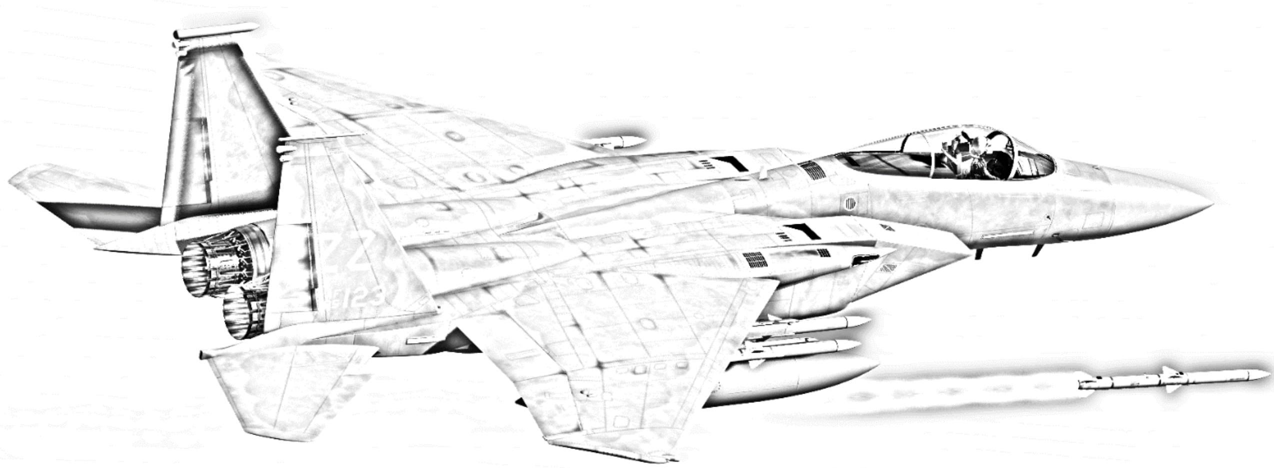
TO 1F-15C-34-1-1 BMS

AVIONICS AND NONNUCLEAR WEAPONS DELIVERY FLIGHT MANUAL

F-15C AND F-15D



Ver.: BMS 4.37.4.1

Date: 19 June 2024

FOREWORD

PURPOSE AND SCOPE

This manual describes the relevant aircraft avionics, weapons systems, support equipment and munitions for employment by the F-15C/D Eagle in BMS.

The Dash-34 is to be read in complement with the F-15 Dash-1 as well as the F-15 checklists.

Please note that the F-15C in BMS is under development and some systems are incomplete or not yet implemented.

Systems/functions that are not implemented will be marked *(N/I)* and may be greyed out, awaiting future implementation.

The following manuals supplement this document to establish the complete Falcon BMS F-15C series:

- TO-1F-15C-1 BMS (Aircraft systems, Normal procedures, and abnormal procedures).
- TO-1F-15C-1CL BMS (Checklists for normal procedures and abnormal procedures).
- F-15C Training Manual (Documentation to accompany Falcon BMS F-15C training missions).

These documents are located in the */Docs/02 Aircraft Manuals & Checklists/02 F-15C folder* of your Falcon BMS install.

The default F-15C keyfile “BMS - Full-F15ABCD.key” can be found in */user/config* folder.

All changes in this document coming with 4.37.4 and 4.37.4.1 are marked with an **orange** line.

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1 MISSION DESCRIPTION

1.1 GENERAL

The McDonnell Douglas F-15C Eagle, is an icon in the world of air dominance and fighter engineering. First flown in July of 1972, this rugged airframe still forms the basis of the latest F-15EX Eagle II which is rolling off production lines today. Dubbed the "W.G.A.S.F."—world's greatest air superiority fighter—by the pilots who fly her, the F-15C Eagle has an undefeated combat record of 104 kills to zero losses to enemy fire.

Today's F-15C is a vastly upgraded version of the original F-15A. Boasting a 9g capable airframe, the Eagle maintains its position as a lethal air superiority fighter by leveraging advanced sensors and employing the latest generation of air-to-air missiles. The Eagles sleek nosecone houses the massively powerful AN/APG-63 radar which provides remarkable target detection and tracking capabilities. Modern cockpit displays allow the distribution of information from various datalink sources, further enhancing the pilot's situational awareness and lethality.

With a length of 63.8 feet and a wingspan of 42.8 feet, this marvel of aeronautics boasts a maximum takeoff weight of 68,000 pounds. Powered by twin Pratt & Whitney F100-PW-220 engines, the F-15C can attain speeds exceeding Mach 2.5 and reach altitudes of over 65,000 feet.

Employing the F-15C in BMS is a unique insight to how this aircraft dominates the battlespace in all regimes of flight, from 45,000ft beyond visual range engagements to low altitude maneuvering dogfights.

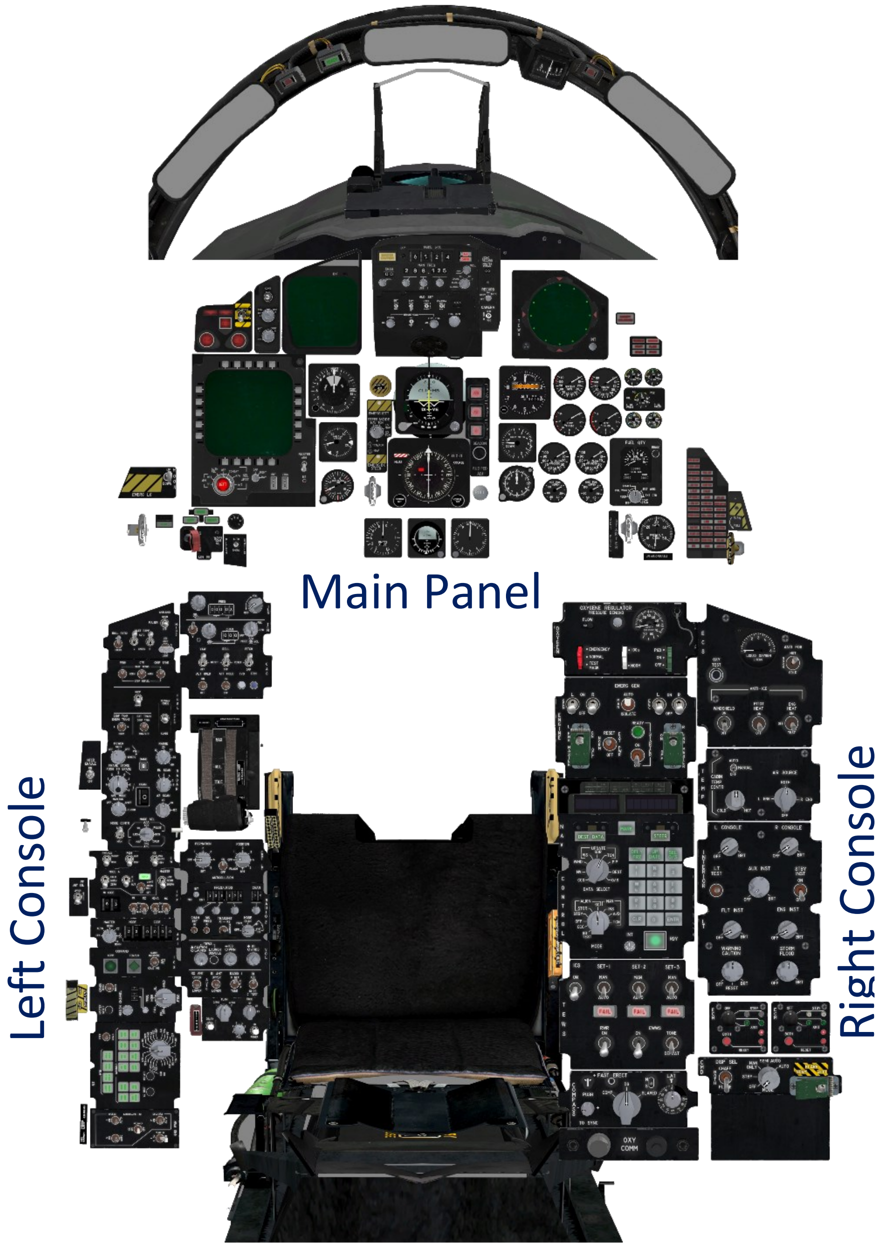
Learn the contents of the manual inside and out…

Nobody wants to be the first Eagle loss in combat, don't let it be you!

2 AIRCRAFT SYSTEMS - GENERAL

2.1 COCKPIT CONTROLS AND DISPLAYS

The following section outlines the functionality and placement of controls and displays related to the weapon system. Its primary objective is to serve as a convenient reference guide for locating the system explained in this manual. Whenever relevant, this section includes a reference to the location where the system is described in comprehensive detail.



F-15C Cockpit Layout

2.1.1 DETAILED COCKPIT CONTROLS AND DISPLAYS

Refer to the TO 1F-15C-1 BMS for a layout and description of the F-15 cockpit and its components.

2.1.2 GENERAL SYSTEMS

2.1.2.1 WEAPONS RELATED AVIONICS

The pilot engages in weapon arming and maintains weapon status across all ordnance using the Programmable Armament Control Set (PACS). The AN/APG-63 radar system is responsible for identifying and pursuing aerial targets. Data pertinent to weapon targeting and attack guidance is projected onto both the Head-Up Display (HUD) and the Vertical Situation Display (VSD). The aircraft's position and comprehensive Situation Awareness (SA) data are showcased on the situation display interface. Controls for radar functionality and weapon operations, necessitating constant accessibility during attack sequences, are positioned on the control stick and throttles.

2.1.2.1.1 VERY HIGH SPEED INTEGRATED CIRCUIT (VHSIC) CENTRAL COMPUTER

The CC (Central Computer) commands issues directives and collects flight data from the aircraft's sensors. It calculates parameters for attack guidance, tracking, and weapon deployment, overseeing the presentation of these details on both the HUD and VSD. The CC's role within the context of A/A attack modes is extensively elucidated in this manual.

2.1.2.1.2 AIR DATA COMPUTER (ADC)

The Air Data Computer (ADC) is a digital processor that furnishes accurate data such as true airspeed (TAS), air density, and angle of attack (AOA) to the CC. This information is then utilized by the CC to calculate parameters essential for gun mode steering and MRM prelaunch computations.

2.1.2.1.3 RING LASER GYRO (RLG) INERTIAL NAVIGATION SET (INS)

The Ring Laser Gyro Inertial Navigation System (RLG INS) stands as the fundamental origin of attitude, accurate heading, and current position data. It delivers pitch, roll, heading, and inertial velocities to the CC to facilitate weapon launch calculations. Additionally, the radar set benefits from this data for tasks such as antenna stabilization and minimizing ground clutter.

Furthermore, the RLG INS supplies inputs to the CC, specifically for overseeing the reticle control during A/A gun operations when the Lead Computing Optical Sight (LCOS) gun steering mode is active.

2.1.2.1.4 NAVIGATION CONTROL INDICATOR (NCI)

The Navigation Control Interface (NCI) of the INS serves multiple functions, including programming Identification Point (IP) and target data, choosing steering destinations, designating offset targets from IPs, marking targets, and conducting navigation position updates.

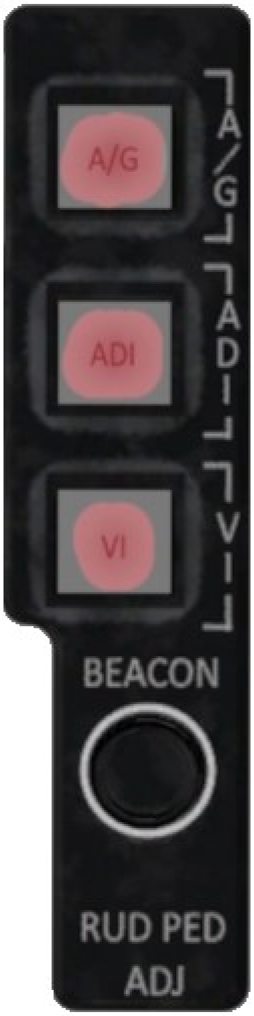
2.1.2.1.5 ATTITUDE HEADING REFERENCE SET (AHRS)

The AHRS serves as the main provider of magnetic heading information and acts as a secondary supplier of attitude data to both the CC and radar systems in the event of an INS failure. For more details, please consult section III regarding potential failure modes.

2.1.2.2 MASTER MODE SELECTION AND CONTROL

The airplane's avionics function across four modes: Air-to-Air (A/A), Air-to-Ground (A/G), Visual Identification (VI), and Attitude Director Indicator (ADI). The selection of these modes is controlled by three master mode buttons, labelled A/G, ADI, and VI, functioning as push ON-OFF buttons. The relevant button lights up to indicate the active master mode.

2.1.2.2.1 A/A MODE



To activate the A/A attack HUD display for the currently chosen weapon on the weapon select switch, ensure that all master mode buttons are in the OFF position. If any master mode button is lit up, it will be deselected when you switch to the GUN option on the weapon select switch.

2.1.2.2.2 A/G MODE

To engage the A/G mode, the pilot selects either MRM or SRM on the throttle weapon switch and activates the A/G master mode button. When the A/G master mode button is illuminated, it signifies the activation of the A/G mode. This action not only activates the A/G weapon release circuits but also selects the A/G RNG radar mode. Additionally, the HUD is commanded to display relevant information for the selected delivery mode. Notably, the launch circuit for MRM and SRM is disabled in this mode.

The A/G mode is partially implemented and will be improved in the future.

2.1.2.2.3 ATTITUDE DIRECTOR INDICATOR (ADI) MODE

A pressed and illuminated ADI master mode button indicates the ADI mode is active. This commands the HUD to display navigation information. The radar, VSD, and missile launch circuits are operational in MRM or SRM modes, and the gun can be fired. Refer to TO 1F-15C-1 BMS.

2.1.2.2.4 VISUAL IDENTIFICATION (VI) MODE

This mode is not implemented yet.

2.1.3 STATION DIAGRAM

AIM-120 Stations:

3, 4, 6, 7 and 2A, 2B, 8A, 8B

AIM-7 Stations:

3, 4, 6, 7

AIM-9 Stations:

2A, 2B, 8A, 8B

General Purpose Bombs Stations:

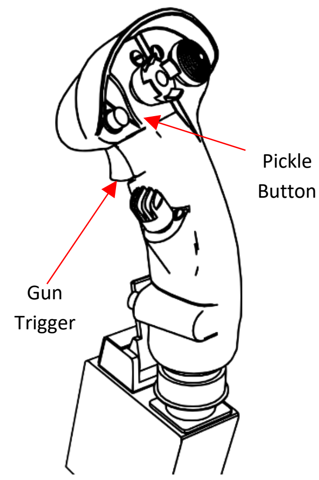
2, 5, 8

Note: Station 1 & 9 are not simulated.

Station Diagram F-15C

2.1.3.1 WEAPON RELEASE (PICKLE) BUTTON

With the master arm switch set to ARM, the weapon release button becomes active. In the A/A master mode, pressing this button initiates the launch of MRM or SRM weaponry.



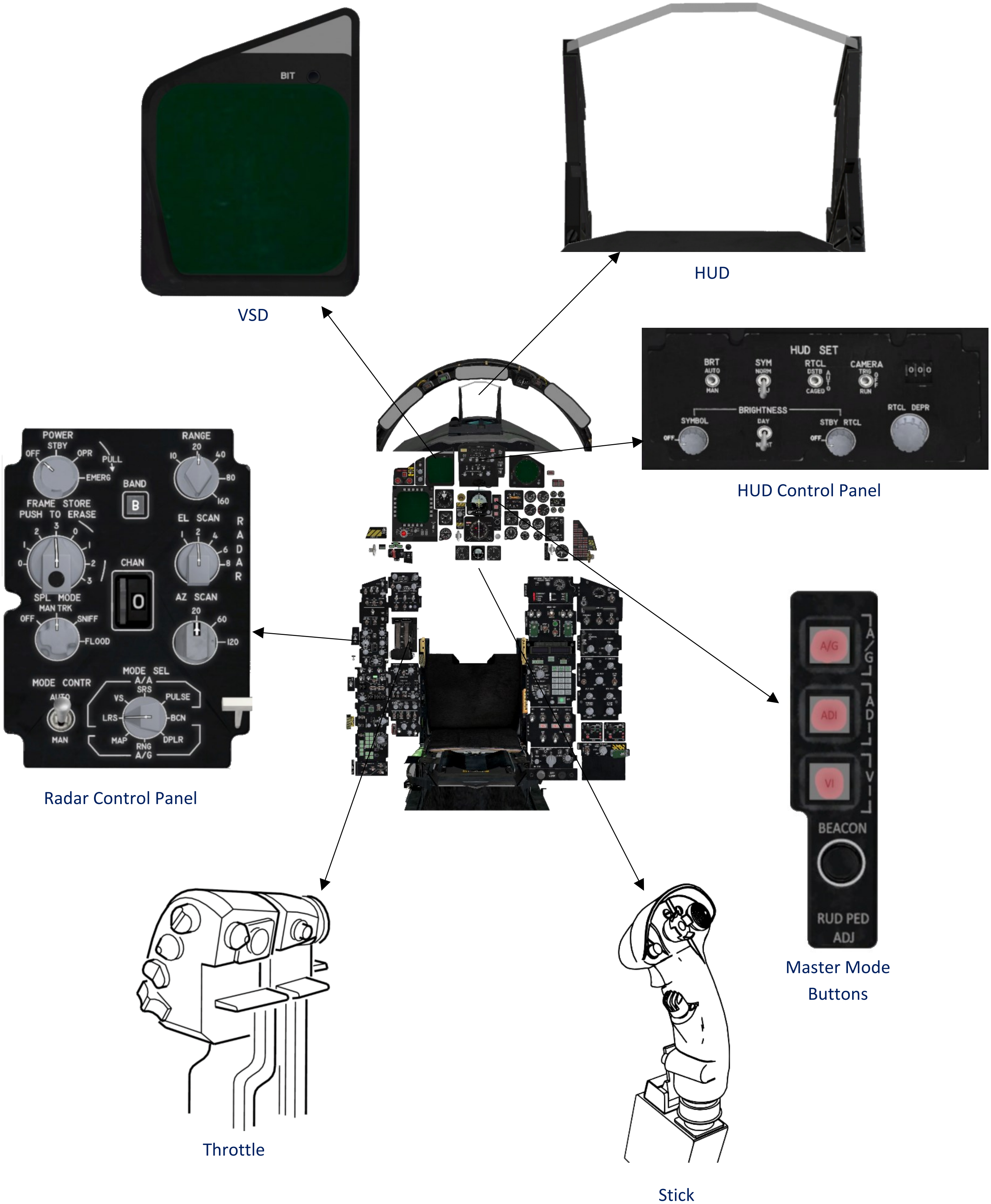
F-15C Stick

2.1.3.2 GUN TRIGGER

Depressing the trigger's initial detent engages the VTR function (not implemented). Depressing the trigger's second detent, provided the master arm switch is in the ARM position, results in gun firing.

