	R FUEL T	Right fuel temp
Low pressure in left utilities	L UTIL P	Left UTIL
Low pressure in right utilities	R UTIL P	Right UTIL
Low pressure in left control circuit	L CONT P	Left control pressure
Low pressure in right control circuit	R CONT P	Right control pressure
Oxygen *	OXY	Oxygen

(Continued)

DWP Category 2 Warnings (Continued)

WARNING	CAPTION	VOICE WARNING MESSAGE
Monitor trip (navigation) *	MON TRIP	Monitor trip
FCS 2nd failure	FCS 2	FCS second fail
FCS REV limits apply	FCS REV	FCS Reversionary
Slats system freeze *	SLATS	Slats fail
Nose wheel steering failure *	NWS	Nose wheel steering
Autopilot failure *	A/PILOT	Autopilot
Probe heating 2nd failure *	PROBE 2	Probe second fail
Hazardous C.G. position *	C G	C G
Left intake cowl failure *	L COWL	Left intake cowl
Right intake cowl failure *	R COWL	Right intake cowl
Airdata failure warning	AIR DATA	Air data
Autothrottle fail	A THROT	Autothrottle fail
Left engine fire	L FIRE	Left engine fire
Right engine fire	R FIRE	Right engine fire
APU fire **	APU FIRE	APU fire
Canopy not locked	CANOPY	Canopy not locked
Hook down uncommanded *	HOOK DWN	Hook down
Brakes loss of function *	BRK FAIL	Brakes
Anti-skid loss of function	A/SKID	Anti-skid

* These captions are able to be displayed as category 3 warnings in certain phases of flight, or during certain combinations of warnings.

** APU Fire Warning also pulses the Canopy Warning Horn to ensure a warning is given during cold ground starts before the Warning System is on-line.

DWP Category 3 Warnings

WARNING	CAPTION	VOICE WARNING MESSAGE
Left engine oil overtemperature	L OIL T	Left oil temp
Right engine oil overtemperature	R OIL T	Right oil temp
Left DECU failure	L DECU	Left DECU
Right DECU failure	R DECU	Right DECU
Left reheat failure *	L RHEAT	Left reheat
Right reheat failure *	R RHEAT	Right reheat
Left engine vibration	L VIBR	Left engine vibration
Right engine vibration	R VIBR	Right engine vibration

(Continued)

DWP Category 3 Warnings (Continued)

WARNING	CAPTION	VOICE WARNING MESSAGE
Environmental control system failure	ECS	ECS
Cabin low pressure	CABIN L	Cabin low pressure
Cabin high pressure	CABIN H	Cabin high pressure
Left AC generator fail	L GEN	Left generator
Right AC generator fail	R GEN	Right generator
Left AC generator overheat	L GEN T	Left generator temp
Right AC generator overheat	R GEN T	Right generator temp
Electrical level 1 fail	ELEC 1	Electrical first fail
Battery overheat warning	BATT T	Battery overheat
SPS pipe overpressure	SPS P	SPS overpressure
Left power take-off shaft failure	L POT	Left power off take
Right power take-off shaft failure	R POT	Right power off take
APU door (GND POF only)	APU DOOR	APU door
Left fuel overtemperature *	L FUEL T	Left fuel temp
Right fuel overtemperature *	R FUEL T	Right fuel temp
Vent pressure/temperature	VENT	Fuel vent
Fuel low level	FUEL LOW	Fuel low
Fuel transfer warning	XFER	Fuel transfer
AAR system failure	FUEL VLV	Fuel valve
Left hydraulics overtemperature	L HYD T	Left hyd temp
Right hydraulics overtemperature	R HYD T	Right hyd temp
Air in left hydraulics (GND POF only)	L HYD A	Left HYD air
Air in right hydraulics (GND POF only)	R HYD A	Right HYD air
MSOC not in use	MSOC	MSOC off
Oxygen *	OXY	Oxygen
Global positioning system failure	GPS	GPS
Laser inertial navigator	LINS	LINS
Radar altimeter	RAD ALT	RAD ALT
TACAN failure	TACAN	TACAN
Navigation computer failure	NAV CPTR	Nav computer
Monitor trip (navigation) *	MON TRIP	Monitor trip

(Continued)

DWP Category 3 Warnings (Continued)

WARNING	CAPTION	VOICE WARNING MESSAGE
Gun loss of function	GUN FAIL	Gun fail
Store hung up	HANG UP	Hang up
Emergency jettison failure	EJ FAIL	Emergency jettison fail
Gun scoop failure	GN SCOOP	Gun scoop
Selective jettison failure	SJ FAIL	Selective jettison fail
NSCAC failure	NSCAC	NSCAC fail
Distribution unit failure	DU FAIL	DU fail
Armament control system failure	ACS FAIL	ACS fail
SCAC channel failure	SCAC	SCAC
FCS 1st failure	FCS 1	FCS first fail
Loss of fuel mass or stores data	FCS MASS	FCS mass
Slat system freeze *	SLATS	Slats fail
Nose wheel steering failure *	NWS	Nose wheel steering
Airbrake failure	A BRAKE	Air brake fail
Autopilot failure *	A/PILOT	Autopilot
Probe heating 2nd failure *	PROBE 2	Probe second fail
Pitch/roll yaw trim failure	TRIM	Trim
Hazardous C.G. position *	C G	C G
FCS reset	FCS RESET	FCS reset
Left intake cowl failure *	L COWL	Left intake cowl
Right intake cowl failure *	R COWL	Right intake cowl
Throttle follow up failure	THROT LK	Follow up throttle
Barometric pressure setting failure	BARO-SET	Baro pressure
CIU single failure	CIU	CIU fail
Double CIU failure rear cockpit	REAR CIU	Rear CIU
CSG single failure	CSG	CSG fail
Double CIU/CSG failure **	CPT DISP	Cockpit display
Map not available	MAP	Map
GPWS failure	GPWS	GPWS
Terrain data failure	TERRAIN	Terrain data
Obstacle data failure	OBSTACLE	Obstacle data
Radar shutdown	RADAR SD	Radar shutdown
Radar total failure	RADAR	Radar

(Continued)

DWP Category 3 Warnings (Continued)

WARNING	CAPTION	VOICE WARNING MESSAGE
Attack computer	ATK CPTR	Attack computer
Transponder failure	XPDR	Transponder
IFF interrogator failure	IFF INT	Interrogator
IFF interrogator cyryptovariable failure	IFF CRYPTO	IFF crypto
IFF interrogator overtemperature	INT T	Interrogator temp
DAS computer failure	DAS CPTR	DASS computer
Flare dispenser failed	FLARE	Flare dispenser
Chaff dispenser failed	CHAFF	Chaff dispenser
ECM / ESM failure	ESCM	Electronic measures
ECM / ESM overtemperature	ESCM T	Electronic measures temp
Missile warner failure	MW	Missile warner
Missile warner overtemperature	MW T	Missile warner temp
Voice warning failure	VOICE	
Communications degraded	COMMS	COMMS
MIDS failure	MIDS	MIDS
MIDS transmission failure	MIDS XMIT	MIDS transmitter
MIDS overtemperature	MIDS TEMP	MIDS temp
MIDS cryptovariable failure	MIDS CRYP	MIDS crypto
Ice detected	ICE	Icing
Windscreen heating system failure	WINDSCRN	Windscreen heater fail
AAR probe lock failed	IFR	IFR probe
Hook down uncommanded *	HOOK DWN	Hook down
Hook loss of function	HOOK	Hook fail
Brake chute loss of function	CHUTE	Chute fail
Brakes loss of function *	BRK FAIL	Brakes
Anti-skid loss of function *	A/SKID	Anti-skid
Left SPS computer failure	L SPS C	Left SPS computer
Right SPS computer failure	R SPS C	Right SPS computer
Left fuel computer failure	L FUEL C	Left fuel computer
Right fuel computer failure	R FUEL C	Right fuel computer
UCS front computer failure	F UCS C	UCS front computer

* These captions are able to be displayed as category 2 warnings in certain phases of flight, or during certain combinations of warnings.
** Double CIU/CSG failure is a category 3 for the voice only in the event of a double CIU failure. In the case of a double CSG failure the voice message is a GUH message.

CATEGORY 4 WARNINGS

This category of warning is the lowest priority and causes only a voice warning message to be played to the pilot. The audio message is played twice and informs the pilot of the nature of the warning. Table is a list of category 4 voice warning messages.

Category 4 Voice Warning Messages

WARNING	VOICE WARNING MESSAGE
Wing tanks empty	Wing tank empty
Center tank empty	Center tank empty
Mass not live (NAV, COMB and APP/LDG POF) *	Mass not live
RAD ALT low height warning (APP/LDG POF) *	Low height
Airframe temperature exceedance (NAV and COMB POF)	Airframe temp
Maximum speed exceed (NAV and COMB POF)	Max speed
DRF selected	Auto recover
Autothrottle override	Autothrottle
Autopilot	Autopilot
Carefree handling take over	FCS override
Passing 5000 ft check	Five thousand feet
Disengagement of baro alt AP mode	Altitude mode drop out
Supersonic advanced warning	Transonic
Auto throttle reheat required	Select reheat
Autocue	Autocue
GPWS terrain valid	Terrain valid
GPWS obstacle valid	Obstacle valid
BINGO one, two, three or four fuel levels attained	BINGO one, two, three or four (as appropriate)
Front DWP failure	DWP fail
Rear DWP failure	Rear DWP fail
VVR failure	VVR fail
VVR run time check	Check VVR
VVR tape end	VVR tape end
IFF transponder auto code change available	IFF transponder ACC available
IFF interrogator auto code change available	Interrogator ACC available
Mode 4 incorrect response	Mode four response
Chaff empty	Chaff empty

(Continued)

Category 4 Voice Warning Messages (Continued)

WARNING	VOICE WARNING MESSAGE
Flares empty	Flares empty
DASS mission data not loaded	DASS data
Decoy trailed	Decoy trailed
IPF breach	IPF breach
MIDS message received	MIDS message
MIDS sync	MIDS sync
Hail radio 1	Hail radio 1
Hail radio 2	Hail radio 2
Radios common tuning	Frequency
Simultaneous CLR/SEC transmission	Beep
Gear travelling speed (Gear down and speed >290 kts but <320 kts)	Gear travel
FTI warning	Check FTI

* Refer also to Table, Category 1 Voice Warning Messages.

RECORDERS

INTEGRATED MONITORING TEST AND RECORDING SYSTEM

The IMRS provides the means to collate and process the status, damage and exceedance of aircraft flight parameters, structural data, engine data and aircraft systems data. The system interfaces with the avionic, attack and UCS databusses and with a number of aircraft subsystems via discrete links (refer to Avionics System Integration pag. 231). Data from the systems and subsystems is used to automatically record information from these systems to:

– Maximize operational readiness.
– Minimize maintenance costs.
– Support debriefing of aircrew.
– Assist in accident and incident investigation.

NOTE

At AVS SP3C/12 the functionality of the MDLR is limited to Single Mission Data (SMD) loading.

The data is stored in the Crash Survivable Memory Unit (CSMU), the Bulk Storage Device (BSD) and the Maintenance Data Panel/Portable Maintenance Data Store (MDP/PMDS). The MDP/PMDS can also be used by ground crew to set up initial aircraft data. The IMRS also stores video and audio data via a Video Voice Recorder (VVR) for post flight analysis. The aircrew can load operational data into the avionic system using the Mission Data Loader Recorder/Portable Data Store (MDLR/PDS). The MDLR also records operational data for post flight analysis.

INTERFACE PROCESSOR UNIT

The Interface Processor Unit (IPU), located in the right avionics bay, collates and processes aircraft flight parameters, structural data, engine health data and aircraft maintenance data. Once acquired the IPU performs any data changes required and then transmits the data to the relevant LRI for storage. It acquires data from the aircraft systems via the avionic, attack and UCS databusses, the engine monitoring unit, Flight Control Computers (FCC 3 and 4) and the Cockpit Audio Management Unit (CAMU). Once the information is processed it is transmitted to the CSMU, the BSD and the MDP via dedicated links.
The Maintenance Data is generated by LRI, Continuous Built in Test (CBIT), Initiated BIT (IBIT), and Power-up BIT (PBIT). It also includes exceedance data and out of range indications or parameter combinations. The stored data includes time of occurrence (provided by GPS, radios or the PMDS), detailed fault data and hardware/software configuration data.
The IPU enables the following functions to be performed:

– Crash recording
– Avionic initiated Built-in-Test (IBIT) handling
– Avionic maintenance data handling
– MDP link handling
– Stores configuration data loading
– Utilities, propulsion and FCS maintenance data handling
– Avionic configuration checking
– Structural health monitoring
– Video voice recorder handling
– Engine health monitoring
– EMU link handling
– Utility system lifed item data transfers
– Event marker recording to MDP
– End of flight recording to MDP

CRASH SURVIVABLE MEMORY UNIT

The Crash Survivable Memory Unit (CSMU) receives and stores data in crash protected Electrically Erasable Programmable Memory (EEPROM) for accident/incident investigation. The CSMU incorporates radio and sonar beacons, and has an orange finish with reflective stripes on the top, bottom and sides. It is installed within the rear fuselage in a position just beneath the aircraft fin. The radio locator beacon is activated by an integral impact switch, which is set to operate when subjected to an acceleration of 35.5 g in any direction. The beacon transmits on 243 MHz and has an effective range of 50 nm. The sonar beacon is activated by immersion in water. It transmits a 38 kHz signal which has an effective range of 1.5 nm.

NOTE

CSMU data is lost if electrical power is re-applied to the aircraft post flight. If the CSMU data is to be retained it can be protected against accidental erasure by isolating the CSMU by tripping circuit breaker 390 (CSMU Write Enable Discrete Circuitry) as soon as possible after electrical power has been removed from the aircraft.

The data for the CSMU is collected and conditioned by the IPU and then transmitted to the CSMU via a direct digital data link. The CSMU also receives the aircraft tail number, the flight number and the IMRS time from the IPU. The CAMU supplies the IPU with crewmembers voice and audio warnings. This is digitized by the IPU and then supplied to the CSMU. Parameter and event data is recorded in digital form, as follows:

- Engine start data, FCS actuator check data and data 90 seconds either side of weight-off-wheels
- The last 90 minutes of flight (as compressed flight data)
- The last 30 seconds of flight (as uncompressed flight data)
- The last 10 minutes of digitized crew members voice and audio warnings data

The unit is automatically activated upon the application of aircraft power.
Recorded data from the CSMU for post flight analysis can be downloaded off aircraft via the Ground Support System (GSS), or whilst on-aircraft via the Ground Loading Unit (GLU).

BULK STORAGE DEVICE

NOTE

DA2 is not fitted with a Bulk Storage Device.

The BSD is located in the left undercarriage wheel bay. The BSD is designed to record and compress data for a ninety-minute flight, depending on the number of parameters to be recorded and their sample rates and resolutions, and upon flight activity for off-aircraft analysis purposes. The definition of which data is to be recorded, and the sample rates and resolutions of that data, is defined via MDP/ PMDS data up-load. The BSD receives compressed data from the IPU through a single serial databus. The data from the IPU comprises engine health monitoring data from the DECUs via the EMU, SPS information from the SPS computers via the UCS databus, and general information from the IMRS system. The general information consists of:

- Calculated SHM data
- Any other data entering the IMRS system and pre-defined on MDP/PMDS data up-load

The BSD downloads its information via the serial databus to the ground servicing equipment. The BSD can store 15 Mbytes of data on EEPROM. Data storage ceases once the memory is full. The BSD then requests to output the data to ground test equipment.

MAINTENANCE DATA PANEL/PORTABLE MAINTENANCE DATA STORE

The MDP/PMDS is the primary interface for the recording and display of maintenance data. The MDP is installed in the aircraft center fuselage behind a hinged door on the left side of the engine air intake (Figure 1.194). The front face of the unit contains a display/keyboard module. The display area is an alphanumeric type and presents information by use of 7x5 dot matrix LED characters. The display can show all standard ASCII characters plus a range of user defined characters. The keyboard area consists of ten touch sensitive keys located either side of the display area. On power up the MDP presents a main menu of options; an option may be selected via the relevant touch sensitive key. When an option is selected the display area re-configures to allow various maintenance functions to be carried out, i.e. refuel or defuel, checking fluid contents and pressures, checking and updating stores data, etc. The main menu display also shows the aircraft status as either GO or NOGO. If at least one failure is recorded the NOGO caption is set. Touching the key next to the NOGO caption selects the NOGO failure details. The brightness of the display is set automatically by a light sensor mounted on the front of the unit, but can be manually overridden by operating the brightness controls located to the right of the display. The PMDS inserts into a slot to the top right of the MDP. The MDP/ PMDS interfaces with other aircraft systems via the IPU. The MDP is powered from PP3 during normal operation or from the battery (via PP5 maintenance busbar) during ground use when no other supplies are available. If operating from the battery a reduced functionality of the MDP is available and no IMRS communication is possible.

The MDP/PMDS performs 4 main functions - display, recording, maintenance and data loading.

Display functions - the following categories of data are accessible via the menu driven MDP keyboard and display:

- System/LRI status and failure data (actual and last flight)
- Limit exceedance data (actual and last flight)
- Status of consumables (actual)
- Armament consumables (chaff/flare, decoys, gun rounds) (actual)
- Weapons/stores configuration data (actual)
- Lifed items

Recording functions - the PMDS records/stores the following information:

- Aircraft and PMDS ident
- LRI failure data (up to 5 flights)
- Exceedance data (up to 5 flight)
- Engine health monitoring (EHM) data
- Structural health monitoring (SHM) data
- SPS life monitoring data
- Hydraulic trend data

Maintenance functions - the MDP contains controls to allow the ground crew to perform the following actions:

– Aircraft inspections and turnaround
– Refuelling/defuelling
– IBIT for the UCS LRI, including the MDP, ACS, air conditioning system and oxygen system

Data loading functions - the MDP touch panel and the PMDS allows information to be loaded into the MDP for onward transmission to other aircraft systems. The following data loading is performed:

– Manual input and downloading of the initial weapons/stores configuration data via the touch panel
– Downloading and uploading of aircraft related data comprising configuration data, initial data for SHM, EHM and SPS life monitoring, harmonization data and BSD data.

The MDP has two modes of operation; ground and flight. The ground mode is selected when the hinged door is open. In this mode the ground crew can access the data stored in the MDP memory to perform aircraft inspection, initiate control functions, select maintenance options, enter stores data and to upload data from the PMDS to the IPU. The PMDS data is automatically down-loaded upon insertion if the MDP and IMRS are powered. The status of the aircraft is also shown on the MDP as a GO or NOGO. When the hinged flap is closed the MDP enters flight mode. Where unserviceability arises the IPU supplies the data to the MDP via a discrete link, where the fault conditions are latched for post flight analysis. The data stored includes time of occurrence, detailed fault data and hardware/ software configuration. Maintenance data is also generated by exceedance monitoring functions, which detect out of range indications of certain parameter, or parameter combinations. SHM data and EHM data are also generated.

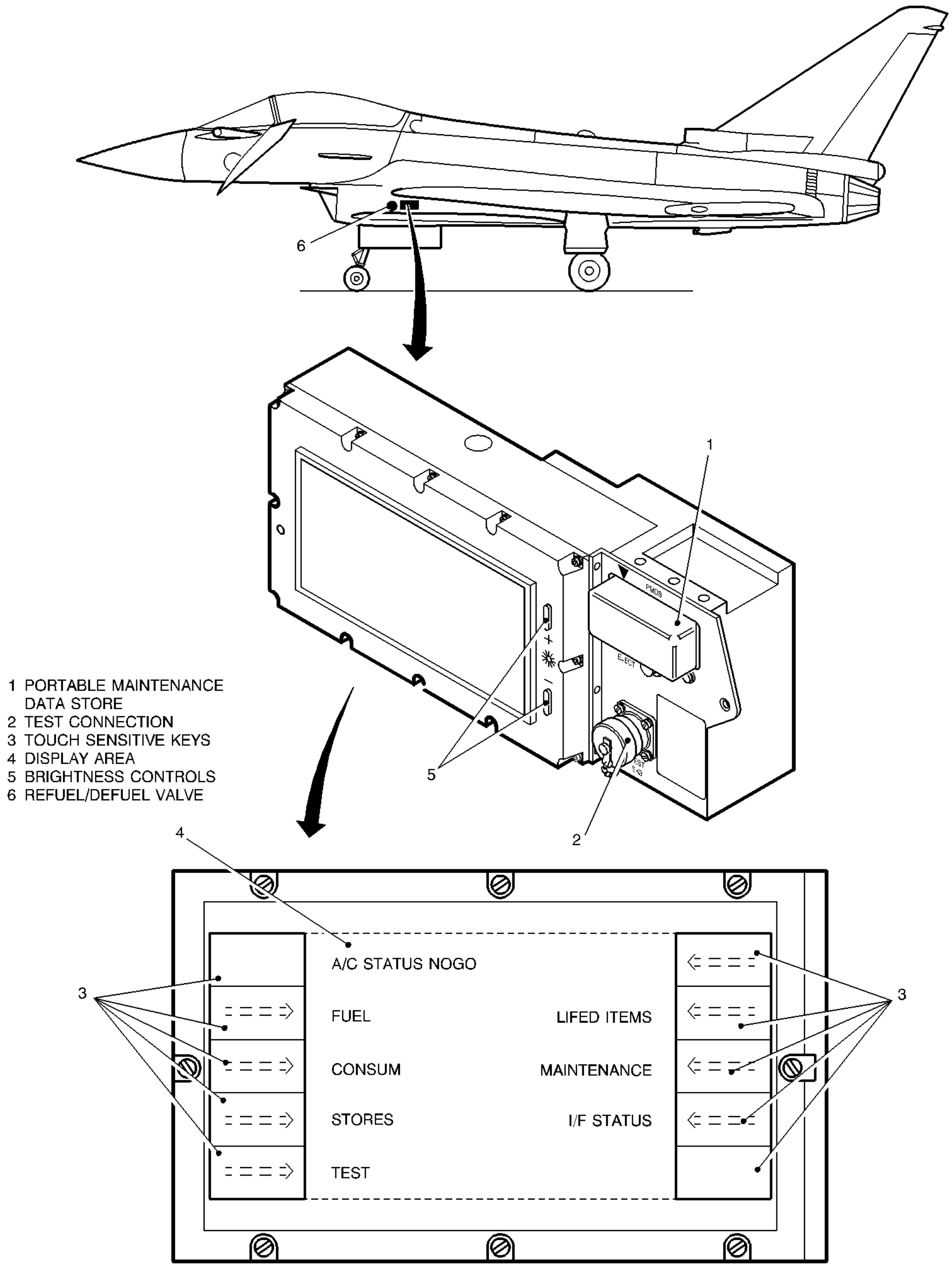


Figure 1.194 - Maintenance Data Panel

VIDEO VOICE RECORDER

NOTE

DA2 is not fitted with a VVR.

The VVR records all the head down primary video displays (as presented to the pilot) and the head up scene as viewed through the HUD, including the outside world. It is also able to record headset audio (including audio warnings) and pilot initiated event markers. In single seat aircraft it is located in the rear of the cockpit, behind the pilots head and is not accessible in flight. In twin seat aircraft it is mounted in the front cockpit, on the right bulkhead to the side of the pilot (Figure 1.195). The VVR operates using commercially available Hi8, 8mm magnetic video tape with a recording time of 90 minutes. It is capable of recording color and/or monochrome video along with audio data. This facility is provided by separate video and audio channels. The VVR interfaces with:

– The CSG for video. Multiplexed video display data from the MHDD and HUD are output from the CSG to the VVR in Red Blue Green (RBG) video format via the video channels
– The CAMU for audio information
– The cockpit databus (STANAG 3838) to receive, via the CIU, event marking, time data, navigation data, input selection, mode control signals and transmit status information
– Two discrete signal lines used to indicate VVR status in the cockpit, i.e. STANDBY or RECORD mode
– One discrete control line from the VVR cockpit control to input Manual Mode Control Signals (STANDBY and RECORD).

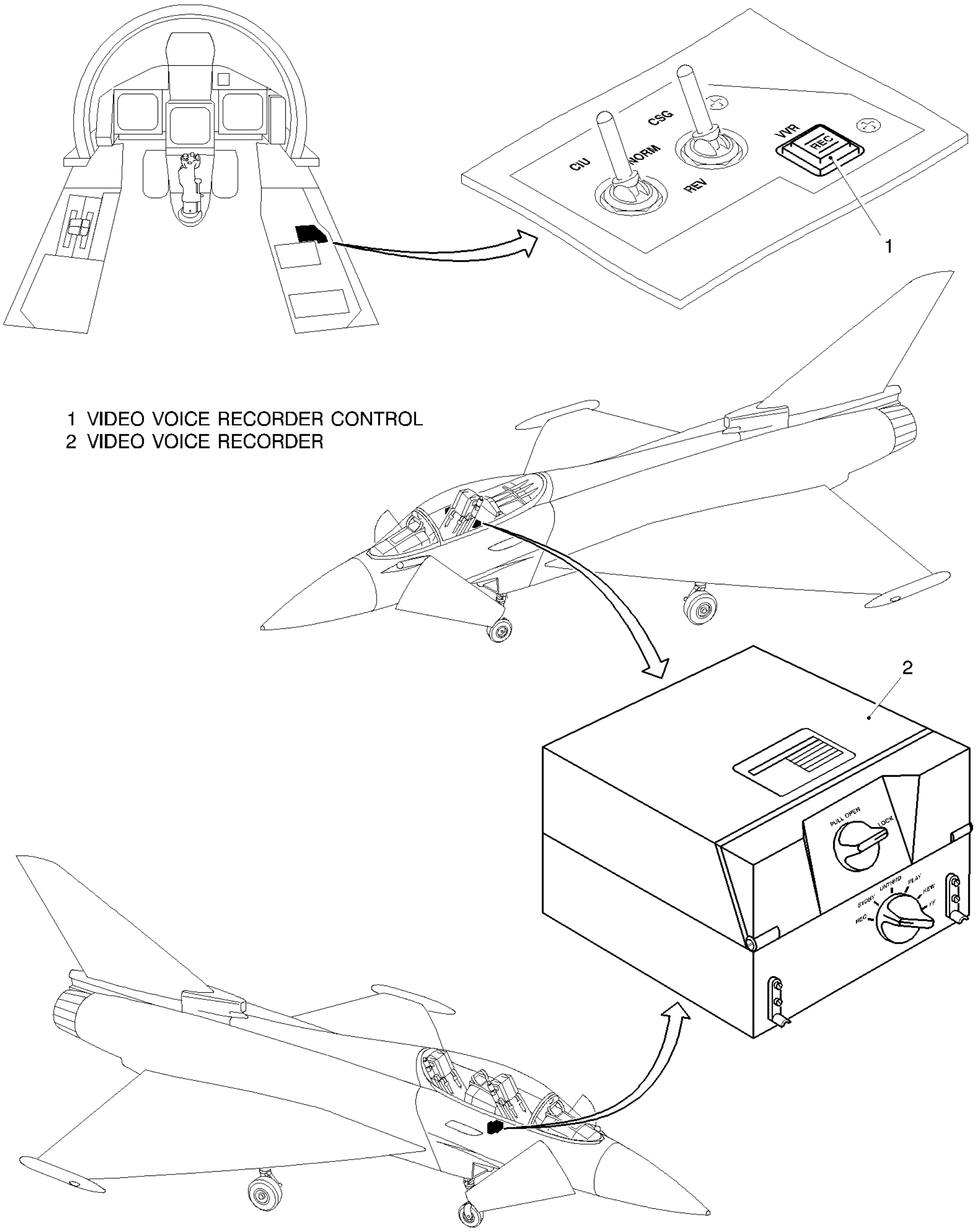


Figure 1.195 - Location of VVR and VVR Control

OPERATION

To indicate whether or not a VVR cassette has been inserted into the unit, the MHDD/ACUE format displays ‘VVR CASSETTE’ to prompt the pilot to insert a cassette. The cassette is inserted by opening the access cover on the front of the unit, inserting the tape and then closing and locking the door by rotating the door control from PULL OPEN to LOCK. The access cover allows the cassette to be inserted and removed as required by single-hand operation, whether or not power is provided to the unit. When closed, the access cover provides a seal to prevent water ingress. The VVR also features an automatic built in heater, which is thermostatically controlled to reduce the effects of moisture. If the unit detects moisture upon power-up, the heaters automatically operate and continue to function for up to 16 minutes (worse case). This does not cause the PBIT to fail, and if at any time after the VVR has become operational moisture is once again detected, the VVR continues functioning in the same mode although with possible degradation of recording quality.

The VVR is constantly tested for failures with an initial PBIT after power-up, followed by a continuous BIT thereafter. During Ground POF, failure of the VVR causes a ‘VVR NOGO - NO RECORDING’ caption to be displayed on the Autocue format, and the VVR is unavailable for use. The failure of the VVR in any POF generates a category 4 ‘VVR FAIL’ warning, and ‘VVR FAIL’ is displayed on the MDE (if the MISC SS is selected see Figure 1.196).

The cassette may be removed 5 seconds after the VVR has entered OFF mode (to allow the tape to unthread) by rotating the door control from LOCK to PULL OPEN.

OFF MODE

Whilst the VVR is in the OFF mode the cassette is not threaded around the head drum and therefore the VVR is not capable of recording. The VVR can enter OFF mode via the following routes:

- On power-up when no cassette is inserted, or a cassette is not fully inserted
- After the End of Mission (EOM), which is indicated via a bus message
- Upon reaching the End of Tape (EOT).

When the VVR is in OFF mode, the VVR cockpit control indication (located on the right console in the front cockpit) is occulted, and ‘VVR OFF’ is displayed on the MDE (if the MISC SS is selected).

END OF MISSION

If the end of mission is reached before the end of the tape, then the VVR records the Mission Complete Index (MCI) after receiving the EOM signal. The EOM signal is initiated before power down, but with weight-on-wheels and both engines < 55% NH. Upon receipt of this signal the VVR constructs and records onto tape the MCI, which consists of:

- Event marker types
- Aircraft tail number
- Time of day and date
- VVR serial number
- Elapsed time reading
- IMRS and UTC time

The MCI requires approximately 60 seconds of tape. If there is insufficient room remaining on the tape to record the MCI, the VVR recognizes this in advance, and rewinds the tape by an appropriate amount before commencing the recording of the MCI. In this case some of the previously recorded VVR information is lost.

END OF TAPE

Upon reaching the end of the tape, the VVR again records the MCI. In order to record the MCI, the tape is first rewound by approximately 60 seconds. The MCI is then recorded over whatever information was on the last 60 seconds of the tape.

The pilot is alerted to the fact that the end of the tape has been reached by a category 4 warning (‘VVR TAPE END’).

VVR STANDBY

Upon power-up, provided that a video-cassette is correctly inserted, the access door is closed and locked and the PBIT is completed, the VVR automatically enters STANDBY mode. In STANDBY mode the tape commences threading, which is completed within 5 seconds, and CBIT is performed. When the VVR is in STANDBY, the ‘REC’ legend on the VVR cockpit control is illuminated, and ‘VVR SBY’ is displayed on the MDE (if the MISC SS is selected).

VVR RECORDING

The VVR can enter RECORD mode either manually or automatically. In the case of automatic control, recording will only occur with weight-off-wheels and a specific moding command occurs (see below). However, the VVR will record with weight-on-wheels if the pilot manually selects VVR record via the dedicated cockpit control. When selected, recording begins within 0.5 seconds. Whilst the VVR is recording status bars appear with the illuminated ‘REC’ legend on the VVR cockpit control, and ‘VVR REC’ is displayed on the MDE (if the MISC SS is selected).

Whenever a video image is recorded, the following information is also recorded by the VVR along with the HUD and MHDD displays:

– IMRS time
– UTC time
– Event markers (only recorded at the time of the event)
– Best Latitude, Longitude and Altitude
– A/C tail number
– Flight ident

The VVR automatically enters RECORD mode under one of the following conditions:

– Air-to-Air POF and weight-off-wheels, or
– Late Arm selected and weight-off-wheels, or
– Radar is in VISIDENT mode and target range <1nm and weight-off-wheels, or
– Air-to-Air trigger selected to first detent and weight-off-wheels

In automatic control, the VVR ceases recording and enters STANDBY mode 15 seconds after the above conditions are no longer met. However, if another of the above conditions is initiated during this time, then the VVR continues to record, and only enters STANDBY 15 seconds after this subsequent condition has been completed or exited.

In manual mode, the VVR exits STANDBY and enters RECORD mode only when the pilot selects the VVR cockpit control. The unit returns to STANDBY mode upon re-selection of the same VVR control. The recording is terminated immediately, with no overrun.

The VVR will record the information at various rates depending upon the weapon type selected and/or the radar mode selected, i.e specific MHDD or the HUD will be recorded more frequently than other displays. The four recording modes are as follows:

– HUD Dominant , where the emphasis is on HUD recording with minimal recording of other displays. This mode is enabled by pressing the trigger to the first detent (unless MRAAM is selected), or on selection of HACQ, SACQ or VACQ radar modes.
– AF Dominant , where the emphasis is on the Attack format with secondary requirements for HUD and Elevation format recording. This mode is enabled by selection of MRAAM, or on selection of VS, TWS, PS, VIS or Gun radar modes.
– HUD and MHDD Integration , where the HUD and the Attack format are principally used. This mode is enabled by selection of A/S radar.
– General Purpose . This is the default mode if no other mode is enabled, with equal recording of all displays.

In the event that mode conflicts occur the mode priority will be as listed above.

EVENT MARKERS

Whilst recording, the VVR may also indicate the locations of certain events that occur by placing appropriate event marker signals on the video, which can then be used to locate specific events during playback. The event markers are designated as follows:

– First trigger detent selection
– First trigger detent release
– Second trigger detent selection
– Second trigger detent release
– Release of store from aircraft

NOTE

Pressing the trigger to the first detent when not already in record mode causes the VVR to enter RECORD mode. Under these circumstances an event maker is generated but may not be recorded because of the 0.5 second delay required for the VVR to commence recording. If the VVR is already in RECORD mode before the trigger is pressed, an event marker will be recorded.

VVR ELAPSED RECORD TIME

A category 4 audio warning (‘CHECK VVR’) is presented after every 20 minutes of recording time, i.e. at 20 min, 40 min, 60 min and 80 min. These times may not represent the actual amount of time that has been used on the currently inserted tape, but instead detail the amount of tape used since the cassette was inserted. The ‘CHECK VVR’ warning acts as a prompt for the pilot to check the MDE for the exact VVR elapsed record time. If the VVR moding key on the MDE is selected whilst recording is in progress, the elapsed record time display will update accordingly to an accuracy of 1 minute.

VVR PLAYBACK

The Ground Support Facility (GSF) is used to de-multiplex the recorded signal to produce a visual display. The GSF is capable of recognizing and locating the recorded event markers thereby enabling the operator to carry out a rapid search of the tape for items of interest. In order to recognize and locate the events the GSF searches for the MCI upon initial cassette insertion. Once the MCI has been read it acts as an index for all events on the tape, thus being able to provide their locations and durations during search mode.

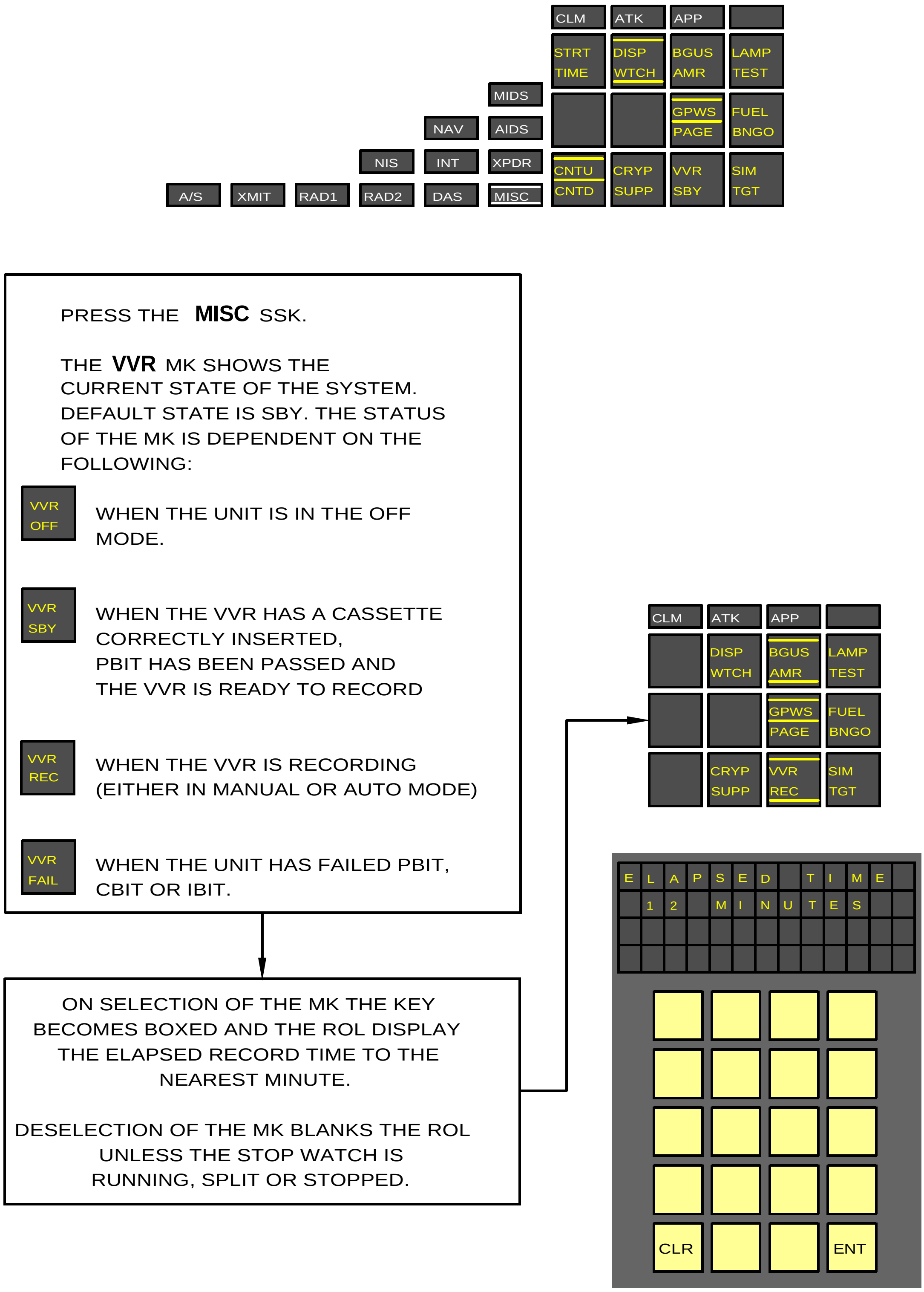


Figure 1.196 - Miscellaneous Subsystem, VVR Moding

MISSION DATA LOADER RECORDER/ PORTABLE DATA STORE

The function of the MDLR is to provide the capability of loading data from the PDS to the aircraft LRI, and recording selected data back to the PDS. The MDLR/PDS allows the pilot or groundcrew to load data into the ACS, the Attack & Identification system, the Communication system, DASS, the Controls & Display system and the Navigation system. Data to be recorded must be specified during the loading of the PDS on the ground station. On single seat aircraft the MDLR is located behind the pilots head. On twin seat aircraft the MDLR is located in the rear cockpit, on the aft right hand console . The PDS is inserted into a compartment in the MDLR after raising a hinged flap.The PDS can be loaded with the following system data:
ACS data:

- Armament library
- Non-weapons loaded
- Air-to-air weapon data
- Selective jettison format

Attack & Identification system data:

- IFF automatic code changes
- AMRAAM data link channels

Communication systems data:

- Radio frequency pairing data
- DVI templates
- MIDS initialization data

DASS data:

- Sensor library updates
- Counter action library updates
- DASS tactical data
- Autonomous early warning report updates
- Scenario number

Display and Control data:

- Large scale maps
- Mission overlay data
- PSMK data

Navigation data:

- Waypoint data
- Pre-planned (auto route) data
- Aircraft alignment data
- Set wind data
- Unplanned (manual) route data
- Mission consumables data

OPERATION

Power to the MDLR is normally supplied from the non-essential supply (PP2). However, in the event that this fails the MDLR draws power from the essential bus bar (PP3) for up to 400 ms. If the failure is longer than this the MDLR enters INHIBIT mode. In this mode the only function supported by the MDLR is memory erasure on ejection of the pilot.

NOTE

> The PDS must not be inserted or removed with power on.

On power up the MDLR carries out a PBIT. The MDLR then enters one of three modes of operation. These are:

- Standby mode
- Mission data loading mode
- Mission data recording mode

STANDBY MODE

This mode is activated when the MDLR is powered but the PDS is not installed, or if the lid of the MDLR is opened when in recording mode, or after erasure of the PDS data.

MISSION DATA LOADING MODE

Data loading mode is initiated at power up with the PDS installed in the MDLR and the lid closed. On successful completion of PBIT, the MDLR begins the data loading process by down loading the first block of data to the bus controller (the attack computer). The first block contains the aircraft number which allows the bus controller to verify the validity of the data. The remainder of the data is then transferred from the PDS to the required systems. Once completed the bus controller selects the MDLR to recording mode.

MISSION DATA RECORDING MODE

In this mode the MDLR accepts data from the attack bus under control of the bus controller. The data is recorded into a specific area of the PDS memory.

DATA ERASURE

The data in the MDLR/PDS, CAMU, and relevant data within the FTI, is erased if the pilot ejects, or if the secure data erasure control is operated. This control is located on the left hand console (in the front cockpit only on twin seat aircraft). The time taken to erase the data after pilot ejection is no longer than 0.2 seconds for 8 Mbytes of memory, or 0.4 seconds for 16 Mbytes of memory. Erasure time may take up to 10 seconds when the secure data erasure control is operated.

STRUCTURAL HEALTH MONITORING

The structural health monitoring (SHM) system is an on-aircraft software based system which calculates fatigue life consumed at specified locations on the airframe. Two SHM versions are being developed and the software enables the user to define whether each location is to be either parameter based or strain gauge based. For parametric based locations SHM algorithms, which reside in the IPU, enable acquisition and processing of real time data that is sourced from the following systems:

– Flight control system (FCS) via direct digital links with FCC
– Armament control system (ACS) via the attack databus
– Fuel gaging via the UCS databus
– Landing gear system via the UCS databus
– Navigation system via the attack databus.

The data is used to calculate the stress at each location by comparison with approximately 17500 ‘templates’ held in the NVM of the IPU. Each template, derived from finite element analysis and the results of ground based fatigue tests, corresponds to a particular aircraft configuration and set of flight parameters. The process iterates, generating a history of stress. For strain gauge based locations the stress is calculated directly from strain gauge measurement at an iteration rate defined by the user. The SHM data generated within the IPU is transmitted to the MDP via a direct link for storage on the PMDS. The cumulative fatigue index (FI) at each of the monitored locations can also be displayed on the MDP. The PMDS has sufficient capacity to store the SHM data of up to five sorties. If a sixth sortie is flown without first retrieving the data associated with the last five sorties SHM data will be lost as the existing data will be overwritten.

NOTE

Strain gauge based fatigue monitoring (in addition to the parametric based fatigue monitoring) is only available on DA4 and DA5. The remaining DA utilize parametric based fatigue monitoring only, and is described below.

SHM INPUT DATA

SHM input data is the data used by the IPU processes to generate SHM output data. Three types of input data are used by the SHM system as follows:

– User definable data
– Data external to the IPU
– Data internal to the IPU.

USER DEFINABLE DATA

The SHM system provides a facility to enable the operator to load new values for specific data which is used within the SHM calculations. This data is known as user definable data and is stored in non-volatile memory (NVM) within the IPU. The user definable data updates can be loaded into the IPU as required via the PMDS at IPU power up. Upon IPU power up a check is made to determine if there are any user definable data updates on the PMDS. If this is the case the new values overwrite the previous values stored in the NVM.

EXTERNAL DATA

External data is the data which is used in SHM calculations which is sourced external to the IPU. The data is acquired from the aircraft systems as outlined in Table.

External Data

DATA TYPE	SOURCE	DESCRIPTION	INTERFACE
Navigation	Navigation sub system	Sink rate and sink rate validity data	Avionics databus
Store Configuration	Armament control system	Armaments data defining the stores carried	Attack databus
Flight parameters	Flight control system	A set of flight parameters describing the aircraft's motion	Direct digital link
Status	Flight control system	Indicates the current status of the flight control system	Direct digital link
Engine	Flight control system	Left and right engine high pressure rotor speed	Direct digital link
Arrester hook	Landing gear computer	Arrester hook position	UCS databus

(Continued)

External Data (Continued)

DATA TYPE	SOURCE	DESCRIPTION	INTERFACE
Landing gear	Landing gear computer	Indicates weight on wheels status	UCS databus
Fuel	Fuel computers	Contents of fuel tanks and validity	UCS databus

INTERNAL DATA

Internal data is data that is sourced internally within the IPU which is used by the SHM for purposes other than SHM calculations. Examples of internal data are IMRS flight time, flight ident and status information of all databusses and digital links that interface with the IPU.

SHM OUTPUT DATA

The SHM output data is available from the aircraft via the MDP and PMDS. The PMDS is able to store SHM data from up to five flights. When five flights are recorded on the PMDS the data stored consists of:

- Five sets of cumulative g and altitude tables
- Five sets of auxiliary data
- Five sets of cumulative Fatigue Indices (FI)
- One set of cumulative Frequency of Occurrence Matrices (FOOM)
- Five sets of error messages

If a sixth flight is flown without removing the PMDS, the data in the first flight file will be overwritten and lost. Therefore, the contents of the PMDS should be downloaded after each flight, or after a maximum of five flights.
In addition the BSD, if fitted, can be used to record a set of parameters as requested by the support personnel via SHM data upload. This enables specific studies to be carried out on any aircraft at any time without the need for special recording equipment, e.g. operational load monitoring exercises.
All SHM data can be associated with one of the following categories:

- g/roll rate data, altitude data and auxiliary data
- Fatigue calculations
- Dynamic data calculations
- Event monitoring

G/ROLL DATA, ALTITUDE DATA AND AUXILIARY DATA

Normal acceleration data (g), roll data and altitude data generation are initiated by the SHM system as soon as weight-off-wheels is sensed at take-off and continues to be acquired and processed by the IPU whilst the aircraft is airborne. The generation of this data is suspended as soon as weight-on-wheels is sensed upon landing. If a touch and go or roller landing is executed data generation resumes five seconds after weight-off-wheels is sensed again. The five-second delay prevents rapid on/off switching of the system should the aircraft bounce during landing. Five types of g/roll rate data are acquired, processed and recorded to produce five g-tables, as follows:

- g band envelope data
- g count envelope data
- g envelope duration data
- g at max roll rate data
- roll rate at max g data

Altitude data is recorded to provide a means of monitoring cabin pressure cycles. The SHM system performs an exceedance type calculation to generate an altitude cycle data table where a count is recorded every time one of ten preset altitude levels is crossed. The ten preset altitude levels span 5000 ft to 50 000 ft at 5000 ft intervals.
Following the end of flight signal (generated by weight-on-wheels and both engines < 55% NH), all the current flight data for the five g data tables and the altitude cycle data table gathered during the sortie is added to the previous flights data stored in the IPU non-volatile memory, e.g. new cumulative data current flight data previous cumulative data. The new cumulative data is then written to the NVM (for use on the subsequent flight) and also sent to the MDP for recording on the PMDS. Maximum and minimum values of airspeed, altitude, g and roll rate within one-minute bands are also available.
Auxiliary data consists of data traditionally collated in the flying log, and additional performance parameter summaries. This data is not primarily used to monitor the usage of the aircraft but provides a source of useful data for fleet management. In addition, much of the auxiliary data generated can be used to monitor the use of the undercarriage. The following data is made available by the SHM system for each flight:

- flight date
- take-off time
- flight duration
- stores configuration
- mass of stores/fuel at each take-off and landing

– number and type of landings (roller, touch and go, arrested, etc.)

In addition, the following performance summaries are available from each flight:

– number of airbrake operations
– undercarriage cycles
– refuelling probe deploys/refuels

Generation of the auxiliary data occurs as soon as the IPU detects weight-off-wheels at take-off, and is immediately transmitted to the PMDS. Auxiliary data is generated and stored again at the first landing and all subsequent take-offs and landings (20 maximum) for that sortie.

FATIGUE CALCULATIONS

Fatigue life usage at 10 locations are calculated by the SHM system using parametric equations. The fatigue index (FI) for each location is calculated on a flight by flight basis and recorded on the PDMS at the end of the flight. In addition, the cumulative FI (a summation of all individual FI since first flight), is stored in the IPU and written to the PMDS at the end of each flight. The cumulative FI for each of the 10 monitored locations can be displayed on the MDP.
Parametric fatigue calculations are executed by the IPU, using real time data. The IPU acquires data from the FCS, ACS and Fuel Gauging System. The FCS provides aircraft altitude, velocities and accelerations; the ACS provides information on the aircraft's store configuration; the Fuel Gauging System provides fuel mass information. Utilizing this data, the stress at each monitored location is calculated by the IPU by comparison with approximately 17500 ‘templates’ stored in its non-volatile memory. Each template, derived from Finite Element Analysis and results of ground based airframe fatigue tests, corresponds to a particular aircraft configuration and a set of flight parameters. The process iterates at a rate of 16 times per second until at the end of the flight a record of fatigue damage exists for each of the monitored locations on the airframe.
Frequency of occurrence matrices (FOOM) for each of the locations are also written to the PMDS at the end of the flight. The FOOM provide a cumulative record of stress cycles encountered by the aircraft but only the latest set of FOOM are stored on the PMDS. The recorded set contains the cumulative counts of stress cycles encountered since the last PMDS down load.

EVENT MONITORING

The SHM monitors in real-time the allowable parameter envelopes for structurally significant events. Any excursions outside these boundaries can be viewed post flight via the MDP. Additional data are available on the PMDS for down load to the ground support system (GSS), where further investigations can be carried out using CSMU and BSD data.
Up to 7 envelope types can be monitored simultaneously; the definition of the parameter envelopes and the event corner points can be defined via GSS/PMDS.

EJ200 ENGINE USAGE AND CONDITION MONITORING

The engine usage and condition monitoring facility is an on-aircraft software based system which enables parameters to be acquired, processed and stored to support calculation of engine life usage. Data acquisition tasks for engine usage calculations are conducted by the EMU and the IPU. The EMU acquires data directly from the both DECU via dedicated links. The IPU in turn acquires the data from EMU and from other on board systems and conducts the necessary data processing in support of engine usage calculations. Configuration error data and maintenance data are sent to the MDP during engine running. Table lists the categories of data handled by the EMU in support of engine usage and condition monitoring activities during engine running. Table lists the categories of data sent from the EMU to the IPU at the end of the sortie (when weight-on-wheels is detected and both engines have been shut down).

Engine Monitoring Unit Transactions (Normal Mode Engines Running)

DATA TRANSFER SOURCE	DATA CONTENT	COMMENTS
IPU	IMRS SYSTEM/UTC TIMES	Message contains IMRS system time and UTC system times. It is sent from the IPU to the EMU.
IPU	EXPECTED CONFIGURATION DATA	This message contains the expected EMU configuration data to be checked by the actual configuration data loaded in the EMU. It is sent from the IPU to the EMU.
IPU	VIBRATION SUMMARY	This message sent by the IPU to the EMU contains vibration data summary data.
IPU	LIFE UPDATE	This message sent by the IPU to the EMU contains engine life update as follows Lifing data. Counts and times data.
IPU	TOTAL FUEL FLOW RATE	This message to the EMU contains total fuel flow rates computed by the fuel computers from the feed line flowmeter and the dry fuel flowmeter.
IPU	PILOT EVENT MARKER DATA	This message to the EMU indicates a pilot detected event.
IPU	MDP REQUESTS	This message to the EMU contains MDP request data. The EMU software will not support the previous shut down data MDP request.
IPU	CONFIGURATION DATA SET	This message sent from the IPU to the EMU contains engine identity codes for configuration checks within the EMU.
EMU	CRASH RECORDER DATA	This message from the EMU contains data to be recorded on the CSMU. The data is transmitted from the EMU to the CSMU via the IPU. The IPU software will set the DECU link status as “unknown”, which means that the CSMU data will be sourced from the FCS system.
EMU	SPECIAL STUDY DATA	This message from the EMU contains special study data to be recorded on the BSD (not fitted until avionic software package 3)
EMU	DECU LINK STATUS	This message is sent from the EMU to the IPU. Depending on the status of the EMU/IPU link the IPU will decide if CSMU data can be derived from this link (otherwise it will be sourced from the FCS system).
EMU	CONFIGURATION ERROR DATA	This message from the EMU contains configuration error data. Configuration error data from the last five flights will be stored on the PMDS.
EMU	MAINTENANCE DATA	This message from the EMU contains the LRI failure data to be transferred during engine running.

(Continued)

Engine Monitoring Unit Transactions (Normal Mode Engines Running) (Continued)

DATA TRANSFER SOURCE	DATA CONTENT	COMMENTS
EMU	PERFORMANCE SNAPSHOT DATA	This message from the EMU to the IPU contains performance snapshot data. Performance snapshot data of five flights is stored on the PMDS. The EMU software will not provide any performance snapshot to the IPU during normal mode (engines running).

Engine Monitoring Unit Transactions (Shutdown Mode)

DATA TRANSFER SOURCE	DATA CONTENT	COMMENTS
EMU	INCIDENT SUMMARY	This message from the EMU contains the propulsion incident data that have been detected by the EMU, (displayed on the MDP)
EMU	MAINTENANCE DATA	This message from the EMU contains the LRI failure data transferred after engine shutdown (displayed on the MDP)
EMU	INCIDENT SNAPSHOT	This message from the EMU contains the incident snapshot data from the engines. These data consist of up to 5 snapshots which are recorded onto the PMDS
EMU	VIBRATION SUMMARY	This message from the EMU contains the vibration summary data from the engines. Vibration summaries for the last 5 flights are stored on the PMDS
EMU	LIFE USED	This message from the EMU contains the life used data and is split into three blocks: 1 Lifing data 2 Usage spectrum data 3 Counts and times data Life used data for the last 5 flights is stored on the PMDS.
EMU	VIBRATION SIGNATURE	This message from the EMU contains vibration signature data of the engines and is stored on the PMDS. The message consists of three sub-formats: 1 Max amplitude and time history combined 2 Vibration snapshot 3 Vibration datum limits.

FIRE WARNING SYSTEM

Warning of an engine bay fire/overheat, category 2, is indicated on two pushbutton selector/indicators located on either side of the head-up panel(s), Figure 1.197. One for the left engine and one for the right engine. Each pushbutton is protected by cover guards to prevent inadvertent operation which could damage the engine.

If a fire is detected, the caption, F, on the respective selector/indicator flashes. By pressing this pushbutton, the contents of the fire bottle, situated in the engine bay, is discharged. Once pressed, further selection of the pushbutton will have no effect.

In addition to the flashing of the caption on the selector/indicators, the engine fire is indicated by flashing attention getters, a dedicated warning panel (DWP) caption and a voice warning message. Indication is also provided by an identical caption on the multifunction head-down display engine format.

Warning of an APU fire/overheat, category 2, is indicated by flashing attention getters, a DWP caption and a voice warning message. The APU fire warning also pulses the canopy warning horn to ensure a warning is given during cold ground starts before the warning system is on-line.

For information on DWP captions and voice warning messages, refer to Visual/Audio Warnings pag. 377.

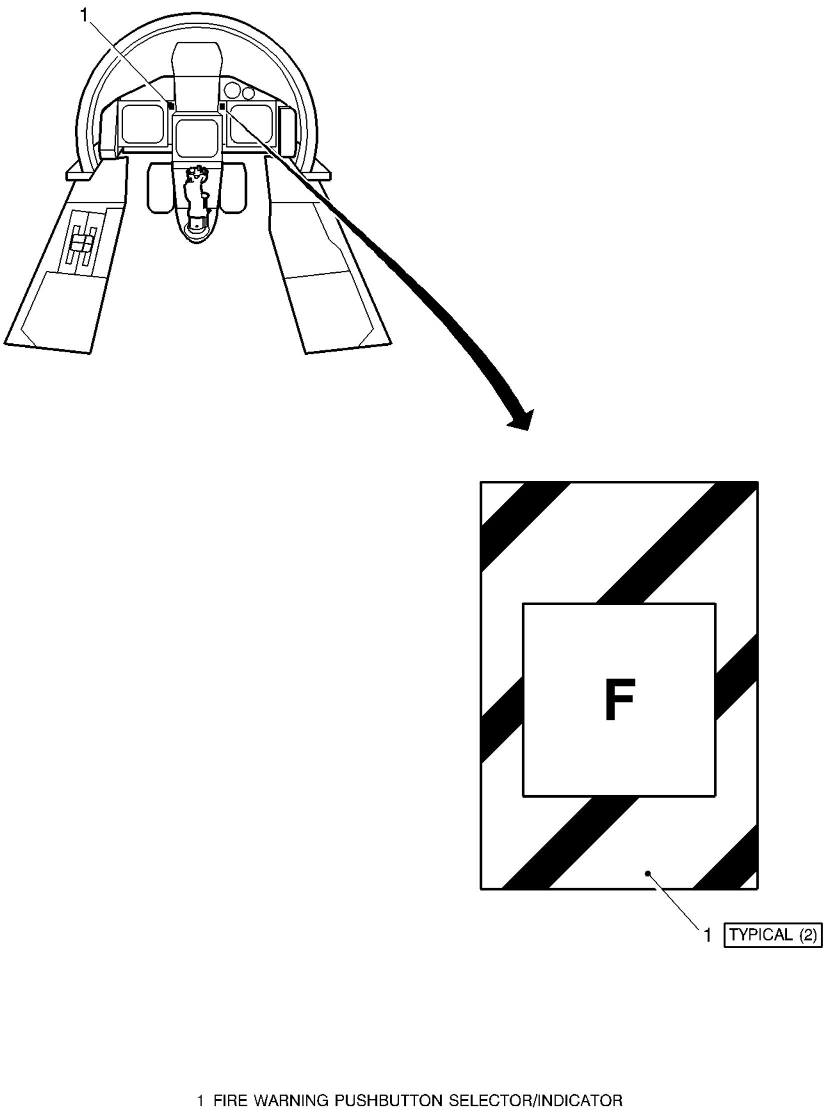


Figure 1.197 - Fire Warning Pushbutton Selector/Indicators

FLIGHT TEST INSTRUMENTATION

COCKPIT CONTROL AND DISPLAY UNIT

CAUTION

THE CCDU CONTROLS THE FTI GPS POD (WHEN FITTED). WITH AIRCRAFT FITTED WITH A FTI GPS POD IT SHOULD BE ASSUMED THAT THE POD IS POWERED, ACTIVE AND TRANSMITTING WHEN THE AIRCRAFT IS POWERED. AIRCREW CARRYING OUT WALK ROUND CHECKS SHOULD NOTE THAT THERE IS A RADIATION HAZARD TO PERSONNEL COMING WITHIN 0.5 METERS OF THE ACTIVE POD AND SHOULD THEREFORE STAY OUTSIDE THIS LIMIT.

The CCDU is a flight test instrument (FTI) and is located in the center panel of the right console. The unit forms an interface with the aircraft's FTI system and comprises a multifunction control panel with integral fixed-function keys, soft keys (SK) and a visual display area. It provides the pilot with the following:

- Functional control of the airborne instrumentation system
- Visual indication of the system status and operation
- Visual display of instrumentation data supplied from the instrumentation data acquisition system.

VISUAL DISPLAY AREA

The visual display area is sub-divided into upper, center and lower information zones. The upper and lower zones display status information. The center zone displays the functions which are available for selection within the FTI system.

UPPER INFORMATION DISPLAY ZONE

The time code generator (TCG) displays real or elapsed time at the top right of this zone. The title of the page which is currently selected (on the center zone) is shown on the top left and all FTI error messages are shown below the displayed time. This zone is illustrated in Figure 1.198.

CENTER INFORMATION DISPLAY ZONE

Upon power-up, this zone, see Figure 1.198, displays the INDEX/MENU page, Figure 1.199. Sub-system options may be selected via the SK adjacent to the zone. When a sub-system has been selected, further detailed options are displayed. At any time, selection of the INDEX/MENU key displays the INDEX/MENU page and also the status of the sub-systems.

LOWER INFORMATION DISPLAY ZONE

This zone, see Figure 1.198, displays the two selected FTI parameters. These parameters are displayed whichever system display is selected.

CCDU CONTROL KEYS

The CCDU contains the following control keys:

FIXED-FUNCTION KEYS

Four fixed-function keys, located at either side of the screen, see Figure 1.198, perform a single function. The MENU key modes the CCDU to display the INDEX/MENU page. The EVENT key is used to memorize the FLIGHT package within the FTI software. The DEFAULT key selects the SKs to preset selections. The fourth SK located at the upper right corner, shifts the display from normal to video inversion mode and vice versa.

During flight the pilot can select a number of pre-defined packages. Any of these packages can be modified in flight. Once modified the EVENT key must be selected to store the modifications as the flight package, overwriting the previous flight package. Failure to select EVENT will result in the modifications being lost on subsequent selections.

SOFT KEYS (SK)

12 SK, located six on either side of the screen, Figure 1.198, are used to mode the different FTI elements that are controlled by the CCDU. They are used to access the different elements available on the INDEX/MENU page and, subsequently, the different modes within each FTI element, e.g. group 2 of the PCM sub-system. When a selection is made, the appropriate legend is highlighted. In cases where selection of more than one SK is necessary, only the last selected SK is highlighted. The further selection of a SK that is already selected, has no effect.

CCDU TOGGLE SWITCHES

Five toggle switches and a rotary dimmer control, positioned below the screen operate as follows:

TRANSPONDER SWITCH

A two position toggle switch, labeled TRANSPONDER-ON/OFF controls power to the aircraft transponder.

TELEM-PCM SWITCH

A two position toggle switch, labeled TELEM-PCM-ON/OFF enables the telemetry pulse code modulated communications link.

TELEM-VIDEO SWITCH

A two-position toggle switch, labeled TELEM-VIDEO-ON/OFF enables the telemetry video communications link.

DAY/NIGHT SWITCH

A two-position toggle switch, labeled DAY/NIGHT controls the intensity of the CCDU display illumination for day or night operation.

CCDU DIMMER CONTROL

A rotary control, labeled BRIGHTNESS controls the brightness of the CCDU display.

SPARE SWITCH

A two position toggle switch which has no function on this aircraft.

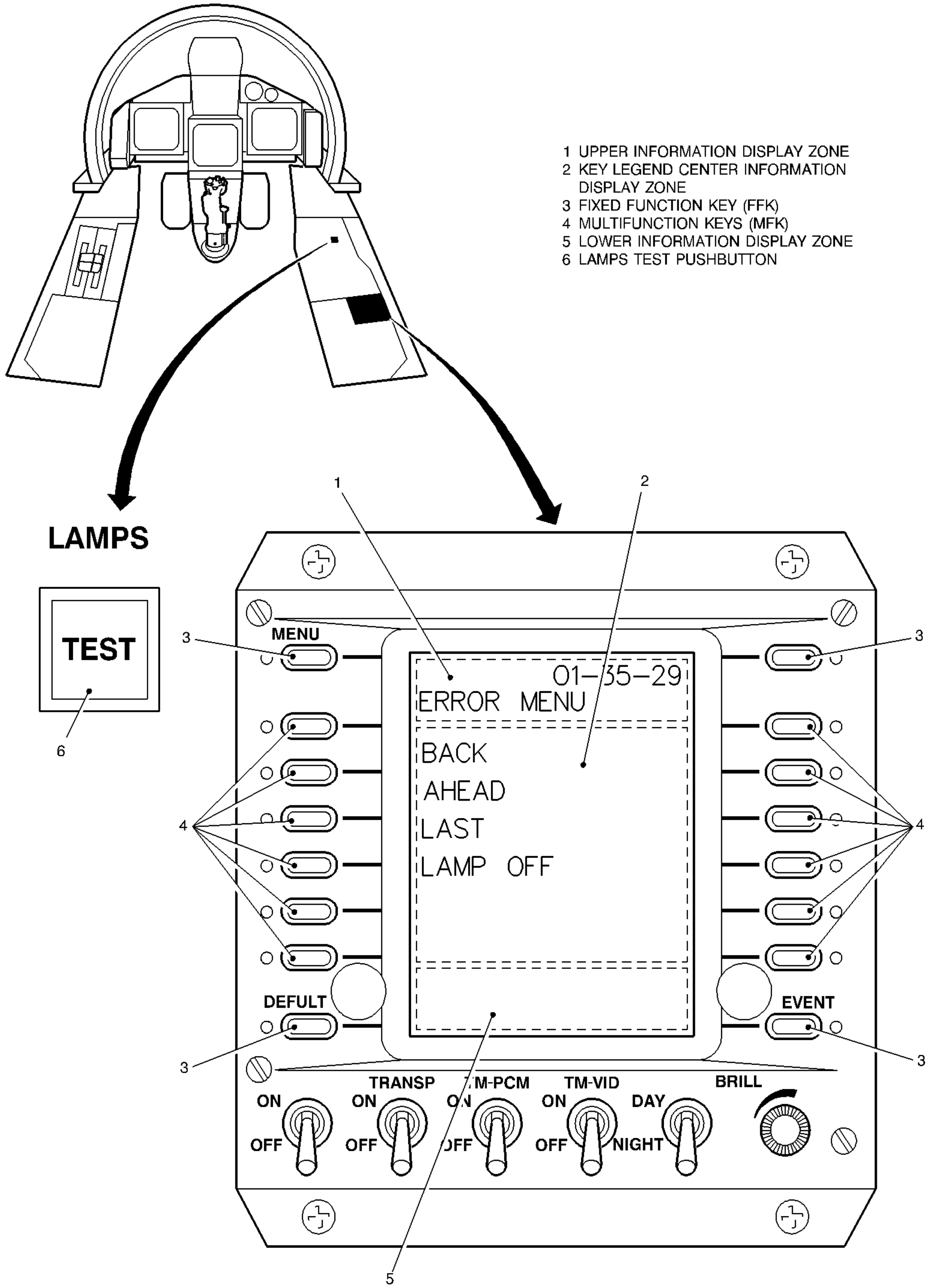


Figure 1.198 - The Cockpit Control and Display Unit

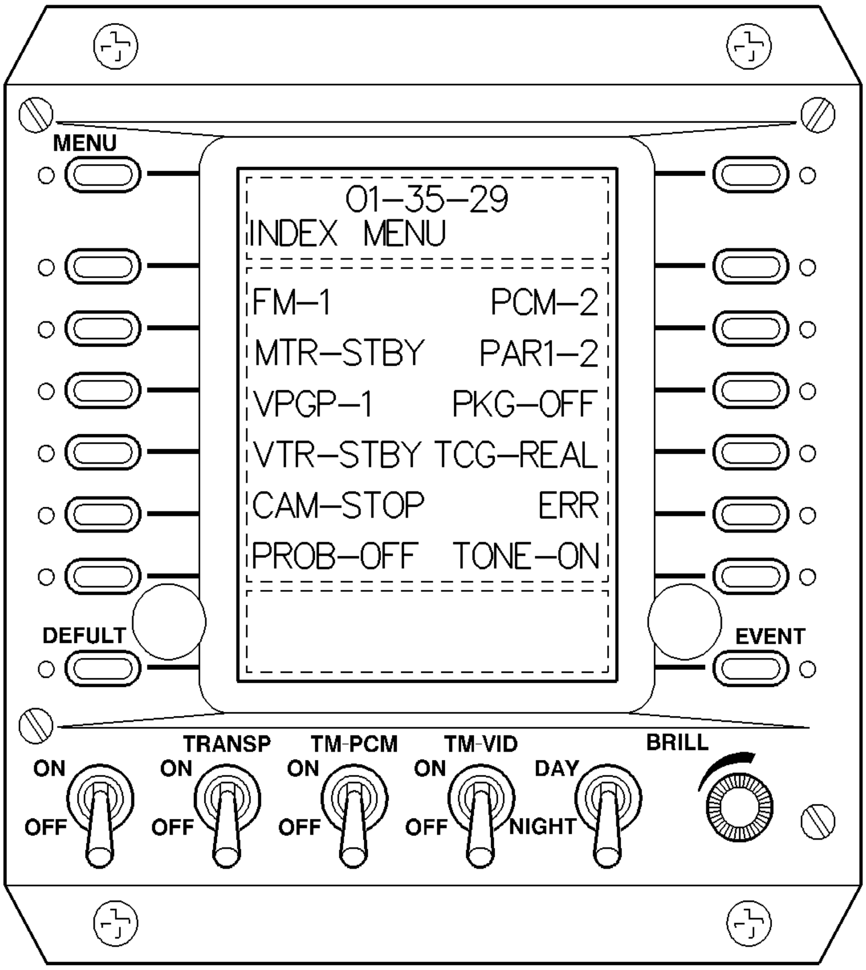


Figure 1.199 - The INDEX/MENU Page

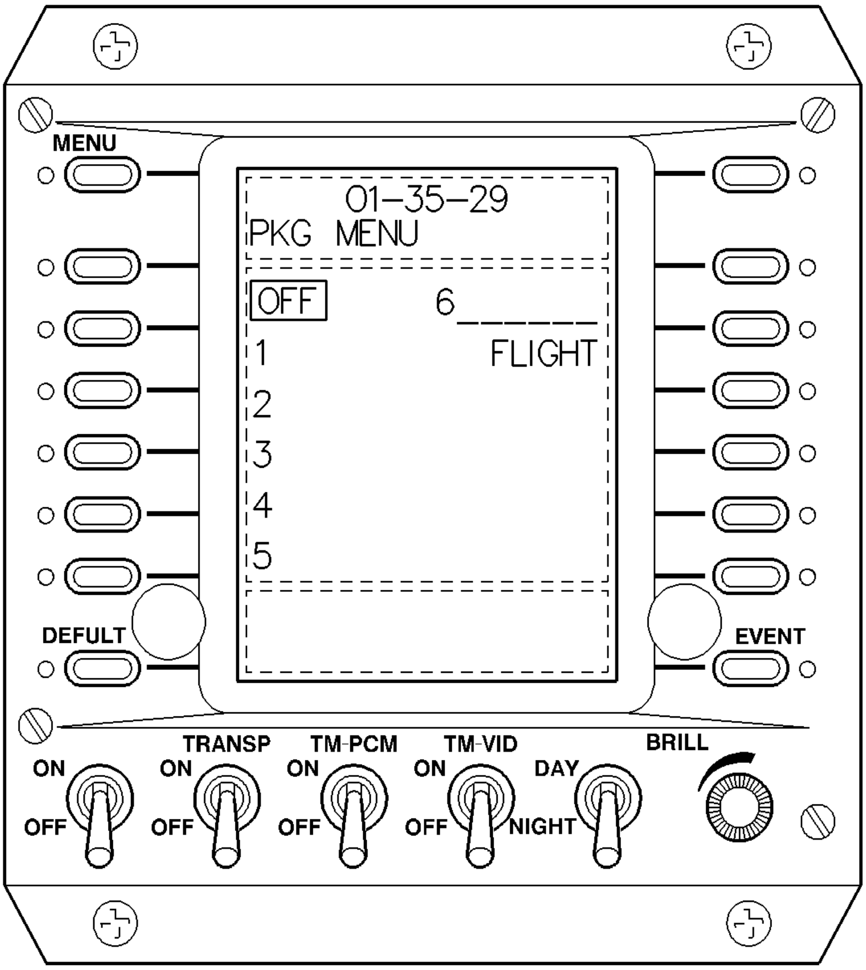


Figure 1.200 - The PACKAGE Selection Page

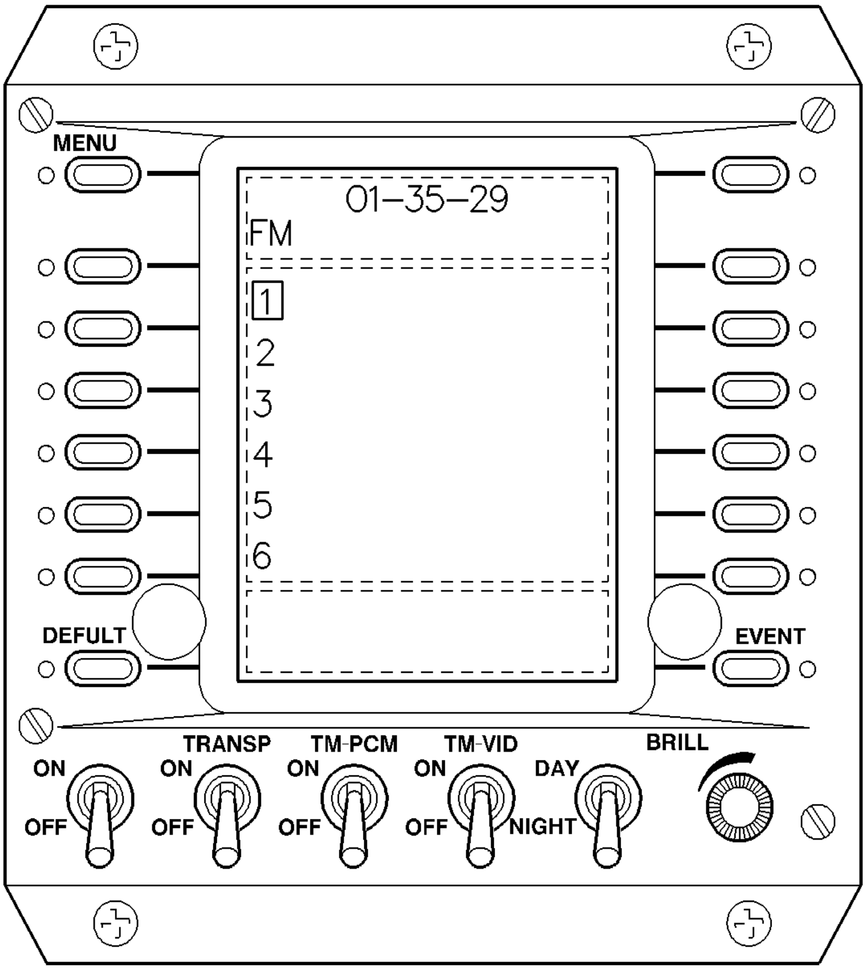


Figure 1.201 - The FM Selection Page

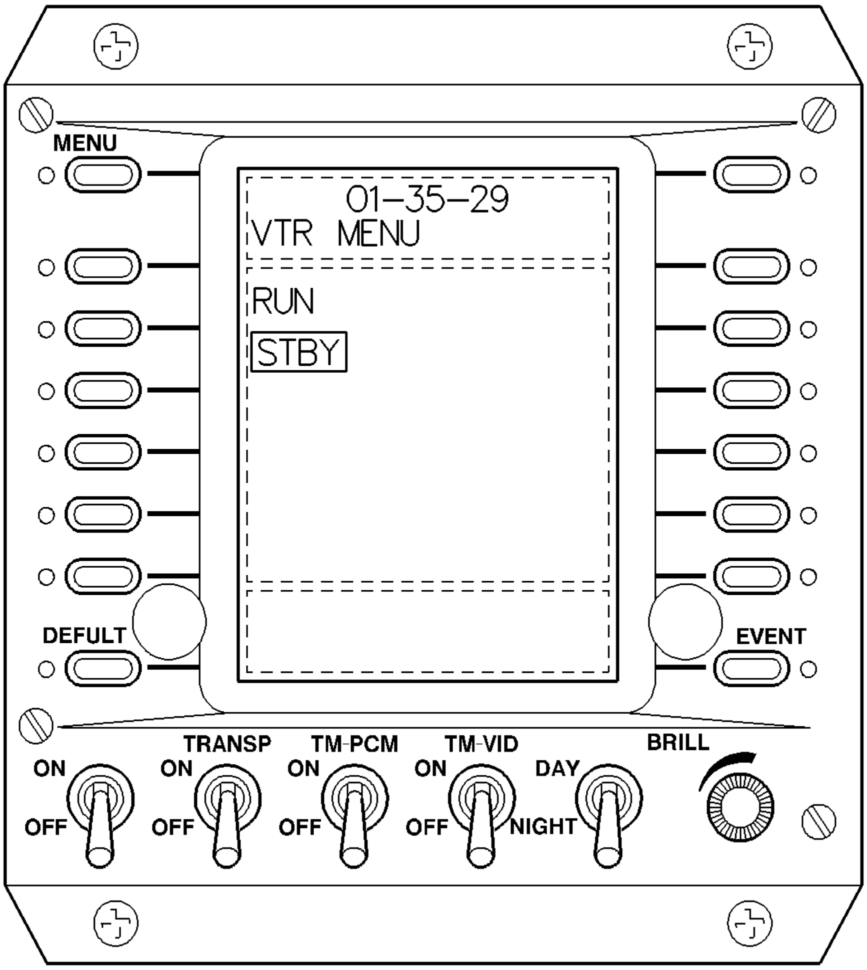


Figure 1.202 - The VIDEO TAPE RECORDER Selection Page

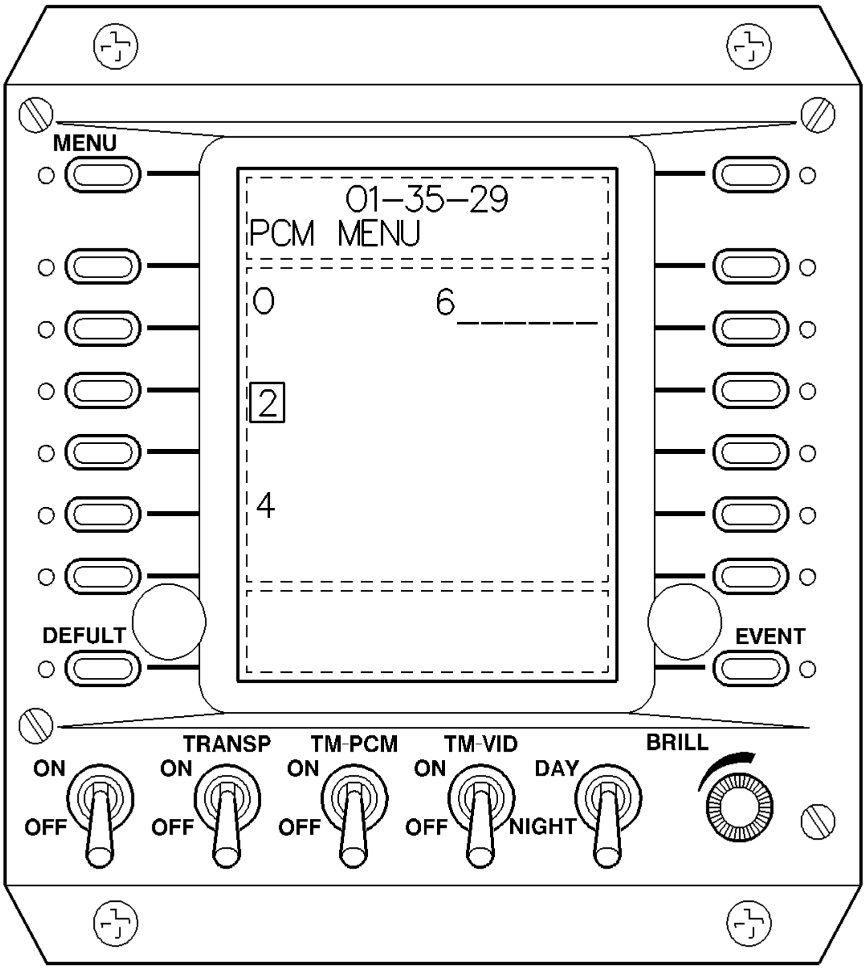


Figure 1.203 - The PCM Selection Page

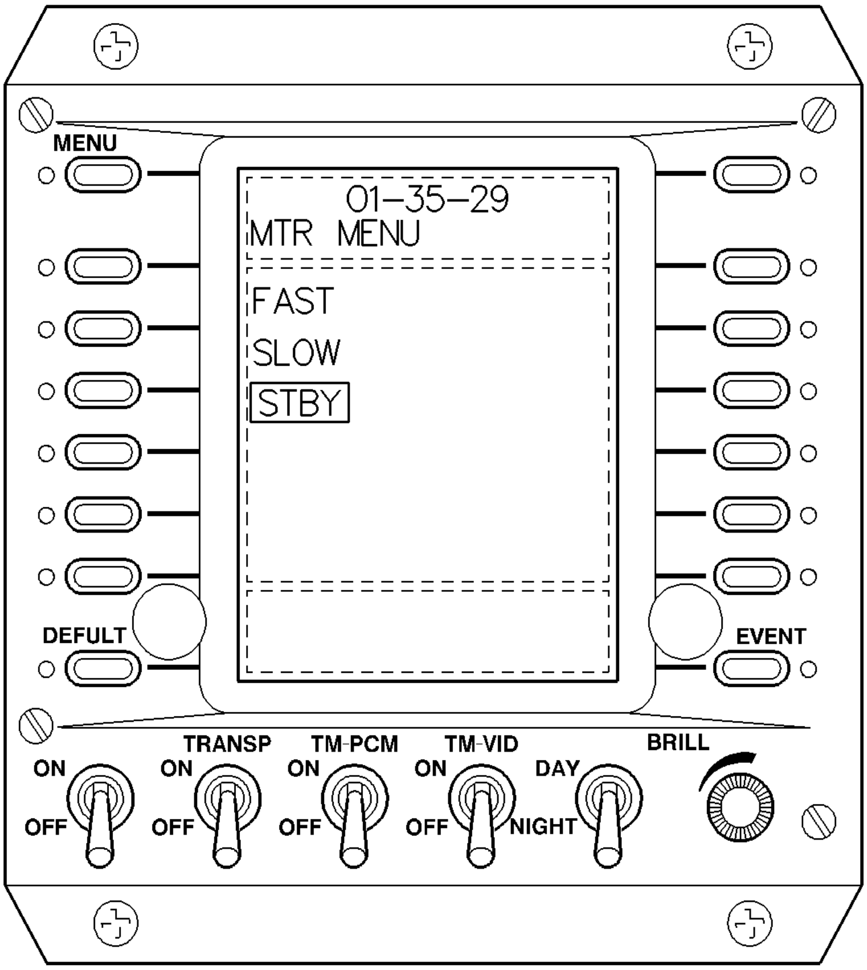


Figure 1.204 - The MAGNETIC TAPE RECORDER Selection Page

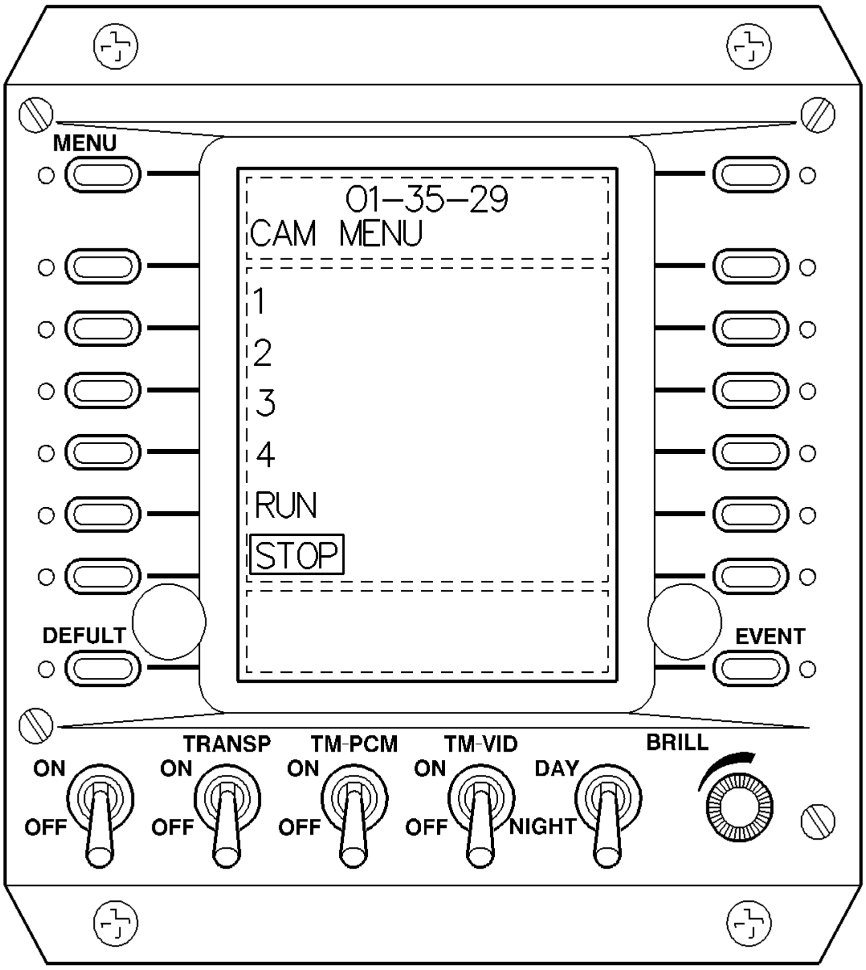


Figure 1.205 - The CAMERA GROUP Selection Page

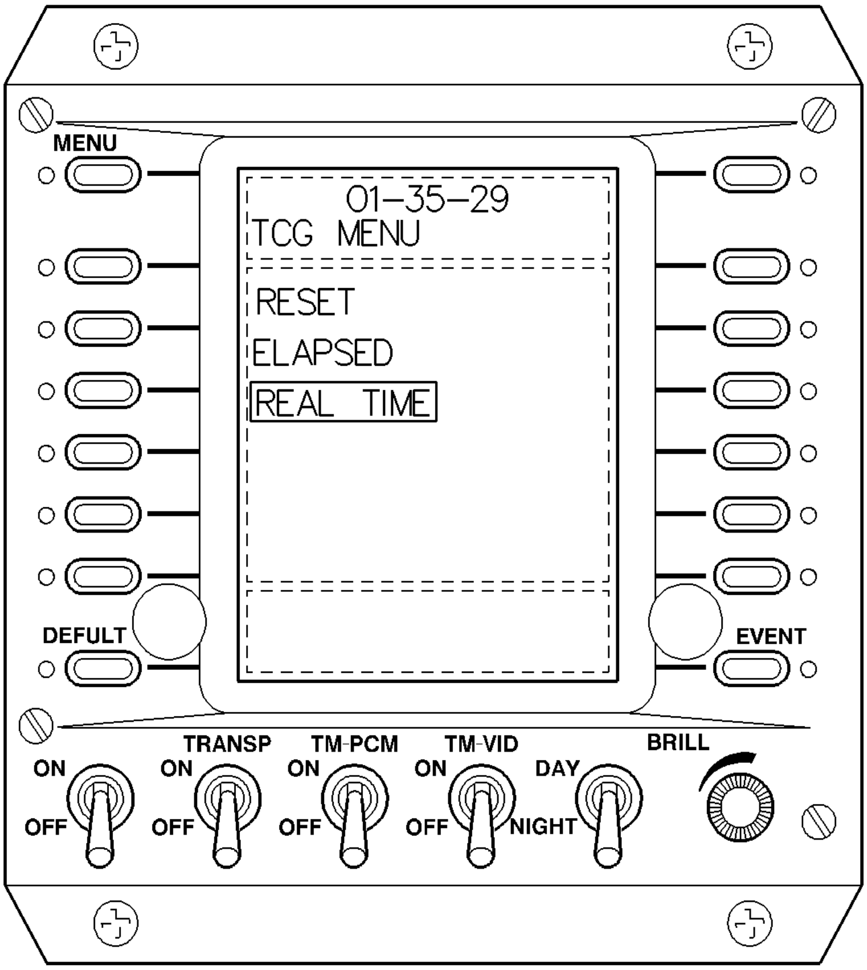


Figure 1.206 - The TCG Selection Page

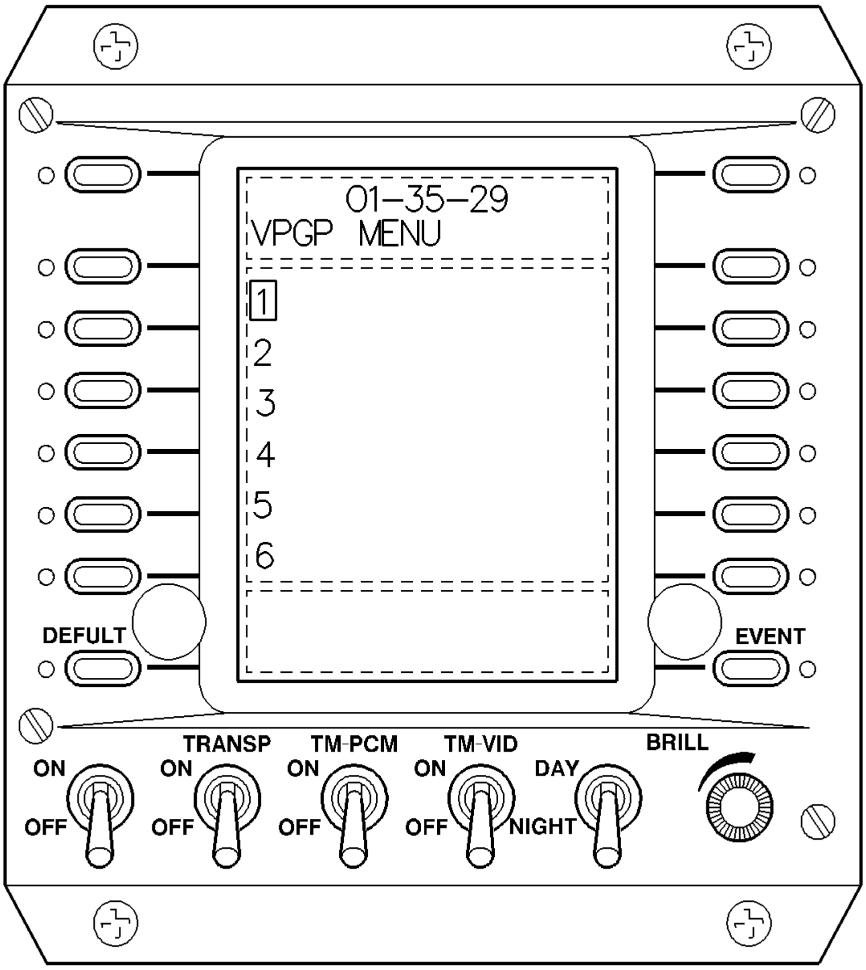


Figure 1.207 - The VIDEO PROCESSOR GROUP Selection Page

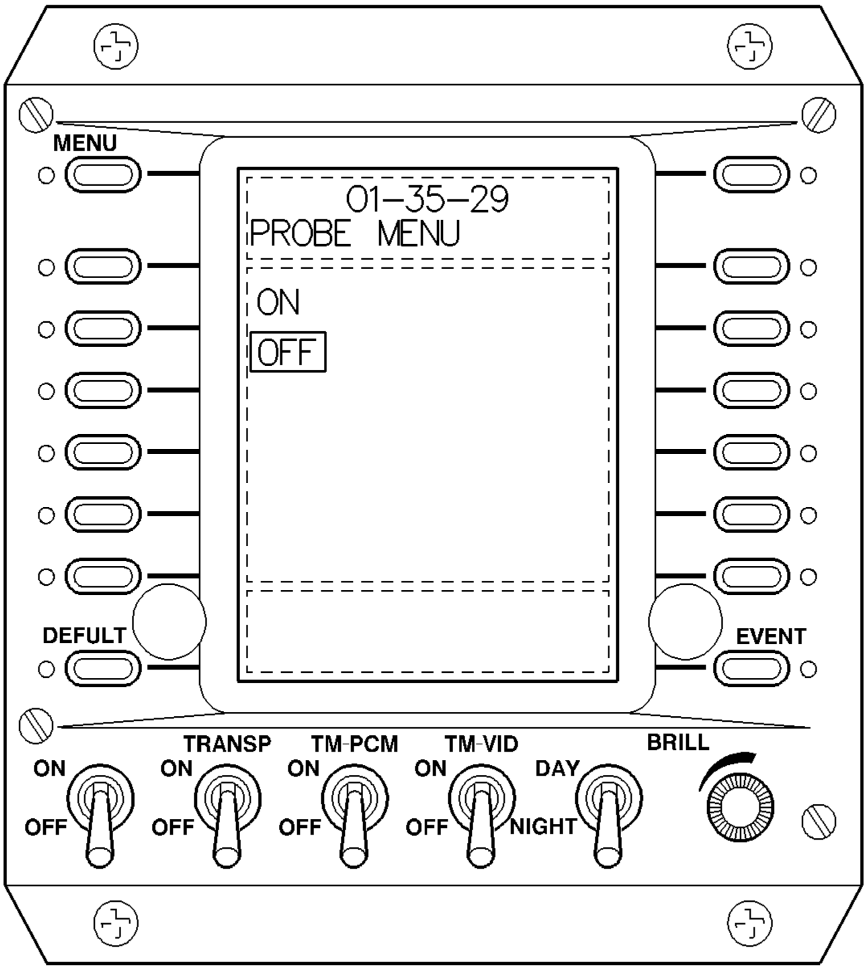


Figure 1.208 - The PROBE HEATER Selection Page

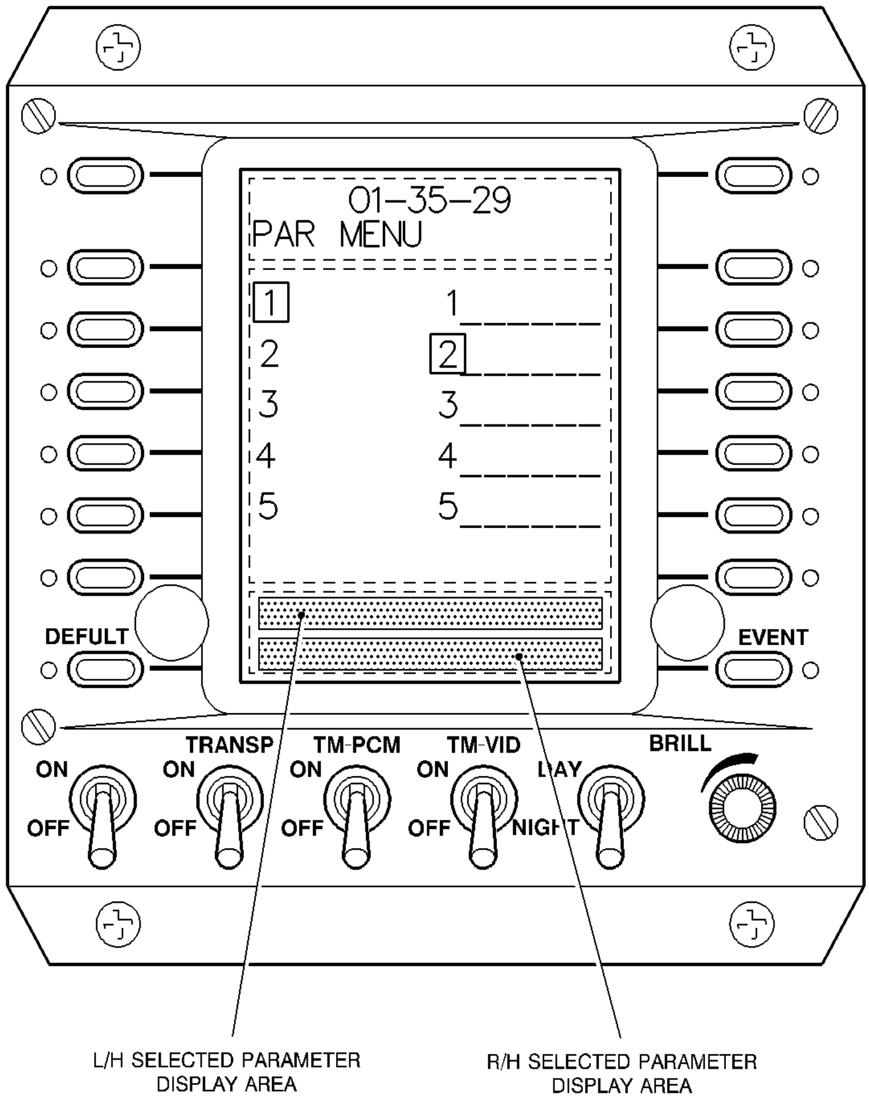


Figure 1.209 - The DISPLAY PARAMETER Selection Page

SERVICING

Servicing diagram

SPECIFICATION SERVICING	NATO	US	SP	UK	GE	IT
FUEL	F34	MIL-T-83133 (JP8)	INTA 151316	DERD 2453	TL9130-0012	AER.M.C 141
	F35	ASTM D1655-92 (JET A-1)	INTA 151317	DERD 2494		AER.M.C. 141
HYDRAULIC FLUID	H515	MIL-H-5606	INTA 157111	DEF STD. 91-48/1	VTL 9150-020	AER.M.O. 261
	H537	MIL-H-83282				
OIL, ENGINE AND GEAR BOX	0156	MIL-L-23699		DERD 2499		
AUXILIARY OXYGEN (GASEOUS)		MIL-O-27210				
FIRE EXTINGUISHING AGENT	BROMO-TRIFLUORO-METHANE (BTM) (HALON 1301)					
EXTERNAL ELECTRICAL POWER	115/220 V ac 3 phase 400 Hz // 28 V dc					

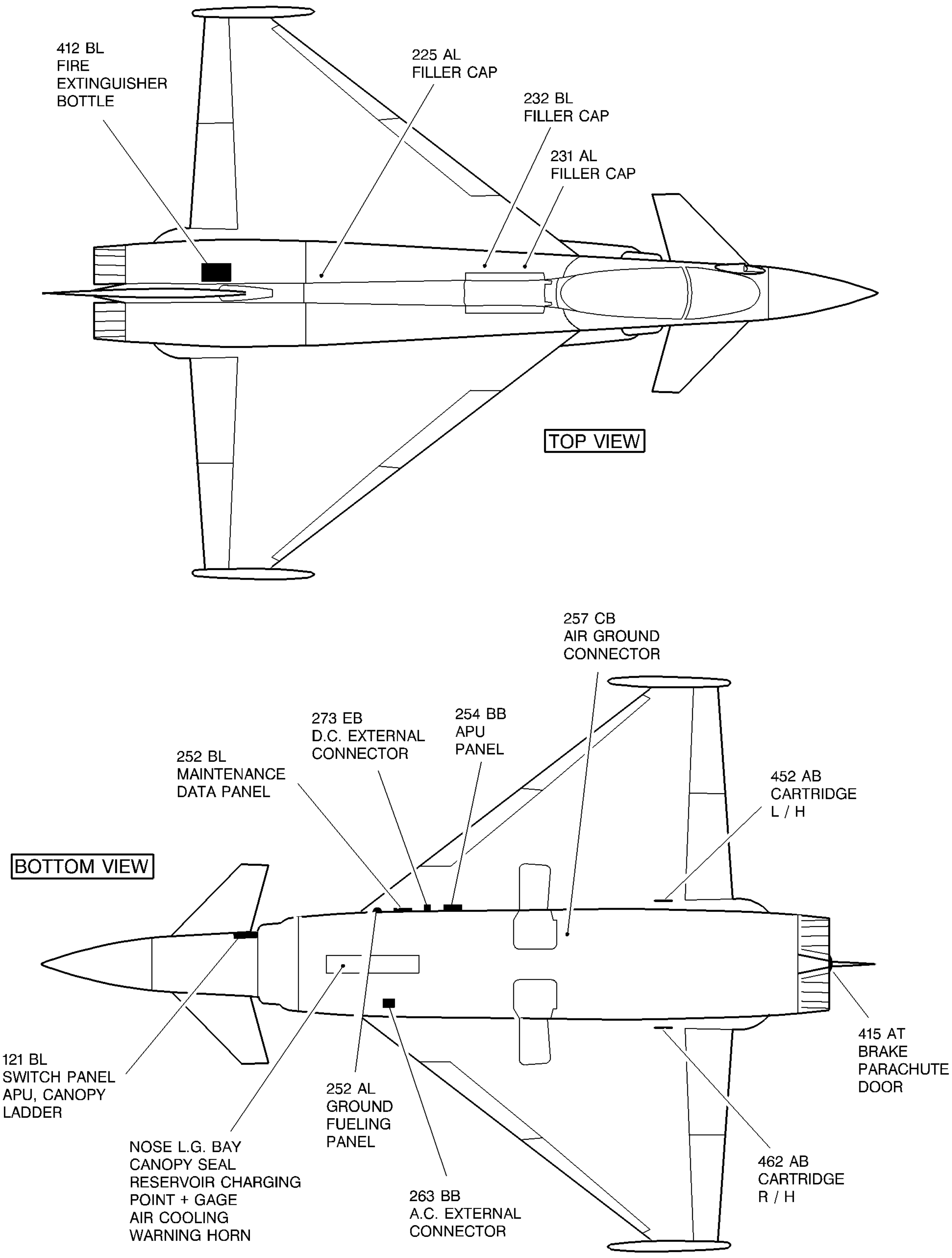


Figure 1.210 - Servicing Diagram

SECTION 2 - NORMAL PROCEDURES

Table of Contents **Page**

NOTE

At the time of printing, the contents of this Section are aligned with the Flight Crew Checklist. However, later developments may cause the Checklist to be further updated. In the event of any contrast with the Checklist, the Checklist takes precedence. This Section will subsequently be updated at the earliest opportunity to agree with the Checklist.

PREPARATION FOR FLIGHT

EXTERNAL CHECKS

The exterior inspection begins at the boarding ladder and continues around the aircraft in a clockwise direction (see Figure 2.1). Check inlets and outlets are clear, doors secured, covers off and pins removed. Be alert for loose fasteners, cracks, dents, leaks and other general discrepancies. Systematically check all pylons, launchers and stores.

Specifically accomplish the following:

Left center fuselage

1. Engine air intake cowls..........................Clear
2. External canopy jettison handle............Secured and covered

Nose section

3. Foreplanes.................Condition
4. Radome ....Secure (2 latches, both sides)
5. ADT............................Condition
6. Nose tire ....Condition, inflation

Right wing

7. Slats...........................Condition
8. Flaperons...................Condition
9. Main tire ....Condition, inflation

Rear fuselage/Fin

10. Arrester hook ....Secured, pin removed
11. Brake chute and door............................Marker flag visible, door closed, pin removed
12. Fin and rudder ....Condition

Left wing

13. Flaperons...................Condition
14. Slats...........................Condition
15. Main tire ....Condition, inflation

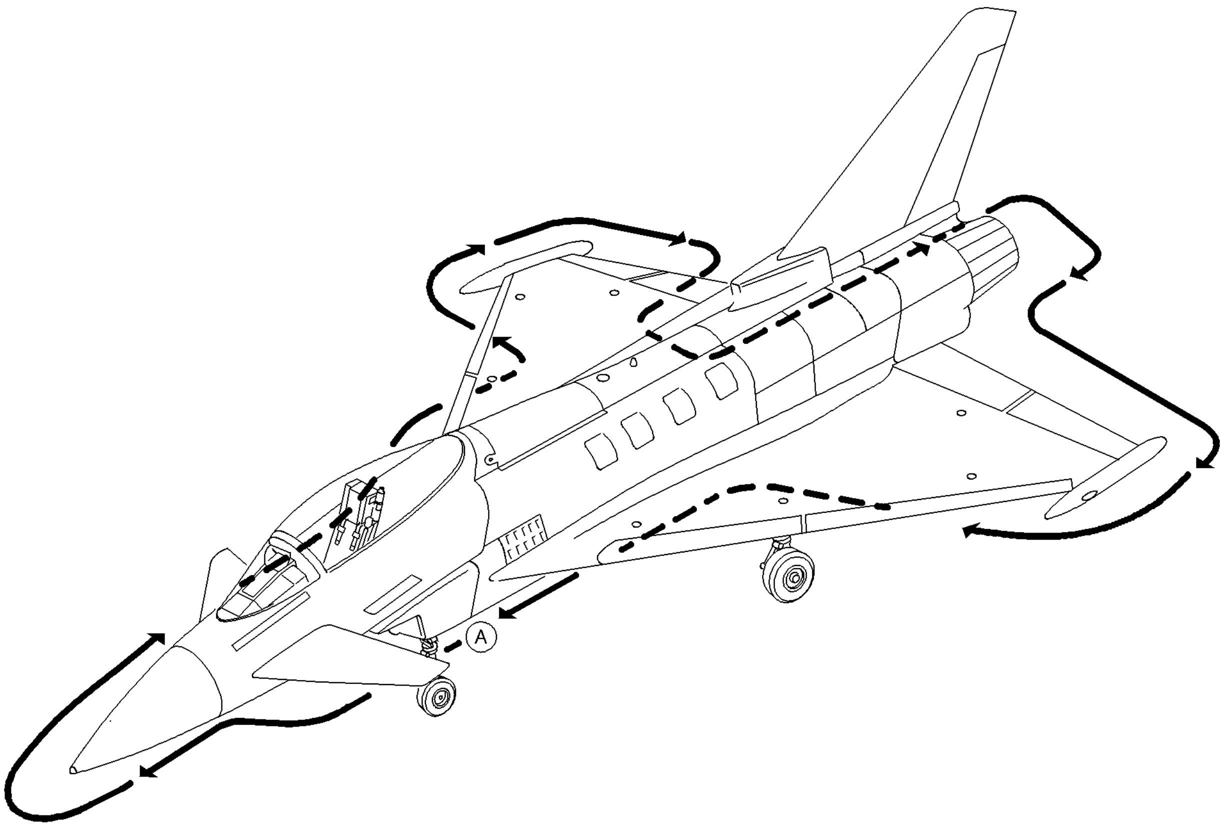


Figure 2.1 - Exterior Inspection

EJECTION SEAT CHECKS

PRE-FLIGHT CHECKS

Before strapping in, carry out the following checks on the seat installation in Table :

Pre-Flight Seat Installation Checks

1.	Make sure that the SAFE/ARMED handle is in the safe position and that the seat firing handle safety pin is in its stowage in the cockpit.
2.	Make sure that the leg restraint lines are correctly positioned in the recesses around the cockpit tunnels and that the calf restraint pennants are securely attached to the seat pan.
3.	Make sure that the two arm restraint line end fittings are engaged in the quick release fitting (QRF).
4.	Make sure, by pulling that the negative-g strap and the two lap straps are secure.
5.	Make sure that the PSP lowering line selector is selected to AUTO.
6.	Make sure that the static cables for the Automatic Deployment Unit (ADU) and the Automatic Liferaft Inflation Unit (ALIU) are connected to their respective anchor brackets on each side of the seat pan.
7.	Make sure that there is no yellow band showing on the right top latch locking assembly.
8.	Make sure that there is no yellow band showing on the left top latch locking assembly.
9.	Select the Anti-g valve lever to the On position (AFT if PEC fitted / Fwd if ASP fitted).
10.	Select the oxygen regulator selector to the MAIN position.
11.	Make sure that the right and left PSP strap connectors are connected to the harness and the PSP lowering line connector assembly is plugged into the spring clip assembly on the left side of the seat pan.
12.	Select the Auxiliary oxygen bottle selector handle to the Reset (down) position.