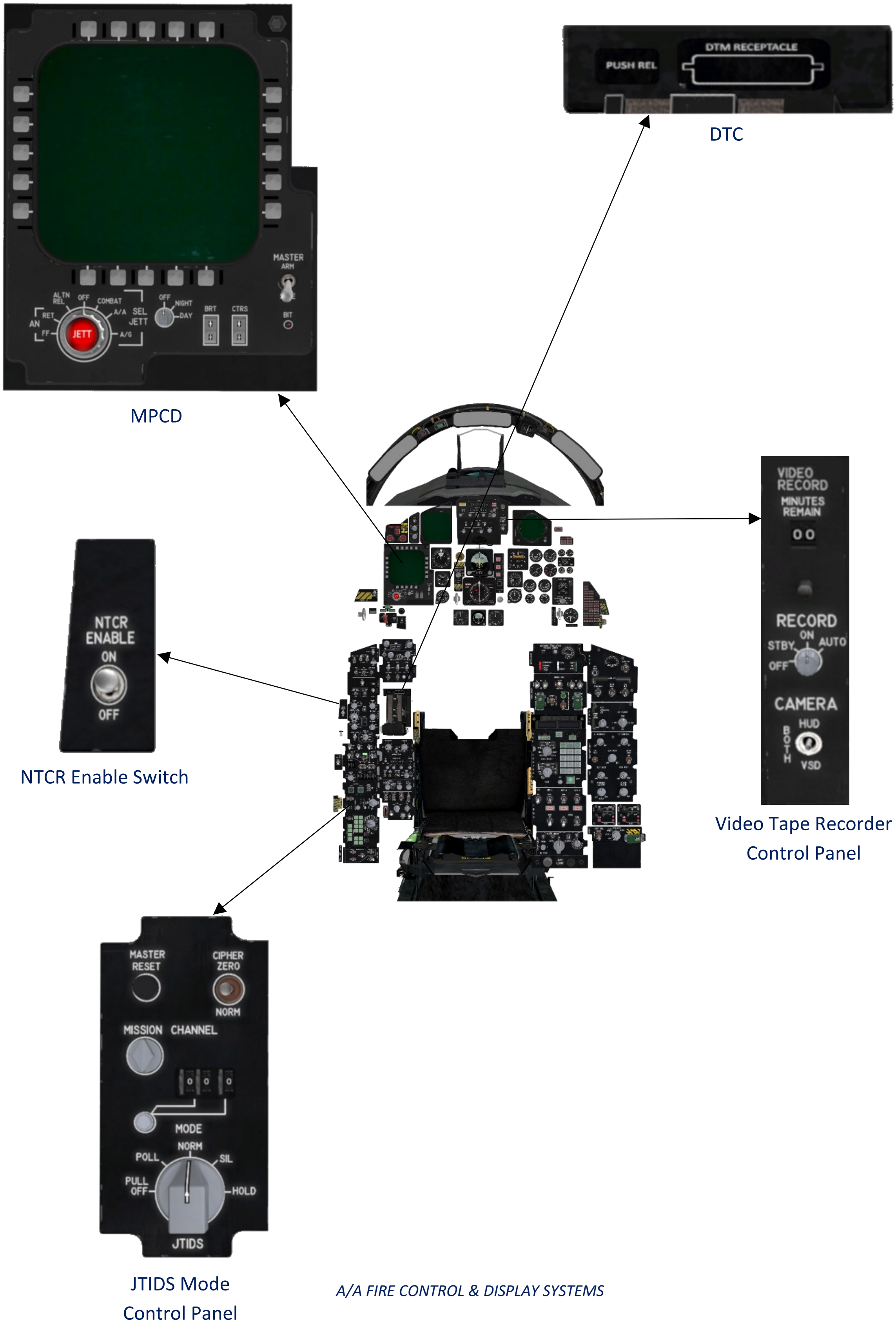
For all information about the stick and throttle, please refer to the F-15 Dash-1.

2.1.3.3 A/A FIRE CONTROL & DISPLAY SYSTEMS



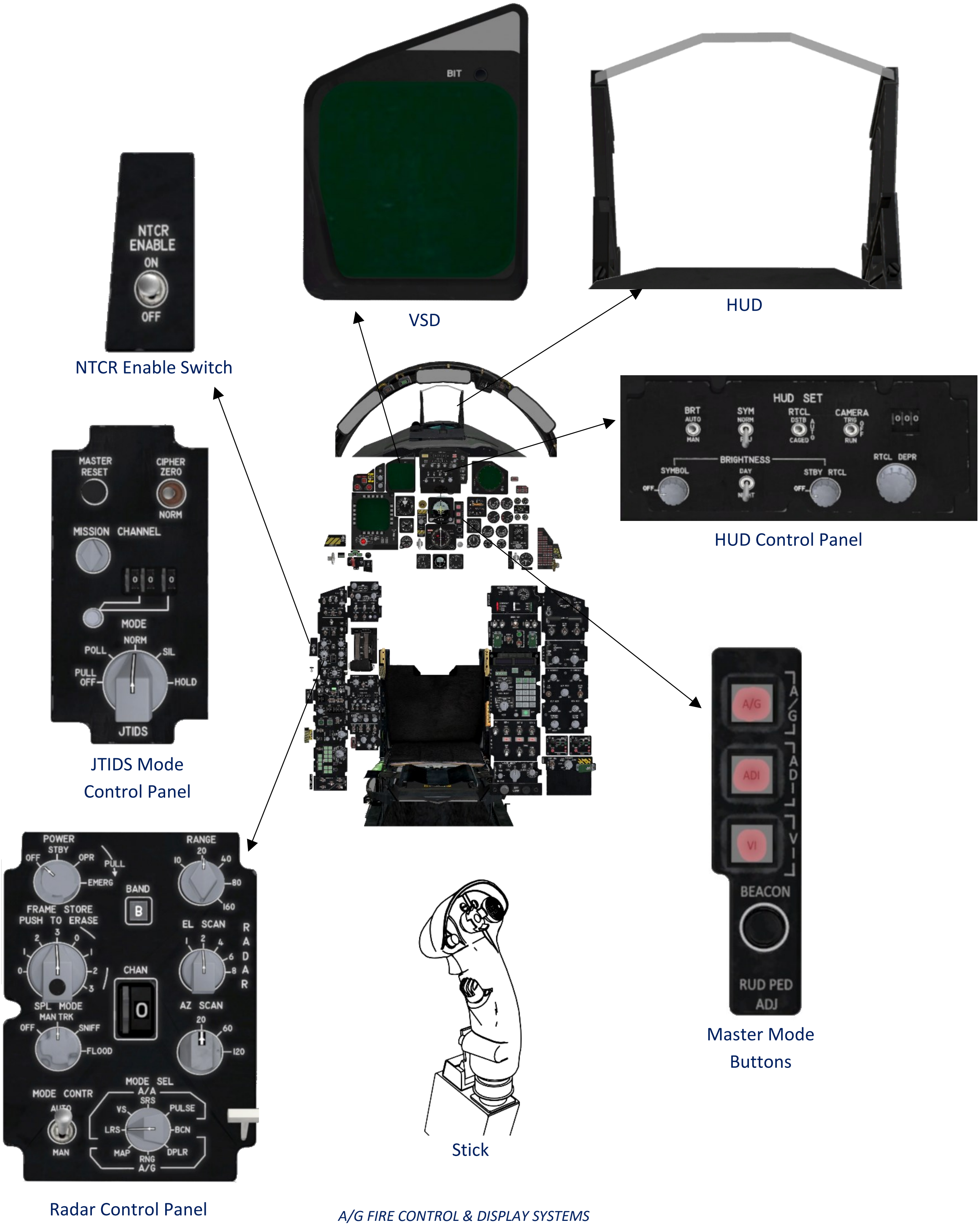
A/A FIRE CONTROL & DISPLAY SYSTEMS

A/A Fire Control & Display Systems (Continued)



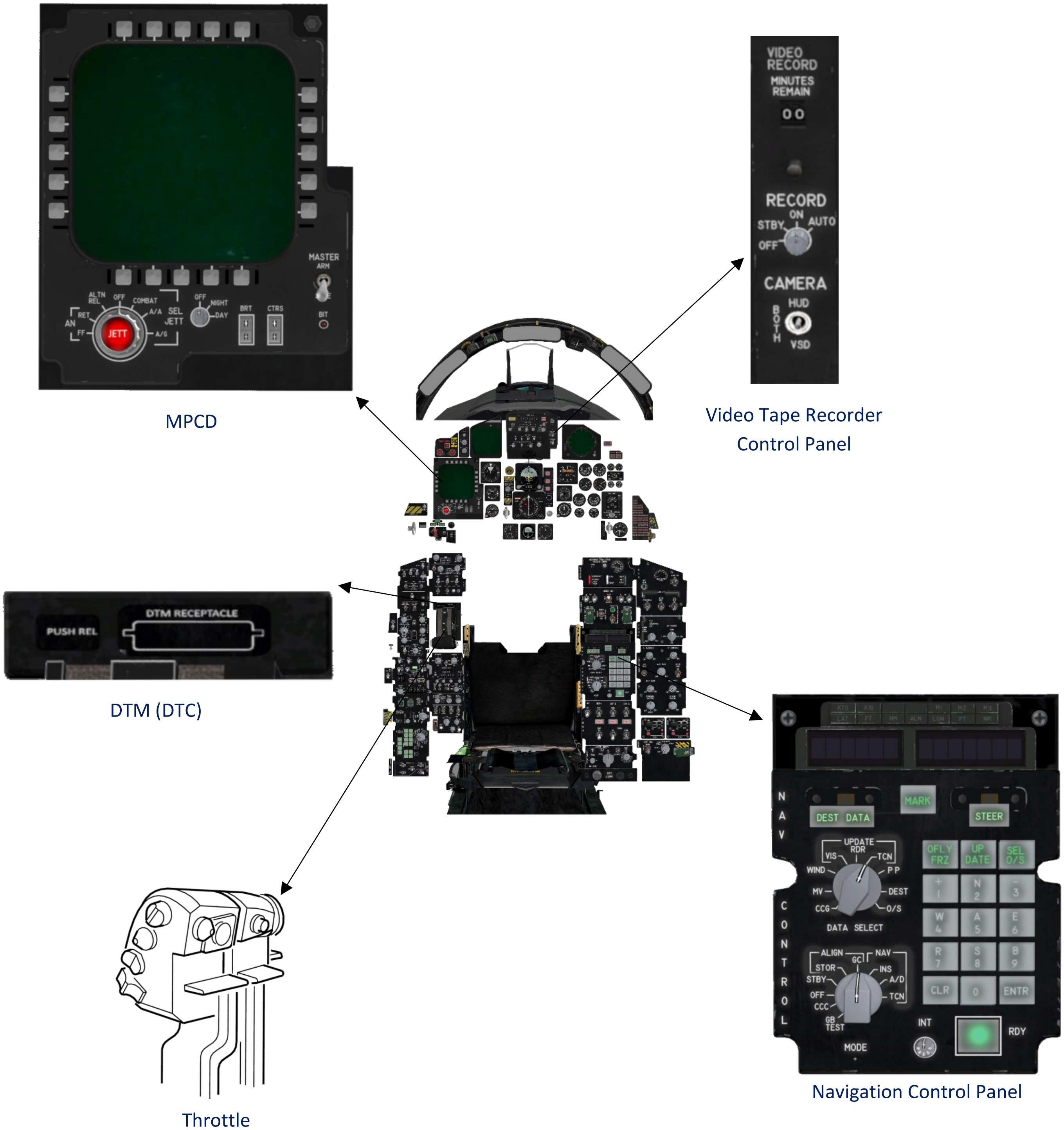
A/A FIRE CONTROL & DISPLAY SYSTEMS

2.1.3.4 A/G FIRE CONTROL & DISPLAY SYSTEMS

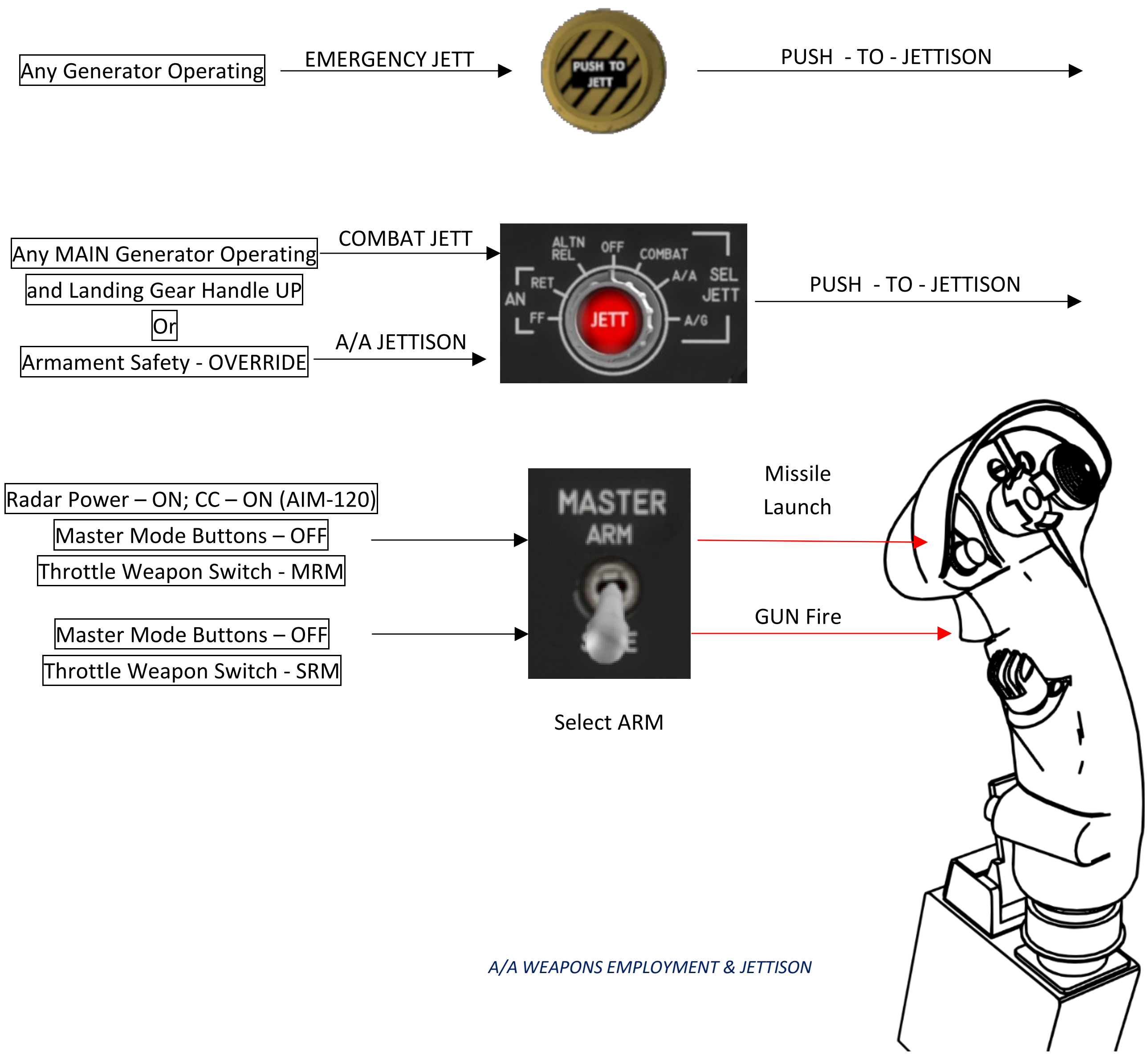


A/G FIRE CONTROL & DISPLAY SYSTEMS

A/G Fire Control & Display Systems (Continued)