STRAPPING AND UNSTRAPPING

STRAPPING IN

Before strapping in it is necessary to perform the ejection seat checks detailed in Data Module Ejection Seat Checks pag. 3.

WARNING

BEFORE ENTERING THE COCKPIT, MAKE SURE THAT THE EJECTION SEAT SAFETY LEVER IS IN THE SAFE POSITION AND THAT THE SEAT FIRING HANDLE SAFETY PIN IS IN ITS STOWAGE IN THE COCKPIT.

When the ejection seat checks are complete proceed as detailed in Table :

Strapping In

1.	Enter the cockpit, taking care not to stand on the seat firing handle. Sit well back in the seat, making sure that the back is well supported.
2.	Adjust the height of the seat pan to achieve normal sitting position and the position of the rudder pedals as required.
3.	Make sure that the legs are inside the loops made by the leg restraint lines routed around the cockpit leg tunnels.
4.	Lay the lap straps over the thighs, making sure that the right strap is outside the liquid suit connector assembly (LSCA) hoses (if fitted).
5.	Connect the arrow head connector attached to the flying clothing to the quick release connector which is locked into the personal survival pack (PSP) connector assembly on the left side of the seat pan, routing the strap underneath the aircrew services package (ASP) hoses.
6.	Remove the ASP man portion and seat portion dust covers and pass to ground crew. Insert the forward end of the ASP man portion to engage under the clamp plate of the seat portion and press down on the handle until it locks into place.
7.	Connect the LSCA (if fitted) by positioning the man portion in the slider, pulling the slider backwards and locking the man portion into the seat portion.
8.	Make sure that the go forward control lever is in the forward (free) position.
9.	Bring the harness quick release fitting (QRF) mounted on the negative g strap up between the legs. Make sure that the QRF is in the locked position.
10.	Bring down the shoulder straps, making sure that the left strap lies over the oxygen tube. If the straps are too short to reach the QRF, extend them by lifting the metal tab on each adjustment buckle.
11.	Draw the left crotch strap forward and up between the legs, making sure that it is not twisted, and lay the thigh pad against the left thigh. Route the crotch strap, inboard to outboard, through the D ring on the end of the left lap strap. Pass the left shoulder strap down through the end loop of the crotch strap from rear to front, turn inwards through 90° and push the angled lug into the QRF. Pull on the lug to ensure it is properly engaged. **NOTE** To insert a harness lug into the QRF, turn the disk knob until the yellow line passes the dots on the body. Hold the knob in this position, insert the lug and release the knob.
12.	Repeat the above using the right harness straps.
13.	Remove the arm restraint lines from the stowage pockets on the sleeves of the flight clothing and connect the lug on each arm restraint line to the QRF ensuring that the lug passes through the seat mounted arm restraint line. Pull on the lug to ensure it is properly engaged. **NOTE** To insert an arm restraint line lug into the QRF, turn the disk knob until the yellow line passes the dots on the body. Hold the knob in this position, insert the lug and release the knob.
14.	Lift and pull the upper part of the left lap-strap ensuring that the slack from the underside of the strap is pulled through the D-ring.
15.	Repeat the above with the right lap-strap.

(Continued)

Strapping In (Continued)

16.	Fully tighten the lap straps, making sure that the QRF remains central. Roll the excess strap outboard and stow in the elasticated beckets on the lap straps.
17.	Sit slightly forward and tighten the shoulder straps, making sure that the straps are tensioned firmly around the body. Sit back in the seat and make sure that the shoulder straps are comfortable and not over-tensioned. If the straps feel over-tensioned, they may be eased slightly by lifting the release lever on the shoulder strap buckle. **NOTE** Sit slightly forward and raise each shoulder in turn when tightening the shoulder straps. This action will make sure that the shoulder straps are correctly positioned and tightened and any slack is pulled from behind.
18.	Sit fully forward and make sure that there is full forward movement. When in the fully forward position, operate the go forward lever to the rear (locked) position, sit back in the seat and make sure that the power reel ratchets back and that all forward movement is prevented.
19.	Move the go forward lever to the forward (free) position and check for freedom to move forward.
20.	Don the flying helmet.
21.	Secure the arm restraint lines to their respective velcro beckets on the shoulder straps.
22.	Connect the mask oxygen hose to the ASP oxygen tube. Route the mic/tel lead over the left shoulder, connect to the helmet and test the mic/tel circuit. Fit the mask (if APU running), set the oxygen regulator to MAIN and check for satisfactory breathing air supply (see note below). Check for leaks using the PRESS TO TEST button. **NOTE** If using external air supply, do not fit oxygen mask until one engine is running.
23.	Close and lock the canopy.
24.	Move the seat safety lever to the ARMED position and make sure that the handle is locked in the ARMED position (this may require the handle to be rocked backwards and forwards).
25.	Check the multifunction head-down display (MHDD) Autocue format to make sure that the ARMED caption is displayed.
26.	When the strapping in procedure is complete and the seat safety lever is in the ARMED position, the ejection option can be used to escape from the aircraft if necessary. **NOTE** The ejection seat can be used to escape from the aircraft regardless of whether the canopy is closed and locked.

UNSTRAPPING

Before vacating the cockpit, proceed as detailed in Table :

Unstrapping

1.	When the aircraft has been parked, support the LSCA man portion and move the seat safety lever to the EGRESS position. This action will disconnect the LSCA man portion and the lowering line connector. Return the seat safety lever to the SAFE position and make sure that the handle is locked. **NOTE** Support the LSCA man portion (if fitted) before moving the seat safety lever to the EGRESS position. The man portion releases with some force.
2.	Check the MHDD/Autocue format to make sure that the SAFE caption is displayed.
3.	Release the oxygen mask and disconnect the mask oxygen hose from the ASP man portion hose. Disconnect the mic/tel lead from the helmet.
4.	**CAUTION** MAKE SURE THAT THE ARM RESTRAINT LUGS ARE CLEAR OF THE QRF BEFORE ATTEMPTING TO VACATE THE SEAT. Release the QRF by turning the face plate 90° clockwise and pressing in the face plate to free the shoulder straps, lap straps, crotch straps and the arm restraint lines. Free the harness straps and lay them clear. Stow the arm restraint lines in the stowage pockets on the flying clothing.
5.	Disconnect the ASP man portion from the seat portion by lifting the handle. Fit the dust covers to the seat and man portions of the ASP.
6.	Vacate the cockpit.

INTERNAL CHECKS

Prior to electrical power on, check all coverguards down except L & R COCKS.

1. L & R LP COCK......... SHUT
2. Throttles..................... HP SHUT and latched
3. Landing gear lever..... DOWN
4. PARK BRK................. ON
5. MHDD & HUD............ ON
6. AIRDRIVE.................. AUTO
7. BATT .... OFF
8. L & R BOOST PUMP .... OFF
9. DC FUEL PUMP........ OFF
10. MASS .... SAFE
11. LATE ARM................. Safe position
12. L & R GEN .... OFF/RESET (Not DA3)
13. Systems gangbar....... Switches as required
14. All other switches....... Guarded, AUTO or forward
15. Stick.......................... Exercise at various rates, confirm stick feel correct

External AC ground power connect:

16. Battery switch .... BATT, **HYD TOT** lit
17. Throttles..................... IDLE-HP SHUT, within 20 sec power is applied

If performing an internal APU start :

18. Battery switch .... OFF
19. Canopy .... As required
20. NAV lights.................. As required

NOTE

Only a total of two APU start attempts is allowed.

21. APU .... Start, APU RUN light on, confirm both bars lit
22. Battery switch .... BATT
23. L & R BOOST PUMP .... L & R BOOST PUMP
24. MASS .... STBY
25. ADI............................ Erect, condition/flags
26. MDE.......................... AIDS, insert PP
27. Landing gear indications.................. 3 greens
28. MHDD/ACUE............. FCS NOGO occulted STORE ERROR checked

If performing an external APU start, connect external DC power source/air cart:

18. L & R BOOST PUMP .... L & R BOOST PUMP
19. ADI............................ Erect, condition/flags
20. MDE.......................... AIDS, insert PP
21. Landing gear indicators .... 3 greens
22. MHDD/ACUE............. FCS NOGO occulted STORE ERROR checked

ENGINES START

BEFORE STARTING ENGINES

NOTE

Before starting engines, assure fire guard are posted and danger areas are kept clear, see Figure 2.2, Figure 2.3 and Figure 2.4.

Check the intercom equipment with the ground crew. Confirm with the ground crew whether the APU or the pneumatic ground cart is to be used. Ensure that the ground crew is ready for engine start and instruct the removal of the access ladder. After canopy has been closed, check that the CNPY warning is not lit.

NOTE

If both throttles are set to IDLE simultaneously, the SPS computer initiates an automatic start-up sequence for both engines, starting the left engine first.

On Phase of Flight (PoF) GND, be sure that the following formats are available on the MHDD's:

- L MHDD: Autocue format
- C MHDD: PA format
- R MHDD: Engines format

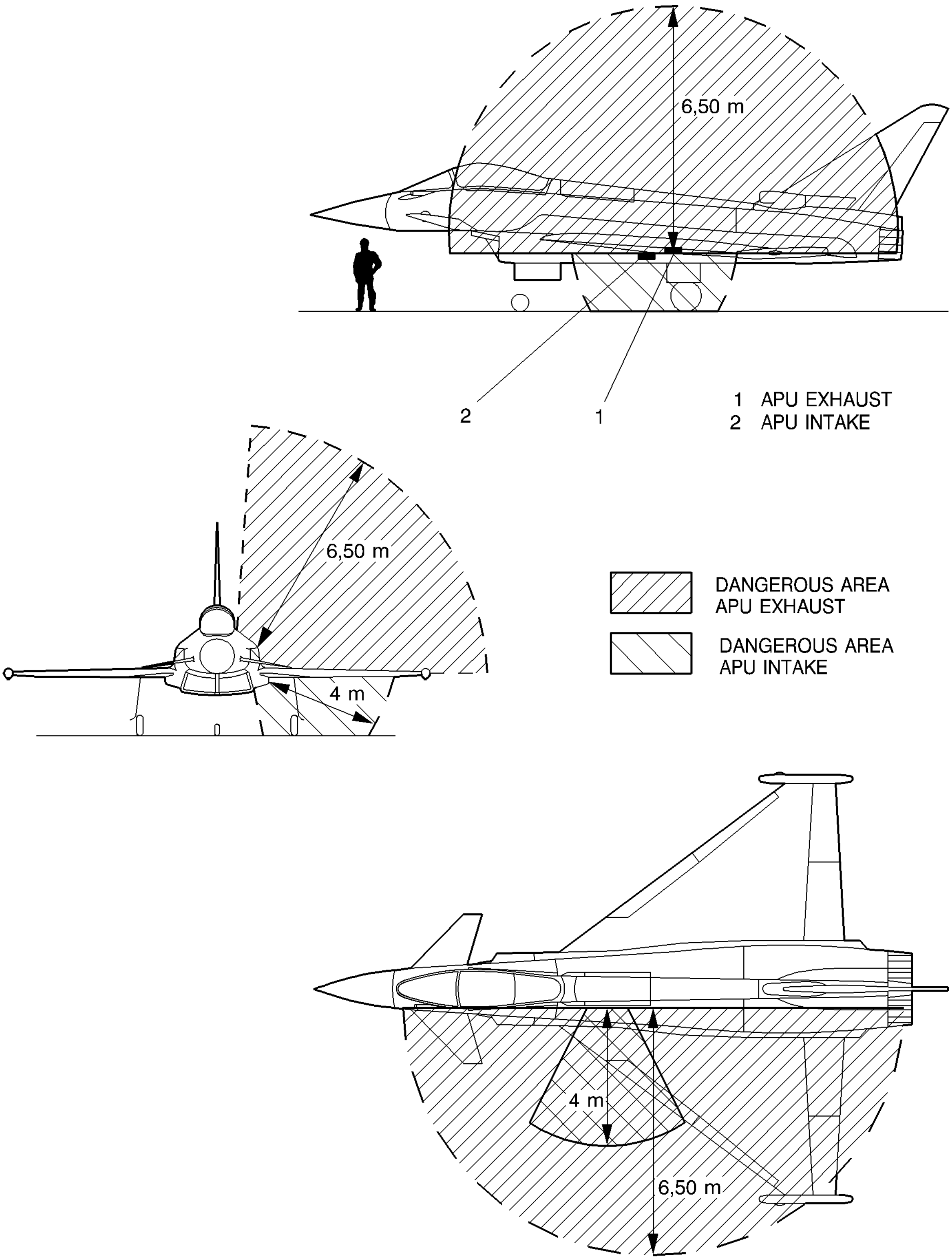


Figure 2.2 - Dangerous Areas During APU Operation.

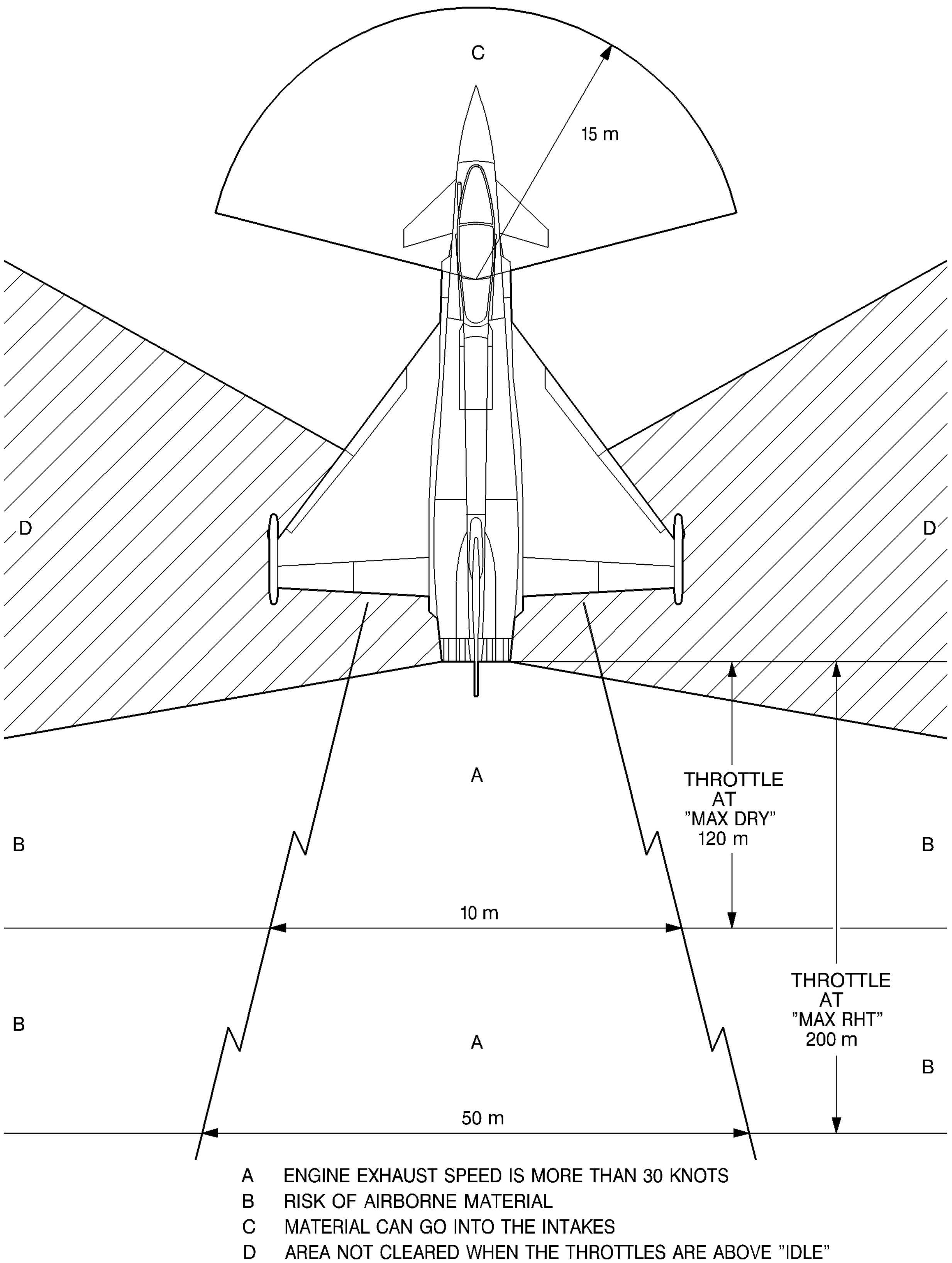


Figure 2.3 - Dangerous Areas During Engine Operation.

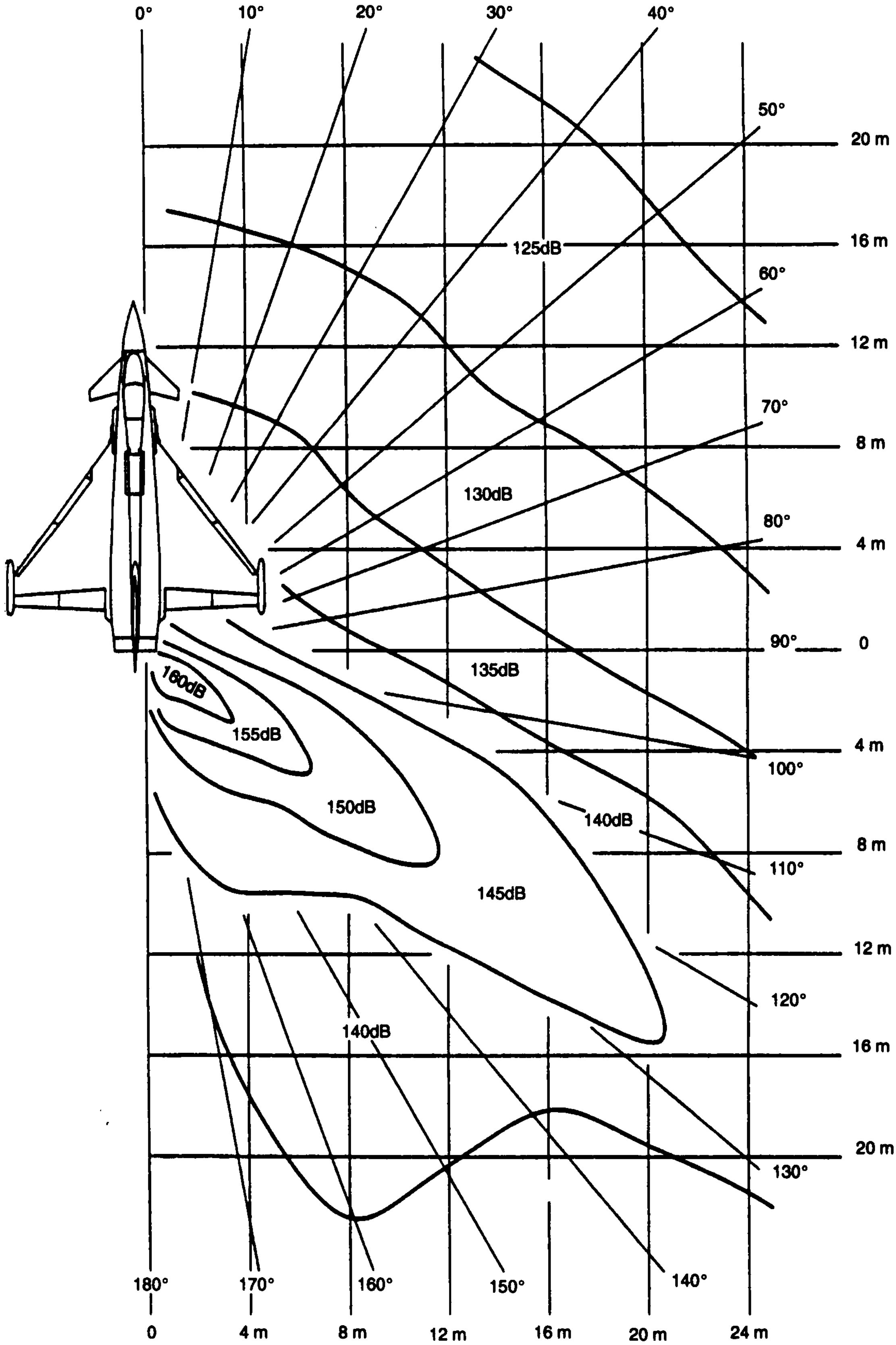


Figure 2.4 - Estimated Noise Levels - Right Engine at MAX RHT Power.

DECU BUILT-IN TEST (BIT)

The system built-in test (BIT) comprises a system initiated built-in test (IBIT) and system continuous built-in test (CBIT), to monitor engine control system functions and check out serviceability.
Initialization of the DECU takes place when the throttle is moved from HP SHUT to IDLE (i.e. DECU power-up).

NOTE

False TBT indications up to 625° C approx. may occur during DECU power-up/start-up. These indications may be ignored.

IBIT will be performed automatically after initialization of the electronic system and is completed within about two seconds. Engine start will not be initiated before completion of IBIT.

NOTE

IBIT will also be performed during engine shut-down.

If the IBIT detects defects which would cause a "Loss of Control" failure, engine start will be inhibited and DECU FAIL WRN indication will be available to the pilot, via the FCS bus. After completion of DECU IBIT the following indications will be available:
MHDD/ENG format:

- L/R OIL P;
- L/R NL: 0%;
- L/R NH: 0%;
- L/R AJ: 100% ± 2%;
- TBT value;
- L/R INTK: –26°
- L/R L1/L2 SK: L1 or L2 boxed;

DWP:

- L/R OIL P;
- HYD TOT.

CBIT testing will start automatically upon completion of IBIT.
The health of the control system is monitored by continuous BIT while the equipment is operating in its selected mode, without interfering with the operation of the system.
BIT results will be transmitted to the EMU, however, this will be not displayed to the pilot.
AIR DRIVE on AUTO links the pneumatic source power to the ATS/M, when commanded by the throttles.

NOTE

Before closing canopy check that CNPY caption is lit.

1. Canopy .... Close, CNPY not lit
2. A COLL...................... As required
3. APU .... Start, APU RUN light on

STARTING ENGINES

Have a ground crew clearance before engine starting.

1. L/R LP COCK............ OPEN (guarded)

CAUTION

- IF RELEVANT OIL P FAILS TO OCCULT AND/OR ATS/M WARNING IS DISPLAYED AT IDLE, SHUT-DOWN THE ENGINE.
- CONFIRM ELEC 1 WARNING LIT BETWEEN 30% TO 53%NH AND OCCULTED AGAIN AT IDLE, IF NOT SHUT-DOWN ENGINE.
- IN CASE OF JET PIPE FIRE, START SHOULD BE CONTINUED UNLESS A GREATER EMERGENCY EXISTS. HOWEVER, IN THE EVENT OF OTHER ABNORMALITIES (E.G. VIBRATIONS, RUMBLING) THE START SHALL BE INTERRUPTED.

Start is to be aborted if NH stagnates (all engines) or drops (-03A, -03B, and -03Z engines) for more than 5 seconds during the start phase, or if NH is less than 30% after 30 seconds from start initiation (-01A and -01C engines).

If the drive clutch does not engage, the start cycle is automatically cancelled 10 seconds after start selection.

NOTE

The DECU automatically aborts start if any of the following conditions occur:

- ESV control is requested;
- DECU loss of control;
- TBT >650°C for 5 secs or >677°C (01A and 01C);
- TBT >650°C for 3 secs or 850°C (03A);
- TBT >700°C for 5 secs or 850°C for 0,3 secs (03B and 03Z);
- Acceleration time from start initiation to 58%NH (OAT<0°C) or to 62%NH (OAT>0°C), exceeds 70 secs (01A, 01C and 03A);
- Acceleration time from 5% NH to 60%NH exceeds 60 secs (03B and 03Z);

Before attempting any further start, perform two dry cranks to dispel excess fuel from the engine.

Movement of the throttle(s) to IDLE, open(s) the HP COCK allowing fuel, which is controlled by the DECU, to flow to the engine(s).

The ignition plugs are automatically de-energized by the DECU when the engine accelerates to self-sustaining speed. When starting cycle is initiated, monitor NH increasing.

NOTE

Expect a 2 seconds delay between throttle IDLE selection and engine response. If both throttles are set to IDLE, the automatic start sequence is initiated, starting the left engine first.

During ground starts, automatic monitoring of NH and TBT is provided by the DECU; however, the pilot can monitor engine parameters on MHDD Engine format and HUP.

2. L and/or R Throttle(s) .... IDLE, check NH increasing

Engine wind-up is very rapid. Typically, idle rpm will be reached in approximately 35 seconds at SLS.

Immediately following first engine at idle:

3. DWP .... HYD TOT, not lit

NOTE

- At idle perform the following checks on the MHDD and HUP:
  - NH: 68.5 to 72.5% (01A and 01C), SLS;
  - NH: 65 to 72% (03A), SLS;
  - NH: 66 to 73% (03B and 03Z), SLS;
  - NL: 41 to 45% (01A and 01C), SLS;
  - NL: 38 to 43% (03A), SLS;
  - NL: 39 to 43% (03B and 03Z), SLS;
  - TBT: Indicating (typically 605-615°C);
  - AJ: 98 TO 102%.
- Repeat step 2, if a manual sequential start-up is required.

POST ENGINE START CHECKS

When both engines are running the APU is automatically shut-down:

1. APU RUN................... Not lit
2. L and R GEN .... ON, left first

NOTE

The MHDD and DWP databus signals are not available for approximately 30 seconds after each generator cycle.

3. DAWG........................ All out
4. MASS......................... STBY confirm MHDD/ STOR displayed

Engine start at OAT below -10°C, following a cold soak, may result in diminished engine response to throttle demand above IDLE. This problem usually cures itself during the time required for ground checks. However pilot shall monitor that L/R GEN captions are out when reaching 60%NH and the ATS/M caption is not displayed.

If AC/DC external ground power was used, request the ground crew to disconnect it.

5. External ground power .... Disconnect
6. PROBE UNLK............ Not lit
7. DC FUEL PUMP .... AUTO
8. MHDD/ACUE .... STORE ERROR checked

ALTERNATIVE SECOND ENGINE START

It is possible to carry out an alternative second engine start by using the live engine only, regardless the aircraft static or taxiing conditions. For both conditions the APU, if running, shall be switched off.

NOTE

The APU is automatically shut-down after for ground speed greater than 10 KDAS.

Set the live engine throttle at 85%NH minimum and, at stabilized rpm, set the other throttle to IDLE. After second engine idle stabilization, retard the throttle of the first engine to IDLE.

1. APU............................STOP, if required
2. APU RUN...................Not lit
3. Throttle live engine.....85% NH minimum
4. Other throttle..............IDLE, NH increasing

Complete Starting Engines as appropriate.

STARTING FAILURES/CANCELLING ENGINES START

STARTING FAILURES

A hot start is indicated by an abnormally slow increase or stagnating NH and then rapidly rising TBT.

The affected throttle must be set to HP SHUT and LP COCK to SHUT to cancel ignition. Two dry cranks must then be carried out without delay to reduce TBT.

Stop the engine if any of the following conditions exist:

– TBT significantly rises, but NH does not increase.
– An internal engine bay fire is detected.
– OIL P caption is still displayed after the engine reaches idle speed.

CANCELLING ENGINE START

CAUTION

- IN THE EVENT OF A JET PIPE FIRE DURING SHUT-DOWN, A DRY CRANK SHOULD BE CARRIED OUT TO DISSIPATE HEAT AND FLAMES.
- IF A DRY CRANK IS NOT POSSIBLE INSTRUCT THE GROUND CREW TO EXTINGUISH THE FIRE WITH EXTERNAL EXTINGUISHERS.

1. Throttle(s)...................HP SHUT
2. LP COCK(s)...............SHUT

DRY CRANK

NOTE

Use this flow chart to determine if a dry crank must be carried out prior to starting the engine.

A Dry Crank is carried out to:

– drain unwanted fuel from an engine following a failed start;
– dissipate heat and flames, in the event of a Jet Pipe fire.

1. Is it more than 6 hours since shut-down?........................ - If YES, go to 5.
   - If NO, go to 2.
2. Is it less than 15 minutes since shut-down?........................ - If YES, go to 5.
   - If NO, go to 3.
3. At some time during its last run, did the engine operate at a speed higher than idle?............................ –If YES, go to 6.
   –If NO, go to 4.
4. Did the engine operate at IDLE for more than 5 minutes?...................... –If YES, go to 6.
   –If NO, go to 5.
5. Dry crank is not necessary before an engine start.

CAUTION

TO PREVENT POSSIBLE INTERNAL DAMAGE, THE ENGINE MUST BE STARTED NOT MORE THAN 5 MINUTES AFTER THE END OF THE SECOND DRY CRANK.

6. Before starting the engine, carry out the following procedure:..... –Dry crank the engine to 27% NH (first dry crank);
   –Stop the dry crank;
   –After approximately 60 seconds, dry crank the engine again to 27% NH (second dry crank);
   –Stop the dry crank.

WARNING

OBTAIN CLEARANCE FROM THE GROUND CREW IMMEDIATELY BEFORE COMMENCING A DRY CRANK.

APU or external air supply on:

1. L/R LP COCK affected side .... SHUT
2. L/R GEN affected side .... OFF/RESET
3. AIR DRIVE................. AUTO
4. Relevant throttle......... IDLE, monitor NH increasing to approx 20-30% NH

If termination is required:

NOTE

Dry crank may be also cancelled by selecting the AIR DRIVE switch to OFF.

5. Relevant Throttle .... HP SHUT

TAXI/TAKEOFF

PRE TAXI

1. Ground crew...............Clear of controls
2. MHDD/ACUE ....FCS READY & FCS AMC AVAILABLE
3. AMC ....Perform, if necessary

NOTE

- The <REV ENV> warning will illuminate and occult again upon initiation of AMC.
- Prior to entry into FRS confirm MASS in STBY and MHDD/STOR displayed.
- The system is configured not to accept AP, therefore on entry into FRS the <A/PILOT> and <FCS RSET> warnings are triggered and must be reset.

4. FCS RSET ....Press, NWS flashing low, T/O steady lit, **DWP:** **REV ENV** lit and occult again; **A/PILOT** and **FCS RSET** lit
5. FCS RSET ....Press, **DWP:** clear
6. CONFIG ....Confirm A lit, guard down

If CG warning to be inhibited:

NOTE

Inhibiting the CG warner is not considered to be a normal procedures. As a consequence this procedures is for info only and not implemented into the DA FCC. When required the relevant FltTest cards shall cover this procedure.

1. ICO.............................Press, NWS flashing high, visual & audio warnings, **DWP:** **NWS** lit
2. TRIM NORM/ CANCEL....................CANCEL
3. AP engage button ......Press **DWP:** **REV ENV** lit for 2 sec, then occult again
4. FCS RSET.................Press, NWS flashing low, T/O steady lit; **DWP:** clear
5. TRIM NORM/ CANCEL.................... NORM

FCS PRE FLIGHT (PFC) AND ACTUATOR MAINTENANCE CHECK (AMC)

FCS PRE FLIGHT CHECK (PFC)

The FCS PFC is automatically performed on power up. For FCS RSET, FCS TEST and MHDD/ACUE indications, refer to Table .

NOTE

The MHDD/ACUE format must not be used as the primary method for indicating safety critical information. The pilot must treat the MHDD/ACUE as an advisory format to support the ground procedures.

ACTUATOR MAINTENANCE CHECK (AMC)

The AMC is inhibited when the FCCs have entered FRS.

NOTE

ICO will interrupt the AMC and set the controls to a safe position.

After ICO, the FCS TEST must be pressed twice to repeat the AMC. First press will reset the AMC to the start point, at this point the FCS NOGO and FCS AMC AVAILABLE prompts are displayed. Second press will restart the AMC.

ENTRY INTO FLIGHT RESIDENT SOFTWARE (FRS)

Upon entering FRS the full FCS mode is available and the control surfaces are set to either:

- Take Off Trim (FCS RSET - T/O steady lit) datum position, or
- DUMP position if DUMP is selected.
- NWS will engage into the low speed mode of +/- 43° (NWS legend flashing low - 0.5 Hz), provided a valid LINS GS signal is available. Otherwise the NWS will enter the medium speed mode of +/- 28° by default.
- The LINS can only align its vertical channel until after FRS entry. This has no effect on the NWS

moding, i.e. the NWS will enter the low speed mode.

– The CONFIG is set by default to 'A` (bars lit), provided that <FCS MASS> and <SCAC> are not lit on the DWP. The MASS switch must be set to STBY prior to entry into FRS.

Manual trim offsets in pitch or roll will cause the TOT legend on the FCS RSET button to flash. Reset by:

– Pressing FCS RSET (TOT steady), or
– Advancing either throttle out of the idle position.

Inhibition of the <CG> warning can be done in a safe manner without adverse effect of the FCS functions.

NOTE

– The procedure to inhibit the CG warning results in disengagement of the DWP <CG> warning caption until either power down of FCS or until a Repeat-PFC is performed.
– When the <CG> warning is inhibited the <FCS MASS> warning, when triggered, may be disregarded for the remainder of the flight.

PRE TAXI CHECKS

1. Anti-g and pressure breathing.................... Test
2. Systems gangbar switches..................... FORWARD

When LINS alignment complete:

3. MHDD/ACUE............... –NAV SEL press
   –BRAKE NOGO not displayed
4. MHDD/STOR............. Check SJ package
5. Instruments HUD/ MHDDs/GUH .... Check, set QNH
6. LOW/HT..................... Check and set as required
7. MDP/panels .... Clear/secure
8. MDE-XMIT .... Confirm STBY
9. External lights .... As required

VOICE must be on to check the function of the LOW/ HT warning.

No brake prompts should be displayed on the MHDD/ACUE, when the EMGY BRK switch is set to NORM and both brake systems are healthy. A single brake failure is indicated by a BRAKES NOGO and BRAKE SYSTEM 1 (or 2) FAIL prompt on the MHDD/ACUE.

FCS should be in FRS prior to select NAV on the MHDD/ACUE to allow the IMU to adopt the LINS True Heading.

NOTE

Operation of the BARO toggle switch, either UP or DOWN, in excess of 23 sec. will fail the baro set facility (<BARO-SET> on DWP).

Check the Baro set switch in the centered position. At this S/W standard, the BARO-SET toggle switch allows only to set the relevant QNH either by selecting momentary UP or DOWN. The position LEFT is omitted, i.e. no quick standard setting (1013) is possible.

CAUTION

WHILST ON GROUND SELECTION OF A RADAR TRANSMITTING MODE SHOULD BE AVOIDED AS INADVERTENT TRANSMISSION CANNOT BE GUARANTEED EVEN WHEN ALL WOW INTERLOCKS ARE SATISFIED.

The radar will default into the standby (STBY) mode of operation following warm-up, provided no radar mode has been pre-selected during warm-up.

MHDD/ACUE FCS Indications

<table>
<tr><td colspan="8">STATES & MHDD/AUTOCUE DISPLAY</td></tr>
<tr><td>CONDITION</td><td>(0) WAIT FOR PWR ON</td><td>(1) WAIT FOR ENG START</td><td>(2) WAIT FOR FRS</td><td>(3) WAIT FOR TAXI</td><td>(4) WAIT FOR T/O</td><td>(5) WAIT FOR LDG UP</td><td>(6) IN FLIGHT</td></tr>
<tr><td>PFC available</td><td rowspan="9">occult
ACUE</td><td colspan="3">FCS PRE-FLIGHT CHECK AVAILABLE</td><td>N/A</td><td>N/A</td><td rowspan="9">occult
ACUE</td></tr>
<tr><td>PFC in progress</td><td colspan="2">FCS NOT READY & FCS PRE-FLIGHT CHECK IN PROGRESS</td><td colspan="2">Transition to State (3)</td><td>N/A</td></tr>
<tr><td>PFC pass</td><td>FCS NOT READY</td><td>FCS READY</td><td colspan="3">Not applicable. See FRS engaged.</td></tr>
<tr><td>PFC NOGO</td><td colspan="2">FCS NOGO plus WARNING cue</td><td colspan="3">Not applicable. See FRS engaged.</td></tr>
<tr><td>AMC available</td><td colspan="2">FCS AMC AVAILABLE</td><td colspan="3">Not applicable. See FRS engaged.</td></tr>
<tr><td>AMC in progress</td><td colspan="2">FCS NOT READY & FCS AMC IN PROGRESS</td><td colspan="3">Not applicable.</td></tr>
<tr><td>AMC pass</td><td colspan="2">FCS READY</td><td colspan="3">Not applicable.</td></tr>
<tr><td>AMC NOGO</td><td colspan="2">FCS NOGO & FCS AMC AVAILABLE</td><td colspan="3">Not applicable.</td></tr>
<tr><td>FRS engaged</td><td colspan="2">Not applicable.</td><td>FCS PRE-FLIGHT CHECK AVAILABLE</td><td colspan="2">If FCS healthy: all FCS indications are occulted</td></tr>
</table>

TAXI CHECKS

CAUTION

THERE IS A TENDENCY OF DIRECTIONAL PIO DURING TAXIING IN NWS LOW SPEED MODE.

NOTE

- A single brake failure is indicated by a BRAKES NOGO and BRAKE SYSTEM 1 (2) FAIL prompt. Brakes pressures are not displayed at AvSP3.
- It is recommended to use the GS display on the HUD.

NWS modes:

- Low speed mode +/- 43°: NWS legend slow flash (0.5 Hz)
- Mid speed mode +/-28°: NWS legend steady lit *
- High speed mode +/- 10°: NWS legend steady lit

* Default mode if LINS has not completed its alignment, except LINS vertical channel.

NOTE

- During low speed taxi, Lift dump is automatically not engaged.
- The LINS cannot align its vertical channel until after FRS is entered. This does not influence the NWS moding.
- Similarily NAV should be selected after entry into FRS to allow the IMU to adopt the LINS True Heading.

The fade-in/out is determined by a combination of LINS GS and wheel speed signal.

1. Instruments................ Check
2. Brakes .... Check
3. NWS .... Check low speed mode

BEFORE TAKEOFF CHECKS

Pilots should be aware that it is possible for the hose to appear connected without the bayonet fitting being fully rotated. Therefore it is necessary to check that the oxygen hose is connected and secure. If the mask is disconnected, an MSOC warning will be triggered at some point (altitude related), and the pilot could become hypoxic.

The fuel balance (difference in contents between forward and aft main fuel groups) is displayed by the FWD and the REAR GUH fuel indicator on the head-up panel (HUP). Fuel difference (difference in contents between the forward transfer tank and the combined total of the aft wing tanks) is indicated by the DIFF caption on the MHDD/ENG and MHDD/FUEL format.

The VENT caption, if displayed should extinguish when the throttles are advanced to above 70 % NL.

1. Harness/visor/oxy ...... Check
2. Oxygen hose .... Connected and secure
3. Fuel........................... Contents/balance
4. Pins........................... 2 stowed (+ EPU DA2)
5. Canopy .... Closed and locked, CNPY not lit
6. Seat safety lever........ ARMED
7. External lights .... As required
8. EPU .... As required (DA2 only)

If external tanks are fitted:

9. Fuel format................. Confirm XFER AUTO

LINE-UP

1. DATUM ADJUST TRIM......................... TRIM
2. JETT EMGY/SEL....... As required
3. ACUE format............. Confirm no brake failure prompts
4. Systems gangbar....... XPDR OFF, then XPDR
5. MDE-XPDR................ As required
6. MDE-XMIT .... As required (DA with radar)
7. Warnings (DWP/ MHDD/DAWG)........... All out except:
   LADDER
   COMMS
   IFF CRYP
   DAS CPTR not DA1/2
8. MASS .... LIVE
9. Rudder pedals .... Ensure neutral

Transponder status can only be confirmed from the MDE and not the RGS.

Advancing the throttles out of the idle position will automatically reset all trims to zero (T/O lit).

The rudder pedals should be neutral to prevent any PIO to develope.

TAKEOFF

NOTE

Takeoff is prohibited with only one operative brake system.

Prior to takeoff the MHDD/ACUE format shall be checked if both brake systems are operative, i.e. no brake fail prompt displayed. Release the brakes, with the stick and rudder pedals at neutral position. Depending on the type of takeoff, advance both throttles to either MAX REHEAT or MAX DRY POWER. Maintain the stick at neutral until rotation. Directional control during the initial takeoff ground run up to rotation speed is maintained by the NWS. The rudder becomes effective from appr. 70 KDAS onwards. The authority of the NWS is rapidly fading from +/- 43° at taxi (low) speed, to +/- 28° (mid) speed when both throttles are advanced for takeoff.

MAX REHEAT TAKEOFF TECHNIQUE

Aircraft acceleration in reheat power is extremely quick. Takeoff data should be considered in respect to the PDM taking into account all relevant factors.

NOTE

In the interest of low pitch oscillations during the take off run it is recommended to release the brakes already at 70% NL.

Holding the aircraft on the brakes, advance the throttles swiftly to the desired condition, as the NL passes 85%, release the brakes with the stick in neutral position, the aircraft will leap forward and the airspeed will increase rapidly. As the airspeed passes 110 KDAS smoothly and progressively apply aft stick of approximately three quarters of stick (75%). Rotation is progressive and predictable allowing easy capture of the desired climb attitude through relaxation of the stick input back to neutral. The desired climb out attitude can initially be controlled by using the E type AOA indicator in the HUD. Once a positive rate of climb has been established, raise the landing gear. Following landing gear retraction the climb bars should be used to control the desired climb attitude.

Directional control during the initial ground run up to rotation speed is achieved by the nosewheel steering (NWS). In order to avoid potential NWS PIOs an instantaneous switch-over from low speed (+/- 43°) to high speed (+/- 10°) occurs when advancing both throttles out of the IDLE position. The rudder becomes effective from approximately 70 KDAS onwards.

A slight tendency to overshoot the target AOA is experienced when a snatch to full back stick is used for the rotation, but even in this case there is a good AOA control and any potential overshoot is easily controlled.

Reheat thrust should be cancelled at approximately 250 KDAS. Do not delay landing gear retraction to avoid exceeding the normal landing gear retraction limit (290 KDAS).

For computation of the exact rotation and takeoff speeds at various takeoff masses, refer to Performance Data Manual (PDM).

Max Dry Power Takeoff Technique

NOTE

For the Max dry Power takeoff lift-off speed is lower than the speed for single engine climb rate at the envisaged climb-out speed, therefore rotation speed has to be increased.

Aircraft acceleration is swift in all configurations currently cleared. The choice of dry power should be considered in respect to the PDM taking into account all relevant factors. Irrespective of the power setting chosen for takeoff, the technique described for the Reheat Takeoff remains the same for the Dry Power Takeoff.

Refer to Performance Data Manual (PDM) Takeoff (Dry Power) Single Seater or Takeoff (Dry Power) Twin Seater.

AFTER TAKEOFF (MAX REHEAT/MAX DRY)

With weight off the nosewheel (WONW), the FCS will fade into the airborne mode within 5 seconds.

FCS RSET - NWS LEGEND

The NWS legend on the FCS RSET button will occult as soon as weight is off the nosewheel.

FCS RSET - T/O LEGEND

The T/O legend remains lit as long as the landing gear is DOWN. The legend will occult during landing gear retraction.

REJECTED TAKEOFF (ABORT)

For rejected takeoff criteria, refer to Abort.

ENGINE/REHEAT FAILURE DURING TAKEOFF

For Engine or Reheat Failure during takeoff, refer to Engine/Reheat Failure during Takeoff .

AFTER TAKE-OFF CHECKS

When the aircraft is airborne, retract the landing gear. The landing gear should be UP and the doors closed and locked before reaching 290 KDAS.

1. Landing gear lever..... UP
2. CONFIG .... As briefed, guard down.
3. JETT EMGY/SEL ...... EMGY not guarded

FLIGHT

CLIMB

NOTE

Climb speed schedule is the applicable KDAS until interception of the corresponding Mach number, then maintain the Mach number.

Data conditions: Drag index 5, ISA

DRY (MAX RANGE CLIMB)	DRY (MINIMUM TIME)
350 KDAS/0.85M	489 KDAS/0.89M

Data conditions: Drag index 15, ISA

DRY (MAX RANGE CLIMB)	DRY (MINIMUM TIME)
350 KDAS/0.85M	455 KDAS/0.88M

Data conditions: Drag index 60, ISA

DRY (MAX RANGE CLIMB)	DRY (MINIMUM TIME)
350 KDAS/0.85M	496 KDAS/0.89M

CRUISE CHECKS

The cruise data presented in the following table is applicable for the following conditions:

Two engines operating, 14 000 kg, ISA

Cruise Data - Two Engines Operating, 14 000 kg, ISA

DRAG INDEX	ALTITUDE	KG/100 ANM	ANM/100KG	RANGE SPEED
5	40 000	318	31.4	0.87M
	30 000	360	27.8	0.78M
	20 000	448	22.3	0.65M
	10 000	562	17.8	0.56M
	Sea Level	709	14.1	0.48M
15	40 000	326	30.7	0.85M
	30 000	369	27.1	0.78M
	20 000	459	21.8	0.65M
	10 000	575	17.4	0.54M
	Sea Level	719	13.9	0.46M
60	40 000	368	27.2	0.81M
	30 000	410	24.4	0.73M
	20 000	508	19.7	0.62M
	10 000	633	15.8	0.52M
	Sea Level	794	12.6	0.44M

DESCENT/RECOVERY

Before descending to low level or recovery for landing carry out normal system checks for recovery. These should include:

- A check of all displays such as HUD/MHDDs/ GUH
- Fuel contents and balance, MHDD and GUH indications
- FCS status
- CONFIG status
- AIRDRIVE position in AUTO
- Landing light on

The recommended configurations for descend are:

Instrument descent

SPEED	THROTTLES	AIRBRAKE
0.9 M/300 KDAS	Idle	IN

Range Descent

SPEED	THROTTLES	AIRBRAKE
0.9 M/250 KDAS	IDLE	IN

Rapid Descent

SPEED	THROTTLES	AIRBRAKE
0.9 M/450 KDAS	IDLE	OUT

* To determine distance covered, time and fuel used to descend from altitude to sea level or between any two altitudes, refer to the Performance Data Manual (PDM) - Part 6, Descent.

LANDING

PRE LANDING

Routine operations should be to cross-check the AOA vs airspeed on approach for the following information:

– Aircraft mass
– Expected approach speed
– Planned AOA on final approach.

The Aircraft Mass can be obtained by adding the remaining fuel (kg) as displayed on the HUP and the MHDD/FUEL format to the Basic Mass Empty (BME).

The expected Approach Speed for various aircraft masses can be determined from the relevant Performance Data Charts in the Performance Data Manuals. The FCCs give speeds for the standard 13° AOA approach assuming 13 000 kg. Variations in speeds due to variations of aircraft masses can be obtained by interpolation and extrapolation, respectively.

NOTE

HUD AOA is only available in APPR/ LDG POF by a E-type indicator, representing 12°, 14° and 16° AOA respectively.

The expected accuracy of this cross-check of AOA and speed, failure free condition, should be within a given tolerance, i.e. at the expected approach AOA the displayed speed should be within +/- 9 KDAS.

If the expected approach speed minus the allowable error is achieved before the expected AOA is achieved (13° standard approach) the pilot will perceive this as an anomaly between AOA and the airspeed, and that either the AOA is under-reading or the airspeed readout is under-reading; in this case the airspeed should be maintained. Conversely, if the target AOA is achieved before slowing down to the expected approach speed plus allowable error, an anomaly exists in either the AOA or airspeed is overreading. Again, the current airspeed should be maintained.

The recommended approach AOA is 13 (15 max) units AOA. In cross wind conditions the crabbed approach method is recommended.

The approach and landing technique assumes:

– The airbrake is IN (retracted) and the leading edge (L/E) is IN (retracted) whith the landing gear DOWN at an AOA below 17°.

For FCS moding of the LDG DOWN refer to Weight on Wheels Moding.

NOTE

– Cross-check AOA/speed for relevant landing mass. If anomaly, assume a degraded system and add 7 KDAS to calculated approach speed.
– Use FTI AOA as back up (when available).

1. Fuel .... Contents/balance
2. Harness .... Locked
3. Landing gear .... DOWN, 3 green 3 D

Approach speed/AOA (L/E IN, A/B IN) :

– SS: 142 KDAS at 13 000 kg/13 AOA add/ subtract 5 KDAS per 1000 kg mass variation. Add 2 KDAS when A/B OUT.
– TS: 148 KDAS at 13 000 kg/13 AOA, +/- 5 KDAS/1000 kg above/below 13 000 kg. Add 2 KDAS when A/B OUT.

LANDING

Check 3 greens and the 3 D in the HUD.

Normal sequence following mainwheel touchdown should be:

– Both throttles IDLE.
– Deploy the brake chute.
– Following nose wheel touchdown, full forward stick should be applied until the brakes have been applied.
– Apply brakes once below MBS.
– Once braking has been started, centre or aft stick pitch stick may be used provided the nosewheel remains firmly in contact with the runway.

NOTE

– For landing in crosswind condition refer to Crosswind Landings, below.
– For maximum sink rate and maximum touchdown AOA and x-wind limits refer to the relevant AWFL.

Approach and Landing:

– Prior to the approach: When below 290 KDAS lower the landing gear. Simultaneous operation of the LDG and the airbrake should be avoided.
– During the approach: Stabilize the speed on a 2.5 to 3° glide path, to achieve an approach speed equivalent to aircraft gross-weight and expected AOA.
– No flare maneuver is necessary to be carried out because the aircraft flares naturally itself when close to the ground.

- The aircraft derotates nicely with neutral stick. Forward stick may be used to assist or quicken the derotation.
- After mainwheel touchdown: Brake chute deployment is recommended at mainwheel touchdown (< 150 KDAS). Optimum braking is achieved by adhering to the sequence of selecting the brake chute before application of the wheel brakes.
- Full forward stick should be applied during the ground roll following nosewheel touchdown, until the brakes have been applied. Once braking has been started, centre or aft stick may be used provided the nosewheel remains firmly in contact with the runway.
- The NWS will be engaged automatically with WONW.
- Lift Dump will be automatically activated (LIFT/ DUMP switch removed), provided all wheels are on the ground, both throttles are at IDLE and aircraft mass is below 21,6 t.
- Pedal application up to full deflection is cleared. At speeds less than 10 kts smooth pedal inputs shall be applied (anti skid drop-out speed).
- When normal taxi speed is reached check the airbrake in, if used, and jettison the brake chute (to avoid damage to the chute).

CROSSWIND LANDING

In cross wind conditions the crabbed approach technique is to be used, by gently applying rudder inputs and roll stick in the kick-off drift maneuver until touchdown. The delay between kicking off drift and main wheel touch down should be minimized. The A/B may be either selected in or out.

NOTE

If during crosswind landings with the brake chute deployed, lateral/ directional control problems are encountered, then the brake chute shall be jettisoned.

When landing in crosswinds greater than 10 kts, the use of into wind roll stick after nosewheel touchdown is required in order to keep the wings level, thus equalizing mainwheel loading and minimizing brake effectiveness asymmetries.

Crosswind limits on approach and landing shall not exceed the following:

Crosswind limits on approach:

- 0 up to 25 kts : 16° AOA max for asymmetric configurations with wind from heavy wing side or symmetric configurations
- 25 kts to 30 kts : 15° AOA max for asymmetric configurations with wind from heavy side or symmetric configurations
- 0 kts to 25 kts : 15° AOA max for asymmetric configurations with wind from light wing side
- 25 kts to 30 kts : 12° AOA max for asymmetric configurations with wind from light wing side

ROLLER LANDING/TOUCH AND GO

NOTE

The term \`Roller Landing' applies when the nosewheel is lowered onto the runway; the term \`Touch and Go' applies when only the main wheels contact runway.

In the case where manual trim offsets have been applied (pitch or roll) prior to roller- or touch and go landings the manual applied trim offsets will fade back to the datum (TOT) with one throttle at least above idle.

SINGLE ENGINE LANDING

The engine bleed air power may decrease to such a level, that very low power is available at the pneumatic driven gearbox, causing possible gearbox oscillation below 50% with associated loss of electric.
Beside this deficiency single engine landing should not lead to problems, as the landing occurs at close to idle power setting.
Crossbleed is operative when single engine taxi (RH or LH engine shut down) is performed.

LANDING WITH AT ENGAGED

The use of the Autothrottle (AT) on approach:

No full stop landings with AT engaged are cleared. Any landing with AT engaged has to be a roller/touch and go landing.

BRAKING TECHNIQUE

CAUTION

- DO NOT APPLY BRAKES WITH THE NOSEWHEEL OFF THE GROUND.
- IF THE BRAKES ARE CYCLED, THERE IS A TENDENCY FOR THE NOSE OF THE A/C TO BOUNCE UP AND DOWN, PARTICULAR IN HEAVY MASS, AFT CG CONFIGURATIONS.

After brake chute deployment and nosewheel on the ground, full forward stick shall be applied until brake application. When steady braking is reached smooth back stick inputs are cleared. Normal braking should only be applied once below Maximum Braking Speed (MBS). Degraded performance of the brakes must be anticipated when used above MBS.

For calculation of Max Braking Speed refer to the Performance Data Manual (PDM).

Pedal application to full deflection is cleared. At speeds less than 9 kts smooth pedal inputs shall be applied (anti-skid drop-out speed).

AERODYNAMIC BRAKING

- Aerodynamic braking is cleared up to 15° AOA for speeds from touchdown speed down to 90 KDAS for the clean aircraft and up to 14° AOA with external tanks fitted.
- Crosswinds in accordance with the AWFL and up to moderate turbulence.
- With or without airbrake deployed. Airbrake deployment or retraction during aerodynamic braking is not cleared.
- Deployment of the brake chute is cleared following mainwheels on the ground.

BRAKE AND/OR ANTI SKID FAILURE

In air single brake or single anti skid failures (loss of either system 1 or system 2) is not indicated.

On power up brake and anti skid system 1 (left) will be active by default, provided the EMGY BRK switch is set to NORM. Any subsequent failure within system 1, affecting either the brake and/or the anti skid, will cause the system to switch to system 2 and to display a system prompt (BRAKE NOGO-SYSTEM 1 FAIL) on the MHDD/ACUE.

A total brake failure (system 1 and system 2) is indicated by the DWP caption **BRK FAIL** (APPR/LDG) or **BRK FAIL** (GND, T/O).

NOTE

When triggered as a secondary, the DWP BRK FAIL warning caption is displayed in all POF.

AFTER LANDING

CAUTION

HARSH BRAKE INPUTS ARE TO BE AVOIDED AT TAXI SPEED, OTHERWISE THE ADS MAY FAIL CAUSING THE <FCS REV> WARNING TO BE TRIGGERED.

When normal taxi speed is reached select the airbrake in, when used, and jettison the brake chute. On DA2 set the EPS to OFF and insert the pin.

With weight on all wheels radar transmission is inhibited (DA with radar). However, to enhance safety the radar shall be set to the STBY mode of operation via the MDE-XMIT, MK STBY.

The MASS should initially be set to STBY. Setting the MASS to OFF will trigger the <FCS MASS> and <FCS REV> warnings with the associated audios.

Normal taxi back should be performed with both engines running.

If single engine taxi is required and the live engine speed is set to below 75% (NH) the GBOX speed may run at 30% instead of 60%. This algorithm is active only on the ground, to allow single engine taxi with NWS available if the left engine is shut down.

1. Brake chute................Jettison
2. MDE-XMIT ....ALL SLNT
3. Seat safety lever ....SAFE (forward)
4. MASS........................STBY
5. External lights ....As required

SHUT DOWN

NOTE

Pump depressurization on ground with running engine (above 60 % NH) is not permitted.

For normal engine shut down the HYD switch (es) must be left in AUTO (HYD circuits pressurized).

Prior engine shut down the EJ200 engines must be operated in idle for 5 minutes (1A standard) or 10 minutes (1C/3A/B/Z standard).

1. PARK BRK.................ON
2. L & R engine ....IDLE, as required

3. DC FUEL PUMP ....OFF
4. Gangbar switches ......As required
5. L & R throttle ....HP SHUT
6. L & R LP COCK ....SHUT
7. FCS TEST..................BIT lit, press, monitor PFC
8. CRYP ERASE............As required
9. All switches ....Guarded, OFF, or set as reqiured
10. L & R BOOST PUMP.........................OFF

CAUTION

DO NOT REMOVE THE PDS FROM THE MDRL UNTIL ALL ELECTRICAL POWER IS REMOVED FROM THE AIRCRAFT.

NOTE

Re-selecting BATT (BATT1/2) to on will erase CSMU data.

11. BATT (BATT1/2) ....OFF
12. MASS.........................SAFE

WEAPON CONFIGURATION/ SELECTIVE JETTISON PACKAGE

AMRAAM FIRING NORMAL MODE

1. Target .... Nominate (XY, PTA, Lock On)
   Check DTL displayed
2. A/A Weapon select switch .... Select AMRAAM (rock forward), check
   - HUD: ”LATE ARM SAFE”
   - HUD: “M” expands to “MRAAM”
   - MHDDs: ”M” and missiles remaining boxed
3. Multiple Missiles (not cleared with PSC 1.0) .... Assign, if required (XY over “M”- Symbol)
4. Steering Dot................. –Follow, fly dot into ASE circle
   –Achieve Optimum Release Altitude
5. Late Arm .... Armed (HUD: ”LATE ARM SAFE” occults)

Inside AMRAAM envelope, above min. range and dot within ASE (“Shoot” Cue):

6. Trigger .... Squeeze to 2nd detent

NOTE

– In case of a missile hung-up (Cat 3 warning) that missile is lost, squeeze trigger again to fire another missile.
– In case of a second hung-up the failed station will be indicated by a red box and all other AMRAAM stations will be displayed with red in-filled boxes. No further AMRAAM launch attempts will be allowed.

7. Aircraft symbol........... Keep within Turnaway Limits until TTA reaches zero
8. Re-attack, if required .... –Head Down Re-attack: - XY insert in PETL
   –Head Up Re-attack: - Press Re-attack switch (Throttle top)

After firing:

9. Late Arm .... Safe (HUD: ”LATE ARM SAFE”)
10. Number of AMRAAMs available .. Check (either HUD, or MHDD/PA, or MHDD/AF, or MHDD/SF)
11. AMRAAM .... Deselect (NO WPN, other WPN, or Visident)

SELECTIVE JETTISON PACKAGE

The package should be normally available within the single mission data loaded via MDLR/PDS but the pilot can change it on ground or in flight by moving the cursor of the X-Y controller on one of the weapons/stores displayed on MHDD/STOR format and de-selecting it by pressing the X-Y controller. The ENT option will appear to indicate the package editing function has been entered. The weapons/stores to be included in the new package can be selected by moving the cursor on each of them and pressing the X-Y controller. So doing, the chosen store is surrounded with a cyan rectangle. In order to allow the SCAC to check the validity of the new package it is necessary to position the cursor over ENT and to press the X-Y controller. Every weapon/store selected, if accepted, turns cyan infilled. The ENT and SEL JETT NOT ACCEPTED messages disappear from MHDD/STOR format if all requirements are fulfilled.

SJ PACKAGE AVAILABLE

1. MHDD/STOR .... Check each selected store is cyan infilled

MODIFICATION OF AN AVAILABLE SJ PACKAGE

1. X-Y controller .... Move over any store to be selected or deselected. Press and verify they are cyan boxed.
2. MHDD/STOR .... Check ENT displayed

NOTE

- Repeat step 1 for each store to be selected.
- When deselected, the stores present in the available SJ package appear cyan infilled and boxed.

3. X-Y controller .... When modification of SJ package

completed, move to ENT and press

4. MHDD/STOR ....Check that selected stores are cyan infilled, SEL JETT NOT ACCEPTED And ENT occulted

SELECTION OF A NEW SJ PACKAGE

1. MHDD/STOR ....SEL JETT NOT ACCEPTED blinking
2. X-Y controller ....Move over any store to be selected. Press and verify it turns cyan boxed
3. MHDD/STOR ....Check ENT displayed

NOTE

- Repeat step 2 for each store to be selected.
- To deselect an erroneously selected store, move X-Y controller over store (cyan boxed), press and verify cyan box disappears.

4. X-Y controller ....When SJ package completed, move to ENT and press.
5. MHDD/STOR ....Check selected stores are cyan infilled, SEL JETT NOT ACCEPTED and ENT occulted

FUEL BALANCE/DIFFERENCE MONITORING

FCS 2B2 Fuel Asymmetry Limits, Clean Aircraft

STAGE	BALANCE KG (HUP)		DIFFERENCE KG (MHDD)	
	FRONT	REAR	FWD	AFT
1	310	190	140	100
2	310	190	140	80
Main Group	310	190	140	80

FCS 2B2 Fuel Asymmetry Limits, Underwing Tanks

STAGE	BALANCE KG (HUP)		DIFFERENCE KG (MHDD)	
	FRONT	REAR	FWD	AFT
UDWG	310	190	350	80
1	310	190	350	180
2	310	190	170	100
Main Group	310	190	210	260

NOTE

- The definition of fuel difference is the difference between the contents of the forward transfer tank and the combined total of the aft wing tanks.
- The definition of fuel balance is the difference in contents between the front and rear main fuel groups.

With fuel asymmetry within the above limits:

- The aircraft can be maneuvered within the CG Zone 1 Limits, provided the fuel asymmetry remains within the above limits when checked at 60 second intervals.

With fuel asymmetry outside or likely to exceed the above limits:

- CG Zone 2 Limits apply.

PERFORMANCE DATA CHART

RECOVERY (TWO ENGINES AND SINGLE ENGINE)

Recovery From Sea Level - 2 Engines, ISA

FUEL REMAINING (KG)	DRAG INDEX	TOTAL DISTANCE (NM)	OPTIMUM ALTITUDE (FT)	MACH NO	DESCENT TO 1000 FT (NM) FROM DESTINATION	FUEL USED (KG)	SEA LEVEL DIVERSION	
							FUEL (KG)	MACH
3600	15	50	16 000	0.64	30	321	373	0.48
		100	29 000	0.80	63	552	744	0.48
		150	32 000	0.82	73	747	1111	0.47
		200	32 000	0.82	73	933	1477	0.47
		250	32 000	0.82	73	1118	1836	0.46
		300	32 000	0.82	73	1302	2195	0.46
1600	15	50	18 000	0.62	34	306	362	0.46
		100	30 000	0.77	67	520	715	0.45
		150	32 000	0.80	74	698	1069	0.45
		200	32 000	0.79	74	873	1420	0.44
		250	32 000	0.79	74	1047	1768*	0.44
		300	32 000	0.78	74	1220	2114*	0.43
5600	60	50	17 000	0.65	28	365	426	0.48
		100	25 000	0.71	45	636	850	0.48
		150	31 000	0.80	59	873	1270	0.47
		200	32 000	0.80	62	1104	1687	0.47
		250	32 000	0.80	62	1330	2096	0.46
		300	32 000	0.80	62	1554	2506	0.46
3600	60	50	18 000	0.63	30	347	413	0.46
		100	26 000	0.70	47	596	818	0.46
		150	31 000	0.74	60	817	1222	0.45
		200	32 000	0.75	63	1029	1623	0.45
		250	32 000	0.75	63	1238	2021	0.44
		300	32 000	0.74	63	1445	2415	0.44

(Continued)

Recovery From Sea Level - 2 Engines, ISA (Continued)

FUEL REMAINING (KG)	DRAG INDEX	TOTAL DISTANCE (NM)	OPTIMUM ALTITUDE (FT)	MACH NO	DESCENT TO 1000 FT (NM) FROM DESTINATION	FUEL USED (KG)	SEA LEVEL DIVERSION	
							FUEL (KG)	MACH
1600	60	50	18 000	0.60	29	329	396	0.44
		100	28 000	0.70	51	557	787	0.43
		150	32 000	0.75	62	758	1176	0.43
		200	32 000	0.74	62	952	1561	0.42
		250	32 000	0.74	62	1145	1943*	0.42
		300	32 000	0.73	62	1336	2323*	0.41

* This distance cannot be covered under these conditions, this value of fuel used is for interpolation only.

NOTE

- Climb speed 350 KDAS/0.85 Mach
- Fuel used values do not include a landing allowance
- Descend at 250 KDAS, IDLE power, airbrake in (range descent).

Range and Endurance - 2 Engines

FUEL REMAINING (KG)	DRAG INDEX	ALTITUDE (FT)	MAXIMUM RANGE			MAXIMUM ENDURANCE	
			MACH	KG/MIN	NM/100 KG	MACH	KG/MIN
3600	15	0	0.49	40.3	13.4	0.34	33.1
		10 000	0.58	36.8	16.7	0.41	30.4
		20 000	0.69	33.9	20.8	0.50	28.5
		30 000	0.81	31.2	25.5	0.61	27.0
		40 000	0.85	29.9	27.2	0.74	28.7
1600	15	0	0.46	36.4	13.9	0.32	30.0
		10 000	0.54	32.9	17.4	0.38	27.4
		20 000	0.65	30.5	21.8	0.46	25.6
		30 000	0.78	28.3	27.1	0.58	24.0
		40 000	0.85	26.5	30.7	0.70	24.2

(Continued)

Range and Endurance - 2 Engines (Continued)

FUEL REMAINING (KG)	DRAG INDEX	ALTITUDE (FT)	MAXIMUM RANGE			MAXIMUM ENDURANCE	
			MACH	KG/MIN	NM/100 KG	MACH	KG/MIN
5600	60	0	0.49	46.1	11.7	0.34	38.3
		10 000	0.59	43.1	14.6	0.41	35.5
		20 000	0.70	39.9	18.0	0.50	33.5
		30 000	0.79	37.3	20.8	0.64	33.1
		40 000	0.85	37.3	21.8	0.77	35.7
3600	60	0	0.47	42.6	12.2	0.32	35.0
		10 000	0.55	38.6	15.1	0.39	32.3
		20 000	0.66	36.0	18.8	0.48	30.3
		30 000	0.73	31.8	22.6	0.60	29.1
		40 000	0.85	33.3	24.4	0.72	30.9
1600	60	0	0.44	38.4	12.6	0.30	31.7
		10 000	0.52	35.0	15.8	0.36	29.0
		20 000	0.62	32.2	19.7	0.44	27.2
		30 000	0.73	29.4	24.4	0.56	25.6
		40 000	0.81	28.4	27.2	0.70	26.2

Recovery Form Sea Level - Single Engine

FUEL REMAINING (KG)	DRAG INDEX	TOTAL DISTANCE (NM)	OPTIMUM ALTITUDE (FT)	MACH NO	DESCENT TO 1000 FT (NM) FROM DESTINATION	FUEL USED (KG)	SEA LEVEL DIVERSION	
							FUEL (KG)	MACH
3600	15	20	4000	0.48	5	128	133	0.47
		40	11000	0.54	17	245	264	0.47
		60	16000	0.60	26	351	389	0.47
		80	21000	0.68	36	449	518	0.47
		100	22000	0.69	38	541	646	0.47
		120	23000	0.70	40	631	744	0.46
		140	27000	0.76	48	719	901	0.46
		160	27000	0.76	48	802	1028	0.46

(Continued)

Recovery Form Sea Level - Single Engine (Continued)

FUEL REMAINING (KG)	DRAG INDEX	TOTAL DISTANCE (NM)	OPTIMUM ALTITUDE (FT)	MACH NO	DESCENT TO 1000 FT (NM) FROM DESTINATION	FUEL USED (KG)	SEA LEVEL DIVERSION	
							FUEL (KG)	MACH
1600	15	20	5000	0.48	7	120	127	0.45
		40	7000	0.49	10	230	248	0.44
		60	16000	0.56	26	330	371	0.44
		80	20000	0.60	33	421	494	0.44
		100	24000	0.67	41	506	616	0.44
		120	25000	0.69	43	587	738	0.44
		140	26000	0.70	45	667	859	0.43
		160	27000	0.70	47	746	980	0.43
5600	60	20	5000	0.49	6	153	159	0.45
		40	9000	0.53	13	294	317	0.45
		60	14000	0.58	21	426	469	0.45
		80	17000	0.62	26	550	623	0.44
		100	19000	0.65	29	669	777	0.44
		120	20000	0.66	31	784	930	0.44
		140	21000	0.68	32	896	1082	0.44
		160	21000	0.68	32	1007	1233	0.44
3600	60	20	5000	0.46	6	147	148	0.42
		40	10000	0.50	14	280	294	0.42
		60	15000	0.56	22	403	440	0.42
		80	17000	0.58	25	518	584	0.42
		100	20000	0.62	30	629	728	0.42
		120	20000	0.62	30	735	871	0.42
		140	22000	0.65	34	840	1013	0.42
		160	22000	0.65	34	942	1155	0.42

(Continued)

Recovery Form Sea Level - Single Engine (Continued)

FUEL REMAINING (KG)	DRAG INDEX	TOTAL DISTANCE (NM)	OPTIMUM ALTITUDE (FT)	MACH NO	DESCENT TO 1000 FT (NM) FROM DESTINATION	FUEL USED (KG)	SEA LEVEL DIVERSION	
							FUEL (KG)	MACH
1600	60	20	3000	0.43	3	139	139	0.43
		40	9000	0.46	12	564	277	0.42
		60	14000	0.51	19	379	414	0.42
		80	16000	0.53	23	486	550	0.42
		100	16000	0.52	22	589	686	0.42
		120	21000	0.59	31	687	822	0.42
		140	23000	0.61	34	784	957	0.41
		160	23000	0.61	34	878	1091	0.41

NOTE

- Climb speed 350 KDAS/MAX DRY.
- Fuel used values do not include a landing allowance
- Descend at 250 KDAS, IDLE power, airbrake in (range descent)
- Applicable to a windmilling or seized engine.

Range and Endurance - Single Engine

FUEL REMAINING (KG)	DRAG INDEX	ALTITUDE (FT)	MAXIMUM RANGE			MAXIMUM ENDURANCE	
			MACH	KG/MIN	NM/100 KG	MACH	KG/MIN
3600	15	0	0.46	32.9	15.4	0.34	28.5
		5000	0.49	31.7	16.8	0.38	27.7
		10 000	0.53	31.2	18.1	0.42	27.5
		15 000	0.59	31.5	19.5	0.46	27.6
		20 000	0.67	32.6	21.1	0.51	27.8
		25 000	0.73	32.1	22.8	0.57	28.2

(Continued)

Range and Endurance - Single Engine (Continued)

FUEL REMAINING (KG)	DRAG INDEX	ALTITUDE (FT)	MAXIMUM RANGE			MAXIMUM ENDURANCE	
			MACH	KG/MIN	NM/100 KG	MACH	KG/MIN
1600	15	0	0.45	30.7	16.2	0.32	25.5
		5000	0.48	29.0	17.9	0.35	24.7
		10 000	0.50	27.3	19.5	0.39	24.0
		15 000	0.55	27.3	21.0	0.43	23.9
		20 000	0.61	27.6	22.7	0.48	24.1
		25 000	0.70	28.6	24.5	0.53	24.4
5600	60	0	0.45	38.9	12.8	0.35	34.2
		5000	0.49	38.4	13.8	0.38	34.1
		10 000	0.54	38.6	14.9	0.42	34.0
		15 000	0.60	38.9	16.1	0.47	34.1
		20 000	0.68	40.0	17.4	0.52	34.4
		25 000	0.72	38.5	18.8	0.57	34.8
3600	60	0	0.43	34.8	13.6	0.33	30.5
		5000	0.47	34.5	14.7	0.36	30.0
		10 000	0.51	34.1	15.9	0.40	30.0
		15 000	0.57	34.7	17.2	0.44	30.1
		20 000	0.63	34.8	18.5	0.49	30.3
		25 000	0.70	34.9	20.1	0.54	30.7
1600	60	0	0.43	32.7	14.5	0.30	27.2
		5000	0.43	29.3	15.9	0.33	26.4
		10 000	0.48	29.8	17.1	0.37	26.0
		15 000	0.52	29.3	18.5	0.41	26.1
		20 000	0.59	30.3	19.9	0.45	26.3
		25 000	0.67	31.2	21.6	0.50	26.6

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SECTION 3 - EMERGENCY PROCEDURES

Table of Contents **Page**

NOTE

At the time of printing, the contents of this Section are aligned with the Flight Crew Checklist. However, later developments may cause the Checklist to be further updated. In the event of any contrast with the Checklist, the Checklist takes precedence. This Section will subsequently be updated at the earliest opportunity to agree with the Checklist.

INTRODUCTION

EMERGENCY PROCEDURES ADVICE

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 OVERTURN OF THE AIRCRAFT IS OUTWEIGHED BY THE PROTECTION GIVEN TO THE PILOT BY THE CANOPY.

– ALL SMELLS NOT IDENTIFIED BY THE PILOT SHALL BE CONSIDERED TOXIC. INSURE THAT THERE IS A GOOD MASK SEAL AND THAT THE AOB IS SELECTED (MSOC DESELECTED). PROPERLY VENT THE AIRCRAFT AND LAND AS SOON AS PRACTICABLE. DO NOT TAKE-OFF WHEN UNIDENTIFIED SMELLS ARE DETECTED.

NOTE

Where differences exist between the FM and the FCC, the FCC procedures are to take precedence.

This section contains procedures to be followed to correct an emergency condition. The procedures are commonly agreed by EF EPC System Engineers and EF JFO. These procedures will insure maximum safety for the pilot and/or aircraft until a safe landing or other appropriate action is accomplished. The most important consideration in all emergencies must be to continue flying the aircraft safely. Thereafter, all emergencies are to be dealt with as follows:

a. Identify the emergency
b. Carry out the Boldface procedure
c. Carry out the subsequent procedure

All the emergency procedures in the Flight Crew Checklist (FCC) are laid out in this manner, that is, indications followed by boldface action (if required), followed by subsequent actions.

The procedures are arranged in the most desirable sequence for the majority of cases; therefore, the steps should be performed in the listed sequence, unless the pilot can determine a good cause for deviation. Multiple failures, adverse weather, and other abnormal conditions may require modification of these procedures.

The nature and severity of the encountered emergency will dictate the necessity for complying with the critical items in their entirety. It is therefore essential, that aircrew determine the correct course of action by using common sense and sound judgement. Telemetry advice, where available, may also enable a more comprehensive failure analysis to be carried out, to determine the correct course of actions.

WARNING TYPES

Two main types of warning exist:

a. System failure warnings:

– Catastrophic warning (CAT C)
– Primary failures requiring immediate action (CAT 2)
– Primary failures requiring attention (CAT 3)

b. Procedural/advice warnings:

– Procedural warnings (CAT 1)
– Procedural advice (CAT 4)

IDENTIFYING AN EMERGENCY

It is essential that the emergency is correctly identified using the visual and audio warnings available. The visual warnings are presented via the attention getters and the dedicated warning panel (DWP) with the audio warnings being presented using attention getting sounds (attensons), voice warning messages and tones. The DWP is a reconfigurable, dot matrix display capable of presenting 27 captions simultaneously. For information on the DWP captions and voice warning messages, refer to Data Module Visual Audio Warnings.

NOTE

In order to ensure that all warnings are displayed to the pilot the attention getters should be cancelled on warning generation and all warning pages viewed on the DWP.

In addition, there are numerous supplementary warnings. Care must be taken to differentiate between similar malfunctions with common captions.

WARNING CATEGORIES

For information on the Warning categories and actions required, refer to Data Module Warnings Management and Failure Analysis.

WARNINGS PRESENTATION MEDIA

The main presentation and control of warnings information will utilize the following media:

a. Visual Attention Getters
b. Attenson
c. Voice
d. Dedicated Warning Panel (DWP)
e. MHDD Procedures and Consequences Format (from SP 3 onwards)

WARNINGS PRESENTATION WITHIN SECTION 3

To help the pilot easily identify the correct procedure to follow in an emergency, this section and the FCC do not show the visual warnings as they are presented on the DWP. Instead, a box is presented containing black text. This black text matches the text presented on the DWP. In section 3, the category of the warning is defined by either shading the interior of the box or by leaving the interior clear. Shading is used to indicate a category 2 warning with a clear interior indicating a category 3 warning. In the FCC, color infill is used instead of shading; red infill indicating a category 2 warning and yellow infill indicating a category 3 warning.

Presented below are sample category 2 and category 3 warnings for the DWP as they are presented in this section.

ELEC2	DWP Category 2 warning
L UTIL P	DWP Category 2 warning
A BRAKE	DWP Category 3 warning

A color example of the actual DWP and DAWG panel display is presented in Data Module Electronic Display Formats.

BOLDFACE PROCEDURES

Bold face procedures are actions which must be carried out immediately following a positive identification of the problem while continuing to fly the aircraft safely. The pilot should be able to carry out these actions without reference to the checklist.

SUBSEQUENT PROCEDURES

These are procedures which are not required to be carried out immediately. After completion of boldface procedures, it is recommended that the diagnosis of the malfunction is confirmed by reference to the indications given in the FCC before carrying out the subsequent actions.

LAND ASAP AND LAND AS SOON AS PRACTICABLE

The FCC instruction ‘Land ASAP’ (Land As Soon As Possible) and ‘Land as soon as practicable’ do not have to be treated as mandatory instructions but as a guide to the urgency of the situation. The degree of urgency to land the aircraft depends on the nature of the failure and the prevailing conditions. The terms are defined as follows:

LAND ASAP

Land As Soon As Possible is defined as a landing which should be accomplished at the nearest suitable airfield, considering the severity of the emergency, weather conditions, field facilities, ambient lighting and aircraft gross weight.

LAND AS SOON AS PRACTICABLE

Emergency conditions are less urgent, and although the mission should be terminated, the degree of the emergency is such that an immediate landing at the nearest airfield may not be necessary.

ABANDONING

EMERGENCY GROUND EGRESS

The pilot must decide whether to abandon the aircraft through manual egress or ejection. The decision will depend upon the type and severity of the emergency situation and the condition/position of the canopy.

If necessary:

NOTE

Rear seat occupant should confirm whether the pilot intends to eject (DA4/6 only).

1. Eject

Otherwise

1. **Seat Safety Lever .....EGRESS**
2. **Throttles....................HP SHUT**
3. Unstrap

WARNING

IF NORMAL CANOPY OPENING NOT ASSURED, USE JETTISON.

CAUTION

MAKE SURE THAT THE ARM RESTRAINT LUGS ARE CLEAR OF THE QRF BEFORE ATTEMPTING TO VACATE THE SEAT.

4. Canopy.......................Open (normal, jettison)

EJECTION

The escape system is cleared from zero to 600 KCAS or Mach 2 whichever is lower.

EJECTION ATTITUDE

The seat is cleared from ground level at zero speed and throughout the flight envelope. The minimum ejection terrain clearances required in various flight conditions are shown in graph form in .

In flight, the optimum speed for ejection is 180 to 230 KDAS. Where possible, to avoid excessive loading on the parachute and seat occupant, reduce the aircraft speed to within the optimum range before ejecting, converting excess speed to height by executing a zoom maneuver. Do not delay ejection if the aircraft is in a descent from which it cannot be recovered.

If recovery from a spin has not been achieved by 5000 ft (1525 m) AGL, eject. If the aircraft is out of control at high IAS, eject above 8000 ft (2440 m) if possible.

Before initiating ejection, alert the other crew member if time permits in twin seat aircraft, lower the visor, sit erect, close eyes tightly, and carry out the following:

– Grasp the seat firing handle, with both hands when possible, stretch the legs out forward of the seat, keep the back as straight as possible and the head hard back against the headpad.
– Pull the handle smartly upwards to its full extent and hold the handle until the harness release mechanism functions.
– If the seat fails to eject, immediately pull the firing handle again. If the handle will not move, make sure that the safety pin has been removed and that the SAFE/ARMED handle is set to the ARMED position before making any further attempts.

ABANDONING IN FLIGHT

To eject normally, complete as much of the Abandoning drills in the flight reference cards as time and conditions permit. At low altitude, the aircraft should be in substantially level flight to provide optimum ejection conditions. If the aircraft is descending, has an excessive bank angle, pitch attitude or rate of descent, additional terrain clearance must be allowed. Where circumstances permit, a zoom maneuver will facilitate escape.

WARNING

IF MAKING A PARACHUTE DESCENT INTO WATER, LOWER THE PSP BEFORE SPLASHDOWN.

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

EJECTION AT LOW LEVEL

Successful ejection at low level requires observance of the limitations on dive angle, bank angle, air speed and terrain clearances given in. The minimum ejection terrain clearances stated are the minimum heights required above ground level, assuming the surface to be level and unobstructed.

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

The graphs in the above data module show the ejection seat performance capability from ejection gun initiation, (no allowance for aircrew reaction time or seat time delays has been made). The data are presented in indicated air speed (IAS) and actual (not barometric) height and are applicable to steady-state unaccelerated flight conditions.

The data applies to ISA sea level atmospheric conditions. Altitude effects on seat performance require that a given terrain clearance must be increased by 2% for every 1000 ft above sea level.

As stated in, each ejection seat follows a slight lateral divergent path after ejection. This has an effect on the maximum bank angle which can be tolerated for a given minimum safe terrain clearance.

1. **Ejection handle .... Pull**

If time and conditions permit:

2. Alert other crew member
3. Ideal conditions .... S+L/180 to 230 KDAS/ 9000 ft
4. Heading .... Towards unpopulated area
5. XPDR .... EMGY
6. Harness .... Tight and locked
7. Oxygen mask .... Tight
8. Visor .... Down
9. Radio .... Call
10. Throttles .... IDLE
11. Ejection position .... Assume
12. Ejection handle .... Pull

TAKEOFF

ABORT

The situation and conditions will dictate the required pilot actions to successfully accomplish an abort. The basic abort procedure caters for all abort situations, e.g. all types of system failures which may lead to an abort and the more critical failure, namely the engine failure case.

The decision to abort or to continue takeoff at the time of failure will mainly depend on speed, aircraft mass, remaining runway length and condition, weather and arresting cable availability.

Most operations are performed from an established base with at least a standard NATO runway and a known standard cable available. Take off data for operations from shorter runways, especially at higher weights and temperatures must be carefully considered with reference to the performance data set.

WARNING

- UNLESS THE EMERGENCY DICTATES, DO NOT APPLY BRAKES ABOVE THE MAXIMUM BRAKE-ON SPEED (MBS) AS DEFINED IN THE MAXIMUM BRAKE-ON SPEED CHART.
- DO NOT APPLY BRAKES WITH THE NOSEWHEEL OFF THE GROUND.

Full brake pedal deflections including stepped pedal inputs may be used to achieve maximum braking which will decelerate the aircraft sufficiently to be in the envelope of the relevant cable.

Maximum deployment speed for the brake chute is 175 KDAS.

Lift Dump will be automatically activated following both throttles at IDLE position and NW contact onto the ground.

If aborting, select both throttles to idle, deploy the brake chute, apply full forward stick following all wheels on the ground, until wheel braking is initiated (below MBS). After positive brake application aft stick may be applied to assist braking action, otherwise return the stick to neutral.

1. **Throttles....................IDLE**
2. **Brake chute...............Deploy**
3. **HOOK ....As required**

BRAKING

For Maximum Brake-On Speeds (MBS) refer to PDM, Part 2 - Takeoff.

For an abort outside the given clearance, deceleration to full stop is only possible with chute deployment prior wheel braking and/or arrestor cable engagement. Once the brake energy has been absorbed, loss of brake capability together with possible asymmetric control behavior has to be expected.

Pedal application to full deflection is possible. At speeds less than 9 kts smooth pedal inputs shall be applied (anti-skid drop-out speed).

CABLE AVAILABLE/ENGAGEMENT ANTICIPATED

The arrestor hook engagement speed for an abort is dependent on the airfield used barrier type. For more information on arrestor hook engagements, refer to PDM, Part 2 - Takeoff.

To ensure successful cable engagement the hook must be released not later than 3 sec. or 200 m prior to arresting. 1 000 ft in front of the cable (runway foot marker) should be used as a guideline.

The brakes must be released 2-3 seconds prior arresting, to ensure that the aircraft is in an un-braked steady condition. Engines at idle.

Cable engagement is cleared with NWS engaged or disengaged.

When the aircraft has stopped, it may be pulled back. To prevent any possible tip-over, brakes should not be used to counteract the roll-back or to correct slight deviation during roll-back. Instead, engine thrust should be increased to counteract the pullback.

NO CABLE AVAILABLE/ENGAGEMENT NOT ANTICIPATED

When a cable is not available or if aborting at an early stage during the take-off roll, retard both throttles to IDLE, deploy the brake chute (if fitted), apply full forward stick until brakes are applied below MBS. If aborting at a late stage, i.e. during rotation, it is recommended to assist the de-rotation by applying half forward stick. For all cases where no cable is available at the departure-end, maximum braking can be applied earliest when the aircraft has decelerated to the recommended MBS which can be obtained from the MBS chart. Refer to PDM, Part 2 - Takeoff.

FCS FAILURES DURING TAKEOFF

Prior rotation the takeoff should be aborted whenever practicable.

If decision to stop is made, apply the ABORT drill.

When airborne establish a nominal 1g level flight and stay within the failure specific FCS envelope for the remainder of the flight.

Following any FCS Failure Condition:

Prior rotation:

WARNING

PRIOR TO TAKEOFF, WHERE THE FCS IS IN A KNOWN FAILURE STATE TAKEOFF IS PROHIBITED.

1. Abort

When airborne:

2. Recover .... Nominal 1g level flight
3. Land........................... Refer to relevant FCS/ Airdata Limits/Failures FCS/Airdata Failures pag. 45

TIRE FAILURE DURING TAKEOFF

If not aborting:

1. **Landing gear .... Do not retract**
2. Land........................... As soon as practicable, refer to Landing with a Known Blown Tire pag. 69

In case of a tire failure ABORT whenever possible. If takeoff is continued do not retract the landing gear to avoid damage to the gear and/or to the gear doors.

If aborting with a main blown tire directional control may be difficult. Therefore it is important to hold the NWS on the ground.

ENGINE FAILURE DURING TAKE OFF

If an engine failure occurs before reaching the minimum go speed, the take-off must be aborted, because the thrust available is insufficient to accelerate the aircraft to take-off speed within the remaining runway.

If an engine failure occurs beyond minimum go speed and before refusal speed, the take-off can either be aborted or continued.

However, once refusal speed is reached, takeoff must be continued since the aircraft cannot be stopped either within the remaining length of the runway, or the remaining runway distance to cable, considering the maximum engagement speed for the cable.

If take-off is continued with partial or total loss of one engine, rotation rate and speed must be the same as with two engines in order to meet the performance data requirements.

Once rotation has commenced, the rotation rate must be maintained until lift-off occurs, but must not exceed 13° to 15°AOA, depending on type of takeoff.

When safely airborne, consider, if possible, landing gear retraction, as single engine climb performance is improved as soon as the landing gear is in transit.

There after, the AOA must be progressively decreased and the aircraft accelerated in a shallow climb.

If required consider external stores jettison.

NOTE

Following external stores jettison, the aircraft will automatically reconfigure. However, if required, the aircraft may be manually reconfigured by pressing the relevant CONFIG selector/indicator.

Select the throttle of the affected engine to HP SHUT and land ASAP.

If decision to stop is made:

1. ABORT

When aircraft stopped:

2. Throttle affected engine .... HP SHUT
3. LP COCK affected engine .... SHUT

If take off is continued:

1. **Throttles .... MAX RHT**

When airborne:

2. Landing gear .... UP, if jettison required
3. External stores .... Jettison, if required
4. Throttle affected engine .... HP SHUT
5. LP COCK affected engine .... SHUT
6. Land........................... ASAP, refer to Single Engine Operations pag. 62

ENGINE REHEAT FAILURE DURING TAKE OFF

L RHEAT or R RHEAT

When a reheat failure occurs the appropriate warning is given on the DWP and MHDD, accompanied by the "Left Reheat" or "Right Reheat" voice warning.

If an engine reheat failure occurs during this phase, the take-off may be either aborted or continued.

If take-off is continued with partial or total loss of one engine, rotation rate and speed must be the same as with two engines in order to meet the performance data requirements.

Once rotation has commenced, the rotation rate must be maintained until lift-off occurs, but must not exceed 13° to 15° AOA, depending on type of takeoff.

During take-off, if required, consider external stores jettison.

NOTE

Following external stores jettison, the aircraft will automatically reconfigure. However, if required, the aircraft may be manually reconfigurated by pressing the relevant CONFIG selector/indicator.

When safely airborne retard the throttle of the affected engine into the dry range; reselection of reheat is not permitted. (For MK101E reheat reselection is permitted).

If decision to stop is made:

1. ABORT

If take off is continued:

1. Throttles...................MAX RHT

When airborne:

2. Landing gear ....UP, if jettison required
3. External stores ....Jettison, if required
4. Throttle affected engine ....DRY range, handle with care

NOTE

- Reheat re-selection is not permitted
- Reheat re-selection is permitted for MK101E only

FIRES

APU/ENGINE FIRE ON GROUND

APU FIRE or CANOPY HORN AUDIO WARNING

with or without

L FIRE or R FIRE

F Button lit

APU FIRE

The APUCU shuts down the APU as soon as a fire or overheat condition (above 260° C) is detected by the APU fire detector.
Provided external power supply is available the fire condition is indicated by the APU FIRE warning on the DWP, flashing attention getters and is accompanied by the voice warning "APU FIRE".
During APU start up the DWP is deactivated; therefore, an APU bay fire warning is provided by the canopy horn audio warning.
The warning is modulated to prevent it from being confused with the normal canopy close warning.

ENGINE FIRE ON GROUND

When a fire is detected in the L/R engine bay, the appropriate warnings are given on MHDD, on DWP and the relevant F button indicator illuminate.
The attention getters flash and the "L/R Engine Fire" voice warning is provided.
If a fire occurs in the rear fuselage, damage to the wiring looms can cause the following sustained or intermittent indications:

- TBT, NL, NH;
- Nozzle (Aj);
- Engine control warnings (L/R DECU) on DWP and MHDD;
- All engine related warnings.

Shut down the engines and close the L/R LP COCKs, then operate the affected engine bay F button.

NOTE

The F buttons provide one shot attempt, and completely discharge the fire extinguishing agent into the selected bay.

1. **APU ....STOP, if running**
2. **L & R Throttles ....HP SHUT**
3. **L & R LP COCKs ......SHUT**
4. **F button ....Press**
5. BATT.........................OFF
6. Emergency ground egress

ENGINE FIRE DURING TAKE-OFF

L FIRE or R FIRE

F Button lit
When a fire is detected in the L/R engine bay, the appropriate warnings is given on the MHDD/DWP. The F button indicator illuminates, the attention getters flash and a voice warning "L/R Engine Fire" is given.
If decision to stop takeoff is made, abort. Otherwise, if refusal speed has been reached the take-off must be continued utilizing the maximum thrust available.
If the fire results in a partial or total loss of thrust in one of the engines, apply the Engine Failure During Take-Off procedure. Consider stores jettison.
When safely airborne with a positive rate of climb, retract the landing gear in order to improve single engine climb performance.
Investigate and apply the appropriate procedure for the affected engine; set the throttle to HP SHUT, LP COCK to SHUT and then press the relevant F button.
Check for further indication of fire and, if confirmed, eject. If fire is not confirmed, land ASAP.
When the fire extinguisher bottle has been discharged and the warning light goes off, it can be assumed that the fire is extinguished.

NOTE

The F buttons provide one shot attempt, and completely discharges the fire extinguishing agent into the selected bay.

When the affected engine is sub-idling (NH<65%) make sure that the hydraulic systems pressure is 280 BAR (R MHDD, HYD Format).
If a fire occurs in the rear fuselage, damage to the wiring looms can provide the following sustained or intermittent indications:

- TBT, NL, NH;
- Nozzle (Aj);
- Engine control warnings (L/R DECU on DWP and MHDD);
- All engine related warnings.

If decision to stop is made:

1. ABORT

When stopped:

2. Throttle affected engine........................HP SHUT
3. LP COCK affected engine........................SHUT
4. F button.....................Press

If takeoff is continued:

1. Throttles....................MAX RHT

When airborne:

2. Throttle affected engine........................HP SHUT
3. LP COCK affected engine........................SHUT
4. F button.....................Press

If fire is confirmed:

Check for further indications of fire.

5. EJECT........................

If fire is not confirmed:

5. Land ....ASAP, refer to Single Engine Emergencies

ENGINE FIRE IN FLIGHT

L FIRE or **R FIRE**

F Button lit

When a fire is detected in the L/R engine bay, the appropriate warning is given on the MHDD/DWP. The F button indicator illuminates, the attention getters flash and a voice warning "L/R Engine Fire" is given.

Immediately shut down the affected engine and operate the related F button.

Check for further indications of fire and if confirmed, eject. If fire is not confirmed, land ASAP.

When the fire extinguisher bottle has been discharged and the warning light goes off, it can be assumed that the fire is extinguished.

If a fire occurs in the rear fuselage, damage to the wiring looms can provide the following sustained or intermittent indications:

– TBT, NL, NH;
– Nozzle (Aj);
– Engine control warnings (L/R DECU on MHDD and DWP);
– All engine related warnings.

NOTE

Cross bleed operation may be checked by the appearance of the L/R X BLEED IN PROG indication on the MHDD PA format.

1. Throttle affected engine....................... HP SHUT
2. LP COCK affected engine....................... SHUT

NOTE

The F buttons provide one shot attempt, and completely discharges the fire extinguishing agent into the selected bay.

3. F button.................... Press

4. Throttle good engine.. NOT BELOW 70%NL

If fire is confirmed:*

Check for further indications of fire.

5. EJECT

If fire is not confirmed:

5. Land .... ASAP, refer to Single Engine Emergencies

FLAMEOUT/RELIGHTING

DOUBLE ENGINE FLAME OUT

L FLAME R FLAME

L OIL P R OIL P

AC

ESS DC

L CONT P R CONT P

HYD TOT

REV ENV

DEFO will be indicated by an uncommanded reduction of NL (HUP).

The L FLAME and R FLAME will not be activated for 5 sec due to a DECU delay function, as neither will function after loss of AC.

Following loss of AC, the HUP will revert to DUSK luminance setting. Time permitting, this can be overridden by selecting the cockpit Lighting Control knob to REV LIGHTS-DAY / DUSK / NIGHT as required.

If HYD TOT *lit or critical aircraft operation occurs:*

1. EJECT

If HYD TOT not lit:

1. **Speed........................Rapidly obtain 0.9 M / 450 KDAS**
2. **Controls....................Minimize / gentle movements**
3. **Either Throttle...........HP SHUT, then reselect MAX DRY**
4. **Other throttle............HP SHUT, then reselect MAX DRY**
5. **Height........................Reduce to below 28 000 ft**

NOTE

- Best relight envelope is above 0.83 M, altitude below 28 000 ft.
- Relight may take up to 60 seconds.

6. Land...........................ASAP, refer to CG2 FCS/Airdata Failures pag. 45

SINGLE ENGINE FLAME OUT

WINDMILL RELIGHT

L FLAME or R FLAME

L OIL P or R OIL P

ECS if not flying within the compatibility area

The assisted relight and the windmill relight are provided to restart a failed or shut down engine.

CAUTION

A RELIGHT MUST NOT BE ATTEMPTED IF ANY ENGINE MECHANICAL FAILURE HAS OCCURRED.

The windmill relight is the normal engine relight procedure in flight when automatic restart fails. The automatic restart initiates under DECU controls. Windmill relight should be initiated whenever the minimum required NH and altitude can be reached.

The assisted relight constitutes the method of starting an engine in flight when the windmill relight is unsuccessful or if flying under low altitude and low airspeed conditions so that windmill relight is not practicable.

Following a flameout, the air drive cross bleed is automatically initiated assuring that both gearboxes remain serviceable.

If automatic restart fails, select the throttle of the affected engine to HP SHUT then to dry range. Windmilling is the normal engine relight procedure, see Figure 3.1, Figure 3.2 and Figure 3.3 windmilling relight envelope.

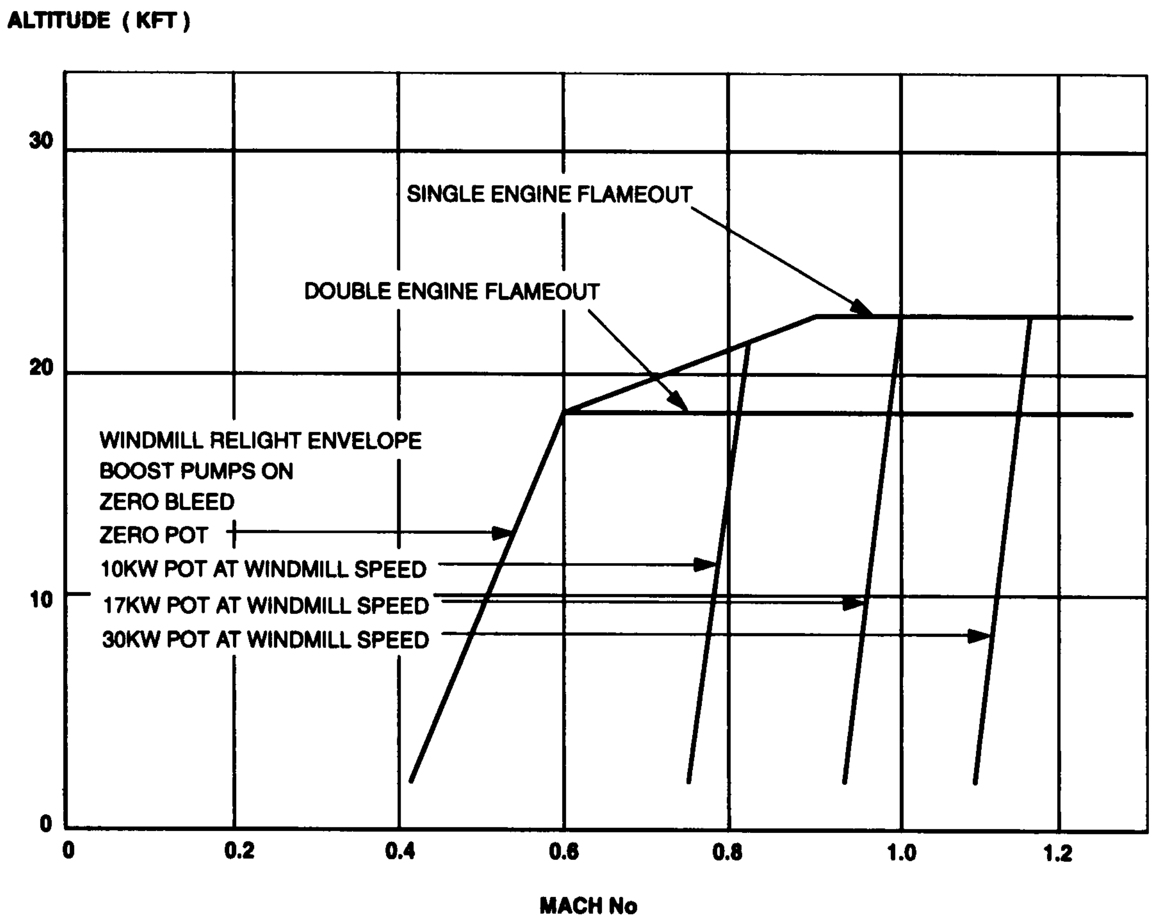


Figure 3.1 - Windmill Relight Envelope (01A, 01C, 03A Engines)

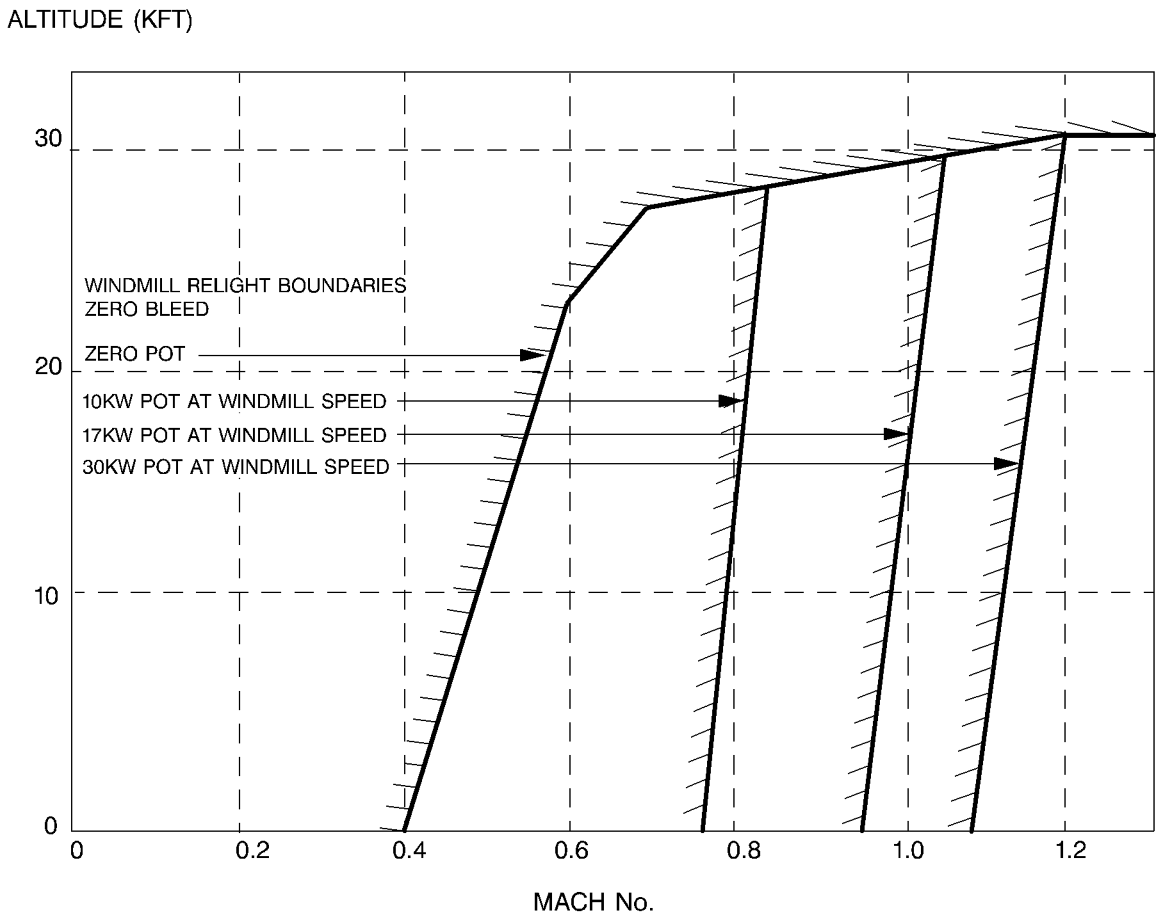


Figure 3.2 - Windmill Relight Envelope (03B, 03Z Engines)

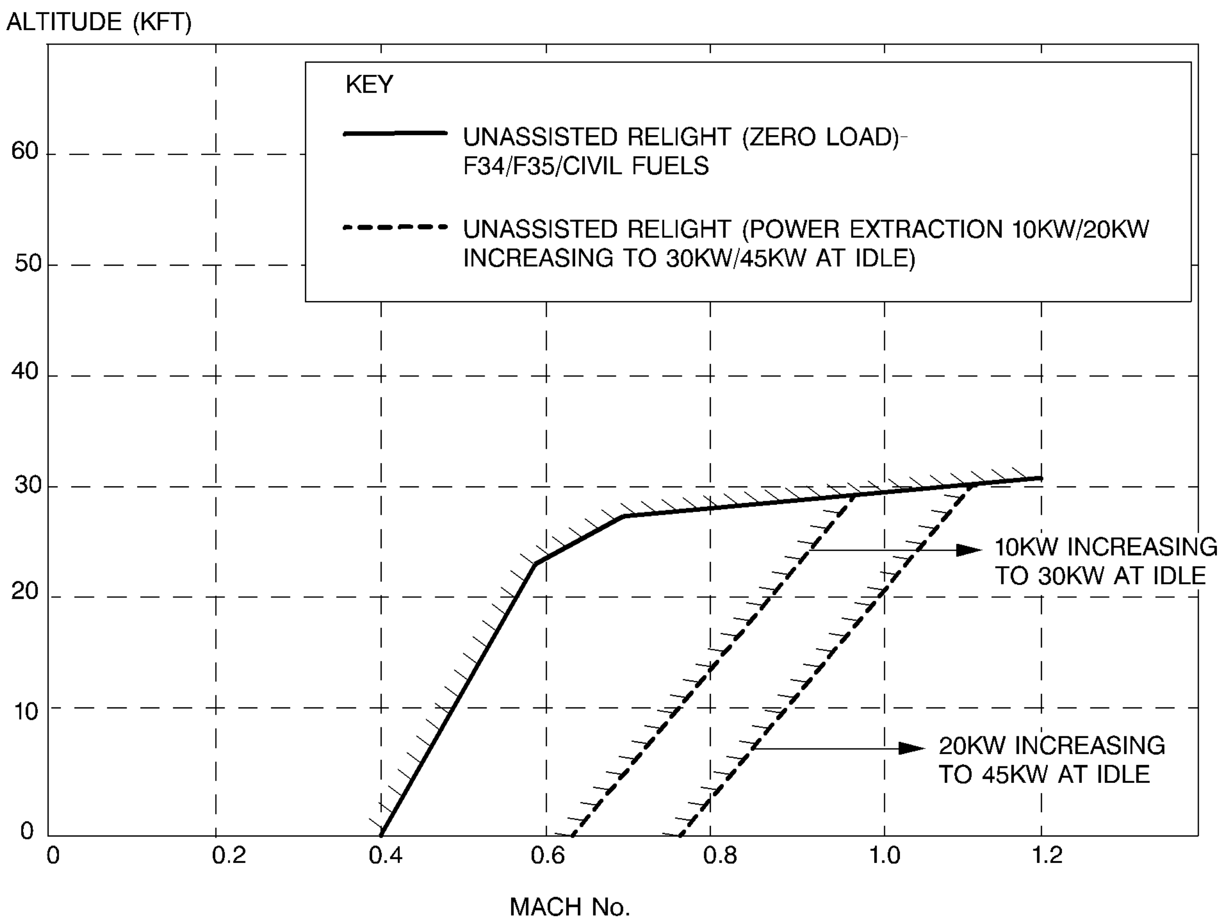


Figure 3.3 - Windmill Relight Envelope (MK101E Engine)

If the aircraft is operated outside the compatibility area the ECS is shut and RAM AIR must be selected, or the aircraft must be recovered into the ECS compatibility area.

CAUTION

TBT SHOULD BE MONITORED DURING RELIGHT BECAUSE IT IS NOT AUTOMATICALLY CONTROLLED BY THE DECU. RELIGHTS ARE TO BE ABORTED IF TBT EXCEEDS 750°C.

NOTE

Observe a slow initial rise in NH and TBT, followed by an engine wind-up to IDLE rpm.When the engine is at idle, the caption OIL P is occulted.

If restart is not obtained or TBT is likely to exceed 750°C when NH is less than IDLE rpm, shut the engine down and attempt further relight at lower altitude/higher airspeed.

CAUTION

IN ADDITION, IF A GEARBOX FAILURE OR GEARBOX UNDERSPEED IS INDICATED (L OR R GBOX, L OR R POT, L OR R CONT P, L OR R UTIL P AND L OR R GEN) REFER TO GEARBOX UNDERSPEED/GEARBOX FAILURE FIRST.

If the relight is unsuccessful consider the drill for assisted relight.

1. **Recover .... Nominal 1g level flight**
2. Throttle live engine .... Max dry, until below 0.9 M (or subsonic) then above 70% NL
3. Airbrake .... Select IN

NOTE

- Best windmilling relight envelope 0.80 to 0.90 M, below 26 000 ft (23 000 ft for 01A, 01C, 03A engines only).
- Below 5% NH windmill relight is inhibited by DECU

4. Affected engine..........Check NH above 5%
5. Throttle affected engine ....HP SHUT, then dry range

If relight is not succesful carry out further attempts at lower altitude/higher airspeed or consider an Assisted Relight.

If TBT exceeds 750°C:

6. Throttle affected engine ....HP SHUT
7. LP COCK affected engine ....SHUT
8. Land ....ASAP, refer to Single Engine Operations pag. 62

If relight is successful but **ECS** *is displayed:*

9. ECS ....OFF/RESET then ECS

If relight not successful and **ECS** *is displayed:*

9. Descent......................Below 25 000 ft

If relight is not successful at altitudes below 25 000 ft and **ECS** *is still displayed:*

10. ECS ....OFF/RESET then ECS

If RESET unsuccessful:

11. ECS ....RAM AIR within limits

ASSISTED RELIGHT

WARNING

A RELIGHT MUST NOT BE ATTEMPTED IF ANY ENGINE MECHANICAL FAILURE HAS OCCURRED.

The assisted relight constitutes the method of starting an engine in flight, only after windmill relight is unsuccessful and particularly under low altitude/ airspeed conditions (with high mass), see Figure 3.4 assisted relight envelope.

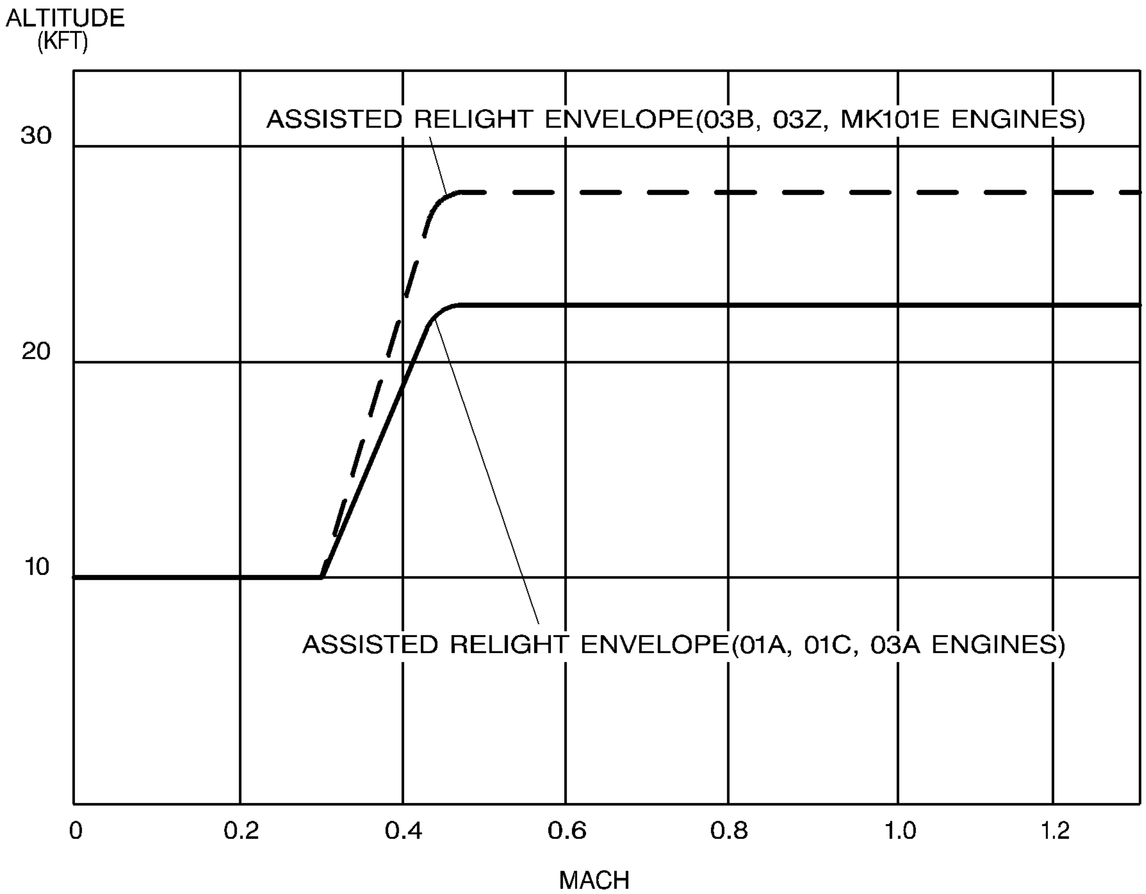


Figure 3.4 - Assisted Relight Envelope

As soon as the assisted relight is requested, the operating cross-bleed is stopped to synchronize the AMAD gearbox speed and engine windmilling speed, then the AMAD gearbox dog clutch is automatically closed to drive the engine up to idle speed in ATS/M driven mode.

Because of the assisted relight procedure requests to stop the operating cross-bleed, it is mandatory to check the windmilling engine speed before to start the assisted relight procedure. In fact, if the hydraulic pump at the donor engine side is failed and the windmilling speed is lower than 50% a total loss of hydraulic power could occur.

The pre-requisites for a successful assisted relight are serviceable air cross bleed and gearboxes.

WARNING

DO NOT ATTEMPT ASSISTED RELIGHT IF LIVE ENGINE HYD OR GEN WARNINGS ARE PRESENT. HYD COULD BE LOST DEPENDING ON THE WINDMILLING SPEED OF THE RELIGHTING ENGINE.

1. Throttle good engine .. 70% NL min
2. Throttle affected engine .... HP SHUT, then dry range
3. AIR DRIVE................. EMGY and release

If TBT exceeds 750°C:

4. Throttle affected engine .... HP SHUT
5. LP COCK affected engine .... SHUT
6. Land.......................... ASAP. Refer to Single Engine Operations pag. 62

If **L ATSM** *or* **R ATSM** *is displayed:*

4. Throttle affected engine .... IDLE
5. Altitude....................... Below 10 000 ft if practicable

ENGINE FAILURES

L/R ENGINE VIBRATION/MECHANICAL FAILURE

L VIBR or **R VIBR**

The majority of all known engine failures are accompanied by the corresponding caption(s) on the R MHDD ENG/DWP. Nevertheless in some cases, i.e. mechanical failure there are no associated warnings. The related mechanical failures can be caused by bearing failures, seizures of rotating parts, blades failures, etc.

Such malfunctions can be accompanied by vibration, engine rundown or seizure, rumbling noises or a loud bang.

If any of the above mentioned symptoms are present within 10 seconds of warning activation, retard the throttle of the affected engine until vibrations disappear. If symptoms are still present, shut down the affected engine.

Maintain the good engine >70% NL to ensure proper SPS cross bleed operation.

1. Throttle affected engine ....Reduce to/in dry range until vibrations disappear

If warning extinguished and vibration no longer persists:

2. Throttle affected engine ....Maintain setting
3. Land ....As soon as practicable

If vibration warning still on and / or mechanical failure is suspected:

2. Throttle good engine ..70%NL min
3. Throttle affected engine ....HP SHUT
4. LP COCK affected engine ....SHUT
5. Land ....ASAP, refer to Single Engine Operations pag. 62

ENGINE VIBRATION / ICING

If **L VIBR** *and/or* **R VIBR** *with* **ICE**

1. **Throttle affected engine...................... Advance by at least 10% NL**

If vibration warning occults within 10 seconds:

2. Continue normal operation

If vibration warning does not occult within 10 seconds:

2. Throttle affected engine(s) .... Reduce within dry range until vibrations disappear

If vibration warning still on and / or a mechanical failure is suspected:

3. Throttle good engine.. 70%NL min
4. Throttle affected engine .... HP SHUT
5. LP COCK affected engine .... SHUT
6. Land .... ASAP, refer to Single Engine Operations pag. 62

ENGINE SURGE (LOCKED IN SURGE)

A surge is an aerodynamic disruption or reversion of airflow through the compressor stages, caused by various reasons such as bird strike, FOD or hot gas ingestion, excessive airflow distortions into the air intake, blade failures, abnormal overfuelling during heavy engine handling, etc.

The typical surge can be expected at high altitude, high AOA, low airspeed and high power demands during engine handling. An engine surge is normally indicated by a rumbling noise, a loud bang or a series of loud bangs accompanied by the abnormal engine parameters, TBT increasing rapidly, with stagnation or reduction of NH and/or NL.

Surges at low altitudes are very unlikely and are normally caused by damaged compressor blades.

If the surge self clears, no immediate action is required.

If the surge does not self-clear, reduce the throttle of the affected engine to IDLE. Normally this action will recover the engine from a surge.

If the surge continues (locked-in surge), a phenomenon which is indicated by a light rumble accompanied by stagnation or subidling NH, abnormal TBT at IDLE, reduce AOA and sideslip, descend and increase airspeed if possible.

Should both engines be affected by locked-in surges, shut down the engine with the highest TBT and lowest NH first and then attempt a relight. Land ASAP.

1. **Throttle affected engine .... IDLE**
2. **Recover .... Nominal straight and level flight**

If SURGE locked in:

3. Altitude/Airspeed........ Descend and/or increase

If SURGE remains and / or TBT increasing:

4. Throttle good engine .. 70% NL min
5. Throttle affected engine .... HP SHUT
6. LP COCK affected engine .... SHUT
7. Land.......................... ASAP, refer to Single Engine Operations pag. 62

NOTE

Engine relight is permissible if required for aircraft critical flight condition provided that no mechanical failure is suspected.

ENGINE OIL PRESSURE LOW

L OIL P or R OIL P

An engine oil low pressure condition, can be caused by loss of engine oil, malfunction of the oil system or by maintaining the aircraft over a prolonged period at an abnormal attitude.

If the L/R OIL P warning is shown, immediately retard the relevant throttle to IDLE and if at zero or negative "G" conditions restore positive "G" conditions with climb and dive angles less than 30°.

However, if the warning persists for more than 10 seconds after the aircraft has attained level flight, the engine must be shut down to avoid bearing failure or engine seizure and land ASAP.

1. **Throttle affected engine .... IDLE**
2. **Recover .... Nominal straight and level flight**

If warning persists for more than 10 sec.:

3. **Throttle good engine .... 70% NL min**
4. **Throttle affected engine .... HP SHUT**
5. LP COCK affected engine .... SHUT
6. Land.......................... ASAP, refer to Single Engine Operations pag. 62

ENGINE OIL OVERTEMPERATURE

L OIL T or R OIL T

An engine oil overtemperature conditions is indicated by the appropriate warning on the DWP, accompanied by the "Left Oil Temperature" or "Right Oil Temperature" voice warning and the attention getters flashing.

An engine oil overtemperature condition can be caused by heat exchanger failure, FCOC failures, bearings overtemperature. If the OIL T warning is shown within 10 seconds from warning activation, retard the relevant throttle to IDLE and recover to 1g level flight. However, if the warning persists for more than 5 minutes after the aircraft has attained level flight, the engine must be shut down to avoid bearing failure.

1. Throttle affected engine .... IDLE
2. Recover .... Straight and level flight
3. Altitude .... Reduce below 36 000 ft, if possible

If L OIL T or R OIL T warnings occults:

4. Continue normal operation

If warning persists for more than 5 minutes:

4. Throttle good engine .. 70% NL min
5. Throttle affected engine .... HP SHUT
6. LP COCK affected engine .... SHUT
7. Land.......................... ASAP, refer to Single Engine Operations pag. 62

NOTE

Engine relight is permissible if required for a critical flight condition provided that the L OIL T or R OIL T has gone out.

ENGINE CONTROL FAILURES

L/R DECU

L DECU or R DECU

CAUTION

SIMULTANEOUS DECU WARNINGS ON THE MHDD/ENG FORMAT AND DWP INDICATE THAT THE DECU IS UNABLE TO MAINTAIN FULL DRY ENGINE CONTROL, AND IS OPERATING IN A DEGRADED MODE DUE TO FAILURES ON EACH OF THE TWO LANES OF THE DECU.

The warning indicates that the engine control is lost of the affected side. The engine automatically stabilizes near idle with no throttle response. Engine indications on MHDD may be unreliable. The engine speed will vary with flight conditions. At lower pressure conditions, this will provide higher thrust levels than at SLS, where the minimum mechanical fuel flow stop represents slightly lower thrust than idle. At high altitude, with the engine running down after a failure, there is a greater risk of surge.

If no other engine malfunctions, engine is automatically stabilized near flight idle :

1. Land ....As soon as practicable

If NL falls below 30% :

1. Throttle good engine ..70% NL min
2. Throttle affected engine ....HP SHUT
3. LP COCK affected engine ....SHUT

CAUTION

THE SHUT-DOWN ENGINE MUST NOT BE RELIT.

4. Land ....ASAP, refer to Single Engine Operations pag. 62

ENGINE AIRFLOW CONTROL SYSTEM FAILURE

If a failure occurs in the engine airflow control system causing a loss of pressure (indicated via FTI), control of the nozzle and VIGV position is lost.
On 03Z engine the DECU automatically inhibits reheat reselection in the event of Hydraulic system (nozzle) failure or reheat flame out, to prevent potential damage to the reheat system.
No warnings will be indicated.

NOTE

A failure within the engine airflow control system is indicated by any of the following:

– Inconsistency between AJ/NH;
– Limited dry modulation;
– No or slow response in reheat.

Use the engine but plan to land with a precautionary single engine approach.

1. Throttle affected engine .... Retard slowly to IDLE

If any other abnormalities:

NOTE

Engine may be left running in the absence of other indications (e.g. surge).

2. Throttle good engine.. Not below 70%NL
3. Throttle affected engine .... HP SHUT
4. LP COCK affected engine .... SHUT

CAUTION

THE SHUT-DOWN ENGINE MUST NOT BE RELIT.

5. Land .... ASAP, refer to Single Engine Operations pag. 62

L/R REHEAT FAILURE

L RHEAT or R RHEAT

A failure to light-up the reheat or reheat flame-out condition will be indicated in the cockpit by the L/R RHEAT warning (reheat selected but not lit) on the MHDD ENG format and DWP.

For 01A, 01C, 03A, engines the warning occurs when the throttle is in the reheat range and the light-up detector (LUD) is not sensing the required Ultra-Violet (UV) radiation in the burning section, or the DECU monitored PS7/PS2 ratio is less than a targeted value for the selected nozzle area.

For 03Z, 03B and MK101E engines the warning occurs when the throttle is in the reheat range and the DECU monitored PS7/PS2 ratio is less than a targeted value for the selected nozzle area. A light-up detector (LUD) is incorporated but is not active on this standard of engine.

The LUD logic is activated after the hot-shot delay time has expired and the PS7/PS2 logic starts working just above the minimum reheat nozzle area.

An emergency reheat shut-down will be activated if a "not-lit" LUD signal is detected and also if a PS7/PS2 ratio is detected beyond tolerance, even with a positive LUD signal or NH is below arming speed.

The reheat sequence arming speed during an acceleration is NH=85%.

A normal reheat shut-down will be initiated if NH falls below the reheat cancellation (disarming) speed, NH=80%, while reheat is operating or reheat being selected.

The reheat fuel flow demands will go to zero and the reheat shut-off valve will be closed immediately. The RHEAT warning (reheat selected but not lit) will disappear when the throttle is retarded to the dry engine range.

If a complete reheat control system failure is present, an emergency reheat shutdown will occur and the nozzle is set to the dry range.

The RHEAT warning is only displayed when reheat is selected and will occult when reheat is deselected.

For MK101E reheat re-selection may be attempted throughout the flight envelope, but will be automatically inhibited by the DECU if the warning was initiated by a nozzle actuation failure within the area of the operating envelope below boundary line "B - B" (see fig. Figure 3-5). The DECU may also automatically inhibit reheat operation following a warning initiated by any other cause within the area of the flight envelope below boundary line "C - C" (see fig. Figure 3-5). This is to prevent potential damage to the reheat system.

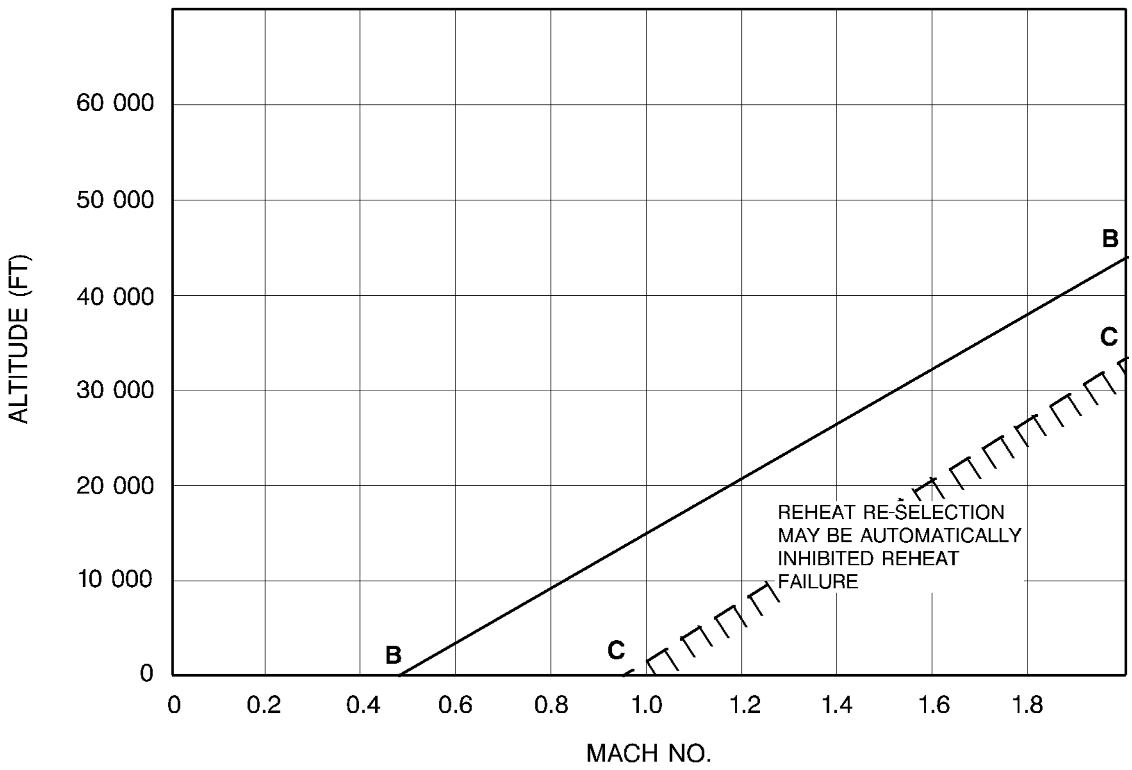


Figure 3.5 - Reheat re-selection boundary

L RHEAT or **R RHEAT**

CAUTION

- IN CASE OF UNCOMMANDED REHEAT SHUTDOWN OR BLOWOUT, REHEAT RESELECTION IS PERMITTED BELOW 250 KDAS AND ABOVE 25 000 FT FOR ENGINE STANDARDS 03B AND 03Z ONLY.
- REHEAT RESELECTION IS PERMITTED FOR MK101E ONLY.

1. Throttle affected engine........................Dry range, and progressive movements

L/R ENGINE PERFORMANCE

L ENG P or **R ENG P**

The ENG P reflects the following engine malfunction(s):

– NH/NL mismatching
– NL min, at max fuel flow, less than scheduled
– DECU loss of control (DECU warning caption also displayed)

The resulting effect is that achievable dry thrust for take-off is reduced.

NOTE

L / R ENG P can occur only with aircraft weight on weels.

If decision to stop is made:

1. ABORT

If take off is continued:

1. Throttles ....MAX RHT

When safely airborne:

2. Throttle affected engine........................IDLE
3. Land..........................As soon as practicable

FUEL SYSTEM FAILURES

LOW FUEL / FUSELAGE FUEL LEAK

FUEL in extreme cases

A low fuel level warning, category 3, will occur if the fuel contents in either the front or rear group falls below 375 kg. The throttles should be set to the minimum practical setting to conserve fuel in the affected group(s). The fuel crossfeed valve must be selected to close (XFEED switch to NORM) until a fuselage fuel leak can be discounted. Fuel contents, balance, consumption and transfer status should then be checked to determine the cause. Fuselage group asymmetry not associated with unequal engine demand or transfer failure indicates a leak within a group or in the associated engine feed lines.

PROCEDURE FOR DA1, DA2, DA3, DA4 AND DA7

Maintain the following conditions until affected group(s) replenished or cause established:

1. Throttles ....Min practicable
2. XFER..........................NORMAL (INHIBIT) (Pre UCS Fuel 3C-2.1 aircraft only)
3. XFEED ....NORM
4. Fuel contents/ balance.......................Check/compare MHDD/GUH

If group contents decreasing in accordance with engine demand:

5. Refer to FUEL BALANCING (Fuel Supply Low Pressure pag. 25)

If leak is confirmed and contents in good group are sufficient to RTB:

NOTE

If XFER switch is set to STOP adhere to VENT Failure limitations if possible (Vent Failure pag. 28).

5. XFER..........................STOP if transfer incomplete
6. Land ....ASAP

If fuel hung-up or automatic sequence not advancing:

CAUTION

- CHECK FOR LATCHED PRESELECTIONS AFTER SETTING THE XFER SWITCH TO ENABLE.
- EACH STAGE MUST BE SELECTED MANUALLY, OTHERWISE TRANSFER WILL RETURN TO AFFECTED STAGES.

5. XFER......................... ENABLE (Pre UCS Fuel 3C-2.1 aircraft only)
6. MHDD/FUEL .... XFER select next usable stage

If fuel flow to main groups restored:

7. Land .... As soon as practicable

If fuel flow to main groups not restored:

7. Land .... ASAP

PROCEDURE FOR DA5 AND DA6

Maintain the following conditions until affected group(s) replenished or cause established:

1. Throttles .... Min practicable
2. XFER......................... INHIBIT (pre UCS Fuel 3C-2.1 only)
3. XFEED .... NORM
4. Fuel contents/ balance...................... Check/compare MHDD/GUH

If group contents decreasing in accordance with engine demand:

5. Refer to FUEL BALANCING (Fuel Supply Low Pressure pag. 25)

If fuel hung-up or automatic sequence not advancing:

CAUTION

- CHECK FOR LATCHED PRESE-LECTIONS AFTER SETTING THE XFER SWITCH TO ENABLE.
- EACH STAGE MUST BE SELECT-ED MANUALLY, OTHERWISE TRANSFER WILL RETURN TO AF-FECTED STAGES.

5. XFER .... ENABLE (pre UCS Fuel 3C-2.1 only)
6. MHDD/FUEL .... XFER select next usable stage

If fuel flow to main groups restored:

7. Land.......................... As soon as practicable

If fuel flow to main groups not restored:

7. Land.......................... ASAP

FUEL SUPPLY LOW PRESSURE

L FUEL P or **R FUEL P**

Low fuel pressure, e.g. double boost pump failure, is indicated by a category 2 warning. Maintain positive g, handle throttles with caution and limit throttle settings to dry range only. If practicable, altitude should be reduced to less than 15 000 ft. The status of the boost pumps must be checked via the MHDD fuel format.

If a single, double or triple boost pump failure has occurred the throttles must be kept within the dry range and the fuel crossfeed valve must be opened by selecting the XFEED switch to OPEN. Selection of the XFEED switch to OPEN will enable both engine feed lines to be pressurized. The aircraft should be landed as soon as practicable.

NOTE

On aircraft equipped with one battery a total AC generation failure combined with a total DC generation failure will result in the depressurization of both fuel supply lines (DC fuel pump has no power supply in this condition). Therefore cooling of the left gearbox and associated utilities is not supported.

If a quadruplex boost pump failure has occurred because of DC contactors failure or a double AC failure, the left throttle must be selected to IDLE and the right throttle set as required but within the limits of the dry range. If a double AC generator failure has occurred, the DC fuel pump located in the front fuel group will run thereby pressurizing the left engine feed line. The fuel crossfeed valve is required to be closed (XFEED switch set to NORM). Setting the left throttle to IDLE and closing the fuel crossfeed valve will ensure that fuel is circulated through the left fuel recirculation line, cooling the left gearbox and associated services. The aircraft should then be landed as soon as possible.

1. Positive g .... Maintain
2. Throttles..................... Dry range only, use with care
3. Altitude....................... Reduce < 15 000ft, if practicable
4. MHDD/FUEL .... Check BOOST PUMP status

If single, double or triple boost pump failure:

CAUTION

DO NOT SELECT XFEED TO OPEN IN THE CASE OF A FUEL LEAK AND/ OR FUEL T WARNING.

5. XFEED .... OPEN
6. Land.......................... As soon as practicable

If a quadruplex BOOST PUMP failure (DC contactors or a double AC failure):

NOTE

An Operating DC FUEL PUMP will not delete the L FUEL P warning.

5. Left throttle .... IDLE
6. XFEED .... NORM
7. Land.......................... ASAP

FUEL BALANCING

The aircraft should be recovered to nominal 1g level flight and use of the throttles restricted to dry range throughout the balancing procedure. The main group contents displayed on the MHDD/FUEL format should then be crosschecked with the main group contents displayed on the HUP (get-u-home) before assessing the main groups for imbalance. In the unlikely event that a disparity exists between the contents data displayed on the MHDD/FUEL and those displayed on the HUP the pilot should consider the HUP data to be of higher integrity.

Assuming there is enough transferable fuel remaining to correct the balance, the best course of action is to direct the remaining fuel to the low group. All remaining transferable fuel can be directed to the forward or the rear group by selection of the XFER / FWD or XFER / REAR softkeys on the MHDD/FUEL format respectively. This `selective transfer' condition must be maintained until the balance is correct, at which point selective transfer must be terminated by deselection of the appropriate softkey.

To balance main group contents where selective transfer is not available (i.e. no transferable fuel remaining, a fuel computer failure or the MHDD/ FUEL format not available) the crossfeed valve should be opened and the boost pumps associated with the low group selected OFF. This will enable both engines to be supplied from the group containing the most fuel. If the crossfeed valve fails to open differential engine power should be used to achieve balance as an alternative.

If a fuel leak is suspected, refer to the Low Fuel / Fuselage Fuel Leak. The crossfeed valve must be set to NORM in this case to prevent loss of fuel from the good group.

Do not open the fuel crossfeed valve in the presence of a FUEL T warning as this will allow hot fuel to enter the unaffected system.

FUEL BALANCE PROCEDURE (PRE UCS FUEL 3C-2.1)

If a fuel leak is suspected refer to Low Fuel / Fuselage Fuel Leak pag. 24.

Maintain fuel balance as follows:

1. Recover......................Nominal 1 g level flight
2. Throttles ....Dry range
3. Fuel contents/ balance.......................Check MHDD/GUH

If inside CG Zone 1 limits:

4. XFER..........................ENABLE
5. MHDD/FUEL ....Select XFER FWD/ REAR as required.

When balance correct:

6. XFER..........................NORMAL (INHIBIT)

If fuel balance not restored or entry into CG zone 2 likely:

6. XFER......................... NORMAL (INHIBIT)

CAUTION

– DO NOT SELECT XFEED TO OPEN IN THE CASE OF A FUEL LEAK OR A FUEL T WARNING.
– DO NOT SELECT BOOST PUMP TO OFF WITH XFEED IN NORM.

7. XFEED .... OPEN

If possible:

8. MHDD/FUEL .... Confirm fuel crossfeed valve open

If fuel crossfeed valve failed closed:

9. Fuel balance.............. Differential engine power only

Otherwise if FWD heavy:

9. R BOOST PUMP....... OFF

If REAR heavy:

9. L BOOST PUMP .... OFF

When balance correct:

10. L or R BOOST PUMP........................ L or R BOOST PUMP
11. XFEED .... NORM

FUEL BALANCE PROCEDURE (POST UCS FUEL 3C-2.1)

If a fuel leak is suspected refer to Low Fuel / Fuselage Fuel Leak pag. 24.

1. Recover..................... Nominal 1 g level flight
2. Throttles .... Dry range
3. Fuel contents / balance...................... Check MHDD / GUH

If selective transfer available:

4. MHDD / FUEL .... Select XFER FWD / REAR as required

When balance correct:

5. MHDD / FUEL .... Deselect XFER FWD / REAR as required

If selective transfer not available:

CAUTION

- DO NOT SELECT XFEED TO OPEN IN THE CASE OF A FUEL LEAK AND / OR FUEL T
- DO NOT SELECT BOOST PUMP TO OFF WITH XFEED IN NORM
- IF XFEED VALVE FAILED CLOSED, REBALANCE BY DIFFERENTIAL THROTTLE SETTING ONLY.

6. XFEED....................... OPEN

If FWD heavy:

7. R BOOST PUMP .... OFF

If REAR heavy:

8. L BOOST PUMP........ OFF

When balance correct:

9. L or R Boost Pump .... L or R BOOST PUMP
10. XFEED....................... NORM

L/R FUEL OVERTEMP

L FUEL T or **R FUEL T**

or

L FUEL T or **R FUEL T**

Two fuel overtemperature triggers are provided from the fuel system. The lower overtemperature trigger (86°C) is for the category 3 warning; the higher overtemperature trigger (93°C) is for the category 2 warning.

Upon receipt of the lower fuel over temperature warning, category 3, the throttles should be increased if practicable, altitude reduced if possible, the FUEL format displayed and the fuel temperature checked.

Upon receipt of the higher fuel overtemperature warning, category 2, the affected engine must be shut down. However the remaining engine must be maintained at ≥70% NL to avoid rundown of the applicable gearbox. If any combination of consequential gearbox oil temperature, hydraulic temperature and AC generator warnings are triggered, the AIR DRIVE switch must be selected to OFF.

1. Throttle affected side .... Increase fuel flow, if practicable
2. Altitude...................... Reduce, if possible

CAUTION

PROLONGED OPERATION WITH A FUEL T WARNING WILL EVENTUALLY LEAD TO CONSEQUENTIAL HYD T, GBOX T, OIL T AND GEN WARNINGS. IF CONSEQUENTIAL WARNINGS DO OCCUR FUEL T HAS PRIORITY.

3. MHDD/FUEL.............. Monitor fuel temp.

If **L FUEL T** *or* **R FUEL T** *triggered:*

4. Throttle good engine .. 70% NL min
5. Throttle affected engine .... HP SHUT
6. LP COCK affected side .... SHUT
7. XFEED...................... NORM

If no cross-bleed:

8. GBOX affected side ... Press
9. Land.......................... ASAP, refer to Single Engine Failures

If associated HYD T and/or GBOX T and/or GEN warning occurs:

10. AIRDRIVE................. OFF

NOTE

If FUEL T and/or HYD T and/or GEN T and/or GEN warnings occult prior to landing the engine may be relit.

FUEL TRANSFER FAILURE

XFER

Upon receipt of a fuel XFER failure warning, category 3, the aircraft should be recovered to nominal 1 g level flight. Fuel contents and balance must then be checked via the MHDD fuel format. Refer to Fuel Balancing and land the aircraft as soon as practicable.

NOTE

XFER warnings may result from sustained lateral g.

1. Recover......................Nominal 1 g level flight
2. MHDD/FUEL ....Monitor contents/ balance

If fuel hung-up or automatic sequence not advancing:

3. XFER..........................ENABLE (Pre UCS Fuel 3C-2.1 aircraft only)

CAUTION

- CHECK FOR LATCHED PRESELECTIONS AFTER SETTING THE XFER SWITCH TO ENABLE.
- EACH STAGE MUST BE SELECTED MANUALLY, OTHERWISE TRANSFER STAGE WILL RETURN TO AFFECTED STAGE(S).
- IF EXTERNAL FUEL HUNG-UP DUE TO PRESSURIZATION FAILURE, HUP AND MHDD TOTAL CONTENTS WILL REFLECT USABLE FUEL ONLY.

4. MHDD/FUEL ....XFER select next usable stage

If fuel flow to main groups is restored:

5. Land ....As soon as practicable

If fuel flow to main groups not restored:

5. Land ....ASAP

Otherwise

5. Fuel ....Balance
6. Land ....As soon as practicable

The following failure cases will also trigger the fuel XFER warning:

- Transfer isolate valve failure.
- Pressure vent valve failure.
- Double transfer pump failure (within the same tank).
- Refuel shut off valve failure within:

  Forward transfer tank.
  Wing tank (any).
  Main group (either).

- Defuel isolate valve failure.
- Transfer valve failure (in front or rear group).
- Spine tank aft transfer pump (twin seat only).

TRANSFER VALVE FAILURE

FUEL VLV

A transfer valve warning, category 3, will only be received if the failure occurs during Air-to-Air refueling. Break contact unless refueling essential. In any case, contact with the tanker should be broken before any individual tank or group indicates full.

WARNING

HAZARDOUS C.G. SITUATIONS MAY RESULT FROM PARTIAL REFUELING. FOLLOWING PARTIAL REFUELING REMAIN IN CG ZONE 1 ENVELOPE UNTIL C.G. CAN BE CONFIRMED WITHIN NORMAL LIMITS.

1. Contact...................... Break - do not attempt Air-to-Air Refuel.

VENT FAILURE

VENT

The VENT warning, category 3, indicates that the fuel tanks are outside their normal operating pressure or temperature limits. The subsequent actions are based on the assumption that an over-pressure condition may exist during climb or an under-pressure condition during dive. Engine speed is maintained during descent to ensure that sufficient tank pressurization air is available from the engine.

1. Speed .... 250 to 400 KDAS
2. Load factor .... Reduce below 5 g
3. Throttles .... < 80% NL
4. Rate of descent .... < 6000 ft/min
5. Rate of climb .... Reduce to 0

If VENT warning remains:

6. Land .... As soon as practicable

If VENT warning occults:

6. Continue

SINGLE FUEL COMPUTER FAILURE

L FUEL C	or	R FUEL C
confirmed, and/or	FCS	
without	ACS FAIL	(suspected)
and	SCAC	(suspected)
with or without	REV ENV	
	FUEL	possible
	CG	CG warning invalid

The loss of a Fuel Computer results in a loss of data provided to the FCS. Under this failure condition, the FCS inhibits the CG warning facility because the Fuel System is only providing simplex data of degraded accuracy.

The FCS also requires that all external tank transfer is suspended following either a left or right Fuel Computer failure. Certain Fuel Computer failures types result in automatic advance of the transfer stage. Following a Fuel Computer failure the FCS uses the last good value of Fuel Mass data provided by the Fuel System, which is then detotalized using DECU derived engine fuel flow within the FCS.

On receipt of a confirmed Fuel Computer failure (i.e. the warning is raised for >30 secs), recover the aircraft to the CG Zone 1 envelope. Confirm via the MHDD/FUEL format that the Fuel System has advanced to Internal (Stage 1) transfer.If the Fuel System has not advanced to Stage 1, then the following procedures should be followed dependant upon the external fuel tank configuration:

TWO EXTERNAL UNDERWING TANKS ONLY

If the Fuel System has not automatically advanced to Stage 1 and either underwing 1000 l external tank contains >360 kg, then the sequence must be advanced manually by selecting the Transfer Commit Switch to 'ENABLE', thereby allowing the selection of the transfer override soft key on the MHDD/FUEL format to 'Stage 1'. Observe the Fuel Balance/Difference Limits () and adhere to CG Zone 1 Flight Maneuver Limits. Land as soon as practicable.

NOTE

With aircraft at UCS 3C-2 (Fuel 3C-2.1), compatible with FCS Phase 3r1 onwards, softkey selection on the MHDD/FUEL format can be achieved without prior selection of the Transfer Commit Switch to 'ENABLE'. This is due to the availability of improved soft key acceptance logic at this standard.

If the Fuel System has not advanced to Stage 1, but both underwing 1000 l external tanks contain ≤360 kg, then manual override is not necessary. However, Fuel Asymmetry Limits must be observed and CG Zone 1 Flight/Maneuver Limits must be adhered to. Land as soon as practicable.

ONE EXTERNAL UNDERFUSELAGE TANK ONLY

When flying solely with an underfuselage 1000 l external tank fitted there is no requirement to manually advance out of External Tank transfer, irrespective of the contents of the tank. However, Fuel Asymmetry Limits must be observed and CG Zone 1 Flight/Maneuver Limits must be adhered to. Land as soon as practicable.

THREE EXTERNAL TANKS

If the Fuel System has not automatically advanced to Stage 1 and either underwing 1000 l external tank contains >110 kg, then the sequence must be advanced manually by selecting the Transfer Commit Switch to 'ENABLE', thereby allowing the selection of the transfer override soft key on the MHDD/FUEL format to 'Stage 1'. Observe the Fuel Balance/Difference Limits and adhere to CG Zone 1 Flight Maneuver Limits. Land as soon as practicable.

NOTE

With aircraft at UCS 3C-2 (Fuel 3C-2.1), compatible with FCS Phase 3r1 onwards, softkey selection on the MHDD/FUEL format can be achieved without prior selection of the Transfer Commit Switch to 'ENABLE'. This is due to the availability of improved soft key acceptance logic at this standard.

If the Fuel System has not advanced to Stage 1, but both underwing 1000 l external tanks contain ≤110 kg, then manual override is not necessary. However, Fuel Asymmetry Limits must be observed and CG Zone 1 Flight/Maneuver Limits must be adhered to. Land as soon as practicable.

Fuel internal transfer rates are degraded.

1. Recover......................Nominal 1g level flight
2. Throttles ....Dry range
3. MHDD/FUEL ....Contents/balance/ stage

If external transfer in progress and either underwing external tank >360 kg (2 x 1000 l U/ Wing Tanks fitted) or either external underwing tank >110 kg (3 x 1000 l external tanks fitted):

4. XFER..........................ENABLE (pre Fuel 3C-2.1 only)
5. MHDD/FUEL ....XFER select STG 1
6. Land ....As soon as practicable, refer to Fuel asymmetry Limits

Otherwise:

4. Land ....As soon as practicable, refer to Fuel asymmetry Limits

AIR-TO-AIR REFUELING PROBE

PROBE

plus **IFR**

1. Recover......................< 300 KDAS 2g max
2. Land ....As soon as practicable

ELECTRICAL SYSTEM FAILURES

DOUBLE AC FAILURE

AC GUH

ELEC 1

LGEN DTRU RGEN

A double AC generator failure is indicated by presence of the AC warning (category 2) caption on the DWP, and results in the loss of all AC services. All MHDD and the HUD will be blank. All DC busbars continue to be supplied by the DC generators backed by the aircraft battery (or batteries on DA1 and 2).

CAUTION

BECAUSE OF LOW PRESSURE IN THE RIGHT ENGINE FUEL SUPPLY LINE, FUEL COOLING OF THE RIGHT GEARBOX AND ASSOCIATED SERVICES IS NOT MAINTAINED. THE DWP WILL BE OPERATING IN REV MODE THEREFORE WARNINGS ASSOCIATED WITH GEARBOX AND HYDRAULIC OVER TEMPERATURES ARE NOT DISPLAYED.

As a consequence of total AC power failure the fuel boost pumps will fail and the emergency DC fuel pump will run automatically (if AUTO selected). Negative G should be avoided due to the resultant loss of pressure in the fuel supply lines, this will insure that fuel flow to the engines is not interrupted. The emergency DC pump insures that a limited supply of pressurized fuel is available in the left engine fuel supply line to prevent a double engine flameout. However because it is necessary to maintain adequate fuel cooling of the left gearbox and its associated services, it is necessary to set the left throttle to IDLE to insure an adequate fuel flow in the left fuel recirculation line. The right throttle setting is limited to dry range only (as required) and must be handled with caution to avoid right engine flameout (low fuel pressure in right engine fuel supply line).

If altitude is above 15 000 ft. a rapid descent should be initiated. Generator reset should be attempted, however if one generator is restored resetting the second generator is not recommended. Resetting the right generator will enable the navigation computer to regain control of the avionics and attack data busses with minimum disruption. If however the left generator is restored the attack computer will regain control of the of the avionic and attack data busses. In either case databus activity will recommence 35 seconds after a successful generator reset (with recovery to reversionary control). The power interrupt will have caused the RADALT low height setting to default to zero, the MHDD to occult and MDE selections to revert to defaults. Therefore following interruption of AC supply the pilot must reset the MHDD, RADALT low height setting and MDE. The aircraft should then be landed ASAP whether the generator reset is successful or not.

NOTE

- Following a successful generator reset the avionic system recovery will cause the following:
  - RAD ALT LOW HT defaults to 0000 ft.
  - Transponder mode C will transmit 0 ft. for 55 seconds
  - Displays and controls will recover to default settings.
- However avionic system recovery may be affected as follows:
  - Irrecoverable loss of MHDD and HUD formats.
  - Irrecoverable loss of DWP warnings (except reversionary mode).
  - Irrecoverable loss of avionic and attack data buses.

Blank MHDD/HUD

1. Throttles .... Left throttle IDLE, right throttle dry power range, handle with caution
2. Rapid descent .... Initiate (if alt 15 000 ft.)

NOTE

If the first GEN is restored, do not recycle the second GEN.

3. R GEN then L GEN ....OFF/RESET, then ON

CAUTION

- ADHERE TO CG ZONE 2 ENVELOPE UNLESS CG CAN BE CONFIRMED WITHIN LIMITS.
- PROLONGED OPERATION WITH A DOUBLE AC GENERATOR FAILURE WILL RESULT IN RIGHT GEARBOX AND RIGHT HYDRAULIC OVER TEMPERATURES.

4. Land ....ASAP, refer to Table for services lost

Services Lost

DOUBLE AC FAILURE - SERVICES LOST	
TRU 1 AND 2	NAVIGATION COMPUTER
FUEL BOOST PUMPS	ATTACK COMPUTER
TRANSFER PUMPS	CIU 1 AND 2
AVIONIC COOLING FAN	CSG 1 AND 2
PROBE HEATING	MHDD L/C/R
ICE DETECTION	HUD
WINDSCREEN HEATING	LINS
BRAKE FANS	GPS (if fitted)
NAVIGATION LIGHTS	RADAR (if fitted)
FTI (in part)	DWP (normal mode)
ACS (except EJ)	

SINGLE AC GENERATOR FAILURE

LGEN or **RGEN**

with or without **ELEC 1**

Under normal operating conditions, AC electrical power is provided by two AC generators. Each generator supplies its own AC busbar via a generator contactor. If a single AC generator failure occurs a category 3 warning is triggered on the DAWG panel, the contactor of the affected generator will open and a bus-tie contactor closes. The bus-tie contactor enables both AC busbars to be connected together enabling the AC power demand of both busbars to be supplied by the live generator. If however, the generator failure occurred through a major electrical short circuit to earth, the bus-tie contactor will be prevented from closing in order to protect the serviceable generator.

Power supply interrupts associated with single AC generator failures may cause some avionic equipment to reset. If the left generator fails, the attack computer may reset, causing the navigation computer to take control of the attack databus and all attack computer functions to be suspended for 55 seconds. During this time the transponder mode C will transmit zero feet. If the right generator fails, the navigation computer may reset, causing the attack computer to take control of the avionic databus and all navigation computer functions to be suspended for 35 seconds.

CAUTION

– ADHERE TO CG ZONE 2 ENVELOPE UNLESS CG CAN BE CONFIRMED WITHIN LIMITS.

– ATTEMPTS TO RESET THE FAILED GENERATOR MAY COMPROMISE AVIONIC SYSTEM RECOVERY.

– IF ELEC1 IS PRESENT LAND ASAP.

Avionic equipment may also experience power supply interrupts if the pilot attempts to reset a failed generator. The extent to which the avionic system is affected by these interrupts is dependant on which avionic system package the aircraft is configured with. If an ELEC1 warning occurs during a single AC generation failure the aircraft must be landed as soon as possible.

If avionic system recovery successful or further degradation of avionics would affect aircraft safety:

1. Failed GEN................ OFF/RESET
2. Land .... As soon as practicable

If irrecoverable avionic system failure has occurred:

1. Failed GEN................ OFF RESET, then ON
2. Land .... As soon as practicable

ELECTRICAL LEVEL 3 FAILURE

	ESS DC	GUH
ELEC 2	ELEC 1	DTRU
with or without	AC	GUH

An ESS DC failure warning, category 2, is indicated when total DC generation failure occurs (no output from either TRU or either DC GEN). During this failure condition essential DC services which are normally supplied from the TRU or DC generators are provided by battery.

Unless DC power generation is restored, the essential DC supplies can only be guaranteed for 7 minutes.

The pilots response to the situation will depend upon whether or not a double AC generator failure has featured in the failure.

ESS DC CAPTION WITHOUT AC CAPTION

In this situation the aircraft has multiple LRI failures which are exclusive to the DC system and cannot be reset. Therefore it is necessary to land the aircraft within 7 minutes. If it is not possible to land within the battery endurance time, it will be necessary to eject, as battery exhaustion will result in violent departure of the aircraft from controlled flight as the FCC becomes less tolerant to decreasing voltage.

ESS DC CAPTION WITH AC CAPTION

In this situation an AC generator reset may restore AC power to the TRU(s). If the generator reset is successful and the ESS DC caption resets, the emergency should be handled as per the Electrical Second Failure Drill. If, however, the generator reset is unsuccessful and it is not practicable to land within the battery endurance time it will be necessary to eject.

Where generator resets have been unsuccessful but a landing is to be attempted it will be necessary to:

- Use the approach-end cable
- Select the landing gear down by the emergency system (single battery aircraft only).
- Shutdown the engines as soon as the aircraft comes to rest.

Total DC generation failure:

1. Time of failure ....Note

If GUH AC not lit and landing to be attempted:

WARNING

BATTERY LIFE IS ONLY GUARANTEED FOR 7 MIN, AFTER WHICH TOTAL FCC FAILURE WILL EVENTUALLY OCCUR.

2. Land ....Within 7 min, perform Landing Gear Fails to lower drill (single battery aircraft only), approach end cable engagement (all aircraft)

If GUH AC not lit and landing within 7 min. not practicable:

2. Heading ....Towards unpopulated area
3. EJECT ....Within time limit

If GUH AC lit:

NOTE

If the first GEN is reset, do not attempt to reset the other one.

2. GEN in turn ....OFF/RESET then ON

If GEN reset unsuccessful and landing within 7 mins not practicable:

3. Heading ....Towards unpopulated area
4. EJECT ....Within time limit

If one GEN restored and ESS DC not lit:

3. Carry out Electrical Second Failure Drill, refer to the relevant DM:

- (DA 1 and DA2)
- Electrical Level 2 Failure pag. 33 (DA5 and DA7)

ELECTRICAL LEVEL 2 FAILURE

ELEC 2	and	ELEC 1
with or without	DTRU	

In the event of a left or right DC channel failure an ELEC 2 warning caption, category 2, will be displayed on the DAWG panel. If the TRU and DC GEN associated with DC busbars PP1 and PP3 have failed the battery will begin to discharge as it maintains the supply to all equipment connected to PP3 (and PP1 if the fuses between PP1 and PP3 are intact). Supply is maintained on DC busbars PP2 and PP4 by their associated TRU or DC GEN (if the TRU has failed).

If the TRU and DC GEN associated with PP2 and PP4 have failed, busbars PP2 and PP4 will not be supplied and therefore supply to the Normal Landing Gear Selector and the brake chute is lost. However supply is maintained to DC busbars PP1 and PP3 by their associated TRU or DC GEN (if TRU has failed) and the battery will continue to be charged.

NOTE

Differentiation by the method detailed below will not be possible in the presence of a double AC generator failure as the DWP will be forced into REV mode in any case.

The aircrew may differentiate between the two failure cases by noting the reaction of the DWP as follows:

- If on receipt of an ELEC 2 warning the DWP initially remains in normal mode, the TRU and DC GEN associated with PP1 and PP3 will have failed and the battery will discharge.
- If on receipt of an ELEC 2 warning the DWP fails to REV mode immediately, the TRU and DC GEN associated with PP2 and PP4 will have failed and the battery will continue to be charged.

Single TRU and single or double DC generator failure, or double TRU and single DC generator failure:

1. Land ....ASAP
2. INTAKE ....OPEN (– 26°) below 340 KDAS

If DWP remains in normal mode initially:

WARNING

- BATTERY WILL NOT BE CHARGED.
- BATTERY ENDURANCE FOLLOWING A SUBSEQUENT TOTAL DC GENERATION FAILURE (ESS DC) CANNOT BE GUARANTEED.
- DWP WILL GO TO REV WHEN BATTERY DISCHARGED.
- TOTAL DC GENERATION FAILURE (ESS DC) AFTER DWP ENTERS REV WILL CAUSE IMMEDIATE LOSS OF CONTROL.
- NO AUDIO WARNING FOR A SUBSEQUENT ESS DC.

If DWP fails to REV immediately:

NOTE

- Battery will still be charged.
- Normal landing gear selections not available. Use Landing Gear Fails to Lower Drill.
- Brake chute not available.

Consider cable engagement

ELECTRICAL LEVEL 1 FAILURE

ELEC 1 with or without **DTRU**

An electrical level 1 failure is indicated by a category 3 warning, and will result from a single TRU failure, a battery over temperature or a single/double DC generator failure. All the aircraft systems remain serviceable, however the aircraft should be landed as soon as practicable since a subsequent failure within the affected DC channel(s) could result in the affected channel(s) being supported by battery power only.

BATT overtemp, single TRU failure or single/ double DC generator failure.

1. Land .... As soon as practicable

GEARBOX FAILURES

POT SHAFT FAILURE

L POT or **R POT**

1. Throttle good side...... 70% NL min
2. Throttle affected side........................... IDLE

3. Land.......................... As soon as practicable

If POT is flailing and/or damage is suspected:

3. AIRDRIVE.................. OFF
4. Throttle affected side........................... HP SHUT
5. LP COCK affected side........................... SHUT
6. Land.......................... ASAP, refer to Single Engine Operations pag. 62 and Services Lost Gearbox Failure pag. 35.

In case of a POT shaft failure a different in speed results between the engine and the gearbox. If the POT shaft fails the gearbox runs down and cross-bleed is automatically initiated to maintain the gearbox at 60% NH. The respective engine speed should be reduced to IDLE immediately. This is to reduce the difference in speed between the engine and the gearbox.

To counteract the possible loss of the generator on the affected side, caused by low cross-bleed, the good engine should be set to min 70% NL.

The ECS is operative provided the aircraft is flying within the compatibility area, otherwise the ECS warning will be triggered after appr. 140 sec.

If the POT shaft is flailing and/or damage is anticipated the gearbox motoring must be stopped by selecting AIRDRIVE to OFF. Shut down the affected engine to prevent serious damage to the gearbox and/or the engine.

Shutting down the AIRDRIVE eliminates cross-bleed causing the ATS/M to stop driving the faulty gearbox. Following a complete gearbox shut down a restart via the GBOX pushbutton is unlikely and not considered valuable.

GEARBOX FAILURE

CROSS-BLEED ACTIVATION

The SPS computer activates the cross-bleed mode if any of the following events is detected:

– Loss of mechanical drive (GBOX speed below engine speed)
– Engine flame-out (engine speed below idle).

Cross-bleed is only performed on one channnel, i.e. simultaneous cross-bleed is inhibited.

During cross-bleed operation, a “CROSS BLEED IN PROGRESS” message is displayed on the MHDD.

LOSS OF MECHANICAL DRIVE

If the SPS computer detects that the gearbox speed is lower than the speed of the relevant engine, loss of mechanical drive is declared and cross-bleed is initiated. Two seconds after detection of loss of mechanical drive, the computer checks the GBOX speed:

– If the GBOX speed is above 65%, the software realises that the loss of drive is false and interrupts the cross-bleed. No warnings are present.
– If the GBOX speed is below 65%, the loss of drive is confirmed. cross-bleed is confirmed, the <POT> failure warning is generated (and locked in), and the cross-bleed message is transmitted to the MHDD for display.

In the latter case the engine is running correctly but a breakage of the relevant POT shaft or a gearbox under-speed condition (50% to 20%), or a gearbox failure has occurred.

Depending on the failure case, PTO shaft breakage or GBOX failure, cross-bleed operation is continued as follows:

PTO Shaft failure:

– The ATS/M accelerates the GBOX up to 60% and controls to maintain this speed within a certain range.

GBOX Failure:

– If the cross-bleed is initiated due to a GBOX failure, the shear neck failure will occur immediately, the GBOX speed drops suddenly and the ATS/M is commanded to accelerate the GBOX. However, due to the very high resistant torque caused by the GBOX seizure, the ATS/M is not able to accelerate the GBOX to a steady state speed. Thus the SPS computer detects an ATS/M underspeed condition and, after 20 second, interrupts the operation of cross-bleed. As a consequence, the <GBOX> warning is triggered (generated normally when GBOX speed is below 50% and a/c in flight).

ENGINE FLAME-OUT

When the SPS computer detects the engine speed to be below idle (- 5%), and the GBOX speed is below 80%, it declares an engine flame-out condition. GBOX speed is also used within the algorithm, since a “false alarm” at certain flight conditions, i.e. high altitude where idle engine speed is very high, could declare an engine flame-out condition.

Once the flame-out is confirmed, cross-bleed is activated to modulate and maintain the GBOX speed at 60%.

If the GBOX speed drops below 55% to 52% prior to ATS/M engagement the GEN may go off line and the relevant <GEN> warning may appear on the DWP. The DWP <GBOX> warning is inhibited during cross-bleed initiation and is not generated

FAILURE CASE OPERATION

Cross-bleed, which is normally initiated following the loss of mechanical drive or an engine flame-out, is automatically terminated under the following failure conditions:

- ATS/M overspeed
- ATS/M underspeed
- GBOX speed sensor failure
- ATS/M speed sensor failure
- ATS/M freewheel failure
- ATS/M control valve failure
- GBOX clutch failed closed

A GBOX underspeed condition means that the available pneumatic power is not sufficient to drive the GBOX at 60% steady state speed.

Two underspeed thresholds are present, namely 50% and 20%:

- In the case the ATS/M speed, during cross-bleed, is detected to drop within the range 20% to 50%, the software will interpret this anomaly as a failure within the air system. When detecting this anomaly the software will react as follows:
  - The cross-bleed will be operative in the case of an engine flame-out. The GEN will go off line, but the hydraulic pump is still capable to deliver a sigificant flow, i.e. no hydraulic warnings will be triggered.
  - In the case of a PTO shaft failure, cross-bleed is automatically terminated if the ATS/M runs below 50% for more than 20 seconds. This situation can lead to excessive differential speed between the two ends of the PTO shaft resulting in excessive damage.
  - The <GBOX> warning will be triggered in any case.

If during cross-bleed the ATS/M speed drops below 20% for more than 20 seconds, the software will automatically terminate coss-bleed and trigger the relevant hydraulic warnings.

The X-bleed function is continued, even in the case when the computer detects an under-speed of the gearbox below 50% but above 20%. This condition is created by other than a gearbox seizure, e.g. by a failure of the PRSOV to correctly regulate the downstream pressure. This allows still to have a certain hydraulic power available, whose level is dependent on gearbox speed. The relevant GEN however, will go off-line below 55% to 50 % gearbox speed.

The most probable reason for the incorrect operation of the cross-bleed is a low pressure supply to the SPS, which in turn is most likely to occur when the aircraft is flying in the incompatibility area where the ECS is automatically shut.

If the aircraft is operated outside the compatibility area at the time of GBOX failure or GBOX under-speed, the ECS is shut and RAM AIR must be selected, or conversely the aircraft must be recovered into the ECS compatibility area.

GBOX OPERATION

NOTE

> A cross-bleed restart via the GBOX pushbuttons should only be attempted following an engine flame-out condition.

The S/W has a 20 seconds time-out for the cross-bleed to attempt to bring both gearboxes up to nominal cross-bleed speed. If required, a cross-bleed restart can be attempted by pressing the GBOX push-button. This restarts the S/W parameters and provides another 20 seconds of run-up attempt before the system shuts off cross-bleed. A successful reset can be achieved within 10 seconds and will normally clear gearbox related warnings.

When pushing the relevant GBOX button cross-bleed restarts, but the ATSM/gearbox speed may only oscillate between 20% and 50% instead of stabilizing at 60% gearbox speed. Cross-bleed is continued allowing the hydraulic pump to run and to provide flow to the hydraulics/utilities.

If a total gearbox failure is present the L or R CONT P, the L or R UTIL P and the L or R COWL warnings are displayed (+ A BRAKE if right system has failed). For safety reasons the aircraft must then be operated in the subsonic envelope only, i.e. below 0.9 M.

In the case of a gearbox seizure, but both engines still running, the differential speed between engine and gearbox is still over 60%. 30 minutes of trouble-free engine running can be expected.

Setting the throttle of the engine of the affected side to IDLE reduces the difference between engine and gearbox speed. The difference in speed can be kept as low as possible when descending in addition to below 10 000 ft.

If the POT is flailing the pilot is not aware which part of the POT is actually flailing. If, e.g. the engine part would flail only the engine needs to be shut down and the gearbox could further be driven by cross-bleed. However, since there is no indication in the cockpit which part of the POT is flailing the AIRDRIVE and the engine should be shut down.

EMGY GEAR lowering uses 3.5 ltr of fluid for extension. In addition when the Airbrake is extended further fluid is required. Therefore to avoid a hazardous situation the Airbrake must be selected to in prior selecting EMGY GEAR DOWN.

L/R GEARBOX FAILURE

L GBOX	or	**R GBOX**
L GEN	or	**R GEN**
L POT	or	**R POT**
L CONT P	or	**R CONT P**
L UTIL P	or	**R UTIL P**
L COWL	or	**R COWL**
	NWS	if left system
	A BRAKE	if right system
	ECS	outside compatibility area

with or without

REV ENV

If above 0.8 M:

1. **Recover.................... Nominal 1g level flight**
2. Throttles.................... Idle
3. Altitude...................... Ideally between 36 000 ftand 20 000 ft

If below 0.8 M but above 150 KDAS:

1. Throttles.................... Dry range
2. AOA/g .... FBS/FFS
3. INTAKE...................... OPEN below 340 KDAS
4. Landing gear lever ..... DOWN below 290 KDAS as soon as practicable

If **L CONT P** *and* **L UTIL P** *is displayed:*

5. EMGY GEAR .... DOWN

NOTE

If fuel probe extended or AAR essential, select probe EMGY OUT.

6. Land.......................... ASAP refer to Services Lost

If POT is flailing and/or damage is suspected:

NOTE

If ECS warning is displayed increase throttle setting of good engine and exit incompatibility area, when applicable.

7. AIRDRIVE................. OFF
8. Throttle affected side .... HP SHUT
9. LP COCK affected side .... SHUT
10. Land.......................... ASAP, refer to Single Engine Operation and to Services Lost

L/R GEARBOX UNDERSPEED

L GBOX	or	**R GBOX**
L GEN	or	**R GEN**

L POT	or	R POT

1. Throttle good side ......70 % NL min
2. Throttle affected side............................IDLE
3. GBOX affected side ...Press, check DWP

If gearbox is recovered (except L or R POT):

4. Land ....As soon as practicable

Services Lost

LEFT GEARBOX	RIGHT GEARBOX
Normal gear	Emergency gear
Normal brakes	Emergency brakes
Left cowl	Right cowl
NWS	Airbrake
Park brake*	Emergency AAR probe
Canopy*	
AAR probe	

* Limited operation of the PARK BRK and the CNPY.

ATS/M FAILURE

L ATSM	or	R ATSM

The warning L ATSM or R ATSM is displayed when:

– The ATSM is operating at a speed above 72 % (over speed threshold).
– The ATSM is incorrectly driven by the gearbox, due to freewheel failure in its engaged position.
– An ATSM freewheel slippage (ATSM speed in excess of gearbox speed) occurs.

NOTE

Automatic cross-bleed is inhibited.

In the remote case of an over speed situation, the problem can be corrected by setting the AIRDRIVE to OFF, thus shutting off the pneumatic power to the ATSM.

In general, engine shut down of the affected side is recommended. If the warning, however, is displayed following an assisted engine relight and the TBT exceeds 750° C, the engine must be shut down. Only when reducing the affected engine performance to IDLE in combination with a descent to 10 000 ft or below, will cause the ATSM to run at a speed of up to 85%. At such a speed the ATSM will still suffer significant damage, but the effect of the failure will be contained within the ATSM casing with no adverse effect for the aircraft.

1. Throttle affected engine .... IDLE
2. Altitude .... Below 10 000 ft if practicable

SPS - OVERPRESSURE

SPS

NOTE

Assisted relight is inhibited.

1. Land .... As soon as practicable

The pressure reducing and shut off valve (PRSOV) is a sleeve type valve which is normally closed. It operates in direct flow mode as a pressure reducing and shut off valve during cross bleed and assisted relight operations. In case of failure of the PRSOV the pressure is not reduced and the assisted relight is automatically inhibited by the SPS computer. Cross bleed is still available.

L/R SPS COMPUTER FAILURE

L SPS C	or	R SPS C

When a left or right SPS computer failure is detected, the appropriate warning is given on the DWP. The attention getters flash and the "left SPS computer" or "right SPS computer" voice warning is given.

When the left or right SPS computer fails the following services for the affected side will be lost:

– Assisted engine relight / start
– Cross bleed operation
– Monitoring and capability to generate the following warnings relevant to the SPS: L/R POT, L/R GBOX, L/R GBOX T, L/R ATSM (DWP normal mode) and, for the left SPS computer failure only, SPS P
– Monitoring and capability to generate the following warnings relevant to the hydraulic system: L/R CONT P (DWP normal mode), L/R UTIL P, L/R HYD T, L/R HYD A (on ground only), plus MHDD/HYD format and SKs functions
– Ice detection system will be lost after left SPS computer failure

– APU FIRE warning on DWP (normal mode only) and the respective aural warning will be lost after left SPS computer failure

– L/R FIRE warning on DWP (normal mode only), respective aural warning and L/R FIRE warning on MHDD/ENG format will be lost after the respective (L or R) SPS computer failure.

CAUTION

L/R ENGINE RELIGHT MIGHT NOT BE POSSIBLE, DUE TO REDUCED ENGINE RELIGHT CAPABILITY.

1. Land.......................... As soon as practicable

If the L SPS C has failed:

2. Icing conditions.......... Exit and/or avoid

SERVICES / WARNING LOST	
Assisted relight/engine start	
Cross bleed (affected engine)	
MHDD / HYD format and SK functions	
SPS warnings:	
L POT	**L GBOX**
R POT	**R GBOX**
L GBOX T	**L ATSM**
R GBOX T	**R ATSM**
HYD warnings:	
L CONT P	(DWP normal mode only)
R CONT P	
L UTIL P	**L HYD T**
R UTIL P	**R HYD T**
Fire warnings:	
L FIRE	(DWP normal mode only)
R FIRE	

(Continued)

SERVICES / WARNING LOST	
	(MHDD/ENG format fire warnings)
	(Aural warning)
APU FIRE	(DWP normal mode only)
ICE	(L SPS C only)

GEARBOX OVER-TEMPERATURE

L GBOX T	or	R GBOX T

and possible:

LGEN	or	RGEN
	or	
LGEN	or	RGEN

The integrated common oil system for the gearbox(G/B) and the air starter motor (ATS/M) is provided with adequate oil cooling by the fuel cooled oil cooler (FCOC).

Each gearbox has an oil level/tank temperature sensor and an oil temperature sensor monitored by the SPS computers.

The L and/or R GBOX T over temperature signal, originated by the L & R SPS computers, indicate a left and/or right gearbox oil over temperature condition. The condition is detected, when the oil temperature sensor fitted on the gearbox is detected not failed and the oil temperature is higher than 165 °C.

The failure is caused either by:

– A failure of the FCOC, then the over temperature is due to a fuel system problem which will eventually cause the IDG to go off line when the temperature reaches its thermal protection limit (L or RGEN displayed).
– A gearbox lubrication failure, i. e. a gearbox pump failure, then the failure is limited to the gearbox oil only.
– A gearbox mechanical train excessive friction. This failure will eventually lead to damage of the gearbox due to lack of lubrication.

In all cases reduced electrical and hydraulic performance have to be anticipated.

High power settings will consume heated up fuel recirculation into the collector tank and reduce oil temperature. This will however also increase fuel and oil pressure and consequently lead to higher fuel and oil temperatures as well. Therefore the throttle should be initially retracted to IDLE on the affected side.

In the case of a gearbox pump failure, setting the respective GEN to OFF/RESET tends to alleviate one of the heat creating source and causing the work load of the gearbox to decrease.

1. Throttle affected side............................IDLE
2. Land ....As soon as practicable

NOTE

If FUEL T warning is also displayed refer to Fuel Overtemperature L/R Fuel Overtemp pag. 27.

HYDRAULIC SYSTEM FAILURES

DOUBLE HYDRAULIC SYSTEM FAILURE

HYD TOT CAT C

with or without **REV ENV**

The catastrophic warning indicates a double hydraulics pump supply pressure failure where the time to eject is critical.
It is therefore essential to minimize reaction time and to eject immediately, regardless of environmental conditions.
The warning is generated by a hard wired link and is displayed when both hydraulics system pressures are below 140 bar and/or reservoir fluid level is below 0.5 ltr in both systems.

NOTE

The <REV ENV> warning is already displayed following a single hydraukics failure, i.e. following display of either the <L CONT P> or the <R CONT P> warning.

If the <HYD TOT> warning is triggered the associated voice warning <DOUBLE HYD FAIL> will override all other audios until the <HYD TOT> would be accepted. The <REV ENV> warning is also treated as a high integrity warning and will be secondary in priority to the <HYD TOT>.

1. Eject

SINGLE HYDRAULIC SYSTEM FAILURE

L/R HYDRAULIC

L CONT P or **R CONT P**

L UTIL P or **R UTIL P**

L COWL or **R COWL**

NWS if left system failed

A BRAKE if right system failed

with or without **REV ENV**

Illumination of the L or R CONT P and the L or R UTIL P on the DWP may indicate a hydraulic leakage, line rupture or hydraulic pump failure. The warnings are displayed when the respective pressure within the hydraulics and utilities system are below 140 bar and/or the respective reservoir fluid level is below 0.5 ltr.
For safety reasons it is required to recover to the subsonic envelope. Ensure that both HYD switches are set to ON.
Select the MHDD/HYD format for pressure/fluid monitoring and failure conditions. A fluid content greater than 3.5 ltr. may indicate that the problem is associated with the pump and not a fluid leak.
The left and/or the right ISOL valve (s) will only be closed automatically when fluid level below 3.5 ltr is detected. However, the DWP warning captions will be displayed when the respective pressure within the hydraulics and/or utility systems is below 140 bar and fluid level drops below 0.5 ltr.
It can be assumed that the FCCs will freeze the cowl (s) to a safe value. The cowls must then be opened manually even in the absence of the COWL warning when flying below 0.35 M at the latest.
To cater for subsequent loss of the opposite UTIL system, reduce speed to below 290 KDAS as soon as practicable and lower the landing gear.
Simultaneous operation of the airbrake and the landing gear should be avoided.

NOTE

Prior to selecting EMGY GEAR the airbrake must be selected to in.

Failure of a SPS computer results in the loss of the relevant MHDD/HYD and DWP information. This includes the relevant MHDD/HYD SK function. Failure of the controls/utility pressure sensors result in blanking the relevant symbol displayed on the hydraulics format.
For systems lost refer to Double Utility System Failure pag. 43.

If above 0.8 M:

1. **Recover....................Nominal 1g level flight**
2. Throttles....................Idle
3. Altitude......................Ideally between 36 000 ftand 20 000 ft

If below 0.8 M but above 150 KDAS:

1. Throttles....................Dry range

2. AOA/g.........................FBS/FFS
3. INTAKE ....OPEN below 340 KDAS
4. Landing gear lever .....DOWN below 290 KDAS as soon as practicable
5. Land ....ASAP refer to Services Lost Table

If **L CONT P** *and* **L UTIL P** *with or without* **REV ENV** *is displayed:*

6. Airbrake......................Select in
7. EMGY GEAR ....DOWN

NOTE

If fuel probe extended or IFR essential, select probe EMGY OUT.

Services Lost

LEFT SYSTEM	RIGHT SYSTEM
Hydraulic System	Hydraulic System
L/H & R/H Foreplanes	L/H & R/H Foreplanes
L/H & R/H I/B & O/B Flaperons	L/H & R/H I/B & O/B Flaperons
Rudder	Rudder
Utilities System	Utilities System
Main Landing Gear	Main Landing Gear- Emergency Extension
Nose Landing Gear	Nose Landing Gear- Emergency Extension
Wheel Brake Normal Mode	Wheel Brake Reversionary Mode
Left Cowl	Right Cowl
NWS	Airbrake
IFR Probe	AAR Probe-Emergency Extension
Park Brake *	Linkless Ammunition Box Drive
Canopy *	
Onboard Cockpit Ladder Hydraulic Equipment *	

* These functions are available on the ground by energy stored in the relevant accumulators.

SINGLE UTILITY SYSTEM FAILURE

L UTIL P or **R UTIL P**

L COWL or **R COWL**

NWS if left system failed

A BRAKE if right system failed

NOTE

- Where a UTIL P warning is followed by a CONT P warning, the action for a controls circuit pressure warning must be followed.
- For system/warning behavior refer to SINGLE HYDRAULIC SYSTEM FAILURE PAG. 41.

1. Speed........................ Below 0.9 M, reduce further to below 290 KDAS as soon as practicable
2. INTAKE .... OPEN 42 sec. (-26°)
3. Landing gear lever..... DOWN
4. Land .... As soon as practicable, refer to Services Lost below

if **R UTIL P** *is displayed:*

5. R ISOL valve .... select MAN confirm CLSD
6. Airbrake..................... Select IN, if applicable

If **L UTIL P** *is displayed:*

5. Airbrake..................... Select in
6. EMGY GEAR............. DOWN

If fuel probe extended or AAR essential:

7. FUEL PROBE............ EMGY OUT, refer to Air-to-Air Refueling Probe pag. 30 for recovery

Services Lost

LEFT UTILITIES SERVICES LOST	RIGHT UTILITIES SERVICES LOST
Main landing gear	Main landing gear-Emergency extension
Nose landing gear	Nose landing gear-Emergency extension
Wheel brakes/A-skid-Normal mode	Wheel brake/A-skid-reversionary mode
Left Cowl	Right cowl
NWS	Airbrake
Normal AAR probe	Emergency AAR probe
Park brake*	
Canopy*	
Onboard cockpit ladder hydraulic equipment *	

* The PARK BRK, the CANOPY and the LADDER can still be operated on the ground due to stored energy within the PARK BRK, CNPY and Ladder accumulator.

DOUBLE UTILITY SYSTEM FAILURE

L UTIL P   R UTIL P

L COWL   R COWL

SLATS

NWS

A BRAKE

BRK FAIL

with or without REV ENV

NOTE

Following an automatic closure of both UTILS ISOL valves, the HYD SK legends will occult, i.e. selection of any ISOL SKs is inhibited.

The L and R UTIL P warnings will be displayed when the pressure in the respective systems drops below 140 bar or the respective fluid level drops below 3.5 ltr. The respective ISOL valve will be automatically closed when the respective fluid level drops below 3.5 ltr.

If the landing gear is not DOWN and locked at the time of the double UTIL failure condition, landing gear lowering, normal and/or emergency, is lost.

1. **Recover....................Nominal 1 g level flight**
2. Altitude.......................Below 55 000 ft
3. Speed ....Below 400 KDAS/0.8 M
4. L & R HYD ....ON
5. AOA/g ....20°/2g
6. INTAKE.....................OPEN 42 sec. (-26°)

If landing gear is DOWN:

7. Land..........................ASAP, adhere to approach-end-cable-engagement Cable Engagement pag. 64

If landing gear is UP:

7. Land..........................ASAP, refer to Landing with Gear Unsafe pag. 67

HYDRAULIC OVERTEMPERATURE

L HYD T   or   R HYD T

Failures within the hydraulic system may cause the hydraulic fluid to overheat, indicated by the illumination of the warning caption L or R HYD T. The excess heat load will be transferred to the fuel via the FCOC and may result in the fuel exceeding its temperature limit as well.

A fuel over temperature condition is normally corrected by increasing fuel flow resulting in increased oil cooling via the fuel cooled oil cooler (FCOC). Alternatively, if this is not possible reduce altitude. However, in the case where the HYD T warning comes on first and a fuel leakage is not suspected, then the throttle should be reduced to IDLE to increase the recirculation line fuel cooling fuel flow through the FCOC. A failure within the

FCOC will eventually cause the generators to go off line when the temperature reaches its thermal protection limit.

Select the MHDD/HYD format to check and monitor the respective hydraulics temperature. The warning is displayed when the hydraulics temperature has reached 135 °C.

The respective utilities circuit should be isolated by manually closing the respective ISOL valve. This will help to reduce temperature, provided the failure is within the UTILS circuit.

Prior to landing the affected ISOL valve should be opened again in order to regain redundancy and the NWS, when applicable. The SK AUTO/MAN shall be pressed in order to allow AUTO closure in the case of a UTILS leak. The affected cowl will not reset, nor the airbrake, when applicable.

If temperature is not decreasing after isolation of the UTILS system, then the overtemp condition is expected to be within the CONTR (HYD) system.

1. Throttle affected engine ....Idle
2. Altitude ....Decrease, if possible
3. MHDD/HYD................Check/monitor HYD temp

If temperature is not decreasing:

NOTE

The delay between selection and confirmation of closure may be up to 2 seconds.

4. ISOL affected side......Select MAN then CLSD **L UTIL P** or **R UTIL P** lit
5. INTAKE ....OPEN below 340 KDAS for 42 sec. (-26°)
6. Land ....As soon as practicable refer to Services Lost Gearbox Failure pag. 35

Prior landing:

7. ISOL affected side......Select AUTO/MAN, DWP clear

NOTE

After repressurizing:

– NWS is available.
– L/R COWL and A BRAKE will not reset.

AIR IN HYDRAULICS

L HYD A or **R HYD A**

The test of air/gas in hydraulics is performed on engine (s) start-up. If the system (s) detect an air/gas content of 2.0 ltr or above either in system 1 and/or in system 2, the DWP warning (s) is/are triggered. After being triggered, the DWP warning (s) are latched and can only be reset by a complete power down.

The air/gas content of system 1 and/or system 2 shall also be checked by the ground crew on the MDP. For safety reasons, an Airworthiness Directive (AD 3061) asks already for corrective actions when the air/contents reading on the MDP is equal or above 1.0 ltr.

NOTE

If <L HYD A> and/or <R HYD A> is/are displayed a complete power down is required.

After 3 minutes, reconnect power and restart engines:

1. DWP .... Confirm <L HYD A> and/or <R HYD A> not lit
2. MHDD/HYD .... Check reservoir level;
   – R System: above 9.0 ltr
   – L System: above 6.0 ltr

NOTE

- If relevant values are not met: Abort.
- The warning is currently triggered after engine start up and air/gas content in the respective system exceeds 2.0 ltr.

FLIGHT CONTROL SYSTEM FAILURES

FCS/AIRDATA FAILURES

NOTE

- The FCS procedures of the Flight Crew Checklist reflect the JFO agreed abbreviated standard.
- This section gives a more detailled description of the failure cause rather than repeating the FCC procedures.

Following any persistent resettable or latched FCS or a fuel transfer failure condition the aircraft shall be recovered and restricted to a specific FCS defined envelope.
The DWP High Integrity Warning (HIW) <REV ENV> will be triggered together or on its own, under the following failure conditions:

CG with or without **REV ENV** :

– The warnings indicate that the aircraft must adhere to the specific CG 1 or LATERAL CG zone envelope.

REV ENV :

– If both the <CG> and <REV ENV> warnings occult but the <REV ENV> is being re-triggered within 3 seconds again, the aircraft must adhere to the more restrictive CG2 zone envelope.

REV ENV :

– If the <REV ENV> warning is displayed on its own, i.e. not being re-triggered following a <CG> warning, the pilot has to adhere to the FCS worst case envelope.

FCS with or without **REV ENV** :

– This envelope is determined by the loss of fuel or stores data, requiring the pilot to adhere to specific fuel procedures.

FCS REV with or without **REV ENV** , GUH AOA occulted/not occulted:

– The envelope to be observed is dependent of the kind of airdata failure or, if the PSR mode has been entered (FUEL PROBE IN), of the PSR cleared mode.

FCS REV

– Following extension of the FUEL PROBE to OUT (in PSR mode), the <REV ENV> warning will extinguish, but the <FCS REV> warning is still lit indicating that the PSR mode is active.

SLATS with or without **REV ENV** :

– A specific SLATS out envelope has to be observed. Refer to SLATS Failure pag. 51.

L CONT P or **R CONT P** with or without **REV ENV** :

– The envelope to be observed is FCS dependent, the detailled procedure is covered under HYD System Failures.

Additional recommendations:

– Initially the aircraft should be recovered to a 1g, straight and level flight condition.
– Only symmetric and gentle course changing maneuvers (GCCM) are considered.
– Throttles - Use with care.
– Additional specific limitations within the relevant AWFL have to be respected.

CG/MASS AND/OR STORE FAILURE CONDITIONS

CG1 ZONE WARNING

CG with or without **REV ENV**

CG2 ZONE ENVELOPE WARNING

REV ENV occulted and re–triggered within 3 seconds
The <CG> and the <REV ENV> warnings have been introduced to warn the pilot that a specific FCS zone envelope must be entered. The <REV ENV> warning is triggered:

– Both, the <CG> and the <REV ENV> warnings will be triggered when either the longitudinal CG, the calculated left and right lateral CG, or the difference between the left and right CG are exceeded.
– If the CG travels further fwd or aft than the cleared <CG1> zone envelope, the controllability of the a/c is severely degraded and the pilot needs to observe a further restriction of the <CG2> zone envelope. In this case, both warnings will extinguish, but the HIW <REV ENV> will be re-triggered.

- The <CG> warner is also influenced by false readings from the fuel gauge probes.
- In the case of a LEAS failure condition.
- Following a <FCS MASS> warning.
- Following a single HYD control system failure (not FCS)

WORST CASE FCS FAILURE

REV ENV

The worst case envelope is defined as the failed state where the pilot gets an unknown failure warning that can be caused by any of the following:

- Longitudinal CG 1 range or Fuel/Store system failed.
- Longitudinal CG 2 range failed.
- Lateral CG warning.
- ADS or IMU failure
- LEAS failure.
- Hydraulic failure.

FCS MASS WARNING

FCS with or without **REV ENV**

NOTE

- Prior to entry into FRS the MASS must be selected to STBY and subsequently the MHDD/STOR format should appear. Failure to select the MASS switch to STBY will cause the <FCS MASS> and the <REV ENV> warnings to be generated.
- Selection of the MASS switch from STBY or LIVE to SAFE will trigger the <FCS MASS> and <REV ENV> warnings.

Following EJ or SEL jettison the <FCS MASS> and <REV ENV> warnings are erroneously raised for about 6 seconds. They should be treated as nuisance warnings.
The <FCS MASS> warning is used as a global warning and is raised together with the <REV ENV> warning, if any of the following input warnings are triggered:

- Fuel data loss warning (compares data of the two fuel computers and looks at the AAR probe)
- Stores data loss warning (hardpoint inputs from SCAC are unknown)
- Stores data loss on initialization (FCS and SCAC compare stores data when in FRS & MASS set to SBY)
- SCAC initialization plausibility check (compares SCAC data from 2 pathes: via ATTACK CMPTR and via CSG, either path not healthy will trigger the warning)
- External tanks warning (compares SCAC tanks on/off with FUEL CMPTR tanks on/off, if different raises the warning)
- Hardwired missile fire signal.

AIRDATA SYSTEM WARNINGS

ADS DESIGN

The following apply for ADS failure conditions:

- 1st failures of ADC Ps and Pt are already not resettable.
- Following a 2nd failure condition no upward reconfiguration is allowed, i.e. no FCS RSET.

ADT PT AND PS

The design uses standard voter/momitor arrangement to safely address sequential failures. However, simultaneous failures (2 vs 2) cannot be resolved using the quadruplex voter/monitors. Therefore, it has been necessary to introduce fifth sources of Pt and Ps to act as arbitrators in the event of such a situation arising.

ADT AOA AND SS

The triplex sourced ADT parameters are each produced as a function of each other and thus cannot be considered as independent signals. Failure of a single parameter will introduce errors to the other two.

FCS REVERSIONARY ENVELOPE

FCS REV and **REV ENV**

AOA ON GUH OCCULTED - BARS LIT ON FCS REV BUTTON.

CAUTION

- LARGE DIFFERENCES EXIST BETWEEN DISPLAYED AIRSPEED AND TRUE AIRSPEED IN THE FCS FAILURE INDUCED REVERSIONARY MODE.
- THE DIFFERENCE COULD BE UP TO +/- 40 KDAS WITH LDG UP AND UP TO + 20/- 20 KDAS WITH LDG DOWN.
- AIRCRAFT EQUIPPED WITH THE NOSEBOOM SHOULD USE THE FTI AOA INDICATOR, IF FITTED.

The IMU will provide autonomous AOA and SS only for a very limited period of time (9 sec.). The warnings are raised to instruct the pilot to recover to the FCS reversionary envelope.

The following possible failure conditions will trigger the <FCS REV> and the <REV ENV> warning, and occult the GUH AOA (HUD LDG POF):

- Two or more confirmed failures of ADT Pt/Ps
- Two or more confirmed failures of ADT AOA/SS

TWO ADT FAIL

After a second failure of ADT Ps fail, Ps is switched to DECU (DA4-7) or ADC Ps (DA1-3), while Pt is still provided by the remaining ADTs. AOA/SS are declared invalid with default values being supplied to the users.

THREE ADT FAIL

After a third ADT Pt failure, DECU (DA4-7) or ADC (DA1-3) Ps and Pt are used to produce the airdata parameters supplied to all users. AOA and SS are declared invalid with default values being supplied to the users.

ADE OR MASSFLOW FAILURES

FCS REV and **REV ENV**

The following possible failure conditions will also trigger both warnings:

- One or more Air Data Estimator (ADE) failure conditions
- Two or more confirmed massflow failures with symmetric throttles
- One or more massflow failures with asymmetric throttles, or
- A transient AOA/SS event.

TRANSIENT AOA AND SS FAILURE

Transient AOA and SS events are a 1 vs 1 vs 1 condition, or range limiting applied.

TT OR MASSFLOW FAILURES

FCS 1 with or without **FCS REV** and **REV ENV**

The <FCS 1> warning is raised following one or more confirmed TT failures, or a confirmed first mass flow failure. The pilot is instructed not to use an asymmetric throttle setting to avoid to tripping the TT monitor. Asymmetric throttle settings will cause a second failure condition with <FCS REV> and <REV ENV> being triggered.

AIRDATA WARNING

AIRDATA with or without **FCS 1**

The <AIRDATA> warning is raised to allow safe recovery to the FCS reversionary envelope initially using IMU autonomous generated AOA and SS. The following possible failure conditions will trigger the <AIRDATA> warning:

- Confirmed 1st failure of ADT α/β/Pt/Ps
- One or more ADC failures (5th source for noseboom a/c)
- A transient failure condition of ADC or ADT Ps Pt, or
- DECU Pt/Ps failure.

NOTE

In general, the pilot cannot distinguish between an ADT 1st fail condition, an ADC failure (DA1-3) or a DECU failure (DA4-7) condition.

FIRST FAILURE OF ADT Α/Β/PT/PS

Pt and Ps data are provided by the remaining ADTs. The accuracy of ADT Pt and Ps is only questionable during simultaneous failure (2 vs 2). However, the design protects against simultaneous failure by using DECU pressure data.

When the accuracy of ADT AOA and SS cannot be guaranteed, the IMU produces autonomous AOA and SS, i.e. not slaved to the ADT data. Autonomous AOA and SS however, are only valid for a short duration of time. Therefore the pilot is instructed by the <AIRDATA> warning to recover to the FCS reversionary envelope, where the ADT AOA and SS accuracy is guaranteed.

ADC/DECU FAILURES

ADC 5th source is failed after 2 ADC Ps or Pt fail. DECU 5th source is failed after 2 DECU Ps or Pt fail.

NOTE

On DA1-3 DECU 5th source failure is only indicated during AAR, if applicable. At all other times a DECU 5th failure condition is suppressed.

ADC FAILING OR ADT PS, PT FAIL

Transient failure conditions are either ADC failing, or ADT Ps, Pt rate limiting exceeded, or simultaneous event, i.e. birdstrike.

Summary of Pressure Sources

	Pressure Source Fail Free	AAR Mode	ADT 2nd Fail	ADT 3rd Fail
ADS Pressure Source	ADTs	DECU	ADC (DA1-3)	ADC (DA1-3)
			DECU (DA4-7)	DECU (DA4-7)

PROBE HEATER WARNING

PROBE 2

The PROBE 2 warning can be generated from a number of different sources, which also depends on the configuration of the aircraft, i.e. with or without noseboom fitted.

Therefore the PROBE 2 warning can be caused by:

- One or more ADT heater failure
- A noseboom heater failure

Heater failures are unlatched and can self reset under certain circumstances. A reset of an ADT generated warning can take between 2 seconds and 30 seconds.

DEGRADED AIRDATA

CAUTION

- DEGRADED AIR DATA SENSORS MAY RESULT IN ERRORS IN HUD/ GUH AIRSPEED/ALT OR ERRORS IN GUH AOA NOT DETECTED BY THE WARNING SYSTEM.
- KDAS MAY BE UP TO +/- 12 IN ERROR.

Discrete errors in AOA or in airspeed, or combination of errors in both, will always manifest themselves as an anomaly in the readings of AOA and airspeed.

In the absence of a speed check (chase a/c) or an anomaly of FTI AOA and approach speed, fly the approach speed plus 7 KDAS which will give a maximum undetected error of between 5 KDAS slow up to 19 KDAS fast.

OTHER FCS WARNINGS

FCS 2 WARNING

FCS 2 with or without **FCS 1**

The following restrictions apply:

- Maneuvering is restricted to the FCS reversionary envelope.
- Roller landings shall not be performed. The nose may switch to GND latched after takeoff.

FCS 1 WARNING

FCS 1 with or without **FCS**

- Maneuvering is restricted to the FCS reversionary envelope.
- If NWS legend flashes in the presence of an <FCS 1> failure, NWS and L/D will engage 2 sec. after derotation.
- Unnecessary asymmetric throttle operation should be avoided. If throttles are asymmetric and there is a WAT or a TT 2nd failure, the <FCS REV> will be permanently raised to ensure that the aircraft is recovered to the FCS reversionary envelope, for which default WAT is valid.

TT failures are presently indicated by the <FCS 1> warning. The <FCS 1> warning is the only warning that indicates both a TT 1st and TT 2nd failure. On a TT 2nd failure the system defaults to a ISA based temperature. This in turn leads to a TAS error of ~ 7%, which couples through the ADE estimated AOA/ SS. In order to keep the estimated AOA/SS error to small values the g limit of the a/c must be kept to observe the REV envelope.

In the presence of an <FCS 1> warning AT mode (if cleared) shall not be used for landing approach, i.e. the AT must be switched off. Single FCC failures (<FCS 1>) will lead to AT disconnect without the <A THROT> warning raised. This may lead to incorrect landing speed.

AUTOTHROTTLE WARNING

A THROT

1. ICO .... Press

THROTTLE LINK WARNING

THROT

NOTE

- For SS indicates a descrepency between AT demand and actual throttle position.
- For TWS indicates AT follow-up function degraded.

DEDICATED VOICE WARNINGS

There are two types of procedural warnings:

– CAT1: A notification of a hazardous situation that requires immediate action, and
– CAT4: Advice of a primary Failure requiring attention.

The main FCS related CAT1 and CAT4 warnings applicable to FCS 2B/2 are summarised in the table below.

VOICE MESSAGE	CAT	SYSTEM	ACTION
SELECT REHEAT	CAT 4 all POF	if no response after 15 sec, warning is repeated every 12 sec	Select Reheat
AIRFRAME TEMP	CAT 4 NAV & COMB	retrigger after 30 sec if still present	Reduce Speed
MAX SPEED	CAT 4 NAV & COMB		Reduce Speed
SPEED LOW RECOVER	CAT 1 all except GND	below 150 KDAS LDG UP below 110 KDAS LDG DOWN	Increase speed refer to dedicated procedure

AIRFRAME TEMPERATURE WARNING

CAT 4 - AIRFRAME TEMP
The airframe temperature warning is raised when:

– Temperature is > 373.16° or < 219.16° K or if total temperature > 390.16 K

The warning can be triggered when:

– at high speed and low altitude, or
– at low speed and at high altitude.

NOTE

The voice warning is only triggered twice then it is suspended.

If at high speed and low altitude:

1. Speed .... Reduce

If at low speed and high altitude:

1. Speed .... Increase

MAX SPEED WARNING

CAT 4 - MAX SPEED
The warning is dependent upon the following factors:

For SS and configuration 1, i.e. no tanks:

– Altitude < 55 000 ft and
– Speed (EAS) > 750 kts or Mach > 2.0.

If altitude above 55 000 ft Mach limit is reduced by 0.2 per 10 000 ft, i.e. at 65 000 ft the warning is raised at 1.8 Mach.

For TWS the overall Mach limit is 1.9.

For configuration 3, i.e. one or more 1 000 ltr tanks:

– Altitude < 45 000 ft and

– Speed (EAS) > 675 kts or Mach > 1.8.

If altitude > 45 000 ft max Mach is reduced by 0.3 per 10 000 ft, i.e. at 55 000 ft warning is raised at Mach 1.5. at 65 000 ft at Mach 1.2

NOTE

- The voice warning is only triggered twice then it is suspended.
- The warning is raised if speed is > 750 KEAS.

1. Speed........................Reduce

AIR INTAKE COWL FAILURE

L COWL or **R COWL**

CAT 3 in GND POF only.

The warnings <L COWL> and/or <R COWL> are generated following a detected failure of the left or right, or both cowl functions. Cowl failures cannot be reset. These failures can be either:

– A failure detected in either the left or the right or both air intake cowl actuator control loop, or
– A failure of the respective or both hydraulic/ utilities systems.

The failed cowl (s) will freeze at the last commanded position. If MAN INTAKE COWL has not been selected at the time of failure (DA1/2/3/5) it can be assumed that the cowl(s) are frozen to a safe value by the FCC monitors, i.e.:

– to 0° (true) cowl angle when flying above 0.4 M, or
– to -26° (true) cowl angle when flying below 0.35 M

FAILURE OF THE AUTOMATIC CONTROL MODE

In the event of a failure of the automatic scheduled system the start solenoid valve(s) is (are) de-energized and the current cowl lip(s) position is (are) hydraulically locked to a safe position.

FAILURE OF THE MANUAL CONTROL MODE (WHEN APPLICABLE)

NOTE

Do not operate both MAN cowls at the same time.

If in MAN mode, and if a failure is detected the cowl will revert to the automatic mode for both cowls, but the affected cowl(s) will be frozen. MAN mode is disabled. The frozen cowl can be moved to the OPEN position by the emergency INTAKE switch.
If the INTAKE VARICOWL MAN pushbutton illumination does not change upon operating the button, then the following procedure can be used:

– Operate the INTAKE VARICOWL up/down switch and check whether the cowl moves accordingly.
– If so, then the manual mode is active, otherwise the automatic mode.
– The mode can now be corrected, if necessary.
– If the INT position display is not available or the indicated INT movements are not in line with the up/down commands nor with the current flight condition, a safe mode is not possible and the flight envelope shall be restricted.

EMERGENCY INTAKE CONTROL

Failure conditions of either cowl will have no effect on the manual operation of the emergency INTAKE control. In case of a total electrical DC failure (PP3 and PP4), the system reverts to battery power for appr. 10 minutes.
In the absence of a detected failure, setting the emergency cowl INTAKE switch to the OPEN position will have no effect on the automatic cowl control.
The INTAKE emergency control switch commands the respective cowl(s), either left or right or both, to move downwards as long as the switch is held to the OPEN position. The system will automatically select the faulty cowl or both cowls, respectively.
The INTAKE emergency control switch enables to inch the cowl lip to the open position by means of:

– Hydraulic pressure in the case of electrical failure, or
– Aerodynamic load, in case of hydraulic supply failure.

1. INTAKE .... OPEN below 340 KDAS/0.9 M for 42 sec. (-26°),

DATUM ADJUST TRIM SWITCH FAILURE

TRIM

NOTE

At this standard the position DA (fwd) is not used (no AP).

The individual pitch, roll and yaw trim cancel discretes are combined in a single cancel discrete.
The trim logic is as follows:

– In the event of TRIM/DA switch failure, the TRIM/DA signals default to DA, i.e. pitch and roll trims are set to trim cancel. The yaw trim function will still be fully operative, provided the yaw trim switch is itself not failed.
– If the TRIM/DA switch is in the TRIM position (AP not engaged/not available) and the stick mounted pitch and roll trim button fails, all trim inputs in pitch, roll and yaw are cancelled. However, when setting the switch to the DA position, the yaw trim function will be restored, provided the yaw trim switch has not failed.
– A second sequential detected failure of the triplex TRIM/DA selector discrete voter/monitor, regardless of switch position at the time of failure, will set the <TRIM> warning. All previous applied trim inputs are fading back to the safe zero datum after 2 seconds. The TRIM/DA switch defaults to DA. All manual trims are inoperative and the failure is not resettable. A single failure results in a FCS 1 warning.
– Following misuse of the pitch/roll trim button, i.e. operation of this button for more than 30 seconds will trigger the <TRIM> warning. All pitch and roll trim inputs are fading back to the safe zero datum. If the trim button is released after display of the <TRIM> warning, the warning will occult after approximately 35 seconds. The trim button can subsequently be used again. Yaw trim is not affected (quadruplex).

RUNAWAY TRIM

The control stick manual trim demands for the pitch and roll axis are only simplex signals and a runaway in pitch and roll has a high probability.
A trim runaway, i.e. failure of the simplex trim pitch/roll button, is not indicated, but the auto trim cancel function will be activated. Up to 30 seconds may be required to invoke the Auto Trim cancel function.

If less than 30 seconds from landing and cross-wind is greater than 20 kts:

1. Do not land-Go around

AIRBRAKE FAILURE

A BRAKE

The warning is displayed when:

– A failure is detected in the airbrake actuator control loop, or
– A failure is detected in the duplex airbrake selector switch voter/monitor, or
– In the case of a right (system 2) hydraulic/utilities failure.

Following the loss of the airbrake function in/out, the airbrake command in/out is lost, but the airbrake will retract:

– In the case of hydraulics loss under aerodynamic loads, or
– In the case of electrical failure under hydraulic pressure.

On setting of low hydraulic capability the A/B is frozen to protect the hydraulics. On reset of the low hydraulics the A/B is commanded to close.
When the airbrake is stuck out, the airbrake switch shall be selected to 'in`. The switch signal then defaults to 'in` and the airbrake should retract.

1. Airbrake ....Select in, check HUD

If airbrake still out:

2. Speed ....Below 0.7 M

SLATS FAILURE

SLATS

with or without **REV ENV**

The warnings are generated following a detected failure resulting in the loss of the leading edge function. These failures can be either:

– A second detected failure in the leading edge actuator control loop (a single failure results in a FCS 1 warning), or
– A detection of an asymmetric position between the left and the right leading edge wing half slats, or
– A detection of leading edge overspeed (hydraulic motor damage).

Failure logic is incorporated to assist the pilot to control the aircraft in the event of a 'freeze` or reduction in speed of the L/E slats.
The logic reduces both pitch and roll full stick authority, and has the purpose of supressing cross maneuver levels.
A failure of one utility system has no effect on aircraft handling, however reduces hinge moment (max drive torque). A second failure, i.e. the loss of total (double) utilities and/or a mechanical failures (shaft breaking etc.) will freeze both slats at their present position.

1. **Recover ....Nominal 1 g level flight**
2. Altitude ....Below 40 000 ft
3. Speed.........................Below 400 KDAS/0.8 M
4. AOA/g.........................20°/2 g

AVIONIC SYSTEM FAILURES

LOSS OF HUD SYMBOLOGY

In the event of a loss of HUD symbology revert to the MHDD head-down HUD format. The format can be displayed by pressing the HUD SK. If MHDD information is not available, revert to the get-u-home (GUH) instruments.

1. MHDD/HUD .... Press

NOTE

- On pre FCS 2B2 aircraft, no attitude or heading data are available on the right glareshield GUH instruments.
- On post AVS 3B aircraft - in the event of loss of symbology in conjunction with loss of HUP GUH data, set the HUD power switch to OFF to recover the GUH data.
- If no MHDD information available, revert to GUH instruments.

INERTIAL NAVIGATION FAILURE

LINS

NOTE

On post FCS 2B2 aircraft all vertical velocity data (including GUH) is inaccurate.

Upon failure of the laser inertial navigation system, indicated by a category 3 warning, use standby and GUH instruments. RAD ALT data occults from the HUD/MHDD and radar functions are lost. NWS 43° mode is lost. Relative TACAN bearing is erroneous, however absolute TACAN range and bearing are still provided.

RADAR ALTIMETER FAILURE

RAD ALT

RAD ALT failed.

In the event of a radar altimeter failure, climb to a safe height above the local terrain and use the barometric altimeter display on the head-up display for further height information.

NAVIGATION COMPUTER FAILURE

NAV CPTR

Upon failure of the navigation computer the system will revert to the attack computer for bus control requirements, but all navigational information except LINS data will be lost. It is important to land as soon as practicable as there is no reversionary bus control. Subsequent loss of the attack computer would necessitate recovery using get-u-home instruments only.

NOTE

Irrecoverable failure of CIU/CSG functions may occur while the avionics databus is under reversionary control.

1. Steering .... Use TACAN for remainder of flight

Avionics bus will be under reversionary control of the attack computer. All navigation functions performed by the navigation computer are lost, however, LINS, TACAN and FCS IMU data will continue to be displayed

TACAN FAILURE

TACAN

TACAN failed.

Failure of the TACAN system is indicated by a category 3 warning. Upon TACAN failure, TACAN range and bearing information is not available.

ATTACK COMPUTER FAILURE

ATK CPTR

Attack bus will be under reversionary control of the navigation computer. No weapon aiming is provided. If subsequent navigation computer failure occurs:

– Only GUH information is available.
– All radar functions are lost.
– The following transponder facilities are lost:
  - Transponder mode C - height transmitted will be zero.
  - Transponder mode selection
  - Transponder NORM/SBY selection
  - Transponder ident.

1. Land .... As soon as practicable

SINGLE / DOUBLE CIU FAILURE

CIU .

A failure is indicated by a category 3 warning. Reversion to second CIU is automatic and requires no aircrew action. A double CIU failure disables the cockpit data bus causing the DWP to switch to reversionary mode, the MHDD soft keys and HUD moding keys to become inoperative and blanking of the left glareshield and right glareshield dedicated read out panel displays. All switches and rotary controls that interface with the avionic systems via the CIU will be inoperative.

Auto reversion to second CIU

1. MHDD ....Select formats most appropriate to prevailing conditions

If conditions (weather/location) are such that a second CIU failure would not affect aircraft safety:

2. Continue sortie

Otherwise:

2. Land ....As soon as practicable

NOTE

Following a double CIU failure:

- Manual selection of the MHDD formats and POF modes is not possible. However, if the POF is made to change automatically, selection of the default formats will be supported.
- A second CIU failure will result in the following:
- DWP switches to reversionary mode (voice unaffected)
- MHDD soft keys are blank
- HUD moding selection lost
- Left glareshield blank
- Right glareshield DRP blank
- Most switches and rotary controls, except those that are hardwired will be inoperative.

SINGLE / DOUBLE CSG FAILURE

CSG

NOTE

Aircrew should be aware that if an unacknowledged warning exists at the time of a CSG failure the attention getters will continue to flash for the remainder of the sortie. Operation of the attention getters will not otherwise be affected.

Upon failure of one CSG, indicated by a category 3 warning, the system will revert to the serviceable CSG. Reversion is automatic and requires no aircrew action.

Auto reversion to second CSG.

1. Land .... As soon as practicable

If the second CSG fails:

A second CSG failure will result in the following:

– DWP switches to reversionary (REV) mode and the CPT DISP caption is displayed

– Voice reversionary

– MHDD symbology lost and soft keys blank

– HUD symbology lost.

2. MDE-XMIT................. RDR SBY (If aircraft is equipped with radar)

GPS FAILURE

GPS

GPS sourced ground speed is lost and therefore cannot be displayed on the MHDD/HUD format. However ground speed will continue to be displayed on the MHDD/HUD format but will be sourced from LINS.

Loss of GPS ground speed on MHDD/HUD.

NOTE

The GS display on the MHDD/HUD will be provided by LINS.

IFF TRANSPONDER WARNINGS

IFF TRANSPONDER FAILURE

XPDR

A failure of the IFF Transponder is indicated by a category 3 warning and the voice warning "Transponder". Upon XPDR failure inform controlling agency.

IFF TRANSPONDER AUTOMATIC CODE CHANGE AVAILABLE WARNING

When Transponder ACC codes have been loaded, their start time is valid and the ACC has not been selected the category 4 voice warning "Transponder A.C.C. available" will be provided.

IFF MODE 4 INCORRECT OWN RESPONSE WARNING

When the system detects that the transponder failed to provide and/or complete a Mode 4 response the category 4 voice warning "Mode 4 Response" will be provided.
The warning may be canceled by either selecting Mode 4 or deselecting the response warning using the XY controller on the Mode 4 response icon.

IFF TRANSPONDER CRYPTOVARIABLE FAILURE (MODE 4)

IFF CRYP

The cryptovariable warning, category 3, is generated in the following cases:

– No cryptovariable codes have been loaded.
– The cryptovariable codes have been cleared during operation.
– A fault occurred in the IFF crypto module.
– The crypto erase function has been selected.

As a consequence the Mode 4 will be lost.

DASS COMPUTER FAILURE

DAS CPTR

A category 3 DAC Failure will have the following consequences:

– MDE Radar channel input lost,
– Radar performance in GUN and VISident mode may be degraded,
– RF interoperability relies on loaded default data,
– MDE CHAFF/FLARE modes lost,
– Expendables release relies on back-up program loaded in dispensers,
– CHAFF /FLARE switch, forward function lost (default chaff only or expendables program).

MDE RADAR CHANNEL INPUT LOST

When the DAC fails the MDE MK "RDR CHAN" will be occulted and lost.

RADAR PERFORMANCE IN GUN AND VISIDENT MODE MAY BE DEGRADED

Normally the DAC passes the allocated channels and the frequency mode to be used, "fixed" or "agility", to the radar. If the DAC fails, the radar will continue to operate on the last information received from the DAC. This means the radar will operate with either fixed frequencies or frequency agility. Therefore if fixed frequency was the last mode, the radar modes normally using frequency agility for better performance will operate on fixed frequencies only and performance may be degraded.

RF INTEROPERABILITY RELIES ON DEFAULT DATA

In case of a DAC failure the continuous monitoring of a frequency conflict between transmitters and receivers is lost. As long as 28 V DC is available the default matrix loaded in the DAC via mission data is still available and will blank receivers on default values, where receivers are blanked more often than necessary.

MDE CHAFF/FLARE MODES LOST

The system relies on back-up mode for expendables release.
Normally Chaff packets are released under software control of the DAC. To provide a reversionary capability, in the event of a DAC failure, a back-up expendable program is stored in each dispenser. This back-up expendable program is downloaded from the DAC as part of its power-up initialization sequence. The back-up program is pre-defined on the ground and will be loaded into the DAC either by

– the GLU with the capability to update it by use of the PDS, or
– PDS, if no multi-mission data has been previously loaded via the GLU.

CHAFF /FLARE SWITCH, FORWARD FUNCTION LOST

The CHAFF/FLARE INITIATE switch has three positions. The forward selection "release default chaff only program or the expendables program selected on the MDEF" will be lost. The aft position “release of default chaff and flares program” will remain.

RADAR SHUT DOWN/TOTAL FAILURE

RADAR SHUT DOWN

RADAR

When the CAT 3 warning Radar Shutdown is indicated by RADAR SD on the DWP with voice warning 'RADAR SHUTDOWN' the Radar will be in an overheat condition and should be switched to STBY first, and then to OFF to avoid damage to the equipment. It will automatically shutdown at a defined temperature. Prolonged operation may lead to a total radar failure with the interrogator function lost also. The interrogator should be switched to OFF.

1. RDR (MDE-XMIT) ......SBY
2. RADAR (gangbar) ......OFF
3. INT (gangbar).............OFF

RADAR TOTAL FAILURE

RADAR

and **IFF INT**

A total Radar failure is indicated by the CAT 3 warning RADAR on the DWP with voice warning 'RADAR'. The failure will be reflected on the Elevation, PA, and Attack MHDD formats. An IFF Interrogator failure will be displayed as secondary warning. All radar and interrogator related functions are lost and autonomous weapon aiming is severely degraded. The radar should be switched to SBY, if SBY on the MDE is still effective, to avoid futher damage to the high voltage equipment, and then to OFF. Radar total failure is suppressed when radar is OFF. The interrogator should be switched to OFF also.

1. RDR (MDE-XMIT) ......SBY, if possible
2. RADAR (gangbar) ......OFF
3. INT (gangbar).............OFF

IFF INTERROGATOR WARNINGS

IFF INTERROGATOR FAILURE

IFF INT

A failure of the IFF Interrogator is indicated by a category 3 warning and the voice warning “Interrogator ”.

IFF INTERROGATOR AUTOMATIC CODE CHANGE AVAILABLE WARNING

When Interrogator ACC codes have been loaded, their start time is valid and the ACC has not been selected the category 4 voice warning “Interrogator A.C.C. available” will be provided.

IFF MODE 4 INCORRECT TARGET RESPONSE WARNING

When Mode 4 is selected and an incomplete Mode 4 response is received from the target this will be indicated by the characters “Mode4” with the associated IFF track or plot on the AF.