2.1.3.5 A/A WEAPONS EMPLOYMENT & JETTISON

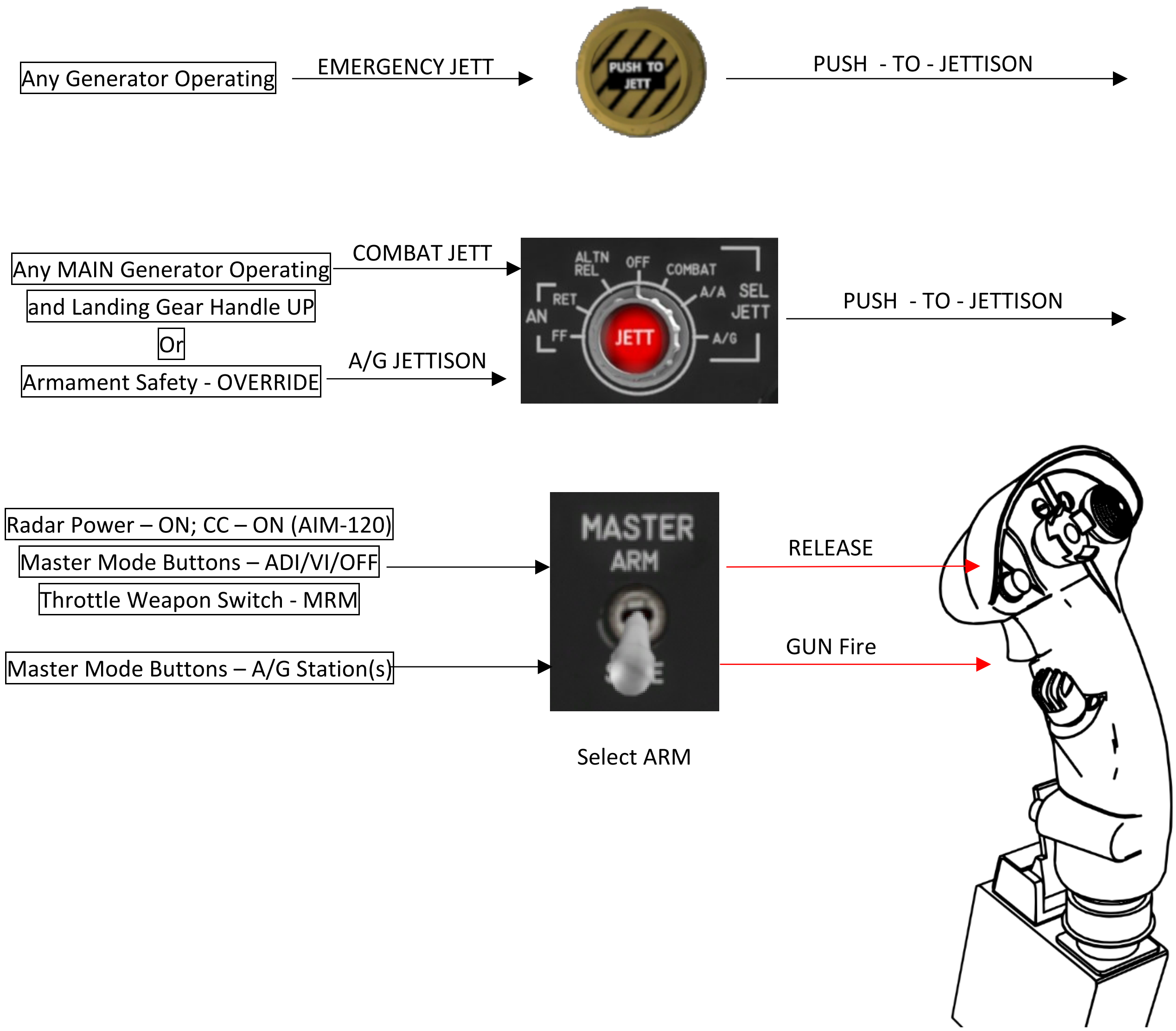


A/A WEAPONS EMPLOYMENT & JETTISON

Please note that the capability to shoot A/A weapons in ADI and VI has not been implemented in this release.

MRM, SRM and GUNs can only be used in the A/A mode so far.

2.1.3.6 A/G WEAPONS EMPLOYMENT & JETTISON



A/G WEAPONS EMPLOYMENT & JETTISON

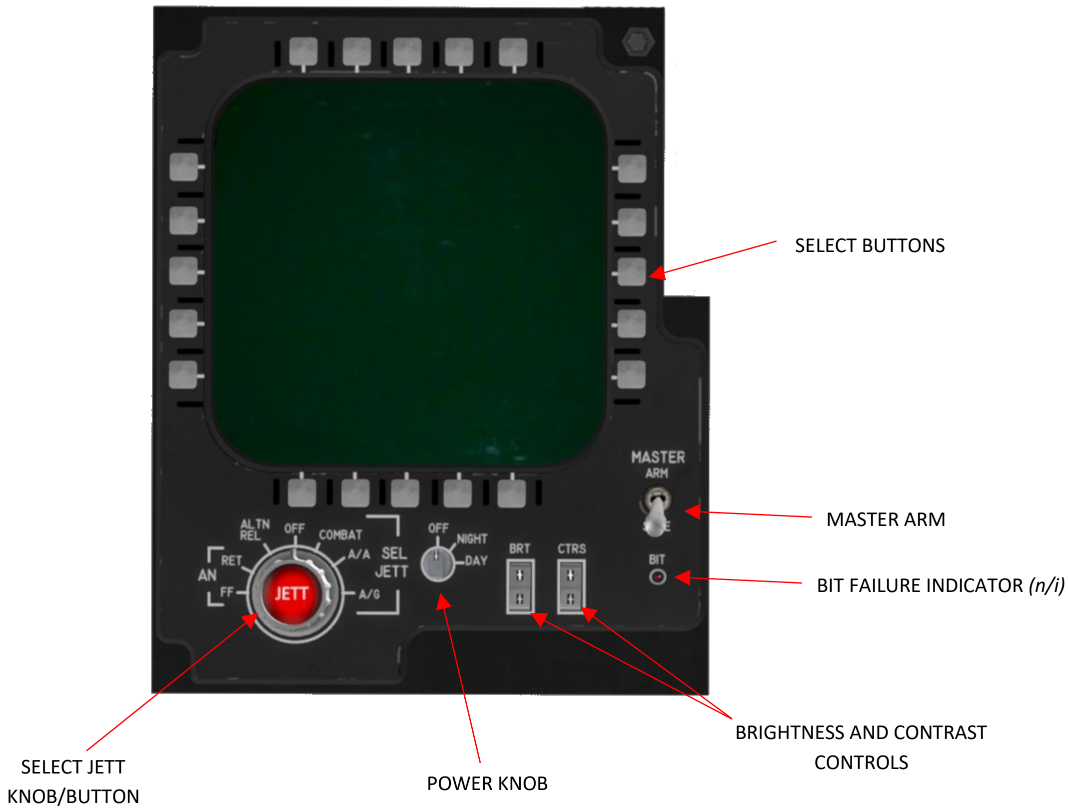
Please note that the A/G functions and systems are not yet fully implemented.

3 PROGRAMMABLE ARMAMENT CONTROL SET (PACS)

The PACS serves as the central hub for all operations related to munitions selection, monitoring, arming, jettisoning, and release sequences. It plays a crucial role as the primary electrical interface connecting the pilot's instructions, the onboard munitions, and the aircraft's avionics systems during weapon attack modes. Additionally, the PACS supplies essential external stores configuration data to the CC to ensure the proper functioning of the OWS.

3.1 MPCD CONTROL PANEL

The MPCD control panel comprises a color display unit (DU) and a set of controls employed for weapon system management. The DU exhibits information regarding the weapons on board, the currently selected weapon, its quantity, and its status. Surrounding the DU, you will find a cluster of 20 buttons designed for selecting various options, altering the weapon program, and choosing alternative displays.



3.1.1 SELECTIVE JETTISON KNOB AND SELECTIVE JETTISON BUTTON

Please refer to the Stores Jettison System chapter in this document.

3.1.2 POWER KNOB

The power knob activates the MPCD.

OFF MPCD is off

Day/Night MPCD is on (no difference yet between day and night setting)

3.1.3 BIT FAILURE INDICATOR

Not implemented yet.

3.1.4 MASTER ARM SWITCH

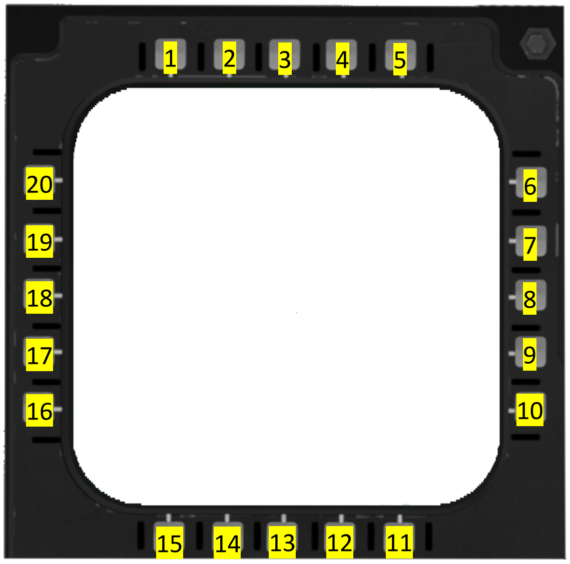
The master arm switch includes a safety lock feature to avoid accidental engagement of the ARM position. To choose the ARM position, the switch must be lifted upwards, moving it out of the detent.

SAFE weapons cannot be utilized.

ARM Either the landing gear handle is UP or the armament safety switch is in OVERRIDE, power is supplied to the master arm switch. This, in turn, activates the capability for weapon release and gun firing. Additionally, the gun cross is displayed on the HUD (Head-Up Display).

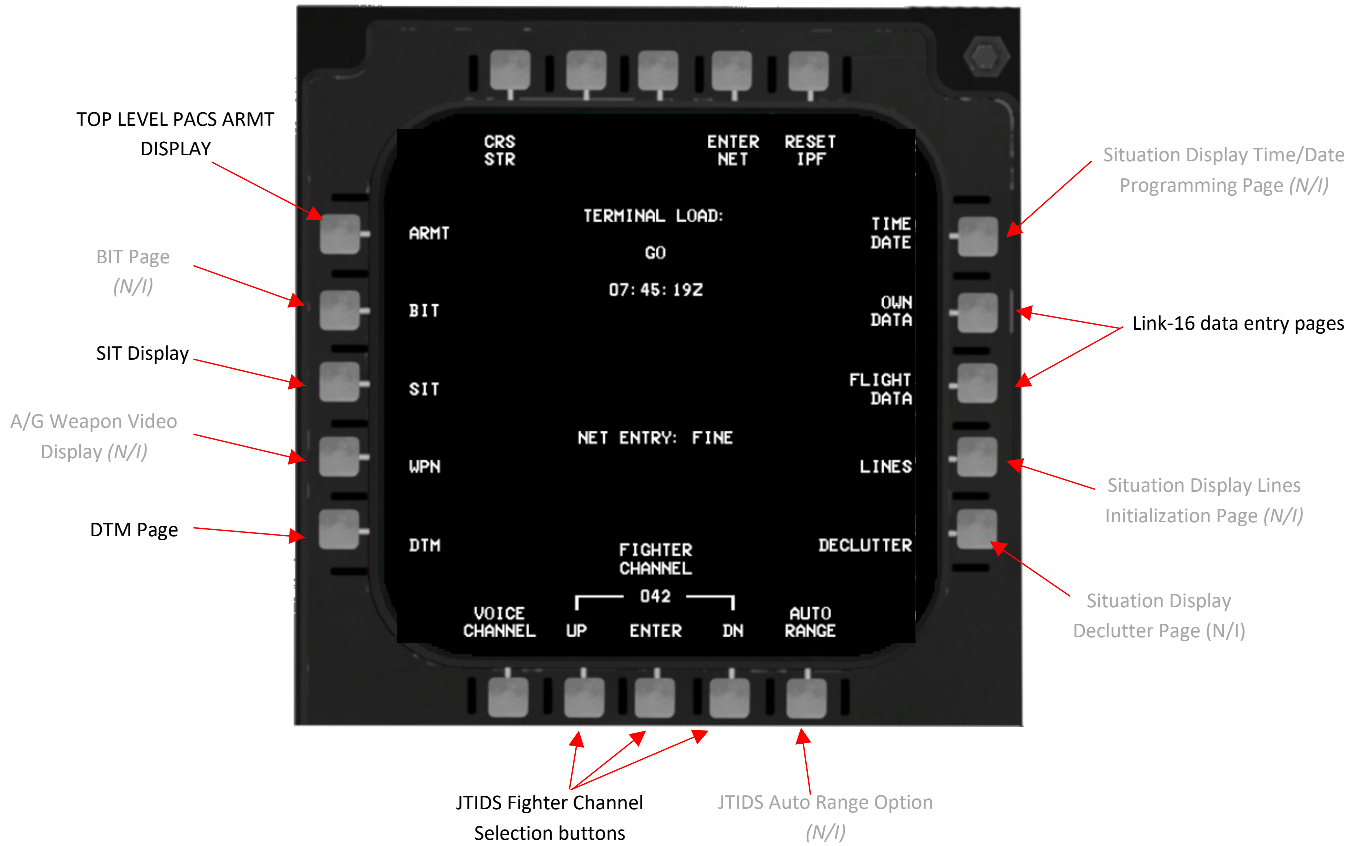
3.1.5 MPCD SELECT BUTTONS

The Multi-Purpose Color Display (MPCD) features a total of 20 pushbuttons (PBs), evenly distributed with five on each edge of the Display Unit (DU). These buttons serve to select, deselect, or modify the weapon or parameter labels situated next to them. In most instances, the selection is visually denoted by displaying a highlighted box around the label. Any exceptions to this rule are specified where relevant. The highlighted box is removed when deselected, and alterations are indicated by a change in the displayed label each time the button is pressed. To facilitate easy reference to specific buttons, this manual employs PB numbers shown on the right sides.