IFF INTERROGATOR CRYPTOVARIABLE FAILURE

IFF CRYP

The cryptovariable warning, category 3, is generated in the following cases:

- No cryptovariable codes have been loaded.
- The cryptovariable codes have been cleared during operation.
- A fault occurred in the IFF crypto module.
- The crypto erase function has been selected.

As a consequence the Mode 4 will be lost.

ENVIRONMENTAL CONTROL SYSTEM FAILURES

PRESSURIZATION/ECS FAILURES

ECS FAILURE

ECS

If there is no other warning, the illumination of the ECS caption indicates that the UCS has detected a single or a combination of the following conditions:

– overpressure, low pressure or overtemperature on the ECS lines
– temperature control failure
– avionic cooling fans functioning without requirement.

If any of the above mentioned conditions occurs, the UCS electrically commands; the variable pressure regulating and shut-off valve and the ECS shut-off valve to close, and the MSOC pressure regulating shut-off valve to open. Precooled air supply to canopy seal, anti-g and MSOG remains. The canopy antimist and demist function is overridden. Simultaneously, the ECS caption comes on.

NOTE

The ECS caption is displayed on the DWP whenever the ECS switch is placed to OFF/RESET and electrical power is on.

Reset the system by setting the ECS switch to OFF/ RESET and then to ECS.

– If the ECS caption goes off, continue normal operation.
– If the ECS caption remains on, the flight is allowed only within the emergency ram air envelope (Figure 3-6). Once the aircraft is within limits, place the ECS switch to RAM AIR (ECS caption goes off).
  Be prepared for a cabin low pressure. If it occurs, CABIN LP caption comes on, descend to an altitude lower than 26 000 feet.

If no other warning:

1. ECS .... OFF/RESET then ECS

If warning persists:

2. ECS .... RAM AIR, within limits (warning occults)

FAN FAILURE

FAN

Illumination of the FAN caption indicates that the avionics cooling fans have failed to operate when required.
In flight, after an ECS failure, if the red FAN caption comes on, switch off all non-essential avionic equipment and land as soon as possible.

WARNING

ANY PROLONGED PERIOD OF FLYING WITHOUT COOLING THE AVIONICS AND GENERAL EQUIPMENT, MAY CAUSE INCREASING EQUIPMENT PERFORMANCE DEGRADATION AND DECREASING RELIABILITY. SUBSEQUENTLY, FLIGHT CONTROL SYSTEM COMPUTERS FAILURE MAY OCCUR.

1. Land .... ASAP

CABIN LOW PRESSURE

CABIN LP

Illumination of the CABIN LP caption indicates that cabin pressure altitude is above 26 000 feet. The most probable cause of this warning is a secondary result of an ECS failure. Nevertheless, it may be due to a high loss of pressure in the cabin.

– If CABIN LP caption comes on, descend to an altitude lower than 26 000 feet.

1. Altitude .... Below 26 000 ft

CABIN HIGH PRESSURE

CABIN HP

Illumination of the CABIN HP caption indicates that cabin differential pressure is higher than 45 KPa, due to failures of the cabin pressure control valve and the cabin safety valve.
Place the ECS switch to OFF/RESET. The ECS caption will come on. Flight is allowed only within the emergency ram air envelope (Figure 3-6). Once the

aircraft is within limits, place the ECS switch to RAM AIR.

Be prepared for a cabin low pressure indication. If it occurs, descend to an altitude lower than 26 000 feet.

1. Recover .... Nominal 1 g
2. ECS .... RAM AIR, within limits

CONTROLLED HOT BLEED AIR LEAK

ECS

MSOC

If a hot bleed-air leak is detected, the UCS electrically commands both engine bleed shut-off valves to close. There is no supply to any line of the ECS, MSOG, canopy seal, anti-g, antimist/demist and crossbleed.

Illumination of ECS and MSOC captions indicate that there is a controlled hot bleed-air leak (the engine bleed shut-off valves are closed) and, by UCS action, the auxiliary oxygen supply is selected.

The flight is allowed only within the emergency ram air envelope (Figure 3-6). Once the aircraft is within limits, place the ECS switch to RAM AIR. Descend to an altitude below 10 000 feet and monitor the auxiliary oxygen bottle (AOB) contents on the MHDD/PA. If the AOB is depleted disconnect the mask hose and breathe cabin air. Land as soon as possible.

1. ECS .... RAM AIR, within limits
2. Altitude .... Below 10 000 ft
3. AOB contents .... Monitor on MHDD/PA
4. g .... 3.6 max

If AOB contents depleted:

5. Mask Hose .... Disconnect and breathe cabin air
6. Land .... ASAP

UNCONTROLLED HOT BLEED AIR LEAK

ECS

MSOC

L ECS LK or **R ECS LK**

Illumination of ECS, MSOC and L (or R) ECS LK captions indicate that there is a hot bleed-air leak, the UCS has commanded both engine bleed shut-off valves to close and an engine bleed shut-off valve does not close (the hot leak is uncontrollable).

There is no supply to any line of the ECS, MSOG, canopy seal, anti-g, antimist/demist and crossbleed.

The UCS has selected the auxiliary oxygen supply.

Shutdown the related engine immediately. The flight is allowed only within the emergency ram air envelope (Figure 3-6). Once the aircraft is within limits, place the ECS switch to RAM AIR. Descend to an altitude below 10 000 feet and monitor the auxiliary oxygen bottle (AOB) contents on the MHDD/PA. Land as soon as possible. If the AOB is depleted disconnect the mask hose and breathe cabin air.

1. Throttle affected engine .... HP SHUT
2. LP COCK affected side .... SHUT
3. ECS .... RAM AIR, within limits
4. Altitude .... Below 10 000 ft
5. AOB contents .... Monitor on MHDD/PA
6. g .... 3.6 max
7. Land .... ASAP, refer to Single Engine Operation

If AOB contents depleted:

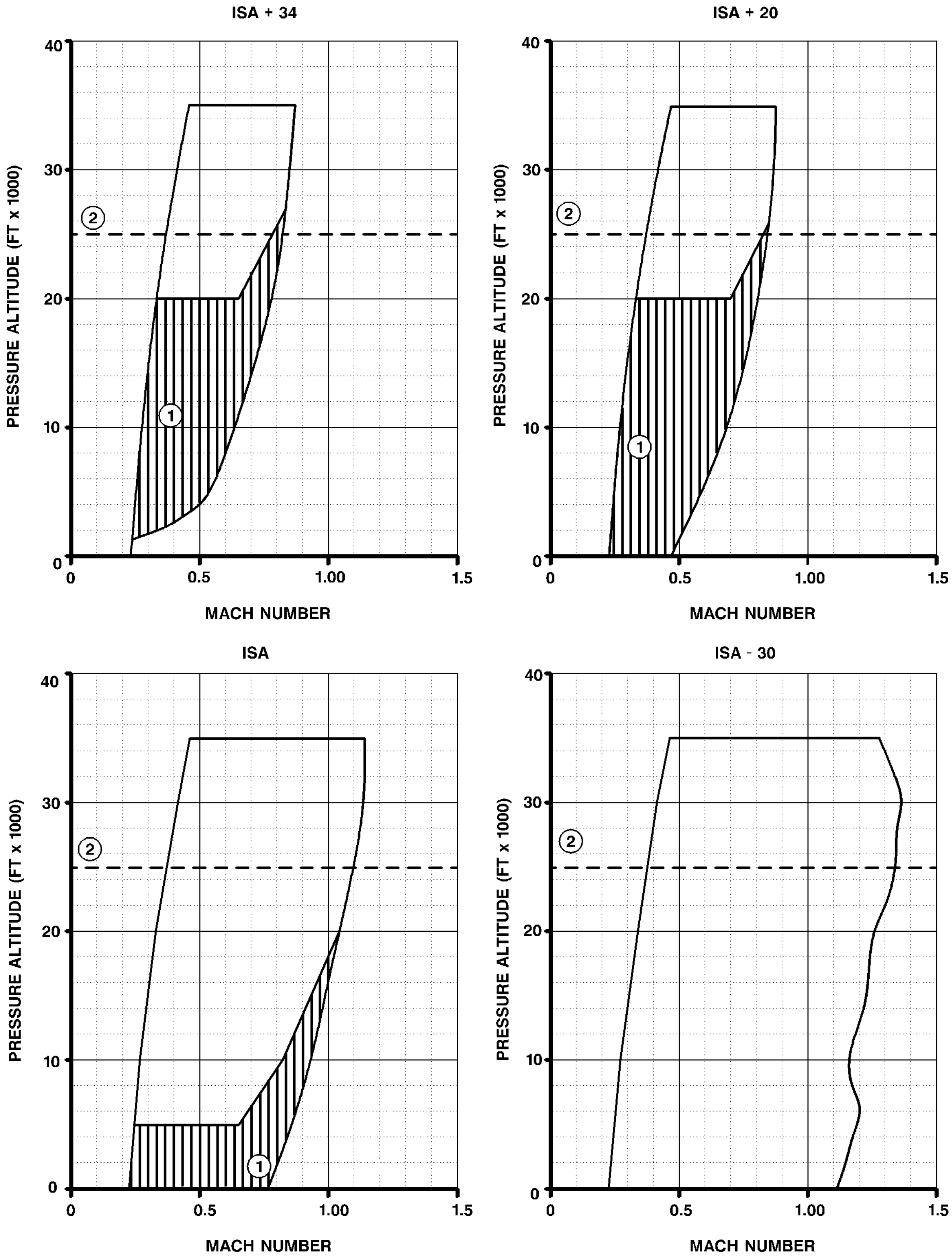
8. Mask Hose .... Disconnect and breathe cabin air

UNCOMMANDED SELECTION OF DEMIST

The uncommanded selection of demist is noticed by the pilot as there is an increase in noise and a demist airflow. Set the DEMIST switch to OFF and if the airflow cannot be deselected; place the ECS switch to RAM AIR, when the aircraft is within the ERA envelope (Figure 3-6).

If the airflow cannot be deselected by selecting the DEMIST to OFF:

1. ECS .... RAM AIR, within limits



① TOO HOT FOR MHDD AND HUD

② LIMIT FOR MEDICAL REASONS

Figure 3.6 - Emergency Ram Air Envelope

ECS COMPATIBILITY AREA

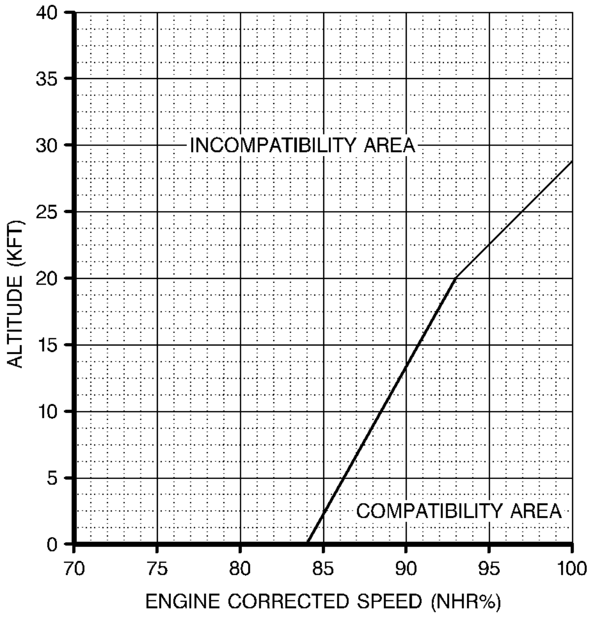


Figure 3.7 - ECS/SPS Compatibility/ Incompatibility Area

SMOKE OR FUMES IN COCKPIT

Consider all unidentified fumes in the cockpit as toxic. Do not confuse condensation from the environmental control system (ECS) with smoke. The most probable source of visible smoke or fumes in the cockpit is from the engine bleed or residual oil in the ECS ducts. This smoke is blue grey in color, has a characteristic pungent odor, and may cause the eyes to sting. Another possible source of smoke or fumes is an electrical malfunction or overheat of equipment located in the cockpit. In the event of electrical short or overload condition, this equipment may generate electrical smoke (usually white or grey in color) but should not cause an open fire since cockpit equipment uses very little electrical current. Cockpit electrical wiring insulation may smolder and create smoke, but will not erupt into a seriously damaging fire.

If smoke or fumes is detected, manually select the auxiliary oxygen supply. Go into limits of the emergency ram air envelope. Once within limits, place the ECS switch to RAM AIR.

If electrical smoke is confirmed, switch off all non-essential electrical equipment. Land as soon as practicable.

If cockpit visibility restricted, slow and jettison canopy.

1. **Auxiliary oxygen ......Select**
2. ECS............................RAM AIR, within limits

If unable to clear smoke:

3. All non-essential electrical equipment .. OFF
4. Canopy Jettison handle .... Pull, if necessary

OXYGEN FAILURES

AUXILIARY OXYGEN FAILURE

OXY

Illumination of the OXY caption indicates that the oxygen concentration (oxygen partial pressure) is below the minimum requirement and the automatic selection of the auxiliary oxygen supply has failed.

Manually select the auxiliary oxygen supply by pulling the auxiliary oxygen selector handle (the MSOC caption will come on). Descend to an altitude below 10 000 ft. Check auxiliary oxygen bottle (AOB) contents during the descent on the MHDD. If AOB contents depleted, disconnect the mask hose and breathe cabin air. Land as soon as possible.

1. **Auxiliary oxygen...... Select**
2. Altitude .... Below 10 000 ft

If AOB contents depleted:

3. Mask hose .... Disconnect, breathe cabin air
4. Land .... ASAP

MSOC FAILURE

MSOC

Illumination of the MSOC caption indicates that the oxygen concentration is below the minimum requirement and the auxiliary oxygen supply has been selected.

Monitor the AOB contents on the pilot awareness format on any MHDD, and after 1 minute:

– If the warning occults, continue with the mission
– If the warning persists, descent to an altitude below 25 000 ft.

- If **OXY** is displayed, descent to an altitude below 10 000 ft. Land as soon as possible.
- If AOB contents depleted, disconnect the mask hose and breathe cabin air.

1. AOB contents .... Monitor on MHDD/PA

If after 1 minute, warning occults:

2. Mission....................... Continue

If after 1 minute, warning persists:

2. Altitude....................... Below 25 000 ft

If OXY *is displayed:*

3. Altitude....................... Below 10 000 ft
4. Land.......................... ASAP

If AOB contents depleted:

5. Mask hose .... Disconnect, breathe cabin air

UCS FRONT COMPUTER FAILURE

UCS CPTR

When a Front Computer failure is detected, the appropriate warning is given on the DWP. The attention getters flash and the "UCS computer" voice warning is given.
If a Front Computer total failure occurs, the following controlled/monitored services will be lost:

- ECS;
- AOB automatic control selection;
- Cabin conditioning;
- MSOC;
- Canopy seal (monitoring);
- Antimist/Demist;
- Anti-g.

CAUTION

CROSSBLEED, ECS, CANOPY SEAL, ANTIMIST/DEMIST, ANTI-G AND MSOC ARE LOST, WITHOUT ECS AND MSOC WARNING DISPLAYED.

1. **Auxiliary oxygen...... Select**
2. ECS .... RAM AIR, within ECS limits
3. Descent .... 10 000 ft or below

If AOB supply depleted:

4. Mask hose .... Disconnect and breath cabin air
5. Land.......................... ASAP

WINDSCREEN HEATER FAILURE

WINDSCR

1. W/S HTR.................... OFF

If mist forms on the windscreen:

2. DEMIST .... REV

SINGLE ENGINE OPERATION

ENGINE FAILURE ON APPROACH

If an engine fails during the approach, normally due to mechanical, FOD and aerodinamic failures advance both throttles above 70% NL and modulate engine speed up to max reheat rating to obtain maximum thrust from the good engine and ensure the engine air automatic cross-bleed operation and eventually engine relight.

If the decision to land is made, after re-establishing the glidepath at 2,5° glideslope, fly 13° AOA until landing is assured. Preselect the lift dump (Lift Dump switch to DUMP) to automatically position the flaperon/foreplanes to a defined lift dump setting to reduce the ground run when WOW conditions are met.

During Taxi at Idle the nozzle is forced to open its max. position as long as NL is below 70% and, if necessary, refer to appropriate drill. If decision to make a go around, level wings, retract gear and climb away accelerating at 13° AOA.

Flaperons/Foreplanes raised to reduce drag and improve overshoot performance by means of automatic control laws functions. Ensure that the engine speed of the good engine is higher than 70% NL. Shut down the failed engine when time permits.

1. Throttle (good engine) .... Not below 70%NL
2. Land .... ASAP, refer to Single Engine Operations

SINGLE ENGINE OPERATIONS

TRANSIT

Regardless which engine has failed, common procedures are available for Transit, Descent/ Recovery and Landing. If necessary, refer to the relevant single engine range and endurance charts in the Flight Crew Checklist.

When one engine has failed and the engine speed is running down to the idle speed, provided that the AIR DRIVE switch is set to AUTO, the air cross-bleed operation will automatically start.

The air will be provided from the good engine, its speed will not be lower than 70%NL (85%NH).

The throttle of the failed engine must be retarded to the HP SHUT position and the LP COCK switch to the SHUT position (guard open). Throttle can then be used to help HOTAS functions.

Selecting the FUEL XFEED to OPEN interconnects the fuel feed lines of the engines and prevents fuel inbalance.

Only if a fuselage fuel leak is present, the FUEL XFEED must remain in the NORM position. Refer to Single Engine Approach Chart to determine mass.

Consider dumping fuel or jettisoning stores to reduce mass and improve conditions for an approach within the dry power range.

CAUTION

- IF THE GOOD ENGINE IS SET TO IDLE, A FAILED ENGINE GEARBOX RUNDOWN/UNDERSPEED IS LIKELY TO OCCUR WITH ASSOCIATED LOSS OF ELECTRICS.
- DO NOT SET THE AIR DRIVE SWITCH TO AUTO IF THE POT SHAFT IS FLAILING AND/OR DAMAGE IS SUSPECTED.

1. Throttle good engine.. Not below 70%NL
2. Negatiive g .... Avoid
3. Fuel .... Check contents/ balance

If no fuel leak suspected:

4. XFEED .... OPEN
5. Land .... As soon as practicable

LANDING

Check fuel contents and calculate approach speed. The airbrake should be IN. Confirm that harness is tight and locked.

The approach is normally flown as a straight-in with 13-14°AOA.

Approach speed/AOA same as with 2 engines.

1. Throttle good engine.. Not below 70%NL
2. Fuel .... Check contents/ balance
3. Landing gear .... Down, below 290 KDAS, 3 green/3D
4. Hook light .... Out
5. Harness .... Locked

OVERSHOOT

The decision whether to continue the approach or overshoot must be made as early as possible. Advance both throttles up to MAX RHT, retract the landing gear and establish wings level at 13-14°AOA climb until clear of obstacles, using rudder to maintain heading.

Accelerate in a shallow climb and carry out the appropriate engine shut-down procedure when time permits.

1. Throttle good engine.. As required, not below 70%NL

APPROACH/LANDING EMERGENCIES

NWS FAILURE AIRBORNE/APPROACH

NWS

or **NWS** NAV POF

with or without **FCS 1**

and/or **FCS 2**

The <NWS> warning can be triggered either by:

- A failure detected in the nose wheel actuator loop, or
- Weight on nose wheel detected jammed on ground, or
- ICO has been activated with LDG DOWN, or
- A failure of FCC3 indicated by **FCS 1** with LDG DOWN.

The conditions resulting in a flashing <NWS> legend on the FCS RSET button are as follows:

- **NWS** plus flashing NWS legend due to ICO, or
- **FCS 2** plus flashing NWS legend due to FLIGHT LATCHED condition (nose wheel jammed on the ground).

With the LDG down, indication is given to the pilot whether or not automatic NWS is available on landing by the following:

NWS displayed and NWS legend not illuminated or flashing on FCS RSET button:

- No automatic engagement of the NWS.

NWS displayed and NWS legend flashing on FCS RSET button:

- No automatic engagement, but pressing the FCS RSET push button makes automatic engagement available on landing.

NWS legend flashing on FCS RSET button, without <NWS> on DWP:

- Automatic engagement of NWS after touchdown, but reduced redundancy of WOWs.

NOTE

Consider approach end cable engagement or aerodynamic braking.

1. Pre Landing Checks ..Perform

After mainwheel touchdown:

2. Brake chute................Deploy

If **FCS 1** *and/or* **FCS 2** *is displayed:*

3. Derotate ....Immediately
4. Directional control ......Use rudder, differential braking below 90 KDAS

For landings, with x-wind greater than 20 kts, or with x-wind equal or greater 10 kts and lateral CG imbalance is present:

After mainwheel touchdown:

2. Derotate ....As soon as practicable

After nosewheel touchdown:

3. Stick ....Full forward and roll into wind until brakes applied
4. Brake chute................Deploy

NOTE

If directional problems occur during x-wind landing, jettison brake chute

5. Directional control ......Use rudder, differential braking below 90 KDAS

NWS FAILURE - PRE TAKEOFF/ LANDING

NWS

with or without FCS 1

and/or FCS 2

Disengagement of the NWS is indicated by:

If NWS is displayed:

– NWS is disengaged by ICO, or a flight latched condition is present.

Flashing the <NWS> legend on the FCS RSET push button at 0.25 Hz:

– NWS is engageable via the FCS RSET push button.

<NWS> legend on FCS RSET button not lit:

– NWS not engageable due to NWS position range exceedance.

If NWS is displayed on landing the nose wheel is in free castor mode. The aircraft is only steerable by differential braking and/or rudder effectiveness.

NOTE

- If during crosswind landings the brake chute is selected on MW touchdown and a nose wheel failure is encountered on nose wheel touchdown leading to lateral/directional control problems then the brake chute shall be jettisoned.
- Steering at low speeds may be difficult. Stop, shut down and tow-in may be necessary.

ANTI SKID FAILURE

A/SKID GND, T/O

A/SKID APP/LDG

The DWP warning caption will be displayed in the case of a total (system 1 and sytem 2) anti-skid failure.

1. Land .... Consider approach end cable engagement, refer to Cable Engagement pag. 64
2. Brakes .... Use with care

WHEEL BRAKE FAILURE

BRK FAIL GND, APPR/ LDG

BRK FAIL T/O

The CAT2 or CAT 3 (depending on POF) DWP warning caption will be displayed following a double brake system failure (system 1 and system 2). There is a high possibility that the <A/SKID> warning is triggered as well.

On the ground, if a single brake failure is detected, the ACUE format will display BRAKE NOGO BRAKE SYSTEM 1 FAIL (or BRAKE SYSTEM 2 FAIL). If both brake systems fail, the ACUE will display BRAKE NOGO for both systems.

In flight, if a single brake failure is detected in brake system 1, the LGC will automatically switch to brake system 2 without displaying a cockpit warning.

In the case of a total LGC failure and pilot detected brake failure, manual changeover from one brake system to the other by the cockpit selectable BRK NORM-REV switch is possible.

1. Land .... Consider approach end Cable Engagement pag. 64, if required

HOOK DOWN

HOOK T/O

HOOK GND, NAV, AA and LDG

Illumination of the HOOK DWN caption on the DWP indicates that the arrester hook is not stowed and locked, without having pressed the arrester hook release pushbutton. Additionally, the arrester hook release pushbutton light is on.

1. Land .... Beyond approach-end-cable or derig cable

CABLE ENGAGEMENT

Make a departure-end-cable engagement when there is a stopping problem (that is, aborted takeoff, wet or icy runway, loss of brakes, etc.) and it is not possible to make an approach-end-cable engagement.

If there is a directional control problem, an anticipated stopping problem, or a minimum roll out is desired, make an approach-end-cable engagement.

Consider the type of emergency, availability of backup cable, runway condition and length, weather, fuel state and any other pertinent factors in determining the proper action in event of a missed engagement.

Determine maximum engagement groundspeed at landing gross mass (see Figure 3-8) and the touchdown speed (refer to Performance Data). If it is required, reduce aircraft gross mass to minimum possible. Clearance between the cable and the underfuselage fuel tank (if fitted) is presently under discussion.

After committed to an approach-end-cable engagement, lock shoulder harness and lower the hook after starting approach.

Touchdown at least 500 ft. from the cable to allow enough time to lower the nosewheel to the runway before engagement. Touchdown as close to centerline as possible. Engage the cable in a three-point attitude and with feet off brakes.

CAUTION

CABLE ENGAGEMENT WITH NOSE-WHEEL OFF GROUND MAY RESULT IN NOSE GEAR AND/OR EXTENSIVE AIRCRAFT DAMAGE.

NOTE

If there are lamps in the runway centerline, an off-center distance of 3 feet is considered the best condition for rolling with the hook down.

Be prepared for departure-end-cable engagement if cable is missed.

After engagement, maintain throttles at idle.

After rolling backwards, keep engine running and await groundcrew instructions.

APPROACH-END-CABLE ENGAGEMENT

1. Mass .... Reduce to min. practicable
2. Hook .... Down, light on
3. Touchdown .... 500 ft. min. before cable
4. Nosewheel .... Lower in front of cable
5. Brakes........................ Do not apply

DEPARTURE-END-CABLE ENGAGEMENT

After touchdown:

1. Brake chute................ Deploy
2. Hook .... Down (1000 ft. before cable), light on
3. Brakes........................ Release 2-3 sec. prior cable

A/C MASS KG	MAXIMUM CABLE ENTRY GROUND SPEED - KT								
	AAE 44B-2C	AAE 44B-2D (NATO)	AAE 44B-2D (GAF)	AAE 44B-2E	AAE 44B-2L	Super BAK9	BAK12 /E32A	BAK13 Am. 1	RHAG MK - 1
12 000	178	165	148	187	175	190	185	151	160
14 000	178	165	148	185	175	190	181	150	160
16 000	178	165	146	181	175	187	175	146	160
17 000	178	163	145	179	175	185	172	145	160
18 000	175	161	144	176	175	183	170	143	160
19 000	172	159	142	175	175	179	169	142	158
20000	168	156	140	173	175	175	162	140	156
21 000	162	154	138	171	175	169	158	139	154
22 000	159	152	136	170	175	164	153	138	152
23 000	154	150	135	168	175	159	148	137	150
24 000	151	148	133	166	175	155	143	136	148

NOTE

Maximum engagement groundspeeds are valid only with idle thrust.

WARNING

The above figure represents a combination of arrester gear limitations and aircraft/hook structure limitations. Exceeding these limitations will cause arresting system failures and/or structural aircraft/hook damage.

Figure 3.8 - Maximum Engagement Groundspeeds

LANDING GEAR EMERGENCIES

LANDING GEAR RETRACTION FAILURE

The relevant landing gear warnings are triggered in all POF except GND.

– GEAR TRAVEL (CAT 4-voice only): If gear DOWN or is not UP and speed exceeding 290 KDAS, but less than 320 KDAS.
– GEAR LIMIT (CAT 1-attenson, voice and AG flash): Gear down limit speed exceeding 320 KDAS.
– In both cases, "GEAR" flashes on HUD.

NOTE

If the LDG selector lever is stuck in the UP position, the FCS control laws do not switch to the LDG DOWN control laws, i.e. roll rate is higher than with LDG lever DOWN.

1. Gear handle stuck down .... Leave down
2. Speed .... Below 290 KDAS

If the gear handle is UP and one or more lights illuminated:

3. Landing gear lever ..... DOWN, below 290 KDAS, 3 green/3 D
4. Speed .... Below 290 KDAS

If gear not fully locked down (green missing, red displayed), refer to Landing Gear Fails to Lower pag. 67.

LANDING GEAR FAILS TO LOWER

CAT 1 - LANDING GEAR (voice, attenson and AG): Landing gear is up, airspeed < 180 KDAS, RAD ALT < 500 ft and both throttles < 89% NH.
"GEAR" flashes on HUD.
If the landing gear is not following the DOWN command of the landing gear lever, the gear can be lowered by means of the emergency gear switch (EMGY GEAR) which is hardwired to a combined gear and door selector valve, thus by-passing the landing gear computer (LGC). The landing gear can be lowered even if the normal landing gear selector lever is stuck in the UP position. The landing/taxi light in this case is not operative since it is only available with the landing gear lever in the DOWN position.
In general the NWS is operative when the EMGY GEAR is selected to DOWN, provided the changeover to the right utilities system is not dictated by loss of the left utilities system.

If the landing gear lever is stuck in the UP position, the FCS control laws do not switch to the landing gear down control laws. Hence, roll rate does not decrease.

1. Gear handle .... DOWN, below 290 KDAS, if possible

If landing gear position unsafe:

2. Airbrake .... Select in
3. EMGY GEAR .... DOWN,below 290 KDAS, 3 green/3 D

If either HUD or HD indicates 3 green or 3 D:

4. Land

If LDG position still unsafe:

4. Land .... As soon as practicable, refer to Landing with Gear Unsafe pag. 67

LANDING WITH GEAR UNSAFE

Before landing consider:

– Runway, overrun, side areas condition
– Crosswind
– Arrestor gear limitations
– Availability of foam
– Jettison requirements

WARNING

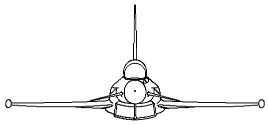
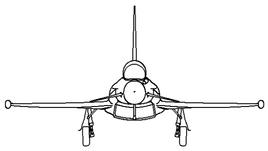
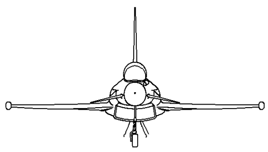
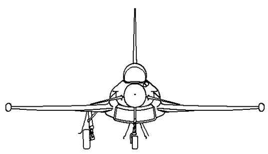
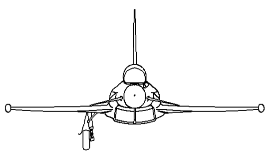
NORMAL CANOPY OPENING IS NOT AVAILABLE WITHOUT WEIGHT ON ALL WHEELS.

NOTE

– If conflicting information for a LDG down status is provided (HUD vs HD), a DOWN indication on either display can be relied on.
– When the LDG control handle is stuck in the UP position, the FCS authorities, e.g. roll control will be higher than with LDG DOWN.
– For landing recommendations refer to TABLE

1. Aircraft mass .... Reduce to minimum practicable

Landing Gear Unsafe Conditions

COCKPIT INDICATIONS	RECOMMENDED ACTIONS
	- Jettison/unarmed launch of all live ordnance - Jettison of asymmetric stores - Retain empty fuel tanks/MPCP - Low angle approach - Touchdown beyond cable or have cable removed - After touchdown: HPSHUT, LP COCKS SHUT, BATT (s) - OFF
	- Retain empty fuel tanks/MPCP - Low angle approach - Perform aerodynamic braking - Brake chute-Deploy - Do not use wheel brakes until the nose is on the ground - Avoid crossing cable with nose lowered or have cable removed - Derotate gently as late as practicable before running out of pitch control - When stopped: HPSHUT, LP COCKS SHUT, BATT (s) - OFF
	NOTE:Expect touchdown on nose gear first. - Jettison/unarmed launch of all live ordnance - Jettison of asymmetric stores - Retain empty fuel tanks/MPCP - Low angle approach - Touchdown beyond cable or have removed - Brake chute-Deploy - After touchdown: HPSHUT, LP COCKS SHUT, BATT (s) - OFF
	- Reset EMGY GEAR RSET - LDG lever UP If unable to obtain other configurations: - EJECTION is recommended
	- Reset EMGY GEAR RSET - LDG lever UP If unable to obtain other configurations: - EJECTION is recommended

The LQP (HD) gear indications are sourced from LGC 2 and in the event of either an open loop circuit between LGC and the LHQP or a failure of the related system 2 downlock proximity sensor then the associated green will fail to illuminate.
The HUD is sourced from LGC 1 and LGC 2. In the event of a system 1 total failure, no HUD indication will be available. In the event of a system 1 proximity

sensor failure, HUD indication will be available and consistent with system 2 LGC selector/LHQP indication.

WARNING

LDG EMGY GEAR EXTENSION FOLLOWED BY AN IN-FLIGHT EMGY GEAR RSET IS PROHIBITED (LOSS OF SYSTEM 2 HYDRAULIC FLUID).

During an EMGY DOWN extension of the LDG approximately 3.5 ltr of hydraulic fluid are transferred from system 2 into system 1. In a worst case, this could cause the ISOL valve of system 2 (right system) to close.

SJ or EJ jettison is possible when full ACS standard is fitted. Store information is available on MHDD/ STOR format.

Excessive fuel must be burned, since a fuel dump facility is not available.

WARNING

- JETTISON U/W TANKS WITH LANDING GEAR DOWN MAY CAUSE DAMAGE TO THE GEAR.
- SHOULD, IN THE CASE OF AN EXTREME EMERGENCY U/W TANKS BE JETTISONED WITH LANDING GEAR DOWN, LAND FOLLOWING "APPROACH-END-CABLE" PROCEDURES.
- AFTER LANDING, NORMAL CANOPY OPENING IS NOT AVAILABLE WITHOUT WEIGHT ON ALL WHEELS.

If conditions are unfavorable, ejection is recommended.

LANDING GEAR COLLAPSING

Should for any reason during landing, the main landing gear collapse, the nose wheel will most probablybreak or collapse as well.

For emergency engine shut down the battery (batteries DA1/2/3) can be set to OFF before the engines stop. The engines will then default to "flight idle". However, HP COCK and LP COCK should always be shut (fire protection).

1. **L and R Throttles ..... HP SHUT**
2. **LP COCKs................ SHUT**
3. BATT (BATT 1/2) .... OFF

WARNING

WITH WEIGHT OFF THE WHEELS THE CANOPY CAN ONLY BE OPENED BY THE EXTERNAL CANOPY HANDLE.

4. Emergency ground egress .... When possible and required

LANDING WITH A KNOWN BLOWN TIRE

If a main tire is blown directional oscillations and/or control problems may occur and an approach-end-cable engagement is recommended. If an approach-end-cable engagement is not practicable, lower the nose as soon as practicable. Nosewheel steering will assist directional control.

Before landing consider:

- Runway, overrun and side areas condition
- Crosswind
- Arrestor gear

Fly a shallow approach.

1. Mass .... Reduce to min practicable

If nose tire blown:

2. Brake chute................ Deploy at mainwheel touchdown
3. Derotate .... As late as practicable

If main tire blown:

2. Land........................... Approach-end-cable engagement is recommended Cable Engagement pag. 64

If approach-end-cable not desired/available:

3. Nosewheel .... Lower ASAP
4. Brake chute................ Deploy

ARMAMENT CONTROL SYSTEM FAILURES

HUNG STORE

HANG-UP

Hang-up is the term used when an unsuccessful attempt has been made to release/jettison weapons/ stores from the aircraft.

The ACS will deselect the hung weapon/store and attempt to select another weapon/store of the same type and an attempt to release a hung weapon/store may be carried out by means of selective or emergency jettison.

Persistence of hang-up reduces probability of mission success due to failure in attempted release, firing or jettison.

WARNING

- FOLLOWING AN ATTEMPTED STORES RELEASE, ANY STORES NOT SEPARATED FROM THE AIRCRAFT MUST BE CONSIDERED SUSCEPTIBLE TO INADVERTENT RELEASE.

- BE PREPARED TO GO AROUND IMMEDIATELY IN CASE OF INADVERTENT RELEASE UPON LANDING.

NOTE

Notify personnel in advance.

1. JETT EMGY/SEL ....Perform as required

If hang-up remains:

2. Avoid populated areas

EJ FAIL

EJ FAIL

Loss of Emergency Jettison function.

1. MASS ....Maintain LIVE for the remainder of the sortie

SJ FAIL

SJ FAIL

Loss of Selective Jettison function.

1. MASS .... Maintain LIVE for the remainder of the sortie

EJ AND SJ FAIL

EJ FAIL with (on ground only)

SJ FAIL

All jettison functions lost, caused by safety pins or handles not properly removed before setting MASS to LIVE.

1. MASS .... STBY
2. Safety pins/handles ... Remove as required
3. MASS .... LIVE

SCAC FAILURE

SCAC with

FCS with

REV ENV

In the event of SCAC failure the weapons/stores control function is lost with the exception of the emergency jettison. The stores configuration data supplied to the flight control system are lost.

All ACS functionality lost except for Emergency Jettison

1. MASS .... Maintain LIVE for the remainder of the sortie

ACS FAILURE

ACS FAIL with

FCS with

REV ENV

In the event of loss of both SCAC RTs on the ATK Bus the weapons/stores control function is lost with the exception of the emergency jettison. The stores configuration data supplied to the flight control system are lost. If the failure cannot be reset the mission should be aborted.

All ACS functionality lost except for EJ

1. MASS .... Maintain LIVE for the remainder of the sortie

NSCAC

NSCAC	with
FCS	with
REV ENV	with
SJ FAIL	with
ACS FAIL	

In the event of NSCAC double channel failure the weapons/stores control function is lost with the exception of emergency jettison. The mass data supplied to the flight control system are lost.

NSCAC double channel failure resulting in:

– MHDD/STOR format frozen

– Loss of missile firing

– Loss of SJ functionality

– Loss of stores data to FCS

1. MASS .... Maintain LIVE for the remainder of the sortie

DU FAIL

DU FAIL	with
ACS FAIL	

Both DU channels fail, leading to the complete loss of missiles availability for firing. EJ/SJ and interface with FCS are still available.

DU double channel failure resulting in:

– Loss of missile firing

JETTISON EXTERNAL STORES (EMGY OR SEL)

In order to get rid of weapon and/or stores, when required, there are two distinct jettison procedures available:

– Emergency jettison
– Selective jettison

The emergency jettison procedure should be followed if the nature of the emergency or the available decision time are important factors.

EMERGENCY JETTISON

To initiate the EJ sequence the pilot shall set the MASS to LIVE, reveal the EMGY JETT pushbutton and depress it. The SCAC interrogates the EMGY JETT pushbutton for logic validity (depression time and normally open/closed signals) to avoid the possibility of EJ being caused by spurious pulses. On receipt of a valid EJ signal, the SCAC commands the pre-defined jettison sequence of all applicable weapons/stores.

SELECTIVE JETTISON

To initiate the SJ the pilot shall check the package presently available, set the MASS to LIVE, reveal the SEL JETT pushbutton and depress it. The SCAC interrogates the SEL JETT pushbutton for logic validity. On receipt of a valid SJ signal, the SCAC commands the jettison of the chosen weapons/stores. The jettison sequence is fully controlled by the SCAC SW.

WARNING

- JETTISON SHALL BE ATTEMPTED OVER CLEARED AREAS ONLY. AVOID POPULATED AREAS.

- IF TANKS HAVE TO BE JETTISONED WITH LANDING GEAR HANDLE DOWN, AN APPROACH-END-CABLE ENGAGEMENT IS RECOMMENDED.

NOTE

- Pre-jettison conditions:
  - Landing gear up and locked
  - 1g +/- 0,5g
  - Straight and level flight
  - Minimize sideslip
  - Jettison of stores is restricted to the FCS GUH envelope, with overriding:
  - 250 to 350 KDAS / up to 0,9 M limit when UFUS external tank contents is below 750 litres
  - 250 to 350 KDAS / up to 0,8 M limit when UWG external tank contents is below 750 litres
  - 150 to 350 KDAS / up to 0,9 M limit when UFUS external tank contents is 750 litres or above
  - 150 to 350 KDAS / up to 0,8 M limit when UWG external tank contents is 750 litres or above
- Post jettison condition:
  - If configuration cannot be determined respect FCS GUH envelope.

EMERGENCY JETTISON

1. MASS.........................Check LIVE
2. JETT EMGY...............Reveal EMGY then press

If EJ successful:

3. MHDD/STOR ....Check ejected stores occulted
4. MASS.........................As required

If EJ unsuccessful and/or stores hung up:

3. Refer to Hang Store

SELECTIVE JETTISON

NOTE

- SJ of U/F stores (excluding tank) is inhibited when the main LDG doors are not closed and locked up.
- MPCP are shown as 1000 ltr tank.

Jettison package:

1. MASS.........................Check LIVE
2. MHDD/STOR.............Check MASS LIVE displayed
3. JETT SEL..................Reveal SEL then press

If SJ successful:

4. MHDD/STOR.............Check ejected stores occulted
5. MASS........................As required

If SJ unsuccessful and/or stores hung up:

4. Refer to Hang Store

SECTION 8 - ATTACK AND IDENT

Table of Contents **Page**

SURVEILLANCE/ATTACK AND IDENTIFICATION SUBSYSTEM

The Attack and Identification Subsystem enables detection, acquisition, identification, prioritizing and engagement of air, ground and sea targets, during day and night, in all weather conditions.

The Attack and Identification Subsystem consists of the following equipment:

– RADAR, refer to The Radar, also called "CAPTOR" is the primary sensor for target detection, tracking and engagement. It is a pulse doppler multiple Pulse Repetition Frequency (PRF) radar with a high degree of automation of functions to minimize pilot workload and to provide optimum performance over a wide range of ambient and target conditions. The radar provides Air-to-Air (A/A) search, Lock Follows (LF) and Air Combat Modes (ACM) against Air-to-Air targets and Air-to-Surface (AS) mapping. pag. 14
– FLIR, refer to Forward Looking Infra Red pag. 76
– IFF Interrogator, refer to Identification System (IFF) pag. 80
– IFF Transponder, refer to Identification System (IFF) pag. 80
– Attack Computer, refer to paragraph Para below.

ATTACK AND IDENTIFICATION SUBSYSTEM FUNCTIONS

The Attack and Identification Subsystem includes the following primary functions:

– The control and operation of the Radar to provide Air-to-Air and Air-to-Surface (SP5A onwards) target location.
– The control and operation of the FLIR to provide Air-to-Air (SP5B onwards) and Air-to-Surface (SP5C onwards) target location.
– The control and operation of the IFF Interrogator to provide identification of radar and non radar targets.

Sensor fusion of Radar, IFF and MIDS tracks and distribution of fused tracks for display and other users.

– The control and provision of Visident steering (cleared for assessment purpose only with SP3C/15) and Air-to-Air Missile aiming information.
– The provision of slaving of SRAAM missiles either by Radar or the XY Controller.

- The pre-launch and post-launch support of Medium Range Air-to-Air Missile aiming information.
- The provision of Air-to-Air and Air-to-Surface Gun aiming (from SP5A onwards) information.
- The control and operation of the Radar to provide an Air-to-Surface ground mapping (RBGM cleared for assessment purpose only at SP3C/15).
- The control and operation of the FLIR to provide an outside world video image.
- The control and operation of the IFF Transponder to provide self identification of the aircraft.
- The provision of Ground (and Flight at later software standard) Static Harmonization for the Radar, FLIR, Air-to-Air and Air-to-Surface Gun (A/S Gun from SP5A onwards).
- The monitoring and reporting of the Attack and Identification Subsystem status.

SENSOR DATA (PLOTS, TRACKS, TARGETS)

TYPES OF SENSOR DATA

Sensor data will be presented as plots, tracks or targets.

PLOTS

Plots are detections of the radar or IFF interrogator which have not been correlated with previous detections. Plots are sent directly to the CSG without attack computer processing and are therefore always unknown.

All plot displays are synthetic; no raw sensor data is displayed in air-to-air modes. A maximum of 180 plots will be displayed.

Plots detected by the radar are initially displayed as 3 x 1.5 mm amber colored rectangles. The plots are displayed for a finite time and decrease in size progressively; the "ageing" time of the plots is usually controlled automatically (AUTO) but can be defined by selecting the "AGE" soft key. Settings of 5, 10 and 15 seconds will be available by toggling through the displayed menu options on the attack format using the plot ageing softkey and leaving the boxed symbol over the desired option for three seconds. The new plot ageing option is displayed on the softkey.

Once the radar correlates the plots (the radar detects the plot at least twice within the first four frames) tracks are formed.

TRACKS

Tracks are detections of one or more sensors which have been correlated with previous detections.

In TWS the radar will automatically determine which plots are to be tracked (up to 20 tracks), dependent on relative priorities of sensor detections. As the priority assignment may not consider the tactical situation plots can be selected manually to be included in the tracking process by XY insert over a plot on the AF or EF. The system will accept up to 20 manually initiated tracks. If 20 tracks have been manually initiated it is not possible to initiate tracking on another track (manually or automatically). Manual track deletion must be used if other tracks are required.

The manually inserted track cannot be overridden by the radar automatically initiated tracks.

A maximum of 20 tracks will be displayed, regardless of automatic or manual initiation. Note if STT is initiated on a plot, not tracked so far, 21 tracks are presented for a short time (dependent of scan volume and track quality for a maximum time of 7 frames) until the first 20 tracks, which then have gone into memory, are deleted.

Manual track initiation is not possible when the RAID picture is displayed.

Different track symbology outline indicates which sensors are supporting a track. The pilot may use this information to reschedule the search priorities of a sensor e.g. Radar, FLIR (IRST from SP 5A onwards).

The correlated track symbols will be displayed with velocity vector and the various Extra Information displays, which contain the accumulated knowledge from all available sensors and provides the best understanding of track movement and track identity.

TRACK GROUP SYMBOL (TGS)

If a sensor detects several tracks in the same area or sensor data has not yet fused, the resulting tracks symbols could overlay each other on the MHDDs; this would result in serious display clutter and it would be difficult for the pilot to identify the track symbols, their TCRIs, velocity vectors etc. This problem is solved by Track Group Symbols on the Attack and PA formats. When two or more track symbols approach within five mm of each other, they are replaced by a single symbol (TGS), a hexagon. Note that the TGS is purely a display function, and has nothing to do with the sensors' or the correlation processes' ability to discriminate between close tracks. For example, two tracks that can be displayed separately when the Attack format is set on a low range scale will form a TGS as the display range is increased and the tracks become progressively closer on the display. Note that plots will not be included in the TGS.

On the AF, the TGS also displays the velocity vectors of the components tracks. Different vectors are drawn for each angle between tracks that are different by more than 20°, e.g. if all component tracks are within 20° then only one vector is drawn, if not then a vector is drawn for each. If velocity vectors of different speeds lie within the same 20° interval, the fastest vector will be shown.

The components of a TGS on the AF are shown by the TCRI in the center of the TGS - this relates to the component track that has the highest position in the designated target list (DTL), or is the highest system priority in the absence of nominated targets - additional components are shown as a string of max. five TCRIs drawn just above the TGS. Friendlies, unknowns and any hostile tracks not allocated a TCRI, are indicated by a '*'.

The color infill of the TGS represents the allegiance of the highest priority track within the group. On the AF the system priority (1-6) of the TGS top component is shown at the right of the TGS. When extra information is selected or the TGS is within 20 NM in POF T/O or LDG the altitude of the top component is displayed instead. On the PA format, only the number of tracks within the TGS are shown, as a number above the symbol. A change priority alert for any TGS component is shown on the Attack and PA Formats by flashing the TGS symbol including the TCRI components string. If PTA is performed, this track becomes highest in DTL and flashing will cease.

The outline of the TGS symbol will reflect by which sensor(s) the top component is being tracked.

When the radar locks onto a TGS component a lock on cross will be shown with the TGS, but it will not be possible to lock-on to TGS top component by placing the XY marker over the TGS and pressing the HOTAS lock button.

Launch Success Zones and raid numbers will only be shown to the top component of the TGS.

A missile in flight against the TGS top component will be shown by changing the infill color to blue. The missile in flight flashing and occulting conditions will be as for normal tracks/targets. Missile in flight against any other components of the TGS will not be shown.

If an IFF interrogation is performed over a TGS, a sector interrogation will result.

The pilot can "open" a TGS by placing the XY cursor over the symbol and inserting or by using DVI. This changes the AF to an expanded TGS zoom box of 4, 10 or 20 NM square (dependent on underlying AF range setting). The display box is stabilized on the centroid of the TGS tracks, and presents an expanded picture in which the pilot can see the relative position of the tracks. A "PP" square also positioned on the TGS box shows the position of the TGS on the underlying AF. The display also includes the underlying range scale and the expanded display type and size. The track components in this TGS zoom box may be manipulated exactly as on the normal Attack Format. The box is closed again by XY insert anywhere outside the ROLs (provided no CSI is captured), or selecting a RAID picture (cleared for assessment purpose only with SP3C/15), or using DVI, or until any other format is selected.

Expanded display moding on the PA format is different, there being three different types of zoom available, refer also to Table :

a. TGS Zoom: A short XY insert on a PA TGS symbol causes display of a TGS zoom box, the center stabilized on the centroid of the TGS. The box size is dependent on the PA range scale from which it was selected.
b. Track Zoom:A long XY insert on a track creates a similar expanded zoom box, centered and stabilized on the track.
c. Area Zoom: A long XY insert, not on a track, creates a similar expanded zoom box, centered on the insert point and ground stabilized.

A TGS can also be "opened" or "Closed" by DVI. If there is only one TGS symbol identified with a specific TCRI - on either AF or PA - the DVI command will open or close it. If the same TGS is displayed on both AF and PA, the DVI command will open that on the AF; a repeat of the DVI command will then open that TGS on PA. Similarly, the command will work first on AF, then PA, if the TGS is on both displays.

TRACK FILTERING

To avoid overloading the pilot with hundreds of tracks, the Avionics System limits the number of tracks to be displayed to 120. The filtering ensures that priority tracks are always displayed.

Tracks which do not meet the priority criteria are filtered on a range basis until the maximum number for display is reached.

The pilot can adjust the position about which range filtering takes place, based on his display requirements. If the pilot selects the window on the world icon, he is then able to use the XY controller to adjust the view of the world represented on the PA format. (This display does not need to include own aircraft position). The range filtering is therefore based on own aircraft position or the selected center of the window on the world.

The pilot can also influence the filtering process by selecting a MIDS NET FILTER (which selects only the MIDS tracks from the selected network for display).

TARGETS

Tracks can be nominated as targets for attack or VisIdent (cleared for assessment purpose only with SP3C/15) by using the XY controller.

The system may hold up to eight targets and Priority Target Accept (PTA) will generate six targets.

Any air to air tracks (radar tracks only cleared for nomination with SP3C/15), except DASS spokes (SP5A onwards), may be nominated as targets.

INDICATION OF TRACK/TARGET DATA

DISPLAY OF TRACK/TARGET DATA ON MHDDS

Tracks are displayed with a bright white outline.

Targets are displayed with a double white outline. To differentiate the number 1 target track symbol it has a bright white double thickness outline.

For a complete list of the available tracks/target symbols refer to Track Attribute Symbology. The attributes indicated by variations in track/target symbol shape, color infill, outline, and peripheral symbols are as follows:

– Allegiance (Track Identity): Tracks are classified as Friendlies, Unknowns, and Hostiles. The allegiance is indicated to the pilot by the shape and color of the symbol.
  - Friendlies are displayed as circles, with a green infill
  - Unknowns as a square with an amber infill
  - Hostiles as a diamond with a red infill.

– Note: At FOC, the avionics system determines the allegiance by evaluating the different available sensor data. At IOC, without the other sensor data the only allegiance that can be determined are friendlies (correct IFF interrogator responses) and therefore the pilot can expect to see only unknown and friendly track symbology displayed.

– Pilot Identity Override (PIO) - If there is a conflict between e.g. IFF and MIDS identity on the same track/target or for any other reason, the pilot may change the displayed classification of a track by XY inserting on the PIO icon, and then XY inserting on that track. The first insert changes the track "shape" to the next most "hostile" classification, depending on the initial classification of the track. A second insert changes it again, a third insert reverts the symbol to its original shape. Note that the infill always remains as decided by the weapons system. For example, a round symbol with an amber infill is an unknown track the pilot has converted to a friendly. The PIO action can be cancelled by XY insert on a blank space, on anything other than a track, insert over the PIO icon or when marker is moved off the format. Any previously converted tracks remain converted on PIO cancel. PIO cannot be carried out on MIDS-only tracks or on Track Group Symbols. PIO will have no effect on a TGS but may be performed on the components in the TGS zoom picture. A PIO which has been performed on a TGS top component cannot be seen on the Track Group Symbol, as the shape will stay a hexagon and the infill will always show the system hostility. Note that TGS zoom is not possible while PIO is active, therfore TGS zoom must be performed before enabling PIO.

– Tracks, targets and first target: Tracks are initially displayed as symbols with a single white outline. If the track is nominated as a target a double white outline is used. To differentiate further the number one target track symbol (i.e. the first target to be engaged and to which the weapon aiming displays apply) has a bright white double thickness outline.

– Track Cross-Reference Indicator (TCRI) -A TCRI is an alphabetical character assigned to hostile and unknown tracks and targets on the head-down tactical displays, and on the designated targets on the HUD. The character assigned to a particular track/target is the same on all the displays. The TCRI is used by the pilot to cross relate track symbols between the various formats and the readout lines on the formats. Note that the simulated target will not have a TCRI assigned.

– Track Velocity Vector (Aspect Angle) -If the system is able to calculate the course and speed of a track, it is indicated by a vector drawn from the track symbol. The angle of the vector against the Attack format grid indicates Angle Between Courses, while the length of the vector is proportional to target speed (TAS). There are three lengths (3, 5 or 7 mm), equivalent to target TAS of 0-300 kts, 300-600 kts, and greater than 600 kts. In the Elevation format the vector indicates also climb or dive greater than 2000 ft/min. In the HUD and HUD HD format the length of the "angle pointer" varies with the size of the TD box and does not indicate target speed.

– Direction of Turn -If the system detects that the track is turning at a rate greater than or equal to five g, the direction of turn is indicated by a short "arm", pointing in the direction of turn, on the end of the velocity vector. Note that high g target maneuvers will not be measured with sufficient accuracy in TWS/PT/PS due to the low track update rate in this modes and are therefore not indicated.

– Rapid Height Change -If a track is detected as climbing or descending at more than 6000 ft/min, an arrow is drawn pointing up or down from the edge of the track symbol.

– System Track Priority -The system continuously evaluates the threat priority of unknown and hostile tracks, and indicates the result of this evaluation for the six highest priority tracks by a single white digit number to the top right of the track symbol. The highest priority is labelled "1". The priority will be occulted while track altitude is displayed.

– Track Altitude -The system calculated track altitude is shown to the top right of the track symbol whenever an initial XY insert on the track symbol is made. It over-writes any threat priority indication (presented at the same position) and is shown as a cyan two-digit number, indicating altitude in thousands of feet (e.g. "15" indicates track altitude is 15,000 ft). The display automatically occults seven seconds after selection; until time out. In POF T/O and LDG the track altitude will be displayed permanently within 20 NM.

– Relative Altitude Bar -A horizontal bar is displayed if the track is more than 10,000 ft different in altitude to own aircraft. The bar is on the top of the track symbol if the track is below, on the bottom of the symbol if the track is above.
– Memorized Track/Target If a target or track leaves the Radar Scan Coverage it will be memorized by the radar and displayed with a dashed symbol outline and if a missile is in flight the dashed outline will be with blue infill. If a lock Follow mode was entered from TWS mode (except via an Air Combat Mode -ACM) then the existing TWS tracks will also go into memory, because the radar then will only be tracking a single object. If the radar stays in the Lock Follow mode for a period of time the memorized tracks will be automatically deleted. On selection of an ACM all existing track files are deleted immediately.

DISPLAY OF TRACK/TARGET DATA ON HUD

Targets are displayed on the HUD in three different sizes of Target Designation (TD) boxes to give an indication of track range. The largest TD box indicates range less than 10 NM, medium indicates between 10 and 20 NM, and the smallest indicates range greater than 20 NM. The TCRI for Unknowns and Hostiles will appear above the symbol. A maximum of eight TD boxes can be displayed on the HUD at any one time.

The TD box for the number one DTL target is displayed on the HUD at all times; when the target moves out of HUD-FoV the TD moves along the HUD boarder and blinks.

TD boxes, which have a medium range missile in flight against them are marked by a cross and will disappear outside HUD-FoV.

A range countdown circle indicates that the number one target is less than 12 000 feet.

Memorized objects are displayed as follows, because no color is available on HUD:

HUD Target Designation Symbology

Object	Radar Tracked	Radar Memorized
Track	dashed, 4 dashes	dashed, 8 dashes
Target	single line	dashed, 8 dashes
1st Target	double line	dashed double line, 8 dashes

SIMULATED TARGET

For training purpose the Attack Computer can generate a synthetic track, selectable on the MDEF via the MISC SSK and SIM TGT MK. The synthetic track is shown on all cockpit displays as a memorized unknown track which does not stale out and occult with time as the real ones. It can be managed like a real track (e.g. target nomination, simulated missile firing) and will cause real displays and responses from the weapon system like missile steering cues, missile priming, post-launch support. It will be presented with the following default values:

– Azimuth: 20° left of own heading
– Altitude: 10 000 ft below own aircraft height (minimum 5000 ft above MSL)
– Slant range: 50 NM
– Groundspeed: 400 Kts
– Groundtrack: straight and level opposite of own heading.

To start again with default values, the SIM TGT function must be de- and reselected on the MDEF. It is not possible to initiate radar lock against the simulated track, nor to delete the track (i.e. using the bin function). The track is deleted by deselecting the SIM TGT MDEF soft key.

Upon selection the target will fly straight and level with a groundspeed of 400 kts opposite of own heading at selection. The target will continue to fly on this heading independant of own manoeuvers.

The function remains operational if the MISC SS is deselected.

For numerical reasons the synthetic target is only initiated if own latitude is within -70 to +70 deg.

The synthetic target is not included in the target priorization process and has no TCRI assigned.

The simulated target will be deselected automatically after 10 minutes.

EXTRA TRACK/TARGET INFORMATION

Extra information on tracks/targets are shown in two Read Out Lines (ROL) on the bottom of the Attack format either on default or by selecting with XY controller.

The left ROL displays number one target information only and will be blank if no number one target is available.

The right ROL shows information of second priority or XY controller selected targets/tracks.

If there are no tracks selected for extra data then extra information for the highest priority track will be displayed in the AF right ROL.

If XY insert is pressed when the cursor is over a track, a 2-digit readout of the height of all targets and tracks within AF coverage is displayed at the top right of each track symbol; these occult automatically after seven seconds, or immediately if the XY is moved off the track.

Target extra data is indicated using the XY controller by positioning over the target reference in the DTL. As the XY marker passes each of the target references in the DTL the extra information for that target is displayed in the AF right ROL and the EF ROL.

The following information is available:

– Track Cross-Reference Indicator, if determined by the avionics system; friendlies do not have a TCRI and therefore a green circle is displayed
– the approximate track size, SMALL, MEDIUM, LARGE, or N/A, based on Radar cross-section; for the synthetic target SIM will be displayed
– the approximate TAS (KT) or MACH (M), depending on status of own aircraft speed on the AF
– the approximate ground track of the track in degrees with three digits (000 to 359)
– the approximate track absolute altitude in 100 ft increments with two digits, dot, one digit (e.g. 20.5 equals 20 500 ft); if less than 100 ft, 0.0 is displayed.

If the track is lost by the system the extra information for the track is removed and extra information for the highest priority track is displayed in the AF right ROL.

If the target is lost by the system the extra information for the target is removed and the following targets move up in the DTL. The extra information for the next target is displayed.

Priority track information is displayed in the AF ROL when:

– the Default key on the AF is pressed
– a track is established from a condition where there were no tracks
– the selected track is nominated as a target.

The Elevation format shows only one ROL, depending on selection. If the track is lost the AF right ROL displays priority data as described above and the EF ROL is occulted.

Even more extra information on a track can be shown by XY insert on the track symbol on the PA format. A five-line page box is displayed adjacent to the track, and several "pages" of data may be available, depending on the nature of the track and the sources of available data. For example, there can be up to three pages (15 lines) of data displayable for a Friendly MIDS Joint User track. The extra info box is automatically occulted three seconds after the XY cursor is moved off the track symbol or the XY cursor is moved out of the box.

Attack Format ROLs

	Left ROL	Right ROL
No. 1 target in DTL available	No 1 target (automatically shown)	Second priority or XY selected track/target
No. 1 target in DTL not available, and/or track lost, and/ or no track selected	Blank	Highest priority track or XY selected track

To cancel the extra information of a track/target either press the Default key on the AF or select another track/target, or delete the track/target file.

MANUAL DELETION OF TARGETS OR TRACKS

Targets or tracks, which tactically can be ignored, can be deleted when for example causing the automatic scan centering facility to scan in a non optimal scan volume.

The deletion of the track will only be temporary if the track is of sufficient priority and still detectable within the scan volume.

Target or track deletion can be done in TWS only and is achieved by "picking up" the Bin icon by XY insert on the bin, positioning the bin by XY over the required target or track, and inserting again, or by using DVI.

Carrying out the same process on a target in the DTL this will only de-nominate the target back into a track. Then a second XY insert on the track symbol will delete the track file if it is derived from own sensors.

Normal moding of the XY cursor, and cancelling the denomination facility, is achieved by either inserting on a blank space or by inserting on the bin icon.

SENSOR FUSION (CLEARED FOR ASSESSMENT WITH DA 6 ONLY)

PRINCIPLES/FUNCTION

To minimize the pilot's workload (display clutter) and improve target/situational awareness a kinematic fusion process in the Attack & Identification system correlates the data from each sensor (Radar, IFF, MIDS), to display a unified air picture including target identity (hostile/unknown/friendly) and priority (1 to 6).

NOTE

The target identity "hostile" will be available at a later aircraft standard.

MIDS TRACK INTEGRATION

The MIU can manage up to 200 A/A MIDS tracks from the Link 16 network which are updated periodically.

The 200 A/A MIDS tracks are passed to the attack computer which attempts to correlates them with the up to 20 radar tracks, managed by the attack computer.

Once the radar and MIDS tracks have passed the sensor fusion process they are displayed on the MHDDs. The displays may then contain a mixture of radar only, MIDS only and radar/MIDS fused tracks, up to a maximum of 20 radar / radar/MIDS fused tracks and up to additionally 10 MIDS only tracks (maximum 30 displayed tracks).

TRACK IDENTITY

In SP3C A/A MIDS only tracks will be classed as unknown. Radar/MIDS correlated tracks will get the identity from the IFF, which may either be unknown or friendly depending on the interrogation result and the mission data setting.

TRACK PRIORITIZING

The priority of the tracks (1 to 6) is to be used as an indication of the relevant threat levels. The generation of the priority is based on the same parameters for all tracks so that a consistent comparison of the track levels can be made. The specific identity and attack capabilities of tracks are difficult to determine and are not always available, therefore the only realistic parameters that can be used are the identity and simple kinetic and potential energy levels, e.g. hostile/unknown/friendly, range, range rate, altitude and aspect angle. The kinematic threat potential is derived from the following parameters:

- slant range
- range rate between ownship and target in the horizontal plane
- absolute value of the difference between ownship track and target azimuth w.r.t. north
- difference between target altitude and ownship altitude
- vertical velocity of the target

If two tracks have the same calculated parameter, the closer one is assigned to the higher priority.

Note that the priority displayed is only a relative threat level and indicates that a priority "1" track is deemed to be more dangerous than a lower priority track. The actual determined threat level is not calculated from all real threat parameters, i.e. specific track type and attack capability.

For display clutter reasons only the top six priority tracks have their priorities indicated on the displays.

No priorization is applied to the synthetic target.

SENSOR MANAGEMENT

SCAN VOLUME/CENTER

In Air-to-Air search modes the radar scan volume (azimuth/elevation in RWS/TWS, velocity in VS) can be adjusted with XY controller as long as the maximum frame time is not exceeded.

Note that there is no range selection for A/A modes beside the range selection on the Attack Format, which only selects the displayed range.

The following default scan volume is set after first radar switch on since aircraft power up:

- two bars
- maximum azimuth width
- elevation angle zero (horizon stabilized)
- 80 NM range scale in TWS on AF or
- maximum velocity scale in VS on AF.

The default volume is also accessed via the SK DFLT on the AF as well as on initial entry of the TWS mode.

On subsequent radar power ups the previous scan volume parameters are used.

When the default selections are altered via PSMK this pre-defined default conditions will be restored.

The center of the scan area can either be adjusted manually or is set automatically when Auto Scan Centering facility (ASC) is selected.

AUTOMATIC RADAR SCAN CENTERING

In TWS mode an Auto Scan Centering facility (ASC) is available. This can be selected manually via the SK SCAN MAN/AUTO or is selected automatically when a track is nominated as target.

This enables the radar to automatically position the search volume in a way, where all actual search tracks can be optimally maintained. This means that the radar scan center in azimuth and elevation is automatically positioned to the geometric center of all current radar tracks, which can be seen on the MHDD formats.

When no targets are nominated the azimuth scan is set to its maximum width and the number of bars are set depending on the range scale currently selected and adjusted when the range is adjusted as follows:

Automatic Radar Bar Setting

Range (NM)	No. of Bars
4-20	6
40	4
80	2
160-240	1

If the pilot manually modifies the radar scan center, ASC is automatically deselected. If no radar tracks are available the position of the radar scan center for ASC equals the last scan center position prior to the ASC selection.
Selection of Lock Follow will not cancel ASC, return to TWS will center on the last lock position.
If the last remaining track is deleted then the radar center remain space stabilized with respect to the scan center at the time when track was deleted.

MANUAL RADAR SCAN CONTROL

AZIMUTH SCAN CENTER

For all search modes the scan center can be moved by XY controller in azimuth and elevation within the radar gimbal limits. Insert anywhere within 4 mm of the scan volume line or centerline, slew as required, and insert to drop at the desired position. The scan volume will always remain symmetrical and when the radar gimbal limit is reached no further centerline movement is possible.
Any changes in the scan center will be reflected on the Attack, Elevation, and PA formats.
With radar at maximum azimuth scan width no centerline adjustment is possible.
When the radar is in warm up, in Passive or inhibited from transmitting, the line is shown dashed.

AZIMUTH SCAN WIDTH

The scan width (length of the bars) can be moved with the XY controller by inserting anywhere within 4 mm of either the left or the right scan width line and slewing it to the desired angle. The scan width then alters symmetrically on both sides about the center line. A second insert will "drop" the scan coverage line at the desired position.
When the radar is in warm up, in Passive or inhibited from transmitting, the lines are shown dashed.

ELEVATION SCAN CENTER

The elevation angle in relation to the horizon is controlled by the scanner elevation control wheel on the throttle top. The current radar elevation scan center is indicated on the AF top right corner with a positive or negative two digit number. Manual control is only active in VS, TWS and RBGM. In ACM or LF the elevation is controlled automatically, in SBY not acknowledged.

ELEVATION SCAN HEIGHT

The elevation scan height (number of bars) is adjusted by selecting the white bar icon on the right side of the AF with the XY controller. Stepping through the number of bars (1, 2, 4, 6 or 8) is displayed with this icon. Default on initial power up will be 2 bar (unless PSMK defined). The scan coverage symbol length will vary with number of bars selected. Shortest with one bar selected and longest with 8 bars selected. The radar bars will be positioned symmetrically about the elevation scan center. When the radar is in ground mapping mode the length of the line will be fixed as for two bar scan.

NOTE

All manual scan settings may be cancelled quickly by selecting SCAN to AUTO or selecting DFLT on the AF.

ATTACK COMPUTER

The Attack Computer (AC), located in the left avionics bay on the top shelf, performs the following processing for the attack and identification subsystem.

- correlation of sensor data
- identification of tracks and targets
- prioritizing of targets
- calculation of target positions
- calculation of weapon envelopes and launch success zones
- calculation of offensive and defensive flight maneuvers (from SP5C onwards)
- calculation of steerings
- calculation for gun firing (cleared for assessment purpose only with SP3C/15)
- data support for missiles
- calculation for breakaway (radar derived information shall not be relied on for safe separation with the target/aircraft with SP3C/15)
- moding for sensors, weapon selection etc.
- calculation for weapon delivery
- interface to display and control subsystems.

It acts as bus controller on the attack bus and a remote terminal on the avionics databus, with the navigation computer acting as bus controller. If the navigation computer fails or is undergoing IBIT the attack computer takes over as reversionary bus controller on the avionics bus and in addition performs some of the navigation computer functions. If the aircraft is on ground (WOW) the navigation computer is automatically restored to bus control if the conditions which generated the hand over are reversed (e.g. completion of IBIT). In the air this return to the navigation computer is inhibited.

ATTACK COMPUTER AS REMOTE TERMINAL ON AVS BUS (NAV COMPUTER BUS CONTROLLER, NORMAL CONDITION)

As a remote terminal the attack computer:

– controls the operation of the Radar and the IFF interrogator selected on the MHDDs, LHGS and HOTAS
– controls the IFF transponder functions selected on the Left Hand Glare Shield (LHGS)
– monitors the IFF transponder operation and transfers the information to the LHGS and RHGS
– receives and controls an eject signal from the ejector seats, which erases any sensitive data stored in the computer (Secure Data Erasure of PDS by ejection or pilot initiation is not cleared with SPC/15)
– controls the IFF IDentification Response selector on the RHGS. When the ID function is available the ID Response selector caption is illuminated, when operated the status bars above and below the ID Response selector caption are illuminated. The status bars extinguish when the IFF transponder stops the ID function
– receives release cues from the SCAC after weapon release.

ATTACK COMPUTER AS BUS CONTROLLER ON THE AVS BUS

As a Bus Controller the attack computer takes over the following navigation computer functions:

– CIU master/slave management (CIU NORM/REV switch selections)
– CSG master/slave management (CSG NORM/REV switch selections)
– Avionics and attack databus health monitoring
– IBIT monitoring for LRIs connected to the avionics and attack databuses
– LRI failure warning generation for cockpit display.

ATTACK COMPUTER OPERATIONAL SOFTWARE

The operational software of the attack computer breaks down in the following functional blocks:

A&I SUBSYSTEM MANAGEMENT

– Subsystem Moding
– Designated Target List
– LRI Health Monitoring.

TARGET DATA MANAGEMENT

– Sensor Control
– Kinematic Data Fusion
– Identity Data Fusion
– Target Priorization.

WEAPON DELIVERY FUNCTIONS

– Air-to-Air Steering
– Missile Envelope Calculation
– Missile Priming
– Missile Flight Time Calculation
– Gun Aiming.

ATTACK COMPUTER BITS

The AC performs three types of Built In Test:

PBIT

The PBIT is performed on power up and power interruptions exceeding 30 ms. The NOGO condition will be displayed on the MDP.

CBIT

The CBIT is entered on successful completion of PBIT and runs continuously during normal operations. Fatal faults will shut down the AC and initiate a CAT 3 warning, amber ATK CPTR caption on the DWP and audio warning.

IBIT

The IBIT is started by maintenance from the MDP for more in depth tests.

BOGUS WEAPONS

To allow the pilot to train with a variety of different weapons and associated attack profiles, a "Bogus" weapon facility is provided within the Armament Control System (ACS). Air-to-air weapons are simulated within the ACS when the facility is enabled, and - in terms of moding and displays and controls response - the system behavior is almost identical to that when real weapons are carried.
Bogus weapons are only available when there are no "real" weapons carried on the aircraft. A mix of real and bogus weapons will not be accepted from the ACS. This also relates to the gun - bogus is not available if there are any gun rounds loaded (gun cleared for assessment only with SP3C/15). The only "real" stores that may be carried while still accessing Bogus are external fuel tanks and SRAAM training (acquisition) rounds or ACMI pods. Also, for Bogus to be available, the mission PDS load must be configured with bogus stores whilst on the ground, as must the Maintenance Data Panel (MDP). The ACS compares the PDS with the MDP on initialization, and will only provide Bogus if both

configurations agree. Failures will be indicated on the MHDD Autocue and Stores format with an "all stores inhibit cross" and "red infilled boxes" at the affected store.

BOGUS AMRAAM

Bogus AMRAAM missiles are decremented in accordance with simulated firing signals.

BOGUS GUN (CLEARED FOR ASSESSMENT ONLY WITH SP3C/15)

Bogus Gun requires that "zero rounds" are entered on the ground and therefore no simulated gun rounds decrement is available, i.e. rounds available will be indicated by a cross in the weapons block on the HUD and AF.

BOGUS SRAAM

To achieve simulation of SRAAM, it is necessary to carry SRAAM training rounds, to permit missile acquisition and the resulting display of symbology and audio cues. Missiles are constantly available with no rounds countdown.

NORMAL OPERATION

A selected bogus configuration may be defined in mission planning and loaded by the PDS as well as via MDP . On aircraft powerup, once the ACS BIT and configurations checks are complete, the STOREs format shows the selected BOGUS configuration.

The bogus weapon (MRAAM, SRAAM or Gun) is selected via the weapon selector as per real stores. After firing, no reset is required for SRAAM or Gun as rounds do not decrement

AMRAAMs are decremented and may be reset via the BGUS AMR MK, accessed via the MDE MISC SSK on the MDEF. Bogus AMRAAMs are resets to the number of bogus AMRAAMS initially loaded, maximum six if no bogus SRAAMs are loaded on outboard stations. The BGUS AMR MK will occult when one or more missiles are in flight to prevent simulation of more than six AMRAAMs at one time.

CONTROLS AND INDICATORS

DISPLAY DECLUTTER

De-clutter control of the CSG generated symbology on the ATK, AA-ATK, FLIR & ELEV and PA formats is implemented via the DCLT Softkey located on the ATK Format. The de-clutter level being indicated on the bottom of the key by the following legends: MAX indicates maximum De-Clutter level. NOR+ indicates normal De-Clutter level and that the next selection of the key will select MAX De-Clutter. NOR- indicates normal De-Clutter level and that the next selection of the key will select MIN De-Clutter. MIN indicates minimum De-Clutter level. Repeated selections of this De-clutter key cycle the de-clutter level through NOR+, MAX, NOR-, MIN, NOR+, etc. The default selection on entering any PoF (except Combat) is NOR-. On entering Combat PoF the default is NOR+ to ensure the pilot can rapidly de-clutter the head down formats.

ATTACK FORMAT DE-CLUTTER

The main purpose of the Attack Format is to help the pilot prioritize targets, initiate attacks and complete the intercept. As this task is independent of phase of flight, Attack format symbols are subject to the same de-clutter logic in all mission phases. The following Attack de-clutter moding should be noted:

– On both the PPI and B-Scope formats all 3 weapons types (M, S & G) and stores remaining data blocks are displayed at MIN de-clutter. At NOR and MAX de-clutter only the currently selected weapon type and rounds/missiles remaining are shown.
– On the PPI display, all range scale digits are displayed at all de-clutter levels. On the B-Scope display only the maximum range digits are displayed at MAX de-clutter.
– Missile envelopes (launch success zone) symbols on both the PPI and B-Scope are shown for the top six targets in the DTL at MIN and NOR de-clutter. At MAX, the envelopes are only shown for the first and second targets in the DTL when MRAAM is selected, or for the first target only when SRAAM is selected.
– When Bullseye has not been defined or the Bullseye grid is not selected a range and bearing read out is given for the XY marker with respect to PP. This own aircraft read out is occulted at MAX de-clutter.

PA FORMAT DE-CLUTTER

As a result of being required to display both target and navigation symbology including the map display and it's associated tactical symbology, the PA format has the greatest potential to become cluttered. In addition more than any other format the type of information that is required to be displayed on the PA format changes with phase of flight, i.e.: During start-up and taxiing (i.e. Ground PoF) the primary task in relation to the PA format is the need to update navigation, route and tactical information.

During the take-off phase, navigation data is the focus, although radar data is also significant. In the navigation phase, route information (e.g. attitude, velocity and timing) is the primary focus. In the combat phases, sensor and weapons data becomes the prime interest. As identified above De-clutter control of the CSG generated symbology on the PA

Format is actioned via the DCLT Softkey located on the Attack format. The effect of this key on the PA is summed up as follows:

- Unlike the Attack and Elevation formats, important data (tracks, etc.) may be located at the top edge of the format. To help to de-clutter this area the own aircraft height, speed and heading information is occulted at MAX clutter level.
- In all phases of flight a full weapons data block is displayed in all de-clutter levels.
- The HSI is not de-cluttered.
- Only the track line from PP to DWP, and the navigation route beyond DWP, are displayed in MAX clutter level.
- All other de-clutter rules that apply to the AF apply to the PA Format.

TACTICAL INFORMATION LEVEL

In addition to the CSG generated navigation and combat symbology displayed on the PA format, the pilot can also select to display the DMG generated Map(s) and the associated Tactical Information. This Tactical symbology is categorized (0, 1 or 2) in the same way as the CSG symbology as detailed above but is de-cluttered both automatically and via pilot selection of the TACT Softkey as follows.

AUTOMATIC TACTICAL INFORMATION DE-CLUTTER

When displayed with the CSG generated symbology set the amount and complexity of symbology available within the tactical data symbology set can result in excessive display clutter at the range scales >120 NM. In order to alleviate this clutter, automatic de-clutter has been implemented by either occulting or reducing the complexity of specific Tactical symbology as follows:

Automatic Tactical Information De-Clutter

Scale (NM)	Line feature text	Alt/Time	Corridor Text 5 Km	Corridor Text 10 Km
120	Displayed	Displayed	Displayed	Displayed
200	Displayed	Occulted	Occulted	Displayed
320	Occulted	Occulted	Occulted	Occulted

PILOT SELECTABLE TACTICAL INFORMATION

The pilot selectable TACTical Information Softkey works in a similar way to the DCLT Softkey on ATK format. However the following significant differences should be noted:

MAX indicates maximum information level (i.e. minimum de-clutter)

MIN indicates minimum information level (i.e. maximum de-clutter

For scales ≥200 NM, MAX Information is not available

At the 320 NM scale, both MAX and NOR Tactical Information levels are unavailable, resulting in the occulting of the TACT Softkey.

ELEVATION FORMAT DE-CLUTTER

In common with the Attack Format, the Elevation Format is used primarily for target prioritization and engagement. EF de-clutter is therefore consistent with that of the Attack Format, and the de-clutter moding is the same for each PoF. As identified above, the DCLT Softkey located on the Attack format also de-clutters the Elevation Format.

HUD & HDH DE-CLUTTER

HUD and HDH de-clutter is controlled through a dedicated pushbutton on the HUP. As the HUD Format is the primary flight information display throughout all mission phases many of the symbols displayed on the HUD are flight or safety critical and so are never de-cluttered. However, unlike the MHDDs, where de-clutter is used to clarify the display of information, HUD de-clutter is necessary to allow the pilot to see through the symbology to the outside world. Of particular note are the following:

- In Ground, Take-off, Combat and Navigation PoF, the 5°, 15° and 25° pitch bars are occulted when MAX de-clutter is selected. All other pitch lines and associated symbology are unaffected. However, all pitch bars are displayed in all de-clutter levels in Approach PoF.
- Only the currently selected weapon type and number remaining are displayed at NOR and MAX de-clutter.
- In Nav & Combat PoF the millibar setting is only displayed in the HUD when changed, and automatically occults 5 secs after the change is complete.

– In NOR and MIN de-clutter all targets (up to a maximum of 8) are shown in all PoF.
– In Combat PoF at MAX de-clutter, with SRAAM or GUN selected, only the first target is shown, while with MRAAM selected the first and second targets are displayed. At MAX de-clutter in all other phases of flight, the first and second targets are displayed.
– Three widths of heading ribbon are available. At MIN de-clutter a wide (55°) ribbon is displayed, at NOR de-clutter a normal (35°) ribbon and at MAX de-clutter a narrow (15°) ribbon.
– Bank angle marks and the VSI are displayed automatically as follows:

HUD and HDH De-clutter

De-Clutter Level	Ground	T/O	NAV	Combat	A/L
MAX	VSI	B and VSI	B and VSI	Nil	B and VSI
NOR	VSI	VSI	Nil	Nil	VSI
MIN	Nil	Nil	Nil	Nil	Nil

HOTAS

XY-CONTROLLER FUNCTIONS

The XY controller on the front of the right throttle is used for the following Attack and Ident functions:

– LF Manual Acquire (AF, PA and EF)
– Initiate Radar Tracks (AF and EF)
– Deletion of tracks (AF)
– Denomination of targets (AF)
– Extra Data on tracks and targets (AF, PA and EF)
– Management of DTL (AF)
– Nomination of tracks as targets (AF, PA and EF)
– Re-attack (AF)
– Bearing/Range Readout (AF)
– Allocate Missiles to Targets (AF)
– Azimuth scan volume adjustment (AF)
– Azimuth scan centerline adjustment (AF)
– Elevation multi-bar scan selection (AF)
– Manual RAID selection (AF) (cleared for assessment purpose only with SP3C/15)
– Own Aircraft Speed (KDAS/MACH) selection (AF)
– Active Scan in Radar Inhibit selection (AF)
– TGS Zoom function (AF and PA)
– Pilot Identity Override (PIO) (AF)
– RBGM Gain selection (AF)
– Radar Attenuation (AF) (not cleared with SP3C/15)
– IFF Mode 4 Own Aircraft Response ON/OFF selection (AF)
– Manual IFF interrogation of tracks, targets or volumes (AF)
– Display Range scale changing (AF, PA)
– Radar Altitude Coverage indication (AF, EF)
– SACQ sightline indication (HUD)
– SRAAM slave indication (HUD)
– Combination of SRAAM Slaved and Radar SACQ Mode (HUD)
– VISident (cleared for assessment purpose only with SP3C/15) position selection (HUD).

A and I XY Functions with Plots/Tracks/Target/TGS

XY Controller/Marker	Attack Format	PA Format	Elevation Format
position over track/target	magnetic lock-on to symbol (marker jumps on symbol when marker comes close to it), no other display change	magnetic lock-on to symbol, no other display change	magnetic lock-on to symbol, no other display change
position over DTL target	magnetic lock-on to symbol, displays extra data in ROL(s) , occults after 7 sec. or if XY is moved off symbol	magnetic lock-on to symbol, no other display change	magnetic lock-on to symbol, displays extra data in ROL
short insert on a plot	initiates a radar track	no plots available on PA format	initiates a radar track

(Continued)

A and I XY Functions with Plots/Tracks/Target/TGS (Continued)

XY Controller/Marker	Attack Format	PA Format	Elevation Format
short insert on track/target	displays extra data in ROL(s), and IFF info if available, and 2-digit height on top right of symbol which occults after 7 sec. or when XY is moved off symbol	displays extra info box (max 3 pages with 5 lines) which occults 3 sec. after XY is moved off symbol, and 2-digit height on top right of symbol which occults after 7 sec. or when XY is moved off symbol	displays extra data in ROL and 2-digit height on top right of symbol which occults after 7 sec. or when XY is moved off symbol
long insert on track/target	displays raid box	displays zoom box	(as for short insert)
short and long insert on TGS	displays TGS zoom box	displays TGS zoom box	TGS not available
long insert on area	initiates area raid	displays zoom box	(N/A)
second insert on track	nominates the track as a target	nominates the track as a target	nominates the track as a target
third insert on track	nominates the track as the top priority target	nominates the track as the top priority target	nominates the track as the top priority target
insert on bin icon, drag bin icon over track and insert	deletes TWS radar track (MIDS tracks may not be deleted)	(N/A)	(N/A)
insert on bin icon, drag bin icon over target (including top priority target) and insert	denominates target	(N/A)	(N/A)

DWP WARNINGS

The following warning is available for the Attack Computer:

Attack Computer Failure Warning

Warning	Category	Voice message	DWP caption	Suppress conditions	System Actions	Mission Consequences
Attack Computer Failure	3	Attack Computer	**ATK CPTR**	during power up/down	NAV Computer takes over	Degraded, depending on NC in REV mode

RADAR

The Radar, also called "CAPTOR" is the primary sensor for target detection, tracking and engagement. It is a pulse doppler multiple Pulse Repetition Frequency (PRF) radar with a high degree of automation of functions to minimize pilot workload and to provide optimum performance over a wide range of ambient and target conditions. The radar provides Air-to-Air (A/A) search, Lock Follows (LF) and Air Combat Modes (ACM) against Air-to-Air targets and Air-to-Surface (AS) mapping.

The radar supports the effective use of the Air-to-Air weapons and the 27 mm internal gun (cleared for assessment purpose only from SP3C/15 onwards).

The automatic features of the avionics subsystem free the pilot to concentrate on the primary requirements of A/A combat, i.e. to detect the target, steer the aircraft and launch missiles or fire the gun (cleared for assessment purpose only from SP3C/ 15onwards). The Hands On Throttle And Stick (HOTAS) concept utilizes switches on the stick and throttle to allow the pilot to control the weapons, sensors and displays during time critical portions of the attack. After a target is visually detected, the pilot never needs to look away or remove his hands from the throttles and the control stick.

Radar acquisition is commanded from the control stick (Air Combat acquisition modes or manual acquisition mode). Attack steering information is automatically presented on the Head-Up Display (HUD) and on the Attack Format (AF) of the Multifunction Head Down Display (MHDD). The pilot uses the command steering cues on the HUD to get within weapon envelope and fires the gun (cleared for assessment purpose only from SP3C/15 onwards) or launches the selected missile with the trigger on the control stick.

The radar operates in conjunction with the IFF interrogator, associating the identification received with existing radar tracks.

Electronic Counter Counter Measures (ECCM) are built into the radar system.

RADAR CHANNEL OPERATION

The radar can transmit either on

– fixed frequency mode, or in
– frequency agile modes.

The available radar channels and frequency modes may be pre-defined for each radar mode individually during mission planning and may be loaded on ground via PDS (SMD). The PDS which will overwrite the previous frequency settings.

The radar channel may be amended also in the aircraft via MDE, the frequency modes may not.

FIXED FREQUENCY OPERATION

The radar can use fixed channels (classified), which must be selected from the enabled (loaded) frequency set. If no channel set has been loaded then the full set of channels is available. The radar requires a minimum of two channels to operate therefore a channel pair (channel A and channel B) must be selected, with a defined channel separation (classified) between the channel pairs.

To reduce the effects of clutter, fixed frequency channels can be modified through the MDEF. When entering of a new channel pair is necessary, it must be considered that the channels are separated by a (classified) amount.

FREQUENCY AGILITY (FA) MODES

The radar can operate in several Frequency Agility (FA) Modes (classified) on a loaded set of channels (known as the Enabled Set) defined during mission planning.

PULSE REPETITION FREQUENCIES (PRF)

For air-to-air operations, the radar provides detection, rapid acquisition and tracking capability for all aspects in look-up and look-down. This is achieved by automatically mechanizing different Pulse Repetition Frequency (PRF) modes, high (HPRF), medium (MPRF) and low (LPRF). Note, that there is no manual selection of PRFs, other than selecting a certain radar mode.

RADAR SCANNING

ANTENNA GIMBAL LIMITS

The radar antenna is electrical driven within ±70° in azimuth and ±60° in elevation. The azimuth and elevation limits are referenced to the fuselage reference line (FRL) of the aircraft.

The bars are overlapping a little bit to ensure scanning between bars without any gaps (refer to Figure 8.1).

RADAR COMPONENTS

The Radar consists of the following subsystems (LRI's):

– Scanner (SCA)
– Processor (PROC)
– Transmitter Auxiliary Unit (TAU)
– Transmitter Power Amplifier (TPA)
– Receiver (RXR)
– Waveguide Unit

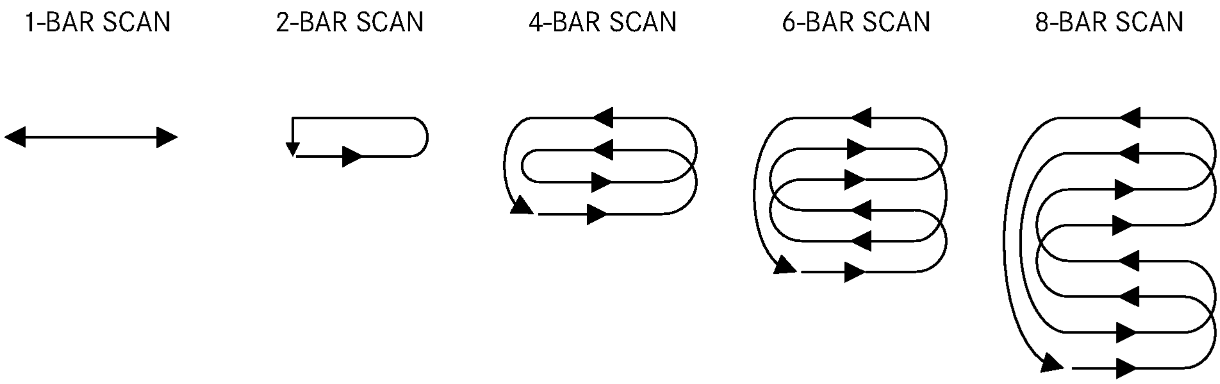


Figure 8.1 - Radar Bar Scan Pattern

RADAR MODES AND OPERATION

The radar provides the following modes:

– Air-to-Air Modes (A/A), incl. Air Combat Modes (ACM)
– Air-to-Surface Modes (A/S), (RBGM only (cleared for assessment purpose only with SP3C/15))

AIR-TO-AIR MODES

The radar operates in the following air-to-air modes:

A/A Search and Track Modes

– Track-While-Scan (TWS)
  - Adaptive Waveform Scheduling (AWS)
  - Priority Search (PS)
  - Priority Tracking (PT)
– Velocity Search (VS)

A/A Lock-Follow Modes (LF)

– Single-Target-Track (STT)
– Visual Identification (VisIdent) (cleared for assessment only with SP3C/15)
– Gun

Air Combat Modes (ACM)

– Slaved Acquisition (SACQ),
– Vertical Acquisition (VACQ),
– HUD Acquisition (HUDACQ).

Additional Moding

– Raid Mode (Raid cleared for assessment purpose only from SP3C/15 onwards)
– Radar Stealth Mode
– Sector Acquisition (currently not available)
– Non Co-operative Identification (NCI) (currently not available)

Air-to-Surface Modes

– Real Beam Ground Mapping (RBGM) (cleared for assessment purpose only from SP3C/15 onwards)

A/A SEARCH AND TRACK MODES

In the air-to-air role the radar may search for tracks dependent on "range" or "velocity" detections, or may track detections taking both "range" and "velocity" into consideration.
Tracking not only involves association of previous detections with the present detection but also involves prediction of the track's next detected position. This enables velocity and range gates to be utilized increasing the accuracy of the tracking information.

TRACK-WHILE-SCAN (TWS)

TWS is the most important and most used radar search mode. It detects and automatically tracks airborne returns and provides outputs of track range, bearing, velocity, altitude, heading, approximate RCS and aspect angle. TWS can be entered directly by selection TWS on the MHDD/ATCK format from any other primary mode, i.e. VS. Any existing lock prior to TWS demand is broken and the radar starts TWS operation in the search state.

The TWS mode's primary function is to provide medium- to long-range situational awareness. TWS is required to provide simultaneous target detection and tracking over a large scan volume. The TWS mode utilizes raw hit detection data to construct multiple target tracks while the radar continues to provide a search capability. TWS multi-target tracking capability is determined by the trade-off between frame time and scan volume. The scan volume and scan center is manually definable by the pilot. The scan center is also controlled automatically by the radar when Auto Scan Centering facility (ASC) is selected or when a track is nominated as target.

When either Scan Centering (Auto/Manual) option is selected, and no targets are nominated, the elevation bars are automatically adjusted according to the selected range on the attack format.

With TWS selected the radar is capable of tracking up to 20 tracks and subsequently detecting and displaying 180 additional plots. When an object is detected and when the radar has sufficient data (i.e. the radar detects the object at least twice within four consecutive frames), it will form a track. The plots will `age' over a period of time and disappear. The ageing rate is normally controlled automatically by the radar, but may be varied by the pilot via soft key selection on the MHDD.

In TWS the radar automatically controls the transmitted waveform (PRF) to provide optimum radar performance under a variety of conditions. For example, when looking down towards the surface, clutter rejection is enhanced by using a combination of medium and high PRF waveforms, while looking up uses a combination of medium and low PRF waveforms to optimize detection performance.

To optimize the operation of the TWS mode (PRFs) for either tracking or searching the following additional modes are implemented:

– Adaptive Waveform Scheduling (AWS), selectable via the SK SRCH-AWS/PS/NORM.
– Priority Search (PS), selectable via the SK SRCH-AWS/PS/NORM.
– Priority Tracking (PT), selected automatically by the system.

ADAPTIVE WAVEFORM SCHEDULING (AWS)

In AWS the radar uses waveforms optimized for target tracking accuracy and jamming resistance, whilst still maintaining a long range detection capability (refer to Figure 8.11). AWS is the default mode when TWS is selected, indicated on the SK SRCH/AWS with AWS boxed.

AWS is also the default mode in PT.

PRIORITY SEARCH (PS)

In PS mode, the radar uses waveforms optimized for long range detection of new targets between existing tracks. It is expected that use of PS will allow target detection (displayed on the ATK format as plots) at greater ranges than in AWS, but tracking correlation and track maintenance may be less effective. PS is selected with the SK SRCH/AWS, which then shows SRCH/PS (PS boxed).

NOTE

PS is only available in TWS. PS is not available when the radar has entered PT.

PRIORITY TRACKING (PT)

After a target is nominated or engaged in TWS the radar automatically enters Priority Tracking, where up to six targets are updated with a higher rate (even when outside the actual radar search area, but within radar gimbal limits), which results in a more stable track and greatly reduces the workload associated with maintaining radar elevation coverage of nominated targets (refer to Figure 8.3).

Priority Tracking is mainly to support targets with AMRAAM in flight - in preference to other DTL targets.

In PT the radar uses also Data Adaptive Scanning (DAS), a facility which is entirely automatic within the radar, and is implemented whenever a nominated target goes outside the radar's elevation or azimuth scan volume coverage; in subsequent sweeps, the radar pauses momentarily at the target azimuth and the scanner is pointed briefly at the target's elevation, before continuing the set scan pattern. The resulting returns are used to maintain TWS tracking on the target.

Note that adaptive scanning is used only for up to six nominated radar targets. Non-target tracks will be lost by the radar if they go outside elevation scan coverage.

NOTE

The search priority option is not available when the radar is priority tracking.

To cancel Priority Tracking, denominate the targets or deselect TWS.

VELOCITY SEARCH (VS)

Velocity search is used against targets with closure rates greater than own ship ground speed and therefore preferred against forward aspect targets. Generally, VS is used to detect long range targets.

VS provides target detection as a function of target velocities relative to the own aircraft velocity (doppler shift) and provides an output of closing speed and bearing. Target data is presented in a B-scope velocity-azimuth format as a 'plot'. The plot will "age" over a period of time and disappear. The ageing rate is normally controlled automatically by the radar, but may be varied by the pilot via soft key selection on the MHDD.

There is no tracking facility in this mode due to the lack of range information available although a plot can be selected for Lock Follow. If Lock Follow is achieved on a VS plot then the display will change to the default range format.

VS mode can be entered directly by selection VS on the MHDD/ATCK format from any other primary mode. Any existing lock prior to VS demand is broken and the radar starts VS operation in the search state.

A/A LOCK-FOLLOW MODES (LF)

Three lock-follow modes, which are optimized for their specific tasks, are available as follows:

– Single-Target-Track (STT)
– Visual Identification (VisIdent) (cleared for assessment purpose only with SP3C/15); if no weapon is selected
– Gun; if gun is selected as weapon type (cleared for assessment purpose only with SP3C/15)

In a Lock Follow mode the radar is locked to a single plot, track or target. This mode provides high accuracy positional data. If lock is achieved when GUN is selected (cleared for assessment purpose only with SP3C/15), the radar enters GUN Lock Follow mode when target is within the Gun mode max/min range (refer to Figure 8.7). Similarly if lock is achieved when VISIDENT is selected, the radar enters VISIDENT Lock Follow mode when the target is within the VISIDENT mode maximum range (refer to Figure 8.8). If neither GUN nor VISIDENT is selected then Single Target Track (STT) is entered.

SINGLE-TARGET-TRACK (STT)

STT is a lock-follow mode that can be selected manually from any search mode (stick top ACM control) or -following an air combat mode selection - automatically. For manual STT initiation, the pilot positions the XY marker over a plot, track, target or display position of interest and presses the RACM/ lock button. If lock is achieved, the track symbol is bracketed by a diagonal cross on the MHDDs and HUD. This radar functionality is also called "External Acquisition".

When the radar has acquired an airborne target and has entered the LF mode STT it continuously tracks the target in range, angle and range rate. Upon uncommanded loss of lock an automatic re-acquisition is initiated (Figure 8.2). If the re-acquisition fails the STT mode is terminated and the radar continuous to operate in the primary mode from which the lock was achieved.

Within a lock-follow mode parallel searching and tracking of other targets is not possible. Therefore if a lock follow mode was entered from TWS mode (except via an Air Combat Mode - ACM) then the existing TWS tracks will go into memory, because the radar then will only be tracking a single object. If the radar stays in the Lock Follow mode for a period of time the memorized tracks will be automatically deleted. Note, that the DTL/PETL will be occulted when there are no designated targets anymore.

If lock-on is attempted within an Air Combat Mode (ACM), but not achieved, the radar remains in the selected RACM until deselection. If lock is achieved, but then lost, the radar will attempt to re-acquire for about two seconds, and then reverts to the previous search mode (or RACM mode, if used to initiate lock) with the elevation and (where relevant) azimuth coverage centered on the last known angular position of the track.

When the radar is in STT, the scan volume controls and elevation bar option selections are not available on the ATCK format, and the radar volume will be occulted on the EF. Range scale options are available, however, during STT, automatic range scale adjustment is enabled.

VISIDENT MODE (VIS) (CLEARED FOR ASSESSMENT PURPOSE ONLY WITH SP3C/15)

Visident is a short range lock-follow mode, providing radar steering to the locked target for visual identification, down to minimum radar range without endangering the aircraft.

It is only available when the radar is in STT, although the mode can be pre-selected with the VIS softkey on the MHDD/ATCK format when in TWS or STT. Pre-selection, indicated on the softkey, allows to set up the required offsets.

When VISident is selected the positioning cue is displayed on the HUD, with the last selected position indicated on the cue, enabling acceptance of this position via a single selection. If no previous selection was made the default position of 6 o'clock on the smaller cone is used.

One of twelve position can be defined on one of two fixed diameter cones about the target. The cones have 30° and 50° semi-angles subtended from the design eye position. The required offset position is defined by selecting the VISident soft key. The HUD displays two concentric circles and the X-Y cursor. The cursor can be slewed round the cones by X-Y inputs, and a short insert changes the cursor from one cone to the other; the desired position is then fixed in the system by making a long insert. This position can be preselected from TWS or STT, or updated any time when in VISident mode. The new position is indicated for 5 seconds and then the positioning cue is occulted from the HUD (refer to Figure 8.9).

NOTE

> Visident is a "Head Up" visual mode and therefore the cones are only displayed in the HUD.

If VISident is preselected and a lock-on is achieved outside the Visident range then lead collision or pure pursuit steering will be provided until the maximum Visident range is reached (refer to Figure 8.10). Within the maximum VISident range, then VISident mode will be entered and the steering will then be lag pursuit to the selected Visident position (refer to Figure 8.8).

If the radar is not locked, with Visident pre-selected, the visident circle and associated range rate cue are occulted, the steer dot provides pure pursuit steering, and only target range, range rate, and a TD box are displayed on the HUD.

If the lock-on is achieved the VISident target information is displayed and will include:

– closing/opening speed (digital and analogue)
– range to target (digital and analogue),
– altitude,
– course (track),
– minimum VISident range,
– minimum radar lock range and air speed,
– min range cross,
– aspect angle.

The range countdown to the target is displayed with an additional closing speed readout when the target range is less than 2 NM. The range countdown will indicate the minimum VISident range of 200 meters. Visident symbology will be provided below this range until radar lock is lost.

The aspect angle of the target is displayed on the HUD with the track sightline indication.

The HUD is automatically decluttered, (general navigation information is occulted).

If a weapon was selected prior VISident selection, the weapon is automatically deselected.

Visident is cancelled with:

- Deselect VIS softkey.
- Break Lock (pre-selection is still active)
- Weapon Selection (also deselects the pre-selection)
- Select another radar mode (VISident preselection will remain selected if this is TWS and will be cancelled if this is SBY, RBGM, VS or ACM).
- Standby

All indications will remain on the HUD until the radar lock break occurs.

GUN MODE (GUN) (CLEARED FOR ASSESSMENT PURPOSE ONLY WITH SP3C/15)

The Gun mode is selected either by selecting Lock On when GUN as a weapon is selected or by selecting GUN when radar is in a Lock Follow mode.

When selected and within maximum Gun mode range, the mode behaves as STT mode and provides data to support gun steering and aiming information.

When within (classified) range, the director gunsight is displayed and the steer dot is occulted (refer to Figure 8.7).

With the target at greater than (classified) range and the radar locked the radar deselects the Gun mode and enters STT. The steering dot gives fighter/target collision steering; the director gunsight is occulted, but the historic tracer line is displayed on the HUD.

When the target is just at the boundary, hysteresis is applied to avoid toggling between those two states.

To cancel the Gun mode break lock on or deselect gun.

AIR COMBAT MODES (ACM)

The radar air combat modes are designed for the short range, air combat maneuvering, where rapid automatic radar acquisition and lock on of a visually detected target is desired. This radar function for this modes is called "Auto Acquisition".

The following radar air combat modes are available:

- Slaved Acquisition (SACQ),
- Vertical Acquisition (VACQ),
- HUD Acquisition (HUDACQ).

The radar air combat modes (RACM) are selected via the HOTAS ACM button. When selected, the radar attempts to lock on the first detection within the search volume. The displayed scan volume is occulted from the attack, elevation and P.A. formats.

If no lock is achieved, the radar continues to search in the selected ACM mode, looking for targets.

If lock is achieved and then lost, the radar continues to search around the last known target position for a short time before it continuous to search in the selected ACM mode.

If the radar locks to an undesired target, then reselection of the ACM will break lock on that target (bump acquisition) and reject it for about two seconds, while the radar searches in ACM acquisition for further targets. The system re-initiates the selected ACM re-commencing the scan pattern from the rejected target position, or the boresight position for SACQ mode, if SACQ mode is the ACM mode. If no lock to a different target can be achieved during this period the radar re-enters the ACM acquisition state (refer to Figure 8.2).

Once lock is achieved the radar enters STT or GUN, if this weapon is selected (GUN cleared for assessment purpose only with SP3C/15), if a weapon is not already selected, the system will automatically select a SRAAM, if available.

The radar ACM modes can be entered directly by selection from any other primary mode. Any lock existing prior to the ACM modes is broken. Radar tracks will go into memory and delete when the track file is no longer valid and the plots will be occulted.

An ACM selection over-rides all other display and radar selections on the attack- and elevation formats. The search mode, from which the ACM was selected will remain on the softkeys (except from RBGM, in this case the last selected A/A search mode will be shown on the soft key).

ACM modes can be terminated by selection of another radar mode. Selecting the break lock function will return the radar to the last selected A/A search mode (also if previously mode was RBGM (cleared for assessment purpose only from SP3C/15 onwards)).

SLAVED ACQUISITION (SACQ)

The SACQ is a narrow acquisition mode, selected by pushing forward on the radar ACM select button on the control stick.

When SACQ mode is selected the radar antenna is initially aligned on the aircraft boresight axis, i.e. the scan volume is adjusted to the 3.1 deg by 3.1 deg around the commanded scan center, indicated on the HUD by a 3° diameter reference circle centered on the aircraft boresight axis (refer to Figure 8.6).

The radar scan center can then be slaved with the XY controller or may be combined with the AIM-9L seeker head (SRAAM Sensor Slaving) (SRAAM X/Y and Radar Slaving with MFRL fitted to Outboard Stations are not cleared with SP3C/15). While radar SACQ mode is engaged, the annotation "HUD" is shown at the marker locate position (next to the MKR LOC softkey) on the AF. When SRAAM Sensor Slaving is selected the reference circle will appear on the HUD at the seeker heads position which is then the position the radar is looking at.

If bump aquisition, i.e. re-selection of SACQ, is selected, e.g. because the radar has locked to an undesired target, the radar antenna is aligned on the aircraft boresight axis again.

The upper range gate is set to 15 NM.

VERTICAL ACQUISITION (VACQ)

The VACQ mode is selected by pushing aft on the radar ACM select button on the control stick.

The radar is commanded to a 2 bar elevation scan pattern from at least -15 deg to +60 deg elevation (refer to Figure 8.5). The azimuth scan coverage will be at least 6.2 deg around the boresight axis. The upper range gate is set to 15 NM. VACQ is weapon independent and takes priority over weapon initialized parameters.

This mode is preferably used when flying with high AoA and high roll rates to search in the upcoming flight path.

HUD ACQUISITION (HUDACQ)

The HUDACQ mode is selected by pushing to the right on the radar ACM select button on the control stick.

On selection, the scan volume (8 bars in elevation) is adjusted to the HUD fields of view which is 30 deg in azimuth (±15° right/left) and 25 deg in elevation (+7,5° up, -17,5° down) (refer to Figure 8.4). The upper range gate is set to 15 NM.

ADDITIONAL MODING

MANUAL RAID MODE (RAID CLEARED FOR ASSESSMENT PURPOSE ONLY FROM SP3C/15 ONWARDS)

A Raid assessment facility is provided within the radar, in which the radar processes the detected radar returns to determine if more than one aircraft or object is present within the detection. Raid improves the range calculation by optimized PRFs and other special radar technics to optimize target resolution. When Raid is selected 75% processing time of a radar scan is used for the normal radar processing and 25% for the Raid processing.

RAID can be selected manually any time with a long XY insert on a track, target or blank area (volume). The facility is only available on the AF when the radar is in TWS or Lock Follow modes.

Any plots detected during manual Raid are displayed with their corresponding 2-digit altitude, as for normal tracks following XY insert. Tracks within the RAID or AREA boxes may be nominated as targets and weapon aiming initiated against them. Therefore information required to enable an attack to be carried out will be displayed with the RAID picture. This will be DTL, weapons remaining, time to autonomous, time to release and the shoot cue.

Tracks within the RAID or AREA boxes may also be de-nominated, using the BIN and UNDO XY functions.

It is not possible to select manual track initiation, alter the selected number of bars, adjust the radar scan width or azimuth center or change the attack format range when the RAID picture is displayed. The symbols associated with the control of these functions are occulted.

The zoom function is also not available when RAID is selected.

The underlying attack format range and the position of the center of the RAID picture is displayed with the RAID picture.

RAID ON A TRACK

Manual Raid on a track is carried out by positioning the XY cursor over the track symbol on the Attack Format and making a long (greater than one second) XY insert. The AF changes to show the Raid Box, a 5 x 5 NM square expanded display centered on the selected track; the display is similar to the TGS expand box, and is differentiated by the legend "RAID TRACK 5" in the top right corner of the display. The "5 " indicates the size of the raid picture (5 x 5 NM). Like TGS expand, a small square shows the position of the expanded box on the underlying range scale, to assist with maintaining situational awareness. Returns produced by the raid processing are displayed as plots - they age in the same way as plots on the normal formats; any tracks that are within the expanded box coverage will also be displayed. The Raid display is cancelled by XY insert anywhere inside the RAID assessment box (provided no symbol is captured with the XY marker) or when any other format is selected. In addition, the number of aircraft or objects detected within the track by the raid process (if greater than one) is displayed as a number (up to two digits, leading zero occulted) to the bottom left of the track symbol on the PA and elevation formats.