3.2 MPCD PAGES

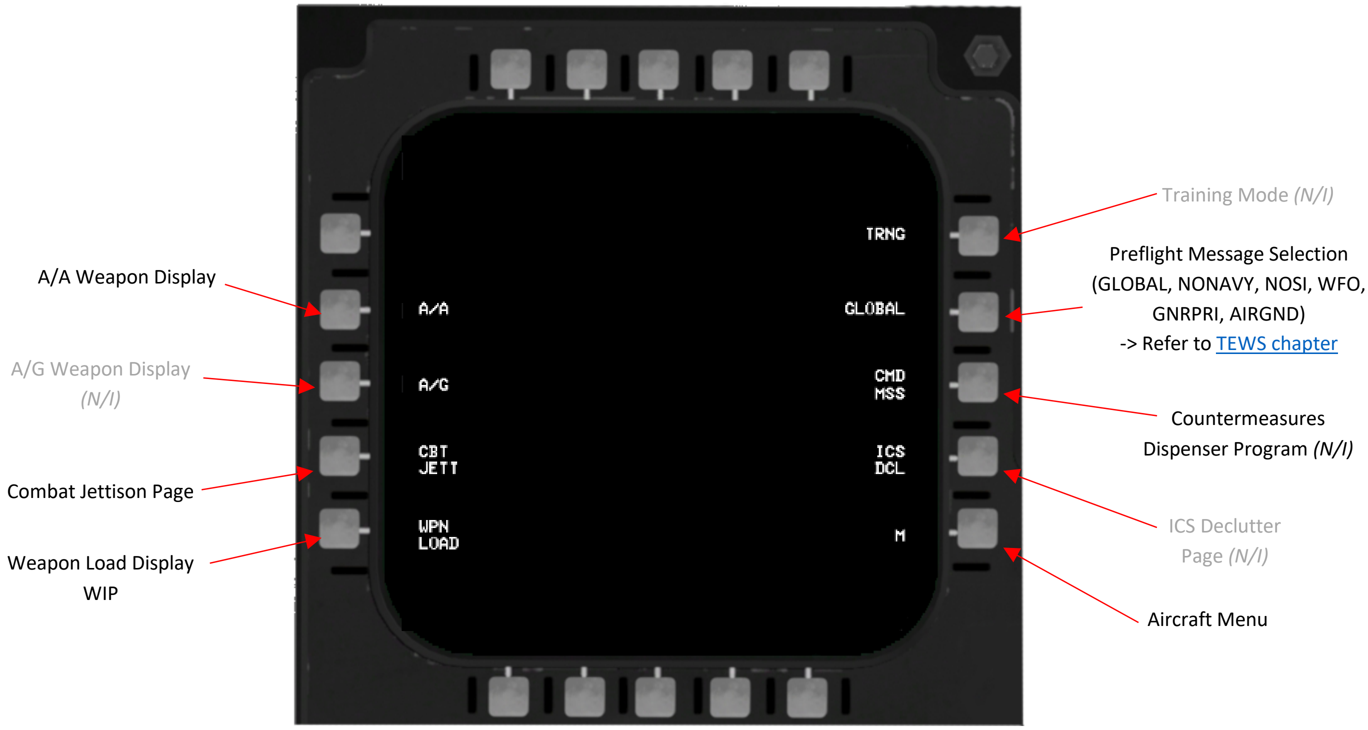
3.2.1 AIRCRAFT MENU PAGE



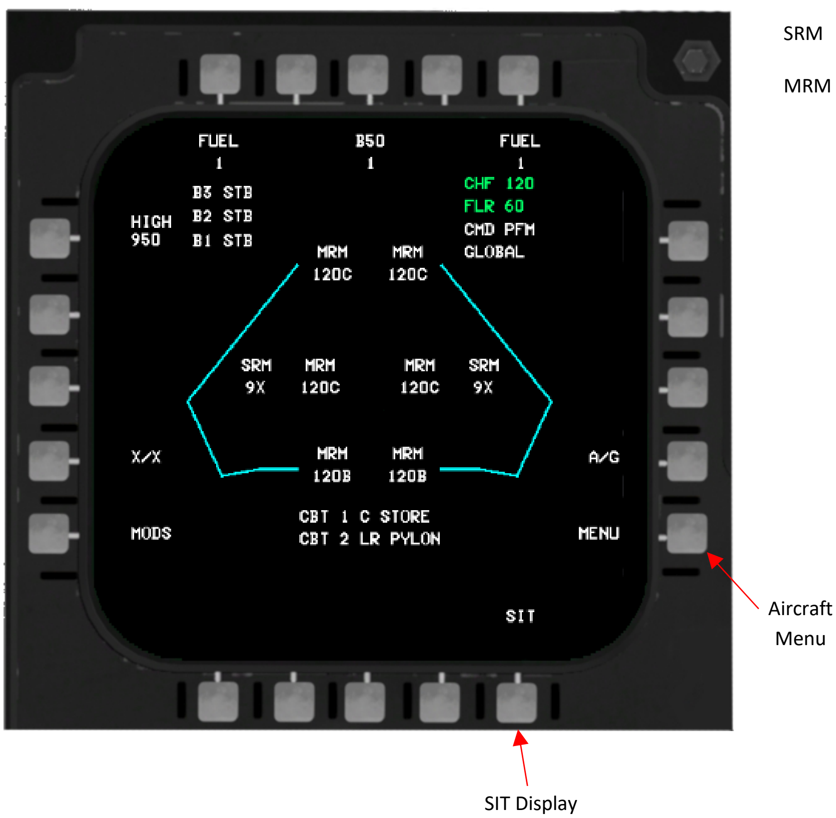
Please refer to the following chapters for more information about all aircraft menu subpages.

Please note that the functionality of all MPCD pages is not fully implemented yet. Only functions implemented will be highlighted/explained.

3.2.2 ARMT PAGES

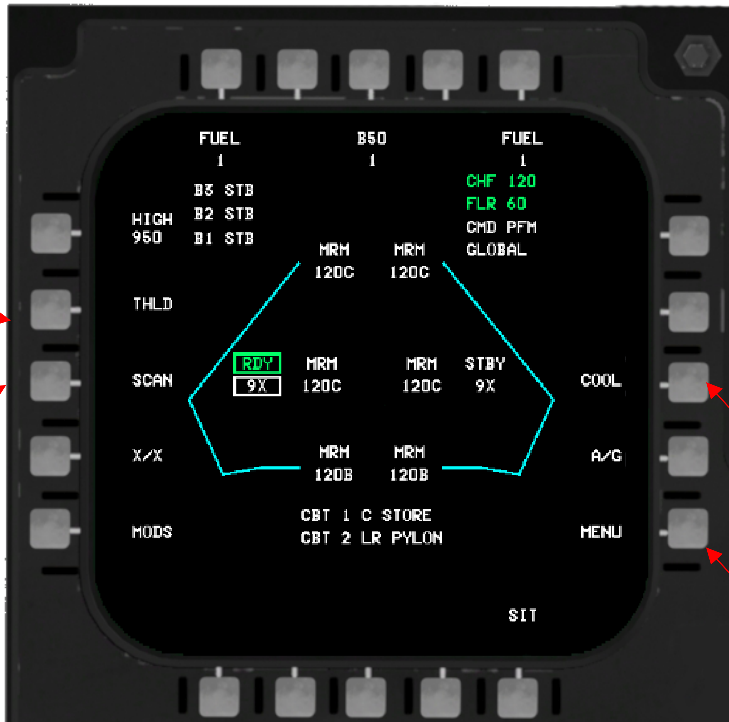


3.2.2.1 AIR-TO-AIR (A/A) WEAPON DISPLAY PAGE (GUN SELECTED)



SRM	Weapon type not selected
MRM	Weapon type not selected

3.2.2.2 AIR-TO-AIR (A/A) WEAPON DISPLAY PAGE (SRM SELECTED)



RDY Station and Weapon ready (MASTER ARM “ARM”)

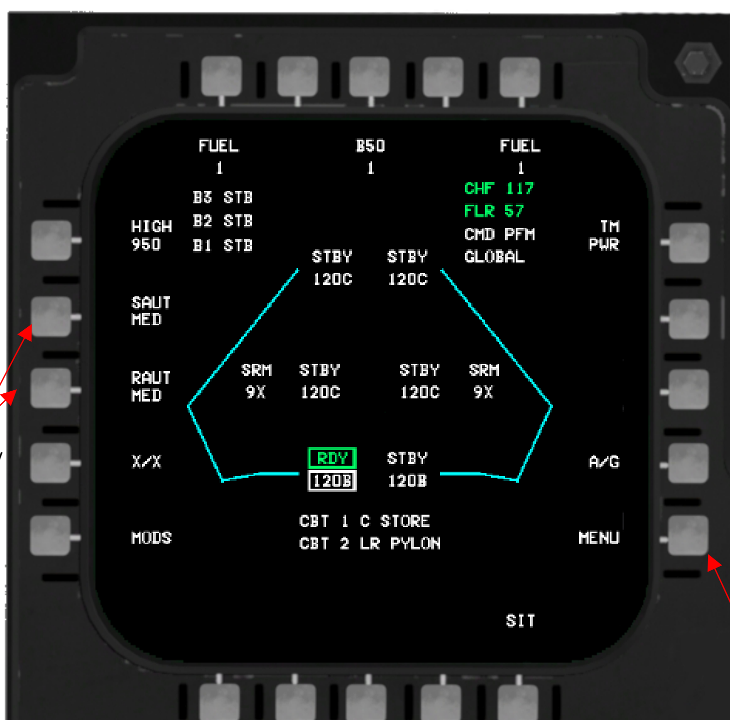
STBY Weapon not selected (MASTER ARM “ARM”)

9X Weapon selected

MRM Weapon type not selected

HUNG Station HUNG store

3.2.2.3 AIR-TO-AIR (A/A) WEAPON DISPLAY PAGE (MRM SELECTED)



RDY Station and Weapon ready (MASTER ARM “ARM”)

STBY Weapon not selected (MASTER ARM “ARM”)

120B Weapon selected

SRM Weapon type not selected

HUNG Station HUNG store

<u>TARGET SIZE</u>

SML Small

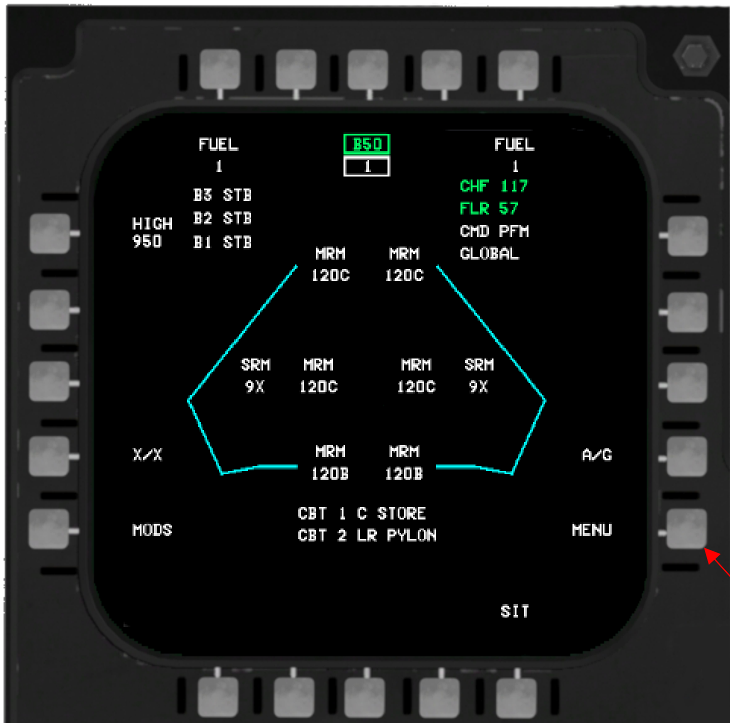
MED Medium

LRG Large

UNKN Unknown

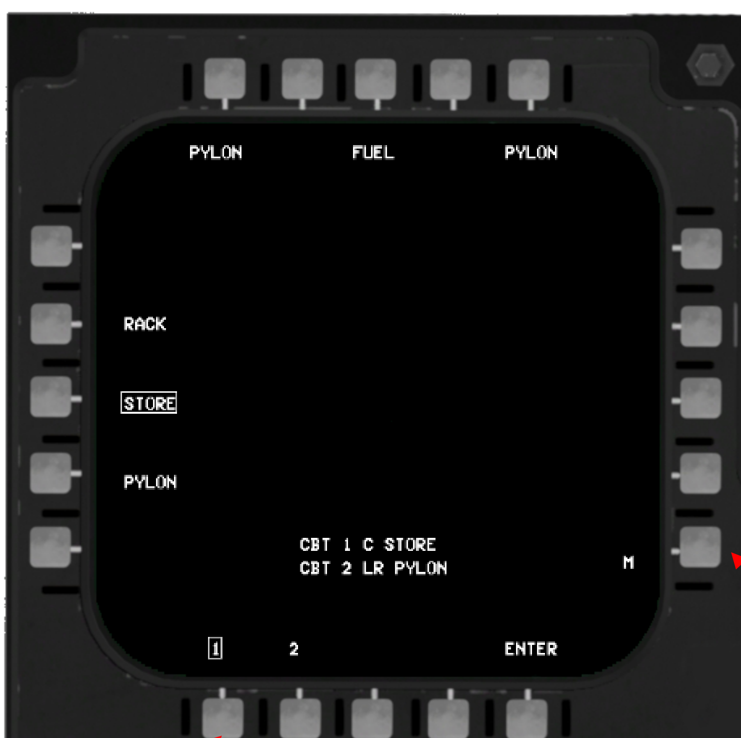
Those options allow the pilot to choose the target size estimate to be provided to AIM-120B/C.

3.2.2.4 AIR-TO-AIR (A/G) WEAPON DISPLAY PAGE (A/G SELECTED)

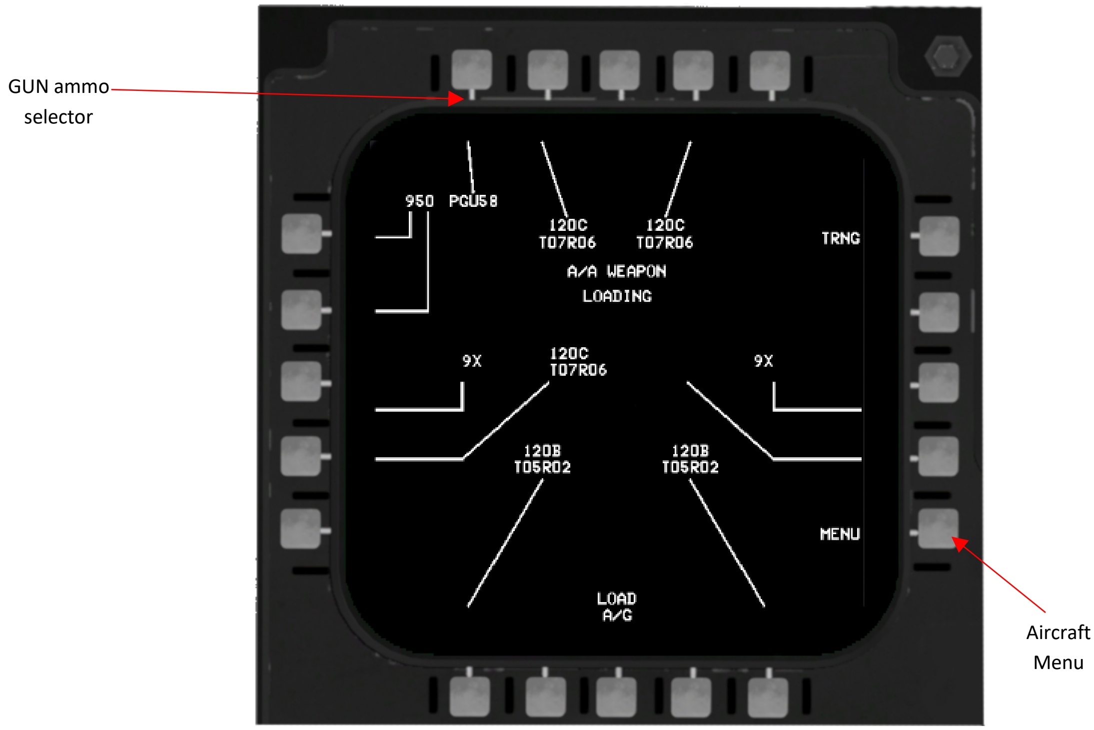


B50	Weapon standby (MASTER ARM "SAFE")
B50	Station and Weapon ready (MASTER ARM "ARM")
1	Weapon amount
MRM	Weapon type not selected
SRM	Weapon type not selected

3.2.2.5 COMBAT JETTISON (CBT JETT) PAGE *(WIP)*



3.2.2.6 WEAPON (WPN) LOAD PAGE (*N/I*)



The WPN LOAD page is not yet fully implemented.

3.3 STORES JETTISON SYSTEM

3.3.1 JETTISON AND RELEASE SAFETY SWITCHES

3.3.1.1 LANDING GEAR CONTROL HANDLE

When the landing gear handle is in the lowered position, the PACS jettison controls lose power.

3.3.1.2 ARMAMENT SAFETY SWITCH

The OVERRIDE setting on the armament safety switch allows for the bypass of the landing gear handle interlock. To keep the switch in the OVERRIDE position, the aircraft must have power applied to it. It will stay in the OVERRIDE position unless manually switched OFF, power to the aircraft is cut, or the landing gear handle is moved to the UP position. It's important to note that this control does not have any impact on the emergency jettison control circuit.

3.3.2 JETTISON CONTROLS

Irrespective of the master arm switch's position, if either the emergency jettison or select jettison button is pressed, all arming solenoids are automatically disengaged prior to the jettison action, ensuring that all stores are released without being armed.

3.3.2.1 EMERGENCY JETTISON BUTTON

The emergency jettison button remains active whenever the aircraft is powered, whether internally or externally. When activated, it results in the jettison of MRM missiles and the contents of pylons on stations 2, 5, and 8. It is of utmost importance to exercise extreme caution to prevent unintended ground-level jettison.

3.3.2.2 SELECT JETTISON KNOB/BUTTON

When the select jettison button is activated, it releases stores based on the following knob positions:

- OFF: Disconnects power from the selective jettison button.
- COMBAT: The initial press triggers the combat jettison program 1. Program 2 is not implemented yet.
- A/A: Chooses air-to-air selective jettison (not implemented yet).
- A/G: Chooses air-to-ground selective jettison (not implemented yet).
- ALTN REL: This setting is not utilized.
- MAN RET: Not implemented.
- MAN FF: Not implemented.