RAID ON AN AREA

The manual RAID on a volume function is only available in TWS.

Manual Raid on an area is carried out by positioning the XY cursor on the AF at the center of the area of interest and making a long XY insert. The AF changes to show the 5 x 5 NM square raid box, but this is now aircraft stabilized. It is differentiated from the track stabilized Raid box and TGS expand box by the legend "RAID WINDOW 5" at the top right corner of the display. Because it is aircraft stabilized - i.e. it "snowplows" a constant range and bearing ahead of the aircraft -any moving returns (shown again as plots and/or tracks) within the box coverage will move across the display. If the raid plots are associated with a radar track, the number of objects within the track is also displayed on the PA and elevation formats.

RADAR NOTCH SELECTION

The Radar cannot detect tracks within ground clutter unless their component of velocity in the direction of ownship is sufficiently great. This deadband area (radar notch) is a physical radar limitation.

Tracks moving just outside of the deadband can be detected.

As road traffic is potential for a lot of tracks to be generated, this would lead to unacceptable display clutter, so the weapon system artificially extends this deadband area (radar notch). The radar can still detect returns within this extended notch, but will not attempt to form new tracks or output information on new returns within this area. If an existing track moves within this area it will be updated and maintained.

To allows the radar to detect low speed tracks when looking down, i.e. helicopters, the radar notch may be selected to LOW with the SK NTCH on the AF (reduced notch size with increased clutter).

The notch operation may also be controlled automatically by selecting the SK NTCH on the AF to AUTO. Then it will operate with a larger notch when looking down (to reduce ground clutter) and a smaller notch when looking up.

The NTCH SK is not available when the radar is in OFF, SBY, PBIT, VS, LF, or any A/S modes.

RADAR MODE TRANSITION AFTER TAKEOFF OR LANDING

On ground the radar automatically enters the SBY mode after switch-on and warm up. On T/O, weight-off-wheels, the radar is automatically put into the TWS mode, provided no other radar mode, e.g. VS has been pre-selected. Radar transmission after weight off wheels is inhibited when Radar Silent (RDR SLNT) has been preselected by the relevant MK on the LGS.

On landing the radar enters automatically the SBY mode.

RADAR SAFETY INTERLOCKS

If weight is on wheels, either left or right main landing gear, all radar emissions are inhibited. This inhibit function may be overrided by groundcrew for testing via the Weight on Wheels Override switch.

If the radar liquid cooling fails all radar active modes are automatically disengaged.

RADAR STEALTH MODE (NOT CLEARED WITH SP3C/15)

In Stealth Mode, SLNT selected on the MDEF, the radar antenna is parked in an position difficult to detect by hostile radars. No transmission or reception will be performed except a 'Significant Events' occurs (see below) or Active Scan icon (from SP5 onwards) is selected (see below).

For detailed description refer also to Transmitter Management.

ACTIVE SCAN ICON

To leave the stealth mode the radar can be commanded to perform two active frame scans by selecting the Active Scan icon (from SP5 onwards) on the AF, using the XY controller. This temporarily breaks the inhibited status of the radar. The radar then searches for two full scan patterns with the mode and the volume selected prior to stealth selection.

A Two Active Frame Scan is not possible if the radar is in OFF, SBY, PBIT, ACM, LF or RBGM (cleared for assessment purpose only from SP3C/15 onwards) prior to stealth inhibit selection.

SIGNIFICANT EVENTS

In 'All Silent' and 'Program' mode, rapidly override of Transmit Inhibit for a particular system may be required, in order to cope with an urgent threat or emergency situation. This is catered for by the following 'Significant Events':

– Selection of ACM - this will engage the Radar in ACM, and allow normal IFF Interrogator operation. Deselection of ACM on HOTAS (i.e. by selecting 'break lock') will return the Radar and IFF Interrogator to 'stealth'. However, deselection by selecting another Radar mode, such as TWS, will initiate a 'Long Term Significant Event', whereby the Radar and Interrogator effectively leave 'stealth' permanently (until reselected as part of 'All Silent' or''Program' modes). In this case, Transmit Inhibit either changes to the 'Null' state, or removes Radar and Interrogator from 'Program' as indicated on the MDE controls.
– Selection of EMGY, or Eject - will activate the Transponder in Emergency mode. Deselecting EMGY will return to 'stealth'.
– Selection of ID - will activate the Transponder in Ident, provided the appropriate modes are selected. Afterwards, the Transponder will return to 'stealth'.

AIR-TO-SURFACE MODES

The radar will operate in the following air-to-surface modes:

RBGM	Real Beam Ground Map (cleared for assessment purpose only with SP3C/15)

REAL BEAM GROUND MAPPING (CLEARED FOR ASSESSMENT PURPOSE ONLY WITH SP3C/15)

This mode provides a pitch-, roll-, and drift-stabilized radar map video on the Attack Format and is selected by the RBGM key. When selected with RBGM softkey, the radar changes into a mapping mode, the Attack Format changes to a PPI format (B-scope not selectable) and the track-oriented radar map is displayed as the radar sweeps. Deselection of RBGM will select the last A/A radar search mode.

Radar elevation scan is controlled manually, there is no automatic scanner pointing. The radar will automatically select between a one bar and two bar elevation scan depending on attack format range; there is no manual selection of scan bars. The elevation coverage and number of bars indications are not displayed on the AF in this mode.

The AF range will remain the same unless the range was greater than the maximum RBGM range, in this case it will become the maximum available RBGM range.

It is possible to alter the attack format ranges, scan width and elevation angle of the scan as for Air to Air operation.

GAIN CONTROL FOR RBGM

The receiver threshold of the radar is controlled via the radar gain function. It is either controlled automatically by the radar or manually by selecting the GAIN SK to MAN (cleared for assessment purpose only from SP3C/15 onwards). A manual gain control selection icon appears on the AF. A XY insert on the icon will toggle the mode of the elevation wheel on the throttle top from scan elevation control to gain control and vice versa. The icon is contrast inverted (white background) to indicate when gain control is active. The gain setting is displayed as percentage (max=100, min=0) in the icon, the higher the number the higher the gain. The setting will stop at 0 and 100, i.e. the value will not wrap over. On selection the last automatic controlled value will appear. When manual control is selected the automatic function will be inhibited.

ATTENUATION CONTROL FOR RBGM (NOT CLEARED WITH SP3C/15)

The transmitter level of the radar is controlled via the attenuation icon using the XY controller. The attenuation value is displayed in whole number from 1 to 6. Default value of max power output is equal to 6, where minimum is equal to 1. Inserting on the upper part of the icon decreases the attenuation setting, i.e. increases radar power. Inserting on the lower part increases the attenuation setting, i.e. decreases radar power. Long inserts change the values at a rate of two steps per second.

MODES - CURRENTLY NOT AVAILABLE

The following mode controls are not supported with software SP3:

– Sector Acquisition (The radar attempts to lock on a non-radar track, e.g. FLIR, MIDS track, by automatically searching in a system defined window when initiated with the RACM/Lock button.)
– Non Co-operative Identification (NCI).

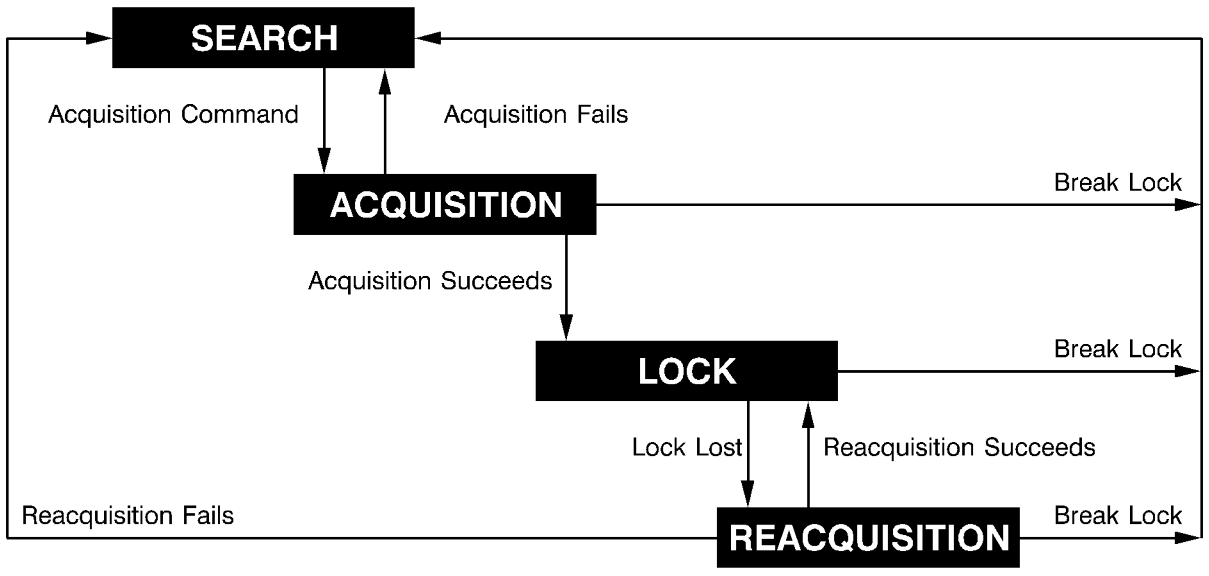


Figure 8.2 - Search/Lock-Follow Moding

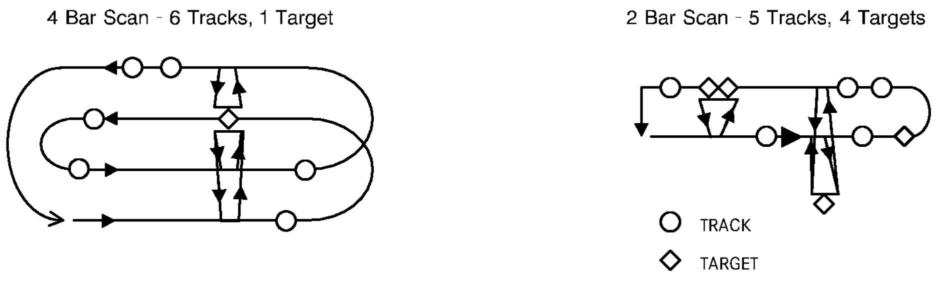


Figure 8.3 - Radar-Priority Track Mode (PT)

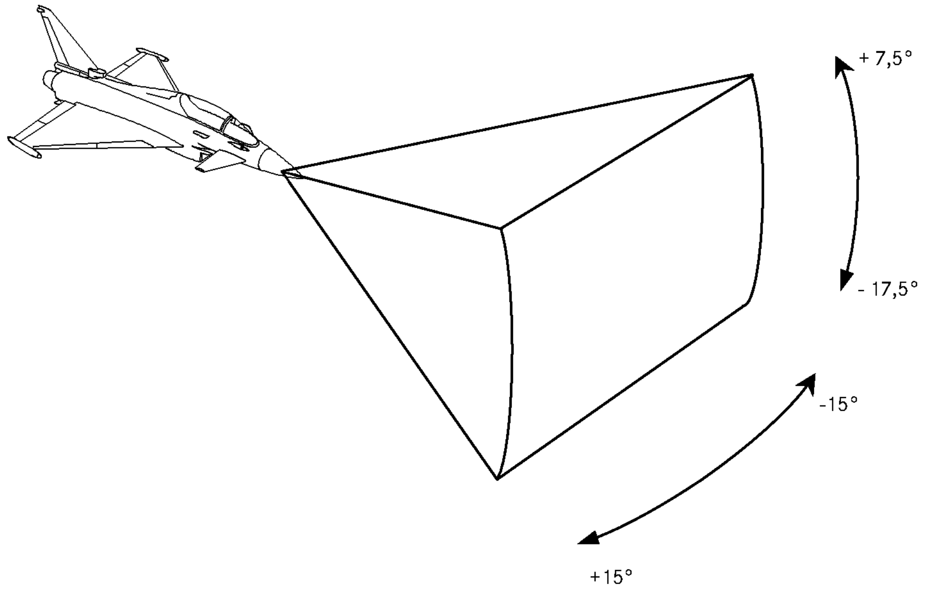


Figure 8.4 - Scan Volume HUDACQ

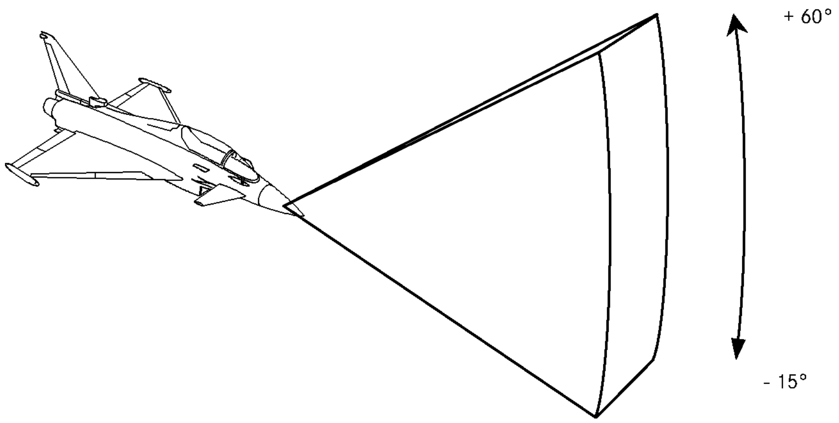


Figure 8.5 - Scan Volume VACQ

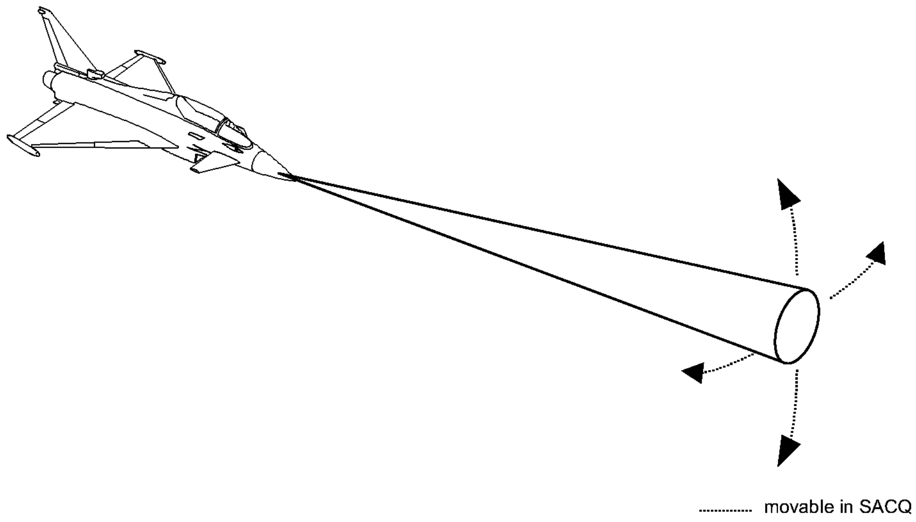


Figure 8.6 - Scan Volume BSTACQ/SACQ

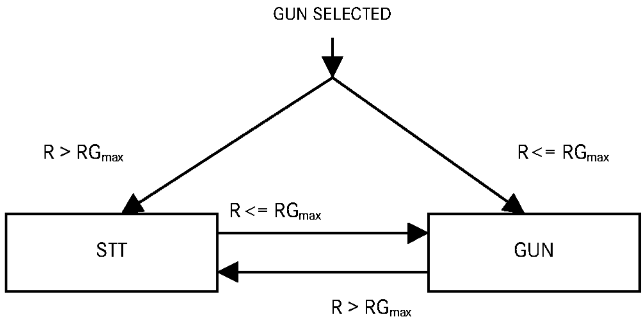


Figure 8.7 - STT/Gun - Moding

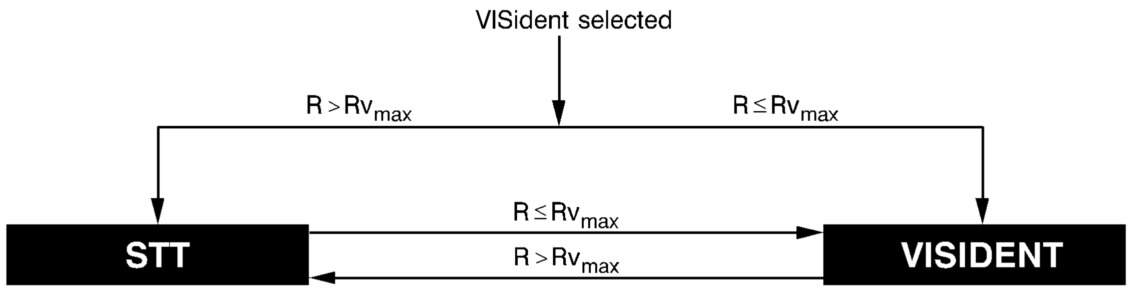


Figure 8.8 - STT/Visident - Moding (cleared for assessment purpose only with SP3C/15)

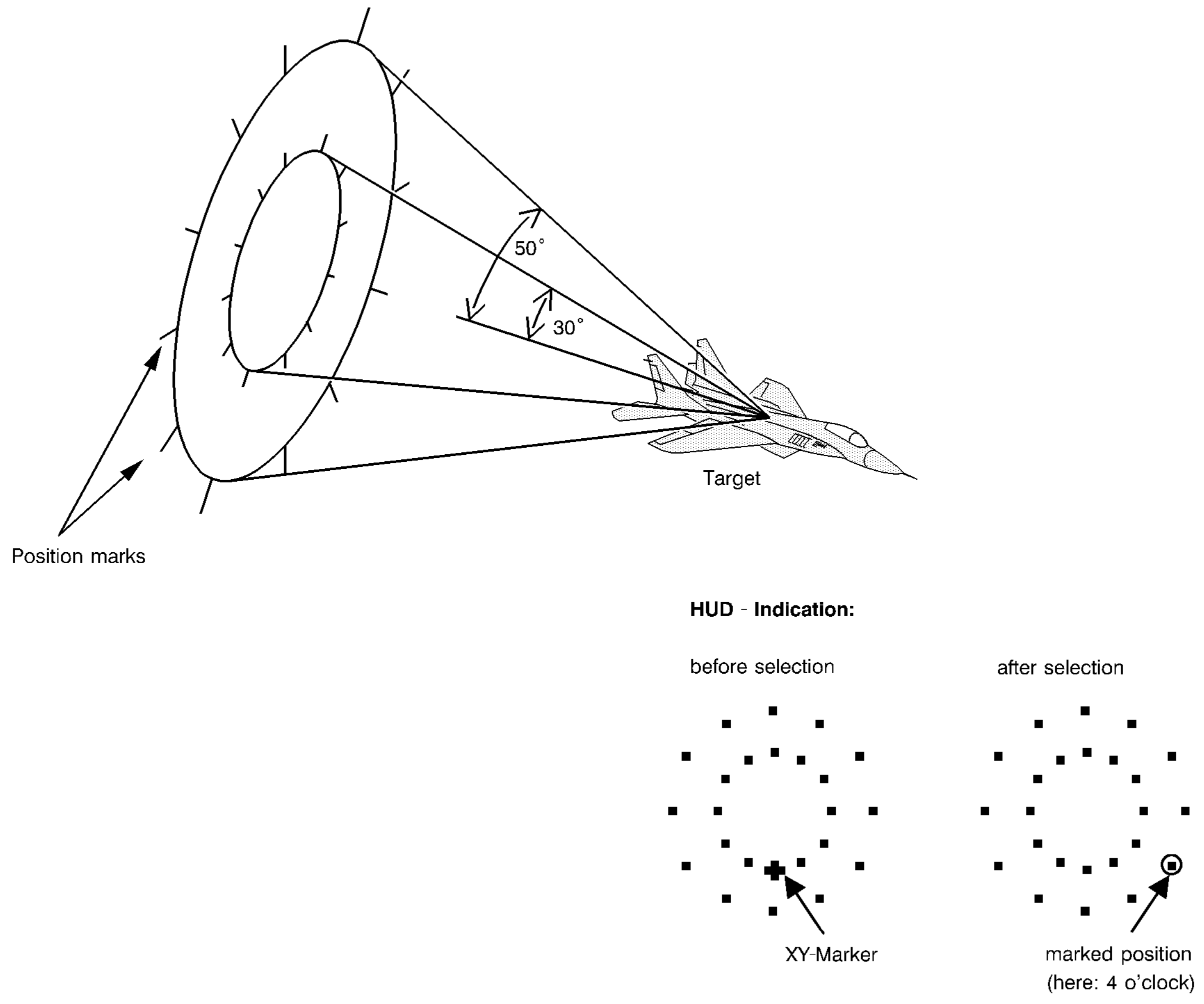


Figure 8.9 - Visident - Positions (cleared for assessment purpose only with SP3C/15)

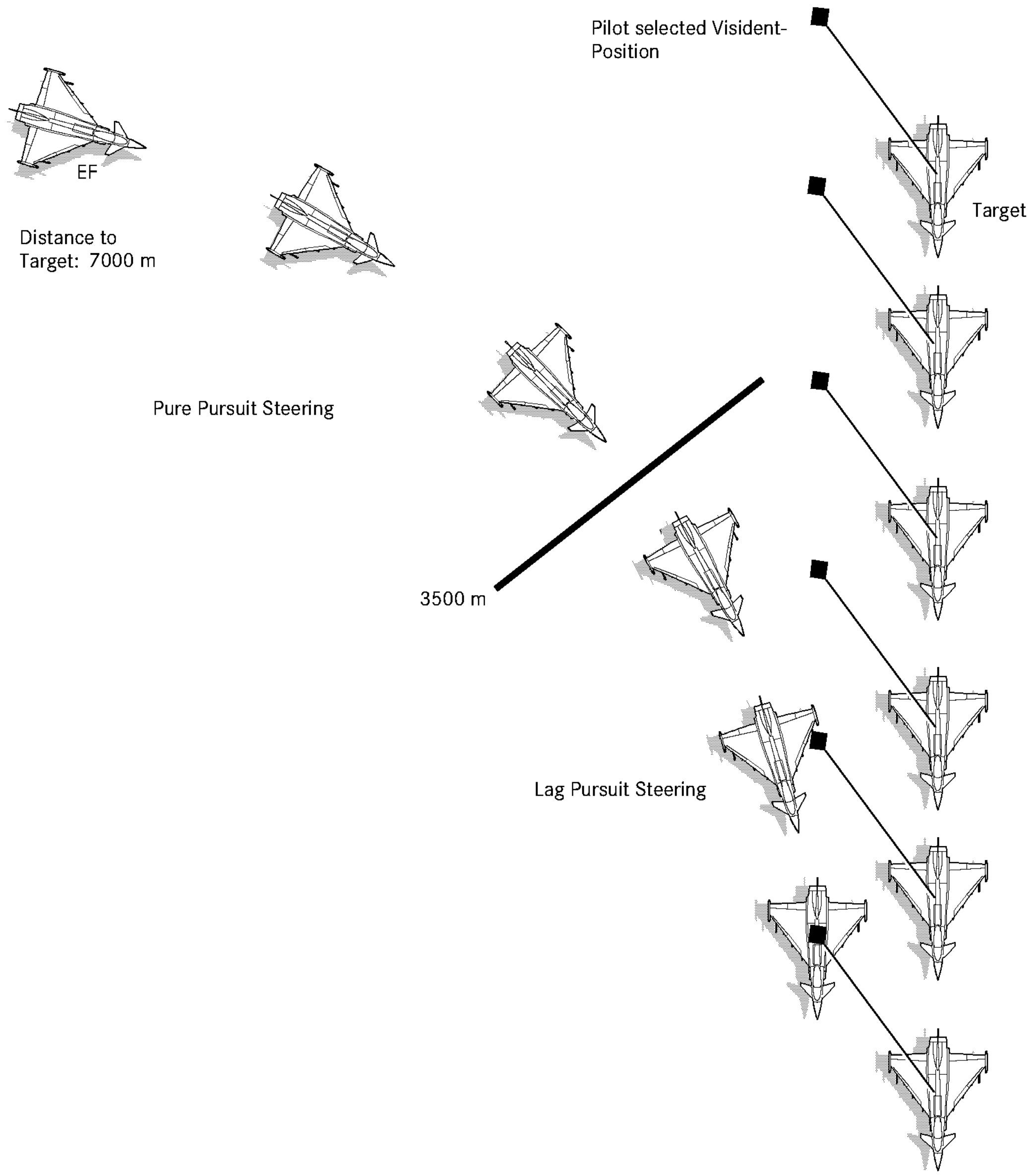


Figure 8.10 - Visident Steering (cleared for assessment purpose only with SP3C/15)

Adaptive Mode Scheduling

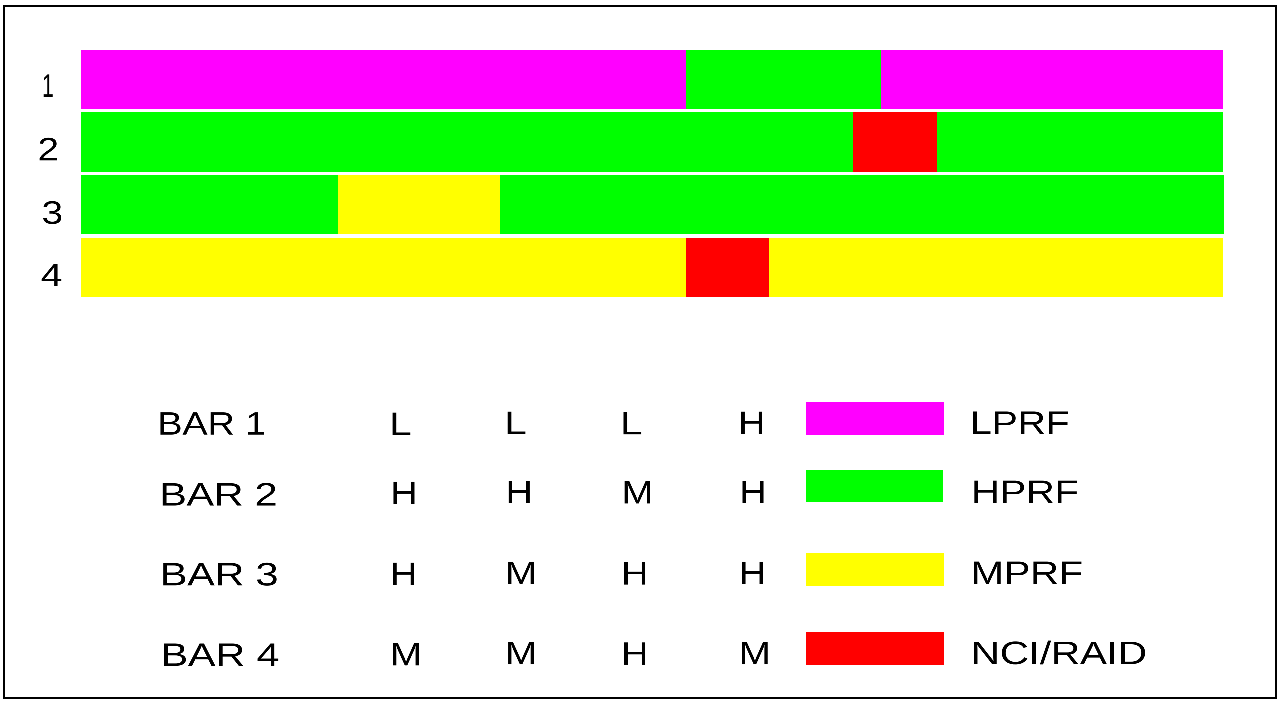


Figure 8.11 - Adaptive Waveform Scheduling (AWS)

RADAR COCKPIT CONTROLS

Moding and function control selections requiring pilot action is performed via:

– Radar switch on and switch off (hardwired)
– MDE Subsystems Keys (SSK) and Moding Keys (MK) on the Left Glareshield (LGS).
– HOTAS radar control switches (Stick and Throttles):
  - Stick Controls (ACM modes, Radar Lock/ Break Lock)
  - Throttles Controls (Elevation Scan control, X-Y controller)
– SKs (located left, right and bottom of the MHDD formats)

RIGHT CONSOLE - GANGBAR RADAR/OFF SWITCH

WARNING

TO ENHANCE RADIATION SAFETY, NO DESELECTION OF SBY OR SELECTION OF A RADAR TRANSMITTING MODE SHALL BE DONE WHILST ANY PERSONNEL ARE CLOSER THAN 55 METERS TO THE NOSE OF THE AIRCRAFT.

NOTE

– Do not set the switch to RADAR unless both GENs are on line.
– When the Radar has been switched off, it is recommended to apply a delay of five seconds before it is switched on again. This is common practice for high voltage high power equipment.

The radar is switched on during the start procedures by selecting the radar switch on the gangbar to RADAR. If system gangbar is not selected to on, a prompt will be given on the autocue format.

After switch on the radar will perform PBIT functions (100 sec.) and warm-up (3 minutes), refer to Figure 8.13. Transmit and receive operations are inhibited during warm-up on ground and in flight.

On completion of the PBIT:

– the "WARM UP" symbol is displayed on the AF (when selected),
– the radar modes are available for preselection on the AF, MDE and HOTAS
– on ground: the radar is defaulted to SBY (MK RDR SBY not boxed although in SBY), unless any radar mode preselection has been done. A preselected mode would be indicated (SK boxed) during warm-up. When preselecting a mode the RDR MK will change from RDR SBY to RDR ON. Pre-selections may be cancelled by selecting SBY again. The radar scan volume is not displayed on the MHDD formats in SBY.
– when airborne: the radar is defaulted to ON (MK RDR ON is boxed) and TWS (boxed automatically), unless any other radar mode preselection has been done. The radar scan volume is displayed dashed on the MHDD formats.

On completion of the warm-up the "WARM UP" symbol is occulted.

On ground transmit and receive operations are inhibited by Weight on Wheel switch. At main wheel lift off the radar will automatically enter either the default mode TWS or any pre-selected mode and the moding key will change from RDR SBY to RDR ON.

LEFT GLARESHIELD - MDEF

XMIT (SSK)

After power up the SSK XMIT is available for selection. The SSK XMIT will enable a set of Moding Keys (MK) described below to manage radar modes, channels and transmission inhibit (refer to Figure 8.12).

The DEK & ROL are configured for RDR CHAN input.

RDR SBY/RDR ON (MK)

The MK RDR SBY or RDR ON will be displayed when SSK XMIT is selected (Figure 8.12), provided the radar is powered up, i.e. switched on (gangbar RADAR) and PBIT cycle is completed. On ground the radar is defaulted to SBY, when no radar mode is preselected (note that no box is displayed with the MK RDR SBY). On preselecting a radar mode the RDR MK will automatically change from RDR SBY to RDR ON.

WARNING

TO ENHANCE RADIATION SAFETY, NO DESELECTION OF SBY OR SELECTION OF A RADAR TRANSMITTING MODE SHALL BE DONE WHILST ANY PERSONNEL ARE CLOSER THAN 55 METERS TO THE NOSE OF THE AIRCRAFT.

NOTE

> If weight is on wheels, either left or right main landing gear, all radar emissions are inhibited. This inhibit function may be overridden by groundcrew for testing via the Weight on Wheels Override switch.

In SBY the scanner is parked at 6 deg up and 70 deg right and the transmitter and receiver is inhibited from functioning but remains warmed up. The radar scan lines will be occulted from the attack and elevation formats to indicate that the radar is not commanded to transmit. SBY selection is also indicated on the AF with the characters "RDR STBY". The attack format radar mode indication is occulted. SBY can be selected during any phase of flight as long as PBIT has been completed.

NOTE

> The SBY mode is automatically deselected on transition to Weight off Wheels and the moding key will change from RDR SBY to RDR ON. If required, the SBY mode must then be selected again.

When the radar is selected from RDR SBY to RDR ON, no warm-up period is required for fully active operation. The radar enters the previously selected A-A search mode. If there is no previous scanning mode to go (i.e. first selection after power up) the radar will enter the default TWS mode.
Transition time from SBY into an operational mode is 0.5 sec maximum.

RDR CHAN

Boxed by default. DEK & ROL are configured to enable one pair of radar channel numbers to be entered and the current channel pair is displayed on the ROL. When entered verify that the ROL's blink to show that the channels are acceptable.

ALL NORM

Boxed by default, indicating that all transmitters are enabled for transmitting. The MKs for the individual transmitters are displayed for pre-selections of the program mode. This MKs are default to NORM when XMIT is pressed, but can be modified through a PDS load.

ALL SLNT

If selected, ALL SLNT is boxed, indicating that all transmitters are inhibited from transmitting.

PROG

If selected PROG is boxed; ALL NORM or ALL SLNT MK are deselected. Any of the system controls set to SLNT will be boxed, those set to NORM will not be boxed.

RDR NORM/SLNT (NOT CLEARED WITH SP3C/15)

This individual transmitter MKs act as preselectors when PROG is not selected. The pre-selections for this individual transmitters are default to NORM when XMIT is pressed, but can be modified through a PDS load. When ALL NORM is selected (boxed) any selection of an individual transmitter key will preselect the relevant transmitter to either SLNT or NORM. The MK legend toggles between SLNT and NORM. The SLNT keys are only active when PROG is operated (boxed), for detailed Stealth Moding refer to Transmitter Management.

HOTAS CONTROLS AND FUNCTIONS

The following functions are selectable via the switches on the control stick and throttle.

CONTROL STICK

On the control stick the following control is used for the radar:

RADAR AIR COMBAT MODE AND LOCK/BREAK LOCK SELECTOR

The RACM and Lock/Break Lock button enables selection of the Radar Air Combat Modes (RACM) or to initiate and break STT (refer to Figure 8.12).
A lock on can be achieved either automatically by an Air Combat Mode or manually.
To manually initiate a lock on, position the XY-marker over the plot, target or track and press the Lock/Break Lock button. No XY insert is required.
The search mode, from which the Lock Follow mode was selected, will remain indicated on the softkeys. This will indicate the radar mode which will be returned to when the lock is cancelled or lost.
Once the radar is locked to a plot/track, the maximum demandable volume is displayed on the attack and P.A. formats but the radar scan volume controls are occulted from the attack format excluding the range control.
The volume is occulted from the elevation format.
The elevation HOTAS control is disengaged.
The radar elevation centerline will be displayed on the attack format and the number of bars selected will be occulted.
The lock symbol is displayed on the attack, elevation, P.A. and HUD formats, indicating the track to which the radar is locked, refer to Figure 8.14.

The sightline and range to the lock follow track is displayed on the HUD.

To break lock press the Lock/Break Lock button again. This cancels the lock even if the XY marker is not positioned over the locked track. The scan volume returns to the previously selected search volume, centered about the "break-lock" track, with the previously selected search scale displayed on the AF, PA and EF formats. The lock on can also be canceled by selecting a radar mode other than the lock on was initiated in.

Air Combat Mode selections are:

- FORWARD - Slaved/Boresight Acquisition (SACQ/BSTACQ)
- AFT - Vertical Acquisition (VACQ)
- RIGHT - HUD Field of View Acquisition (HUDACQ)

If the pilot wants to lock on to a different target whilst remaining in the current ACM mode, he can 'dump` the current radar lock and force the radar to search for another target to lock on by reselecting the current ACM.

The HUD formats associated with each of these modes are shown in Figure 8.15.

An ACM selection over-rides all other displays and radar selections on the ATCK format and the HUD.

THROTTLE CONTROLS

SCANNER ELEVATION/GAIN CONTROL WHEEL

The throttle top assembly includes a control wheel for either manual control of the scanner elevation centerline or the radar gain in RBGM (cleared for assessment purpose only from SP3C/15 onwards) (refer to Figure 8.12). An light blue elevation scale on the right side and a digital display on the top right corner of the AF provide an indication of scanner elevation. The elevation side scale indicates the maximum and minimum elevation scan limits with markers at 0 degrees, +/- 30 degrees and +/- 60 degrees. A radar gain icon on the AF, selectable with the GAIN SK to MAN (cleared for assessment purpose only from SP3C/15 onwards), allows toggling between the elevation or gain control modes with XY inserts and provides gain level indication. The control wheel is only live in VS, TWS and RBGM (cleared for assessment purpose only from SP3C/15 onwards) but movement in LF, STBY or ACM will be ignored. In ACM or LF the elevation is controlled automatically.

X-Y CONTROLLER

The X-Y controller on the front of the right throttle is used for the following radar control and display format functions:

- LF Manual Acquire (AF, PA and EF)
- Initiate Radar Tracks (AF, PA and EF)
- Deletion of tracks (AF)
- Denomination of targets (AF)
- Extra Data on tracks and targets (AF, PA and EF)
- Management of DTL (AF)
- Nomination of tracks as targets (AF, PA and EF)
- Reattack (AF)
- Bearing/Range Readout (AF)
- Azimuth scan volume adjustment (AF)
- Azimuth scan centerline adjustment (AF)
- Elevation bar scan selection (AF)
- Manual RAID selection (AF) (cleared for assessment purpose only from SP3C/15 onwards)
- Own Aircraft Speed (KDAS/MACH) selection (AF)
- Active Scan in Radar Inhibit selection (AF)
- TGS Zoom function (AF and PA)
- Pilot Identity Override (PIO) (AF)
- RBGM Gain selection (AF) (cleared for assessment purpose only from SP3C/15 onwards)
- Radar Attenuation (AF) (not cleared with SP3C/15)
- Display Range scale changing (AF, PA, EF)
- Radar Altitude Coverage indication (AF, EF)
- SACQ sightline indication (HUD)
- SRAAM slave indication (HUD)
- VISident position selection (HUD) (cleared for assessment purpose only at SP3C/15)
- Altitude Scale Change (EF)

For detailed XY-controller operation refer to Radar MDE and X-Y Functions pag. 41.

OWN AIRCRAFT SPEED

XY insert over the own aircraft speed display changes the speed indication from KDAS to Mach number, and vice-versa on the AF. Whatever selection is made here also causes a consistent change to the speed indication for tracks and targets shown in the ROLs, except that in the ROLs, true airspeed is displayed rather than airspeed.

MHDD FORMATS

Attack and Identification relevant information is available on the following MHDD formats:

- MHDD/ATCK-TWS format
- MHDD/ATCK-VS format
- MHDD/ELEV format
- MHDD/PA format
- MHDD/DASS format
- MHDD/ACUE format
- MHDD/HDHUD format

For head down display operation, a Climb/Dive Ball may be displayed on the AF and EF. The C/D Ball is selected with the SK "C/D BALL" on the PA Format. The following information will be presented with the C/D Ball:

– Steering dot
– Turnaway limits for MRAAM inflight
– Allowable Steering Error (MRAAM, AIM-9L)
– Climb/dive and bank angles
– Horizon line with blue sky above and brown earth below
– Aircraft symbol

ATTACK FORMAT (ATCK)

The MHDD/ATCK format provides the primary display and feedback to the pilot for sensor control, attack conversion cueing, and weapon launch cueing.
The MHDD/ATCK format is automatically displayed by default on the LMHDD in T/O, NAV, CMBT and APP/LDG POFs.
When the radar is switched on and PBIT is completed, "WARM UP" will be displayed on the AF until warm up is completed.
The following SKs are available:

MHDD/ATCK Format SKs

SK Label	Selected Mode is boxed
PPI	When pressed selects PPI format from B-Scope format (default unless PSMK defined).
B-SP	B-Scope presentation is the default format in TWS, unless PSMK defined.
RBGM	Selects Real Beam Ground Mapping (cleared for assessment purpose only at SP3C/15).
TWS	Default mode of the radar.
VS	Selects velocity search mode.
GAIN	Selects between either automatic (default) or manual gain control when in RBGM (cleared for assessment purpose only from SP3C/15 onwards).
AUTO or MAN	(cleared for assessment purpose only from SP3C/15 onwards)
SCAN	Selects between automatic (AUTO) and manual (MAN) center line positioning in TWS.
AUTO or MAN	
NTCH	Selects between notch filter "AUTO" or "LOW", SK not available when radar in: OFF, SBY, PBIT, VS, LF, or any A/S modes.
AUTO or	Automatic operation will be with larger notch when looking down (to reduce ground clutter) and a smaller notch when looking up.
LOW	Allows the radar to detect low speed tracks when looking down, i.e. helicopters, but with increased clutter (boxed when selected).
ACUE	Selects the Autocue format. Upon selection the SK remodes to enable return to Attack format. Available with weight on wheels and until landing gear up is selected.
UNDO	Rapid denomination of all targets
VIS	Selects/deselects Visident mode against a designated track. (cleared for assessment purpose only at SP3C/15).

(Continued)

MHDD/ATCK Format SKs (Continued)

SK Label	Selected Mode is boxed
SRCH	Selects between the following search priority modes:
AWS or	Adaptive Waveform Scheduling (default)
PS or	Priority Search
NORM	Normal Mode (no AWS or PS)
DFLT	Enables to set the format back to its default values.
MKR	Sets the Marker next to this SK.
LOC	
AGE	Selects plot ageing time (AUTO, 15, 10 or 5 sec). Default setting is AUTO.
AUTO (MAN)	
DCLT	Selects between three declutter levels, Normal (NOR), Maximum (MAX) and Minimum (MIN) on the head down displays. "+" or "-" indicates that the next press will select either MAX or MIN declutter.
MAX or NOR+/NOR- or	
MIN	
HUD	Selects the MHDD HUD display.
XFOV	Selects/deselects AIM-9L to wider field of view scan pattern (only shown when AIM9-L selected).

ELEVATION FORMAT (ELEV)

Radar plots and tracks are also shown on the MHDD/ELEV format, which can be selected to present either a profile or a C-Scope format. The profile format is a range/elevation format on which radar data is presented at true slant range and elevation from aircraft position. C-Scope is an elevation/azimuth display with a selectable canopy outline image. The profile or the C-Scope format is selectable by the SK PROF/CSCP. On selection of the ELEV format PROF will be default (boxed).

The MHDD/ELEV format is automatically displayed by default on the right MHDD in NAV and A/A CMBT POFs. The ELEV format can also be selected from the MHDD/formats HYD, FUEL, WPT and FREQ by use of the ELEV SK.

The PROF default settings are the range scale set to the same as on the ATCK, and the height scale set to 60 000 ft (PSMK definable). The height scale is adjustable by bumping the XY cursor at the top and bottom of the display. The heights displayed are 0-10 000 ft, 0-20 000 ft, 0-40 000 ft, 0-60 000 ft or 0-1000 000 ft. Own aircraft height is shown by a green triangle on the left side. Only height scales which include own aircraft height are selectable, e.g. if flying in 50 000 ft only 0-60 000 ft or 0-100 000 ft scales are available. If PP reaches the top of the current scale then the height scale will automatically change to the next height. The radar profile scan coverage will be displayed with light blue lines (dashed when inhibited).

The CSCP is an azimuth versus elevation display. It may be selected manually from the SK available in PROF format, or automatically on entry into full Visident mode (cleared for assessment purpose only at SP3C/15) or if Velocity Search mode is selected on the ATCK format. To allow easier transition to short range combat a canopy outline and horizon line is selectable via the SK OUTL. These will be aircraft axis stabilized and tracks/targets are referenced to the horizon. The radar azimuth and elevation scan coverage will be displayed as a light blue sector (dashed when inhibited). Track and target symbology is identical to that shown on the ATCK and PA format, except that the velocity vector proboscis is drawn only vertical up or down, to indicate a climb or descent rate greater than 2000 ft/min. TGS symbology is not used.

NOTE

In VS mode this is the only elevation format available.

PILOT AWARENESS FORMAT (PA)

The PA format is designed to assist the pilot in developing situation awareness by providing a single display relating all relevant target and tactical data to his geographic position. Tracks, navigational routes and tactical overlays are shown.
The MHDD/PA format is automatically presented by default on the CMHDD in all POF.
Tracks symbology is identical to that shown on the ATCK format, except that TGS symbols do not show the component velocity vectors and the TCRIs of the tracks other than the top component track are not displayed: instead a total number of tracks within the TGS is shown by a number above the TGS.
The radar scan coverage symbology is identical to that shown on the ATCK format (PPI), except that it is displayed with an additional max. range arc. When the radar is selected to VS mode, the arc will displayed dashed to indicate the previous max. range of the radar in azimuth.

DASS FORMAT

The DASS format displays radar and IRST (SP 5 onwards) scan coverage in both axes. The azimuth coverage is shown as arcs based on screen center, while elevation coverage is shown as white (IRST) and light blue (Radar) bars adjacent to the elevation scale.

AUTOCUE FORMAT

The following prompts are displayed for the radar system during ground operation:

– "SYSTEMS GANGBAR" when the radar is off after engine start.
– "PDS ERROR A+I DATA" when a PDS Attack and Identification Data loading error occurs.

TRACK-WHILE-SCAN (TWS)

On takeoff with weight-off-wheels the radar will automatically enter TWS, if no other mode has been pre-selected on the ground. In flight if SBY has been selected, on de-selection of the SBY mode the radar will enter the last scanning mode that was selected. If no previous scanning mode exists the radar will enter TWS mode.
The scan volume remains the same as the volume for the mode from which TWS was selected, (or default if no previous selection was made), unless manually adjusted.
If this was VS then the display range will be the last selected range.
If this was Lock Follow then the volume will be the previous search volume and range, with the centroid positioned about the position of the Lock Follow track.
If this was an ACM the volume will be the last selected search volume.
If this was RBGM (cleared for assessment purpose only from SP3C/15 onwards) then the volume will remain the same.
When the XY marker is displayed on the A.F. within the radar scan volume a readout of the radar altitude coverage, at the range of the marker, will be displayed with the marker. The light blue digits indicate whole thousands of feet and show negative values when radar intercepts the ground.

TWS B-SCOPE

TWS B-Scope is a range/azimuth presentation of radar contacts, where range is represented along a vertical scale and azimuth along the horizontal scale. The horizontal scale is marked at 0°, 30° and 60° left and right of centerline (max horizontal scale is 70° either side). The two scales are combined to form a range/azimuth grid (displayed in blue) against which the position of radar contacts are shown (depending on which range scale is selected). Current radar elevation coverage is indicated by a vertical white line positioned against an elevation scale. The length of the line is dependent upon the elevation coverage provided by the current bar scan pattern.
B-Scope is default, unless PPI is PSMK defined.
Deselection of RBGM (cleared for assessment purpose only from SP3C/15 onwards) (PPI only) by selection of a radar A/A mode will automatically default back to B-Scope if B-Scope was the previously selected radar A/A display.

TWS PPI-SCOPE

TWS PPI-Scope or Plan Position Indicator is a range/range presentation selectable by the pilot on the MHDD/ATCK format. It presents all data relevant to own aircraft position.

VELOCITY SEARCH FORMAT (VS)

The vertical scale represents the target's contribution to the closing velocity. The bottom of the scale represents - 900 KT (opening) and the top of the scale represents either + 4500 KT or + 1000 KT (closing), depending upon which scale is selected. Own aircraft velocity is shown by the green line at zero range rate.
The horizontal scale is marked at 0°, 30° and 60° left and right of centerline (max horizontal scale is 70° either side).
The velocity scales are increased or decreased by "bumping" the XY cursor on the top or bottom of the display respectively.

The grid lines on the vertical scale represent a quarter increment of the selected scale. The two scales are combined to form a velocity/azimuth grid (displayed in blue) against which radar symbols are read according to the formerly selected velocity scale.

During operation in VS, radar contacts will only be displayed as radar plots (amber rectangles). If subsequent radar scans fail to update the plot, the plot will occult. Radar tracks cannot be initiated in VS mode although the relevant plot will be promoted to track status if lock-on was successful. If Lock Follow is achieved on a VS plot then the display will change to the default range format.

The scan volume remains the same as volume for the mode from which VS was selected. If the mode from which VS was selected was Lock Follows then the volume is set to the previous scan width, and number of bars from the last selected search mode selected, centered about the Lock Follow track position.

The velocity coverage will be the default coverage, for the first selection of this mode, or the previously selected value of this parameter will be used.

The display velocity scale will be the last selected, if no pre-selection is made then this will be the full velocity coverage display.

The profile option is not available in this mode, therefore a c-scope elevation format will be displayed.

The SRCH PS softkey is occulted.

On the P.A. format the scan volume range limit is displayed as a dashed line at the limit selected in the previous mode.

DISPLAY SCALE CONTROL

DISPLAY RANGE (AF, EF, PA)

The display range is selected:

– manually using the XY controller or
– is automated in TWS with ASC selected and a target nominated or
– is automated in Lock Follow mode in relation to the ranges of the nominated targets.

The range scales are increased or decreased by "bumping" the XY cursor on the top or bottom of the display respectively with a change rate of two steps a second.

The range presently selected is indicated on the AF as 4, 10 20, 40, 80, 160 or 240 NM (240 not for RBGM (cleared for assessment purpose only from SP3C/15 onwards)).

Auto changing of displayed range will occur when all nominated targets close to within 75% of the next lower range scale but not below 10 NM. When any nominated target opens to 85% of the current display range it will auto change to the next highest scale.

It is still possible to manually change the display range scale.

During STT, automatic range scale adjustment is enabled, however, range scale options are still available.

The range grids will be adjusted on the AF and EF profile format accordingly to indicate the new range selection.

The radar scan volume will be adjusted on the PA format accordingly to indicate the new range selection.

DISPLAY VELOCITY SCALE (VS)

In VS mode the velocity scale can be altered from + 4500 kt to -900 kt and + 1000 kt to -900 kt using the XY controller. The own aircraft velocity will be indicated at the zero velocity line.

NOTE

The VS mode does not include range, therefore the only elevation format applicable to this mode will be the c-scope format.

DISPLAY HEIGHT (EF)

The height scale can be selected by "bumping" the XY cursor on the top or bottom of the display, and is limited to a scale which includes own aircraft.

Changing the display altitude coverage has no effect on the radar scan volume, i.e. this is purely a display function.

The default height for this format is 60,000 feet and the range is equivalent to the AF range. The Normal softkey selects the default format for the appropriate POF at its default settings.

This function is not available on the Elevation C-Scope Format.

DISPLAY ELEVATION COVERAGE (C-SCOPE)

The elevation c-scope format is an azimuth versus elevation display. This format can be selected manually via the elevation format or automatically when VISIDENT is entered (cleared for assessment only with SP3C/15). The elevation coverage of this format is controlled by the range selected on the attack format, refer to Table , or by selection of the canopy outline.

When canopy outline is selected a canopy outline image with the horizon line is displayed on the C-scope referenced to airframe for easier transition to short range combat. In all other cases it is referenced to heading.

Auto and manual elevation scale changing is inhibited.

C-Scope Auto Range/Elevation Coverage

AF Range (NM)	C-Scope Elevation Grid Scales
≤40	± 60°
80	± 30°
160	± 20°
240	± 10°

The azimuth scale will always be ± 60°.

DEFAULT SELECTION

The DFLT softkey on the attack format selects the following default conditions, unless altered via PSMK:

- B-SP format,
- Auto Plot Ageing,
- 80 NM range scale,
- Any XY functions being carried out are cancelled and the XY marker is displayed in the default (marker locate) position,
- Radar TWS,
- 2 bars scan,
- Maximum scan width,
- Azimuth and elevation scan centers set to zero if auto scan centering is not selected,
- Auto scan OFF,
- VISIDENT is not preselected (VISIDENT cleared for assessment purpose only with SP3C/15),
- The search priority is set to AWS.

NORMAL SELECTION

The NORM softkey on the right MHDD will be available at the same position as the DFLT SK, when the format for the current POF is not the EF. It enables the default format to be displayed for each POF with associated default parameters for that format.

PILOT SELECTABLE MULTIFUNCTION KEYS (PSMK)

The PSMK settings will be used as the initial set-up for the displays and radar selections, and when the default key is selected on the attack format, and the normal key is selected on the elevation format. The following settings can be predefined:

- PPI/B-SP (AF).
- C-Scope/Profile (EF).
- Default Scan Volume Settings:
  - semi-scan width on (AF)
  - number of bars: 1,2,4,6,8 on (AF)
- Default elevation height: 10, 20, 40, 60, 80, 100 kft on (EF)
- Display range: 4,10,20,40,80,160,240 (AF, EF)
- Velocity scale: +4500 to -900 / +1000 to - 900 kts (AF)
- AUTO scan centering: ON/OFF (AF)
- Plot ageing: AUTO, 5, 10, 15 seconds (AF)
- Search priority: AWS/PS/NORM (AF)
- Climb/Dive Ball (AF, EF)
- Canopy Outline (Image) (EF)
- Canopy Outline (Horizon Line) (EF)
- Outline Select

HUD DISPLAY

The following HUD symbology is presented for radar operation:

- ACMs Volumes (refer to Figure 8.15):
  - HUDACQ
  - VACQ
  - SACQ
- XY Marker
- VISIDENT Positioning Cue (cleared for assessment only with SP3C/15)
- VISIDENT Target Information (cleared for assessment only with SP3C/15)
  - Target Altitude (digits)
  - Target Range (scale, digits, circle)
  - Target Closing Speed (scale, digits)
  - Target Calibrated Airspeed (digits)
  - Target Track (digits)
- Minimum Radar Lock Range
- Steer Dot
- Lock On Symbol
- Target Designator (TD)

Targets are displayed on the HUD in three different sizes of Target Designation (TD) boxes to give an indication of track range. The largest TD box indicates range less than 10 NM, medium indicates between 10 and 20 NM, and the smallest indicates range between 20 and 40 NM. The TCRI for Unknowns and Hostiles will appear above the symbol. A maximum of 8 TD boxes can be displayed on the HUD at any one time. The TD box for the No. 1 DTL target is displayed on the HUD at all times; when the target moves out of HUD-FoV the TD moves along the HUD border and blinks. TD boxes, which have a medium range missile in flight against them (target in PETL) are marked by a cross and will disappear outside HUD-FoV.
Memorized objects are displayed as followed, because no color is available on HUD:

HUD Target Designator Symbology

Object	Radar Tracked	Radar Memorized
Track	dashed, 4 dashes	dashed, 8 dashes
Target	single line	dashed, 8 dashes
1st Target	double line	dashed double line, 8 dashes

The target designator in the HUD is available in the following radar modes:

– Track While Scan (TWS)

– Single Target Track (SST)

– VISident (cleared for assessment only with SP3C/15) and Gun (cleared for assessment only with SP3C/15).

In VISident (cleared for assessment only with SP3C/15) mode the HUD is automatically decluttered, (general navigation information is occulted).

DVI INPUTS

NOTE

In SP3 DVI will have no effect on the avionics sub-system apart from the Displays and Controls sub-system, which will simply provide visual feedback of command recognition in the HUD ROL.

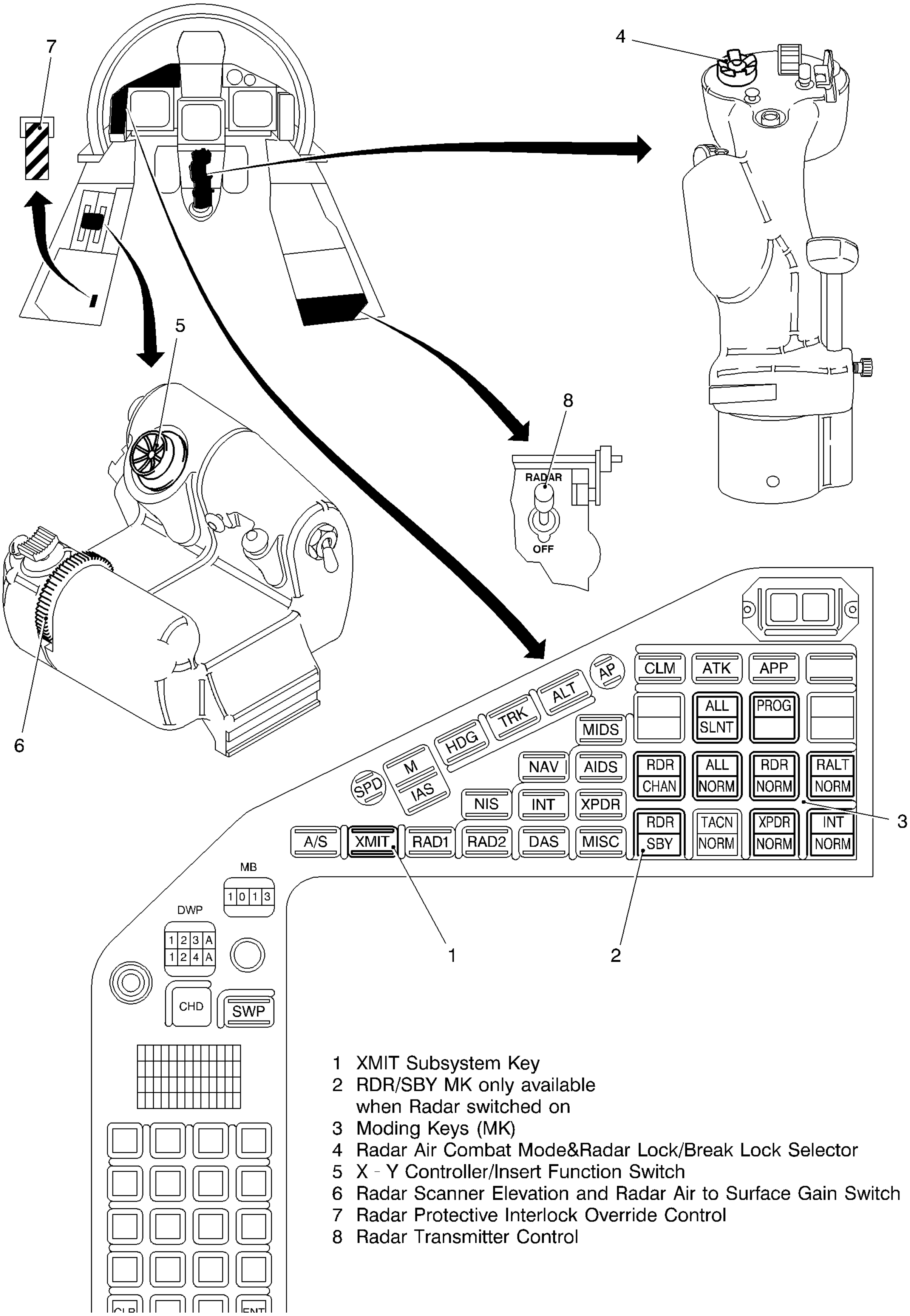
For DVI commands refer to DVI -Description.

DWP WARNINGS

The following warnings are available for the radar system:

Radar Failure Warnings

Warning	Cate-gory	Voice mes-sage	DWP caption	Suppress conditions	Other dis-play indi-cations	Second-ary warn-ings	System actions	Mission Conse-quences
Radar Total Failure	3	Radar	**RADAR**	when OFF	EF, PA, AF	possible Interrogator failure	None	radar and interrogator lost, aiming degraded
Radar Shutdown	3	Radar Shutdown	**RADAR SD**	No	No	None	possible auto shutdown	None, may lead to Total Failure



1 XMIT Subsystem Key
2 RDR/SBY MK only available when Radar switched on
3 Moding Keys (MK)
4 Radar Air Combat Mode&Radar Lock/Break Lock Selector
5 X - Y Controller/Insert Function Switch
6 Radar Scanner Elevation and Radar Air to Surface Gain Switch
7 Radar Protective Interlock Override Control
8 Radar Transmitter Control

Figure 8.12 - Cockpit Controls

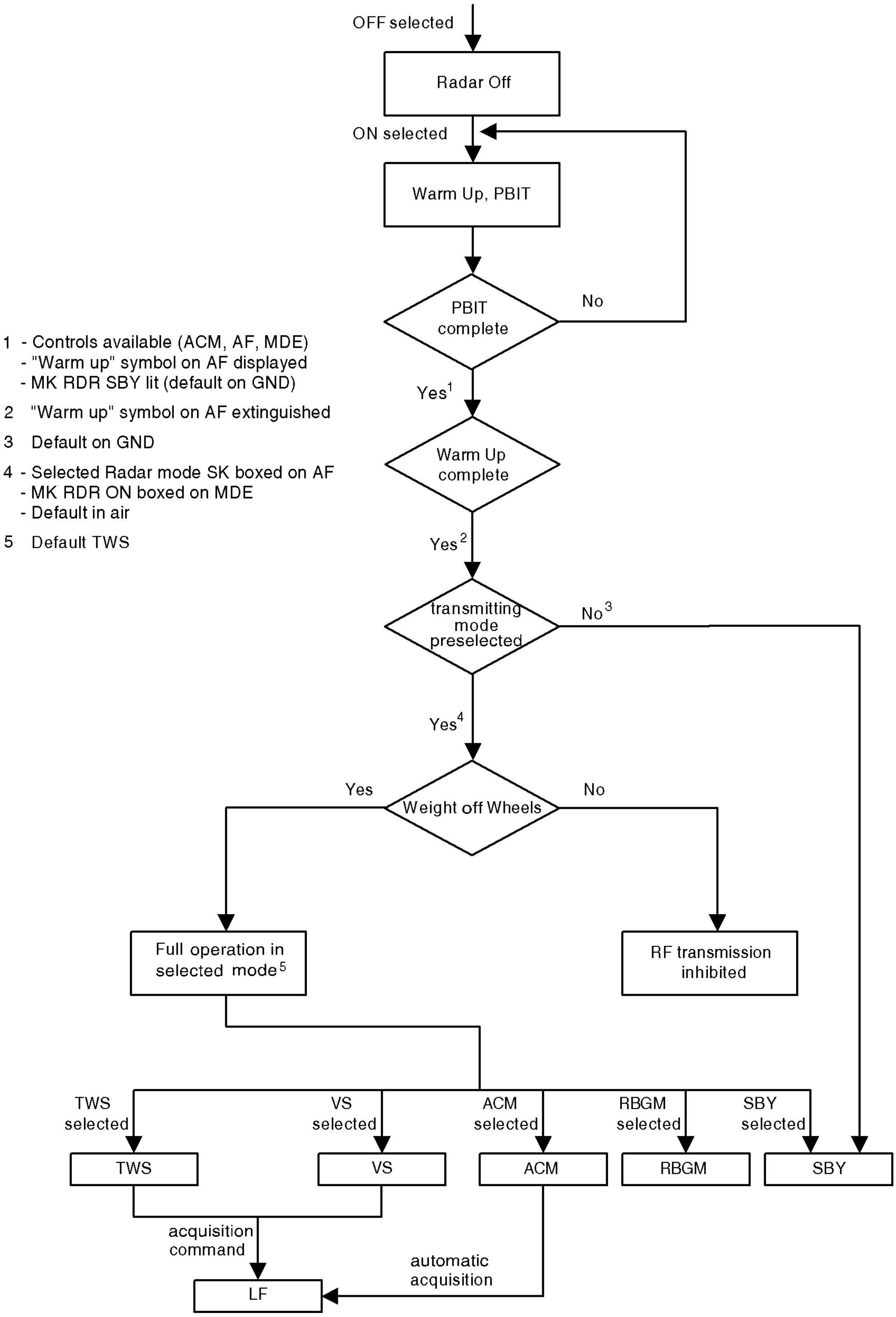


Figure 8.13 - Radar Moding

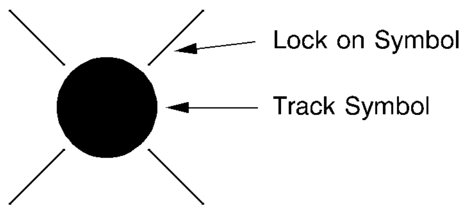


Figure 8.14 - Radar Lock On Symbol

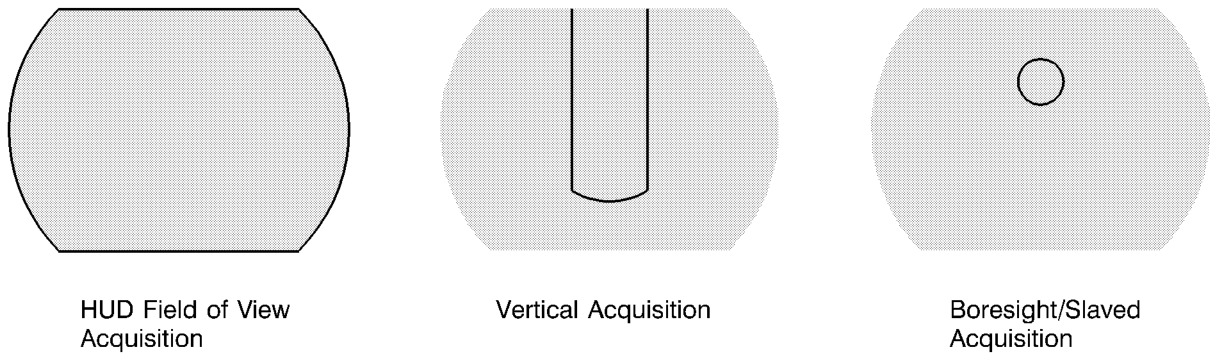


Figure 8.15 - HUD Indication - Air Combat Modes

RADAR MDE AND X-Y FUNCTIONS

The following examples illustrate how the radar is able to be controlled and manipulated via the MDEF and X-Y controller. For more information on the MDEF refer to (Electronic Displays and Controls - Manual Data Entry). For more information on the X-Y controller refer to (Electronic Displays and Controls - VTAS).

The radar may be controlled via the XMIT subsystem. On selecting the XMIT SSK the system defaults to that as shown in Figure 8.16 . With the XMIT SS selected the pilot is able to perform the following functions via the MDEF moding keys:

- Select the radar between STANDBY and ON (Figure 8.17)
- Define a radar operating channel (Figure 8.18)
- Select all transmitters to SILENT mode (Figure 8.19), or NORMAL mode (Figure 8.20)
- Preselect transmitters to SILENT or NORMAL as required (programmable STEALTH mode) (Figure 8.21)

Under certain circumstances, whilst in ALL SLNT or PROG mode, the XMIT SS will automatically be presented to the pilot (Figure 8.22).

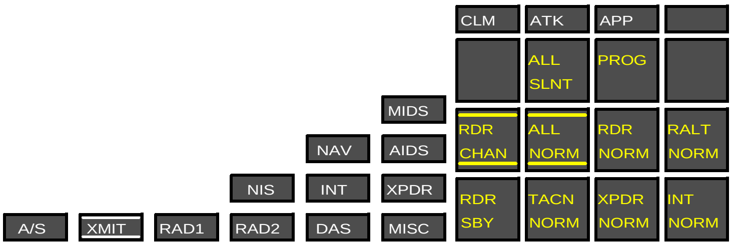
The functions available via the X-Y controller are as follows:

- Change the range/velocity scale (Figure 8.23)
- Adjust the scan width (Figure 8.24)
- Adjust the scan center (Figure 8.25)
- Select the bar scan pattern (Figure 8.26)
- Initiate tracks (Figure 8.27)
- Nominate targets (Figure 8.28)
- Perform Pilot identity Override on tracks and targets (Figure 8.29)
- Perform TGS zoom (Figure 8.30)
- Perform RAID zoom (Figure 8.31)
- Request extra information on tracks and targets (Figure 8.32)
- Re-order the defined target list (Figure 8.33)
- Allocate missiles to targets (Figure 8.34)
- Select lock follow acquire mode (Figure 8.35)
- Re-attack previously attacked targets (Figure 8.36)
- Denominate targets (Figure 8.37)
- Delete tracks (Figure 8.38)
- Radar attenuation control (Figure 8.39)
- Radar gain control (Figure 8.40)
- Range/bearing readout (Figure 8.41)
- Perform active frame scan whilst in stealth mode (Figure 8.42)
- Slew the radar scan volume onto a selected target whilst in radar slaved acquisition mode (Figure 8.43)
- Slew the SRAAM seeker head onto a selected target whilst in SRAAM manual mode (Figure 8.44)
- Select a position on which to approach a VISIDENT target (Figure 8.45).

NOTE

With respect to VISIDENT maneuvers (Figure 8.45), the following shall be observed:

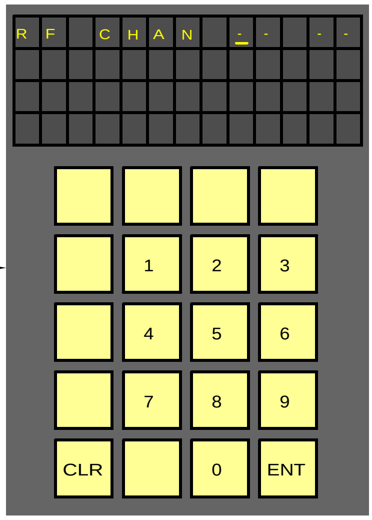
- To enter VISIDENT mode, the pilot must lock to the target using the Radar LF mode.
- At approximately 500m the pilot should expect to see the steering dot directing him to his final VISIDENT position. Range and range rate to the target aircraft should be continuously monitored directly from the HUD.
- Once the VISIDENT maneuver has been initiated the pilot will constantly evaluate whether or not it is safe to continue. This judgement will be based upon procedures, his training and recent experience, and information derived from his displays in conjunction with external visual cues, if appropriate, and support from ground based systems or other external sources. If, at any time, the pilot is not satisfied with any aspect of the approach towards the target aircraft he will commence a repositioning maneuver, which requires him to generate lateral, vertical and velocity vector separation from the target. Once the pilot is satisfied with his position relative to the target the VISIDENT maneuver may be recommenced.



PRESS THE **XMIT** SSK.

RDR SBY SHOWN BY DEFAULT ON POWER UP IF RADAR IS SWITCHED ON AND HAS PASSED PBIT.
IN SBY MODE THE RADAR'S TRANSMITTER AND RECEIVER ARE INHIBITED.

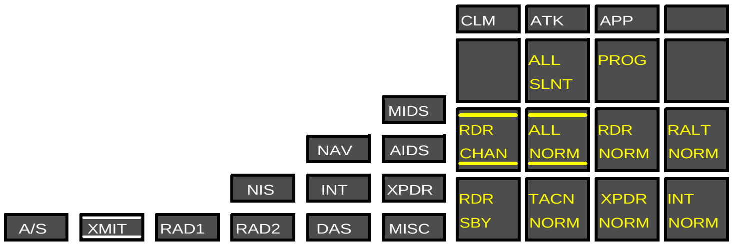
DEK AND ROL CONFIGURE TO ENABLE A PAIR OF RADAR CHANNEL NUMBERS TO BE ENTERED OR TO DISPLAY THE CURRENT CHANNEL PAIR AS NECESSARY.



NOTE

THE PRESELECTIONS FOR THE INDIVIDUAL TRANSMITTERS DEFAULT TO NORM, BUT CAN BE MODIFIED THROUGH A PDS LOAD

Figure 8.16 - Transmitter Default Moding



PRESS THE **XMIT** SSK.

↓

STANDBY MODE IS SELECTED BY DEFAULT IF THE RADAR IS SWITCHED ON, HAS PASSED PBIT AND WEIGHT-ON-WHEELS.

NOTE
THE MK IS NOT PRESENTED IF THE RADAR IS TURNED OFF.

↓

PRESS THE **RDR SBY** MK.

↓

THE MK RECONFIGURES TO SHOW **RDR ON**.

↓

ON SELECTION OF **RDR ON** THE RADAR WILL ENTER THE LAST AIR SEARCH MODE PREVIOUSLY SELECTED. IF THERE IS NO PREVIOUS SCANNING MODE TO GO TO (I.E. THE FIRST SELECTION AFTER POWER UP) THE RADAR ENTERS TWS MODE

NOTE
WITH **RDR ON** SELECTED, TRANSMISSION IS INHIBITED UNTIL WEIGHT-OFF-WHEELS.

↓

PRESS THE **RDR ON** MK, RADAR RETURNS TO STANDBY MODE.

Figure 8.17 - Radar Standby/On Mode Selection

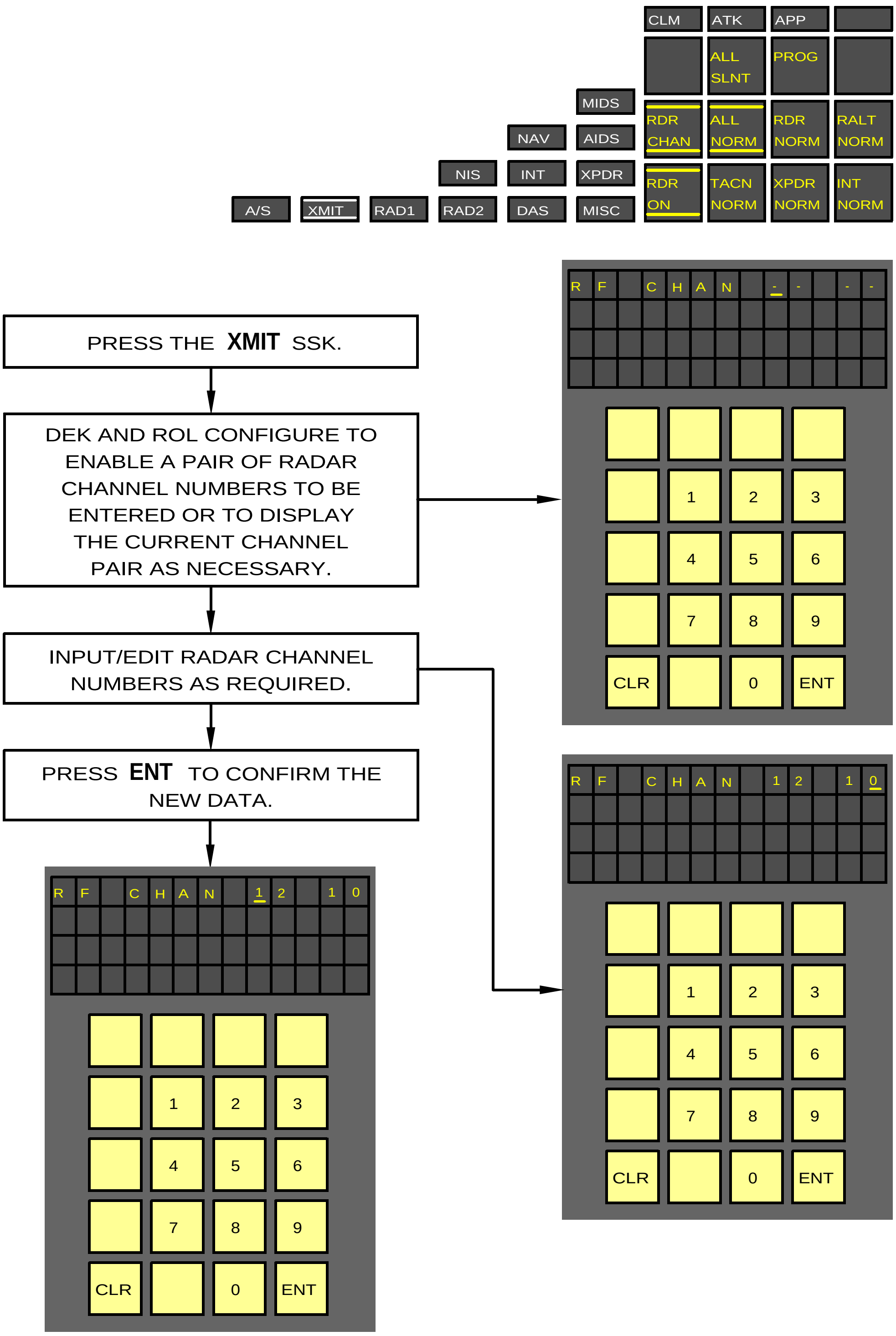
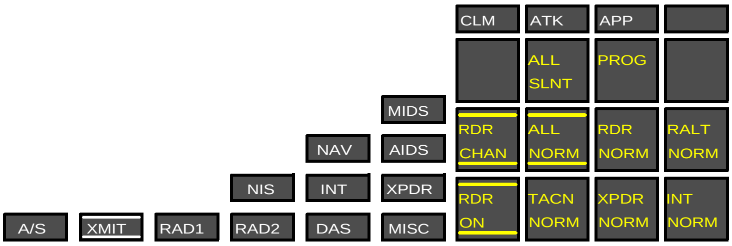


Figure 8.18 - Radar Operating Channel Definition



PRESS THE **XMIT** SSK.

PRESS THE **ALL SLNT** MK OR THE MHDD/REV **ALL SLT** SK.

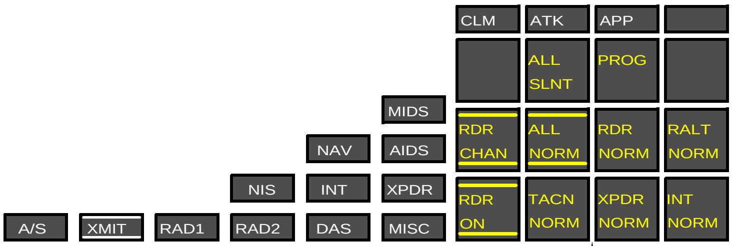
THE TRANSMISSION VIA THE FOLLOWING EQUIPMENT IS SUSPENDED:
- RADAR
- IFF INTERROGATOR
- IFF TRANSPONDER
- RADALT
- TACAN.

THE **ALL SLNT** MODE IS DESELECTED WHEN A MUTUALLY EXCULSIVE MODE IS SELECTED (I.E. **ALL NORM** MODE OR THE PROGRAMMABLE STEALTH MODE).

NOTE

- V/UHF RADIOS AND PDME ARE UNAFFECTED BY SELECTION OF THE **ALL SLNT** MK.
- MHDD/REV FORMAT AND PDME ONLY AVAILABLE FROM AVS SP5.

Figure 8.19 - All Silent Mode Selection



PRESS THE **XMIT** SSK.

NORM MODE IS SELECTED BY DEFAULT ON INITIAL SELECTION OF THE XMIT SUB SYSTEM.

THE TRANSMISSION VIA THE FOLLOWING EQUIPMENT IS ENABLED:
- RADAR
- IFF INTERROGATOR
- IFF TRANSPONDER
- RADALT
- TACAN.

NORM MODE CAN BE DESELECTED BY SELECTING THE **ALL SLNT** MODE OR THE **PROG** MODE.

NOTE
MHDD/REV FORMAT ONLY AVAILABLE FROM AVS SP5.

Figure 8.20 - NORM Mode Selection

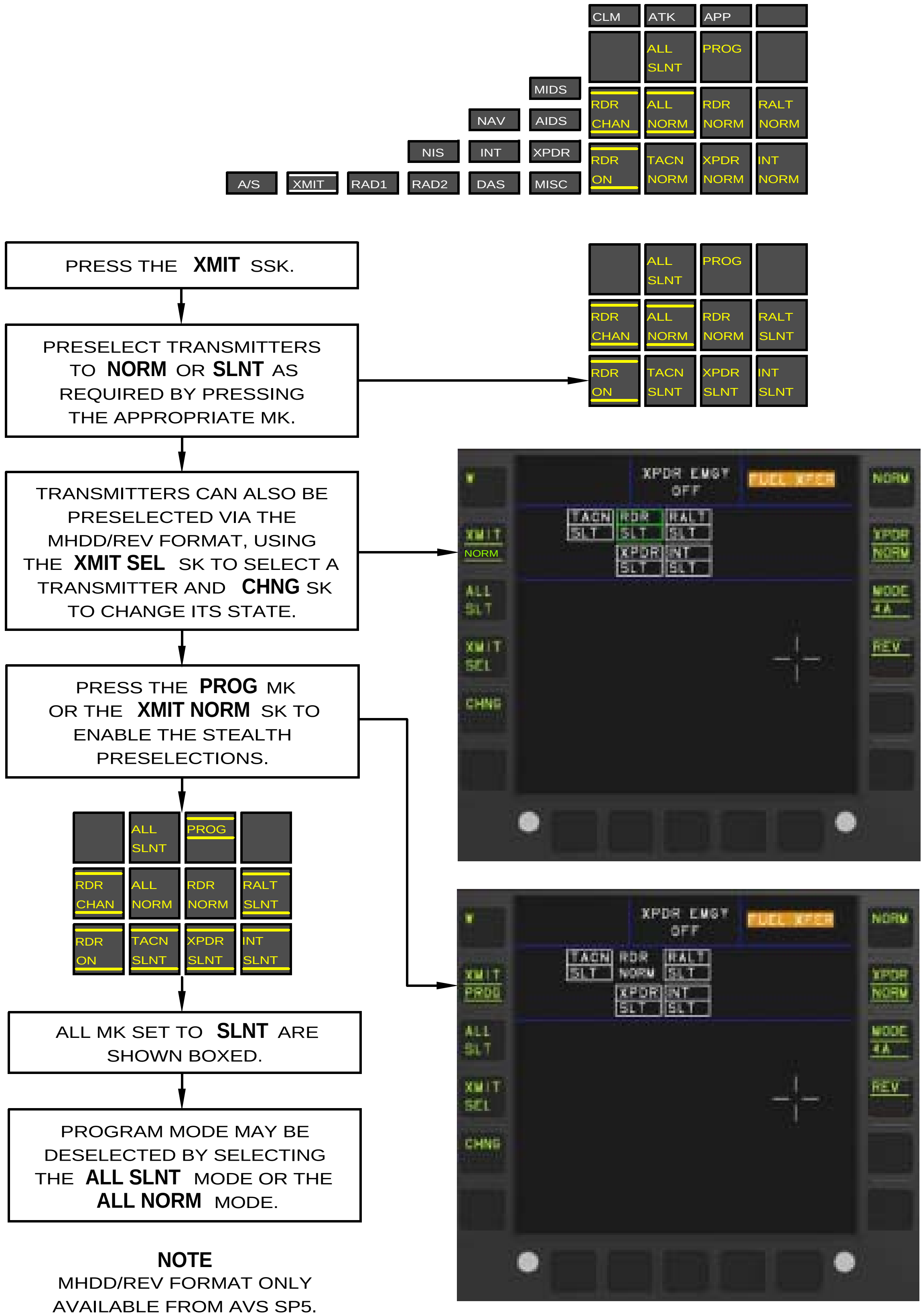
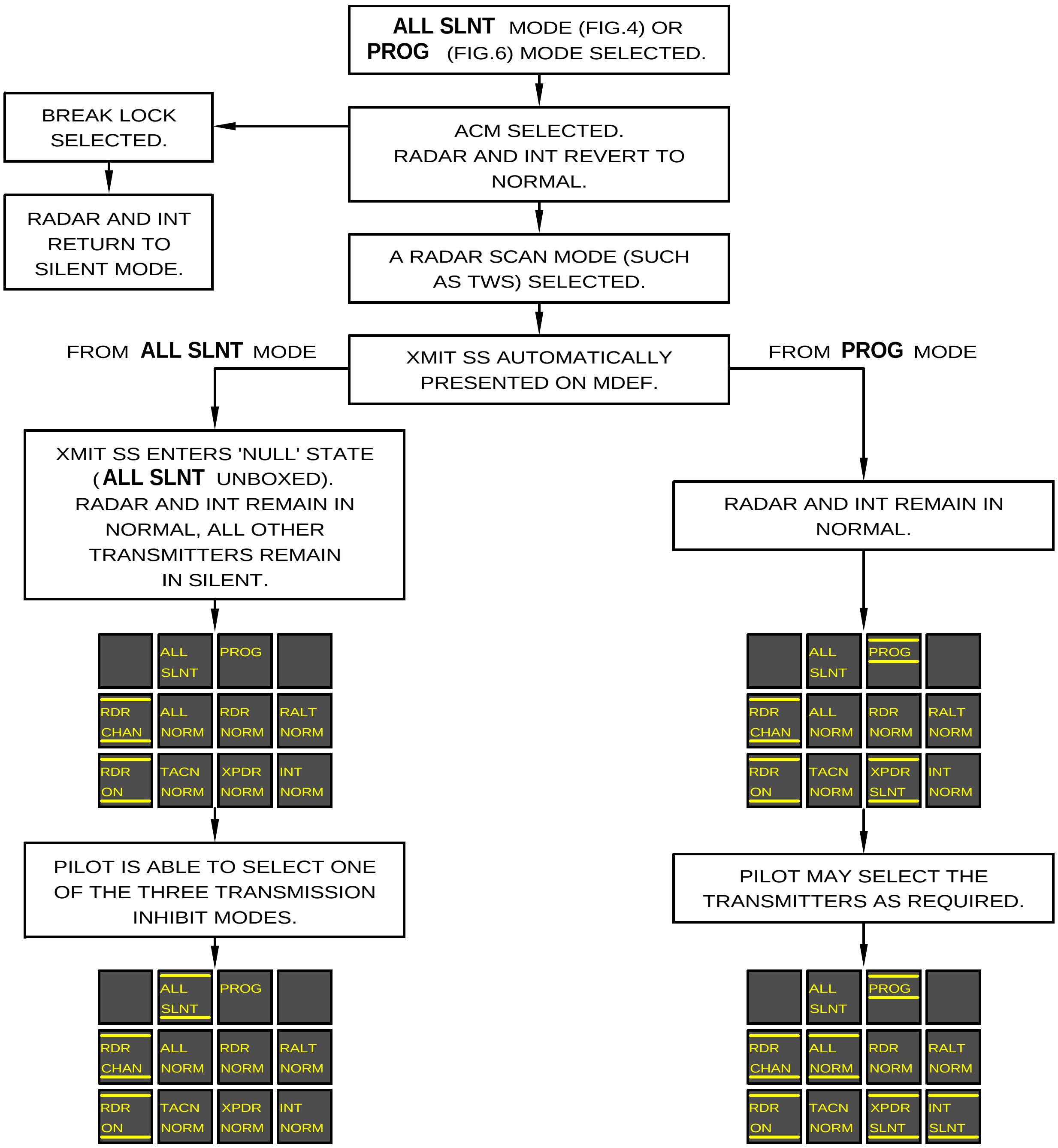


Figure 8.21 - Programmable Stealth Mode Selection



NOTE

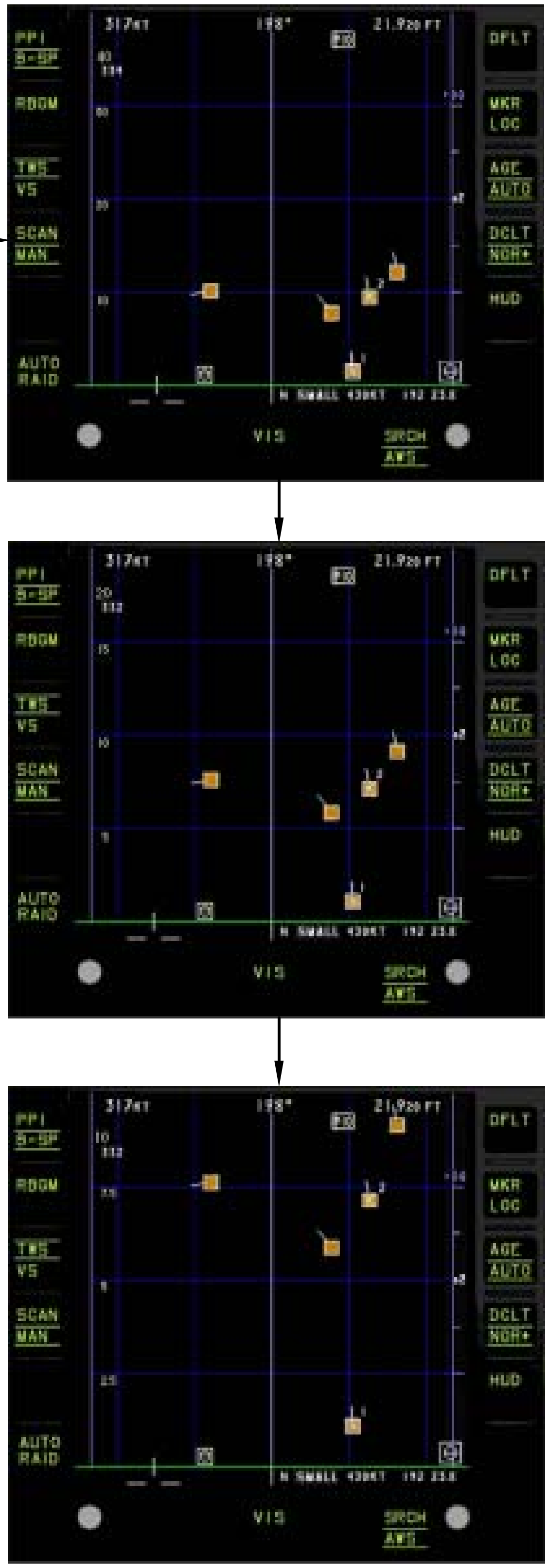
- SELECTION OF EMGY OR EJECTION ACTIVATES THE XPDR IN EMERGENCY MODE. DESELECTING EMGY RETURNS THE XPDR TO SILENT.
- SELECTION OF ID ACTIVATES THE XPDR IN IDENT MODE. DESELECTION (EITHER MANUALLY OR AUTOMATICALLY) RETURNS THE XPDR TO SILENT.
- THE RADAR WILL REVERT TO NORMAL WHEN ACTIVE SCAN IS SELECTED (FIG.27). THE RADAR RETURNS TO SILENT MODE WHEN 2 FRAME SCANS COMPLETED.

Figure 8.22 - Auto Selection of XMIT SS

INCREASE OR DECREASE THE RANGE/VELOCITY SCALE AS REQUIRED BY DRIVING THE X-Y MARKER AGAINST THE UPPER AND LOWER EDGES RESPECTIVELY (RANGE SCALE SHOWN IN EXAMPLE).

RANGE/VELOCITY SCALE CHANGES ONE STEP IN CHOSEN DIRECTION.

IF THE X-Y DEMAND IS MAINTAINED THE RANGE SCALE WILL CHANGE AT A RATE OF TWO STEPS PER SECOND UNTIL MAX OR MIN RANGE IS SELECTED. RANGE SCALES AVAILABLE ARE: 240, 160, 80, 40, 20, 10 OR 4 NAUTICAL MILES.



NOTE

- WHEN ALL NOMINATED TARGETS CLOSE TO WITHIN 75% OF THE NEXT LOWER RANGE SCALE, THE DISPLAY RANGE WILL AUTOMATICALLY CHANGE TO THE NEXT LOWEST SCALE, UNLESS THE CURRENT RANGE SCALE IS 10NM OR BELOW.
- WHEN ANY NOMINATED TARGET OPENS TO 85% OF THE CURRENT DISPLAY RANGE THEN THE SCALE WILL AUTO CHANGE UP TO THE NEXT HIGHEST SCALE.

Figure 8.23 - Changing Display Range/Velocity Scale

PERFORM AN X-Y INSERT OVER ONE OF THE SCAN COVERAGE LINES (THIS PROCEDURE APPLIES TO B-SCOPE AND PPI FORMATS).
X-Y MARKER IS HIGHLIGHTED.

EXPAND OR CONTRACT THE SCAN WIDTH BY DRAGGING THE SCAN COVERAGE LINE TOWARDS OR AWAY FROM THE SCAN CENTERLINE RESPECTIVELY.

WHEN THE REQUIRED SCAN WIDTH HAS BEEN ACHIEVED PERFORM AN X-Y INSERT TO CONFIRM NEW SETTING

NOTE
THE SCAN WIDTH MAY BE ADJUSTED UP TO ITS MAXIMUM LIMITS (±70° IN AZIMUTH)

Figure 8.24 - Scan Width Control

PERFORM AN X-Y INSERT OVER THE SCAN CENTERLINE (THIS PROCEDURE APPLIES TO B-SCOPE AND PPI FORMATS). X-Y MARKER IS HIGHLIGHTED.

REPOSITION THE SCAN CENTERLINE BY DRAGGING IT TO THE REQUIRED POSITION.

PERFORM SECOND X-Y INSERT TO CONFIRM THE NEW POSITION.

NOTE

WITH THE SCAN MAN/AUTO SK SELECTED TO AUTO:

- WITH TARGETS NOMINATED: THE SCAN CENTER MOVES BASED ON THE CENTROID OF ALL TRACKS/TARGETS.
- WITH NO TARGETS NOMINATED: THE SCAN VOLUME IS AUTOMATICALLY SET DEPENDENT UPON RANGE AS FOLLOWS:
  - 4, 10, 20NM RANGE SCALE - 6 BAR, ±70° WIDTH
  - 40NM RANGE SCALE - 4 BAR, ±70° WIDTH
  - 80NM RANGE SCALE - 2 BAR, ±70° WIDTH
  - 160, 240 NM RANGE SCALE - 1 BAR, ±70° WIDTH

ANY MANUAL CHANGE IN AZIMUTH OR ELEVATION CANCELS AUTO MODE.

Figure 8.25 - Scan Center Control

POSITION X-Y MARKER OVER SCANNER ELEVATION BAR.

PERFORM AN X-Y INSERT OVER THE ELEVATION BAR TO SELECT THE NEXT PATTERN IN THE SEQUENCE:

1 BAR
2 BAR
3 BAR
4 BAR
6 BAR
8 BAR

IF X-Y INSERT IS PRESSED AND HELD SCAN PATTERN CHANGES AT A RATE OF TWO STEPS PER SECOND.

Figure 8.26 - Bar Scan Pattern Selection

SELECT THE **ATK**, **PA** OR **ELEV** FORMAT.

POSITION X-Y MARKER OVER THE REQUIRED RADAR PLOT.

PERFORM A SINGLE X-Y INSERT OVER THE PLOT.

SYSTEM INITIATES A TRACK FILE AND THE PLOT IS REPLACED (ON ALL FORMATS) BY TRACK SYMBOLOGY.

ALLEGIENCE:
FRIENDLY
UNKNOWN
HOSTILE

TRACK CROSS REFERENCE INDEX

SYSTEM PRIORITY

VELOCITY VECTOR:
0-300KTS
300-600KTS
600+KTS

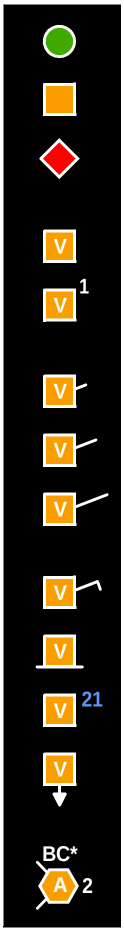
DIRECTION OF TURN (IF>5g)

RELATIVE ALTITUDE

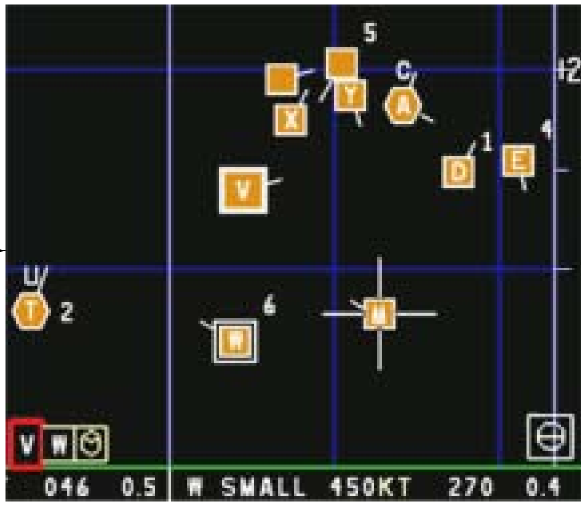
ALTITUDE

RAPID HEIGHT CHANGE

TRACK GROUP SYMBOL:
A = HIGHEST PRIORITY TRACK WITHIN TGS
BC = OTHER TRACKS WITHIN TGS WITH TCRI
* = TRACK WITHIN TGS WITHOUT TCRI
2 = SYSTEM PRIORITY OF HIGHEST PRIORITY TRACK WITHIN TGS



VELOCITY VECTORS OF COMPONENT TRACKS ARE SHOWN IF ANGLE BETWEEN COURSES >20°



NOTE

ONLY 20 TRACK FILES MAY BE MANUALLY INITIATED. IF 20 MANUALLY INITIATED TRACK FILES EXIST, ANY FURTHER INITIATION IS IGNORED.

Figure 8.27 - Track Initiation

SELECT THE **ATK**, **PA** OR **ELEV** FORMAT.

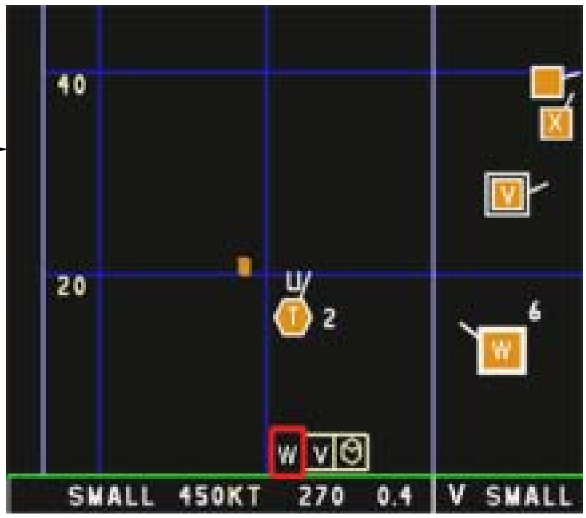
POSITION X-Y MARKER OVER THE REQUIRED TRACK AND PERFORM X-Y INSERT. EXTRA DATA IS PRESENTED; REFER TO FIG.17. X-Y IS HIGHLIGHTED.

PERFORM A SECOND CONSECUTIVE X-Y INSERT. TRACK BECOMES A TARGET AND IS ADDED TO THE DTL AT THE HIGHEST UNOCCUPIED SPACE.

NOTE

ONLY 8 TARGETS ARE ALLOWED IN THE DTL. IF 8 DTL TARGETS ALREADY EXIST A NEWLY NOMINATED TARGET WILL REPLACE THE NUMBER 8 DTL TARGET.

PERFORM A THIRD CONSECUTIVE X-Y INSERT. TARGET PROMOTED TO NUMBER 1 TARGET. EXTRA DATA ASSOCIATED WITH THE NUMBER 1 TARGET IS ALWAYS PRESENTED IN THE LROL (**ATK** FORMAT).



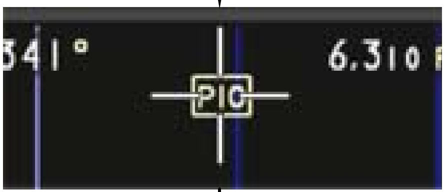
NOTE

A RED HIGHLIGHT BOX INDICATES THAT THE MANUALLY NOMINATED NUMBER 1 TARGET CONFLICTS WITH THE SYSTEM DERIVED NUMBER 1 PRIORITY TRACK. THE SYSTEM DERIVED NUMBER 1 TRACK ALSO FLASHES.

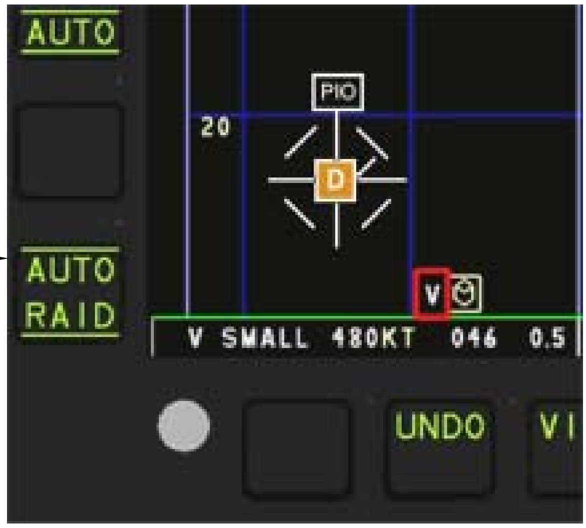
Figure 8.28 - Target Nomination

SELECT THE **ATK** FORMAT.

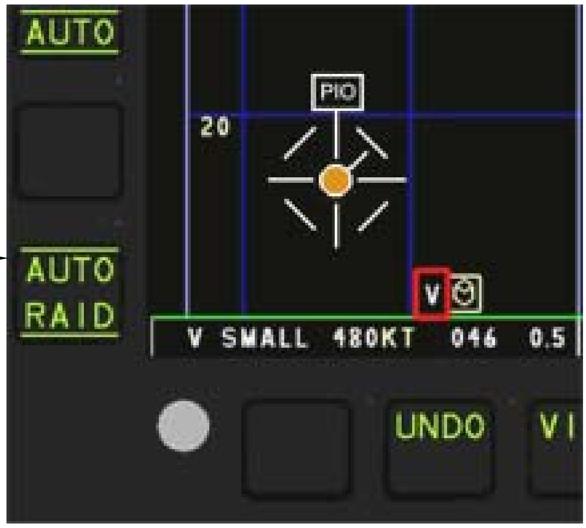
POSITION X-Y MARKER OVER THE PIO ICON AND PERFORM X-Y INSERT.



PERFORM A SINGLE X-Y INSERT OVER THE TRACK / TARGET WHOSE IDENTITY IS TO BE CHANGED.



SYMBOLOGY CHANGES TO MATCH NEW TARGET ALLEGIANCE.



NOTE

PIO TO RE-DEFINE TARGET ALLEGIANCE CHANGES THE SHAPE OF THE SYMBOLOGY BUT NOT ITS COLOUR.

PIO IS POSSIBLE ON TGS. FIRST X-Y INSERT PERFORMS TGS ZOOM (REFER TO FIG.15). PIO REMAINS ENABLED FOR ANY TGS COMPONENT.

PIO CHANGE ALLEGIANCE SEQUENCE			
INITIAL	FIRST INSERT	SECOND INSERT	THIRD INSERT
UNKNOWN	FRIENDLY	HOSTILE	UNKOWN
FRIENDLY	HOSTILE	FRIENDLY	HOSTILE
HOSTILE	FRIENDLY	HOSTILE	FRIENDLY

Figure 8.29 - Pilot Identity Override

SELECT THE **ATK** FORMAT.

POSITION X-Y MARKER OVER THE TARGET GROUP SYMBOL (TGS) TO BE EXPANDED THEN PERFORM X-Y INSERT.

TGS ZOOM PICTURE REPLACES **ATK** FORMAT SHOWING RELATIVE POSITIONS OF ALL TRACKS/TARGETS CONTAINED WITHIN THE TGS. ALTITUDE AND ANY IFF INFORMATION ALREADY AVAILABLE FOR TRACKS/TARGETS WITHIN ZOOM PICTURE ARE SHOWN (IAW SELECTED IFF MODE AND EXCLUDING MODE C).

ALSO SHOWN ARE:

- TGS ZOOM POSITION CUE, INDICATING THE POSITION ON WHICH TGS ZOOM WAS SELECTED, SHOWN IN RELATION TO THE UNDERLYING B-SCOPE OR PPI DISPLAY.
- UNDERLYING **ATK** FORMAT RANGE SCALE.
- SIZE OF ZOOM AREA.

TRACKS / TARGETS CAN BE MANIPULATED BY THE X-Y CONTROLLER IN THE NORMAL MANNER.

TGS ZOOM CAN BE DESELECTED BY PERFORMING AN X-Y INSERT ON A BLANK AREA OF THE TGS ZOOM PICTURE (INCLUDING TGS POSITION CUE) OR BY SELECTION OF RAID (FIG.16).

Figure 8.30 - TGS Zoom

SELECT THE **ATK** FORMAT IN TWS OR AA LOCK FOLLOW.

↓

POSITION X-Y MARKER OVER A TRACK, TARGET OR BLANK AREA OF THE FORMAT.

↓

PERFORM A LONG X-Y INSERT.

↓

RAID ASSESSMENT IS PERFORMED.
5NM X 5NM RAID WINDOW IS DISPLAYED ON THE **ATK** FORMAT SHOWING TRACKS, TARGETS AND INDIVIDUAL RAID PLOTS.

INFORMATION SHOWN:

- RAID POSITION CUE: INDICATING THE POSITION ON WHICH MANUAL RAID WAS SELECTED, SHOWN IN RELATION TO THE UNDERLYING B-SCOPE OR PPI DISPLAY.
- 'RAID TRACK 5' WHEN RAID SELECTED ON A TRACK OR TARGET (RAID WINDOW CENTERED ON SELECTED TRACK OR TARGET).
- 'RAID WINDOW 5' WHEN RAID SELECTED OVER BLANK AREA (RAID VOLUME STABILIZED AT FIXED RANGE AND AZIMUTH FROM OWN AIRCRAFT).
- UNDERLYING **ATK** FORMAT RANGE SCALE.
- ALTITUDE FOR EACH TRACK OR TARGET.

↓

TRACKS MAY BE NOMINATED FOR ATTACK IN THE NORMAL MANNER.

↓

RAID MAY BE DESELECTED BY X-Y INSERT OVER A BLANK AREA OF THE FORMAT, THE RAID POSITION CUE OR SELECTION OF ANOTHER RADAR MODE.

NOTE

WITH MANUAL RAID SELECTED ON **ATK** FORMAT, RAID NUMBER ASSOCIATED WITH THE 'RAIDED' TRACK, TARGET OR PLOT IS SHOWN AGAINST ASSOCIATED TRACK, TARGET OR PLOT ON THE **PA** AND **ELEV** FORMATS IF >1, EG:

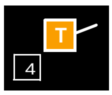


Figure 8.31 - RAID Zoom

SELECT THE **ATK** OR **ELEV** FORMAT.

PERFORM X-Y INSERT OVER THE TRACK/TARGET.
ALTITUDE OF ALL TRACK/TARGETS WITHIN RADAR COVERAGE VOLUME IS DISPLAYED FOR 7 SECONDS.
ANY IFF INFORMATION ALREADY AVAILABLE FOR THE TRACK/TARGET IS ALSO DISPLAYED ON THE **ATK** FORMAT (EXCLUDING MODE C).

ALTERNATIVELY POSITION THE X-Y OVER THE TCRI/SYMBOL IN THE DTL (**ATK** FORMAT ONLY).

THE FOLLOWING EXTRA DATA IS DISPLAYED IN THE RROL (**ATK** FORMAT) AND ROL (**ELEV** FORMAT):

- ESTIMATED SIZE (SMALL, MEDIUM, LARGE, N/A OR SIM)
- SPEED
- TRACK
- ALTITUDE

IF X-Y INSERT IS PERFORMED ON A TRACK OR TARGET ON THE **PA** FORMAT AN EXTRA DATA BOX IS PRESENTED THAT SHOWS:

- SIZE ESTIMATE
- G LEVEL
- CLOSURE SPEED
- ALTITUDE

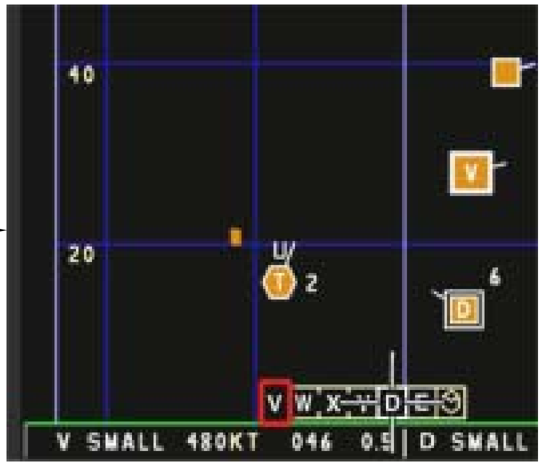
ALTITUDE OF ALL TRACKS/TARGETS WITHIN THE RADAR COVERAGE VOLUME IS DISPLAYEDFOR 7 SECONDS.

EXTRA DATA BOX OCCULTS 3 SECS AFTER MARKER LEAVES TRACK/TARGET.

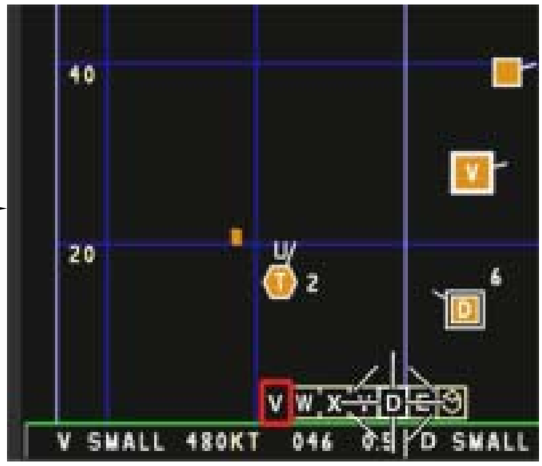
Figure 8.32 - Extra Data on Tracks and Targets

SELECT THE **ATK** FORMAT.

POSITION X-Y MARKER OVER THE TARGET TO BE MOVED IN THE DTL.

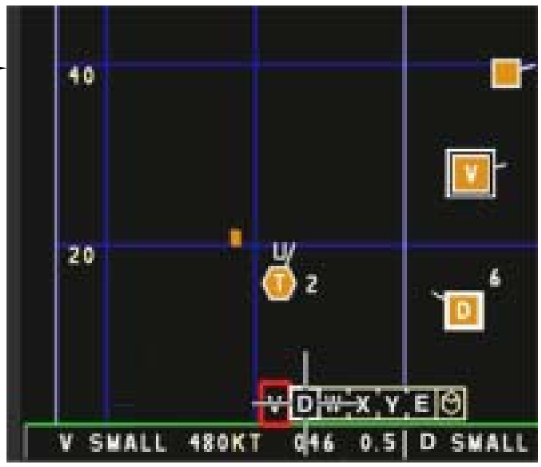


PERFORM X-Y INSERT.



DRAG TARGET TO NEW POSITION IN THE DTL. DTL REORDERS AS THE TCRI IS DRAGGED.

PERFORM X-Y INSERT TO DROP SELECTED TARGET INTO THE REQUIRED POSITION.



NOTE

WHILST IN DRAG MODE, THE X-Y MARKER CANNOT BE MOVED VERTICALLY DOWNWARD OR HORIZONTALLY LEFT OR RIGHT OFF THE DTL.

IF MOVED VERTICALLY UPWARD OFF THE DTL, DRAG MODE IS CANCELLED, THE HIGHLIGHT IS OCCULTED AND THE DTL REMAINS AS IT WAS BEFORE DRAG MODE WAS SELECTED.

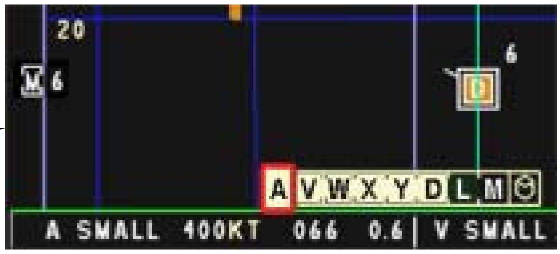
Figure 8.33 - Re-order Defined Target List (DTL)

SELECT THE **ATK** FORMAT.

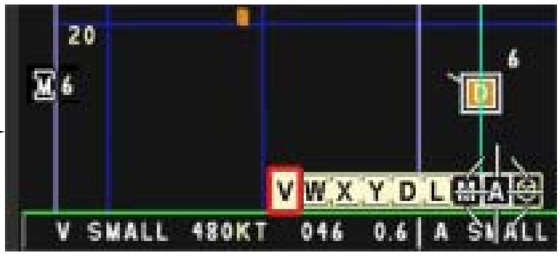
SELECT AMRAAM VIA THE WEAPON SELECTOR SWITCH ON THE STICK TOP. ONE AMRAAM IS AUTOMATICALLY ALLOCATED TO EACH TARGET IN THE DTL. TARGETS WITH A MISSILE ALLOCATED ARE DISPLAYED CONTRAST INVERTED.

WITH AMRAAM SELECTED AND WHEN A TARGET IS NOMINATED (FIG.13) IT IS ALLOCATED AN AMRAAM, IF ONE IS AVAILABLE.
IF NO AMRAAM ARE AVAILABLE THE TARGET IS STILL ADDED TO THE DTL (MAX 8), BUT IS NOT CONTRAST INVERTED TO INDICATE THAT NO MISSILE HAS BEEN ALLOCATED.

IF A TARGET WITHOUT A MISSILE ALLOCATED IS PROMOTED TO NUMBER 1 TARGET, IT IS AUTOMATICALLY ALLOCATED A MISSILE AT THE EXPENSE OF THE TARGET FURTHEST TO THE RIGHT OF THE DTL WITH MISSILE(S) ALLOCATED TO IT.



A TARGET MAY BE DRAGGED ANYWHERE WITHIN THE DTL (SEE FIG.18). MISSILE(S) ALREADY ALLOCATED WILL MOVE WITH THE TARGET UNLESS THIS WOULD CREATE A GAP IN MISSILE ALLOCATION, IN WHICH CASE ITS MISSILE(S) WILL BE RE-ALLOCATED SUCH THAT THE GAP IS FILLED.
IF A TARGET WITHOUT A MISSILE ALLOCATED IS DRAGGED TO A POSITION HIGHER UP THE DTL, IT IS AUTOMATICALLY ALLOCATED A MISSILE AT THE EXPENSE OF THE TARGET FURTHEST TO THE RIGHT OF THE DTL WITH A MISSILE(S) ALLOCATED.



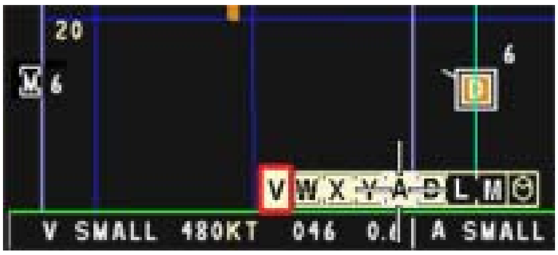
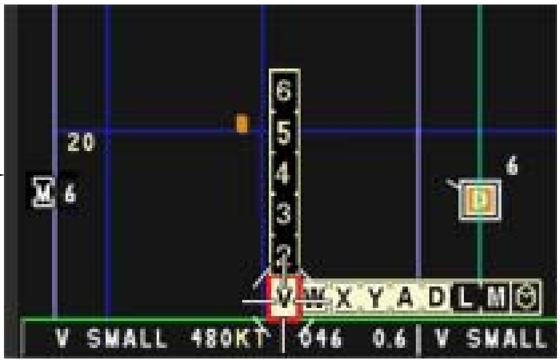


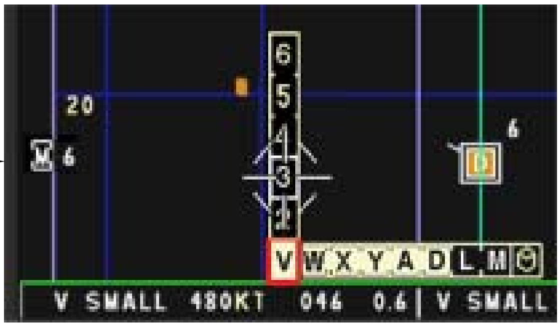
Figure 8.34 - Missile Allocation (Sheet 1 of 3)

TO CHANGE MISSILE ALLOCATION, POSITION X-Y MARKER OVER AMRAAM REMAINING ICON AND PERFORM AN X-Y INSERT.

X-Y MARKER IS AUTOMATICALLY RE-POSITIONED OVER FIRST TARGET IN DTL. MISSILE ALLOCATION MENU IS DISPLAYED ABOVE TCRI CONTAINING MAXIMUM NUMBER OF AMRAAM AVAILABLE (IF GREATER THAN 1).



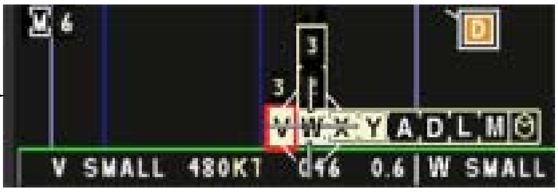
MOVE X-Y MARKER OVER MENU AND INSERT OVER THE REQUIRED NUMBER OF MISSILES.
THE MARKER CANNOT BE MOVED SIDEWAYS OFF THE MENU. IF THE MARKER IS MOVED UPWARDS OFF THE MENU THE FUNCTION IS CANCELLED AND THE MENU OCCULTS. THE MARKER CAN BE MOVED DOWN ONTO THE DTL TO SELECT ANOTHER TARGET IF REQUIRED.



AFTER INSERT THE NEW VALUE FOR MISSILE ALLOCATION IS DISPLAYED ABOVE TCRI, THE MARKER RETURNS TO THE TCRI AND THE MISSILE ASSIGNMENTS TO OTHER TARGETS CHANGE ACCORDINGLY.

Figure 8.34 - Missile Allocation (Sheet 2 of 3)

IF REQUIRED MOVE X-Y MARKER TO ALTERNATIVE TARGET IN DTL. MISSILE ALLOCATION MENU IS DISPLAYED ABOVE TCRI AND CONTAINS THE MAXIMUM NUMBER OF AMRAAM AVAILABLE **MINUS** THE TOTAL NUMBER OF MISSILES ASSIGNED TO TARGETS HIGHER-UP IN THE DTL.



SELECT THE REQUIRED NUMBER OF MISSILES TO BE ALLOCATED.

AFTER INSERT THE NEW VALUE FOR MISSILE ALLOCATION IS DISPLAYED ABOVE THE TCRI, THE MARKER RETURNS TO THE TCRI AND THE MISSILE ASSIGNMENTS TO OTHER TARGETS CHANGE ACCORDINGLY.

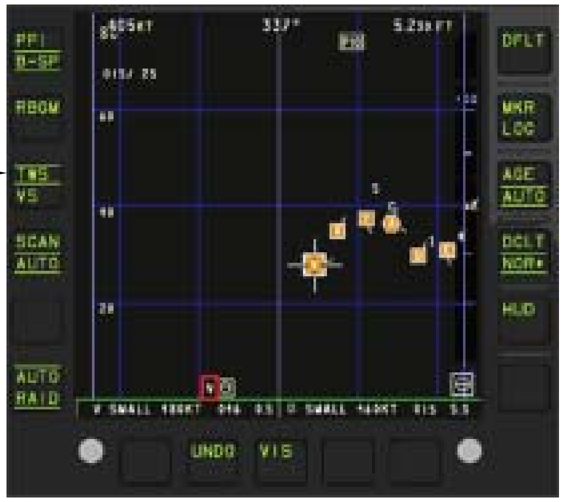
X-Y INSERT OVER A TCRI WITH MULTIPLE MISSILES ALLOCATED RESETS THE MISSILE ALLOCATION TO 1 AND RE-ALLOCATES MISSILES ACCORDINGLY.

WHERE MULTIPLE MISSILES HAVE BEEN ALLOCATED, X-Y INSERT OVER A TCRI THAT HAS NO MISSILES ALLOCATED (PROVIDED THE TCRI IS IMMEDIATELY TO THE RIGHT OF THE LAST TARGET WITH MISSILES ALREADY ASSIGNED) WILL ASSIGN ONE MISSILE TO THAT TARGET AT THE EXPENSE OF THE TARGET FARTHEST TO THE RIGHT WITH MORE THAN ONE MISSILE ALLOCATED TO IT.

Figure 8.34 - Missile Allocation (Sheet 3 of 3)

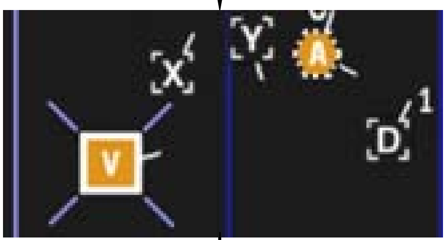
SELECT THE **ATK, PA** OR **ELEV** FORMAT.

POSITION X-Y MARKER OVER PLOT, TRACK OR TARGET TO WHICH THE RADAR IS TO BE LOCKED.



SELECT THE LOCK / BREAK LOCK STICK TOP CONTROL.

THE RADAR LOCKS TO THE DESIGNATED PLOT, TRACK OR TARGET. WHICH IS THEN PROMOTED TO NUMBER 1 TARGET IN DTL.



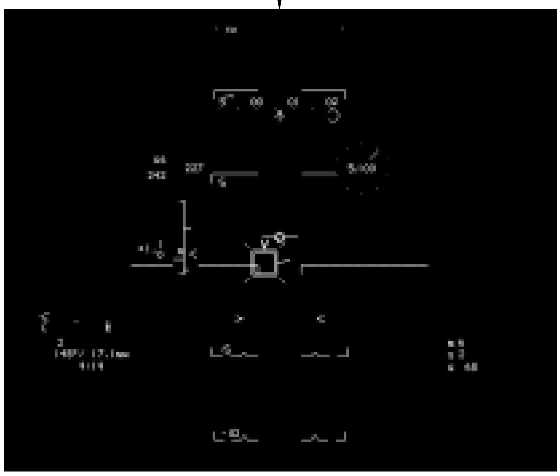
THE SYSTEM ENTERS ONE OF THREE LOCK MODES:

- **GUN LF MODE** (IF GUN IS SELECTED AND IN RANGE)
- **VISIDENT LF MODE** (IF THE VIS SK HAS BEEN SELECTED)
- **SINGLE TARGET TRACK MODE** (**STT**) (IF NEITHER OF THE ABOVE CONDITIONS ARE MET)

(**STT** MODE SHOWN)

NOTE

WHEN RADAR LOCKS TO A TARGET, ALL OTHER PLOTS, TRACKS AND TARGETS GO INTO 'MEMORY' AND WILL EVENTUALLY OCCULT.



PRESS THE LOCK / BREAK LOCK CONTROL TO BREAK THE RADAR LOCK.

RADAR RETURNS TO THE SEARCH MODE FROM WHICH LF WAS INITIATED.

Figure 8.35 - Lock Follow Acquire

SELECT THE **ATK** FORMAT.

POSITION X-Y MARKER OVER THE TARGET TO BE RE-ATTACKED IN THE PETL.

NOTE
THE PETL CAN CONTAIN UP TO 8 PREVIOUSLY ATTACKED TARGETS.

PERFORM X-Y INSERT. TARGET IS REPOSITIONED IN THE FIRST POSITION IN THE DTL. MISSILES ARE RE-ALLOCATED ACCORDINGLY. THE TARGET CAN BE DRAGGED TO ANY OTHER POSITION IN THE DTL IF REQUIRED (FIG.18).

NOTE
IF THE DTL CONTAINED 8 TARGETS PRIOR TO SELECTION OF RE-ATTACK THE LAST TARGET IN THE DTL IS AUTOMATICALLY DENOMINATED.

Figure 8.36 - Re-attack Targets

SELECT THE **ATK** FORMAT.

POSITION X-Y MARKER OVER THE TRACK DELETE ICON AND PERFORM X-Y INSERT.

A COPY OF THE ICON IS ASSIGNED TO THE X-Y MARKER.

DRAG THE ICON OVER THE TARGET WHICH IS TO BE DENOMINATED OR OVER ITS TCRI IN THE DTL.

PERFORM A SINGLE X-Y INSERT ON THE TARGET SYMBOL OR TCRI.

THE TARGET IS DENOMINATED. THE TCRI IS OCCULTED FROM THE DTL. ANY MISSILES ALLOCATED WILL BE RE-ASSIGNED IF APPROPIATE.

A DENOMINATED TARGET RETURNS TO TRACK STATUS AND MAY BE DELETED BY SUBSEQUENT X-Y INSERT.

TO CANCEL TRACK DELETE MODE DRAG THE ICON TO A BLANK POSITION OR OVER THE TRACK DELETE ICON. THEN PERFORM A SINGLE X-Y INSERT.

Figure 8.37 - Target Denomination

NOTE
TARGETS MUST BE DENOMINATED BEFORE DELETION (SEE FIG.22).

SELECT THE **ATK** FORMAT.

↓

POSITION X-Y MARKER OVER THE TRACK DELETE ICON AND PERFORM X-Y INSERT. →

↓

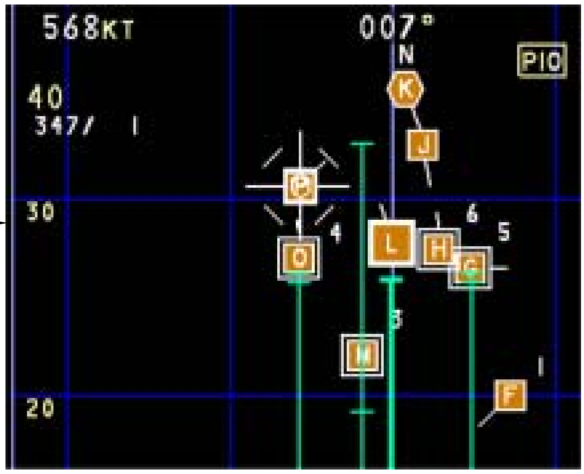
A COPY OF THE ICON IS ASSIGNED TO THE X-Y MARKER.

↓

DRAG THE ICON OVER A TRACK TO BE DELETED.

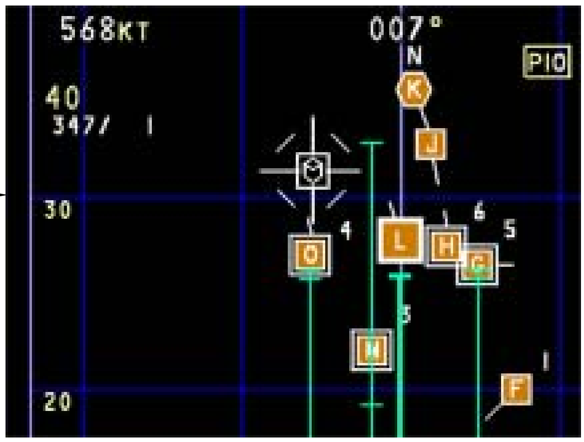
↓

PERFORM A SINGLE X-Y INSERT ON THE TRACK SYMBOL. →



↓

THE TRACK SYMBOL AND ALL ASSOCIATED FILES ARE DELETED. →



↓

TO CANCEL TRACK DELETE MODE DRAG THE COPY OF THE ICON TO A BLANK POSITION ON THE FORMAT OR OVER THE TRACK DELETE ICON THEN PERFORM A SINGLE X-Y INSERT.

Figure 8.38 - Track Deletion

PRESS THE **RBGM** SK. ATTENUATION CONTROL ICON IS SHOWN.

INSERTING OVER THE LOWER ICON DECREASES THE RADAR POWER OUTPUT BY ONE STEP (ATTENUATION INCREASES). THE NUMBER BETWEEN THE CHEVRONS CORRESPOND TO THE FOLLOWING ATTENUATION LEVELS:

6 = 0DB
5 = 3DB
4 = 6DB
3 = 9DB
2 = 12DB
1 = 15DB

DEFAULT SETTING ON SELECTION IS 6.

INSERTING OVER THE UPPER ICON INCREASES THE RADAR POWER OUTPUT BY ONE STEP (ATTENUATION DECREASES).

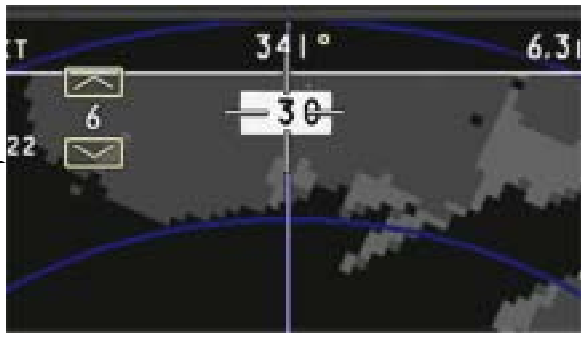
IF THE X-Y CONTROL IS PRESSED AND HELD RADAR ATTENUATION IS CHANGED AT A RATE OF TWO STEPS PER SECOND UNTIL EITHER THE MAX OR MIN VALUE IS REACHED.

Figure 8.39 - Radar Attenuation Control (RBGM)

SELECT THE **ATK** FORMAT AND PRESS THE **RBGM** SK.

PRESS THE **GAIN AUTO** SK TO SELECT **GAIN MAN**.
MANUAL GAIN CONTROL ICON IS DISPLAYED.
SETTING IS SHOWN AS A PERCENTAGE (100 = MAX, 0 = MIN).

PERFORM AN X-Y INSERT OVER THE GAIN ICON.



RADAR GAIN CONTROL IS ASSIGNED TO THE ROTARY CONTROL ON THE LEFT THROTTLE TOP.

MOVING THE CONTROL UPWARDS INCREASES GAIN, WHILST DOWNWARD MOVEMENT DECREASES GAIN. THE GAIN SETTING VALUE WILL LIMIT AT 0 AND 100 (THE VALUE WILL NOT WRAP AROUND).

Figure 8.40 - Radar Gain Control (RBGM)

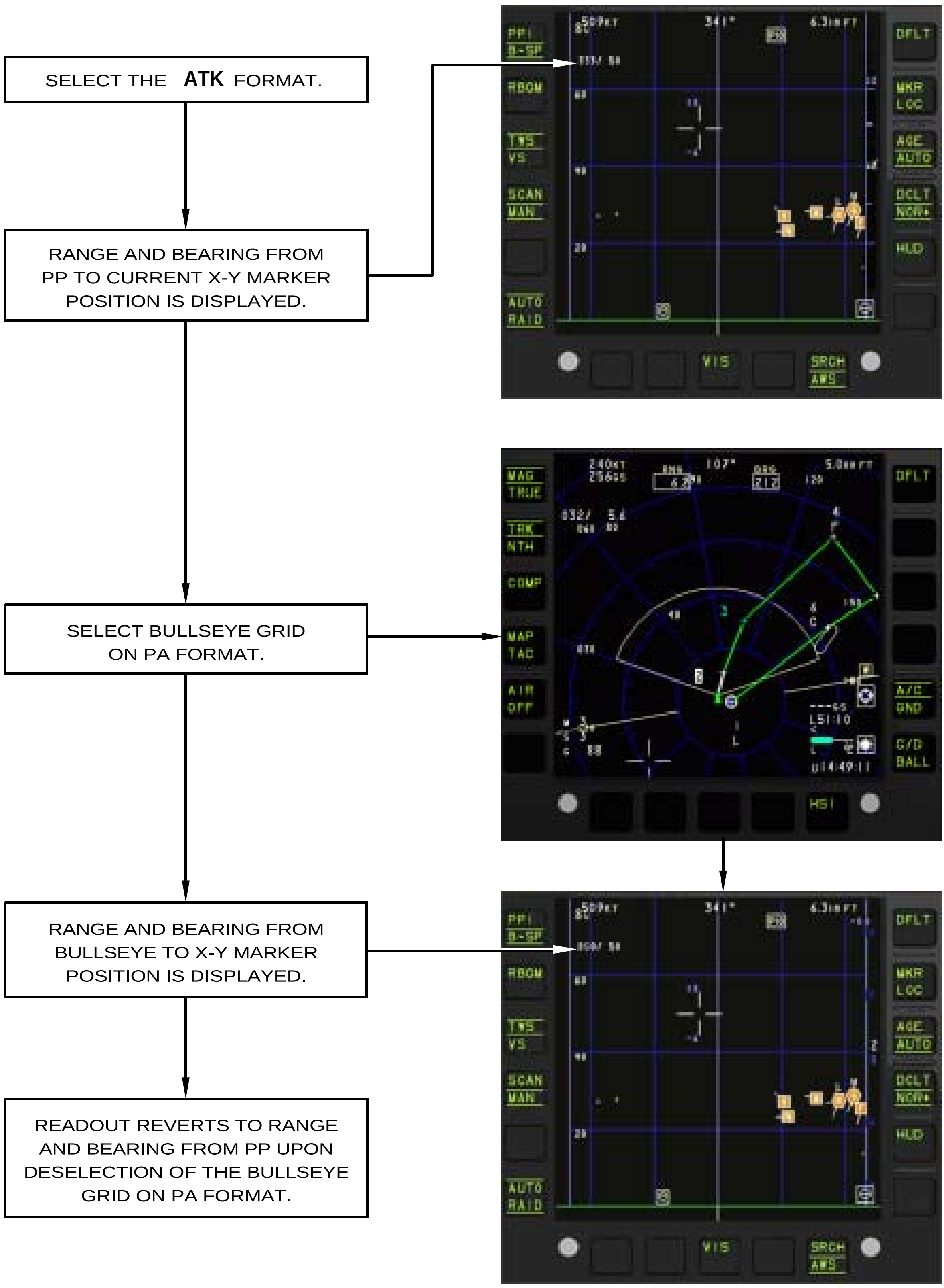


Figure 8.41 - Range/Bearing Readout

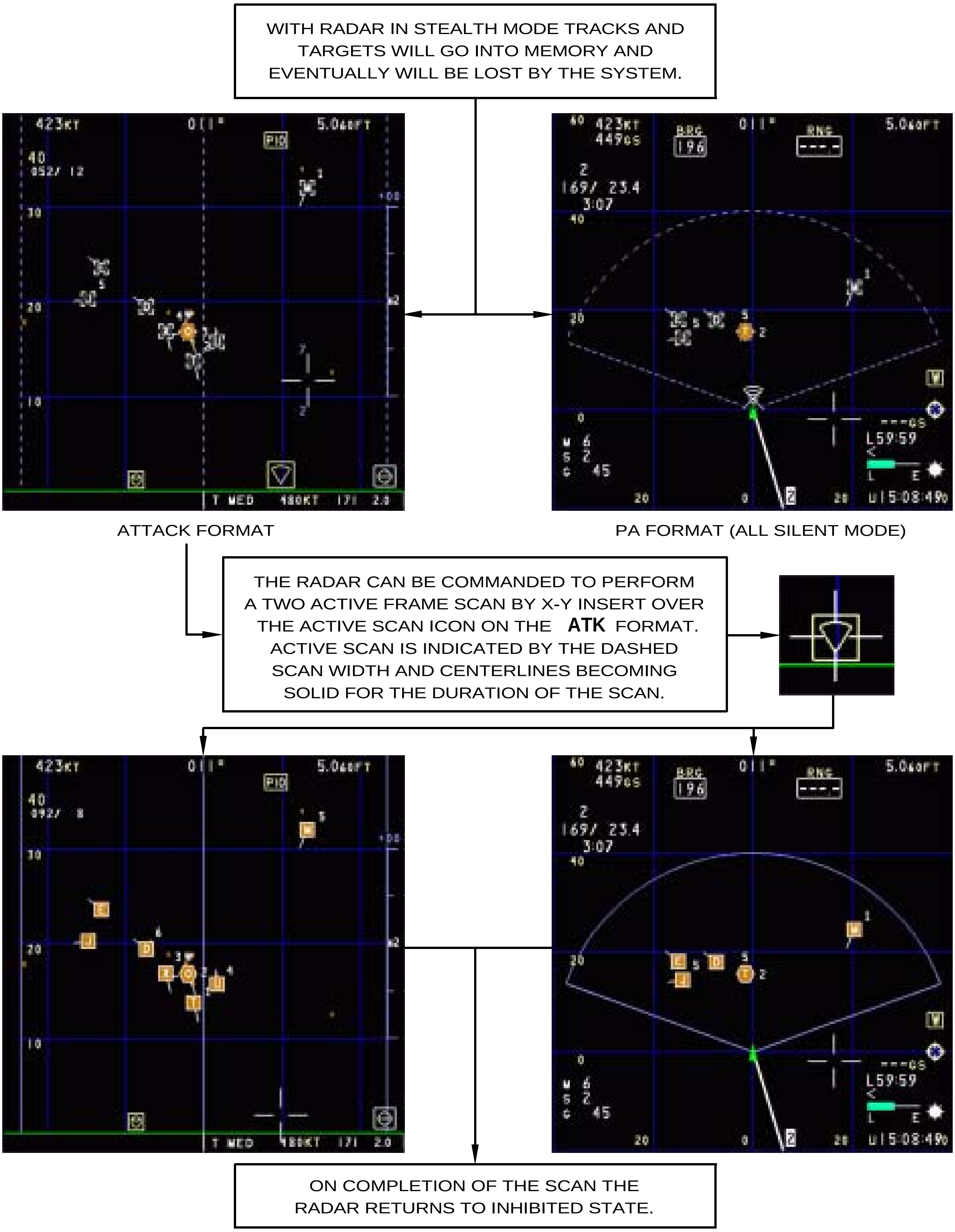
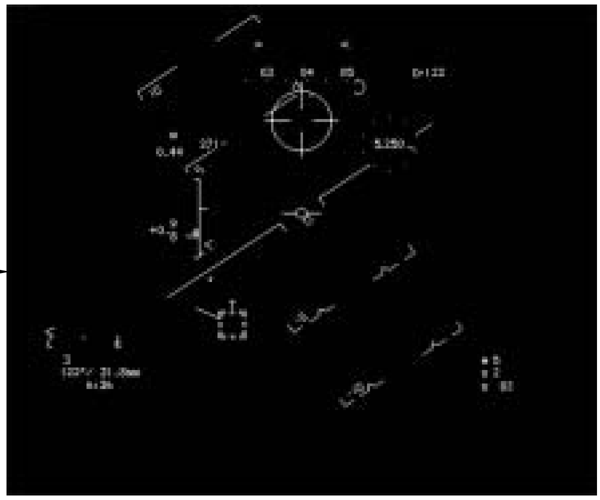


Figure 8.42 - Active Frame Scan

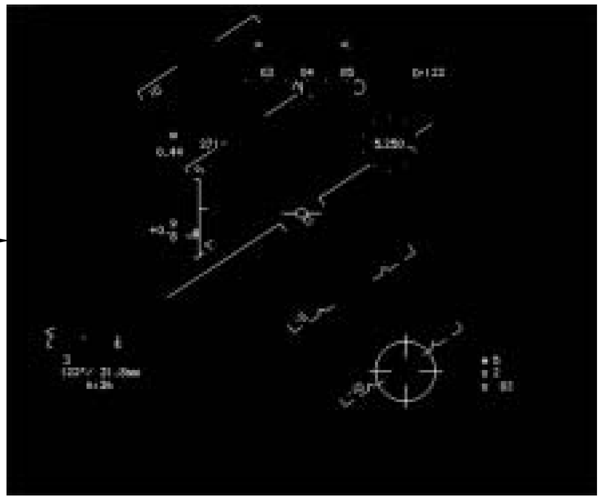
SELECT SACQ MODE USING THE VTAS ACM SELECTOR.

THE X-Y MARKER JUMPS TO THE BORESIGHT ACM POSITION ON THE HUD.
THE SACQ SYMBOL ALIGNS WITH THE X-Y MARKER POSITION.
RADAR TRACKS GO INTO MEMORY AND EVENTUALLY OCCULT.



NOTE
IF SRAAM SLAVING IS IN PROGRESS (FIG.29) THE SACQ SYMBOL WILL ALIGN WITH THE X-Y MARKER AND SRAAM SEEKER HEAD SYMBOL POSITION.

THE RADAR SCAN VOLUME IS SLEWED USING THE X-Y CONTROLLER.



LOCK IS OBTAINED ON THE NEAREST DETECTED TARGET IN THE SACQ SCAN VOLUME AND INSTRUMENTED RANGE.

ONCE LOCK IS ACHIEVED THE RADAR ENTERS STT, OR GUN LF IF THIS WEAPON IS SELECTED. IF A WEAPON IS NOT ALREADY SELECTED THE SYSTEM AUTOMATICALLY SELECTS SRAAM (IF AVAILABLE).

THE X-Y MARKER RETURNS TO THE MARKER LOCATE POSITION ON THE MHDD FORMAT.

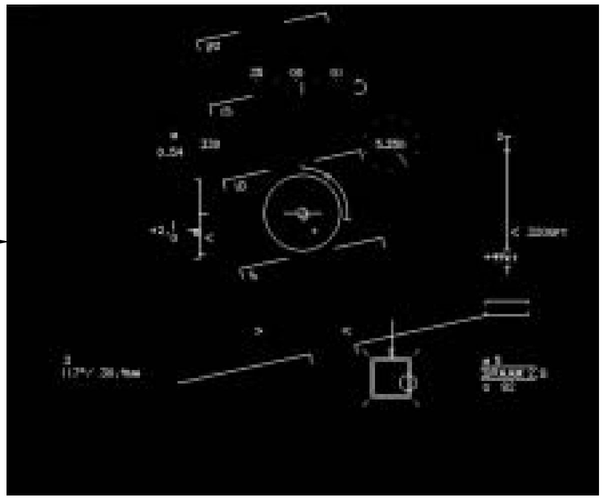
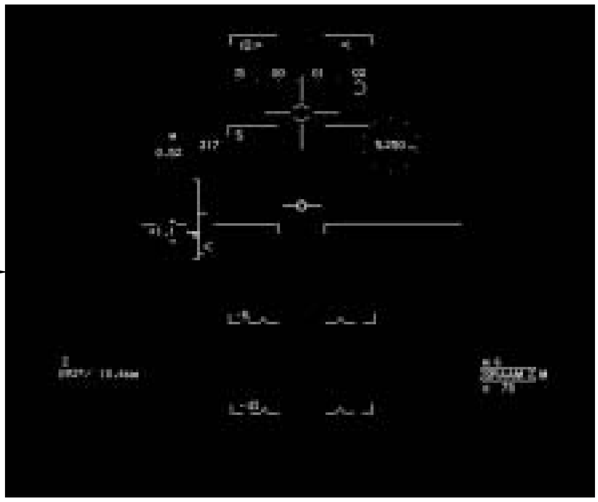
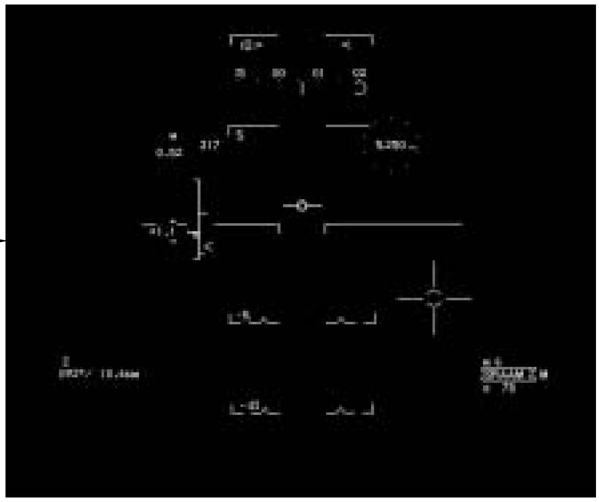


Figure 8.43 - Radar Slaved Acquisition Mode (SACQ)

SELECTION OF SRAAM MANUAL MODE DEFAULTS THE SRAAM SEEKER HEAD SYMBOL AND X-Y MARKER TO THE ACM BORESIGHT POSITION.
IF THE X-Y MARKER IS ALREADY ON THE HUD IN ANOTHER SLAVING MODE (I.E. SACQ), THE X-Y MARKER REMAINS AT ITS CURRENT LOCATION AND THE SRAAM SEEKER HEAD SYMBOL ALIGNS WITH THE X-Y MARKER.



THE SRAAM SEEKER HEAD ALIGNS WITH THE DEMANDED SIGHT LINE INDICATED BY THE X-Y MARKER.



ONCE THE SEEKER HEAD IS LOCKED TO A TARGET THE X-Y MARKER RETURNS TO THE **MKR LOC** POSITION ON THE GROUP A MHDD, OR IF RADAR SACQ IS ALSO SELECTED REMAINS IN THE HUD AND IS SLEWABLE BY THE PILOT. TO SELECT ANOTHER TARGET THE PILOT MUST RE-SELECT SRAAM MANUAL MODE AND SLEW THE X-Y MARKER TO THE NEW TARGET.

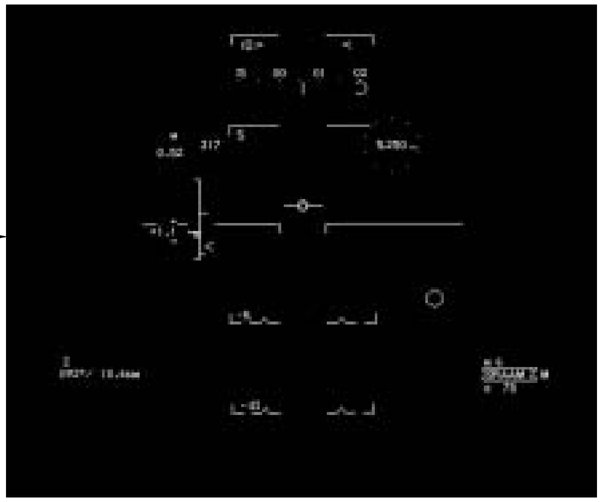
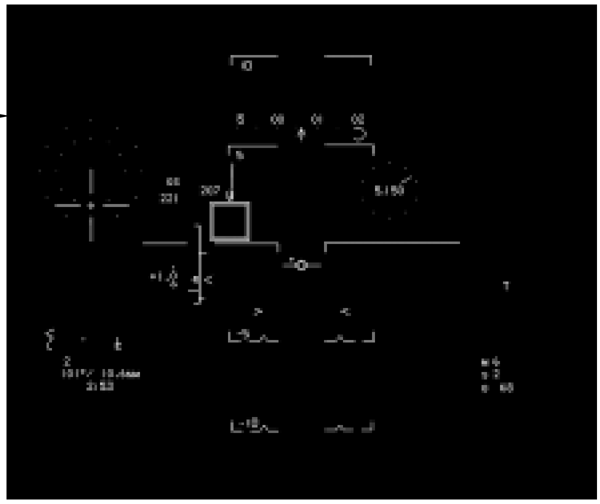


Figure 8.44 - SRAAM Manual Mode

SELECT THE **VIS** SK ON THE **ATK** FORMAT WHEN THE RADAR IS EITHER IN TWS OR LF MODE.

VISIDENT POSITIONING CUE IS DISPLAYED ON THE HUD WITH THE X-Y MARKER AND VISIDENT POSITIONING CUE MARKER AT THE 6 O'CLOCK POSITION ON THE INNER CIRCLE (DEFAULT POSITION), UNLESS A PREVIOUS SELECTION HAD BEEN MADE.



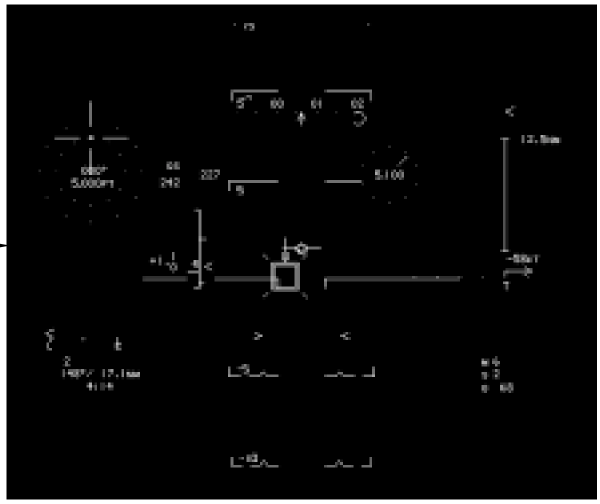
MARKER MAY BE MOVED FROM CIRCLE TO THE OTHER BY SHORT X-Y INSERT.

MARKER MAY BE MOVED AROUND THE CIRCLES BY NUDGING THE X-Y CONTROLLER IN THE DESIRED DIRECTION.

LONG X-Y INSERT SELECTS POSITION. IF OUTSIDE VISIDENT RANGE THIS ACTS AS A PRESELECTION.
X-Y MARKER RETURNS TO THE **MKR LOC** POSITION ON THE GROUP A MHDD.

POSITIONING CUE OCCULTS 5 SECONDS AFTER SELECTION HAS BEEN MADE.

IF OUTSIDE VISIDENT RANGE THE WEAPON SYSTEM PROVIDES LEAD COLLISION STEERING INFORMATION TO LF TARGET OR NUMBER 1 TARGET IF IN TWS MODE.



VISIDENT MODE IS ENTERED WHEN THE TRACK/TARGET IS WITHIN VISIDENT RANGE AND PROVIDED LF IS SELECTED. VISIDENT STEERING IS PROVIDED TO THE OFFSET POSITION SELECTED.

THE VISIDENT POSITION CUE MAY BE DISPLAYED AND UPDATED AT ANY TIME BY SELECTING THE **VIS** OR **VIS CUE** SK ON THE **ATK** FORMAT.

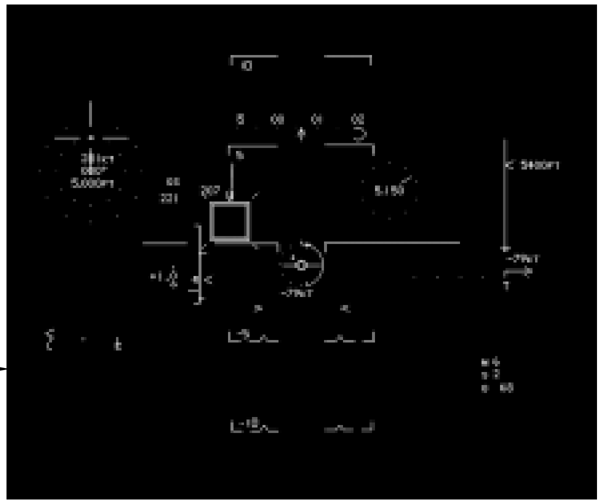


Figure 8.45 - Position VISIDENT Mode

DEFENSIVE AIDS AND SUBSYSTEM (DASS)

DEFENSIVE AIDS COMPUTER

The Defensive Aids Computer (DAC) provides:

– control of manual initiated dispensing of Chaff and/or Infra-Red (IR) decoys, in accordance with pre-programmed sequences,
– manages RF interoperability of all on-board emitters and receivers by means of a programmable blanking and suppression matrix (on-board RF interoperability is cleared for assessment purpose only with SP3C/15),
– provides a “stealth management” function for the on-board emitters,
– controls Radar channel allocation,
– limited support for the ESM/ECM and Missile Warner equipment. Automatic dispensing of expendables in response to ESM/ECM or Missile Warner outputs is not supported at this software standard.

The DAC interfaces with other LRIs via the Attack Bus and the DASS Bus and provides the following functions:

DASS COUNTERACTIONS

At IOC the available DASS counteractions are limited to the manually commanded dispensing of chaff and/or IR decoys from two chaff dispensers and two flare dispensers.

RF INTEROPERABILITY (ON-BOARD RF INTEROPERABILITY IS CLEARED FOR ASSESSMENT PURPOSE ONLY WITH SP3C/15)

The aim of RF Interoperability is to maximize weapon system performance by utilizing suppression and blanking techniques on a priority dependent on the current scenario, whilst minimizing the loss of performance caused by mutual interference. This is achieved by careful selection of operating frequencies, antenna locations, management of emissions in the time and frequency domains and, as a last resort, suppression and blanking. Management of emissions and suppression/blanking is shared between the DAC and the ESM/ECM equipment.

STEALTH MANAGEMENT

The DAC also contributes to overall stealth moding by intelligently managing ECM transmissions in accordance with PDS-loaded criteria.
This means, for example, that transmissions will be inhibited throughout a specific sortie unless the DASS decides to respond with all necessary countermeasures when it detects threats beyond pre-defined thresholds.
The Stealth Management function enables the pilot to inhibit transmissions from the following groups of RF emitters:

– Radar
– IFF Interrogator
– IFF Transponder
– Radalt
– Tacan

RADAR CHANNEL CONTROL

A default channel pair allocation, contained in mission data, will be employed unless the pilot inputs a modified channel allocation. If the pilot modifies the channel allocation, the DAC will check that the new allocation is valid. If valid, the selected channel allocation is passed to the Radar for application.

MISSION DATA LOADING

An area of non-volatile "sensitive memory" is provided within the DAC for storage of classified mission data. The contents of this memory will automatically be erased in the event of pilot ejection, physical removal of the DAC from the aircraft or pilot operation of the crypto erase switch in the cockpit (Secure Data Erasure of PDS by ejection or pilot initiation is not cleared with SP3C/15).
The DAC may be loaded with two types of mission data:
a. Multi mission data and
b. Single mission data.
Multi-mission data is loaded from the Ground Loader Unit (GLU) into the DAC's non-volatile, "sensitive" memory to avoid a loss of such data in the case of a power interruption. Once the multi-mission data has been loaded into NVM and on each subsequent power-up, the DAC will copy the multi-mission data into a "working copy" in RAM, which may be modified by single-mission data.
Multi-mission data for ESM/ECM, MW, LW is also stored in the DAC's sensitive memory and sent to the equipments following power-up or following the arrival of new multi-mission data for these equipments or following a request by these equipments.
Single-mission data is also loaded into the DAC's non-volatile memory, received from the Portable Data Store (PDS), via the Mission Data Loader Recorder (MDLR) and the Attack bus.
This single-mission data may modify all or part of the "working copy" of the multi-mission data. Single-mission data for ESM/ECM, MW, LW is also stored in the DAC's sensitive memory and is downloaded to these equipments. Distribution of single and multi-mission data to ESM/ECM, MW, LW requires the modification of the transaction table.

BUILT IN TEST

A BIT function runs continuously (CBIT) and an interruptive BIT function (IBIT) will be performed if requested.

HEALTH MONITORING

The DAC will monitor the status bits of all Remote Terminals (RT) on the DASS bus. Confirmation of RT failures will result in transactions being disabled, maintenance data being generated and warnings being set. When the ESM/ECM Remote Terminals fails on the DASS bus, the concerned transactions can be switched to the Attack bus.

The DAC will monitor IBIT requests and will check that LRIs on the DASS bus have started and have finished IBIT.

DWP WARNINGS

The following warning is available for the DAC:

DAC Failure Warning

WARNING	CATE-GORY	VOICE MESSAGE	DWP CAPTION	SYSTEM ACTIONS	MISSION CONSE-QUENCES	SYSTEM CON-SEQUENCES
DAC Failure	3	DASS Computer	**DAS CPTR**	Expendables release relies on back-up program loaded in dispensers. RF interoperability relies on loaded default data	Radar performance in GUN and VISident mode may be degraded	MDE Radar channel input lost. MDE CHAFF/ FLARE modes lost. CHAFF / FLARE switch, forward function lost (default chaff only or expendables program).

FORWARD LOOKING INFRA RED

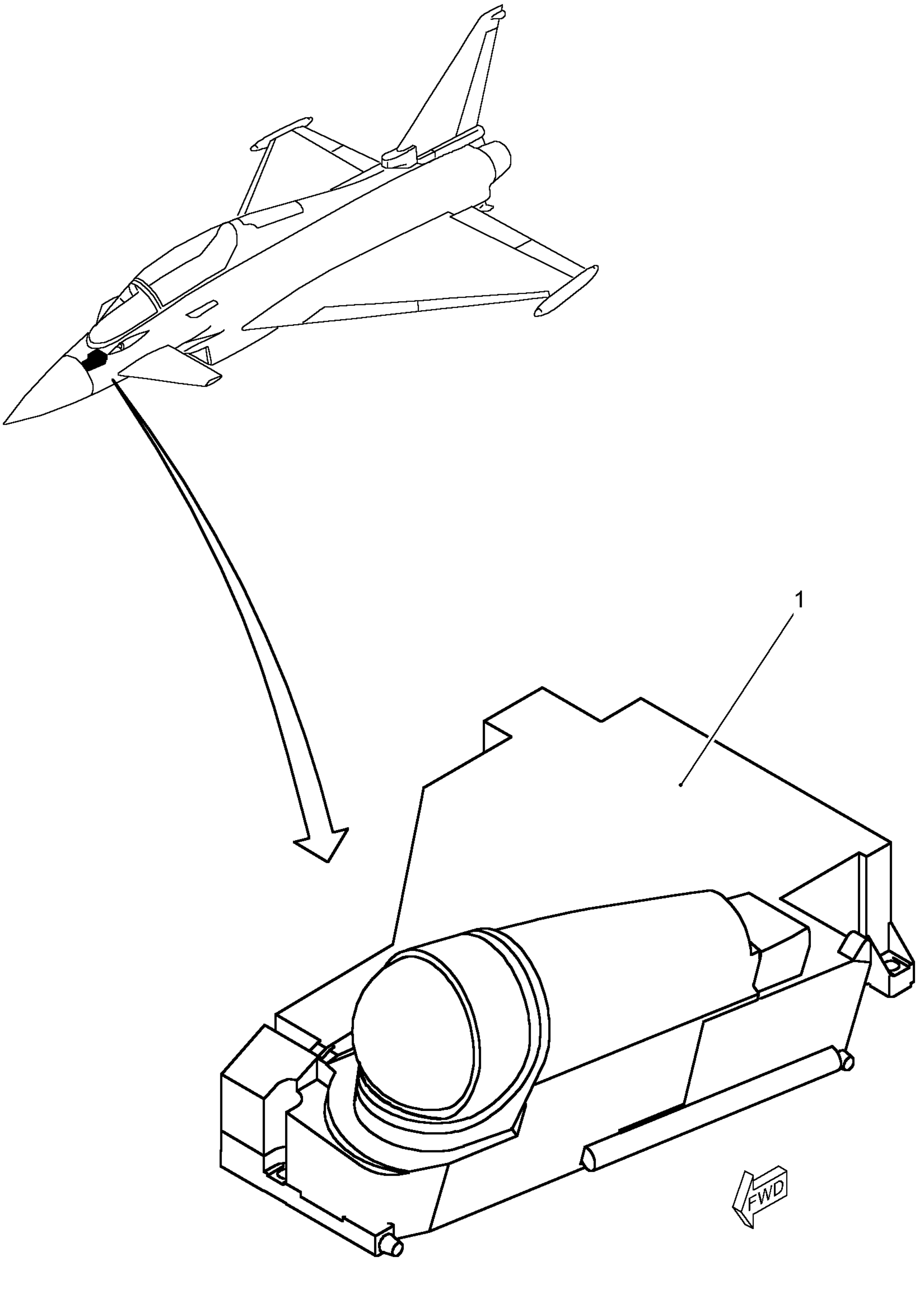
WARNING

WITH SP3C/12, DISPLAY OF THE FLIR IMAGING MODE ON THE HUD IS CLEARED FOR ASSESSMENT PURPOSE ONLY AND SHALL NOT BE RELIED UPON TO FLY THE AIRCRAFT.

The Forward Looking Infra Red (FLIR) is a passive electro-optical sensor that operates in the infrared spectrum. The sensor is being fitted on the top left side of the aircraft front fuselage, forward of the cockpit, see Figure 8.46. Only parts of the opto-mechanical sub-assembly are located on the outer side of the fuselage and the detected IR radiation is passed through the IR window inside the sensor through lenses and mirrors.
The FLIR system generates an IR image of the outside world for ground target engagement and terrain navigation assistance at night or in poor visibility. A major advantage of the FLIR system is that the system is completely passive, with no detectable electromagnetic emissions that may be sensed by potential targets.

COOLING

To allow the detection of weak radiation emissions the detector is cooled by using a Stirling Split Cooling Engine.



1 Flir

Figure 8.46 - FLIR Location Drawing

FORWARD LOOKING INFRA RED CONTROLS AND DISPLAYS

RIGHT CONSOLE - GANGBAR FLIR/OFF SWITCH

NOTE

Do not set the switch to FLIR unless both GENs are on line.

The FLIR/OFF switch on the gangbar selects the FLIR on or off. If system gangbar is not selected to on the prompt “SYSTEMS GANGBAR” will be given on the MHDD Autocue format.

HUD CONTROL PANEL (HUP)

HUD FLIR DISPLAY SELECTOR

The pushbutton labelled FLIR is not used at this software package.

MHDD ELEVATION FORMAT

SBY/ON SK: Selects the FLIR in either standby or on and indicates the current status. In ON the image will be displayed on the HUD.

HUD

WARNING

WITH SP3C/12, DISPLAY OF THE FLIR IMAGING MODE ON THE HUD IS CLEARED FOR ASSESSMENT PURPOSE ONLY AND SHALL NOT BE RELIED UPON TO FLY THE AIRCRAFT.

The FLIR image in Flying Aid is displayed on the HUD, when selected to ON with the SK on the Elevation Format. Raster image brightness, balance and contrast may be adjusted using the thumbwheel controls on the HUP.

NOTE

Image characteristics will also be controlled automatically by the FLIR system, therefore adjustments should be kept to a minimum.

DWP WARNINGS

There are no warnings available for the FLIR system at IOC.

FORWARD LOOKING INFRA RED MODES

The following modes, depending on POF, are provided:

STANDBY MODE (SBY)

After power-up and on completing PBIT the system enters the STANDBY mode. In STANDBY the FLIR activity is reduced to minimize power consumption and wear and movable optical components and scanning mechanisms are held in park position. Transition time to any operational mode is less than 2 seconds.
When in STANDBY mode the sensor head is cooled and ready for immediate operation.
SBY is selectable from all operational modes.

FLYING AID MODE (FLAD)

WARNING

WITH SP3C/12, DISPLAY OF THE FLIR IMAGING MODE ON THE HUD IS CLEARED FOR ASSESSMENT PURPOSE ONLY AND SHALL NOT BE RELIED UPON TO FLY THE AIRCRAFT.

This mode provides an image, projected onto the HUD, to assist operation in poor weather and/or low light conditions. The image overlays the outside world as seen through the HUD. It will be optimized for the recognition of surface objects in the direction of flight and below the horizon. At later avionics software packages the image will be also displayable on the MHDD.

IMAGE ALIGNMENT

Alignment of the FLIR image with the outside world will be performed once, before the first flight by use of ground test equipment. There will be no facilities to allow alignment of the FLIR by the pilot during flight.

NORMAL OPERATION

GROUND OPERATION

With full electrical power available (e.g. after engine start, and with the systems gang bar FLIR switch ON) the FLIR goes through a start up PBIT and defaults to the standby (SBY) mode when PBIT is complete. Upon switch ON, the sensor cooling is started which is likely to be in the order of 6 minutes to achieve full performance. During cooling the operating mode may be selected but the performance will be degraded until the operating temperature is achieved. The sensor will then be maintained cooled in all operating modes (including SBY). The FLIR is switched into FLAD mode using the FLIR SBY/ON soft key on the Elevation Format and the FLIR image will be displayed on the HUD.

IN-FLIGHT OPERATION

WARNING

WITH SP3C/12, DISPLAY OF THE FLIR IMAGING MODE ON THE HUD IS CLEARED FOR ASSESSMENT PURPOSE ONLY AND SHALL NOT BE RELIED UPON TO FLY THE AIRCRAFT.

If the FLIR image is required during or after takeoff, the FLIR must be selected from SBY to ON, and the Flying Aid image will be displayed on the HUD.

FLIR IMAGE ON THE HUD

The FLIR image is displayed in raster format on the HUD. Subject to satisfactory alignment, it should overlay the outside world 1:1 at all practical distances from the aircraft. Normal HUD symbology is retained, superimposed on the FLIR image. To rapidly occult the FLIR image from the HUD, select the FLIR SBY/ON soft key on the Elevation Format to SBY. FLIR image contrast and brightness on the HUD may be adjusted using the thumbwheels on the HUP.

IDENTIFICATION SYSTEM (IFF)

NOTE

The IFF Interrogator is not installed in DA 1, 2, 3 and 7.

The Identification Friend or Foe System (IFF) comprises of the IFF Interrogator and the IFF Transponder. For identification of other aircraft the interrogator will transmit an interrogation signal which will or will not be answered by a recognizable transponder signal. The answers are then categorized friendly or unknown and are displayed against the radar plots.

IFF INTERROGATOR (INT) (NOT INSTALLED IN DA 1, 2, 3 AND 7)

The IFF Interrogator function is to identify unknown platforms by updating their status from unknown to friendly. The result of the interrogation process will be displayed on the Attack and the PA Format.

The interrogator unit is installed in the avionics bay and consists of a control processor including transmitter and receiver and an aerial located on the radar antenna.

IFF TRANSPONDER (XPDR)

The IFF Transponder provides automatic self identification in response to interrogations from other platforms or transponds on pilot's action (IDENT) when requested by ATC.

The equipment is also capable to transmit EMERGENCY replies in either civil or military modes as pre-selected by the pilot. On ejection the XPDR will transmit the military emergency distress code (Front Seat only in Development Aircraft).

The XPDR unit is installed in the avionics bay and consists of a control processor including transmitter and receiver and two IFF antennas; a Lower Antenna located on the left hand engine bay door and an Upper Antenna located forward of the cockpit windscreen. Replies will be transmitted through the antenna which received the strongest interrogation signal.

The transponder receives interrogation signals with a 1030 MHz carrier frequency, detects and decodes them and, in case of a correct interrogation transmits reply signals with a 1090 MHz carrier frequency.

BUILT IN TESTS (BIT)

A Power-up BIT, a Continuous BIT and an Initiated BIT will provide ground and in-flight failure detection and isolation within the transponder and the interrogator.

The Power-up BIT is performed when aircraft power is applied and OFF is deselected. During STANDBY and OPERATE conditions a Continuous BIT is automatically performed as long as the equipment is powered up. An Initiated BIT is selectable with the SK “A&I IBIT” on the Maintenance Format (MNTC) (available on the MHDD/ACUE format, on the ground only), from either STANDBY or OPERATE condition (without STEALTH) and will halt normal operation.

POWER SUPPLY

The interrogator will be supplied with 115 V single phase AC power and 28 V DC.

The transponder will be supplied from DC essential bus bar.

IDENTIFICATION SYSTEM CONTROLS AND INDICATORS

NOTE

The IFF Interrogator is not installed in DA 1, 2, 3 and 7.

RIGHT CONSOLE - GANGBAR

IFF TRANSPONDER SWITCH

The two positions of the toggle switch are labelled XPDR and OFF. Following XPDR switch on and completion of the PBIT, the transponder is automatically defaulted to the standby mode of operation "SBY".

IFF INTERROGATOR SWITCH

The two positions of the toggle switch are labelled INT and OFF. Following Interrogator switch on and completion of the PBIT, the Interrogator is automatically defaulted to the normal mode of operation "NORM" and will operate and transmit normally, unless:

a. The stealth requirements (SLNT) are selected via MDE.
b. INT STBY has been selected via MDE.
c. Inhibited by WOW.

LEFT CONSOLE

SECURE DATA ERASE SWITCH

The coverguarded switch SECURE DATA ERASE will erase all loaded secure data of the XPDR and Interrogator.

LEFT HAND GLARESHIELD (LHGS)

The following Sub-System Keys are used to manage the Transponder and Interrogator:

INT (SSK)

The INT SSK will enable the following set of Moding Keys (MK).

SBY/NORM

In SBY all interrogator functions are available and preselectable but interrogator transmissions are inhibited.

In NORM (selected by default) the interrogator is fully operational with the modes selected. Transmissions are inhibited when WOW signal present and are automatically enabled when weight is off the wheels. The control is moded independently from the INT stealth control.

MODE 1

Selects or deselects Mode 1 (selected by default).

MODE 2

Selects or deselects Mode 2.

MODE 3A

Selects or deselects Mode 3A (selected by default).

PAGE 2 (CODE INFO)

Reconfigures the MKs to display the CODE INFO MK, which shows the time left for all the ACC codes currently stored and the current codes selected for the modes 1/3A currently in use. The time shown is always related to ACC codes and therefore independent of manually entered codes in use.

The Page 2 MK remodes to Page 1 and will call up page 1 again.

MODE 4 (LOADING OF INTERROGATOR CRYPTO VARIABLES NOT CLEARED WITH SP3C/15)

First press selects Mode 4 A, second press selects Mode 4 B and third press deselects Mode 4 (Mode 4 MK is only available if cryptovariables are loaded).

Cryptovariable data may be erased by use of the SECURE DATA ERASE switch and will be erased automatically on ejection.

Cryptovariable data may be erased in emergencies or when not required anymore and will be erased automatically on ejection of either seat.

MODE C

Selects or deselects Mode C.

ACTV DCDE

This enables the active decoding and display of the Mode 1 and 3A codes of the responding target on the MHDD.

1/3A CODE

Independently to the PDS loaded ACC code pairs, eight pairs of codes for Mode 1 and 3A can be entered manually and selected with the DEK brackets. Changing a pair of codes will be active on pressing ENTer. The 1/3A key (selected by default) is available independently from ACC/MAN selection.

ACC/MAN

ACC enables Automatic Code Change of Mode 1 and 3A codes, using a PDS-loaded code set.

MANual code change (selected by default) uses manually entered codes for Mode 1 and Mode 3A. ACC is inhibited when this function is selected.

The ACC/MAN key is only available when ACC codes are loaded and the current ACC code start time is less or equal to the present UTC time (from the GPS). When the ACC is not loaded or is no longer valid the MK legend is occulted and manual code change is automatically selected by the system. If codes have only be loaded for one mode then the ACC operation will only apply for this mode. The codes may be entered manually via MDEF (1/3A Code).

AUTO SPFC

Selects Auto Specific interrogation (selected by default), i.e. a track is automatically interrogated on track initiation.

INT ALL

The system interrogates all existing A/A radar tracks held within the system and within scan coverage. On completion of the interrogations the mode is automatically deselected. Subsequent selections of the MK before auto-deselection will have no effect on the displays but will request fresh interrogations of all tracks. Successful response will be indicated on the Attack, Elevation and Pilot Awareness formats for 5 seconds after the response of the last track.

XPDR (SSK)

Selection of the XPDR SSK will enable the following set of Moding Keys (MK):

SBY/NORM

In SBY (selected by default) the XPDR will still receive interrogations, but will not reply unless emergency is selected. All XPDR functions are available and preselectable.

In NORM the XPDR is fully operational with the modes selected and transmissions are not inhibited by WOW to allow ATC interrogation on ground. The control is moded independently from the XPDR stealth control.

MODE 1

Selects or deselects Mode 1 (selected by default). The XPDR can only respond in Mode 1 when an operating code is available. The last code is held in the Non Volatile Memory (NVM) until overwritten by a new code. Codes can be entered via the MDEF or loaded via PDS.

MODE 2

Selects or deselects Mode 2 (selected by default). The XPDR can only respond in Mode 2 when an operating code is available, either loaded via PDS or from the Non Volatile Memory (NVM). The last code is held in NVM until overwritten by a new code.

MODE 3A

Selects or deselects Mode 3A (selected by default). The last code is held in the Non Volatile Memory (NVM) until overwritten by a new code. Codes can be entered via the MDEF or loaded via PDS.

CODE INFO

Shows the time left for all the ACC codes currently stored and the current codes selected for the modes 1/3A currently in use. The time shown is always related to ACC codes and therefore independent of manually entered codes in use.

MODE 4

MODE 4A is selected by default, indicated on the boxed MK MODE 4A. Next presses will toggle through MODE 4B, deselection of MODE 4 and selection of MODE 4A again. If no Mode 4 cryptos have been loaded, the MK is occulted and the mode cannot be selected. Cryptovariable data may be erased by use of the SECURE DATA ERASE switch and will be erased automatically on ejection.

MODE C (MK)

Selects or deselects Mode C (selected by default).

NOTE

The XPDR receives the altitude information directly from two Flight Control Computers. In case that no valid altitude information is available the XPDR will transmit altitude zero.

MIL/CIV

Selects between MIL and CIV emergency codes transmitted when EMGY is selected (default is MIL).

1/3A CODE

Independently to the PDS loaded ACC code pairs, eight pairs of codes for Mode 1 and 3A can be entered manually and selected with the DEK brackets. Changing a pair of codes will be active on pressing ENTer. The 1/3A key (selected by default) is available independently from ACC/MAN selection.

ACC/MAN

ACC enables Automatic Code Change of Mode 1 and 3A, using a PDS-loaded code set.
MANual code change (selected by default) uses manually entered codes for Mode 1 and Mode 3A. ACC is inhibited when this function is selected.
The ACC/MAN key is only available when ACC codes are loaded and the current ACC code start time is less or equal to the present UTC time (from the GPS). When the ACC is not loaded or is no longer valid the MK legend is occulted and manual code change is automatically selected by the system. If codes have only be loaded for one mode then the ACC operation will only apply for this mode. The codes may be entered manually via MDEF (1/3A Code).
The currently selected state, i.e. ACC or MAN is also displayed on the RGS.

MODE S

Selects or deselects the ATC Mode S (Level 2).

XMIT (SSK)

After power up the SSK XMIT is available for selection. The following Moding Keys (MK) are enabled to manage the IFF interrogator and transponder transmissions.

ALL NORM

Boxed by default, indicating that all transmitters are enabled for transmitting. The MKs for the individual transmitters are displayed for pre-selections of the program mode. This MKs are default to NORM when XMIT is pressed, but can be modified through a PDS load.

ALL SLNT

If selected ALL SLNT is boxed indicating that all transmitters are inhibited from transmitting.

PROG

If selected PROG is boxed; ALL NORM or ALL SLNT MK are deselected. Any of the system controls set to

SLNT will be boxed, those set to NORM will not be boxed.

XPDR NORM/SLNT; INT NORM/SLNT

This individual transmitter MKs act as preselectors when PROG is not selected. The pre-selections for the individual transmitters are default to NORM when XMIT is pressed, but can be modified through a PDS load. When ALL NORM is selected (boxed) any selection of an individual transmitter key will preselect the relevant transmitter to either SLNT or NORM. The MK legend toggles between SLNT and NORM. The SLNT keys are only boxed when PROG is selected (boxed).

MISC (SSK)

CRYP SUPP

With MISC selected the MK CRYP SUPP will be available. Selection of the MK CRYP SUPP (boxed) will suppress all cryptovariable related warnings (Voice, DWP and Autocue Format) with the following restriction. If any of the following four warnings occur, RAD1, RAD2, XPDR or IFF INT the suppression is removed and the warning(s) shown. The MK will be deselected and must be reselected for the suppression to be enabled again. If cryptovariables are loaded suppression is not available and will be removed (unboxed). Deselection of the CRYP SUPP (unboxed) will remove the suppression of the cryptovariable related warnings.

RIGHT HAND GLARESHIELD (RHGS)

RGS FLAP

The system status (SBY, ACC, MAN, SLT) and currently selected modes are displayed on the RGS flap.

TRANSPONDER EMERGENCY CONTROL

Pressing the recessed EMGY pushbutton on the RHGS will start transmission, upon interrogation, of either MIL or CIV emergency codes as preselected. A second press deselects the transmission of the EMGY code. Stby and stealth state will be overridden during that time.

IDENTIFICATION RESPONSE SELECTION

The identification pushbutton, labelled ID, is used to transpond for about 20 seconds when requested by ATC. The ID button will not be illuminated in SBY. Stealth state will be overridden during that time.

HOTAS

STICK TOP

The pilot initiates track or area interrogation (volumes not available at SP3), and defines the interrogation volume, using the IFF interrogate button on the stick top.

THROTTLE TOP

The XY controller is used for the following IFF functions:

– IFF Mode 4 Own Aircraft Response ON/OFF selection via XY on icon (AF)
– Manual IFF interrogation of tracks, targets (including TGS) or volumes (volumes not available at SP3) (AF)
– Pilot Identity Override (PIO) (AF)
– IFF Extra Information

For detailed XY-controller operation refer to Identification System MDE and X-Y Functions pag. 88 Identification System MDE and X-Y Functions.

ATTACK FORMAT

IFF returns are displayed on the AF as green (friendly) or amber (unknown) plots or as track attributes. The plots are of a lower display priority than track symbols, and are therefore usually overwritten. A successful interrogation may convert an unknown track into a friendly, and the track symbol may then change accordingly to a green infill circle.

The allegiance can be overwritten by use of the Pilot Identity Override Icon.

The Mode 4 Response Icon is used to select the Own Challenge Reply Indication and the CAT 4 Incorrect Own Response Warning to on or off, using the XY controller (default is on). When selected to on, the icon is shown as a box with a bright white circle with a dull white line through the circle. When correct response was sent the circle will get a green infill inside for a minimum of 1 second. When selected to off a dull white circle with dull white line through the circle will be shown with black casing.

Mode 4 Challenge Reply Indication (from SP5 onwards) is provided for a minimum of 1 seconds.

The area interrogation box (from SP5 onwards) is drawn on the attack format for the duration of the sector interrogation or for 2 seconds whichever is the longest, when selected by the pilot. Three areas are available, 25% of the display area (defined as 25% of the current range scale long by 25% of the total scan width wide), 50%, and 100%. The 25 and 50% areas are nominally centered on the position defined by the XY cursor. The areas are selected sequentially, first press of the button giving 25%, second 50%, and third press the full screen.

To avoid unnecessary IFF transmissions, IFF informations already available for a track will be displayed when extra information is selected on that track using the XY controller. Mode C altitude information is excluded.

Mode 1 and 3A codes of the responding target are displayed with white digits next to plots, tracks and targets when active decoding is selected.

Mode C Altitude is displayed in whole thousands of feet with plots, tracks and targets for 5 seconds when interrogated.

EMGY will be displayed when a military emergency code has been received against a track or target. EMGY will always shown in the top code position, if other codes are already displayed they will move down one position.

PILOT AWARENESS/ELEVATION FORMAT

The result of the identification process (from SP5 onwards) will be displayed as track allegiance (color and format).

REVERSIONARY MDE FORMAT

The MHDD Reversionary MDE format can also be used for transmit inhibit control and Mode 4/4A/4B selections in case of left glareshield malfunctions.

AUTOCUE FORMAT

The following prompts are displayed for the IFF system during ground operation:

– "SYSTEMS GANGBAR" when the transponder or interrogator is off after engine start.
– "ACC AVAILABLE" when power is on and ACC codes are loaded and the current ACC code start time is less or equal to the present UTC time (from the GPS) but ACC is not selected.
– "CRYP ERROR IFF XPDR" when power is on and cryptovariables are not available/loaded.
– "CRYP ERROR IFF INT" when power is on and cryptovariables are not available/loaded.

IFF WARNINGS/FAILURES

The following warnings are available for the IFF system:

IFF Failure Warnings

Warning	Category	DWP caption	Voice message	Suppress conditions	Other display indications	Mission Consequences
Transponder Failure	3	**XPDR**	Transponder	when OFF	No	Transponder lost
Interrogator Failure	3	**IFF INT**	Interrogator	when OFF	No	Interrogator lost
IFF INT or XPDR Cryptovariable Failure	3	**IFF CRYP**	IFF Crypto	manually selectable	on Autocue	Mode 4 lost
Mode 4 incorrect own response	4	None	Mode 4 Response	when alerting mode deselected (Icon)	No green infill for one second in Response Icon on PA and AF	Self identification possibly incorrect
Mode 4 incomplete Target response	N/A	N/A	N/A	N/A	indicated by "MODE 4" with the associated IFF track or plot on the AF	N/A

(Continued)

IFF Failure Warnings (Continued)

Warning	Category	DWP caption	Voice message	Suppress conditions	Other display indications	Mission Consequences
IFF Interrogator Overtemperat-ure	3	INT T	Interrogator Temp	None	None	None, but may lead to Interrogator Failure
IFF Transponder ACC available	4	None	Transponder ACC available	when ACC already selected	None	None
IFF Interrogator ACC available	4	None	Interrogator ACC available	when ACC already selected	None	None

IDENTIFICATION SYSTEM MODES AND OPERATION

NOTE

The IFF Interrogator is not installed in DA 1, 2, 3 and 7.

The IFF transponder and interrogator operate in the following modes:

IFF/SSR PROTOCOL MODES

Military modes (IFF) are defined by the numbers 1, 2, 3 and 4 and civilian modes (SSR) by the characters A, C and S. The civilian modes are also called ATC-Modes and are used by military aircraft also, but the civilian terminology for the identification system is Secondary Surveillance Radar (SSR). The military Mode 3 uses the same formats as the civilian Mode A and is therefore called Mode 3/A. The IFF/SSR system operates in the following protocol modes:

Mode 1	Military mission identification code.
Mode 2	Military personal identification code.
Mode 3/A	Civil and military ATC identification code.
Mode 4	Military identification, using one of two cryptovariable code sets (A or B) to encode the transmission signals and decode the replies. Mode 4 is only available if cryptovariables have been loaded. (Loading of Interrogator cryptovariables is not cleared with SP3C/15).
Mode C	Civil and military aircraft barometric altitude information.
Mode S (Level 2 Basic Surveillance)	Civil and military cooperative, surveillance and data link system for Air Traffic Management (ATM). Each Mode S equipped aircraft is assigned a unique address which allows interrogations to be directed to a specific aircraft.

In addition to the common modes there are the following specific modes to the Interrogator and the Transponder:

INTERROGATOR MODING

MANUAL AND AUTOMATIC INTERROGATIONS

Tracks may be interrogated either manually or automatically.
Plots may be interrogated manually by Area/Sector interrogation (not available at SP3).

AUTOMATIC INTERROGATION (AUTOSPECIFIC OPERATION)

Autospecific interrogation is used to automatically interrogate new initiated radar tracks until a satisfactory response is received or the system failure criteria are met. The track is then classified, i.e. the track allegiance on the Attack, Elevation and Pilot Awareness formats is updated, but the response information is not displayed to avoid display clutter. The pilot can re-interrogate tracks manually at any time if confidence is lost in the track or for any other reason, see below.

NOTE

> When radar achieves lock from an ACM selection, the IFF interrogator automatically interrogates the resulting track whether AUTO SPFC is selected or not.

If the IFF is in Silent mode (stealth moding) when the ACM is selected, it is automatically set to NORM. If ACM is subsequently cancelled by break lock, the IFF returns automatically to Silent mode. If ACM is cancelled by selecting another radar mode (e.g. TWS), the IFF and the radar remain in NORMal mode. To return to Silent mode the MDEF XMIT moding keys must be selected manually (displayed automatically when the new radar mode is selected).

MANUAL INTERROGATION

Manual interrogations are carried out in the following three ways:

SINGLE TRACK INTERROGATION

Track interrogation by positioning the XY cursor on the track and pressing the stick top IFF interrogate button. The successful response will be used to update the track allegiance, on the Attack, Elevation and Pilot Awareness formats. The response information from the track is displayed on the AF when it received and then for a further 5 seconds. Note, if the radar is locked to a track, IFF can be carried out directly by IFF interrogate press - there is no need to identify the track with the XY cursor.

SECTOR/VOLUME INTERROGATION

Sector interrogation (not available at SP3) is used to interrogate objects in a defined search area/sector, which are not tracked by the radar. To interrogate a sector place the XY cursor on an empty space on the AF and press the IFF Interrogate button on the Stick Top Controller. The sector will be displayed on the AF for 2 seconds to indicate that the sector has been selected and to select another sector size before the sector occults. Note that interrogation over a TGS will also perform a sector interrogation. The 25% and 50% areas are nominally centered on the position defined by the XY cursor. The areas are selected sequentially, first press of the button giving 25%, second 50%, and third press the full screen. The sector width depends on the Azimuth Scan Coverage selected on the radar. With area interrogation no radar track data correlation will be performed, therefore pure IFF-plots will appear which will be displayed for about 5 seconds. Correct responses are displayed as green circle IFF plots (friendly), all other replies as rectangular orange IFF plots (unknown).

ALL TRACKS INTERROGATION

The INT ALL function on the MDEF INT SSK keyset will specifically interrogate all existing A/A radar tracks held within the system and within scan coverage for one time until a satisfactory response is received or the system failure criteria are met. Depending on the amount of tracks this interrogation may take some seconds. Response information for each track will then be displayed for about 5 seconds and INT ALL will be deselected automatically. A manual track interrogation will interrupt the INT ALL function and will be continued when the manual track interrogation is finished.

AUTOMATIC CODE CHANGE

This facility enables automatic selection and use of Mode 1 and 3A codes, with the codes automatically changing at pre-defined times. The code set to be used, the start time, and the time interval between changes are loaded via PDS. The Mode 1 and 3A codes in use at the time, and the time remaining for operation in ACC, are shown on the MDEF ROLS if the CODE INFO moding key is selected. If no ACC codes have been loaded, or the ACC time is invalid, the ACC/MAN moding key is occulted and ACC mode cannot be selected. If codes have been loaded, and ACC time is valid, but ACC has not been selected, a prompt is displayed on the Autocue format in GND POF. A voice warning prompt ("INTERROGATOR ACC AVAILABLE") is given when in NAV and AA POF if the ACC conditions become valid and whenever there is a change between these POF during flight and ACC is available but not selected.

If ACC codes have been loaded for only one mode then the other mode will automatically be forced into active decode operation, see below.

ACTIVE DECODE

If the Active Decode facility is selected (ACTV DCDE), the received Mode 1 and 3A codes are shown on the Attack Format as 2 digit (mode 1) and 4 digit (mode 3A) readouts adjacent to the associated track symbol or plot when a manual interrogation has been selected. The readouts occult after 5 secs.

The response codes of targets or tracks which have been interrogated in Mode 2 are not displayed.

Active decode may be used for both specific and area interrogations.

FORCED ACTIVE DECODE

When no codes have been loaded for mode 1 or 3A then Active Decode will be automatically initiated for the modes which do not have codes defined since comparison with interrogation codes is not possible.

Forced Active Decode responses will not provide identity inputs to the correlation process for tracks or plots. The Forced Active Decode selection will not be indicated via the MDE.

MODE 4 (LOADING OF CRYPTO VARIABLES NOT CLEARED)

Mode 4 uses codes based on one of two crypto sets (A or B) stored within the system. The desired set is selected by sequential presses of the Mode 4 MK. Cryptovariable data may be erased in emergencies or when not required anymore via the Secure Data Erase switch and will be erased automatically on ejection.

When Mode 4 is selected and the transponder replies correct to a challenge this will be indicated on the Attack Format for a minimum of 1 second. This indication can be deselected using the XY controller on the Mode 4 response icon.

When Mode 4 is selected and the interrogator receives an incomplete Mode 4 response this is indicated with the associated track, target, or IFF plot on the Attack Format by the characters “MODE4”.

A truncation function stops Mode 4 interrogations when the reply is correct to minimize the enemy's ability of analyzing the used crypto codes.

NOTE

> NATO operating procedures currently restrict the use of Mode 4 with other mode selections to C2 units, AEW units and CRCs, and inhibits Mode 4 sector interrogations. However the system selection of Mode 4 with other modes will not be inhibited since NATO operational procedures may change.

IFF TRAINING MODE (NOT AVAILABLE AT SP3C)

A training mode is implemented, allowing the use of IFF responses from interrogated tracks to change the display of allegiance of specific tracks. The facility is accessed through the MDEF on the second page in the INT sub-system. The training mode selection will only be available when Mode 1 and ACTV DCDE is selected.

To cancel training mode deselect either training mode, or ACTV DCDE, or Mode 1, or clear one or both training codes.

PREBRIEFED TRAINING MODE

The pilot may enter (manually, or via PDS) two Mode 1 codes, one for exercise "friendlies", and one for "hostiles" - termed fakers. In flight, when training mode has been selected, the weapons system will display all those tracks responding with the friendly squawk as Friendlies, those with the faker squawk as Hostiles, and all other tracks as Unknowns.

TARGET OF OPPORTUNITY TRAINING MODE

If defined opponents are not available (no codes loaded), the TOO training mode will display tracks as friendly if that transponds with the defined “friendly” training code. All other tracks will be displayed as hostile.

PILOT IDENTITY OVERRIDE

The pilot may override the system defined identity of a track using the XY controller with the Pilot Identity Override icon on the Attack Format.

DEFAULT MODING

On initial power up, several modes are automatically selected as default; the pilot may change these at any time, and the revised settings are retained for use thereafter. The default mode selections are:

- NORM (transmission inhibit by WoW on GND)
- Mode 1
- Mode 3A
- 1/3A CODE (MDE DEK & ROL are configured for manual entry of mode 1 and 3 codes)
- MANual (ACC/MAN MK is not present if ACC codes are not loaded or no longer valid. System will operate in MAN mode.)
- AUTO SPFC

All other modes are deselected.

TRANSPONDER MODING

AUTOMATIC CODE CHANGE

This facility enables automatic selection and use of Mode 1 and 3A codes, with the codes automatically changing at pre-defined times. The code set to be used, the start time, and the time interval between changes are loaded via PDS. The Mode 1 and 3A codes in use at the time, and the time remaining for operation in ACC, are shown on the MDEF ROLS if the CODE INFO moding key is selected. If no ACC codes have been loaded, or the ACC time is invalid, the ACC/MAN moding key is occulted and ACC mode cannot be selected. If codes have been loaded, and ACC time is valid, but ACC has not been selected, a prompt is displayed on the Autocue format in GND POF. A voice warning prompt ("TRANSPONDER ACC AVAILABLE") is given

when in NAV and AA POF if the ACC conditions become valid and whenever there is a change between these POF during flight and ACC is available but not selected.
If codes have only been loaded for one mode then the ACC operation will only apply for this mode.

MODE S (LEVEL 2 BASIC SURVEILLANCE)

The Mode S will allow to interrogate more data from specific aircraft which can include:

- Mode 3/A Code
- Mode C Barometric Altitude (-1000 to +126750 ft).
- Aircraft Registration Number or Aircraft Identification.
- Mode S Aircraft Address.
- On-Ground Indicator.
- Maximum Cruising True Airspeed.
- Data Link Capability Report.

MIL/CIV

Selects either the civil or military emergency code which will be transmitted by the Emergency function on the RHGS. The two modes are mutually exclusive, the default being MIL.
On ejection the system will transpond on the military code unless the unit is currently switched off (Front Seat only in Development Aircraft).

EMERGENCY

To transmit either MIL or CIV emergency distress codes select the EMGY button on the RHGS. The modes required for military emergency operation (Mode 1, 2, and 3) and for civil emergency operation (A and S) will be as selected via the MIL/CIV key. Stealth state and Stby will be overridden during that time. Upon deselection of the emergency mode the transponder will return to normal or STBY operation as selected.

NOTE

> The EMGY function is not available when transponder is switched OFF.

Upon ejection the IFF XPDR will automatically transpond on the military modes unless the unit is currently switched off (Front Seat only in Development Aircraft).

IDENTIFICATION

The Ident function (ID) will transpond in Mode 1, 2, 3A and S for about 20 seconds if this modes are selected, a minimum of one mode must be selected. When ID is re-triggered within that period the time is extended accordingly. Stealth state will be overridden during that time.

DEFAULT MODING

On initial power up, several modes are automatically selected as default; the pilot may change these at any time, and the revised settings are retained for use thereafter. The default mode selections are:

- SBY
- Mode 1
- Mode 2
- Mode 3A
- Mode 4A (when codes are loaded only)
- Mode C
- MIL
- 1/3A CODE (MDE DEK & ROL are configured for manual entry of mode 1 and 3 codes
- MANual (ACC/MAN MK is not present if ACC codes are not loaded or no longer valid. System will operate in MAN mode.)
- Mode 4 response icon on AF is set to ON

All other modes are deselected.

IDENTIFICATION SYSTEM MDE AND X-Y FUNCTIONS

The Identification system consists of the IFF Transponder and IFF Interrogator. Its equipment, modes of operation and controls and indicators are described in Identification System (IFF) pag. 80.
The following examples illustrate how the Transponder and Interrogator are controlled via the Manual Data Entry Facility (MDEF) and X-Y controller.
The modings relevant to the Transponder and Interrogator are accessed via their individual SSK - the XPDR SSK for the Transponder and INT SSK for the Interrogator. Information relevant to the Identification system is shown on the read out lines (ROL), the RGS Flap and various MHDD formats.

TRANSPONDER

On selection of the XPDR SSK the system defaults to that shown in Figure 8.47, and the pilot is able to perform the following functions:

- Select between the STANDBY and NORMAL mode (Figure 8.48)
- Select military mission identification code (Mode 1) (Figure 8.49)
- Select personal identification code (Mode 2) (Figure 8.50)
- Select military/civilian identification code (Mode 3A) (Figure 8.51)
- View code information (Figure 8.52)
- Select coded transmission (Mode 4A or 4B) (Figure 8.53)

- Select IFF own mode 4 response information between on and off (Figure 8.54)
- Select civil and military altitude information (Mode C) (Figure 8.55)
- Select military/civilian emergency code (Figure 8.56)
- Manually input information for Modes 1 and 3A (Figure 8.57)
- Select a specific 1/3A code for use (Figure 8.58)
- Select between the manual code change and automatic code change facility (Figure 8.59)
- Select Mode S (Figure 8.60).

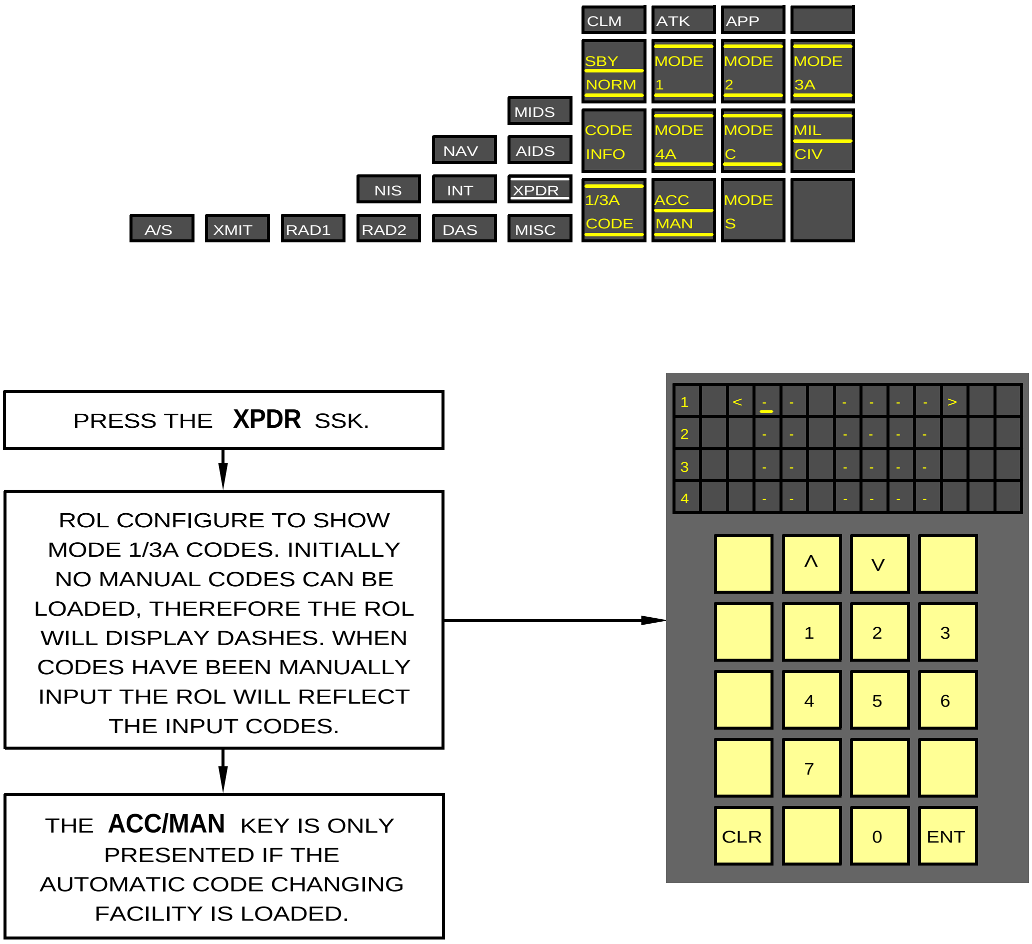


Figure 8.47 - Transponder Default Mode

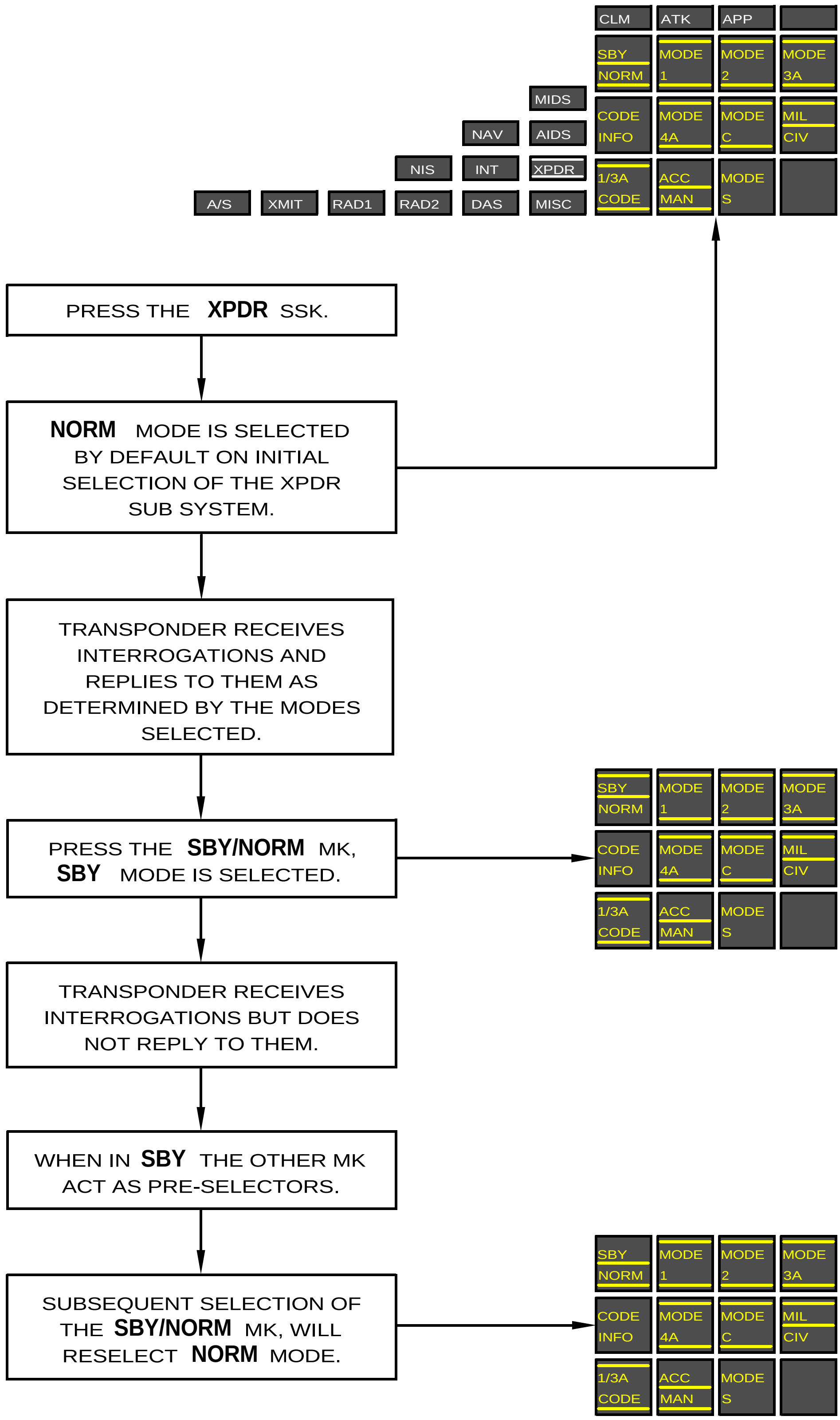


Figure 8.48 - Standby/Normal Mode Selection

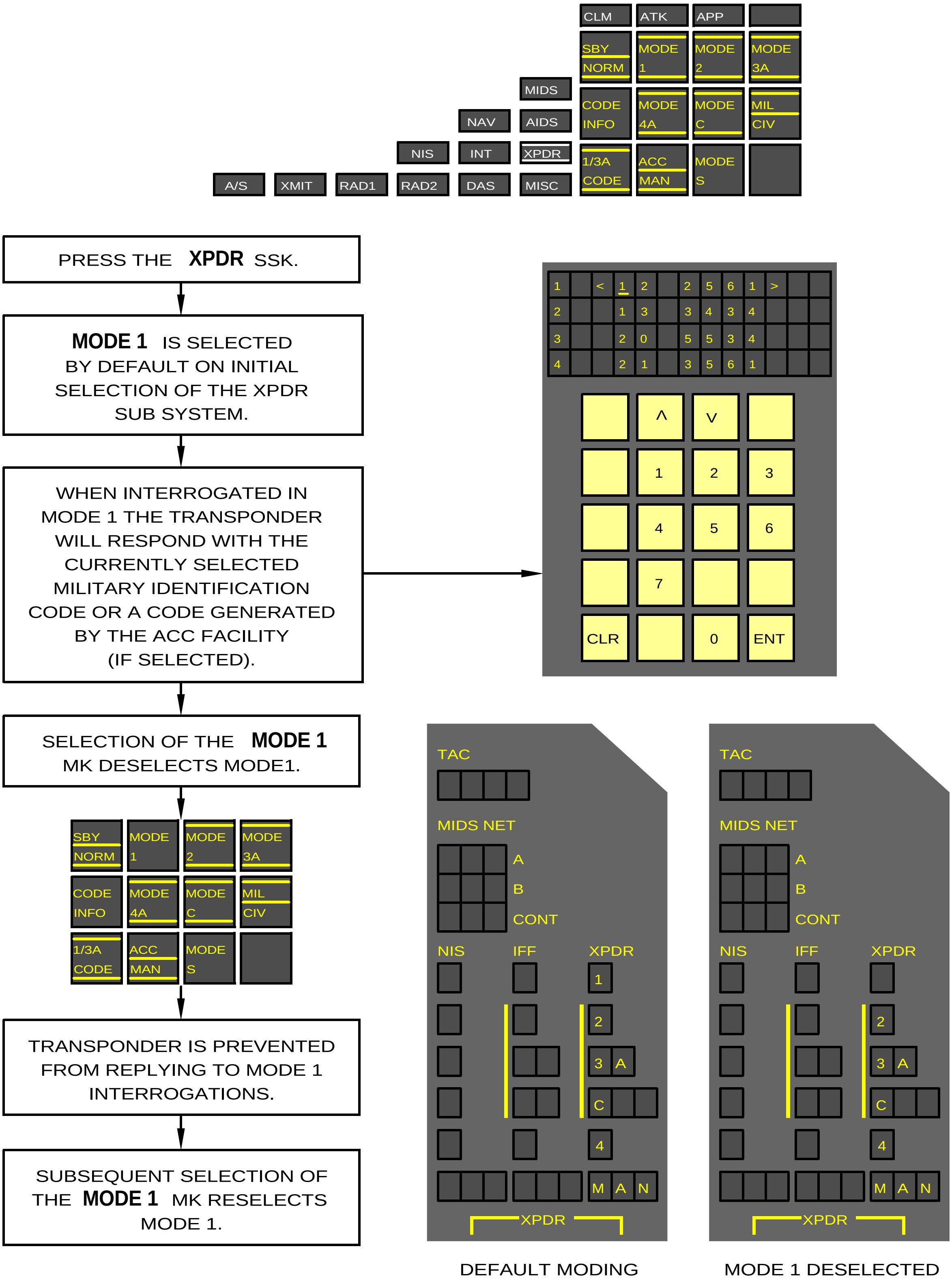
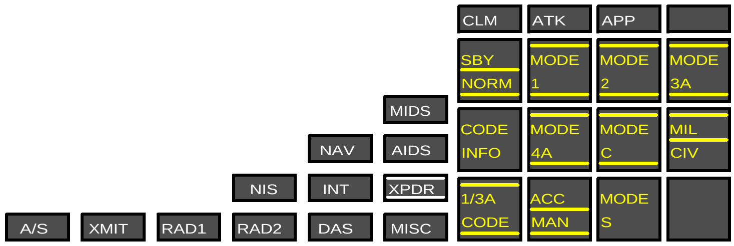


Figure 8.49 - Military Identification (Mode 1)



PRESS THE **XPDR** SSK.

MODE 2 IS SELECTED BY DEFAULT ON INITIAL SELECTION OF THE XPDR SUB SYSTEM.

WHEN INTERROGATED IN MODE 2 THE TRANSPONDER WILL RESPOND WITH THE AIRCRAFTS PERSONAL IDENTIFICATION CODE.

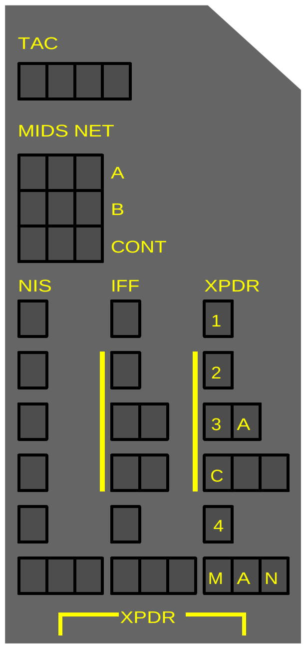
SELECTION OF THE **MODE 2** MK DESELECTS MODE 2.

TRANSPONDER IS PREVENTED FROM REPLYING TO MODE 2 INTERROGATIONS

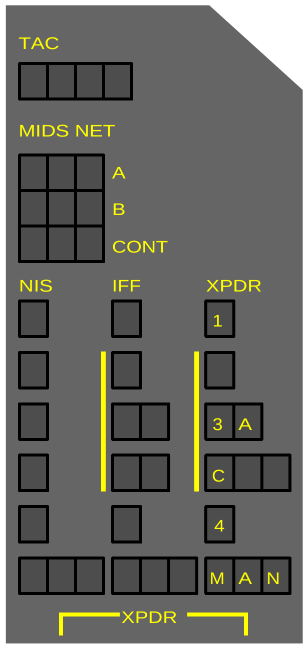
SUBSEQUENT SELECTION OF THE **MODE 2** MK RESELECTS MODE 2.

NOTE

MODE 2 IS LOADED INTO THE SYSTEM BY THE GROUNDCREW. IT CANNOT BE ENTERED OR ALTERED BY THE AIRCREW.



DEFAULT MODING



MODE 2 DESELECTED

Figure 8.50 - Personal Identification (Mode 2)

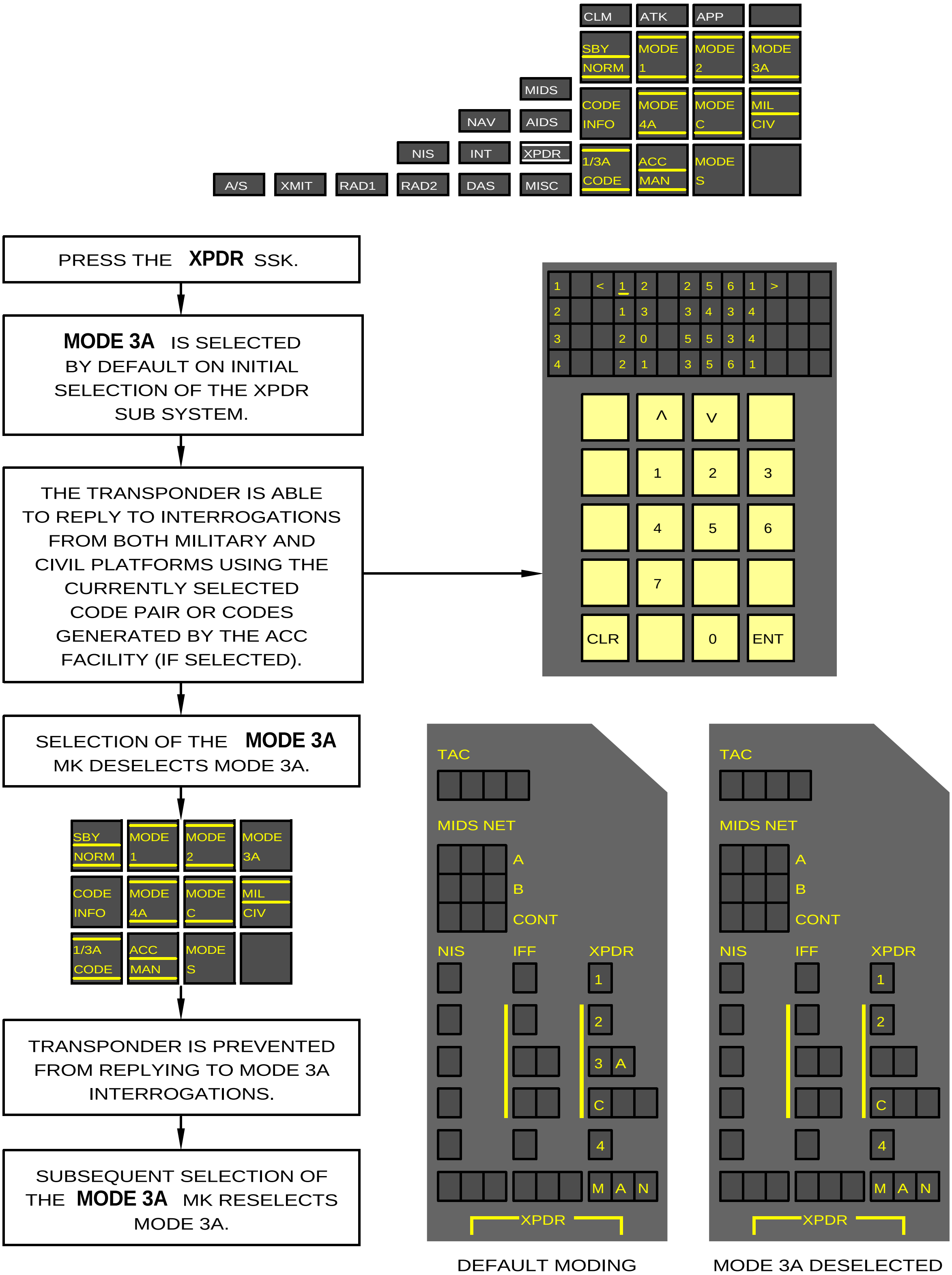
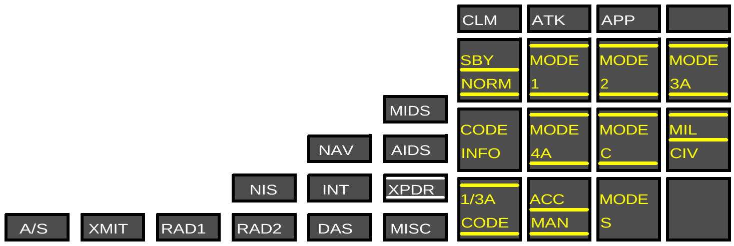
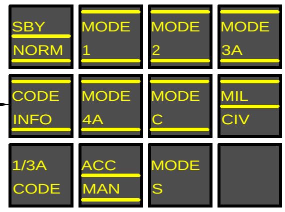


Figure 8.51 - Military/Civil Identification (Mode 3A)

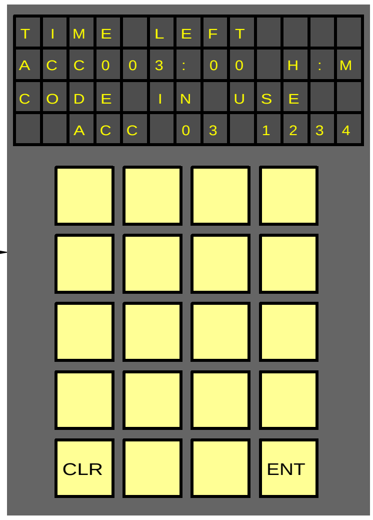


PRESS THE **XPDR** SSK.

PRESS THE **CODE INFO** MK. 1/3A CODE MK IS DESELECTED AS A CONSEQUENCE.

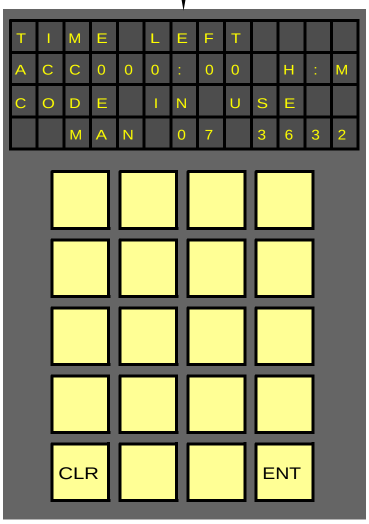


DEK AND ROL CONFIGURE TO SHOW **ACC** TIME REMAINING AND THE CURRENT CODE PAIR IN USE.



ROLS WILL BE UPDATED AS THE CODE CHANGES.

IF ALL CODES HAVE BEEN USED OR NO CODES EXIST, ZEROS WILL REPLACE THE VARIABLE DATA.



NOTE

IF CODE INFO IS DESELECTED A 'NO MODE' STATE WILL BE ENTERED AND THE DEK AND ROL WILL BE BLANKED.