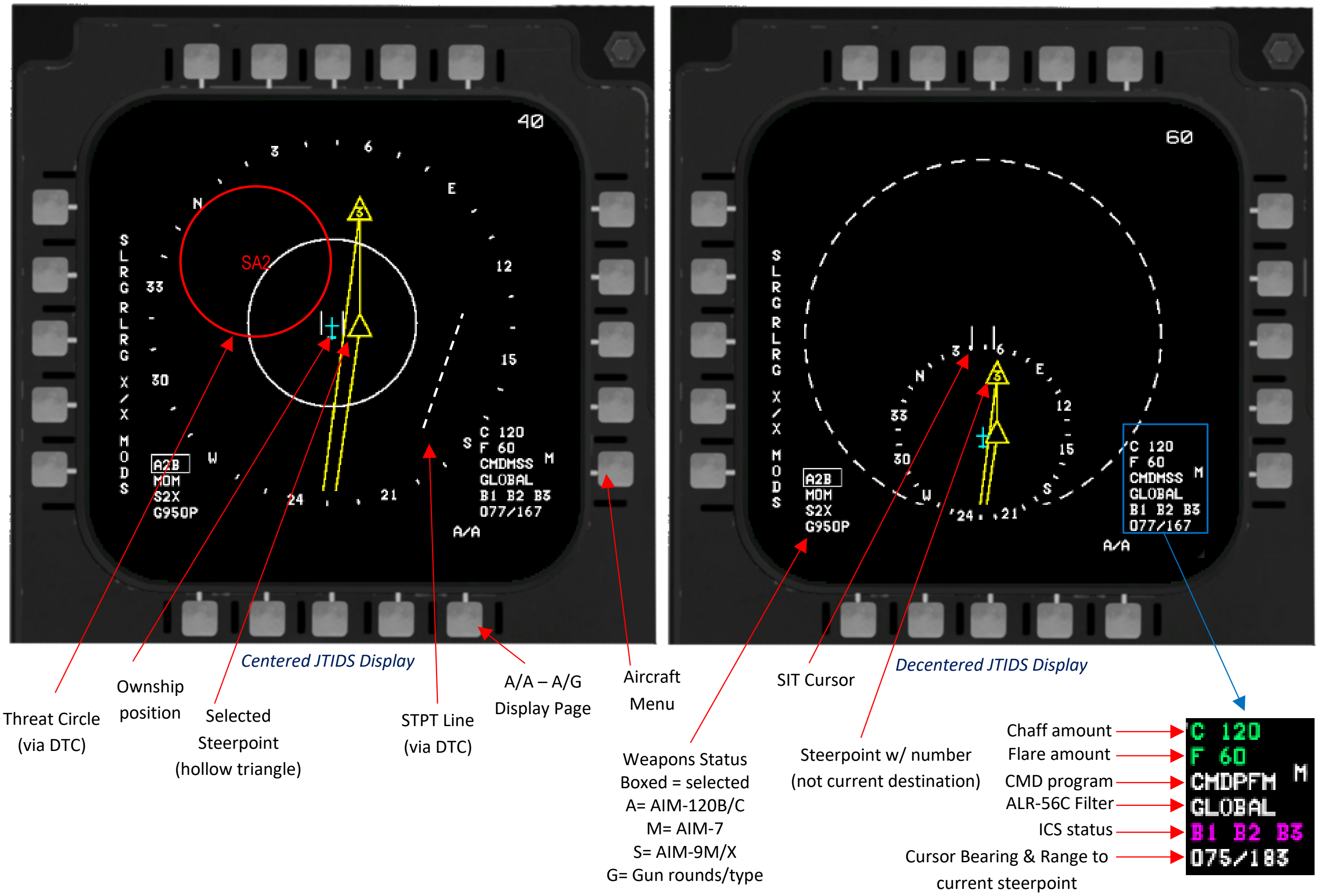
3.3.2.3 COMBAT SELECTIVE JETTISON

Only Combat Selective Jettison program 1 is implemented at this stage. If JETT is depressed when COMBAT is selected, all A/G ord and fuel tanks will be jettisoned. This is the most useful jettison mode in a combat environment.

3.3.3 PROGRAMABLE COMBAT JETTISON

Not implemented yet.

4 SITUATION (SIT) DISPLAY



The Situation (SIT) Display offers a six-color, comprehensive gods eye view of the aircraft and can be accessed via the 'SIT' option from the main MPCD menu and weapons display pages.

The SIT display enhances situational awareness by presenting critical information such as ownship weapons status, target data, geographic references, and other data programmed via the Data Transfer Module (DTM).

Geographic references such as SAM threat circles (PPTs) and steer-point lines can be programmed from the 2D UI and displayed upon successful Data Transfer Module (DTM) load.

The SIT display can be manipulated via the Castle Switch on the F-15 Stick Grip.

CASTLE SWITCH

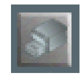
Forward	TDC control to VSD display 	(Cursor symbol)
Aft ≤ 1sec.	TDC control to SIT display 	(Cursor symbol)
Right	Last SIT display or toggle self-centered/decentered	
Left	Expand (zoom) selection	

5 DATA TRANSFER MODULE (DTM)

The Data Transfer Module (DTM) serves as a memory module - it is employed to input mission data into both the CC and PACS through the Programmable Signal Data Processor (PSDP). In BMS this works identically to the Data Transfer Cartridge (DTC) employed by the F-16.

5.1 MISSION PLANNING IN THE BMS 2D USER INTERFACE (UI)

The BMS 2D UI does not currently display F-15 specific interface for the DTM, however all relevant information can be input via the DTC or 'DATACARTRIDGE' UI.



The data cartridge/DTM allows customization of F-15 UHF radio frequencies, IFF codes/modes, JTIDS Link-16 data and automatically inputs any saved pre-planned threat (PPT) waypoints plus STPT lines from the 2D UI.

The following highlighted tabs of the DTC UI demonstrate the F-15C specific data entry field. All other fields relate to F-16 only data fields and will not be used by the F-15C.

For full information on the data cartridge, consult 'BMS-User-Manual.pdf' located in:

C:\Falcon BMS 4.37 (Internal)\Docs\00 BMS Manuals

5.2 DTM READ DATA

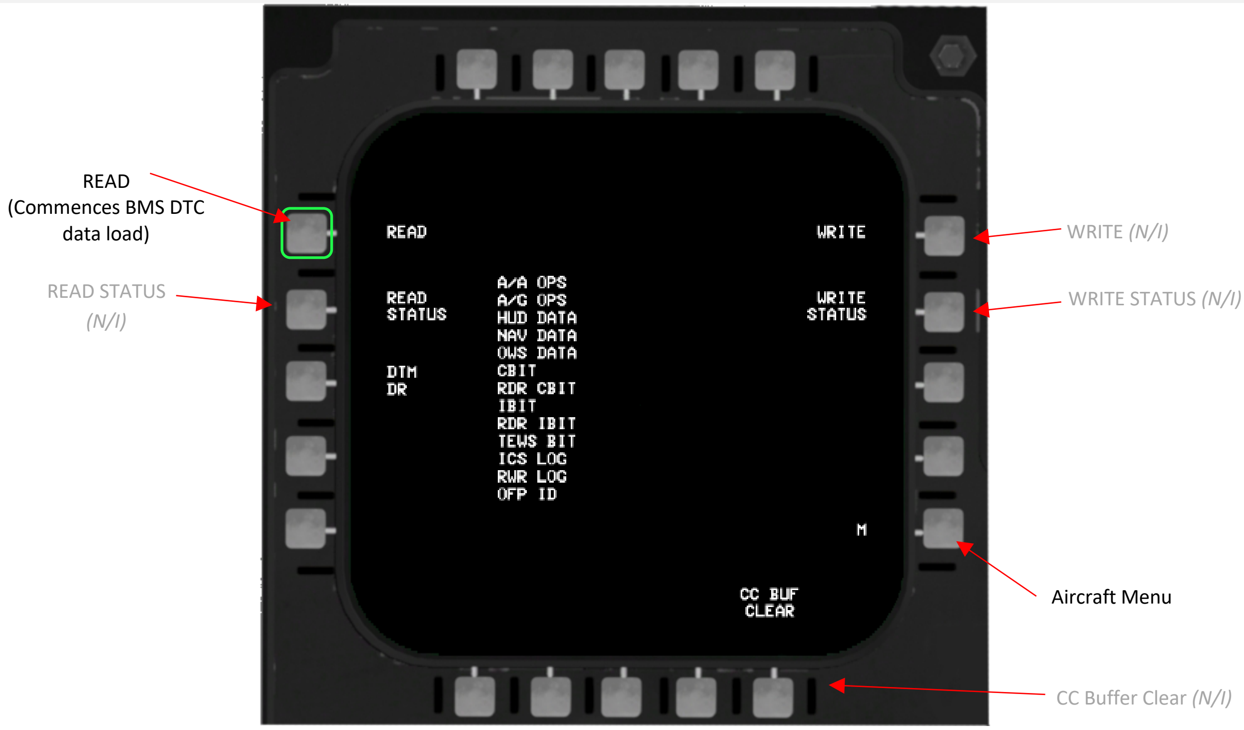
During data transfer operations, NCI keyboard inputs are temporarily disabled to ensure the process's integrity. The Data Transfer Module (DTM) facilitates the transfer of various data sets and data types, categorized as follows:

CC DATA	**PACS Data:**

• INS Navigation Destinations (waypoints):
  ○ Latitude/Longitude (lat/long)
  ○ Elevation, MSL
  ○ Magnetic variation (mag var)
• Pre-Planned Threat (PPT) data:
  ○ Position
  ○ Type
  ○ Steerpoint lines
• IFF Codes/Modes
• JTIDS/L16 data
• UHF channel presets
	○ A/A Weapon Load (gun rounds/missiles)
	○ A/G Store Load
	○ EWS Countermeasure Dispenser Program 1 and 2
	
	A/G Programs *(N/I)*

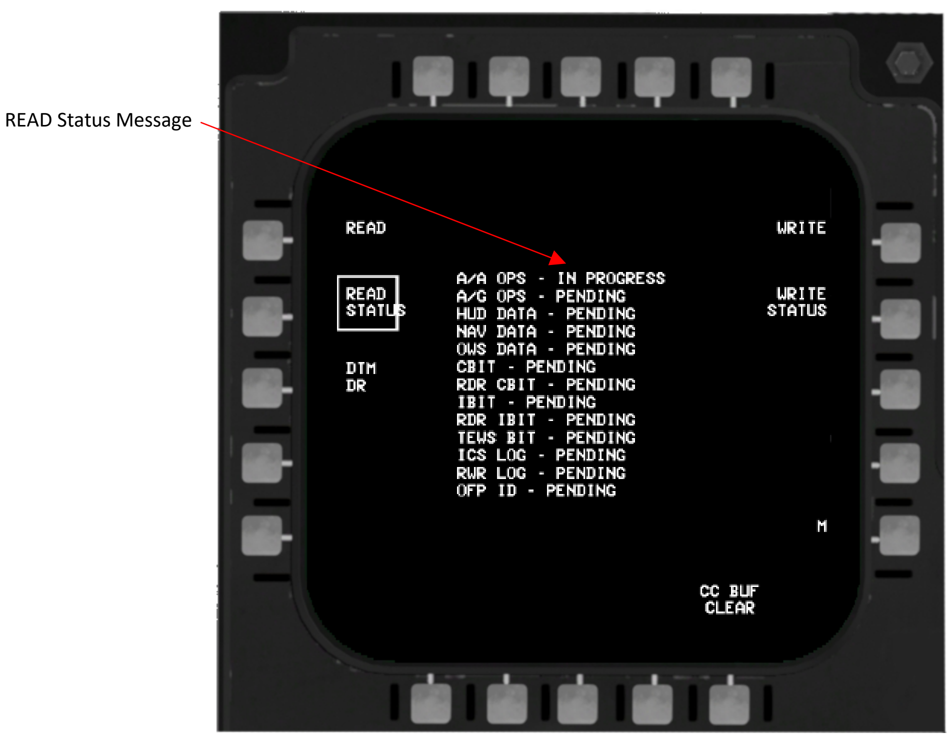
These data sets and types are integral to various operational and training procedures, ensuring the effective functioning of the systems involved.

5.2.1 DTM MPCD PAGE



Data transfer is accomplished by selecting ‘READ’ OSB to commence data transfer.

5.2.2 DTM READ OPERATION



READ TRANSFER MESSAGES

IN PROGRESS - The read process is currently transferring data types in this data set.

PENDING - Data transfer not yet attempted.

PARTIAL XFER - Some data transferred, some data missing. The old data is no longer usable.

NO XFER - No data transferred to PSDP or CC or PACS. The old data remains intact if already loaded.

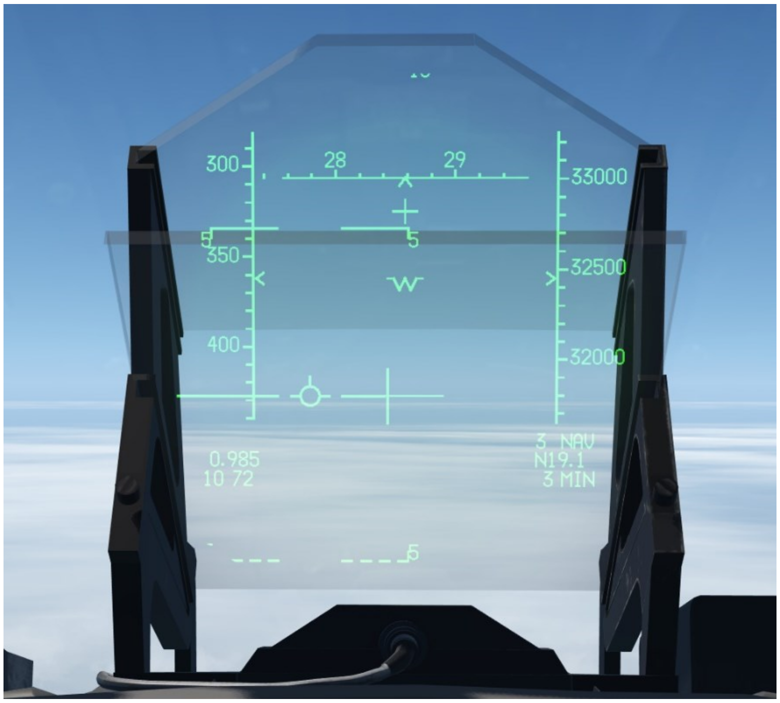
NOTE: Partial or No transfer instances can be attempted again by another press of the READ OSB.

Once DTM READ is commenced, READ STATUS OSB becomes boxed and read status is displayed next to each DTM load item. Successful DTM read is indicated by read status messages becoming blank and READ STATUS OSB becoming unboxed.

6 STICK GRIP & THROTTLE CONTROL

Please refer to the TO-1F-15C-1 BMS.

7 HEAD-UP DISPLAY (HUD) SYSTEM



The Head-Up Display (HUD) presents attack symbology and steering cues for weapon delivery. In case of failures in the CC, ACS, PACS, or HUD symbol generator unit, a standby reticle serves as a contingency display for attack information.

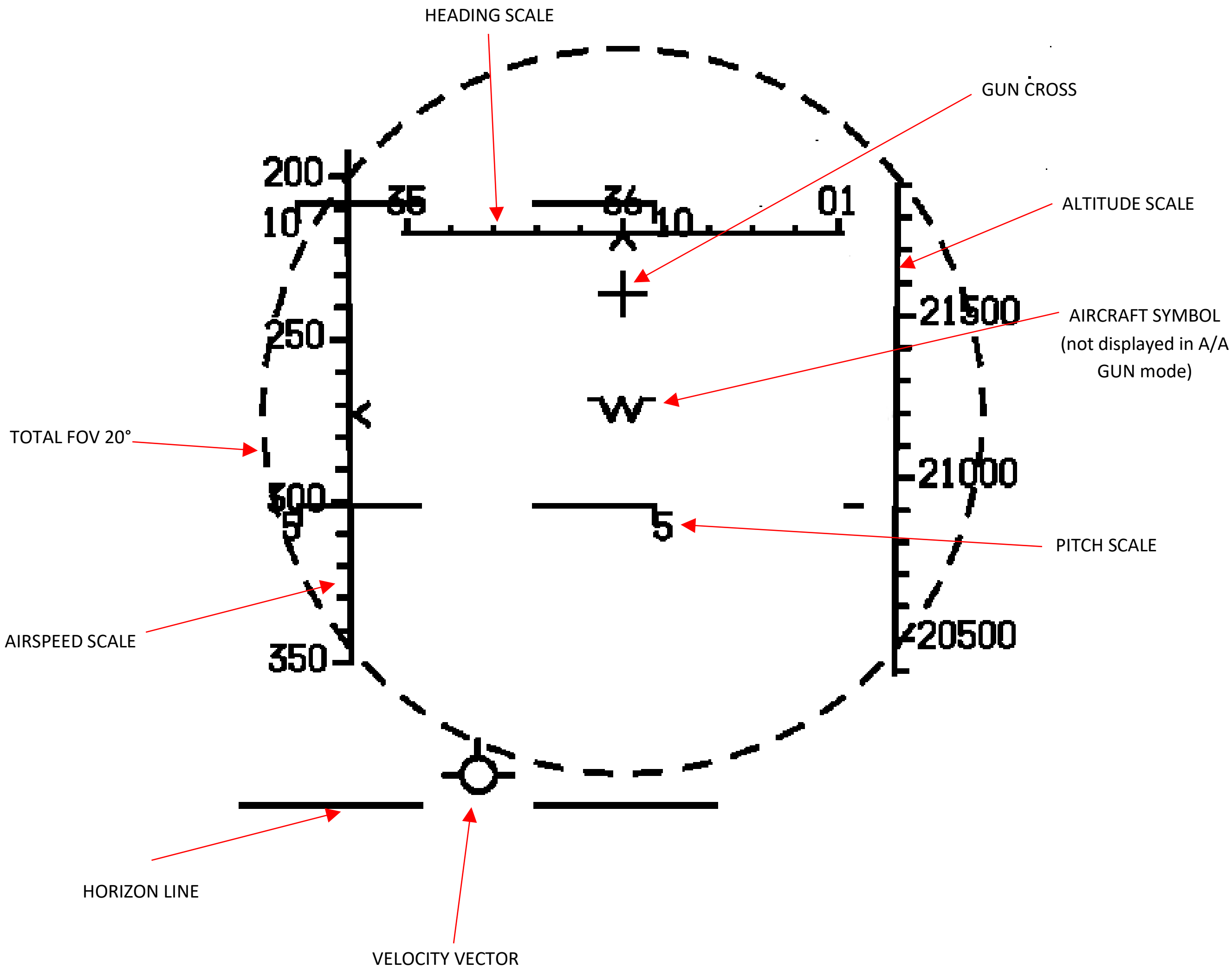
The HUD system, an electro-optical sight system, generates symbolic flight and attack guidance data and projects these symbols directly into the pilot's Field of View (FOV). The selection of HUD display modes is controlled through the master mode buttons. When in A/A master mode, the display for MRM, SRM, or GUN attacks can be chosen by manipulating the throttle weapon switch.