Figure 8.52 - View Code Information

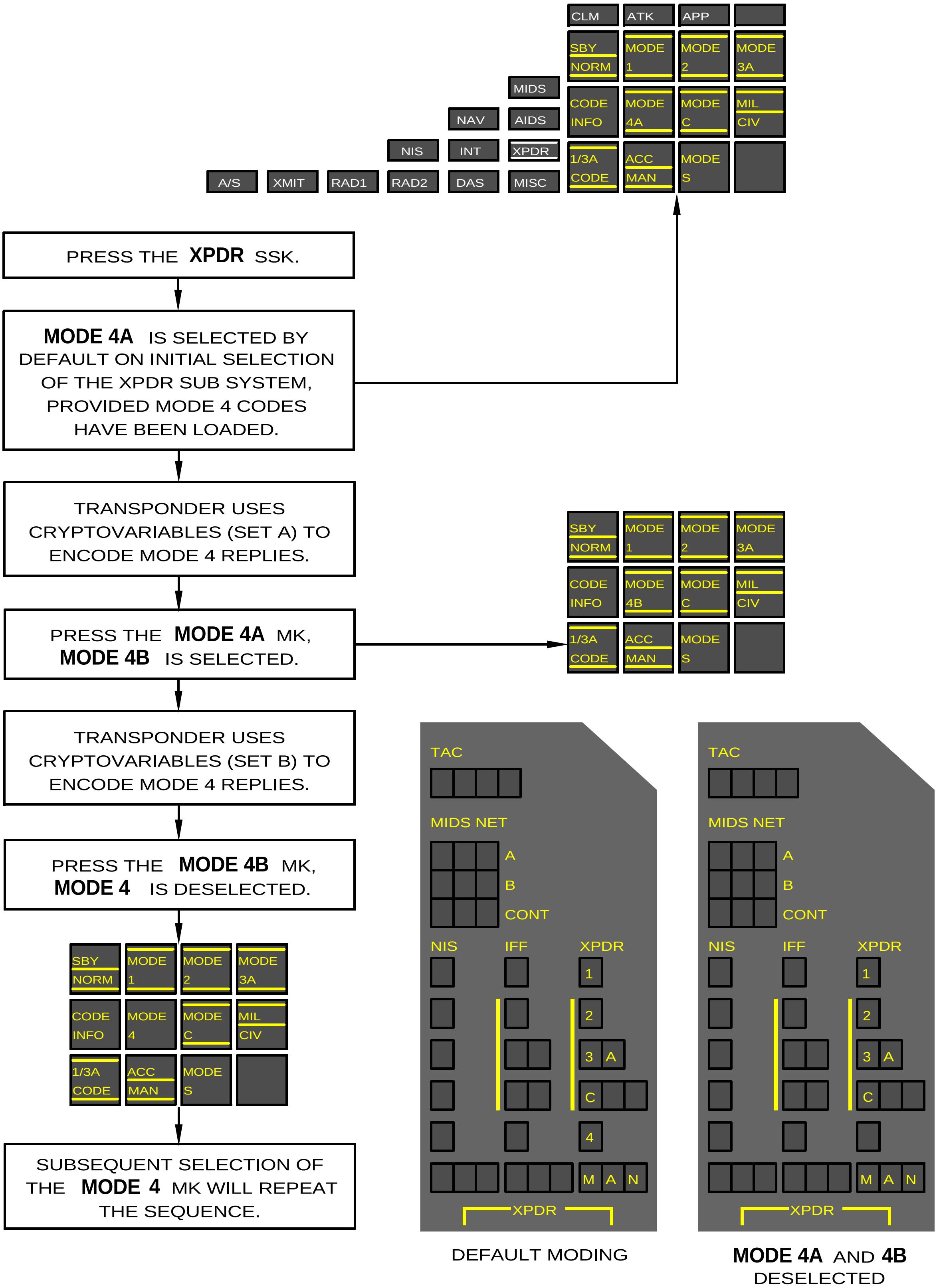


Figure 8.53 - Coded Transmission (Mode 4)

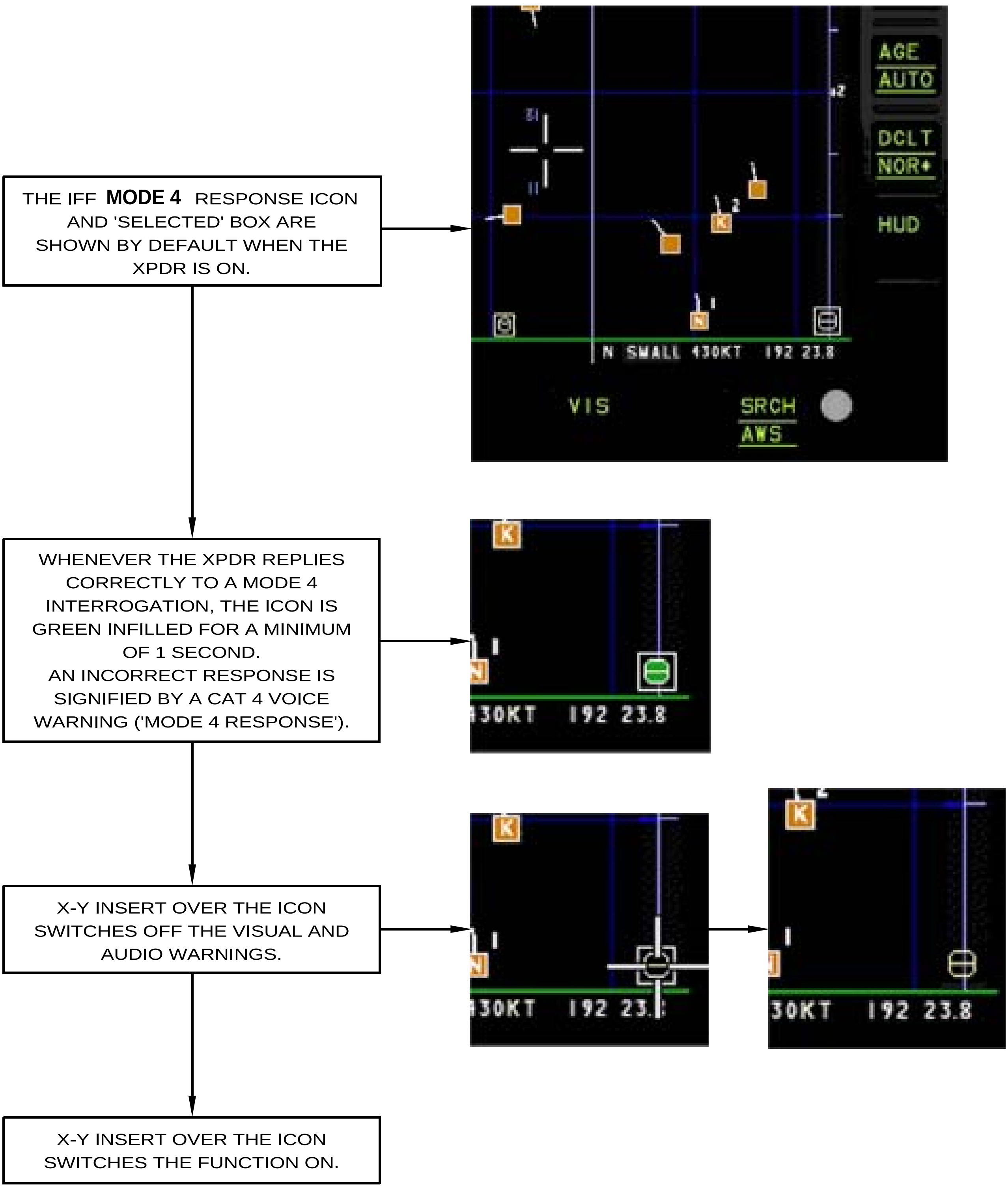


Figure 8.54 - IFF Own Mode 4 Response

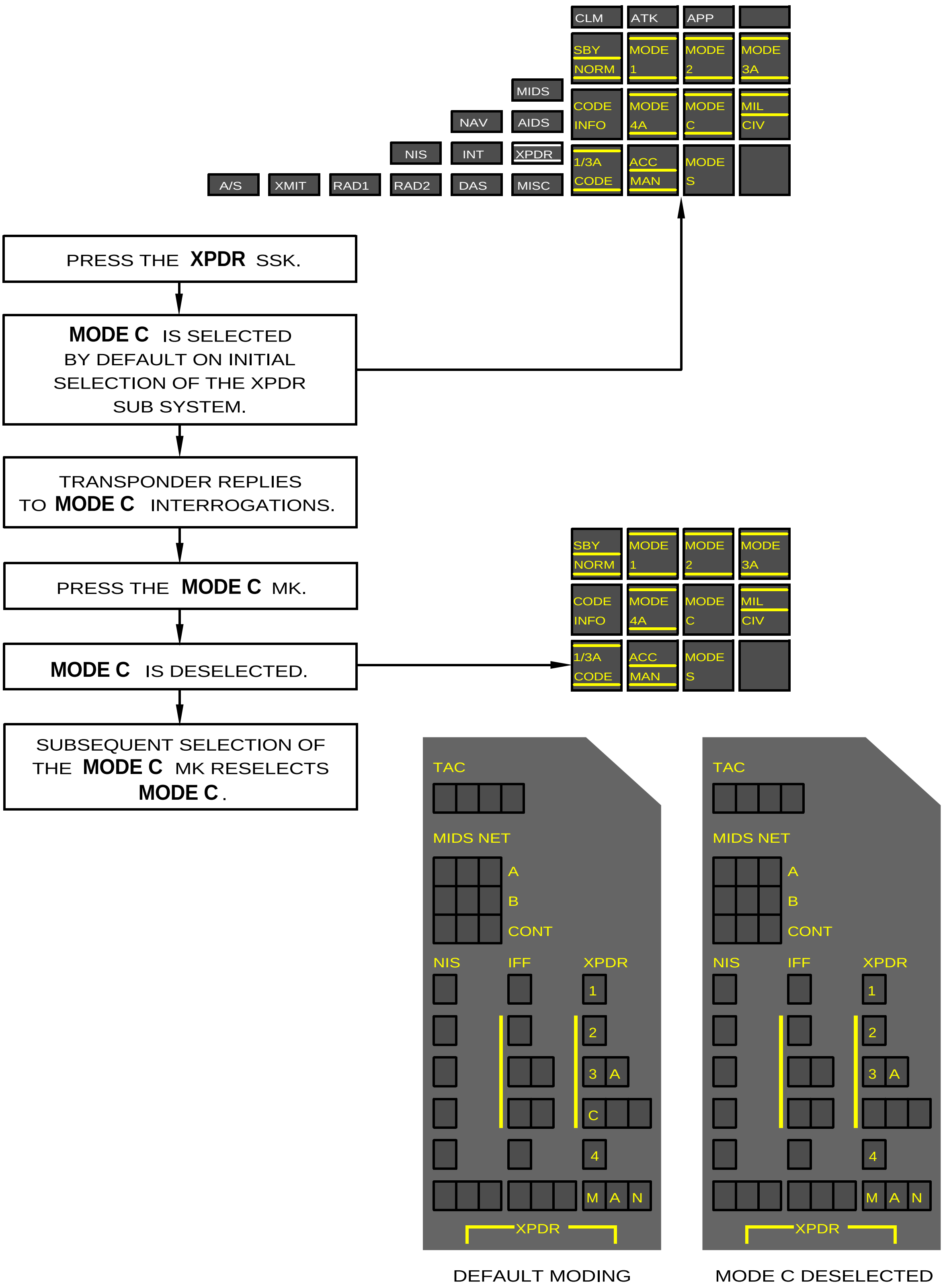


Figure 8.55 - Altitude (Mode C)

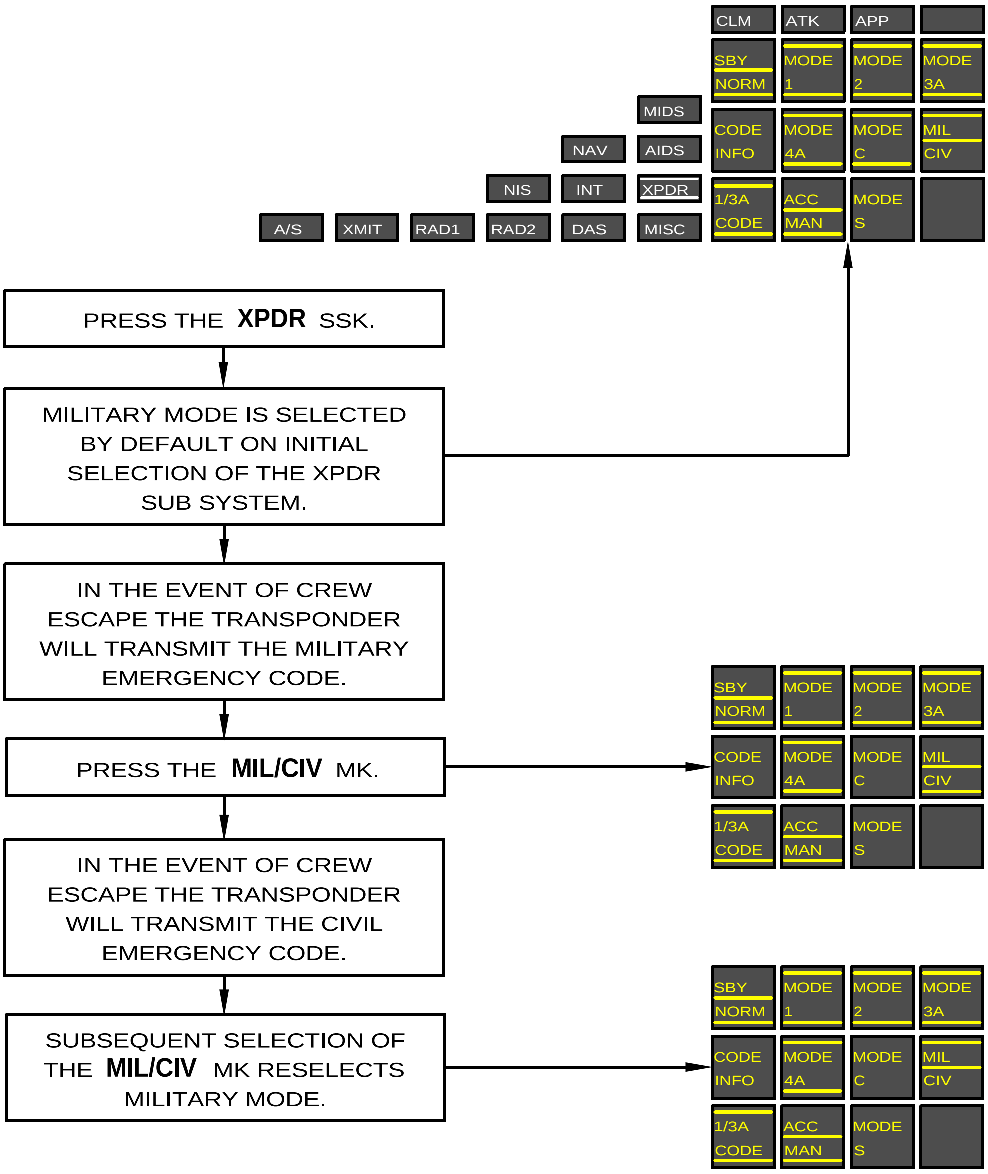


Figure 8.56 - Military/Civil Emergency Code Selection

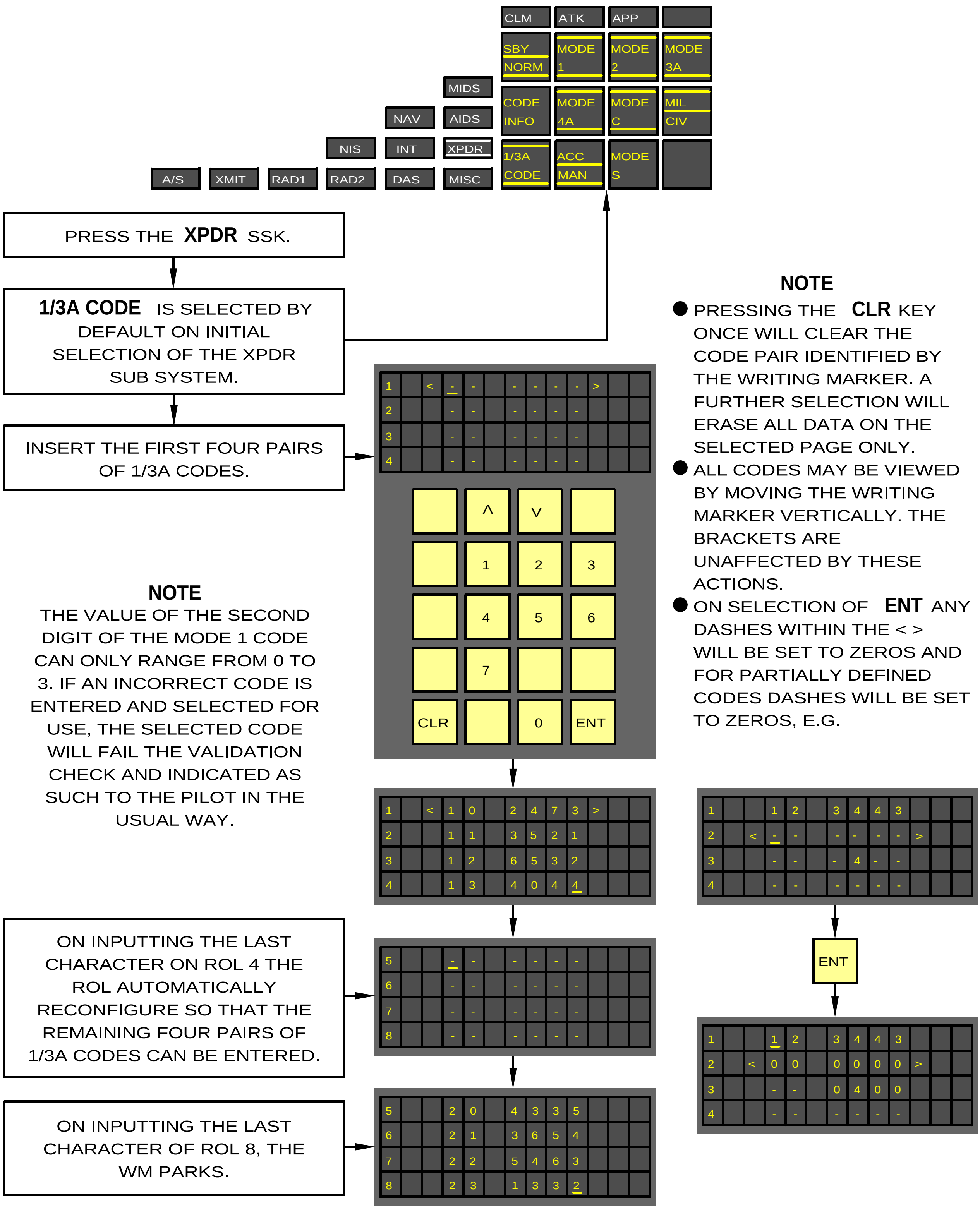
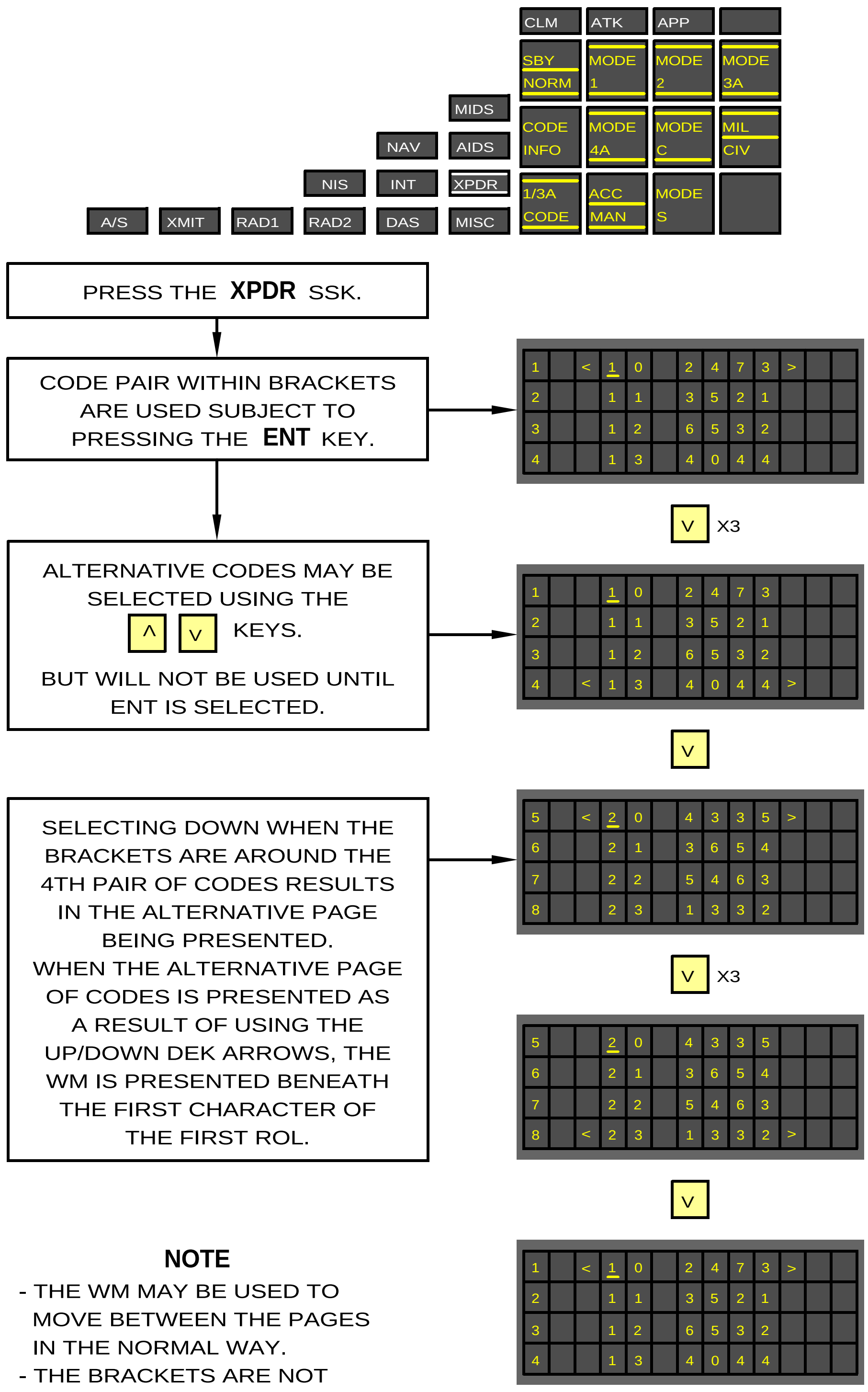


Figure 8.57 - 1/3A Code Input



NOTE

- THE WM MAY BE USED TO MOVE BETWEEN THE PAGES IN THE NORMAL WAY.
- THE BRACKETS ARE NOT AFFECTED BY THE MOVEMENT OF THE WM.
- THE WM WILL ALWAYS BE SHOWN ON THE ROL PAGE IN VIEW, WHEREAS THE BRACKETS MAY NOT.

Figure 8.58 - 1/3A Code Selection

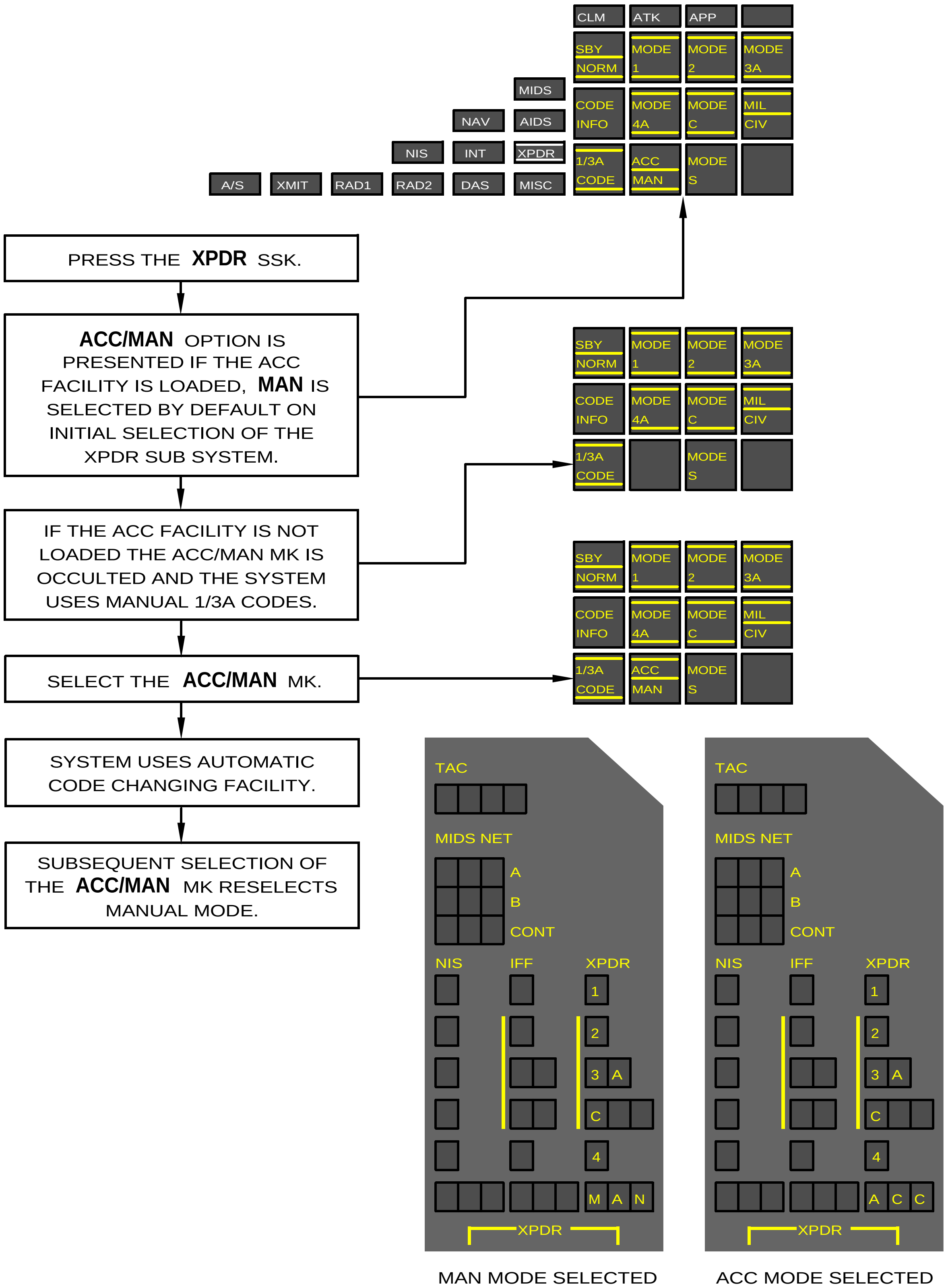


Figure 8.59 - Manual/Automatic Code Selection

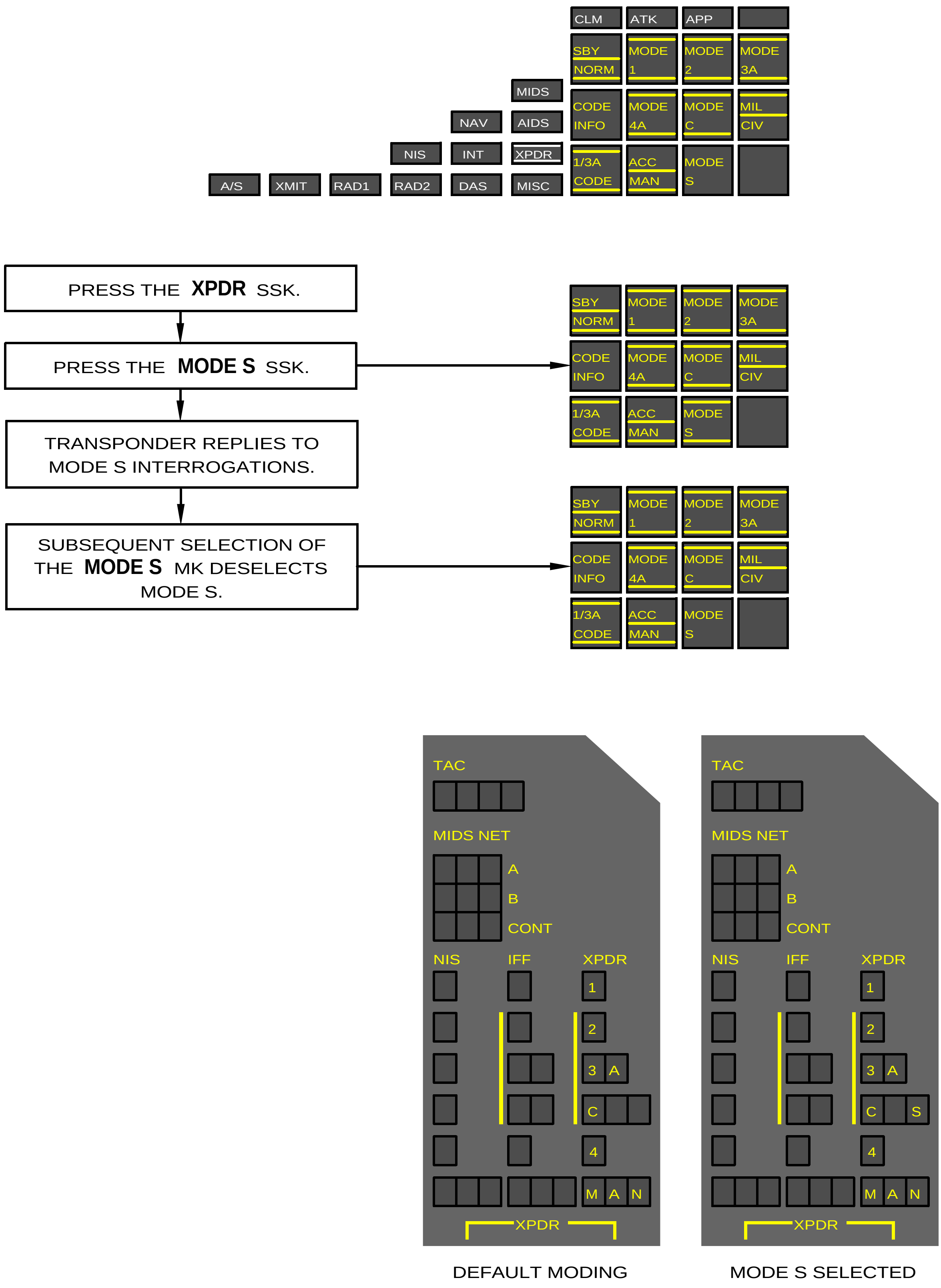
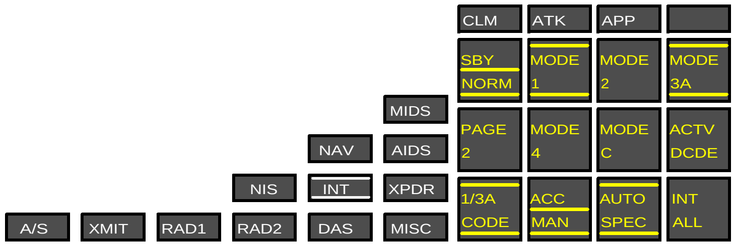


Figure 8.60 - Mode S Selection (ATC)

INTERROGATOR

On selection of the INT SSK the system defaults to that shown in Figure 8.61, and the pilot is able to perform the following functions:

- Select between the STANDBY and NORMAL mode (Figure 8.62)
- Request military mission identification code (Mode 1) (Figure 8.63)
- Request personal identification code (Mode 2) (Figure 8.64)
- Request military/civilian identification code (Mode 3A) (Figure 8.65)
- View code information (Figure 8.66)
- Request coded transmission (Mode 4A or 4B) (Figure 8.67)
- Request civil and military altitude information (Mode C) (Figure 8.68)
- Manually input information for Modes 1 and 3A (Figure 8.69)
- Select a specific 1/3A code for use (Figure 8.70)
- Select between the manual code change and automatic code change facility (Figure 8.71)
- Perform automatic interrogation of tracks (Auto Specific Interrogator operation) (Figure 8.72)
- Perform a manual interrogation on a selected track (Figure 8.73)
- Perform a manual interrogation on a volume in space (Figure 8.74)
- Display actual responded 1/3A codes from selected tracks (Active Decode) (Figure 8.75)
- Perform an interrogation on all tracks in the coverage area (Figure 8.76)

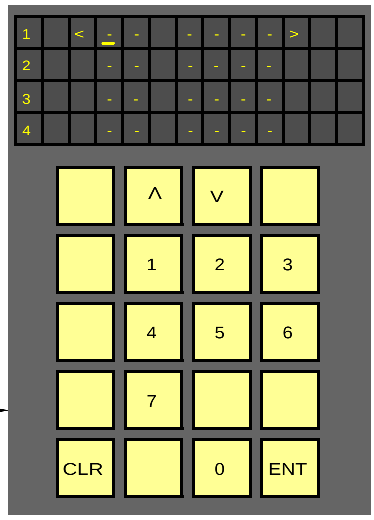


PRESS THE **INT** SSK.

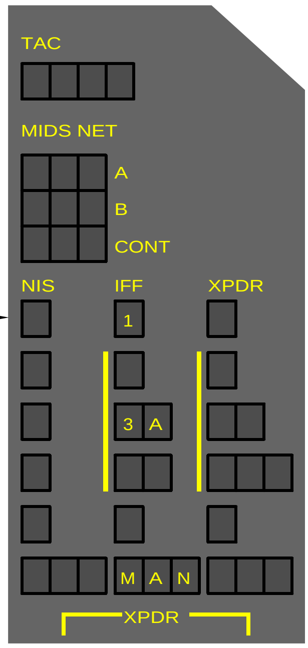
SYSTEM DEFAULTS INCLUDE:

- NORM MODE
- MAN MODE
- AUTO SPFC MODE
- MODE 1
- MODE 3A
- 1/3A CODE ENTRY.

DEK AND ROL CONFIGURE TO ENABLE MODE 1/3A CODE INSERTION.



CURRENT INTERROGATOR MODING IS ALSO DISPLAYED ON THE RGS FLAP.



DEFAULT MODING

NOTE

IF ACC IS NOT LOADED OR NO LONGER VALID, THEN THE **ACC/MAN** MK LEGEND IS NOT PRESENTED AND THE SYSTEM WILL OPERATE IN MAN MODE.

Figure 8.61 - Interrogator Default Moding

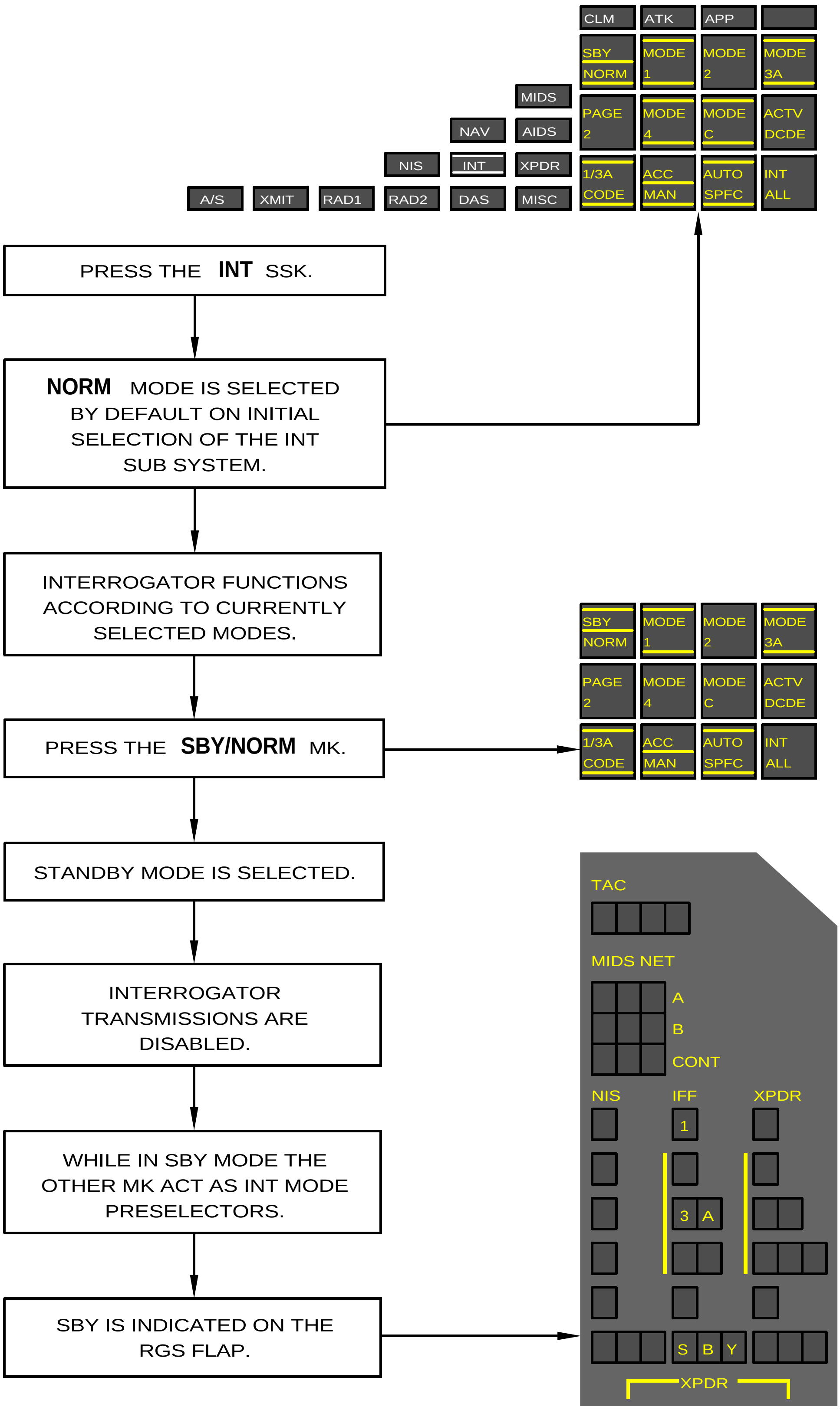


Figure 8.62 - Select Between Interrogator Normal and Standby Mode

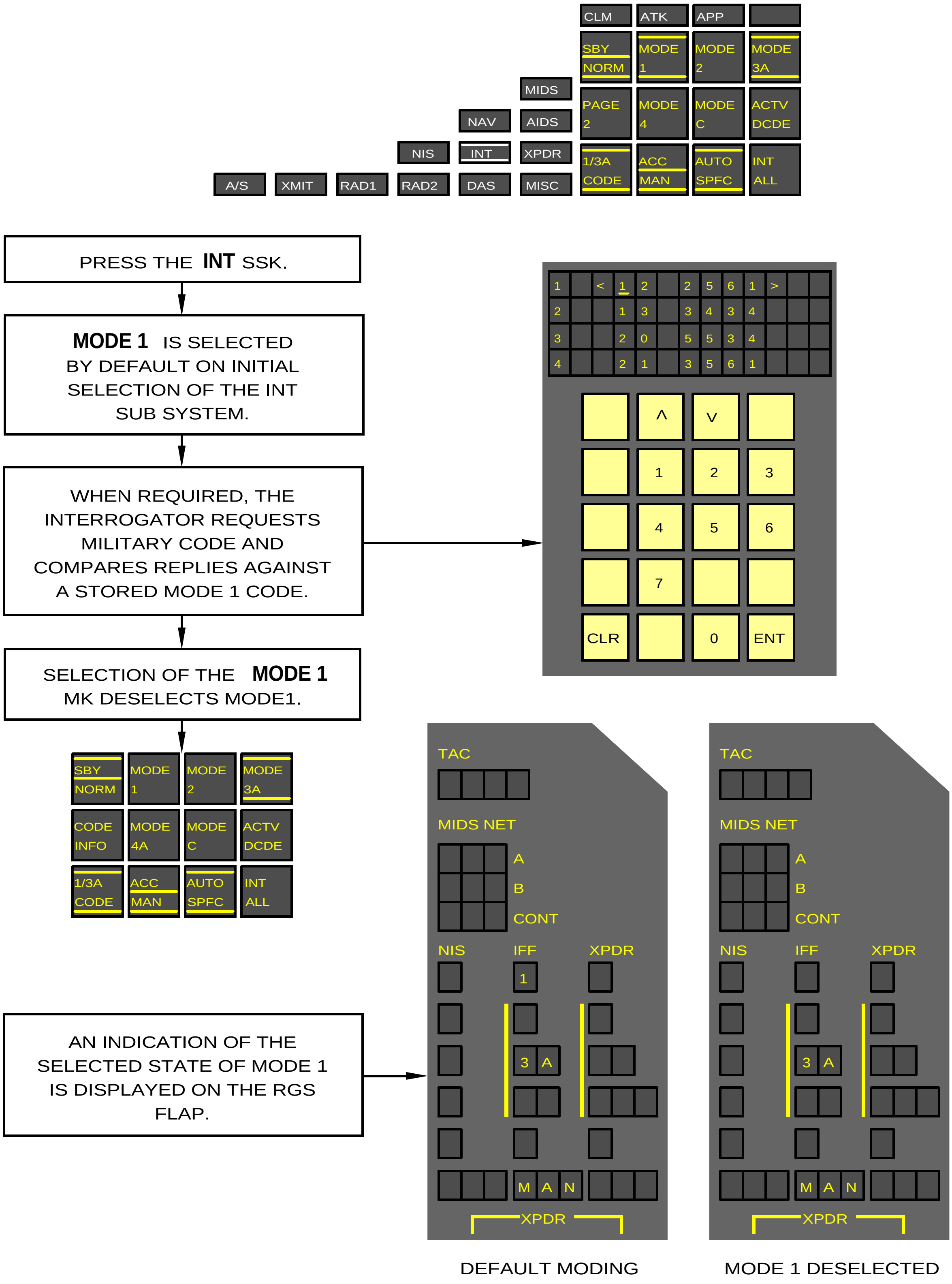
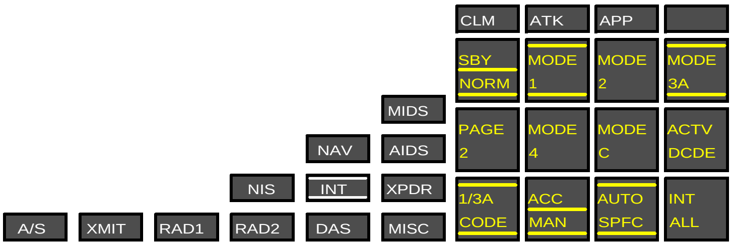
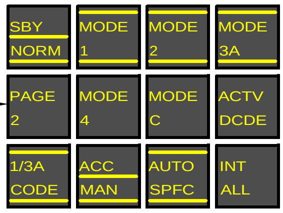


Figure 8.63 - Request Military Identification Code (Mode 1)



PRESS THE **INT** SSK.

PRESS THE **MODE 2** MK TO SELECT PERSONAL IDENTIFICATION MODE.



WHEN REQUIRED, THE INTERROGATOR REQUESTS PESONAL CODES AND ANALYSES RESPONSES.

SUBSEQUENT SELECTION OF THE **MODE 2** MK DESELECTS MODE 2.

AN INDICATION OF THE SELECTED STATE OF MODE 2 IS DISPLAYED ON THE RGS FLAP.

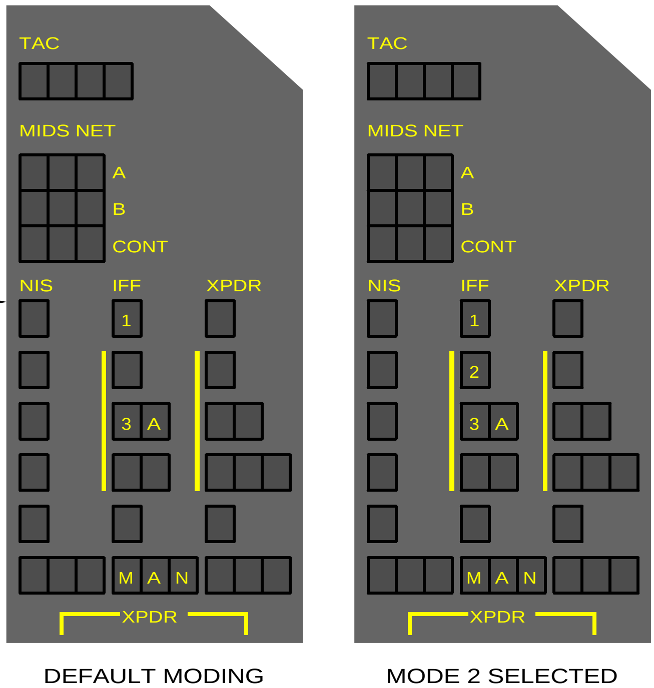
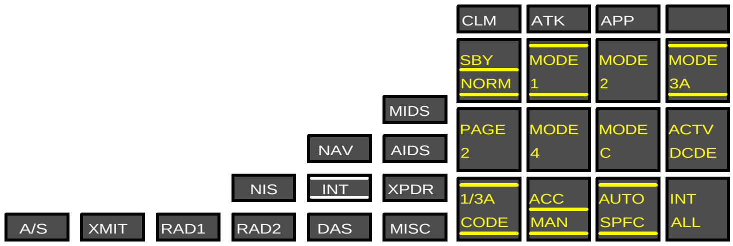


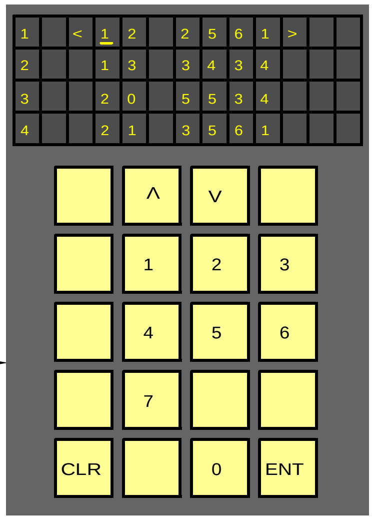
Figure 8.64 - Request Personal Identification Code (Mode 2)



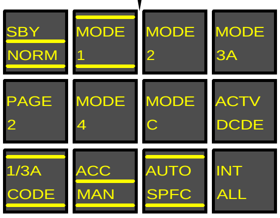
PRESS THE **INT** SSK.

MODE 3A IS SELECTED BY DEFAULT ON INITIAL SELECTION OF THE INT SUB SYSTEM.

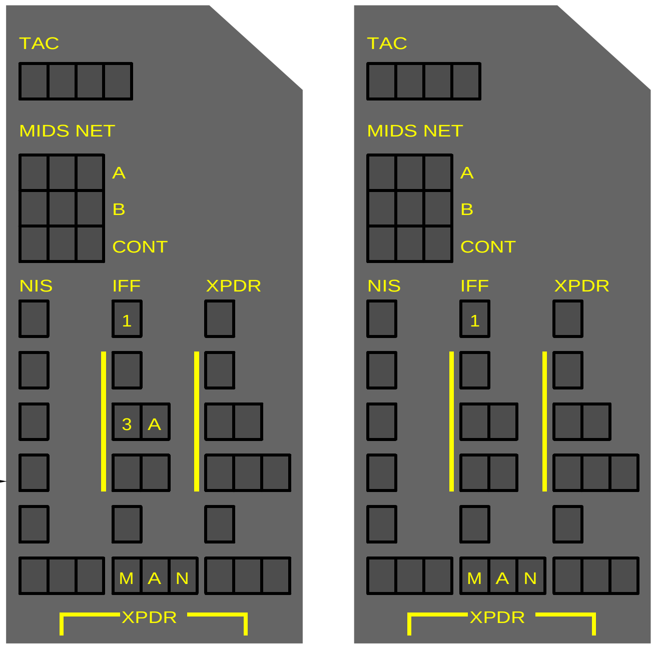
WHEN REQUIRED, THE INTERROGATOR WILL INTERROGATE BOTH MILITARY AND CIVIL PLATFORMS AND ANALYSE REPLIES AGAINST A STORED MODE 3A CODE.



SUBSEQUENT SELECTION OF THE **MODE 3A** MK DESELECTS MODE 3A.



AN INDICATION OF THE SELECTED STATE OF MODE 3A IS DISPLAYED ON THE RGS FLAP.



DEFAULT MODING

MODE 3A DESELECTED

Figure 8.65 - Request Military/Civilian Identification Code (Mode 3A)

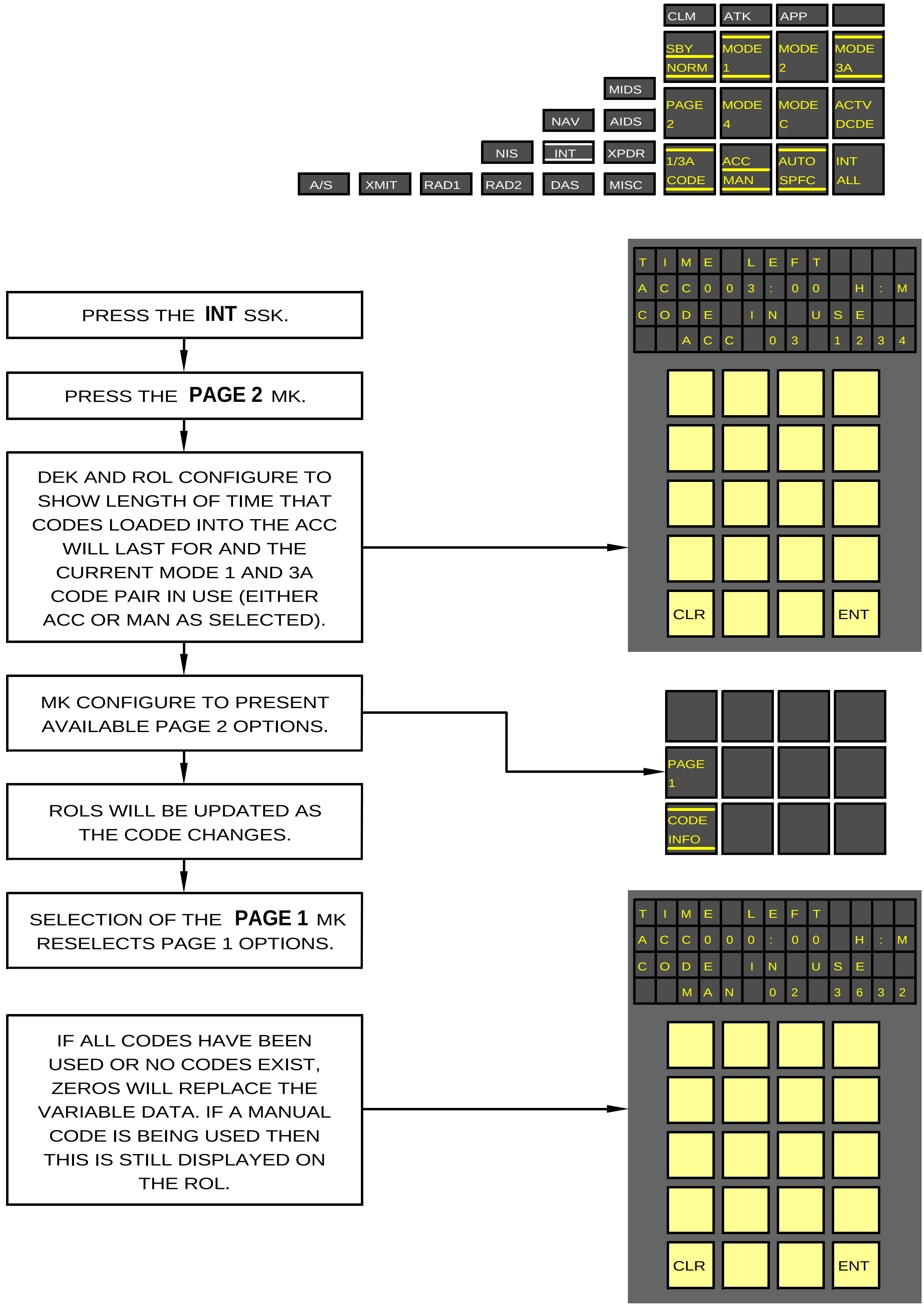


Figure 8.66 - View Code Information

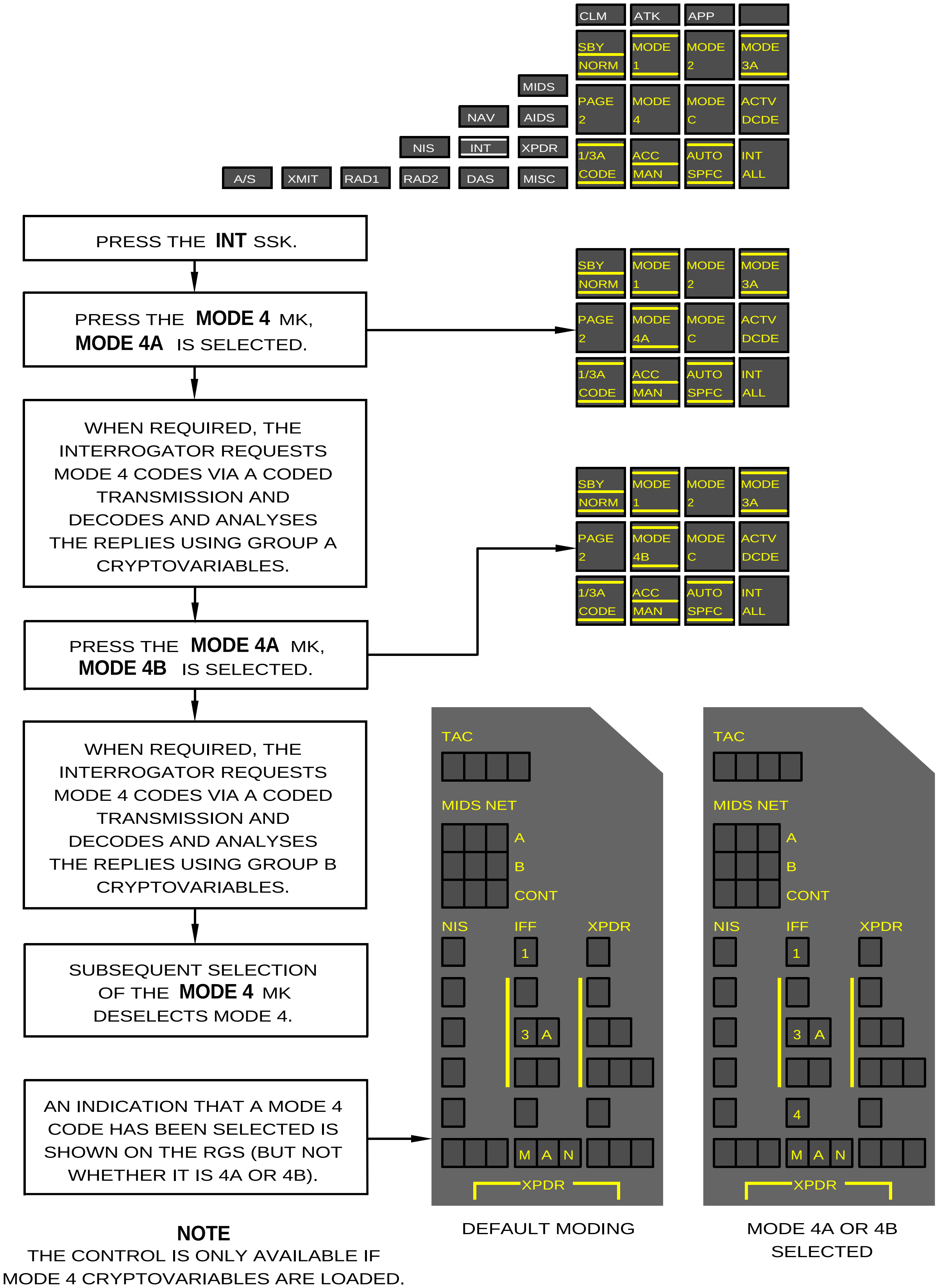


Figure 8.67 - Request Coded Transmission (Mode 4)

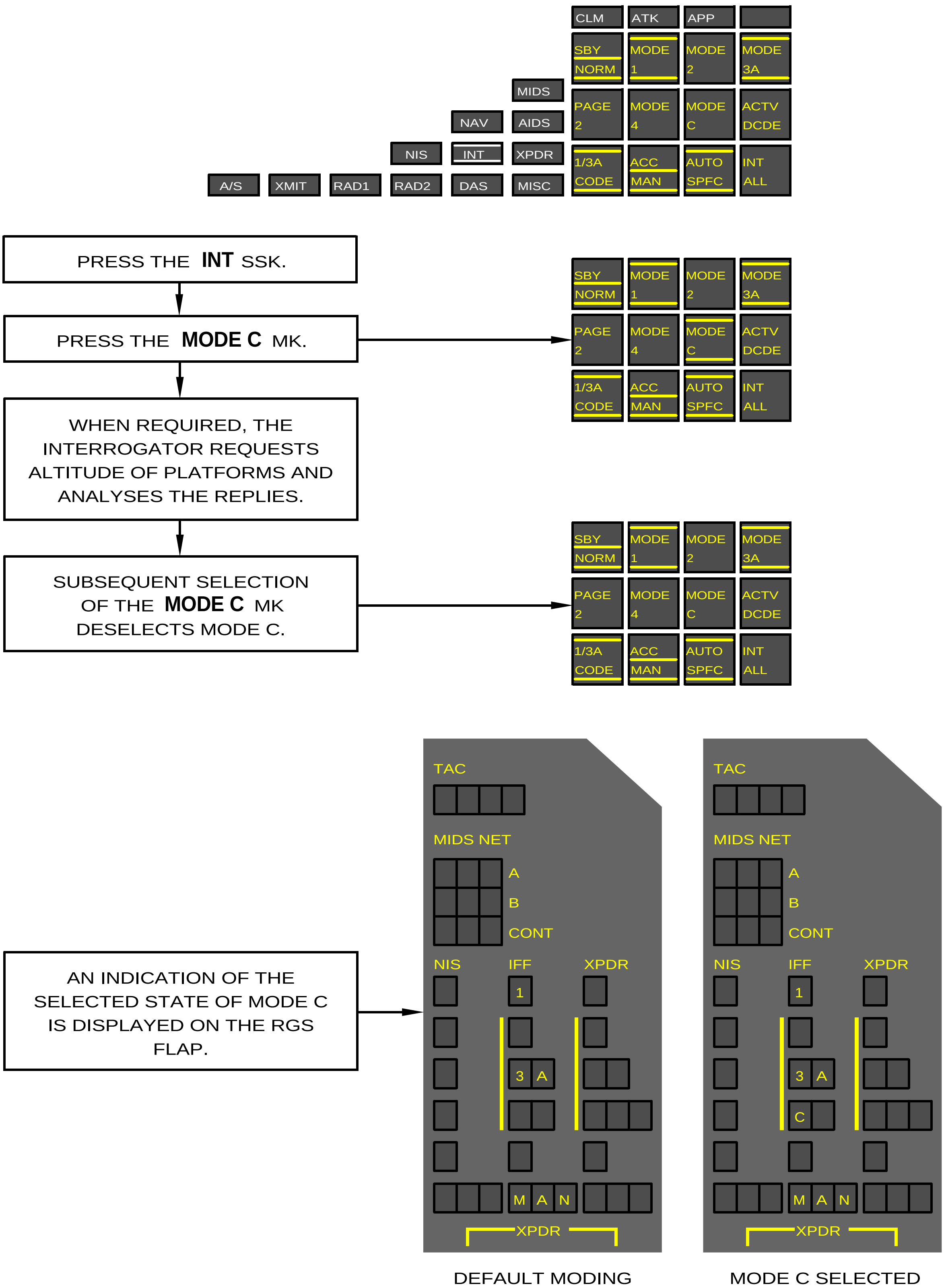


Figure 8.68 - Request Altitude (Mode C)

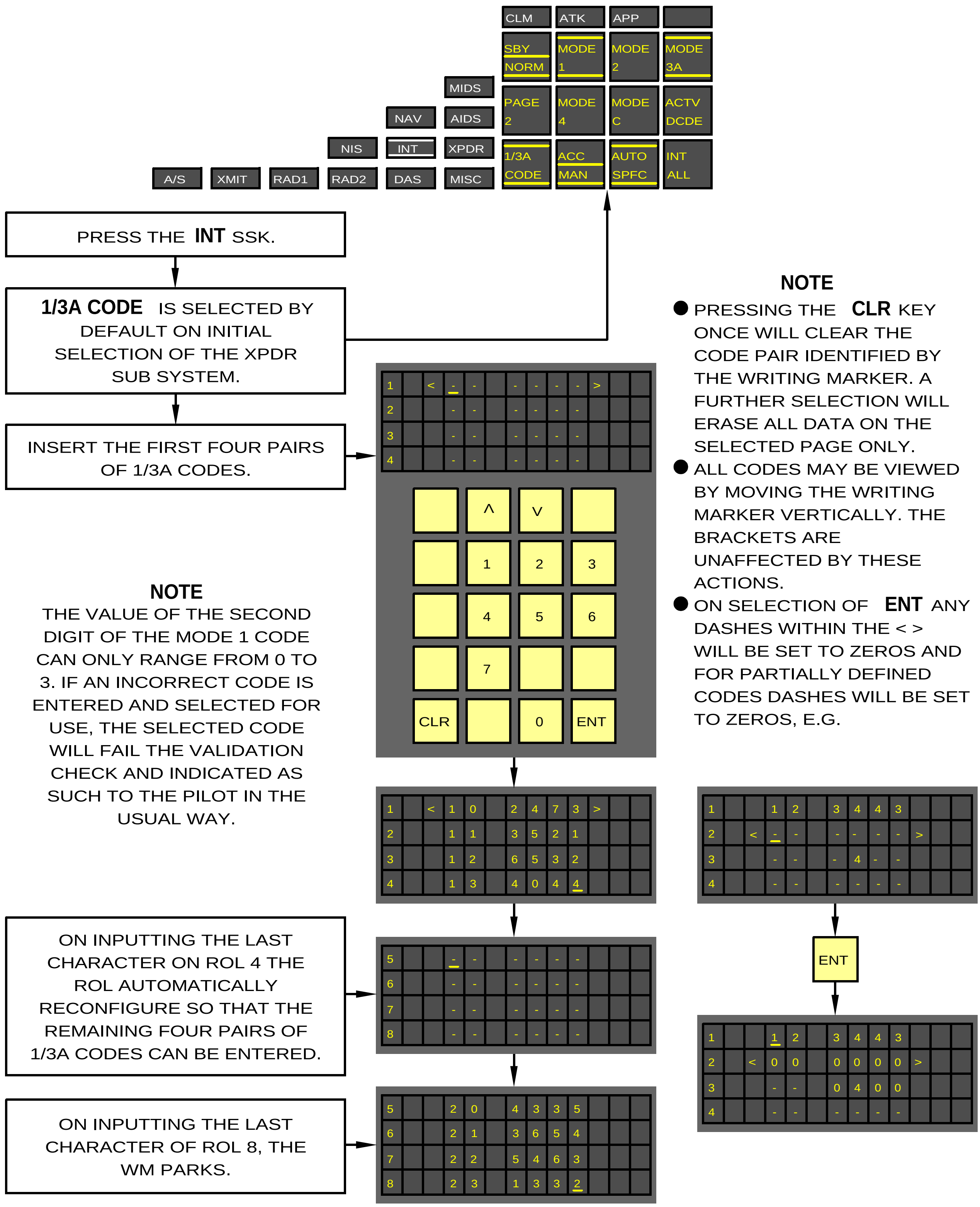


Figure 8.69 - Input 1/3A Codes

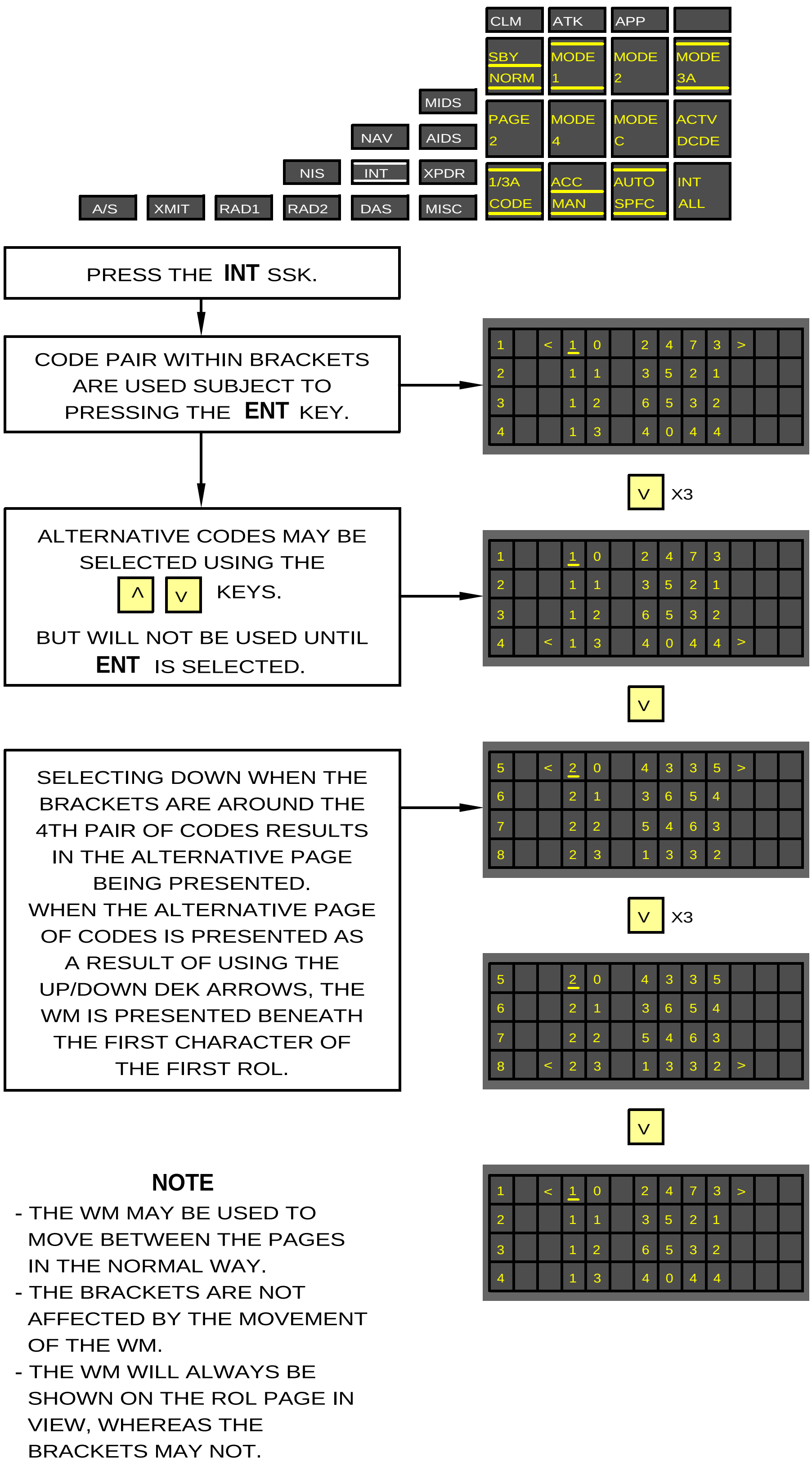


Figure 8.70 - Select 1/3A Codes

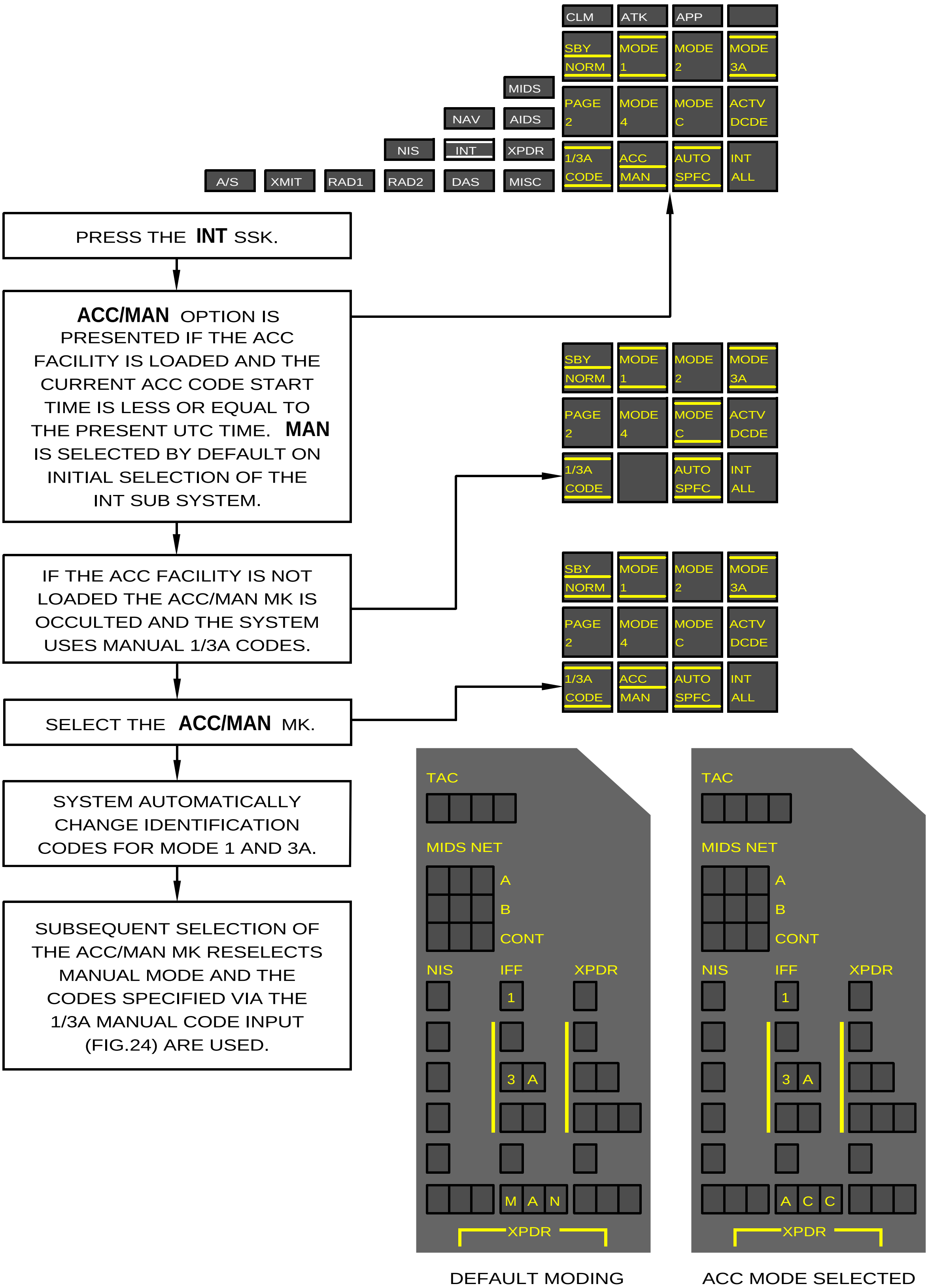
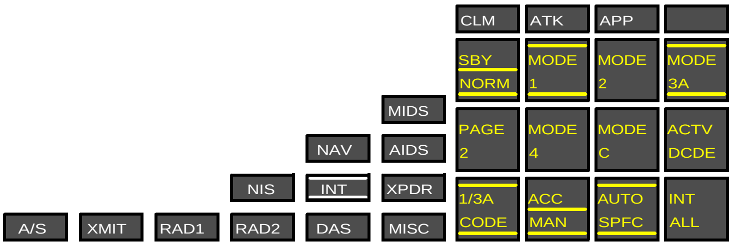


Figure 8.71 - Manual/Automatic Code Change Selection



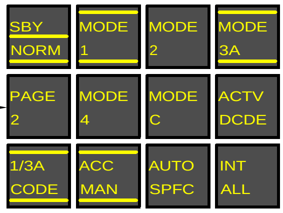
PRESS THE **INT** SSK.

AUTO SPFC OPTION IS SELECTED BY DEFAULT ON INITIAL SELECTION OF THE INT SUB SYSTEM.

INTERROGATIONS IN THE SELECTED MODES ARE INITIATED AUTOMATICALLY BY THE SYSTEM UNTIL A SATISFACTORY RESPONSE IS OBTAINED OR THE SYSTEM FAILURE CRITERIA ARE MET. SUCCESSFUL RESPONSES MAY BE USED TO UPDATE THE TRACK ALLEGIANCE ON THE **ATK**, **ELEV**, AND **PA** FORMATS IF PRE-DEFINED IFF SYSTEM CRITERIA ARE MET THAT DEEM THE TRACKS 'FRIENDLY', OTHERWISE THEY REMAIN AS 'UNKNOWN'. RESPONSE INFORMATION IS NOT DISPLAYED TO AVOID CLUTTER.

NOTE
'HOSTILE IDENTIFICATION IS NOT PROVIDED AT SP3C.

PRESS THE **AUTO SPFC** MK TO DESELECT THE FUNCTION.



SYSTEM WILL ONLY INTERROGATE WHEN MANUALLY INSTRUCTED BY THE PILOT.

SUBSEQUENT SELECTION OF THE **AUTO SPFC** MK RESELECTS THE FUNCTION.

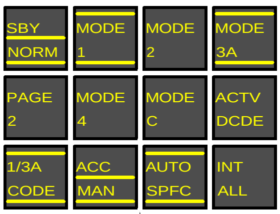


Figure 8.72 - Auto Specific Interrogator Operation

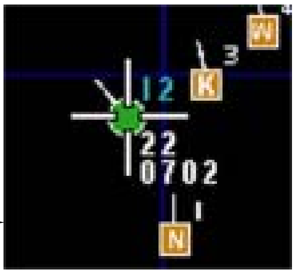
MANUAL IFF ON A TRACK (**ATK** FORMAT) IS AVAILABLE WHEN RADAR IS IN TWS OR LOCK FOLLOW MODE.

POSITION X-Y MARKER OVER REQUIRED TRACK WHEN IN TWS MODE. IF IN LF MODE IT IS NOT NECESSARY TO POSITION THE X-Y MARKER OVER THE TRACK.

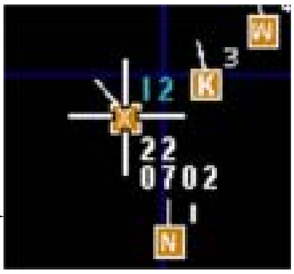
SELECT IFF INTERROGATE CONTROL ON STICK TOP.

IFF INTERROGATIONS ARE CARRIED OUT ON THE SELECTED TRACK UNTIL A SATISFACTORY RESPONSE IS RECEIVED OR THE FAILURE CRITERIA ARE MET FOR EACH OF THE SELECTED CODES.

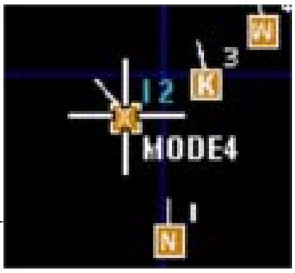
SUCCESSFUL RESPONSES MAY BE USED TO UPDATE THE TRACK ALLEGIANCE ON THE **ATK**, **ELEV** AND **PA** FORMATS IF PREDEFINED IFF CRITERIA ARE MET, WHICH DEEM THE TRACKS 'FRIENDLY'.
RESPONSE INFORMATION IS DISPLAYED ON THE **ATK** FORMAT WHEN IT IS RECEIVED AND FOR A FURTHER 5 SECONDS.



IF UNSUCCESSFUL RESPONSES ARE RECEIVED OR THE RESPONSES FAIL TO MEET 'FRIENDLY' CRITERIA THE TRACK ALLEGIANCE SYMBOL REMAINS AS 'UNKNOWN'.



MODE 4 INCOMPLETE RESPONSES ARE SHOWN BY THE LEGEND 'MODE 4'.



NOTE

'HOSTILE' IDENTIFICATION IS NOT PROVIDED AT SP3C.

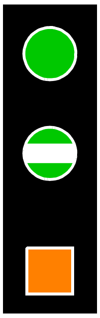
NATO OPERATING PROCEDURES RECOMMEND THAT MODE 4 INTERROGATIONS SHOULD NOT BE USED INCONJUNCTION WITH OTHER MODES.

Figure 8.73 - Manual Interrogation on a Selected Track

POSITION THE X-Y MARKER AT THE CENTER OF A VOLUME OF AIRSPACE OR OVER A TGS THAT IS TO BE INTERROGATED (**ATK** FORMAT).

SELECT THE VTAS IFF INTERROGATE CONTROL. A SECTOR SIZED AT 25% OF THE SELECTED RANGE SCALE AND MAXIMUM SELECTABLE AZIMUTH LIMIT IS DISPLAYED CENTERED ON THE X-Y POSITION.

THE SECTOR IS DISPLAYED FOR THE DURATION OF THE INTERROGATION OR FOR 2 SECONDS, WHICHEVER IS THE LONGEST.
IFF PLOTS DETECTED IN THIS VOLUME WILL BE DISPLAYED FOR 5 SECONDS.



INDICATES FRIENDLY IFF PLOT.

INDICATES A DEFINITELY FRIENDLY PLOT (MODE 4 RESPONSE)(BAND ONLY SHOWN FOR ONE RADAR FRAME TIME).

INDICATES UNKNOWN IFF PLOT.

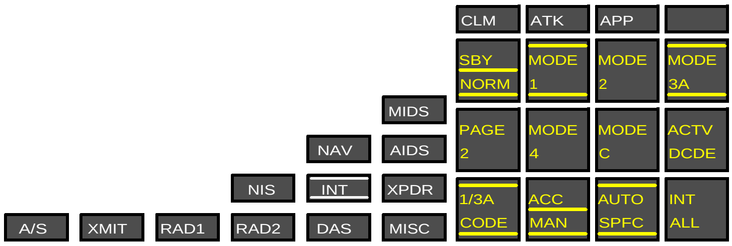
NOTE
IFF PLOTS ARE OF A LOWER PRIORITY THAN TRACKS AND WILL THEREFORE BE OVERWRITTEN BY TRACK SYMBOLOGY, WHERE APPLICABLE.

PROVIDED THE X-Y MARKER IS NOT MOVED, SUBSEQUENT IFF INTERROGATE SELECTIONS WITHIN 2 SECONDS WILL SELECT A 50% SECTOR SIZE FOLLOWED BY A 100% SECTOR SIZE.

AN IFF SELECTION WITHIN 2 SECONDS WITHIN THE 100% SECTOR WILL SELECT THE 25% SECTOR SIZE.

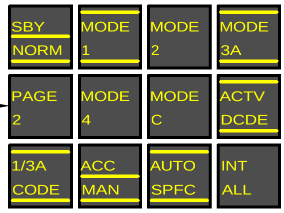
NOTE
CORRELATION WITH RADAR TRACK DATA IS NOT PROVIDED FOR VOLUME INTERROGATIONS.

Figure 8.74 - Manual Interrogation on a Volume of Space



PRESS THE **INT** SSK.

PRESS THE **ACTV DCDE** MK.

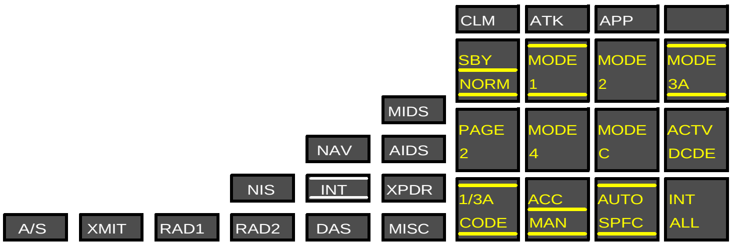


FOLLOWING MANUAL INTERROGATION ON A TRACK (FIG.27) OR VOLUME OF SPACE (FIG.28), THE ACTUAL CODE(S) (1 AND/OR 3A ONLY) WITH WHICH PLATFORMS REPLY WILL BE DISPLAYED FOR 5 SECONDS ON THE **ATK** FORMAT.

AT SP3C COMPARISON WITH INTERROGATING CODE IS NOT CARRIED OUT, THEREFORE REPLIES ARE NOT USED TO PROVIDE IDENTITY INPUTS TO THE CORRELATION PROCESS. ACTIVE DECODE PLOTS ARE DISPLAYED AS UNKNOWN IFF PLOTS (SEE FIG.28).

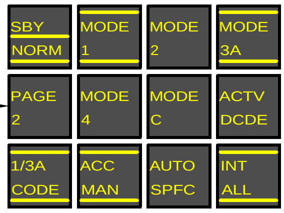
SUBSEQUENT SELECTION OF THE **ACTV DCDE** MK DESELECTS THE FUNCTION.

Figure 8.75 - Active Decode



PRESS THE **INT** SSK.

PRESS THE **INT ALL** MK.



SYSTEM INTERROGATES ALL TRACKS IN THE TRACK FILE. SUCCESSFUL RESPONSES WILL BE INDICATED AS FRIENDLY TRACKS ON THE **ATK**, **ELEV** AND **PA** FORMATS IF PRE-DEFINED IFF SYSTEM CRITERIA ARE MET THAT DEEM THE TRACKS 'FRIENDLY', OTHERWISE THEY REMAIN AS 'UNKNOWN'. RESPONSE INFORMATION FOR EACH TRACK IS DISPLAYED AS RESPONSES ARE RECEIVED AND REMAINS DISPLAYED UNTIL 5 SECONDS AFTER THE RESPONSE OF THE LAST TRACK.

THE FUNCTION IS AUTOMATICALLY DESELECTED ON COMPLETION OF THE INTERROGATIONS.

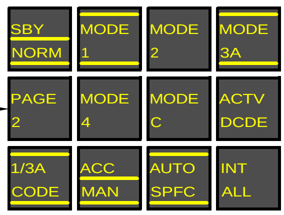


Figure 8.76 - Interrogate All

ARMAMENT CONTROL SUBSYSTEM (ACS)

The Armament Control Subsystem (ACS) is part of the Armament System. The ACS controls the selection, arming and firing of all weapons; it also controls the jettison of external stores both in emergency (EJ) and Selective (SJ) modes. Monitoring and indication of the subsystem and Stores/Weapons status, is shown to the pilot on the MHDD (STOR, ACUE, PA and ATTACK formats) and the HUD (COMBAT symbology).
The ACS performs safety critical and non safety critical functions which are separated and isolated, physically and electrically. The system is interconnected by dedicated links and by databus for routine inter-system and equipment communication. The Armament Control Subsystem includes the following LRI:

- Safety Critical Armament Controller (SCAC);
- Non Safety Critical Armament Controller (NSCAC);
- Master Armament Safety Switch (MASS) and related Remote MASS Position Indicator (RMPI).
- Armament Safety Break Contactors (ASBC);
- Distribution Unit (DU);
- Fuselage Station Unit (FSU);
- Inboard Wing Station Units (ISU);
- Centre Wing Station Units (CSU);
- Outboard Wing Station Units (OSU);
- Integrated Tip Station Units (ITSU);

The LRI of the ACS are interconnected by the Weapons databus and/or dedicated links. The system communicates with the rest of the avionic systems via the SCAC and NSCAC which are connected to the Attack databus. The Armament sub-system is connected by dedicated links to the Trigger, Weapon Commit/Release Control, Late Arm, Selective Jettison (SJ) and Emergency Jettison (EJ) controls.
The ACS has duplicated channels (Ch. A and Ch. B) to ensure that no single defect within the sub-system can cause:

- the execution of the EJ or SJ of any store before the relevant interlocks have been checked;
- the loss of the EJ or SJ function when requested;
- inadvertent firing/release of an armed weapon or gun firing.

In order to operate, the ACS needs both 28V DC and 115V AC electric power supplies:

- 28V DC power is provided via the two independent aircraft bus bars PP2 and PP3
- 115V AC power is provided via the two independent aircraft bus bars XP1 and XP2.

The ACS perform and/or support the following main functions:

- Weapons and stores configuration monitoring and management
- Weapons selection, arming, harmonization, priming and release control
- Gun selection and firing control
- Stores jettison (EJ/SJ) control
- Weapons and stores servicing data management
- Armament system monitoring and maintenance data management
- Provision of weapon training facilities
- FCS, PRP, and DASS operation support

NOTE

- On aircraft configured with AVs SP3C onward, the ACS support the following weapons management:
  - AIM-9L: full management from wing tip and outboard stations
  - ASRAAM (analogue mode only): as per AIM-9L
  - AMRAAM: full management from fuselage and outboard stations
  - gun: firing control
- Initial weapon harmonization is provided (i.e. full ground static plus initial flight static correction). A-A weapon training is available using training AIM-9L and bogus gun, ASRAAM, AMRAAM.

SAFETY CRITICAL ARMAMENT CONTROLLER (SCAC)

The SCAC controls all ACS safety critical functions.
The SCAC has a two channel architecture and its two channels are functionally synchronous.
The SCAC can operate in two modes: Normal or Reversionary. The operational mode is defined by the SCAC NORM/REV switch, where respectively NORM means the SCAC operates in dual channel mode and REV means that single channel operation of the SCAC is authorized.
The SCAC interfaces with the Weapon bus and the Attack bus as double Remote Terminal.
Operational software is resident in the SCAC while Mission software is loaded via the Attack bus.
The SCAC main functions are:

- Integrity, symmetry and consistency checks on the two stores configuration data sets loaded from MDP and PDS.
- Compatibility checks between the loaded stores configuration and the actual returns from the store stations.
- Stores and store stations serviceability checks.
- Control of the DU for 115V AC three-phase power distribution to the stores and store stations when required.
- Continuous monitoring of the current "A/C stores inventory" and transmission of the relevant data to FCS (in support of carefree handling) and to other avionic subsystems, e.g. IMRS for mission monitoring and D+C to display the data on the MHDD/STOR format.
- Control of all weapons selection, arming, firing and release.
- Emergency jettison of all applicable stores/ weapons.
- Selective jettison of groups of stores/weapons chosen among all applicable ones.
- Gun firing control and monitoring.
- Control of stores jettison/release sequence and corresponding time intervals between any two subsequent stores to achieve a safe separation and support aircraft mass balance control.
- Supply of subsystem operation and weapons/ stores status (when available) to IMRS .
- Control and management of Aircraft Station Interface (ASI) safety critical functions.
- Control and management of consistency and compatibility of loaded configuration.
- Control of the ASBCs for the application of fire power supply to the station units and the relevant stores/weapons.
- Provision during weapon release and gun firing of a proper HW signal to:
  - Propulsion, to prevent possible engine flame-out
  - FCS, to protect the air data system
  - DASS, to prevent missile approach warner malfunction
- Isolate and lock out failed safety critical functions via armament moding.

The SCAC interfaces with external equipment by means of:

- ATTACK bus, as a double remote terminal, to communicate with all AVS subsystems and other external systems (e.g. FCS, UCS, PRP)
- WEAPON bus, as a double remote terminal, to communicate with NSCAC
- Dedicated links, all consisting of duplex discrete hardwire lines, to transmit/receive signals subject to high integrity or high speed requirements (weapon arming, firing, jettison commands, store-on-station monitoring).

The SCAC main interfaces are:

- Armament control elements (ACE), via dedicated links.
- NSCAC, station units and stores, both via weapon bus and dedicated links.
- DU, via Weapon bus.
- Tank ejection units, via dedicated links, direct for centre wing stations, passing through the FSU for the centre fuselage station.
- Flight control system (FCS), digital engine control unit (DECU), attack computer (AC) and navigation computer (NC), both via Attack bus and dedicated links.
- Landing gear computer (LDG), armament ground test switch (AGTS) and gun control junction box (GCJB, via dedicated links.

NON SAFETY CRITICAL ARMAMENT CONTROLLER (NSCAC)

The NSCAC performs the computation of ACS non safety critical aspects which include missile servicing, data handling and weapon priming and moding. The NSCAC is a two channel digital computing unit and controls the non safety critical functions of the ACS, receiving data from the Attack Bus and providing the relevant computations as required for the selected store. All store data are sent to the Weapons/Station Units via the Weapon Databus.
The NSCAC exchanges data and control signals with the SCAC to support all store launch functions, except launch commands, via the Weapon Bus.
The NSCAC implements all ACS non-safety critical functions, including weapon moding and priming plus all ACS LRIs health status reporting for maintenance operations.
It is a digital computing unit with a dual channel architecture, where one channel is active and the other is in hot stand-by (i.e. ready to take over if the primary channel fails).
The NSCAC main functions are:

- Data bus controller (dual redundant) for the weapon bus
- All non-safety critical operations required by weapon/stores management, i.e.:
  - weapon priming data transfer to/from aircraft (A+I, NAV, FCS) via the Attack Bus
  - aiming data conversion from the aircraft main reference axis system to each applicable weapon local axis system and viceversa
  - subsequent aiming data transmission under control of the SCAC either directly to

the weapon or through the relevant station unit
- weapon stations Harmonization process for weapons alignment control
- weapon priming data built-up and transmission (or bridging from A+I) to station units / weapons (wake-up, targeting data and uncertainty data messages for AMRAAM, seeker moding and slaving commands for AIM-9L / ASRAAM, etc)
- weapon data receipt and processing from weapons / station units (status message from AMRAAM, operating seeker mode and position from AIM-9L / ASRAAM, etc)
- DU control for Video (HB1, HB3) and Audio (LB1) signals routing / processing (e.g. to route the audio tone signal generated by the first SRAAM ready to be fired to the pilot headset for lock-on verification and consent)
- collection of all ACS LRIs health status and maintenance data from station units and launcher electronic units for subsequent transmission to IMRS

The NSCAC interfaces with external equipment by means of:

– ATTACK Bus, as a double Remote Terminal, to communicate with all AVS subsystems (e.g. A+I, NAV, IMRS) and other external systems (e.g. FCS)
– WEAPON Bus, as a dual redundant Bus Controller, to communicate with all ACS LRIs, missile launchers Electronic Units and weapons/stores with an intelligent interface compatible with STANAG-1760 communication protocol

The NSCAC main interface is with the SCAC, via Weapon Bus, as required to support all stores operations (except for direct release / firing commands).
Other NSCAC interfaces on the Weapon Bus are:

– all Station Units and Stores, to support stores operations and monitoring
– DU, to control video and audio signals routing

NSCAC interfaces on the Attack Bus are:

– Flight Control System (FCS), Attack Computer (AC), Navigation Computer (NC), to support missile priming and Harmonization processes
– Interface Processing Unit (IPU), for ACS monitoring and maintenance support.

DISTRIBUTION UNIT (DU)

The DU is a dual channel LRI with a double remote terminal interface on the Weapon Bus. It acts as a switching box to perform the following two main functions:

– Distribution of 115V AC three-phase electrical power to the stores fitted on the 13 store stations. This function is carried out under direct control of the SCAC that commands the DU (via Weapon Bus) to switch the proper relays within the ACS Bus Bar Box so that each store station - when required - can be connected to the two aircraft 115V AC power bars XP1 and XP2.
– Routing of MIL-STD-1760A CLASS II signals (audio and video lines) between the stores fitted on any store station and the relevant AVS subsystems (COMMS and D+C). This function is carried out under direct control of the NSCAC and presently is limited to the routing of the audio tone of the first SRAAM that is ready to be fired to the pilot head set. For this purpose the DU:
  - receives each missile audio tone via a discrete HW line
  - performs an A/D conversion of the signal in order to filter it with respect to the audio level threshold input from the NSCAC and communicates the results to the NSCAC via Weapon Bus
  - routes the analogue signal of the best available missile (as indicated by the NSCAC) to the pilot headset via a dual discrete HW link with the Communication and Audio Management Unit (CAMU)

– No Video signal processing function is presently required

FUSELAGE STATION UNIT (FSU)

The FSU is a dual channel LRI with a double remote terminal interface on the Weapon Bus. It provides the interface for the 5 fuselage store stations, controls and monitors the Ejection Release Unit (ERU) of the centre fuselage pylon, the TEU of the Supersonic Fuel Tank (SFT) and the 4 Missile Ejection Launchers (MEL) to support release/ jettison capabilities of the relevant stores. All discrete inputs from the stores interface are acquired by both FSU channels and the relevant information are transmitted via Weapon Bus to both SCAC and NSCAC via the selected RTs. The SCAC provides the FSU with 5 independent release consent signals (one for each store station) and another 5 independent jettison signals via dedicated HW links (duplex hardwire lines); for weapon release, further SCAC commands via Weapon Bus are required. Once initiated by the proper SCAC commands, the FSU generates all the outputs necessary to complete the release/jettison of each store, controlling the due signal output sequence and timing. For each of the 5 store stations, jettison functions are fully duplicated and separately powered from two different power supplies.

WING PYLON STATION UNIT (WPSU)

A WPSU is installed within each wing pylon - outboard, centre, - when present on aircraft: it is a single channel LRI with a single remote terminal interface on the Weapon Bus. The WPSU provides the interface between the aircraft and the store/ weapon or carrier/launcher fitted on the corresponding wing store station: it controls and monitors the ERU to support release/jettison capability as applicable. The SCAC provides the WPSU with a discrete signals (release consent and jettison) via dedicated HW links (duplex hardwire lines); for weapon release, further SCAC commands via Weapon Bus are required. Once initiated by the proper SCAC commands, the WPSU generates all the outputs necessary to complete the release/ jettison of the store, controlling the due signal output sequence and timing. Jettison functions are fully duplicated and separately powered from two different power supplies.

INTEGRATED TIP STATION UNIT (ITSU)

An ITSU is a single channel LRI with a single remote terminal interface on the Weapon Bus which is integrated within each wing tip stub pylon of the aircraft. The ITSU provides the interface between the aircraft and the SRAAM fitted on the ITSPL: it controls and monitors the relevant electromechanical devices (missile detention and cooling mechanisms) to support the release capability. The ITSU also includes dedicated electronics to perform the A/D conversion of the analogue line-of-sight signals generated by the missile IR seeker for the NSCAC and vice-versa the D/A conversion of seeker slaving data generated by the NSCAC for the missile aiming.

ARMAMENT CONTROLS

ACS functions can be either controlled by the pilot/ ground-crew or by safety critical inputs from external systems/subsystems. The pilot controls are all located in the cockpit. Refer to Weapon System CONTROLS AND INDICATORS pag. 130 or all remaining ACS Controls are reported in the following:

Weight-On-Wheels (WOW). The WOW HW signals are generated by two double pole changeover switches fit within the main landing gear mechanism and directly wired to the SCAC via dedicated HW links (duplex hardwire lines). On receipt of such discrete signals, the SCAC inhibits the firing/release functions while the aircraft is on ground: only Emergency Jettison is not affected by WOW.

Armament Ground Test Switch (AGTS): this is a double pole changeover switch located in the right main landing gear bay, used to override the WOW signals interlock for ACS ground testing purposes.

Landing Gear Up Lock switches. These switches are located in each of the three LG mechanisms. They provide information about the present state of the left and right Main LG wheels (Up/Down) and of all LG doors (Closed/Open). Such HW signals (bridged to the SCAC by LG Computer via dedicated HW lines) are used to inhibit:

– release/firing of the external stores from the fuselage ejector launchers, when the main gear is not up-locked
– missile firing from the fuselage stations, when the nose gear is not up-locked.

Store on Station switches. These switches are located on the mechanical interface with the stores (pylons ERUs and MFRLs, fuselage MELs) and wired to the SCAC via duplex hardwire lines: such signals are used by the SCAC to monitor the presence of the relevant stores and/or store carriers. If the mechanical interface cannot include S.o.S. switches (e.g. TEU for supersonic fuel tanks and ITSPL for SRAAM missiles on the wing tip stub station) the relevant store presence state is provided to the SCAC via dedicated HW links with the store electric interface.

FUNCTIONAL DESCRIPTION

On aircraft configured with AVs SP3C onward, the ACS supports the following functions:

– Weapons and stores configuration monitoring
– Emergency jettison
– Selective jettison
– SJ package preparation
– SRAAM management
– AMRAAM management
– Gun management
– Weapon stations harmonization
– weapon training facilities
– ACS Built-in Test (BIT)

WEAPONS AND STORES CONFIGURATION MONITORING

The External Stores Configuration data are input to the SCAC via two different external sources: one set of data is programmed by the ground crew on the Maintenance Data Panel (MDP) and the other is loaded as part of the mission data via the Portable Data Storage (PDS) or the Ground Loading Unit (GLU - as a back-up source). Both data sets are input to the UCS bus, the Interface Processor Unit (IPU) and then to Attack Bus. These two sets of data are only accepted with Weight-On-Wheels set to "True".

The pre-flight operation includes the power-up BIT, the configuration checks and the inventory validation.

CONFIGURATION CHECKS

The configuration checks are carried out by the SCAC on ground after ACS P-BIT completion. The P-BIT is started on ground by setting the MASS to STDBY and includes all ACS electronic equipment start-up checks. Both data sets are received from the ATK bus and undergo two different validity check: integrity checks (verification of consistency with the system design and specification requirements) and symmetry checks (L/R wing, F/R fuselage stations). If both data sets are available and valid then they are cross-checked by the SCAC. If no discrepancies is detected, the stores configuration data is accepted and displayed on the MHDD/STOR format. If either data sets are not available when requested by the SCAC or one of the two sets is not valid but:

– at least one of the two is available and valid or
– both sets are available but not consistent with each other,

then the ACPT/RJCT soft key on MHDD/STOR format is activated and the pilot intervention is required (SCAC operation; are suspended).

INVENTORY VALIDATION

The SCAC starts the inventory validation after the stores configuration checks have been successfully completed. The process is carried out station by station and it consists of two groups of checks: compatibility and serviceability. The compatibility checks verify the consistency between the loaded stores and the assigned stores configuration. The serviceability checks ensure, where possible, if each store is ready to be used thus enabling all support functions required to reach the operational conditions.

If no errors have been detected at the end of the compatibility checks, the SCAC performs the serviceability checks, where required, or continues the validation on the next station in the pre-defined sequence. If any errors have been detected the SCAC removes all kind of electrical power applied to that station, sets the relevant H.P. status to "UNKNOWN" and continues the validation. When the process has been completed the SCAC transmits the following data:

– present store state to the FCS
– store availability to the displays and controls system
– present store state and availability to the IMRS

If a store though present is not available, a proper symbol will be shown on MHDD/STOR format.

If the hard point state results unknown in more than one station the FCS reduce the take-off and flight envelopes, and the SCAC will inhibit all firing and release functions with the exception of emergency jettison and gun firing. This state can only be recovered by recycling the MASS (STDBY/SAFE/ STDBY) after the problems detected during the inventory validation process have been solved.

EMERGENCY JETTISON

To initiate the Emergency Jettison (EJ) the pilot shall:

– switch the MASS in "LIVE" position
– uncover the EMGY JETT pushbutton (located in the cockpit - left hand quarter panel) and depress it.

Following such operation, the SCAC interrogates the EMGY JETT pushbutton for validity logic to verify the depression length of time and both the normally-open and normally-closed signals from the pushbutton: this is made to avoid the possibility of EJ being caused by spurious pulses.

On receipt of a valid EJ signal, the SCAC removes any electric power that is possibly applied at that very moment to the weapons/stores which are going to be jettisoned and commands the EJ sequencer to perform the jettison of all applicable stores in a pre-defined sequence; the time interval between each individual store jettison is pre-defined as well. The whole process is controlled via a HW logic: as such it does not depend on the present stores configuration and once initiated cannot be stopped nor modified.

When the EJ process is initiated, each ACS Station Unit involved is commanded in turn by the SCAC to connect both the HW jettison command and the 28V DC fire power supply lines through to the relevant ACIS LRI (ERU, TEU or MEL). The 28V DC fire power supplies are provided by both PP2 and PP3 bus bars and routed by the SCAC (respectively via ASBC 1 and 2). Within the ACIS LRI, the jettison command closes an isolation circuit that allows the 28V DC fire power supplies to detonate the relevant Electric Explosive Device (EED, i.e. cartridges) and perform the jettison operation.

SELECTIVE JETTISON

When a Selective Jettison (SJ) operation is carried out only those stores/weapons that have been chosen among all applicable ones and included in a valid SJ Package are jettisoned. The next paragraph explains how to prepare (i.e. load, edit and validate) a proper SJ package.

To initiate the Selective Jettison (SJ) the pilot shall:

– check the SJ package presently available,
– switch the MASS in "LIVE" position,
– uncover the SEL JETT pushbutton (located in the cockpit - left hand quarter panel) and depress it.

Following such operation, the SCAC interrogates the SEL JETT pushbutton for validity logic (the same applied to the EMGY JETT pushbutton for EJ). On receipt of a valid SJ signal, the SCAC removes any electric power that is possibly applied at that very moment to the weapons/stores which are going to be jettisoned and commands the jettison operations of the chosen stores. The jettison sequence for SJ is fully controlled by the SCAC SW: it is determined and continuously re-assessed with respect to the overall aircraft mass balance requirements, i.e. it depends on the configuration of the stores present on board at that very moment and as such it can be modified or even stopped by adverse events (e.g. hang-ups). On the other side, the time interval between each individual store jettison is fixed (300 ms). The terminal processes implemented in each store station for the SJ of the relevant store/weapon are the same already detailed above for EJ.

SJ PACKAGE PREPARATION

A SJ package should be normally available within the single mission data loaded via MDLR-PDS; in such case, the SCAC takes responsibility for checking the pre-loaded SJ package (with respect to SJ applicability and mass balance requirements) before accepting it.

If the pre-loaded SJ package is missing or it is present but does not pass the validity check then a blinking "SEL JETT NOT ACCEPTED" message is displayed on the top right side of the STOR format and the system enters automatically into SJ package editing function: a fixed "ENT" option will be then displayed on the centre right side of the STOR format, just below the blinking message. If the pre-loaded SJ package passes the validity check then a SJ package is available and displayed on the STOR format (the silhouettes of selected stores/ weapons appear with a cyan in-fill): no blinking message will appear. In any case, the pilot can decide at any time to change the present SJ package by entering willingly into SJ package editing function; he can do so simply moving the cursor of the X-Y controller on one of the stores displayed on the STOR format and de-selecting it (by pressing the X-Y controller). In that case the "ENT" option will appear on the STOR format indicating that the pilot has entered the SJ package editing function.

Once SJ package editing function has been entered, the pilot can choose the stores he wants to include in the SJ package among those that can be jettisoned (as displayed on the STOR format with a cyan rectangle surrounding the relevant silhouettes) by moving the cursor with the X-Y controller on each of them: the store where the cursor is positioned can then be selected by pressing the X-Y controller. When the SJ package has been completed then it must undergo the SCAC checks: this can be obtained by moving the cursor on the "ENT" option displayed on the STOR format.

At this point the SCAC runs the validity check for the new SJ package: if all requirements are fulfilled then the "ENT" and "SEL JETT NOT ACCEPTED" messages disappear and a new SJ package is available, otherwise the whole SJ package editing procedure re-starts.

SRAAM MANAGEMENT

At SP3C onward standard, the ACS can support the full weapon management of AIM-9L missiles; the same applies to ASRAAM missiles (analogue mode only, i.e. used as AIM-9L). SRAAM management is supported for missiles fitted on both the ITSPL on the wing Tip stations and the MFRL on the wing Outboard stations.

Since the end of stores configuration checks on ground the ACS starts supporting the SRAAM basic functions. In particular the ACS supports each missile IR seeker cooling by switching the 115V AC three-phase power supply to the relevant cooling mechanism (HiPPAG), providing its logic control unit with the required 28V DC power, and controlling it via Weapon Bus commands. The SRAAM cooling is activated if:

– the MASS is set to "STDBY" but SRAAM has been selected
– the MASS is set to "LIVE".

The weapon type selection can be made in two ways:

– manually, by the pilot, via the A-A Weapon selector located on the Stick Top (centre downward push)
– Automatically, by AVS request to ACS when a target is acquired by A+I sensors and no other A-A weapon is selected.

The ACS is responsible for the selection of the individual weapon to be fired, taking into consideration the mass balance requirements and the seekers operational status (audio tone level, line of sight, target obscuration). When the ACS has determined the best SRAAM available for firing then the relevant audio tone is routed to the head-set of the pilot, who can still reject it (e.g. because of the audio signal poor quality); in this case a new SRAAM station will be evaluated by ACS and proposed to the pilot as the next weapon to be fired. The reject button is located on the throttle top.

The SRAAM seeker can be either Caged (i.e. forced to aim at a definite direction in space as commanded by the system under ACS control) or Uncaged (i.e. free to move following the IR sources caught within its field of view, under control of the missile own avionics).

When Caged, the seeker is normally slaved to ACS slaving controls that depend on the seeker mode chosen by the system at that moment; three modes are available:

– BORESIGHT, when the seeker is aligned along aircraft X-axis boresight;
– SLAVED TO TARGET, when priming data are originated by A+I sensors (i.e. RADAR and FLIR, when available);
– MANUAL, when priming data are originated by A+I on direct input from the pilot via X-Y Controller.

The SRAAM seeker mode is selected by ACS, depending on the pilot request, the available target data sources and the operational conditions. The pilot request is made by depressing recursively the A-A weapon selector in the centre position; the pre-defined sequence is: BORESIGHT→STT→MANUAL. A default seeker mode is assigned at weapon type selection: BORESIGHT for the manual selection, STT for the automatic selection.

The XFOV soft key is also available to the pilot on the MHDD when the ATTACK format is displayed: when pressed, it enables the SRAAM seeker scan mode i.e. the seeker is slaved to a circular pattern that is superimposed on the normal seeker slaving track (as determined by the priming mode currently in use, whichever it is) effectively extending its physical field of view.

As a reversionary mode (no slaving sources available) the AIM-9L seeker could also be slaved to the missile own boresight; this mode is used by ACS only when the weapon type selected is not SRAAM, in order to cage the seeker and avoid that sudden in-flight accelerations might damage its mechanism.

The SRAAM seeker is Uncaged by ACS to allow it to lock-on the target, once it has been properly acquired. Such condition is determined by the ACS, also depending on the seeker mode used to track the target and/or on the input got from the pilot, i.e.:

– when in STT mode the SRAAM is uncaged without pilot intervention, as soon as the ACS has determined that the target is not obscured, the line of sight is aligned to A+I priming data and the audio tone is good; the pilot can re-cage the seeker manually, if required by combat operations.
– when in BORESIGHT or in MANUAL mode, the ACS still performs some checks on the seeker target acquisition status but waits for the pilot command to uncage it.

The pilot can command to uncage / re-cage the seeker by toggling the A-A weapon selector on the stick top to the centre right position.

The ACS controls SRAAM seekers in such a way that all available SRAAMs are always aiming at a same direction in space;

– if no SRAAM is locked-on then all seekers are slaved to the system priming data provided by A+I;
– if a SRAAM is uncaged and locked-on then all remaining ones are caged and slaved to its present aiming direction.

Due to the fast changing conditions during short range combat operations, no visual indication is provided to the pilot about which SRAAM is presently selected by ACS. The MHDD/STOR format is properly updated only after firing: if the missile has gone the relevant symbol disappear, if a hang-up occurs the symbol is covered with a red rectangle.

The SRAAM seeker head position is displayed on HUD Combat format, indicating its current sight line. If the seeker head moves outside the HUD field of view the "diamond symbol" flashes on the periphery of the display. The symbol is stationary if boresight mode is selected. If the currently selected missile cannot acquire the target its seeker head position is indicated by a "broken diamond".

NOTE

The HUD Combat mode is not available if aircraft altitude is below 5000 ft.

When the pilot intends to fire a SRAAM, the Late Arm switch has to be moved to the Armed position and the Trigger must be pressed. As a consequence of Late Arm operation, if the MASS is in "LIVE" position and the aircraft in flight, then the SCAC:

– commands the ASBCs to route the 28V DC 2 Fire Power to all available SRAAM stations
– commands all SRAAM launchers (via Weapon Bus) to unlock the relevant In-Flight Operable Lock (IFOL).

If any station fails to unlock then that station is declared unavailable; if the first station selected for firing has failed then a new station is selected. When the pilot presses the Trigger the SCAC performs the final Safety Interlock Checks: if the MASS is in "LIVE" position, the aircraft is in flight, the Late Arm is armed and the selected SRAAM station IFOL is unlocked, then the Release Consent discrete signal is sent to the ITSU or MFRL (as applicable) followed by the data bus command to initiate the AIM-9L firing sequence. At that point, as soon as the missile battery has become active and the missile is ready to be fired, the ITSU / MFRL outputs the Motor Fire signal to ignite its rocket motor.

AMRAAM MANAGEMENT

At SP3C onward, the ACS can support the full weapon management of AMRAAM missiles; this applies to missiles fitted on both the MEL on the 4 Fuselage shoulder stations and the single MFRL on the Wing Outboard stations. Most of the ACS functions dedicated to AMRAAM are fully transparent to the pilot, who can therefore concentrate on combat operations. The weapon type selection can be made by the pilot via the A-A Weapon selector located on the Stick Top (forward push).