The complete FOV covered by the HUD is circular, encompassing 20 degrees both in azimuth and elevation. The optical axis, which is the center of the FOV, is positioned 4 degrees below the waterline. The HUD incorporates a depressible standby reticle display featuring a 2-mil diameter aim dot and a 50-mil diameter circle centered around this dot.

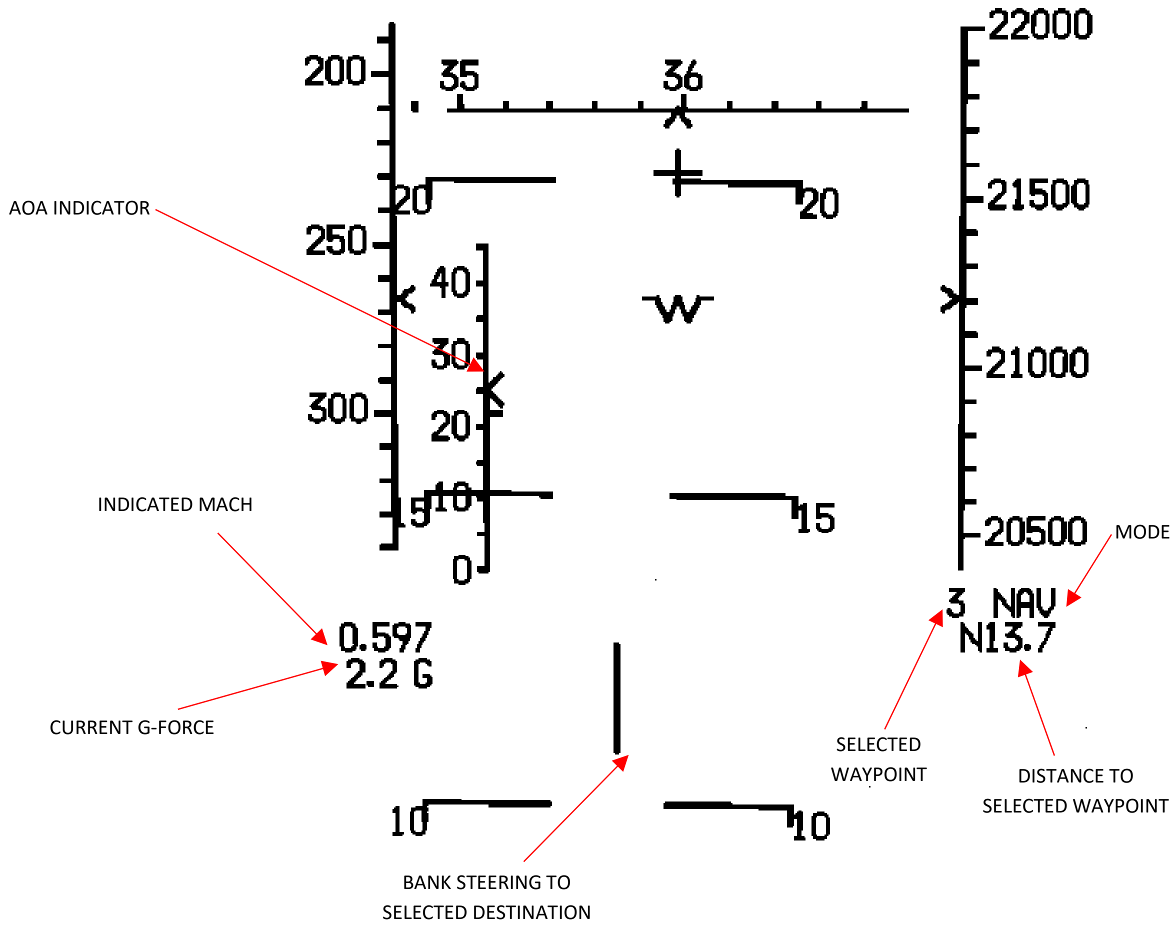
7.1 HEAD-UP DISPLAY CONTROL PANEL

Please refer to the TO-1F-15C-1 BMS.

7.2 HUD SYMBOLS - ALL MODES

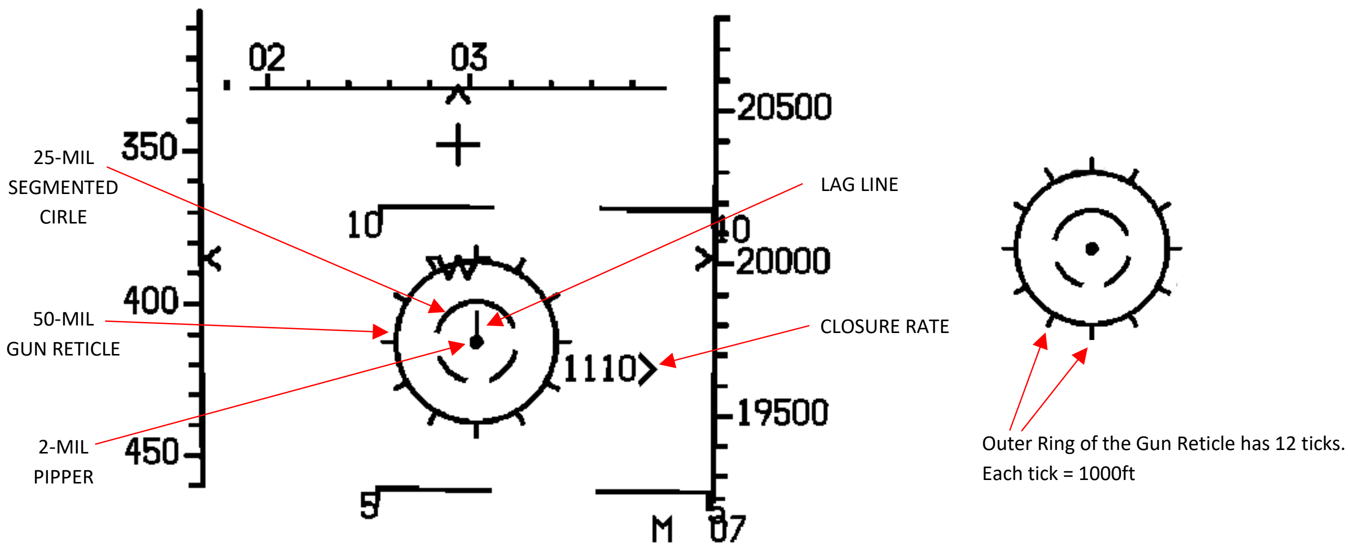


7.3 HUD SYMBOLS - ADI MODE



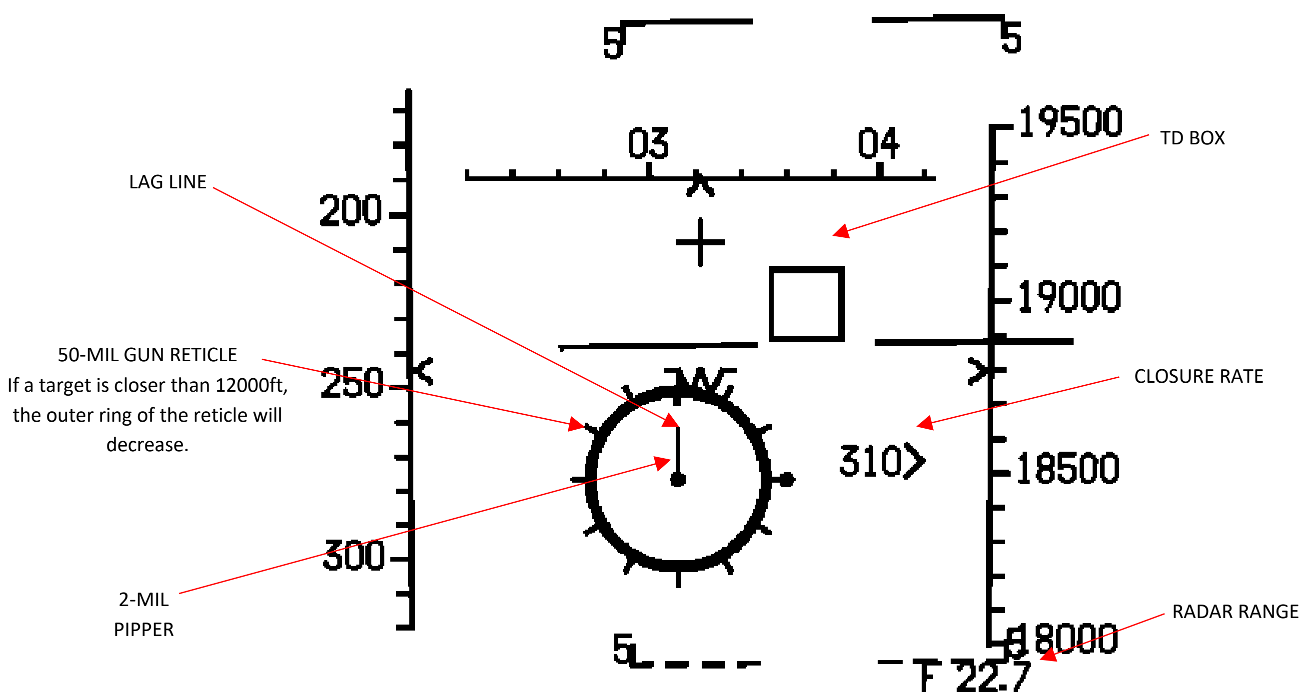
7.4 HUD SYMBOLS – AIR-TO-AIR

7.4.1 GUN MODE – NO LOCK

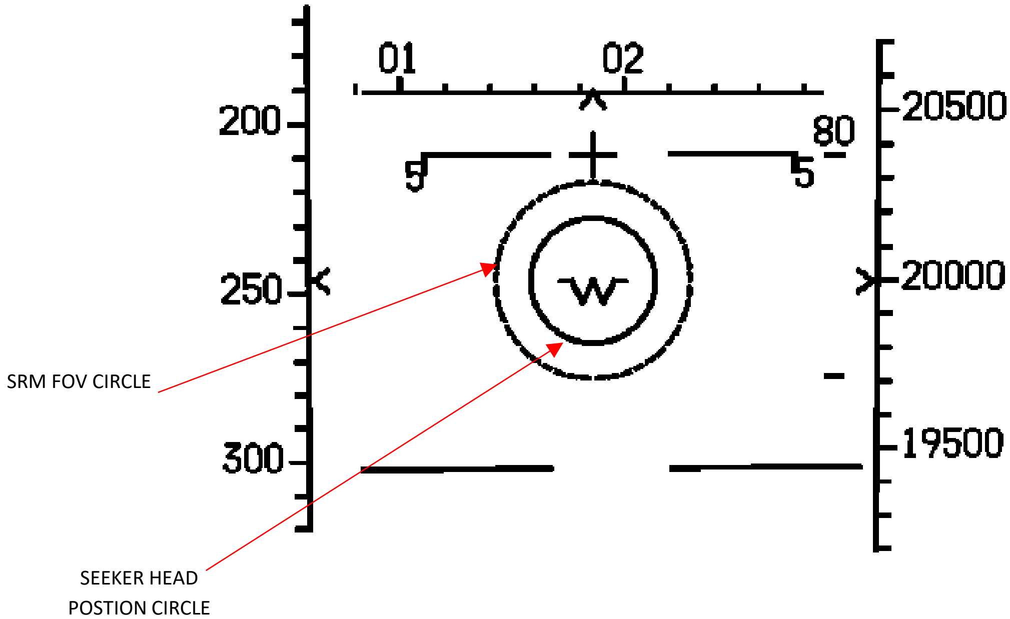


With the weapon select switch in GUN, pressing COOLIE DOWN and holding initiates LCOS reticle stiffen for the LCOS gunsight. Please note that reticle stiffen only works in the UNLOCK status. The gun and HUD gun cross are harmonized at a range of 2250 feet forward of the gun muzzle and 1000 feet if reticle stiffen is selected.

7.4.2 GUN MODE – LOCK

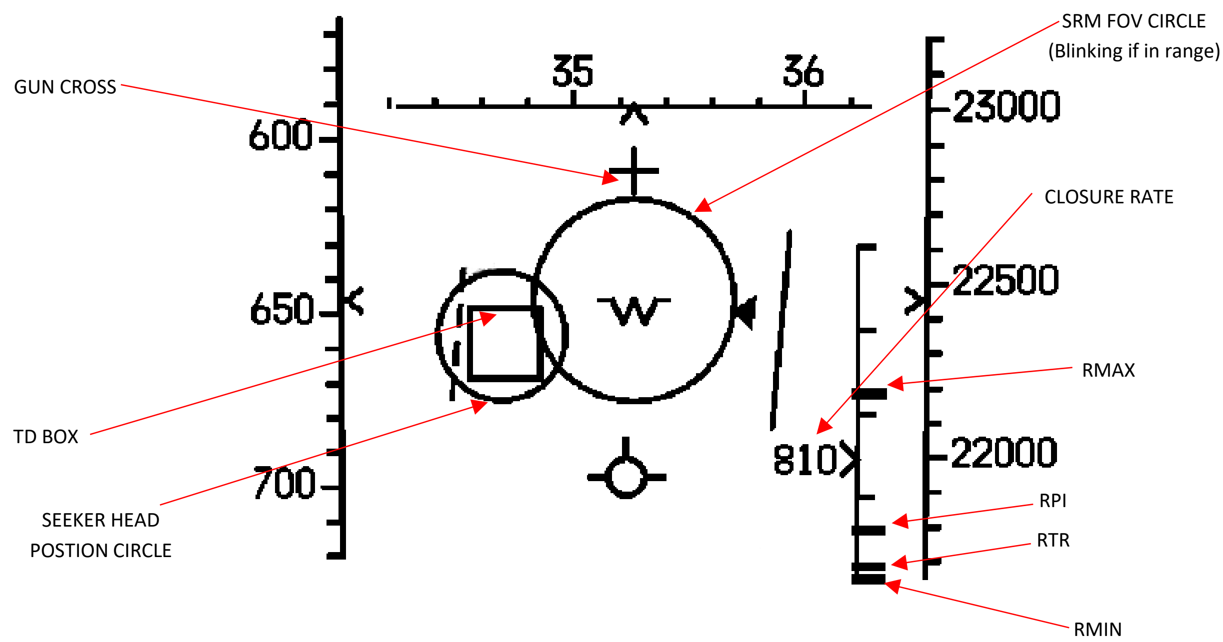


7.4.3 SRM MODE (AIM-9) – NO LOCK



This HUD window applies for the AIM-9 L/M/X. The AIM-9P HUD symbology consists of SRM FOV circle only.

7.4.4 SRM MODE (AIM-9) - LOCK



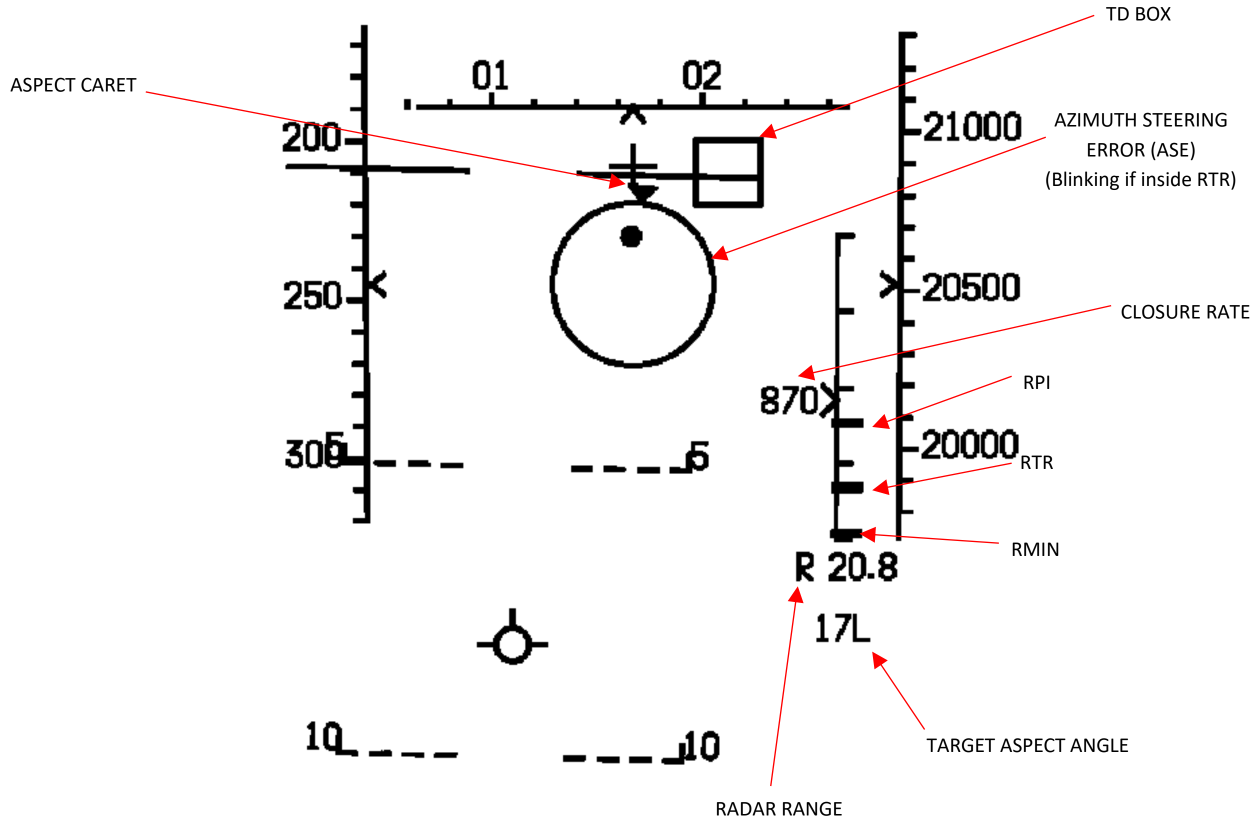
RMAX Rmax represents the maximum launch range necessary to achieve even a marginal probability of success.

RPI RPI represents the maximum launch range achievable with the existing steering setup, ensuring a high probability of success. In this context, it is assumed that the target does not perform any maneuvers; hence, the target's velocity is considered constant with no acceleration. As steering optimization involves aligning the dot precisely within the ASE (Allowable Steering Error) circle, the current steering configuration closely approximates optimal steering. Consequently, Rpi approaches Ropt. When the dot is centered, both Rpi and Ropt are identical.

RTR Rtr signifies the maximum launch range when engaging a target that initiates an evasive turn and run maneuver at launch. This calculation is based on the assumption of the current ownship steering configuration. There is a direct connection between Rtr and Rmin indicated by a vertical line.

RMIN Rmin represents the minimum launch range necessary to achieve even a marginal probability of success. In this calculation, target accelerations are presumed to remain constant for the Time of Flight (TOF) corresponding to Rmin. Additionally, it is assumed that ownship velocity remains constant from the moment of release to separation. A vertical line serves as a connection between Rtr and Rmin.

7.4.5 MRM MODE (AIM-120, AIM-7)



RPI RPI represents the maximum launch range achievable with the existing steering setup, ensuring a high probability of success. In this context, it is assumed that the target does not perform any maneuvers; hence, the target's velocity is considered constant with no acceleration. As steering optimization involves aligning the dot precisely within the ASE (Allowable Steering Error) circle, the current steering configuration closely approximates optimal steering. Consequently, Rpi approaches Ropt. When the dot is centered, both Rpi and Ropt are identical.

RTR Rtr signifies the maximum launch range when engaging a target that initiates an evasive turn and run maneuver at launch. This calculation is based on the assumption of the current ownship steering configuration. There is a direct connection between Rtr and Rmin indicated by a vertical line.

RMIN Rmin represents the minimum launch range necessary to achieve even a marginal probability of success. In this calculation, target accelerations are presumed to remain constant for the Time of Flight (TOF) corresponding to Rmin. Additionally, it is assumed that ownship velocity remains constant from the moment of release to separation. A vertical line serves as a connection between Rtr and Rmin.

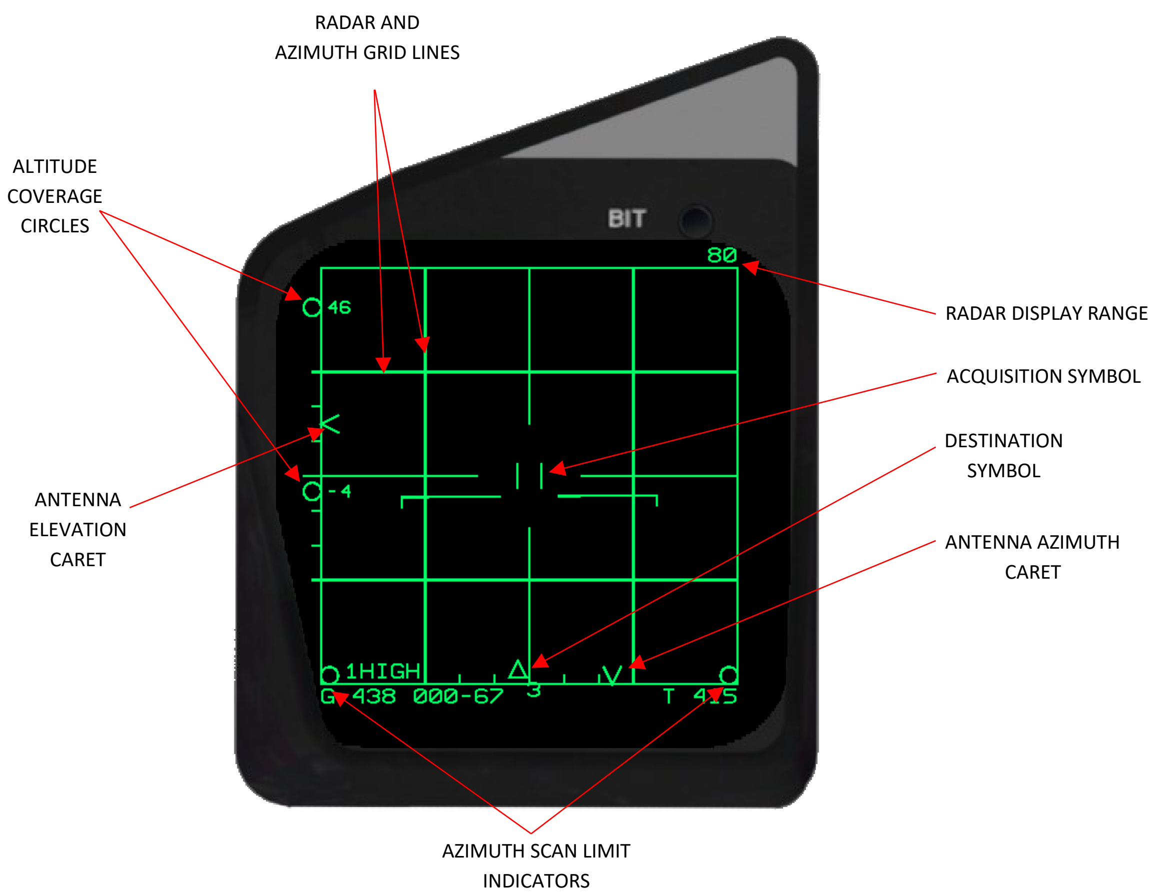
7.4.6 HUD SYMBOLS – AUTO ACQUISITION MODES

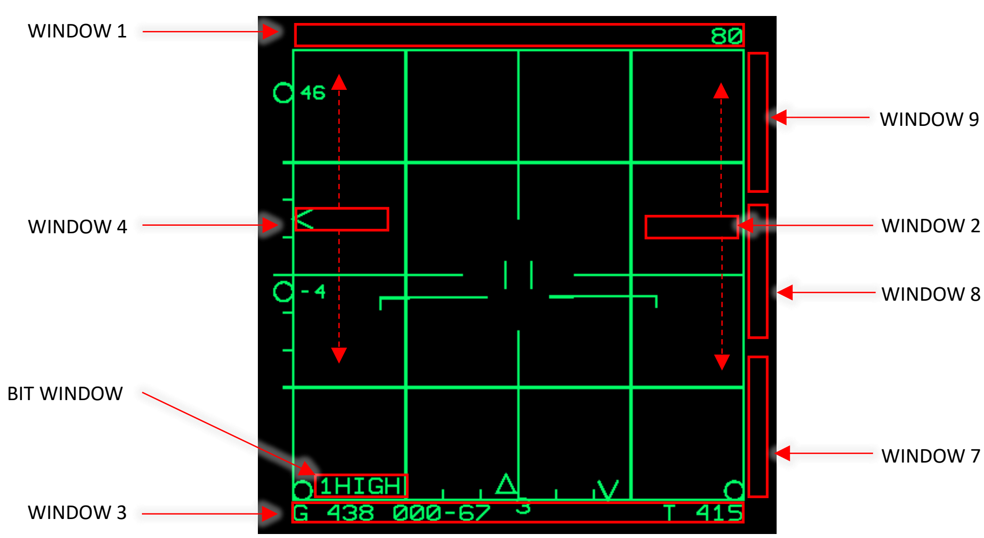
For auto acquisition radar mode HUD symbols, refer to section 'Auto Acq Modes – HUD Displays'.

8 VERTICAL SITUATION DISPLAY (VSD)

The VSD displays radar information from the APG-63 Radar and displays it as a B-scope presentation. For more information on radar specifics, refer to Section 9 – AN/APG-63 Radar.

8.1 VSD SYMBOLS AND WINDOWS

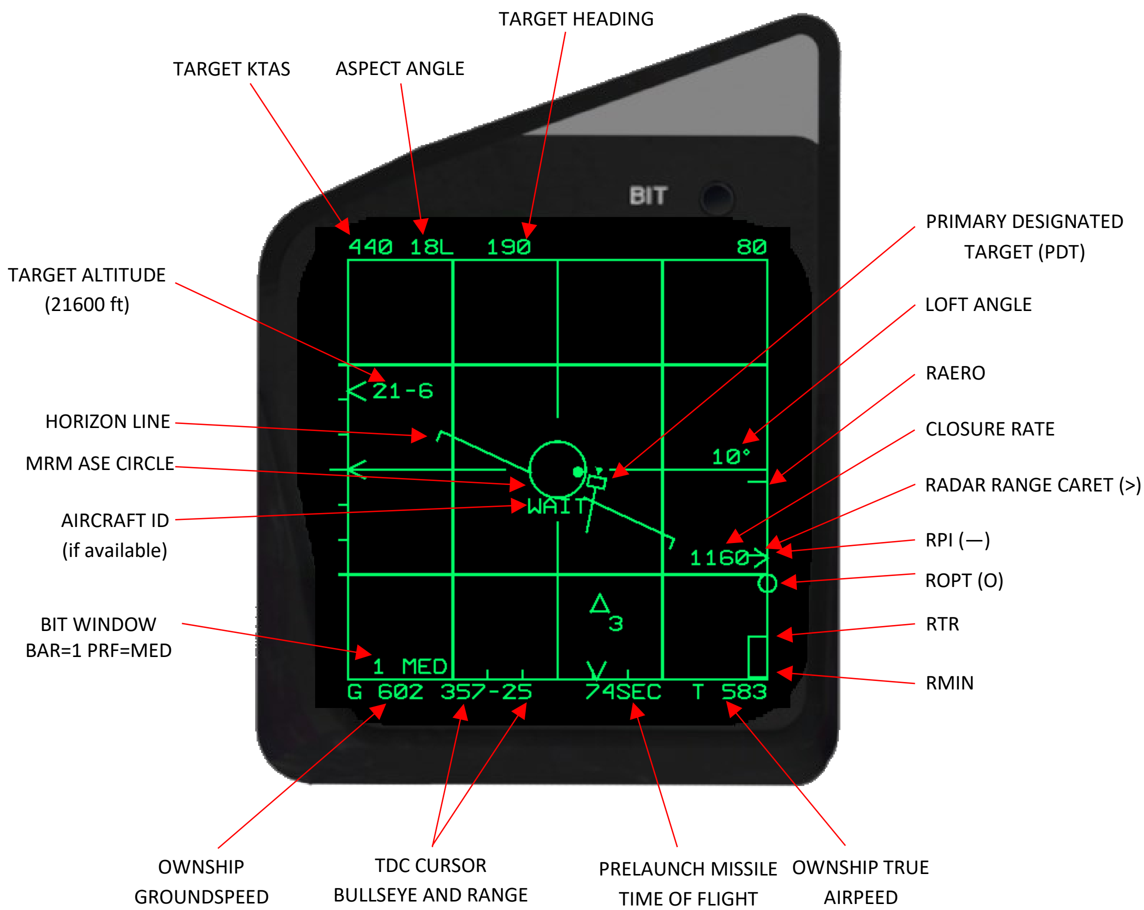




WINDOW	INFORMATION DISPLAYED
WINDOW 1	TARGET TRACK DATA, SELECTED RADAR RANGE
WINDOW 2	TARGET RANGE RATE/CLOSING VELOCITY
WINDOW 3	OWNSHIP GROUND SPEED, CURSOR BULLSEYE BEARING/RANGE, MRM PRE-LAUNCH TTI, OWNSHIP TRUE AIRSPEED
WINDOW 4	TARGET ALTITUDE
WINDOW 7	N/I
WINDOW 8	N/I
WINDOW 9	N/I
BIT WINDOW	CURRENT RADAR BAR SCAN, CURRENT RADAR PRF

8.1.1 VSD TARGET SYMBOLS

8.1.2 VSD A/A SYMBOLS WITH DESIGNATED TARGET



8.1.3 VSD – A/G – MODE

Not implemented yet.

8.1.4 VSD – RANGE AND AZIMUTH SCAN SELECTION

RANGE Move acquisition symbol up or down over the edge of the VSD.
Available ranges are: 10, 20, 40, 80, 160 NM (Nautical miles).

AZIMUTH Move acquisition symbol left or right over the edge of the VSD.
Available azimuths are: 20, 120 degrees.

9 AN/APG-63 RADAR

9.1 RADAR EQUIPMENT SETS

Doppler (PD) attack radars are primarily designed for air-to-air combat. These radars offer valuable information, such as target range, range rate, antenna angles, and angular rates, which are crucial for computing the necessary parameters for selected weapon attack modes. The radar generates synthetic video data on the Visual Sensor Display (VSD) using digital techniques, presenting targets in symbol form. In air-to-air modes, a B-scan format is employed, showing range (or velocity in the case of the APG-63 radar) versus azimuth scan data. The radar's mode controls are conveniently located on a single panel on the left console, while additional operating controls can be found on the throttles and control stick grip.

These radars consist of multiple Line Replaceable Units (LRUs) and connecting waveguide assemblies. Most of the equipment is housed in the forward left equipment bay. Key distinctions between radar systems lie in their mode capabilities, frequency agility, sensitivity, and Electronic Counter-Countermeasures (ECCM) capabilities. Differences in Line Replaceable Units (LRUs) are outlined below.

The primary antenna receives high-power radio frequency (RF) energy from the transmitter and emits a focused beam for illuminating targets. Radar returns are processed and directed to the receiver for target detection, tracking, and display. In most modes, except for the beacon mode, the radiated beam from the antenna is vertically polarized. However, when the beacon mode is chosen, the antenna roll gimbal rotates 90° to provide the necessary horizontal polarization for beacon operation.

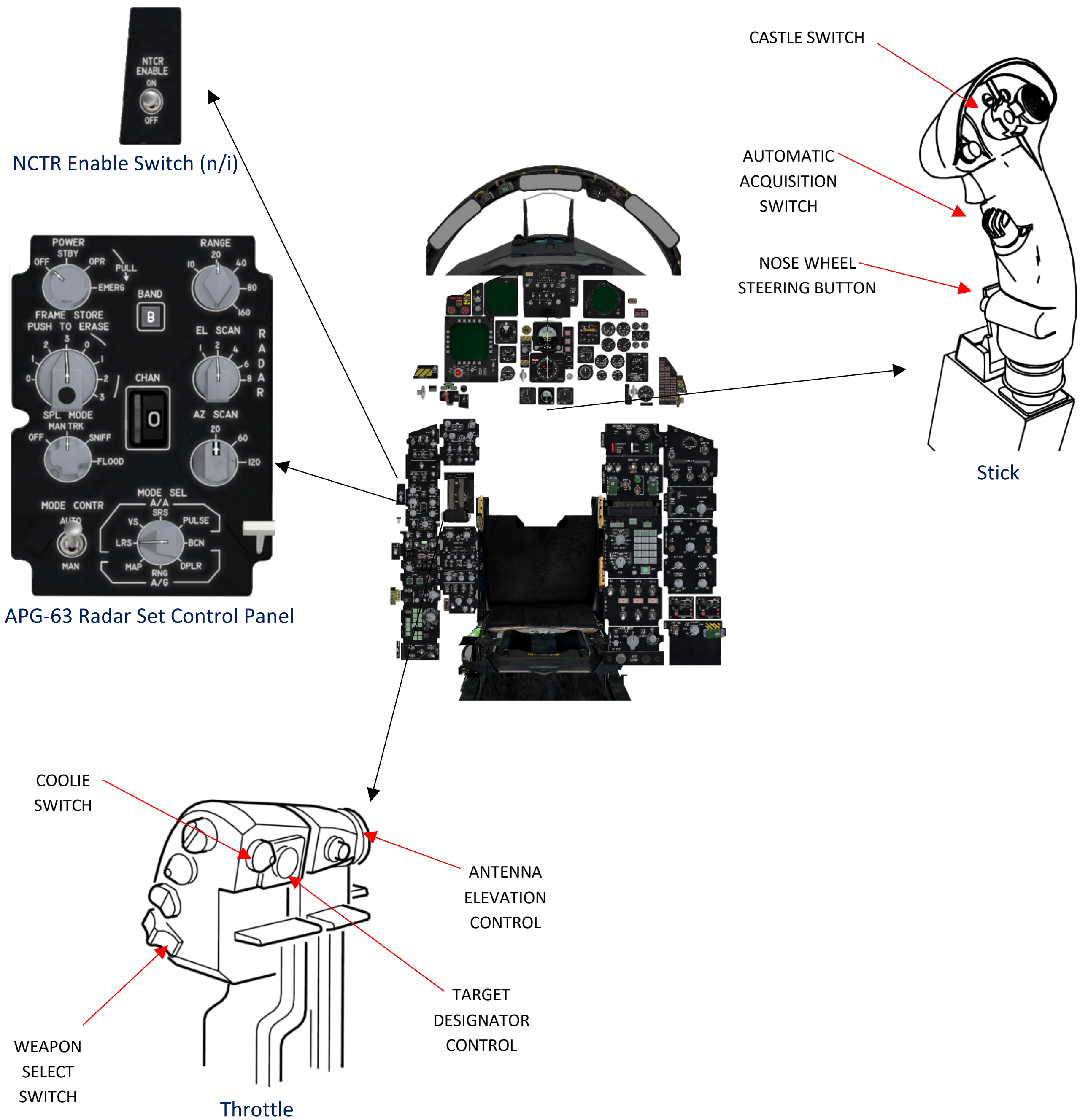
The antenna also includes the null-filling horn and guard horn. The null-filling horn is a small aperture antenna situated on the upper edge of the main antenna, offering broad-angle coverage with vertical polarization. It transmits some RF energy during AIM-7 missile launches to fill in the null region of the main antenna pattern. Both the main antenna and the null horn serve as primary sources of high Pulse Repetition Frequency (PRF) radiation for AIM-7 missile illumination and guidance. An additional source of AIM-7 missile illumination is provided through the flood antenna (refer to Flood Mode). The guard horn, mounted on the lower edge of the main antenna, is designed to receive wide-angle RF side lobe energy. This signal is compared to the main receiver signal to reduce false alarm rates.