The ACS is responsible for the actual selection of the individual weapon to be fired, following a sequence that takes into consideration the mass balance requirements and the weapon operational status. The latter can be "GOOD", "DEGRADED" or "UNSAFE TO LAUNCH", as determined by the SCAC during the serviceability checks that are carried out on ground at the end of the store configuration checks, and it is recorded within the relevant missile Health Status message.

AMRAAM priming processes are mainly controlled by A+I: the Attack computer makes use of sensors inputs and pilot indications to compute the targeting and uncertainty data. Such data are then sent to ACS (via Attack Bus) and routed to the missile (via Weapon Bus) . The most significant function carried out by ACS for AMRAAM priming is the Harmonization process of each weapon station, consisting of the correction of the direction cosines matrix operated by the NSCAC before transmitting it to the missile as part of the targeting data message. AMRAAM priming only takes place during the final missile firing sequence. In fact, at the end of serviceability checks all electric power supplies to AMRAAM are removed and the missiles are carried in flight like inert stores until the pilot requests the launch of the first missile in sequence.

When the pilot intends to fire an AMRAAM, the Late Arm switch has to be moved to the Armed position and the Trigger must be pressed. As a consequence of Late Arm operation, if the MASS is in "LIVE" position and the aircraft in flight, then the SCAC:

– commands the ASBCs to route the 28V DC 2 Fire Power to all available AMRAAM stations
– if there are AMRAAM missiles fitted on the Wing Outboard stations, commands both launchers (via Weapon Bus) to unlock the relevant In-Flight Operable Lock (IFOL). If any station fails to unlock then that station is declared unavailable; if the first station selected for firing has failed then a new station is selected.

When the pilot presses the Trigger the SCAC performs the final Safety Interlock Checks: if the MASS is in "LIVE" position, the aircraft is in flight, the Late Arm is armed and the selected AMRAAM station IFOL (if applicable) is unlocked, then the Release Consent discrete signal and the 115V AC power are sent to the missile and the AMRAAM Launch Events Sequence is triggered. During such sequence the following events occur:

– the NSCAC wakes up the missile and synchronizes it with the aircraft time
– the missile replies to the system with wake-up confirmation
– Targeting and Uncertainty Data messages are sent to the missile for priming
– the missile confirms it has correctly received priming data and is ready to launch.

At the end, if no failure interrupts the sequence, the SCAC removes the 115V AC power and sends to the relevant station the "AMRAAM LAUNCH" or "AMRAAM EJECT" final command causing either the MFRL umbilical retraction mechanism activation or the MEL umbilical disconnection by ejection, as applicable. Following the umbilical disconnection the AMRAAM rocket motor is ignited after a short time gap (that depends on the type of launcher used).

GUN MANAGEMENT

NOTE

The gun is installed on DA3 aircraft only.

At SP3C onward, the ACS can support the full GUN management, i.e. mainly:

– available gun rounds monitoring
– gun firing control
– gun re-cocking (following a cartridge misfire).

The GUN selection can be made by the pilot via the A-A Weapon selector located on the Stick Top (backward push). The GUN interface with the ACS is represented by the Gun Control Junction Box (GCJB), a GUN system LRI fully controlled and monitored by the SCAC via discrete lines.
When the pilot intends to fire with the GUN, the Late Arm switch has to be moved to the Armed position and the Trigger must be pressed. As a consequence of Late Arm operation, if the MASS is in "LIVE" position and the aircraft in flight, then the SCAC provides the 28V DC 2 Fire Power to the Gun ammunition box to activate the gun rounds loading operations. After 100ms, the actual firing sequence

can be activated with a (short) TRIGGER press. Both Trigger changes of state (Press and Release) are monitored by the SCAC to determine the length of the burst. FCS, PRP and DASS are timely informed that GUN firing is due/on-going. There are no absolute limitations to the maximum number of GUN rounds that can be fired in a single burst.
When the GUN control requirements are not fulfilled and such event is detected:

– the "GUN FAIL" warning is generated and GUN firing is inhibited
– failure and maintenance data are sent to IMRS for recording.

GUN firing can be inhibited just for the single burst (e.g. pulse-to-pulse incorrect timing) and then enabled again for a subsequent firing trial. On the other hand, if the SCAC detects own internal failures relevant to the GCJB interface then the GUN firing is inhibited indefinitely.

WEAPON STATIONS HARMONIZATION

At SP3C onward, the ACS can support full weapon stations Harmonization. Missile aiming to a given target can be affected by errors due to the weapon misalignment with respect to its own theoretical position on board. The ACS Harmonization process has been designed to overcome the problems caused by missiles misalignment. Missile misalignment can be caused mainly by:

– store station and launcher installation on aircraft (Ground Static misalignment), that can be measured (Ground Static Data)
– continuous aircraft in-flight maneuvers (Flight Static misalignment) that can be mathematically modeled (Flight Static Data)

The ACS Harmonization process is carried out by the NSCAC that makes use of:

– Ground Static data, loaded via IPU,
– Flight Static data, directly input with the application SW
– Present Flight Data, input during flight from FCS, NAV and A+I.

This process generates Harmonization Correction data used to modify the missile targeting data and compensate misalignment effects. For SRAAM priming, these data are used for converting the seeker sight line polar co-ordinates from the missile own axis reference system to the aircraft main axis reference system before routing them to A+I and vice-versa to convert priming data generated by A+I into slaving signals for the missile seeker. For AMRAAM priming these data are simply used to properly modify the direction cosines matrix sent to the missile within the targeting data message: such matrix is then used by the missile to convert target data - computed with respect to a general inertial axis system - into its own reference axis system.
The whole harmonization process is completely transparent to the pilot. At SP3c onward, harmonization is provided for all wing missile stations (Tip and Outboard) and fuselage stations.

WEAPON TRAINING FACILITIES

At SP3C onward the ACS provides Weapon Training Facilities (WTF). WTF are available in flight if bogus/training weapons are included in the stores configuration loaded on ground from MDP and PDS. No real stores (with the exception of external fuel tanks, pods and training weapons) can be carried on board if WTF is to be enabled: if a mix of real and bogus/training weapons is detected during the stores configuration checks then all ACS functions are inhibited (with the exception of EJ).
The following weapon types are allowed and supported with WTF:

– Training AIM-9L and ATM ASRAAM
– Bogus AMRAAM
– Bogus Gun, with "zero real gun rounds".

When in flight, the pilot can select at any time an allowable bogus weapon configuration and/or reset it as desired after firing simulation. For this purpose, in addition to the normal AA weapon type selector on the stick top some dedicated soft keys are made available on the Manual Data Entry (MDE) facility, following the "MISC" key press. When WTF is enabled:

– the ACS provide most of the usual store management functions, but safety critical HW signals to the stations (e.g. Release Consent discrete) are inhibited
– Emergency and Selective jettison are fully supported for all applicable stores (i.e. tanks)
– the ACS will not check for hang-up following a simulated firing
– ACS interfaces with FCS and Propulsion reflect the actual conditions existing on the A/C, i.e. :
    • during a simulated firing no change of mass occur and no firing plume is actually generated therefore no HW firing signal is sent to FCS and PRP;
    • the real stores configuration (e.g. tanks, pods, training weapons) is continuously monitored and the relevant information for FCS is updated as usual.
– The symbology and information displayed on MHDD and HUD is generally maintained as for the real mode operations; e.g. AMRAAM bogus missiles are decremented in accordance with simulated firing signals; however, no count down simulation applies to AIM-9L training

missiles and available GUN rounds (permanently set to zero).
– A+I and the remaining AVS sub-systems fully operate as in normal (real) mode.

ACS BUILT-IN TEST (BIT)

The ACS Design includes several types of BIT, applicable to different operational conditions.

POWER-UP BIT (P-BIT)

Started on ground by the pilot, setting the MASS to "STDBY". Includes all ACS electronic equipment start-up checks.

CONTINUOUS BIT (C-BIT)

Run continuously, since P-BIT completion. It is monitored by the SCAC SW. It Includes all ACS and ACIS electronic equipment C-BIT, plus the monitoring of ACIS and GUN non-electronic LRIs interfacing ACS.

EXTENSIVE BIT (E-BIT)

Characteristic of SCAC design only, it is dedicated to investigate and report internal faults in detail, at equipment level. It starts automatically when a discrepancy failure is detected during the C-BIT but its source cannot be identified by normal checks. At the end, if the pilot requests the single channel operation mode, the SCAC can exclude the failed channel.

INTERRUPTIVE BIT (I-BIT TYPE 1 ON GROUND ONLY)

This is the most complete ACS BIT available at SP3-B standard. It is run on ground by SCAC Application SW on Pilot request from the MHDD/ACUE format (select "ACS" and then, when page 2 is displayed, select "IBIT" soft key). This BIT includes checks on all ACS and ACIS electronic equipment, with the exception of DU and Armament Control Elements. It can be performed with weapons loaded on aircraft stations.

WEAPON SYSTEM CONTROLS AND INDICATORS

The Armament Control Sub-system (ACS) is operated by controls and indicators located in the cockpit as described in the following:

– Master Armament Safety Switch (MASS) Figure 8.77
– Remote MASS Position Indicator Figure 8.77
– SCAC Norm/Rev Switch Figure 8.77
– Jettison Control Unit Figure 8.77
– HOTAS Controls Figure 8.78
– MHDD STORE format Figure 8.79
– MHDD PA format Figure 8.80

MASTER ARMAMENT SAFETY SWITCH (MASS)

The Master Armament Safety Switch (MASS) is a three position switch located on Front Cockpit right hand console top mid section. The MASS control knob is a rotary control selecting one of three positions with the following associated functions:

– SAFE - In this position the MASS isolates the ACS from all electrical power;
– STBY - In this position the MASS isolates the power required by the ACS for safety critical functions (arming, release, firing and jettison); in the STBY position, power is available to the logic elements of the ACS units, to allow all computation and control functions to operate;
– LIVE -In this position all the required power supplies are made available to the ACS.

Selection of the MASS LIVE position is mechanically protected such that the control top has to be raised (pulled) in the direction of the control shaft during the clockwise selection from STBY to LIVE. Only one of the legends is visible at any one time, the remaining two are completely obscured by the control top.
When the MASS is in the SAFE position, the Display and Controls Sub-system (D+C) is able to sense this position. Depending on the constraints of the (D+C), a MASS SAFE/STBY/LIVE indication will be displayed on the MHDD STORE format.

REMOTE MASS POSITION INDICATOR (RMPI)

The Remote MASS Position Indicator provides visual indications to the ground crew of the current activation state of the ACS. The RMPI is located on the vertical surface of the structure forward of the Front Cockpit left hand Glareshield and is visible to the ground crew. These visual indications correspond to the present MASS position when electrical power is available. The Remote MASS Position Indicator window legends are:

– SAFE position - green square surrounded by thin white border;
– STBY position - series of black and amber stripes at 45°;
– LIVE position - inverted red triangle (base uppermost) against white background.

When electrical power is unavailable (unpowered) the MASS Remote Position Indicator window legend is a black square. Figure 8.77

SCAC SWITCH

The SCAC NORM/REV switch, (labelled SCAC NORM/REV) is a two position toggle switch which is locked in both forward and aft positions and must be unlocked by pulling in the direction of the control shaft prior to selection of either position. The SCAC NORM/REV switch provides the following functions:

– NORM - The SCAC operate in dual channel mode.
– REV - The SCAC is authorized to operate in single channel mode.

JETTISON CONTROL UNIT

The Jettison Control Unit identified with the label JETT is located on the Front and Rear Cockpit Left Hand Quarter Panel and houses the Emergency Jettison (EJ) and Selective Jettison (SJ) pushbuttons in a common arrangement. The EJ pushbutton labelled EMGY and the SJ pushbutton labelled SEL are coverguarded. The consequences of inadvertent release of stores are potentially catastrophic. There are two type of protection against unintentional EJ/SJ command:

– a raised barrier surrounds the two pushbuttons.
– a coverguard denies access to the EMGY or SEL pushbutton when not required. It either covers the EMGY pushbutton, simultaneously exposing the SEL pushbutton or viceversa.

EMERGENCY JETTISON FUNCTION

Upon selection of the JETT EMGY pushbutton with the MASS in LIVE position, the ACS generates the outputs necessary to jettison downwards all applicable stores/weapons from the aircraft in a fixed sequence. The ACS on receipt of EJ initiation demand, initiates the downward jettison of all allowable stores in a fixed pre-defined sequence; the time interval between each individual store jettisonable is pre-defined as well.

SELECTIVE JETTISON FUNCTION

Upon selection of the JETT SEL pushbutton with the MASS in LIVE position, the ACS generates the appropriate sequence of jettison signals for the selected store(s)/weapon(s) only, i.e. only those weapons/stores identified in the validated SJ package will be jettisoned taking into account the requirements for the aircraft mass balance and safe separation.

HOTAS CONTROLS

Many ACS functions are controlled via HOTAS controls, to allow a rapid weapons management under all conditions.

AIR TO AIR WEAPON TRIGGER + HUD CAMERA

Pressing the Air to Air Trigger + HUD Camera to the first detent runs the Video/Voice Recorder (VVR) if not already running. Pressing to the second detent fires the selected weapon if an AAM or the Gun is selected. The second detent can only be reached if the Late Arm is in the armed position.

LATE ARM SAFETY INTERLOCK (LAS)

The Late Arm Safety Interlock enables the Weapon Commit/Release control and Air to Air Trigger operation.
The LAS is a two position (SAFE/ARMED) slider type control. With the control set to the safe position, it both inhibits the electrical function and prevents the mechanical selection of the trigger and the Weapon commit/release control. It also provides an interlock to prevent weapon arming /fuzing.
Selection of the ARMED position (indicated by exposing an orange marker) enables the functions of both the Trigger control and the Weapon Commit/ Release control. Selection of the armed position also removes the mechanical detent of both controls and removes the arming /fuzing interlock.

AIR TO AIR WEAPON SELECTOR/SRAAM RECAGE SELECTOR

The Air to Air Weapon selector/SRAAM Recage selector are used to select the Air to Air weapons and to cage/recage SRAAM.
The Air to Air Weapon selector/SRAAM Recage selector is a six position toggle switch which enables selection of MRAAM (forward selection), air-to-air gun (aft selection) and SRAAM (center push selection). Repeated selection of SRAAM enables sequential selection of the SRAAM priming modes (boresight, slaved to sensor and manual). The switch also allows the pilot to cage/recage SRAAM (right of centre position).

AIR TO SURFACE WEAPON COMMIT/RELEASE CONTROL

The Weapon Commit/Release control is used to release the pre-selected air-to-surface Weapon Package.

NOTE

The Weapon Commit/Release control is not functional at AVs SP3.

SRAAM REJECT BUTTON

The SRAAM reject button, is used to reject the currently selected SRAAM missile and select the following in the sequence.

SRAAM XFOV KEY

This is a soft key, available to the pilot on the MHDD when the ATTACK format is displayed: when pressed, it enables the SRAAM seeker scan mode i.e. the seeker is slaved to a circular pattern that is superimposed on the normal seeker slaving track (as determined by the priming mode currently in use) effectively extending its physical field of view.

MHDD STORE FORMAT

The STORE format, provides a diagrammatic representation of weapon system status and current stores configuration. The STORE format also displays the MASS state, number of remaining gun rounds and "SEL JETT NOT ACCEPTED" caption, when the SJ package input to the ACS has been checked and rejected by the SCAC so that SJ is not available. The SK on the STORE format are described in Table.

STORE Format Soft Keys Set

SOFT KEY	FUNCTION
W	Selects the Warning Procedures format for display (inoperative).
STOR	Selects the Weapon Configuration/ Selective Jettison format.
HYD	Selects the Hydraulic format.
FUEL	Selects the Fuel format.
WPT	Selects the waypoint/airfield list format for display (inoperative).
ENG	Selects the Engines format.
NO WPN	Deselects the selected weapon.
ELEV	Selects Elevation format.
FREQ	Selects Radios format.
NORM	Selects Default format.
DASS	Selects Defensive AIDS Sub-system format.
HUD	Selects Head Up Display format.

WEAPONS SELECTION

An indication of weapon selection is provided in the bottom left corner of the HUD and MHDD PA format. The letters M, S and G are used to indicate selection of MRAAM, SRAAM and gun respectively. Each letter is suffixed by a number denoting the quantity of stores/rounds remaining of that particular type.

DEDICATED WARNING PANEL (DWP)

Information on specific ACS failures or abnormal conditions are displayed on the DWP and are presented to the pilot as follows:

– ACS FAIL - Warning Category 3 in all POF.

  The consequences on the system functioning are: loss of store control except the Emergency Jettison and loss of external store mass data supplied to FCS.

– DU FAIL - Warning Category 3 in all POF.

  The consequences on the system functioning are: loss of 3 phase to the stores, loss of weapon functions related to HB1, HB3, LB lines and no tone for AIM-9L.

– NSCAC - Warning Category 3 in all POF.

  The consequences of automatic selection of NSCAC reversionary modes and further NSCAC failures will cause the loss of store control functions except Emergency Jettison.

– SCAC CHANNEL failure - Warning Category 3 in all POF.

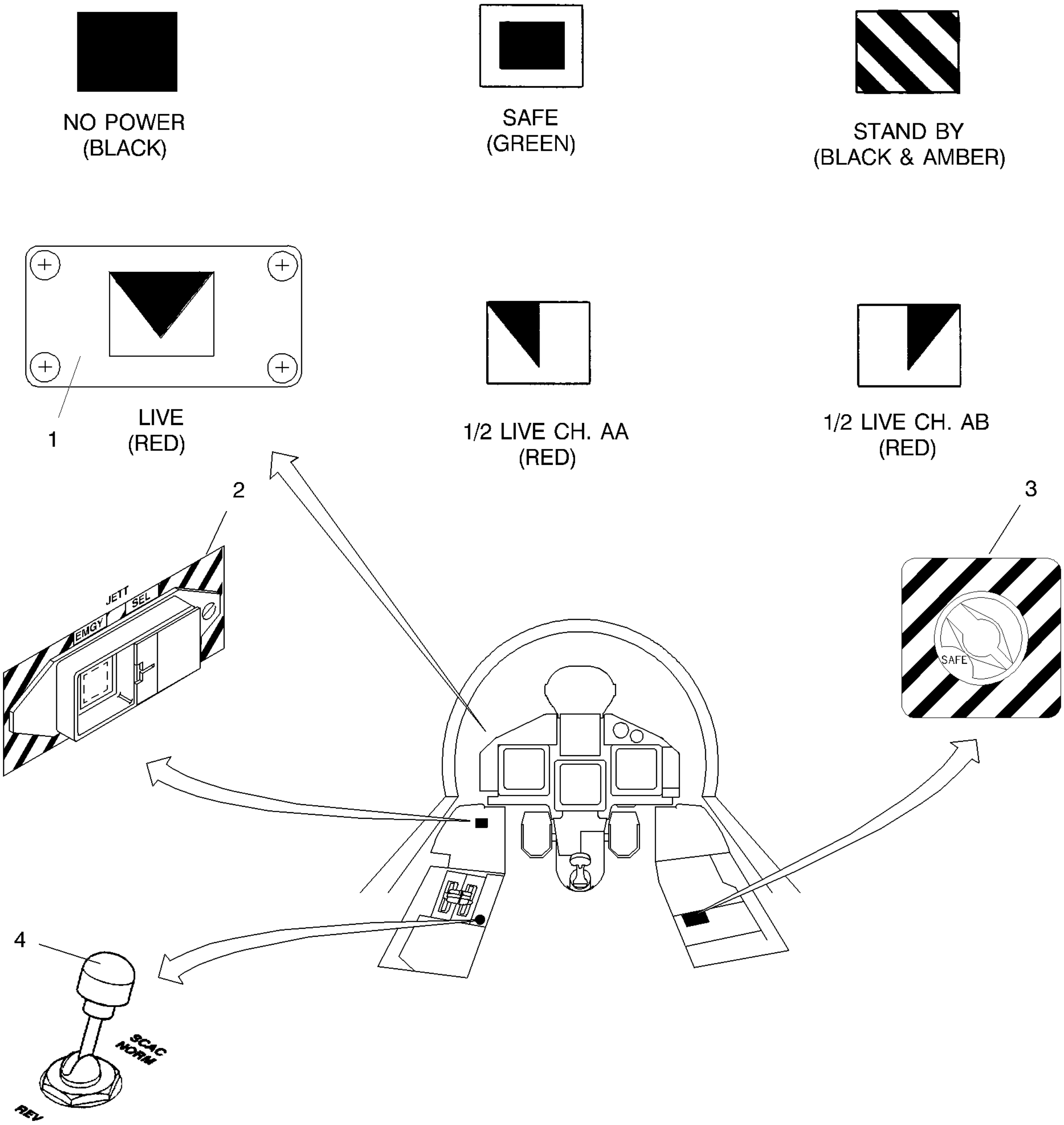
  The consequences on the system functioning are: loss of store control except the Emergency Jettison and stores mass data to FCS.

– MASS NOT LIVE - Warning Category 4 (except on GND when it is not provided and on T/O when its category is 1). The voice warning message "MASS NO LIVE" is heard by the pilot in the headset, when in T/O the Master Safety Switch (MASS) is not set in LIVE position and the throttles are advanced, or when in-flight the MASS is not set in LIVE position and the LATE ARM switch is enabled.

– HANG UP - Warning Category 3 in all POF (except on GND when it is not available). When a weapon/store has failed to separate following a jettison or firing command.

– GUN FAIL (DA3 only) - Warning Category 3 in all POF. The SCAC received the signals error from the trigger, gun control junction box (GCJB) or SCOOP circuit simulator and inhibited the gun fire operation.

– GUN SCOOP FAIL (DA3 only) - Warning Category 3 in all POF. The SCAC received the signals error from the SCOOP circuit simulator and inhibited the gun fire operation.



1 MASS REMOTE POSITION INDICATOR
2 JETTISON CONTROL UNIT
3 MASTER ARMAMENT SAFETY SWITCH
4 SCAC NORM/REV SWITCH

Figure 8.77 - Weapon System - Controls and Indicators

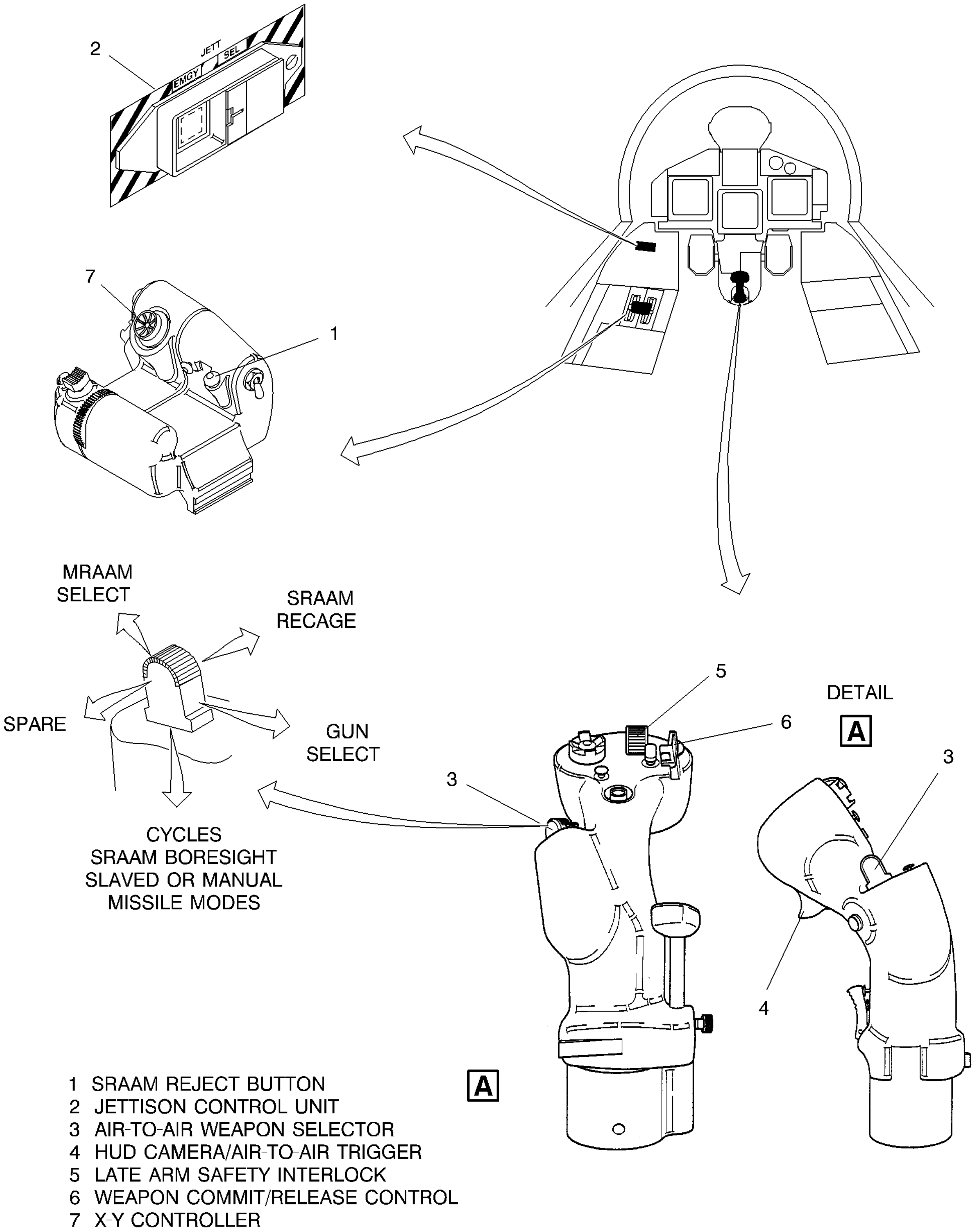
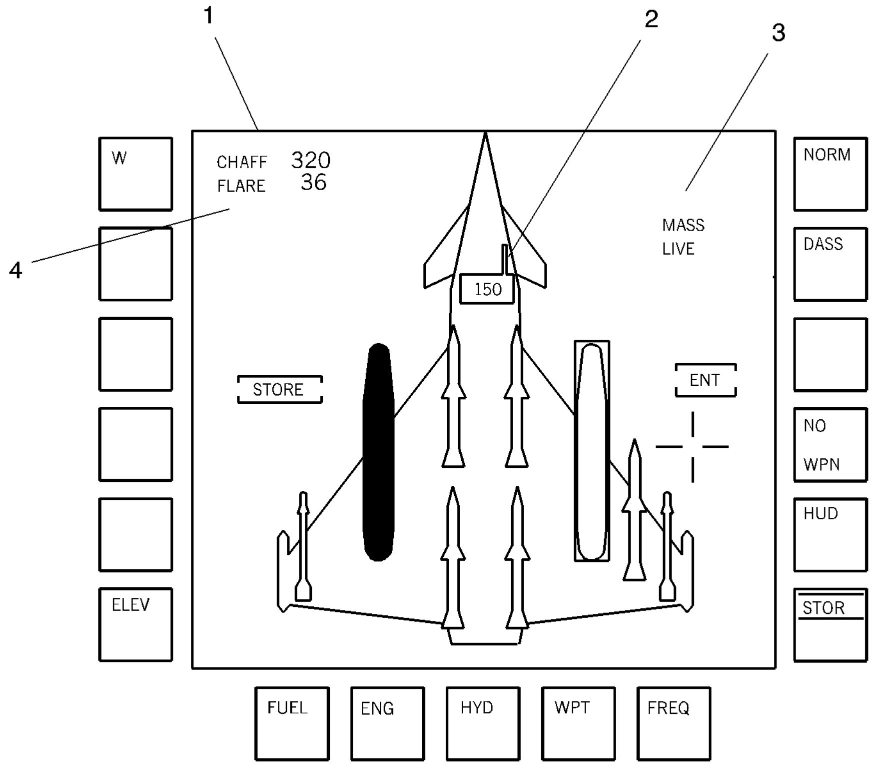
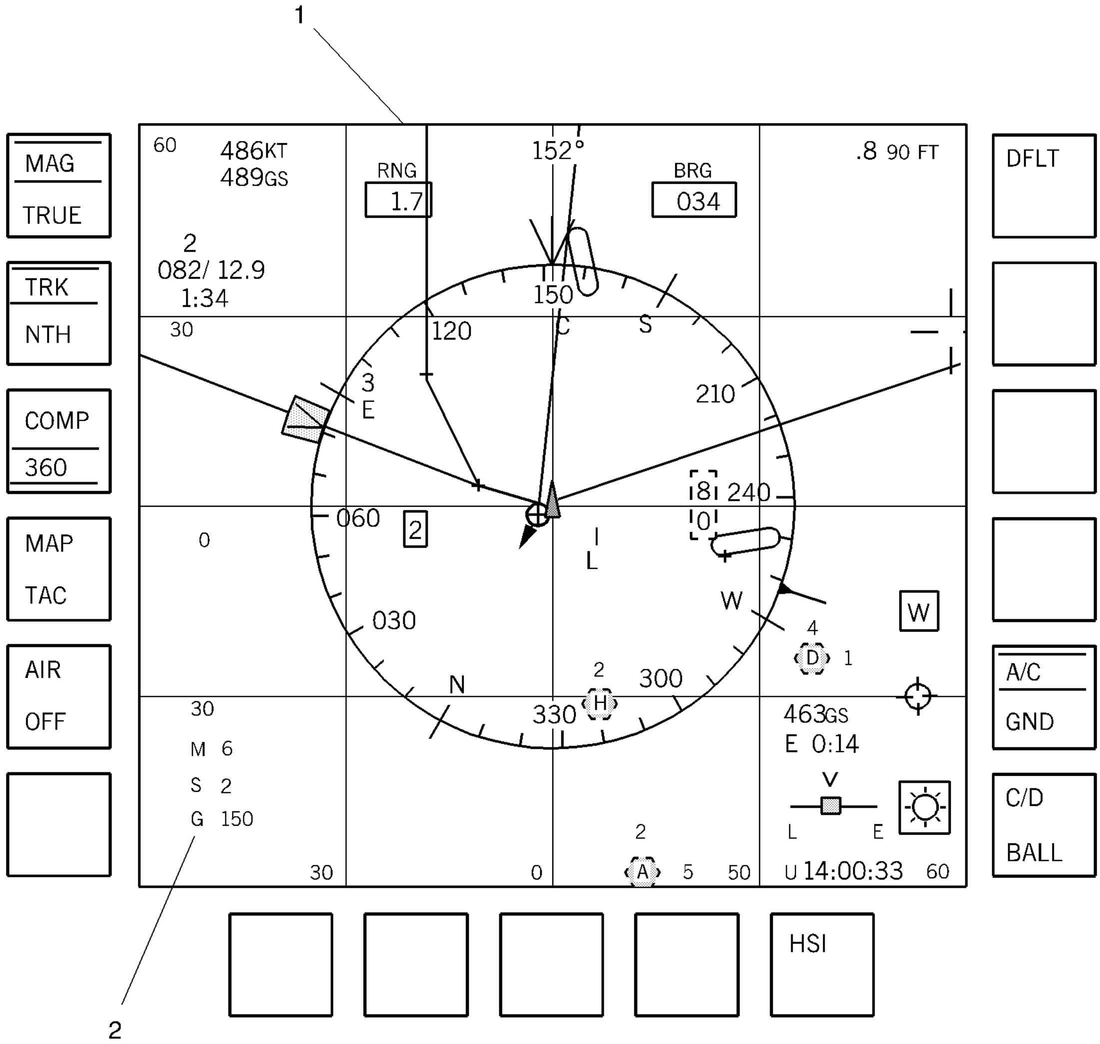


Figure 8.78 - HOTAS Controls



1 REMAINING CHAFF
2 GUN REMAINING ROUNDS
3 MASS STATE DISPLAY
4 REMAINING FLARE

Figure 8.79 - STORE format



1 MHDD PA FORMAT
2 WEAPON AVAILABILITY

Figure 8.80 - MHDD Pilot Awareness format

STORES MDE AND X-Y FUNCTIONS

The X-Y controller is a force sensitive finger operated device fitted on the right (inboard) throttle top that controls the position of an X-Y marker on the MHDD formats and also on the HUD. The top of the control is depressible and this action is used to perform the insert function. More detailed information pertaining to the X-Y controller is contained within DM

The pilot is able to perform the following X-Y functions within the MHDD/Stores format:

– Define a Selective Jettison Package
– Display descriptive legends for stores.

SELECTIVE JETTISON PACKAGE

A selective jettison package may be loaded via the PDS/MDLR, but if required the pilot is able to use the X-Y function to set-up a selective jettison (SJ) package on the MHDD/Stores format (Figure 8.81). X-Y insertion over a store station boxes that station to indicate that it has been pre-selected for inclusion or exclusion in the SJ package in accordance with the following criteria:

– If the store is not infilled, then boxing that store will ultimately select it for inclusion in the SJ package.
– If the store is infilled (this shows that the store is already part of the SJ package), then boxing that store will ultimately exclude it from the SJ package.

NOTE

SRAAM are not jettisonable. If a twin store carrier is pre-selected, both stores are jettisoned (if two remain).

The pilot is able to select/deselect stores in turn until the entire package is nominated. When all the required stores have been nominated in this way, the pilot performs an X-Y insert over the ‘ENTER’ to enter the amended package into the system and the selected package is subjected to a validation check.

If accepted the new package replaces any previously selected package, and the symbols for the stores are infilled or emptied as appropriate to confirm their selection or deselection.

An SJ package will not be accepted which, on ejection of the stores, would create an imbalance that exceeds the FCS limits. Should any stores not be accepted as a result of the validation check, their symbols do not change but remain boxed. The box flashes at 2 Hz to draw the pilots attention to the store that has caused the package to be rejected. In addition a ‘SEL JETT NOT ACCEPTED PROMPT’ is displayed (with a flashing outline box) to indicate that the package has not been accepted until the problem has been rectified. The pilot may modify the package as required by repeating the selection and ‘ENTER’ procedure.

If the MHDD/Stores format is deselected before the new SJ package has been successfully entered, no change is made to the current package held in the system and all pre-selections are cancelled.

STORES LEGENDS

Legends are automatically displayed by default for seven seconds on initial selection of the MHDD/ Stores format (Figure 8.82). At any other time the pilot is able to display descriptive legends for all the stores by performing an X-Y insert over the ‘STORES’ legend icon. The stores legends remain displayed for as long as the X-Y marker remains on the ‘STORES’ legend icon. When the X-Y marker is moved off the stores legend icon, all stores are occulted immediately.

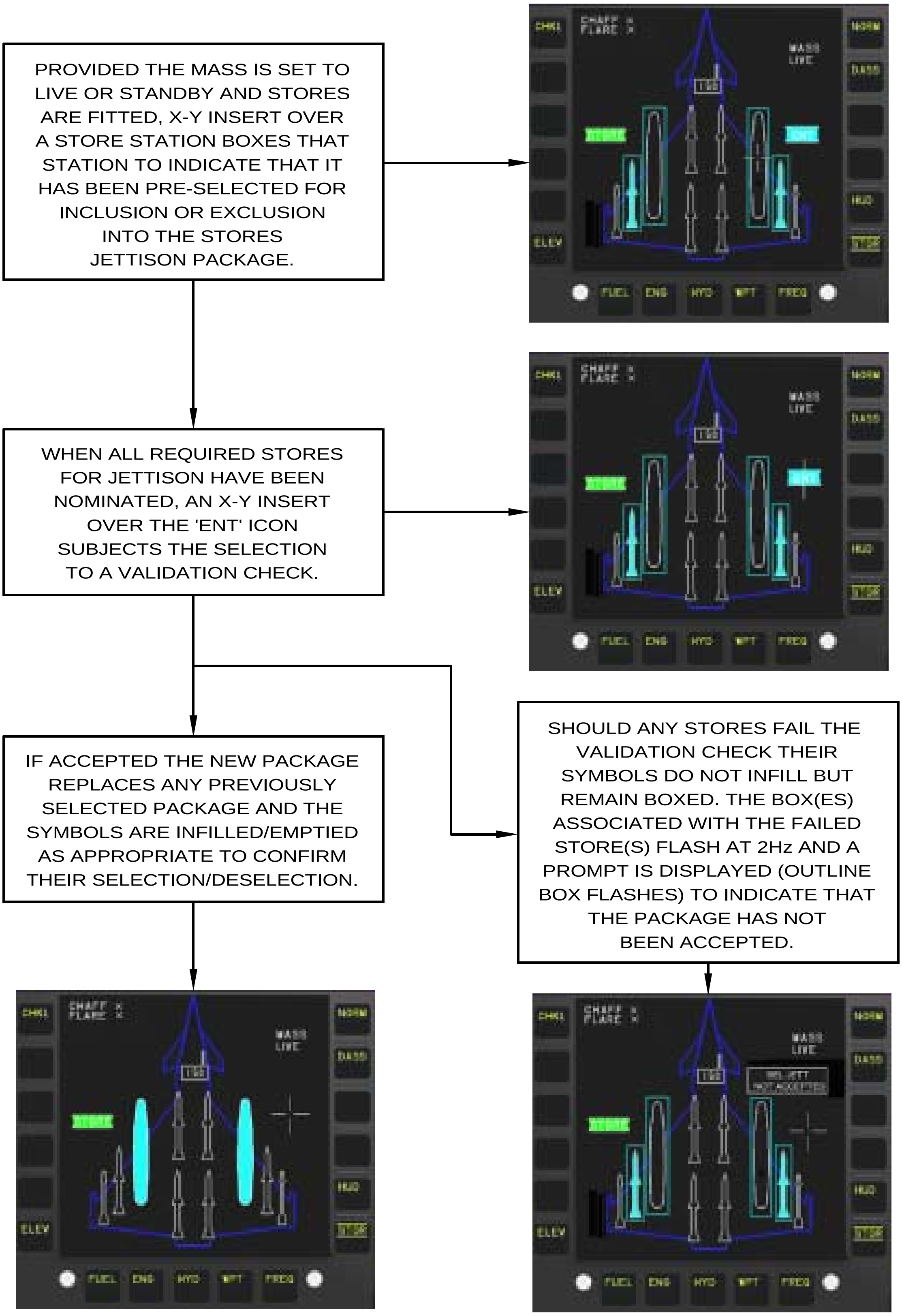


Figure 8.81 - Selective Jettison Package

LEGENDS ARE AUTOMATICALLY DISPLAYED BY DEFAULT FOR SEVEN SECONDS ON INITIAL SELECTION OF STORES FORMAT, OR AT ANY TIME BY PRESSING AN X-Y INSERT OVER THE 'STORES' LEGEND.

WHEN THE X-Y MARKER IS MOVED OFF THE 'STORES' LEGEND ALL STORES LEGENDS ARE IMMEDIATELY OCCULTED.

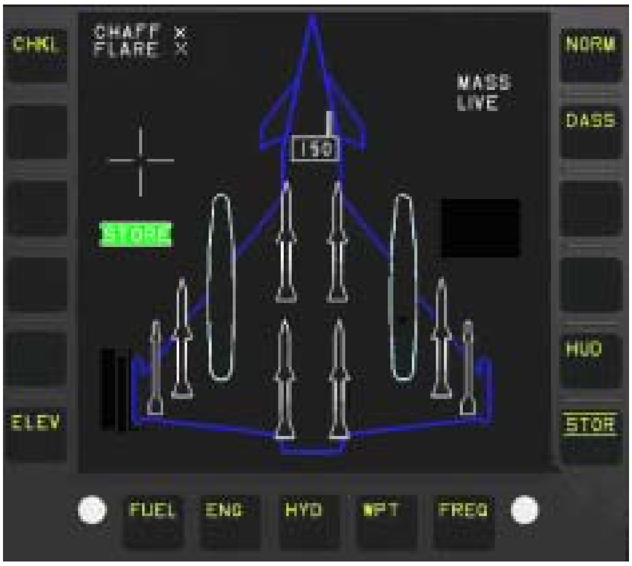


Figure 8.82 - Displaying Stores Legends

AMRAAM

AMRAAM PRINCIPLE FUNCTION

The Advanced Medium Range Air-to-Air Missile AIM-120 (AMRAAM) is a radar-guided, all weather, air-to-air missile for attacking airborne targets in medium range under ECM conditions.

The missile radar is capable of acquiring and tracking a target.

After launch, the AMRAAM can receive continuously target position information from the launch aircraft via data link. An inertial navigation system guides the AMRAAM to the target coordinates until the missile radar goes active and detects the target on its own. In an ECM environment the missile will “Radar Home ON Jam” (RHOJ).

The AMRAAM weapon system includes the missile, launcher, handling equipment, adapters, and ground support equipment.

The AMRAAM system includes electrical interface provisions between the Attack and Identification system and the AMRAAM.

The AMRAAM may be launched in a “Visual Mode” without Radar Lock On.

AMRAAM MISSILE

The AMRAAM missile (see Figure 8.83) consists of the guidance section, armament section, propulsion section, control section, wings, fins/control surfaces, harness and harness cover. Hooks and structural components of the rocket motor and warhead are part of the airframe and provide mechanical interface with the launchers.

GUIDANCE SECTION

The guidance section includes the hardware and software necessary to perform the functions of acquisition and track, navigation, guidance autopilot, fuzing (except the contact fuze), data link processing of the signals received from the control section, and secondary power section.

The guidance section consists of the Radome, seeker, transmitter, electronics unit, Inertial Reference Unit (IRU), Target Detection Device (TDD), batteries, power converter related harnesses and structure. All units except the TDD are contained within a sealed structure consisting of the pyroceram radome, skin sections and aluminum aft bulkhead. The TDD and antennas are attached to the skin section.

For the midcourse guidance messages from the launch aircraft are decoded via rear data link antenna receiver.

Terminal guidance is provided by illuminating the target with RF energy by the missile seeker, receiving reflected energy for signal processing to provide antenna pointing error information and missile steering commands to the control section.

SEEKER/SERVO

The seeker/servo electronics subassembly contains the following:

– Main Radar Antenna
– Guard Band Antenna
– RF Processor
– Servo Electronics
– Torquers in Azimuth and Elevation
– Inner and Outer Gimbals
– Rate Gyros in Azimuth and Elevation
– Radome

The Main Radar Antenna (MRA) radiates energy to illuminate the target and gathers energy for the signal processing to see the target.

The Guard Band Antenna (GBA) is a special antenna, which is mounted on the main antenna and designed to gather energy in the sidelobe of the main antenna.

The RF processor provides down-conversion of the I-band input signal to an L-band signal to be sent to the IF receiver. It also provides some preamplification and determines the noise figure to the missile.

The servo electronics controls the signals for the torquers.

The torquers are small motors that move the antenna assembly in azimuth and elevation.

The inner and outer gimbals provide the stable platform.

The rate gyros provide a feedback signal proportional to the angular rate of antenna motion and are used primarily in the TRACK mode.

TRANSMITTER

The transmitter consists of the following parts:

– Transmitter,
– Electrical conversion unit,
– Batteries.

The transmitter uses a Traveling Wave Tube (TWT), which allows a greater output power to be provided.

The entire system operates with two major waveforms: medium and high PRF.

The Electrical Conversion Unit (ECU) is powered from either the two thermal batteries or from the rectifier to supply the missile with DC power.

Upon ignition, the thermal batteries provide the required electrical power to the ECU for the entire flight time of the missile.

ELECTRONICS UNIT

The Electronics Unit (EU) is composed of eight circuit card:

– launch sequencer
– program memory
– remote terminal
– IF receiver/range correlator
– input/output
– filter processor
– AMRAAM data processor
– frequency reference unit.

The main task of the Launch Sequencer (LS) is to provide signals for firing batteries, eject command, unlock fins and rocket motor firing. It also provides the power-up master reset signal for launch.
The program memory stores the flight program and also the programs for BIT.
The remote terminal chassis is an interface between the aircraft and the missile during the launch cycle.
The IF receiver takes the incoming L-band signals and the range correlator extracts the range information from the signal return.
The filter processor carries out various digital filtering on the signal and breaks up the signal into various range and doppler bins.
The AMRAAM data processor is the main computing element of the missile.
The frequency reference unit is basically a frequency synthesizer which provides the clocks for the data processing. In addition, it develops the signal that is to be transmitted and sends it to the transmitter for amplification.

INERTIAL REFERENCE UNIT (IRU)

The inertial reference unit provides data for navigation and acceleration (in three physical axis, along with three-axis angular rates) of the missile.

TARGET DETECTION DEVICE (TDD)

The target detection device is an active C-band doppler radar, which is used to sense the approach of the target during the final moments of missile flight. It consists of four antennas, which are mounted on the skin of the guidance section, an RF processing assembly and three digital circuit cards.

ARMAMENT/WARHEAD SECTION

The armament section is located behind the guidance section in the missile and contains the Safety, Arming and Fuze Device (SAF) and the warhead. The warhead is detonated upon command from the TDD as soon as the target is within the kill radius of the missile.
For flight safety, the system is armed by the SAF. The SAF prevents the warhead from detonation until a safe separation distance from the launching aircraft is reached by employing an out-of-line explosive train between the detonators and the warhead. The SAF commits to arm after enable power is switched on by the Launch Sequence Unit (LSU) and a sustained longitudinal acceleration over a specified g level has been applied for a minimum time. After a minimum delay, which gives safe separation distance, the SAF will automatically arm the missile.
It also provides for safe storage, ground operation and captive carriage.
A contact fuze sensor is also integrated in the SAF, which will initiate detonation of the warhead when a sustained longitudinal deceleration over a specified g level has been applied for a minimum time.

PROPULSION SECTION

The AMRAAM propulsion section consists of three major parts:

– arm-fire-device
– rocket motor
– filter rectifier.

The arm-fire device (AFD) is an electromechanical device that provides ground and captive flight protection against inadvertent rocket motor ignition by utilizing out-of-line pyrotechnic elements and open circuits to the AFD initiators.
The safe or armed status is indicated in the Arming and Fuze Device (AFD) window located on the left side between the missile wings (see Figure 8.84).

NOTE

When the missile is installed on the underfuselage right hand rear station, the AFD window is only visible by the use of an inspection mirror in combination with a flashlight.

The AFD window will show a white “S” on a green background when in the safe position, and a white “A” on a red background when in the armed position.
The high-performance rocket motor utilizes a single reduced-smoke propellant in a boost-sustain configuration, an asbestos-free insulated case, which is an integral part of the airframe, and an integral aft closure/ blast tube/ nozzle assembly with a removable exit cone to facilitate control section installation.
The filter rectifier takes the 115 V 400 Hz 3-phase aircraft electric power form and converts it to +/- 135 V DC for use by the missile ECU.

CONTROL SECTION

The control section consists of four independently controlled electromechanical servo-actuators, four thermal batteries connected in parallel, a X-band data link assembly, four fins and a steel fuselage section. The missile wiring harness includes a 36-pin control section test access connector used for depot or factory system or section level testing. When unmated, a flight plug is installed.

AUXILIARY MISSILE HARDWARE

The missile includes wings, control surfaces and a wiring harness to electrically interconnect the missile sections. Parts of the wiring harness, which run outside the normal structure, are protected by a removable harness cover. The harness cover also contains a Thermally Initiated Venting System (TIVS), which cuts through the rocket motor case and safely vents the motor during a fuel fire cook-off condition.

TECHNICAL DATA

Length	3.66 m
Diameter	18 cm
Wingspan	53 cm
Finspan	64 cm
Weight	158 kg
Radar frequency	X-band
TDD frequency	C-band

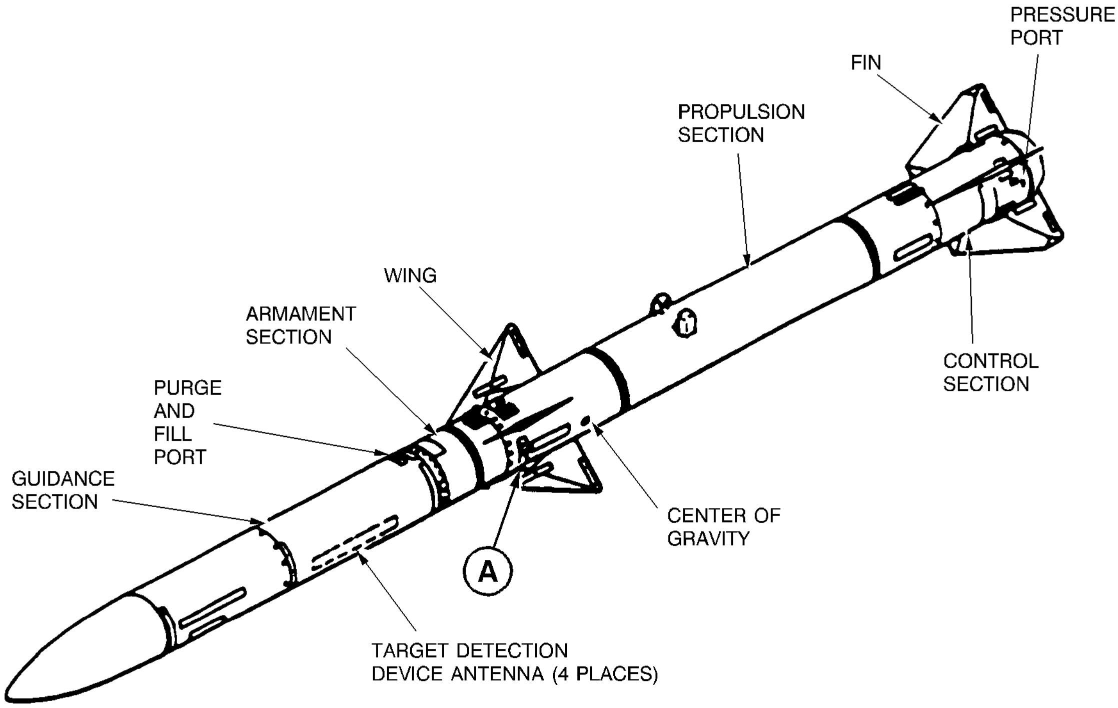


Figure 8.83 - AMRAAM missile (overall view)

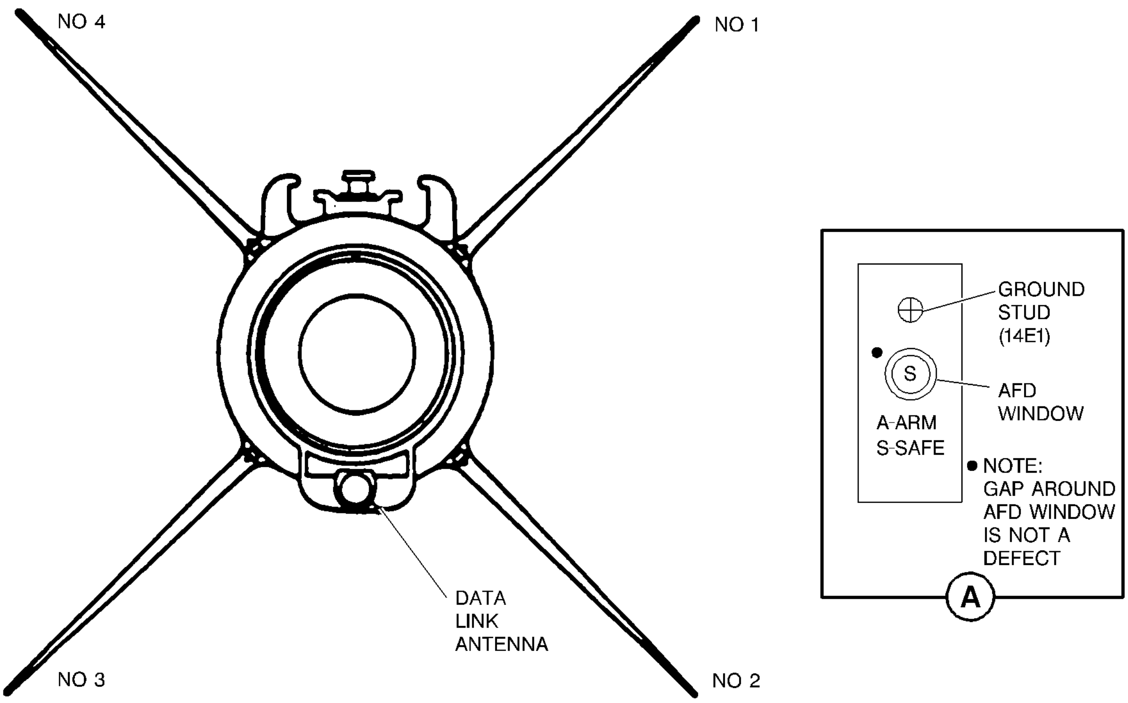


Figure 8.84 - AMRAAM missile (rear view)

AMRAAM FIRING

AMRAAM ATTACK

LAUNCH MODES

AMRAAM may be fired in either Normal or Visual Mode. With AMRAAM selected and a target in the DTL, the AMRAAM will be fired in Normal Mode. With AMRAAM selected and no target in the DTL, the AMRAAM will be fired in Visual Mode.

The pilot can also select Visual Mode by a second selection of AMRAAM on the HOTAS weapon select switch, refer to Figure 8.90 AMRAAM Mode State Transition Diagram.

NORMAL MODE

In Normal mode of operation, the missile is primed with the best available track data from own aircraft radar prior to launch. After launch the missile is inertially guided towards a precalculated intercept position. The target position is updated post-launch using the aircraft-missile data link. During mid-course guidance, the target must be kept within the radar scan volume, to maintain track data. At a pre-determined stage, the missile attempts to acquire the target using its own sensor. Once the missile acquires the target it uses the target updates received from the launch aircraft in parallel with its own target measurements. At a later stage in flight or when data link is lost, the missile turns off its data link receiver, and the AMRAAM enters fully autonomous operation. No data link transmissions can be received anymore.

VISUAL MODE

In short range environment, in the absence of target position information from the aircraft radar, the medium range missile can also be fired against targets which have been acquired visually by the pilot. The target must not be tracked by the radar.

In this mode the missile does not receive target position information either prior to or post launch, but flies out along weapon boresight and immediately attempts to acquire a target within its own radar field of view. Therefore the missile will go active directly after launch.

Visual Mode launch can be selected in two ways:

a. When no targets are designated (no DTL present), the first selection of AMRAAM on the weapon selector switch will select Visual Mode without acquisition cone (circle) in the HUD. Second selection will select the circle to on, third selection to off and so on.

b. When targets are designated (DETL present), the first selecting of AMRAAM on the weapon selector switch will select Normal Mode with ASE circle in the HUD. Second selection will select the Visual Mode with acquisition cone (circle) and third selection will re-select Normal Mode.

There are no cockpit controls required for priming of AMRAAM once visual mode is selected via the weapon select switch.

WEAPON SELECTION INDICATION

The AMRAAM selection is displayed on the HUD and MHDD weapon blocks with the number of missiles available. For example, when there are 5 AMRAAM available, the HUD will show "MRAAM 5" and the AF will show "M 5" boxed.

NOTE

When all stores have been fired, the weapons block shows "X" as number remaining.

AMRAAM MISSILE ASSIGNMENT

If one or more MRAAMs are allocated to the target, then the target index in the DTL is shown contrast inverted (black character on white background).

AUTOMATIC MISSILE ASSIGNMENT

If targets are designated, the system attempts to assign a single missile to each target in the DTL. It starts with the No. 1 target and moves down the DTL, assigning missiles until either all available missiles on the aircraft have been assigned, or all targets in the DTL have been assigned a missile.

Whenever new targets are nominated, existing ones are denominated or lost, or the DTL is re-ordered in any other way, the system will always attempt to assign a missile to each target in their priority order, within the constraints of the number of available missiles and any additional missile assignments made by the pilot. The system records multiple missile assignments and attempts to maintain these multiple assignments regardless of the weapon currently selected.

If a MRAAM fails to fire on pilot trigger press (a "hang up") the system responds by automatically assigning another missile (if one is available) to that target. If all missiles had been previously assigned, the missile assigned to the lowest priority DTL target is taken and re-assigned to the No. 1 target.

MULTIPLE MISSILE ASSIGNMENT

When AMRAAM is selected the pilot can manually assign more than one missile to a target. An insert by XY on the Missile Remaining "M" symbol on the AF modes the display and the XY controller for missile assignment. Upon XY insert the XY marker jumps onto the number one target in the DTL. Positioning the XY cursor over the required target alpha in the DTL creates a "ladder" display above the alpha, the ladder length being equal to the number of available missiles. XY inserting on the required number in the ladder assigns that number of missiles to that target.

If the number of missiles assigned to a target is increased but the requested number of missiles are not available for assignment, then the system automatically de-assigns missiles from targets lower down in the DTL until the requested number of missiles are available. Note that the system is not allowed to de-assign missiles from targets higher up in the DTL in order to fulfill a multiple missile assignment. This is reflected in the length of the ladder.

AMRAAM STEERING LAWS

Steering cues are shown on the HUD and, when the C/D Ball has been selected, on the Attack and Elevation Formats. The steering dot must be followed with the aircraft symbol in the HUD.

To get the first target of the DTL within the angular limits of the AMRAAM LSZ the steering dot must be "flow" into the ASE circle (around the aircraft symbol).

For steering laws see Figure 8.86.

STEERING WITH NO MISSILE SELECTED

With targets nominated but no weapon selected and the time to collision is less than 1000 sec., the steering dot provides lead collision steering (refer to Figure 8.87). If the time to collision is more than 1000 sec., the steering dot provides pure pursuit steering (refer to Figure 8.88).

STEERING WITH MRAAM SELECTED

While outside the weapon envelope the steering dot provides fighter/target collision steering in azimuth and elevation (refer to Figure 8.87). If the calculated collision point can not be reached within 1000 sec. Pure Pursuit steering is provided (refer to Figure 8.88).

NOTE

> Steering is for fighter/target collision only and does not consider optimum release altitude (ORA), therefore the pilot must input additionally steering commands to reach the ORA.

When inside Rmax, the dot provides optimum launch steering in azimuth (Lead Pursuit) and optimum launch angle in elevation. This steering is defined by missile requirements and will give the missile optimized kinetic energy and will minimize missile maneuvers (refer to Figure 8.89).

The transition between these conditions is 'smoothed' such that there is no obvious jump in the steering display.

Smoothing starts 5 seconds before reaching Rmax, i.e. "Time to Releas" is less than or equal to 5 seconds.

When inside Rmin the steer dot and ASE are occulted.

PRE-LAUNCH MISSILE SUPPORT (PRIMING)

ENGAGEMENT ORDER NUMBER

If more than one AMRAAM is launched against the same target, they are provided with different "Engagement Order Numbers" prior to launch.

GENERATION OF AMRAAM MISSILE ID

In order to establish an unambiguous link to each AMRAAM in flight, the AC determines an unique ID for each missile prior to launch.

DETERMINATION OF THE DATALINK PARAMETERS FOR AMRAAM POST-LAUNCH SUPPORT

As part of the pre-launch sequence parameters like datalink frequency and pulse width for the AMRAAM post-launch datalink are determined and sent to the missile.

The transmission channels for the datalink are defined by the DASS. The radar is informed of these channels and determines the corresponding transmission frequency as difference value to a defined base frequency.

FIRING A SINGLE MISSILE

To fire the missile the Late Arm switch on the stick top must be moved to the Armed position and the trigger must be pressed to the second detent (first detent starts the VVR only). Note that the missile will be fired even when a valid shoot condition does not exist.

If no designated target exists the AMRAAM is released in Visual Mode.

FIRING MULTIPLE MISSILES

When firing multiple missiles against one or several targets then the next missile can be fired by pressing the trigger again to the second detent, provided that the previous missile has finished its release and the Late Arm is still selected to Armed. If the previous missile has not finished its release (takes about 1.6 sec.) the second trigger press is ignored.

LAUNCH

By pressing the trigger, electrical power is sent to the missile to ignite its thermo batteries. The missile uses the first 150 to 235 msec to initialize and test the AMRAAM Data Processor (ADP). After this period a time synchronization of the missile and a "wake-up" is performed. The missile receives now target and system data from the avionics system and, in turn, transmits status information to the avionics system until the guidance section of the missile is operational and updated. After a final internal safety check the missile reports commit-to-launch as status to the avionics system, which initiates the firing sequence. Approximately 1.25 sec (not exceeding a max. of 1.6 sec) will elapse from trigger activation to missile ejection.

After safe separation the rocket motor is started, full missile guidance will commence at about 80 ft in front of the aircraft.

LAUNCH SEQUENCE

The automatic Launch sequence is

a. left wing
b. right wing
c. left rear
d. left forward
e. right rear
f. right forward

provided all missiles have the same status.

MISSILE PHASES OF FLIGHT

After AMRAAM launch in the normal mode the missile uses three distinct guidance phases, which are command-inertial, autonomous-inertial and active terminal (see Figure 8.85).

After launch the missile will continue on command-inertial guidance, updated via data link, until it is close enough to switch on its active radar seeker for the active terminal phase of its flight. Data link is achieved using the lower-power side lobes of the aircraft radar acting as data link.

POST-SHOOT STEERING

At SP3 there is no post-shoot steering, only "Turnaway Limits" will be indicated. Post-shoot steering will be available at a later software standard. If there is no target in the DTL anymore the steering dot is occulted.

MRAAM DE-SELECTION

With one or more medium range missiles still in flight MRAAM is deselected, either by selecting SRAAM, Gun, NO WPN, or VISident the system continues to generate the post-shoot indications and to transmit Data Link messages to the in-flight AMRAAM' until the TTA for the last AMRAAM in flight decrements to zero.

Note that the Steer Dot reflects the steering law on the selected weapon type. For example, if the pilot selected SRAAM from AMRAAM with medium range missiles in flight then the Steer Dot would reflect SRAAM steering to the DTL No. 1 target, but the post-hoot turnaway limit symbology would allow the pilot to support the in-light medium range missiles whilst carrying out the SRAAM attack.

MISSILE HUNG-UP

If a MRAAM fails to fire on pilot trigger press (a "hang up") the system recognizes the hang up and therefore does not move the target into the PETL upon trigger press. The target will remain in the No. 1 position and missile assignment is retained (if one is available). The pilot must press the trigger again to fire the new missile. A Cat 3 warning with its associated voice warning will be generated.

As the missile may not be recoverable the total number of available missiles on board is decremented by one. The Stores Format will indicate the hang-up missile. To clear the hang-up state the pilot may attempt to selective jettison the hang-up missile.

RE-ATTACK

RE-ATTACK (HEAD UP)

A previously attacked target may be selected for re-attack by pressing the re-attack switch (throttle top). Note that this re-attack procedure is only available with MRAAM, Gun or "No Weapon" selected.

RE-ATTACK (HEAD DOWN)

A previously attacked target (i.e. whose track alpha is now in the PETL) may be selected for re-attack by inserting once with the xy marker positioned over the target alpha in the PETL.

AIMING INDICATION

WEAPON AIMING CUES

ACQUISITION CONE (VISUAL MODE)

A gapped circle of fixed diameter centered on the LFD in the HUD and HD HUD format will indicate where the AMRAAM will search when launched in Visual Mode (7.5° around the boresight). The circle is displayed automatically when Visual Mode is selected from Normal Mode (second selection on weapon select switch when targets are designated). The circle is initially not displayed when Visual Mode is selected without designated targets, but could be switched on or off by further selections to AMRAAM with the weapon select switch.

ALLOWABLE STEERING ERROR (ASE)

When within Rmax1, the system calculates the Allowable Steering Error (ASE) and displays it as a circle on the HUD, HDHUD and Climb/Dive Ball when selected. This is a measure of the maximum allowable error between the steering dot and the HUD aircraft symbol whilst still providing the missile with sufficient energy to allow a hit if launched at that moment. At Rmax the circle has the size of a dot which increases for smaller ranges and collapses at Rmin. The consequence of firing an MRAAM whilst the steering dot is outside the ASE circle will be insufficient kinetic energy for the missile to reach the target.

LAUNCH SUCCESS ZONES (LSZ)

With a missile selected and targets nominated, the system calculates the minimum and two maximum ranges of the weapon.

The two maximum ranges are:

a. Rmax1, the maximum launch range assuming that the target remains at 1 g, i.e. non-maneuvering (also called '1 g envelope'),

b. Rmax2 (also called Rmvr), the maximum launch range assuming that the target performs a worst case escape maneuver (up to 9 g) during the MRAAM fly-out (also called 'no escape' range).

The minimum range (Rmin) is defined by the larger of the following ranges:

– the slant range at which the target just cannot be reached by an AMRAAM by kinematic reasons

– the slant range at which an AMRAAM launch would endanger the own aircraft.

The minimum range (Rmin) is indicated by flashing cross on the HUD TD box.

The LSZ scales for up to the first six targets are shown on the Attack Format. The LSZs are calculated simultaneously where the iteration rate is highest for the top DTL target and is gradually decreased for the remaining DTL targets. That for the No. 1 target is shown double thickness to highlight it from the other LSZs. Where several LSZs are calculated for close targets grouped in a Track group Symbol, only the LSZ for the highest target in the DTL within the Group is displayed on the AF.

The LSZ for the No. 1 target is shown also on the HUD and HDHUD. The LSZ is not of constant scale and cannot therefore be judged by length, but a range marker with a digital readout moves in elevation against the scale line to reflect the own range relative to Rmin, Rmax1 and Rmax2. If the target range is less than Rmin the marker will park at the bottom scale (Rmin) and rotate to point down. If the target range is greater than Rmax1 the marker can travel past the maximum range limit of the LSZ scale. If it reaches the HUD FOV limit, the pointer will park and rotate to point up.

A digital readout of LSZ Rmax is also displayed on top of the LSZ scale.

TARGET ASPECT ANGLE

Indicates the aspect angle between first target and own aircraft with up to two digits followed by "R" or "L" representing right or left movement. "1R" to "17R" represents angles 5° to 175° clockwise, "1L" to "17L" represents angles 5° to 175° anti-clockwise. Between "1R" and "1L" single character "T" indicates tail approach, between "17L" and "17R" a "H" indicates head on approach.

Example: "2R" will be shown for angles ≥15° and <25°. Note that target aspect angle is also indicated via the attack format track/target velocity vectors and HUD aspect angle pointers.

MRAAM TARGET RANGE CIRCLE

A circle of fixed diameter centered on the aircraft symbol indicates range to target when sightline range is ≤ 12 000 ft. The circle unwinds anti-clockwise when range decreases or winds up when increasing. In addition a MRAAM minimum range marker is also provided. When the minimum range >12 000 ft or the data is invalid, the marker (dot) is displayed at the 12 o'clock position.

OPTIMUM RELEASE ALTITUDE (ORA)

With MRAAM selected, a target nominated and outside Rmax, the system calculates the optimum launch altitude. This is displayed for the No. 1 DTL target, on the Attack Format at the position of the shoot cue, which will occur upon successful firing opportunity, refer to Para . Inside Rmax the ORA and will be occulted.

NOTE

The steer dot does not consider the optimum release altitude.

PROBABILITY OF INTERCEPT (POI) AMRAAM

With AMRAAM selected, the system calculates the probability that the missile will acquire, track, and intercept the No. 1 DTL target if data link updates are provided until missile goes autonomous. Factors affecting POI are target range with respect to Rmax and the selected radar mode. POI is displayed as a percentage (e.g. 100%) above the MRAAM range to target scale on the HUD and HDHUD when the target is within Rmax. The PIO figure is only valid when the pilot centers the steering dot within the ASE.

MINIMUM RANGE INDICATIONS

When target range equals calculated Rmin, a small flashing cross is displayed on the HUD TD box to prompt the pilot he is now at minimum firing range. This indication is provided for the top 6 targets in the DTL.

BREAKAWAY INDICATION

WARNING

DO NOT RELAY ON RADAR DERIVED INFORMATION FOR SAFE SEPARATION.

To highlight the fact that there is a risk of the aircraft colliding with the No. 1 target (if it is the radar LF track), the system generates a large breakaway indication when certain conditions are satisfied. These conditions involve a minimum range to target (150 m) and/or a minimum 'time to collision' to target (5 sec.). The indication is a large outline cross displayed on all HUD and MHDD formats.

Note that the breakaway indication is presented for air to air lock follow targets only.

SHOOT CUE

When the following firing parameters are satisfied:

a. target range is less than Rmax and greater than Rmin, i.e. the target is within the LSZ
b. the steering dot is within the ASE circle
c. the POI is greater than 50%

the flashing characters "SHOOT" are shown for the number 1 target on the Attack Format. On the HUD and HDHUD a flashing diamond on top of the Target Designator Box and the flashing characters "SHOOT" are shown.

NOTE

There are no missile firing interlocks related to the SHOOT cue. The pilot may fire at any time, irrespective of the display of the cue.

TIME TO RELEASE/RMAX

While the target is outside the weapon envelope the system calculates the time until the No. 1 target reaches Rmax. If there is no closing speed between the aircraft and the target, the time to Rmax is set to a constant value. This is displayed in digital form on the Attack Format, the HUD and the HDHUD (below the LSZ).

TIME TO AUTONOMOUS (TTA)

Prior to launch and when inside Rmax the system monitors the aircraft-target geometry and kinematics and calculates the time that the AMRAAM would take to commence autonomous operation after launch, if fired now. Until the missile goes autonomous the launch aircraft should maintain the target track in order to provide radar data link to the AMRAAM. After launch calculation continues and takes into account target maneuvers and elapsed missile flight time.

The TTA is displayed as follow:

– On the AF the TTA for all missiles in flight are presented in analogue format (circle winding down), and the single longest TTA in digital format. The TCRI identifies each missile if several missiles are in flight. The analog indication will occult approximately one second after TTA reaches zero.
– On the HUD and HDHUD, the single longest TTA is displayed in a digital format on the right lower corner, and the analog indication of the longest TTA of all missile in flight against a target will be indicated by a caret on the target symbol.

TURNAWAY LIMITS (STAND OFF STEERING CUE)

With medium range missile in flight the system calculates the steering limits, in both azimuth and elevation, that allows the pilot to maintain the target within the radar gimbal limits. If several medium range missiles are in flight the system calculates a combined turnaway limit such that, all targets may be kept within the radar gimbal limits and all missiles remain within the data link side-lobe limits. The turnaway limits are indicated on the HUD and HDHUD as a box. Keeping the aircraft symbol within the box will keep the aircraft within the turnaway limits. The box is also displayed on the L and R MHDD C/D Ball when selected. The Turnaway Limits are removed when all the TTA for AMRAAM have reached zero.

TIME TO IMPACT

At the time of launch, the system starts to calculate the time that the AMRAAM will take to hit the target, which will obviously be longer than the AMRAAM time to autonomous. This calculation is updated cyclically after missile release to take account of target maneuvers and elapsed missile flight time.

Due to a maneuvring target the time to impact may increase and may exceed the remaining maximum AMRAAM flight time. The system generates a 'caution' to the pilot by "flashing" the missile in flight cues (i.e. blue infill on the Attack Format and the cross inside the TD box on the HUD). The flashing

will stop if the target can be reached by the missile again, e.g. due to a favorable target maneuver.
When the system has calculated that the missile has reached the target, or the missile flight time has exceeded its maximum possible flight time then the blue infill reverts back to the system hostility color.
When the time to impact (or the longest time to impact if multiple AMRAAM's are in flight against a single target) reaches zero, the missile in flight indications are removed from the track symbols on the Attack, Elevation and PA Formats and HUD/HDHUD.

MISSILE IN FLIGHT CUE

When a MRAAM is in flight against a target in either the DTL or PETL and no further MRAAMs are allocated to that target then a dark blue infill is shown around the index, and a vertical cross is drawn inside the HUD TD box, until the missile flight time reaches zero.

WEAPON CHANGE POST SHOOT

If another weapon (e.g. SRAAM) is selected following MRAAM launch the system continues to provide mid-course guidance data link (AMRAAM) for the calculated missile time to impact or maximum time of flight. The steering dot reflects the steering law of the current selected weapon type. For example, with SRAAM selected with a MRAAM in flight then the steer dot provides SRAAM steering to the DTL number 1 target, but the turnaway limit symbology is still presented to ensure continued support for the MRAAM until the appropriate time.

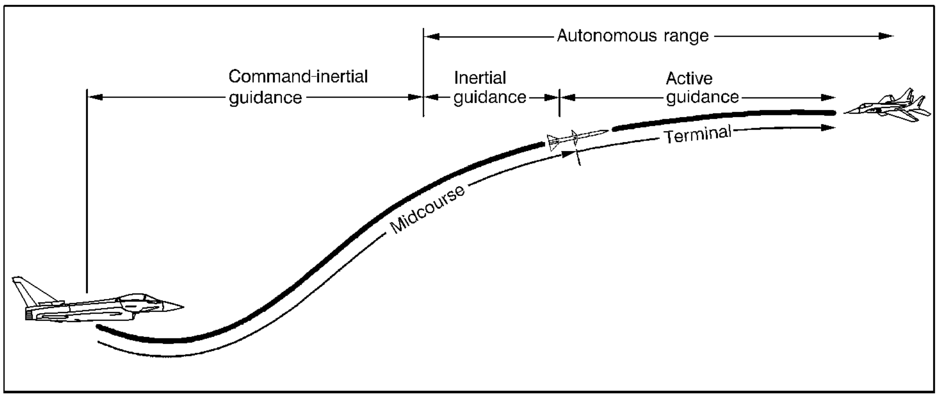


Figure 8.85 - AMRAAM Phases of Flight

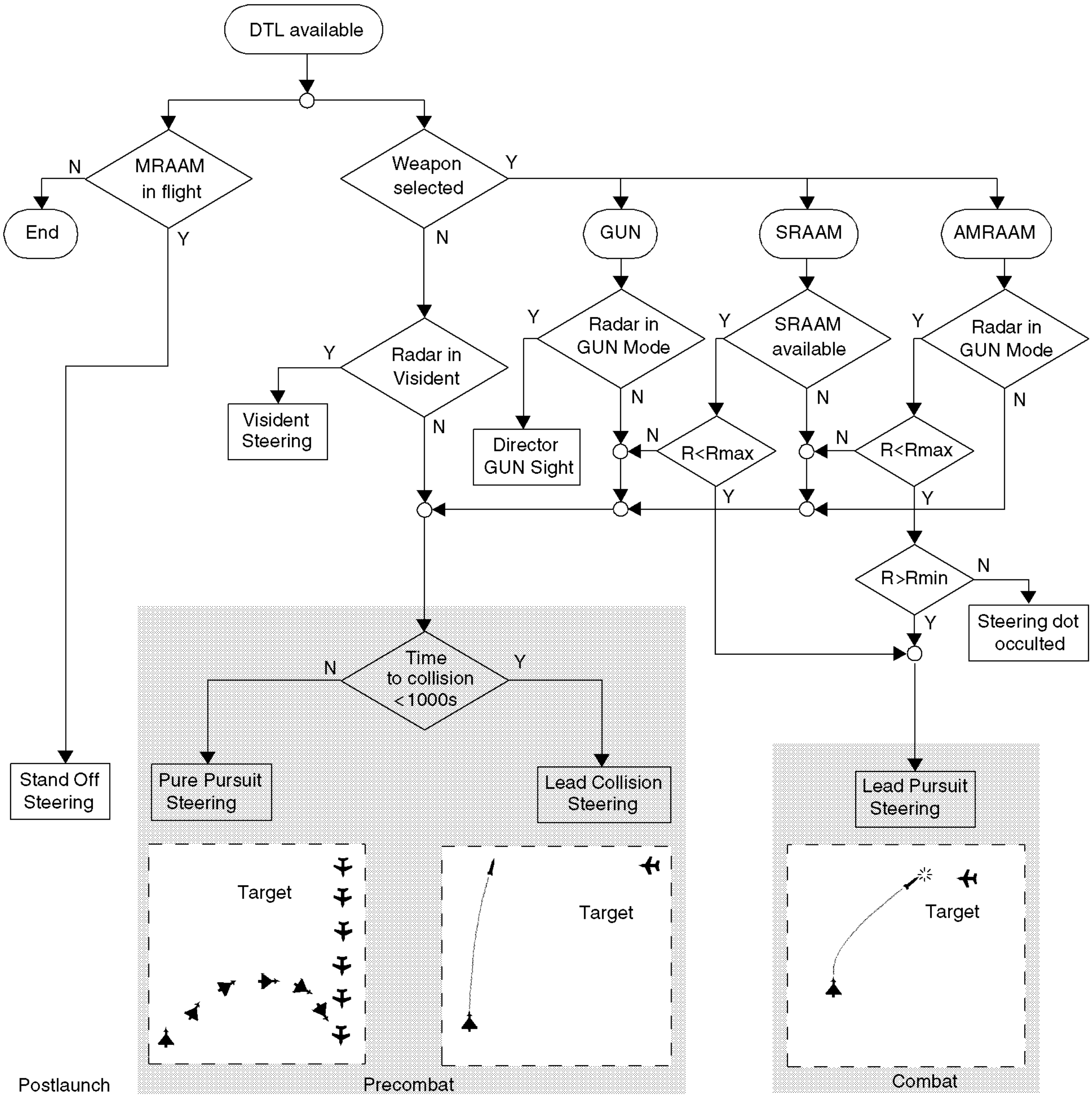


Figure 8.86 - Steering Moding

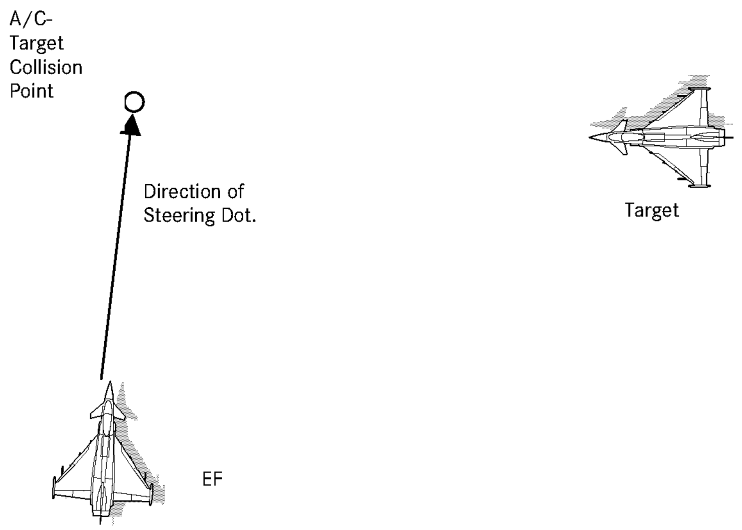


Figure 8.87 - Lead Collision Steering

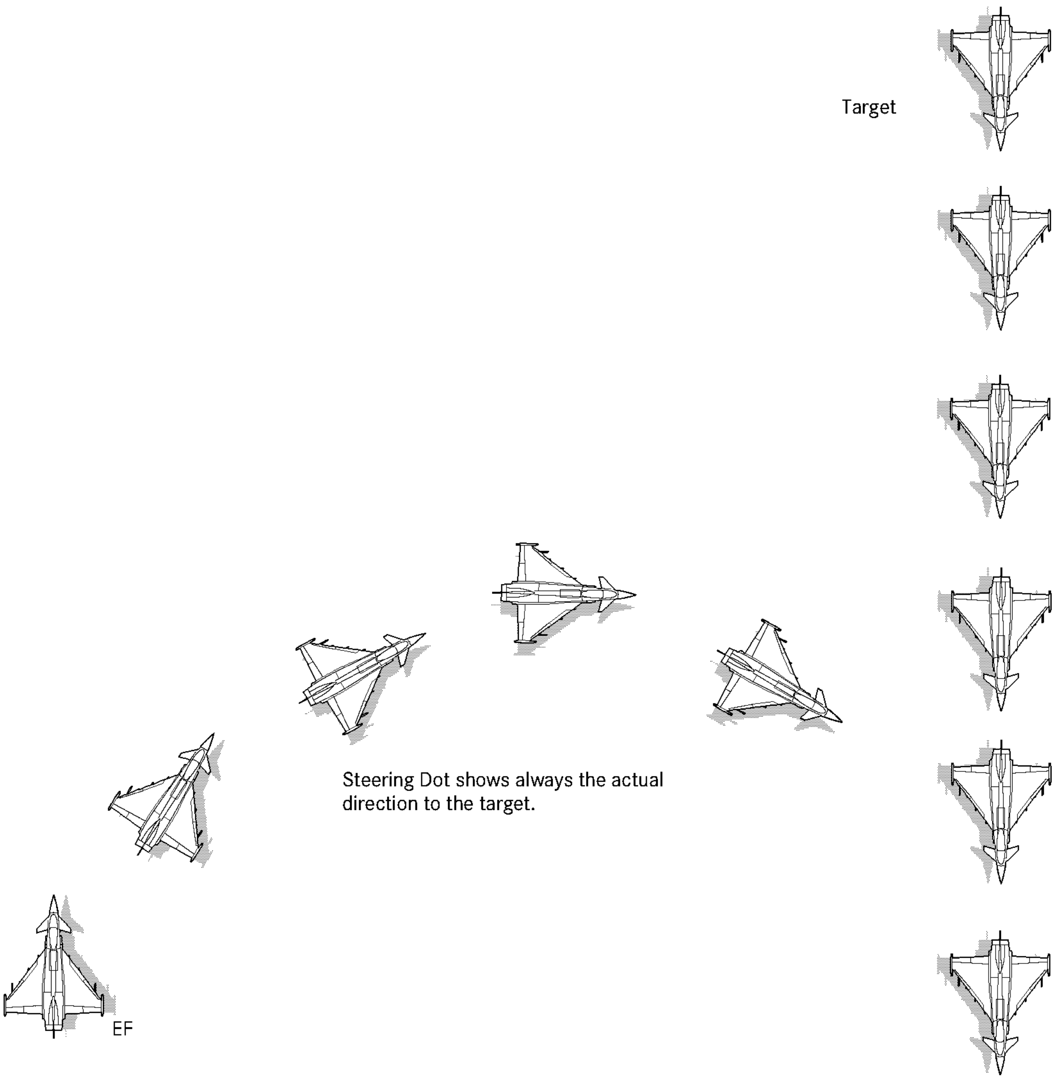


Figure 8.88 - Pure Pursuit Steering

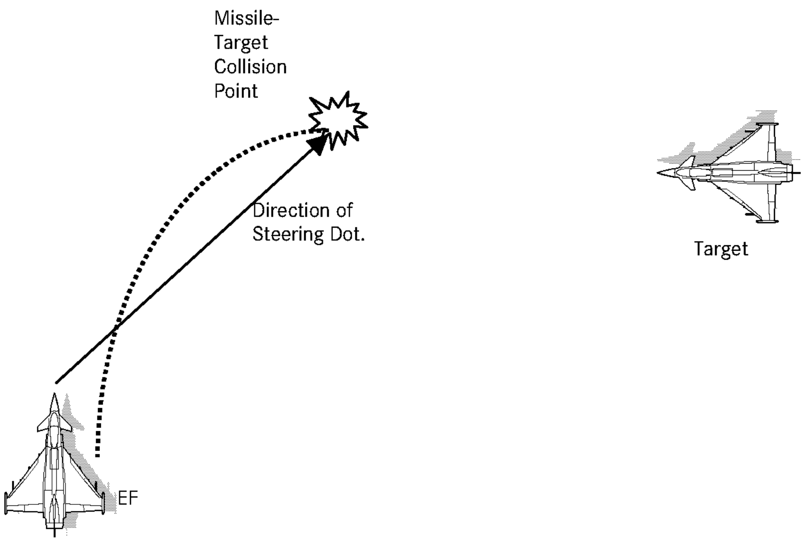
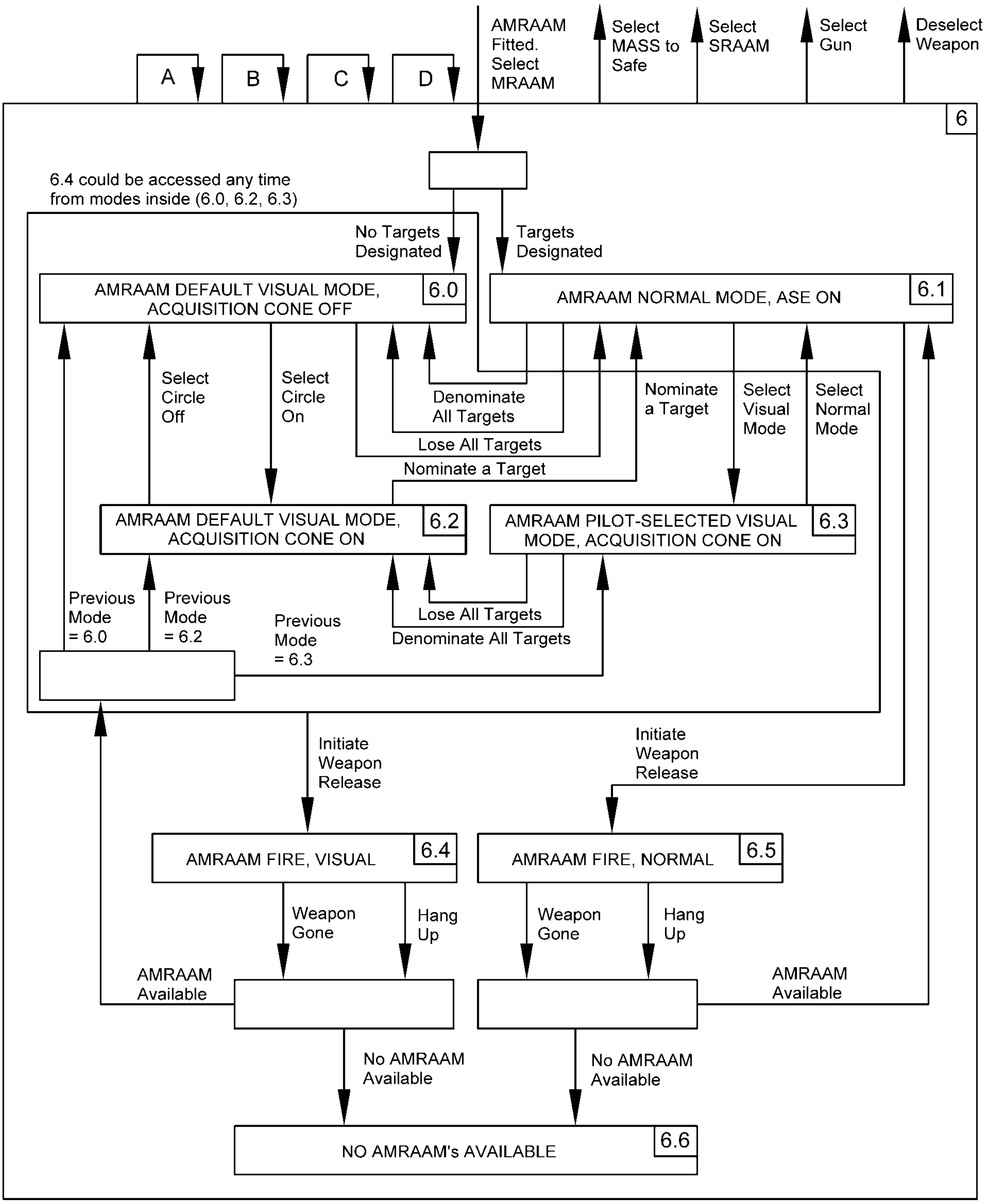


Figure 8.89 - Lead Pursuit Steering



A = Select Late Arm to Safe
B = Select Late Arm to Armed
C = Select MASS to Standby
D = Select MASS to Live

Figure 8.90 - AMRAAM Mode State Transition Diagram

ARMAMENT CARRIAGE AND INSTALLATION SYSTEM (ACIS)

The Armament Carriage and Installations System (ACIS) consists of specific items which are essential to the carriage of the stores in various weapon configurations.
The ACIS carries the stores in safe conditions and ensures safe separation and effective release/ jettison when commanded by the pilot. The ACIS is designed for the EFA's primary role of Air to Air combat, but also considers its secondary role Air to Surface missions capabilities.
The aircraft can carry 4500kg of external stores on its 13 suspension stations.
An overload configuration can carry up to 6500kg of external stores with possible associated reduction of the maneuverable envelope.

WEAPON STATION

The 13 weapon stations are located under the fuselage and under the wings see Figure 8.91 Weapon Station and Pylon Configuration.
They are as follows:

– Four underfuselage stations dedicated to the Medium Range Air to Air Missiles (4 AMRAAM) and configured to a low drag missile installations (stations No. 2 and 3) on ejector launchers.
– One center underfuselage station where either pylon equipped with one AHDERU (station No. 1) or the 1000 l Supersonic Fuel Tank (SFT) equipped with the Tank Ejector Unit (TEU) can be fitted.
– Six underwing stations (station 4, 5, 6 left and right). Stations 4 carry the inboard wing pylons equipped with ALDERUs and it is also possible to install the Twin Store Carrier (TSC). Stations 5 carry either the centre wing pylons equipped with AHDERUs or the 1000 lt Supersonic Fuel Tanks (SFT) equipped with Tank Ejecting Unit (TEU). Stations 5 are the wet stations when fuel tanks (1000 lt or 1500 lt) are fitted. Stations 6 carry the outboard wing pylons equipped with ALDERUs and it is also possible to install the Twin Missile Carrier (TMC).
– Two underwing Integrated Tip Stub Pylon Launchers (ITSPL) (station 7) are dedicated for carrying ASRAAM/AIM-9L or AISPOD.

ACIS CONFIGURATION

The objectives of the Flight Test Programme regarding to the ACIS configured to interface with AVs SP 3B can be briefly summarized as follows:

– Equipment installation
– Loading/unloading of external stores
– Carriage of external stores configuration
– Fuel tanks jettison in emergency condition when I-AHDERU is fitted
– Fuel tanks jettison when AHDERU is fitted
– AIM9L firing in boresight from tip station
– Jettison AMRAAM from underfuselage stations

The external stores configuration is the basic AIR-TO-AIR with or without external fuel tanks. Four AMRAAM Captive Air Training Missiles (CATM) and two AIM-9L Handling Round (HR) or Environmental Round (ER) or Booster Round (BR), are carried.
The AMRAAM are loaded on the four underfuselage stations dedicated to the Medium Range Air-to-Air Missiles (MRAAMs) and on the MFRL installed on the two outboard wing pylons. The AIM-9L are loaded on the two Integrated Tip Stub Pylon Launchers (ITSPLs) dedicated to the Short Range Air-to-Air Missiles (SRAAMs) and on the MFRL installed on the two outboard wing pylons.

SYSTEM CONFIGURATION DESCRIPTION

To achieve the objectives of the Flight Test Programme for DA7 and to allow loading and carriage of the external store configuration, the ACIS is composed by the following role equipments:

– Two Integrated Tip Stub Pylon/Launcher (ITSPL)
– Two Rail Beam full standard with cut-outs for MFRL Common Component Detent Mechanism and Snubbers
– Two MFRL Common Component Detent Mechanism and Snubbers
– Four Captive Carriage MRAAM Eject Launcher (CCMEL)
– Four full standard MRAAM Eject Launcher (MEL)
– Three Tank Eject Unit (TEU)
– Two centre wing pylon
– Two Interim AHDERU or two Full Standard AHDERU
– Two Outboard Wing Pylon
– Two Advanced Light Duty Ejector Release Unit
– Two Multi Function Rail Launcher

INTEGRATED TIP-STUB PYLON/LAUNCHER

The two Integrated Tip-Stub Pylon/Launcher (ITSPL) are fitted under the left and right wing of the aircraft (station 7). Each ITSPL is permanently bolted to the wing and is equipped with the following components:

– Rail Beam full standard with cut-outs for MFRL Common Component Detent Mechanism and Snubbers
– MFRL Common Component Detent Mechanism and Snubbers

The ITSPL function is to ensure carriage/launching of the AIM-9L missiles from the aircraft. The ITSPL are not jettisonable.

The external structures have labels applied indicating the location of the dummy components and the operating points.

RAIL BEAM

The Rail Beam is attached to the ITSPL structure by means of a large amount of equally spaced countersunk screws via anchor nuts fixed to the Rail Beam side walls. Its function is to allow the loading, unloading, launching and carriage of AIM-9L missiles.

MFRL COMMON COMPONENT DETENT MECHANISM AND SNUBBERS

The Common Components Detent Mechanism and Snubbers are mounted on the Rail Beam by means of countersunk screws.

The function of the Detent Mechanism is to prevent fore and aft longitudinal movements of AIM-9L missile during carriage by restrain the missile forward hanger, to allow engagement/ disengagement of the detent latches for missile loading/unloading and to permit the missile firing.

The main function of the snubbers is to eliminate all roll about the x-axis of the AIM-9L missiles throughout the flight envelope.

DUMMY COMPONENTS

The following dummy components are fitted in the ITSPL:

– Chaff Dispenser
– Cooling Bottle with Control Valve

These components are Mass and Center Gravity representative of the real components.

CENTRE WING PYLON

The Centre Wing Pylon (CWP) is installed underwing by means of a main spigot and an aft yaw bolt.

The CWP function must ensure carriage/jettison of the 1500 lt fuel tank from the aircraft. The CWPs is equipped with the following components:

– Interim AHDERU or Full Standard AHDERU;
– Fuel, Air, Electrical Connections for the 1500 lt fuel tank;
– WPSU.

Cut-outs in the CWP structure provides accessibility to AHDERUs operating points (safety handle, cartridges, throttles, arming units, supplementary safety devices, strong points, sway brace preloading device, manual latching).

The CWPs external structure has labels applied which indicate the location of the operating points and the applicable max torque value.

The full electrical wiring is provided within both LH and RH CWPs.

INTERIM ADVANCED HEAVY DUTY EJECTOR RELEASE UNIT (I-AHDERU)

NOTE

- The Interim AHDERU is mechanically similar to the AHDERU full standard and differs for the gas system, which is now at abandoned CERU 204 cartridge standard instead of the current ARD-446 which is still under development.
- This Interim standard leads to a performance limitations of one emergency jettison only.

The Interim Advanced Heavy Duty Ejector Release Unit (I-AHDERU) is an ejector release unit with conventional 14" and 30" twin hook spacing installed in either the center underfuselage station or the left and right center wing stations of the aircraft. It is a light and compact unit intended to carry and release or eject externally carried stores.

To achieve the objectives of the Flight Test Programme the I-AHDERU permit correct loading/ unloading of the 1500 lt fuel tank and ensure safe carriage, restraint and the emergency jettison.

The fuel tank can be latched to the I-AHDERU by automatic and dependent engagement and latching of the store lugs in the ERU hooks. The latching mechanisms allow only the open or closed positions of the hooks with no intermediate positions. The I-AHDERU kinematic can also be manually operated, for both latching and unlatching, at central operating points. The hooks status is sensed by two independent microswitches. To avoid any inadvertent release, a dedicated clearly visible safety handle operable from both sides is available (SAFE and UNSAFE positions) to mechanically and electrically inhibit the release of the suspended stores. The safety handle can only be placed in the SAFE position when both hooks are fully engaged in the closed position. The stores are then braced by driving the crutching system from a single easily accessible operation point. The store bracing is applied by lowering, along vertical guides, two swaybraces, located at the extremities of the unit and connected to gather by a threaded rod and wedges driving system, which evenly distributes the crutch load, both on ground and in flight, as well as ensuring a high store alignment repeatability because of their stiff and fixed geometry. With the

store latched and braced the operating areas for these safety devices are fully accessible.
Two impulse cartridges, can be fitted in the combustion chamber of the pylons located on the top of the unit in a central position, in order to provide the needed power source for ejection. The cartridges are independently ignited by the two channels of the electrical circuit. Sympathetic ignition occurs in case of failure of one of the electrical channels without loss of performance. Each firing circuit of I-AHDERU is fully protected against electrical hazards with a relay, an RF filter, a surge limiter and a resistor.

ADVANCED HEAVY DUTY EJECTOR RELEASE UNIT (AHDERU)

The Full Standard AHDERU is considerably similar at the I-AHDERU with the exception of:

- the gas system which is optimized to the ARD-446 cartridges standard;
- the hook design which is enhanced to favor the opening during the release and jettison phase;
- the latching system design is improved to ensure the hooks independence during loading and to constrain the hooks to a simultaneous movement during opening.

CAPTIVE CARRIAGE MRAAM EJECT LAUNCHERS (CCMEL)

There are four Captive Carriage MELs (CCMELs), fitted under the left and right center fuselage (station 3) and under the left and right rear fuselage (station 2).
The aft left hand launcher is identical to the fwd right hand launcher and conversely the aft right launcher is identical to the fwd left hand launcher.
Each CCMEL is bolted to the relevant attachment points into the fuselage and is permanently attached to the aircraft. The main function of the CCMEL is to permit correct loading and unloading of the AMRAAM. The CCMEL also ensure Safe carriage and restraint of the missile to the aircraft throughout the flight envelope. The CCMELs fitted into the aft bays are provided with a baseplate which includes cut-outs for the fwd and aft rams, the fwd and aft missile lugs and the ground safety devices.
The baseplate is removable to give access for role change. The CCMEL contains only the FTI wiring.

MRAAM EJECT LAUNCHERS

Four MELs, two configured as left hand and two as right hand launchers, are installed on the aircraft. The basic aft left launcher is identical to the forward right hand launcher and conversely the aft right hand is identical to the forward left hand launcher. Each MEL will be bolted to the relevant two attachment points into the fuselage and will be permanently attached to the aircraft. The MEL function is to permit the correct loading, unloading, carriage, jettison and firing of the AMRAAM.

TANK EJECTING UNIT (TEU)

The TEU is designed to carry, release and jettison an external 1000 liters Supersonic Fuel Tank (SFT) or to carry the MPCP (MPCP release and jettison is not allowed).
The TEU is a "spigot bolt" type Latching System with an integrated cartridge powered ejecting device. The SFT can be jettisoned by the TEU which is electronically controlled by the ACS.
The TEU consist of five main components:

- the block and barrel assembly;
- the operating and safety mechanism;
- the crutching and latching mechanism;
- the gas system;
- the electrical assembly.

The block and barrel assy is the major structural component of the TEU. It is attached via four mounting bolts to the SFT or MPCP.
The operating and safety mechanism consists of the cam and kinematics assembly which is triggered by a "Safety Handle" to operate the TEU manually. The three positions of the Safety Handle are:

- Unlatched: the latching elements of the TEU are withdrawn, the SFT or MPCP can be loaded to, or down-loaded from the aircraft.
- Armed: the gas pipes are open, the locking cam is rotated in such a way the cartridge ignition circuit is closed.
- Safe: release and ejection of the SFT is physically inhibited and the cartridge ignition circuit is interrupted.

The crutching and latching mechanism comprise of crutching collar, a worm and wheel gearbox, a conical ring, a latching element and a preload device.
The gas system consists of the breech with two cartridges holder assemblies, a valve and a tube which connects the breech with the ejection piston installed in the block and barrel assembly. The two cartridges are fired by an electrical impulse via an isolation unit controlled by the ACS.
The electrical assembly comprises an isolation unit with dual redundant firing circuits, a safety switch and all necessary wiring and connectors.

MULTI PURPOSE CAMERA POD (MPCP)

The Multi Purpose Camera Pod (MPCP) can be carried on the underfuselage center station and/or on the left and right wing center stations.
The MPCP is a dummy store thoroughly representative of the 1000 lt Supersonic Fuel Tank shape and inertia.

NOTE

When the MPCP is installed the jettison functionality is not required and it is therefore inhibited.

EXTERNAL FUEL TANKS

There are two types of fuel tanks and are as follows:

– A 1000 liter Supersonic Fuel Tank (SFT) with an integrated pylon and ejector device (TEU) installed on the underfuselage center station and/or on the left and right center wing station The fuel tanks may be jettisoned in such a way to obtain a clean aerodynamic airflow.
– A standard 1500 liter subsonic Tornado fuel tank can be carried only on the left and right center wing (stations 5) attached to the Interim AHDERU/AHDERU by 30" hooks.

OUTBOARD WING PYLON

Two handed OWPs can be installed on each wing outboard station by means of a main spigot and an aft yaw bolt. The OWP function is to ensure carriage and jettison of the MFRL and the carriage of the TMC. The OWP are equipped with two ALDERU and two WPSU each. Cut-outs in the OWP structure provide accessibility to the ALDERUs operating points (safety handle, cartridges, throttles, arming units, supplementary safety devices, strong points, sway brace preloading device, manual release, manual latching). The external structure have labels applied which indicate the location of the operating points and the applicable max. torque value.

ADVANCED LIGHT DUTY EJECTOR RELEASE UNIT

The ALDERU is of the crutched type, interfaces with 14 inc. spaced Portal Suspension Lugs and permits vertical ejection by means of two pistons. Pitch control is provided by varying the pressure ratio to the piston by means of pitch controlling device (throttle setting). The hooks are designed to facilitate the release/jettison and the latching system is designed in such a way the hooks move simultaneously during release/jettison and independently during loading.
Each ALDERU is bolted to the four attachment points provide within the OWP and permits the correct loading/unloading, carriage of the MFRL with/without AIM-9L/ASRAAM/AMRAAM missiles and jettison of the MFRL when loaded with the AMRAAM. Security of the store to the ALDERU is achieved by the use of a cockpit device operated by the safety handle. The presence of the safety handle prevents unwanted drop of the store on ground. The safe condition is achieved by turning the safety handle to the SAFE position providing the interruption of the firing lines and the mechanical inhibition of the release and jettison capability.

MULTI FUNCTION RAIL LAUNCHER

NOTE

The MFRL can be jettisoned only when the AMRAAM is carried on.

Two MFRL can be attached to the OWP via an ALDERU by means of 14 inc. spaced bail lugs and hard points to interface with relevant crutch arms. The MFRL is able to carry AIM-9L, ASRAAM and AMRAAM missiles within the required flight envelope and it has been designed following the modular concept. The main modules of the MFRL are the following:

– Rail
– Forward Detent Unit
– Snubbing Units
– HiPPAG
– Electronic Unit

Forward detent unit, snubbing unit and HiPPAG are common components with the ITSPL. Security of the missiles to the MFRL is achieved by the use of a safety device. The presence of the safety pin prevents unwanted missile firing on ground. The safe condition is achieved by inserting the safety pin in the proper receptacle providing the interruption of the firing lines and the mechanical inhibition of the firing capability.

RAIL

The rail has been designed to allow easy loading/ unloading, carriage and firing of AIM-9L and AMRAAM missile.

FORWARD DETENT UNIT

The forward detent unit embodies the following mechanism for carrying mechanical and electrical functions:

SNUBBING UNIT

The snubbing units are designed to minimize roll and pitch free travel of all missiles types during carriage applying forces directly on the missile hangers. The snubbers engage the missile automatically during loading operation, allow easy release of the missile by a single action when unloading and are self releasing during missile launch, such that there is no interference with any missile. The forward and rear snubbing units are mechanically interconnected by an interlink mechanism such that these are operated

via a single point located in the Forward Detente Unit during missile loading/unloading.
For AIM-9L and ASRAAM carriage the following snubbing units are provided as common components with the ITSPL and directly fixed on the rail beam:

– forward snubbers for the AIM-9L and ASRAAM forward hanger as part of the forward detent unit
– after snubbers for the AIM-9L and ASRAAM rear hanger

HIPPAG

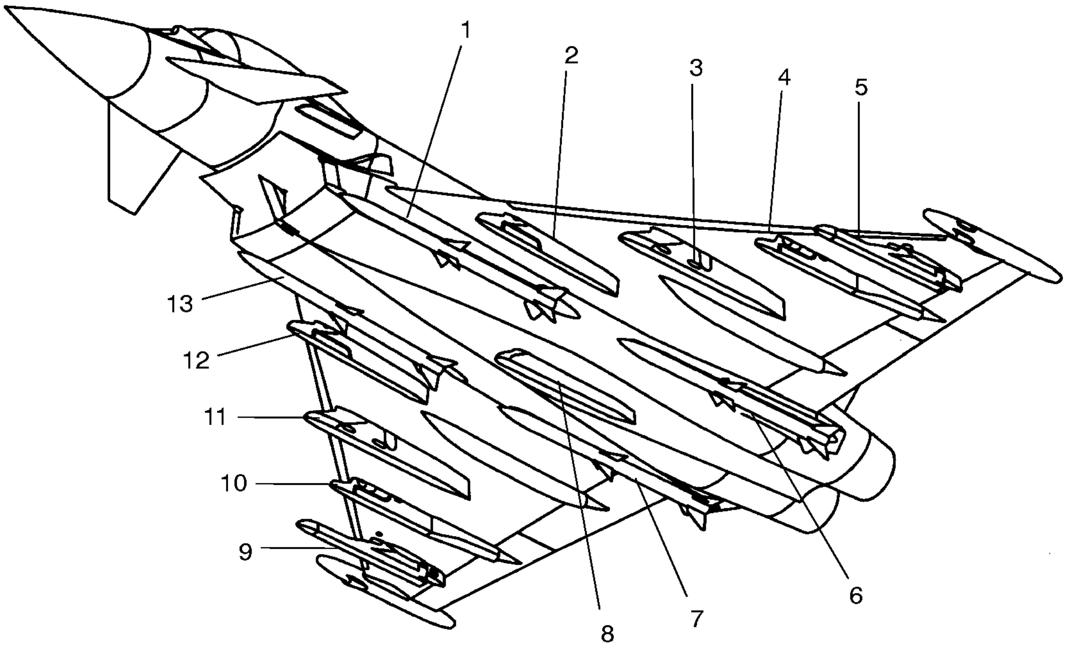
The High Pressure Pure Air Generator is an off-the-shelf item which supplies pure air as a cooling gas to the AIM-9L and ASRAAM. The HiPPAG is installed on a mounting tray to be compatible with both the MFRL and ITSPL installations.
HiPPAG consists of three main components:

– Electronic Control Unit
– Motor/Compressor
– Filters

HiPPAG has also a control valve to shut off or open the gas supply to the missile.

ELECTRONIC UNIT

The electronic unit is capable of converting aircraft power and processing aircraft/missile signals essential to a range of missile operational and test functions.
The electronic unit power supplies, discrete input/output interfaces, Digital-to-analogue (D/A) and Analogue-to-digital (A/D) converters, processors and memories, one dual redundant Remote Terminal (RT) and one Dual Redundant Bus Repeater.



1	FRONT LH MRAAM EJECT LAUNCHERS (MEL) STATION 3
2	LH INBOARD WING PYLON (STATION 4)
3	LH CENTRE WING PYLON (STATION 5)
4	LH OUTBOARD WING PYLON (STATION 6)
5	LH ITSPL (STATION 7)
6	REAR LH MRAAM EJECT LAUNCHERS (MEL) STATION 2
7	REAR RH MRAAM EJECT LAUNCHERS (MEL) STATION 2
8	CENTRE UNDER FUSELAGE PYLON (STATION 1)
9	RH ITSPL (STATION 7)
10	RH OUTBOARD WING PYLON (STATION 6)
11	RH CENTRE WING PYLON (STATION 5)
12	RH INBOARD WING PYLON (STATION 4)
13	FRONT RH MRAAM EJECT LAUNCHERS (MEL) STATION 3

Figure 8.91 - Weapon Station and Pylon Configuration