9.2 RADAR BUILT-IN TEST (BIT)

The radar Built-In Test (BIT) system verifies both radar performance and the accuracy of radar parameters entered into the Central Computer (CC). All calculations related to missile launches, including head aiming and English bias adjustments, are executed within the CC. The CC's own BIT routines are responsible for validating its operations and confirming that the CC program, which relies on radar input, is functioning correctly.

Throughout power-up, Operational Readiness Test (ORT), and Initialization BIT (I-BIT) procedures, messages are displayed in the BIT window to provide information about the radar's activities at specific times.

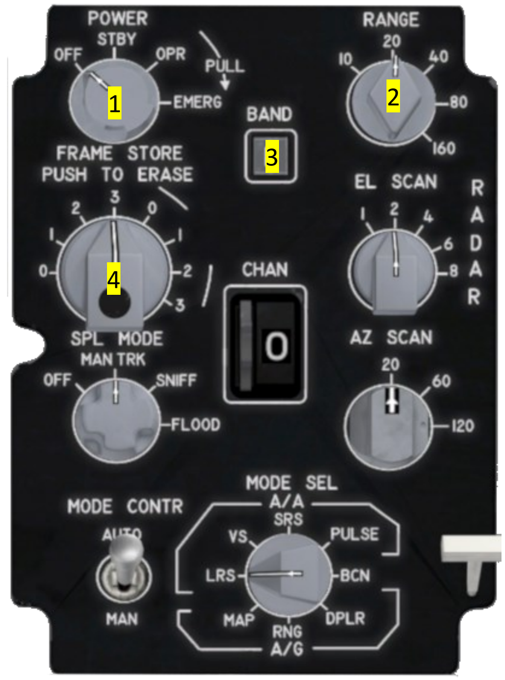
9.3 RADAR CONTROLS



Radar Controls

9.3.1 RADAR SET CONTROL (RSC) PANEL

The RSC controls several functions of the APG-63 Radar.



1- **Power Knob**

OFF Radar completely off.

STBY All radar functions are functioning properly, with the exception of the transmitter high voltage and RF transmission circuits. When the "STBY" mode is selected from OFF position, the Built-In Test (BIT) window will sequentially display "PSP LD," followed by "081TST," "042TST" as well as other BIT displays. The BIT is finished after approximately 120 seconds. The knob can be switched to the "OPR" mode.

OPR The radar operates at full capacity unless the aircraft is on the ground and the W-ON-W interlock is engaged. If the OPR mode is selected from the OFF position, the BIT test like described under STBY will executed first before the radar is functional.

EMERG Initiates complete radar operation, bypassing all radar protective interlocks, except for the W-ON-W interlock and the transmitter coolant flow interlock.

2- **Range Knob**

The range knob offers a manual option for choosing the display range scale, with available ranges of 10, 20, 40, 80, or 160 nautical miles (NM).

3- **Frequency Band Selector**

This switch is non-functional yet.

4- **Frames Store knob**

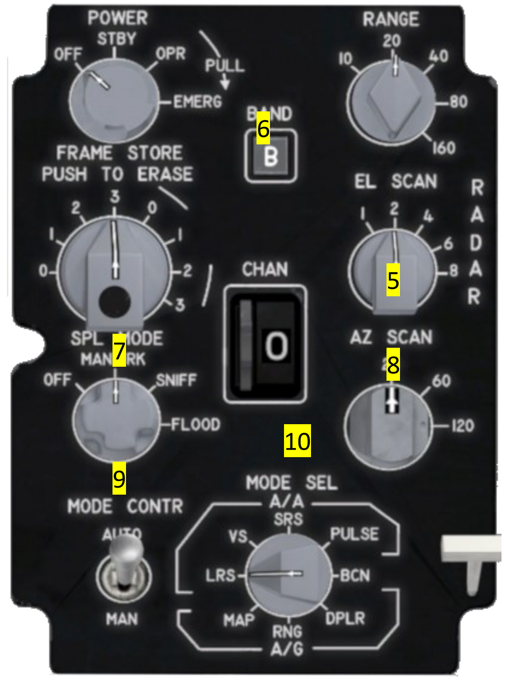
The frame store knob allows for manual adjustment of the duration for which target data is shown on the VSD (Vertical Situational Display). In this context, one frame corresponds to the time it takes to complete the current bar scan selection. For instance, if a four-bar elevation (EL) scan is chosen, one frame represents the entire cycle of the four-bar scan. The utilization of multiple frame data aging is particularly useful when operating in the Long Range Search (LRS) radar modes. Notably, this feature is also available in the Short Range Search (SRS) mode.

0 Target data is displayed only on the current bar.

1 thru 3 This function allows you to choose the duration for which historical target data is displayed. In this display, the target return within the current bar is shown at its maximum brightness. Furthermore, any stored target data from previous bars or frames is displayed with reduced intensity, indicating the range and azimuth position of the target a specified number of bars or frames ago. When the frame store is

configured for one or more frames, Angle Of Jam (AOJ) strobes are eliminated at the second End Of Bar (EOB) after detection.

5- **Elevation Scan Knob**



The elevation (EL) scan knob allows manual selection of elevation scan patterns with options of one, two, four, six, or eight bars. It's important to note that the EL scan knob is non-operational during TWS (Track While Scan) mode.

6- **Channel Selector**

This switch is non-functional.

7- **Special Selector**

This switch is non-functional.

8- **Azimuth Scan Knob**

The azimuth (AZ) scan knob enables manual selection of three different azimuth antenna scan patterns: 30°, 60°, or 120°. Notably, the physical 20° position on the AZ scan knob corresponds to a 30° azimuth (sort mode) scan pattern, which is further explained in the Sort Mode section of the manual. When in TWS (Track While Scan) mode, the AZ knob provides the flexibility to choose between two options: the two-bar 60° pattern (selected at 120) or the four-bar 30° pattern (selected at either 60 or 20).

9- **Mode Select Knob**

Only AUTO mode is implemented. AUTO enables the weapon select switch to control various radar settings:

SRM(AUTO) When selected, the radar enters SRS. If entered from GUN, 20 NM range and the RSC selected AZ scan is initialized with six-bar EL scan. If entered from MRM, AZ scan does not change from the present setting. Range is limited to 80 NM; therefore range scale does not change unless the present scale is greater than 80 NM. A minimum four-bar EL scan is selected unless the RSC is set to a greater number.

MRM(AUTO) When selected, the radar enters LRS interleaved H/MPRF mode. If entered from SRM, range/AZ scan values are not changed and EL scan is as selected on the RSC. If entered directly from GUN, the range, AZ scan and EL scan are as selected on the RSC.

GUN In search, the radar enters the gun scan and the operating parameters are determined automatically. Parameters cannot be changed in the GUN auto acquisition mode. From TWS, selecting GUN causes the radar to transition to STT on the PDT.

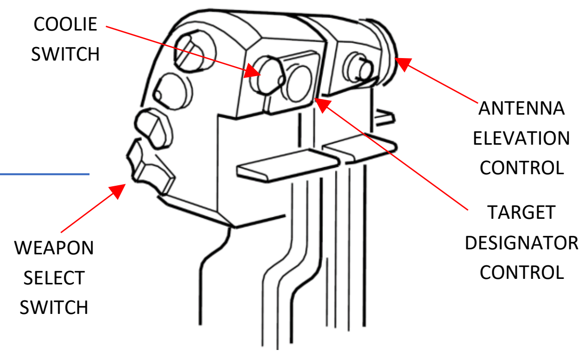
10- **Mode Selector**

Only LRS mode is functional. See chapter Radar Search Modes for more information.

9.3.2 RADAR CONTROLS (THROTTLE)

9.3.2.1 WEAPON SELECT SWITCH

GUNS	Activates 20mm gun submode
SRM	Activates short range missile submode
MRM	Activates medium range missile submode



Throttle

9.3.2.2 ANTENNA ELEVATION CONTROL

The antenna elevation control is responsible for positioning the center of the selected bar scan pattern within a range of ±40° in elevation. However, it's important to note that this control output is not utilized in STT (Signal Target Track), DTWS (two-bar scan patterns), or the auto acquisition modes. When the control is rotated to the rear, it moves the antenna upwards in elevation. This elevation change can be observed by checking the elevation caret and scale on the left border of the VSD, as well as by reviewing the VSD altitude coverage data.

The antenna elevation control operates as a spring-loaded rate control device, allowing rotation through approximately ±30° and automatically returning to the central neutral position upon release. Its logic functions similarly to the Target Designator Control (TDC) logic used to control the acquisition symbol. When you apply a fixed deflection to the control, it commands a constant rate of change in the scan center altitude (at the range of the acquisition symbol). Deflection of approximately 3° or less has no impact, but between 3° and roughly 8° of deflection, the commanded rate gradually shifts from 0 to 3000 Feet Per Second (FPS). Between 8° and 23° of deflection, a consistent rate of 3000 FPS for altitude scan center change is commanded. From 23° to around 27° of deflection, the commanded rate linearly increases to the maximum rate of 15,000 FPS.

As the antenna elevation control employs rate control logic rather than position control logic, it can automatically adjust the scan center elevation based on radar operational conditions. For instance, when exiting STT, the search elevation is initialized to the target's elevation instead of beginning at the last commanded value in the search mode. Moreover, elevation angle is reset to zero upon exiting SS (Single Target Search), BST (Bar Scan Track), LR BST (Long Range Bar Scan Track), vertical scan, or auto guns.

When transitioning from an Air-to-Ground (A/G) mode back to Air-to-Air (A/A) search, the elevation scan center is set to an initial position of 0°.

9.3.2.3 TARGET DESIGNATOR CONTROL (TDC)

The Target Designator Control (TDC) is powered up when the radar's power knob is turned away from the OFF position. The TDC is designed as an isometric positioning device and includes a depressible action switch. It allows you to adjust the position of the VSD acquisition symbol at a rate directly proportional to the amount of force applied to the TDC. A left/right force influences the symbol's azimuth positioning, while an up/down force affects the symbol's range or range rate in a Visual Search mode.

When the TDC is pressed (in the action position), the radar antenna becomes aligned with the azimuth position of the acquisition symbol. Releasing the TDC issues a command for radar lock-on in any Air-to-Air (A/A) search mode.

9.3.2.3.1 AUTO RANGE SCALE SWITCHING, RANGE BUMP (TDC)

RADAR SEARCH or TWS (Track-While-Scan)

In the MRM or SRM weapon modes, when the TDC is assigned to the VSD, if the pilot moves the acquisition symbol to the top (99%) or bottom (1%) of the VSD, the display automatically switches to the next higher or lower range scale, respectively. Simultaneously, the acquisition symbol relocates to the center of the display. It's important to note that range adjustments are not accessible when dealing with dashed acquisition symbols on the VSD.

STT (Single Target Track)

When the target's position extends beyond 95% of the currently displayed range (or 99% in a 10-mile range scale), the radar automatically switches to the next higher range scale. Conversely, if the target's position falls below 45% of the displayed range, the radar selects the next lower range scale.

Upon transitioning to STT from either the search or Track While Scan (TWS) modes, there's a brief 3-second delay before the auto range scale decrease takes effect. During this time, the radar can automatically increase the range scale as necessary to maintain STT. However, if TWS or Return-To-Search (RTS) mode is initiated during the 3-second delay, the scale won't be decreased.

When the acquisition symbol is displayed on the Air-to-Air (A/A) radar during STT with MRM selected, you have the option of manual range bumping, as previously described in the Radar Search or TWS modes. After a range scale change resulting from a bump, the acquisition symbol is repositioned to the new midpoint range.

The standard STT auto range bumping logic is paused once a manual range bump occurs, except when increasing the scale if the radar target range exceeds or equals 100% of the current scale. In such cases, the automatic range scale adjustment based on the radar target range is restored. It's worth noting that the range scale cannot be bumped to a scale smaller than the current radar target range.

The regular automatic range scale selection logic is reactivated under the following circumstances:

a. Exiting MRM during STT (removing the acquisition symbol from the display).

b. Exiting STT mode (for instance, returning to search or TWS) and subsequently re-entering STT.

9.3.2.3.2 AZIMUTH BUMPING (TDC)

In MRM or SRM weapon modes, when the TDC is assigned to the VSD, you have the capability to perform azimuth bumping. This adjustment is based on the azimuth position of the acquisition symbol on the VSD and the deflection of the TDC. However, it's essential to note that azimuth bumping is not an option when dealing with dashed acquisition symbols on the VSD.

When the acquisition symbol reaches either of the extreme azimuth positions on the VSD and the TDC is deflected toward that direction, the azimuth scan selection changes as follows:

SCAN AT AZ BUMP	SCAN AFTER AZ BUMP	
	SEARCH	***TWS (N/I)***
30°	60°	60°
60°*	120°*	30°
120°*	60°*	N/A

***Current bug results in az bump from LRS alternating between 120° and 20° only.**

When the azimuth scan is modified using the azimuth bumping method, the acquisition symbol's azimuth position resets to the center of the VSD. This feature is not yet implemented for TWS.

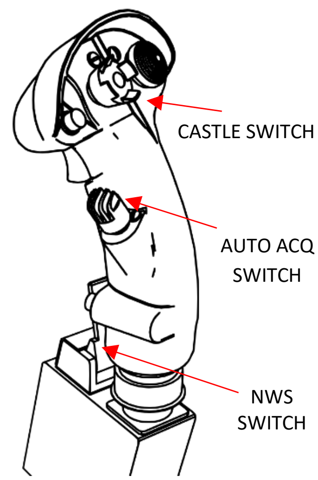
9.3.2.4 COOLIE SWITCH

UP In TWS radar mode, coolie switch UP steps to the next TWS contact, or designates the radar priority target (RPT) if no target is currently designated.

DOWN - In TWS radar mode, coolie switch DOWN un-designates the current Primary Designated Target (PDT).
- Slave/Bore for AIM-9M/X.

9.3.3 RADAR CONTROLS (STICK GRIP)

9.3.3.1 AUTO ACQUISITION SWITCH



The auto acquisition switch is a four-position switch (FWD, AFT, OFF and DOWN), designed to return to the neutral (OFF) position when released. Below is a list of the switch functions in relation to the radar's operating status.

FWD:

- In radar search mode, selects various auto acquisition radar modes (SS, BST, LRBST).
- If in space designate (acquisition mini-raster, selects non designated high data rate TWS (2/3BAR 30°AZ HDTWS) (N/I).
- If in non-designated TWS (NDTWS), toggles between 3 and 4 bar NDTWS.
- If in designated TWS, toggles 3 bar HDTWS, 4 bar TWS. (N/I)
- In STT, toggles 2 and 3 bar D/HDTWS. (N/I)

AFT:

- If in radar search mode, selects VTS auto-acquisition radar mode.
- In space designate (acquisition mini-raster), selects NDTWS (2BAR, 60°AZ*)
- In ND/DTWS, selects STT on the radar priority target.
- In STT, selects DTWS.

DOWN:

- Returns To Search (RTS). It drops all locked tracks and enters the search mode selected on the Radar Control Panel.
- Air refuelling receptacle release.

*Current implementation results in a 30° azimuth scan.

9.3.3.2 CASTLE SWITCH

When the F-15E stick grip is in use, pushing the castle switch forward or backward results in a clear acquisition symbol on the MPCD or VSD. This symbol informs you which display is currently being influenced by the Target Designator Control (TDC). Conversely, a dashed acquisition symbol indicates that the control does not have authority over that particular display.

Upon powering up or when the radar transitions into any auto acquisition mode, TDC control automatically switches back to the VSD display.

UP TDC control to VSD display (Cursor symbol)
AFT ≤ 1sec. TDC control to SIT display (Cursor symbol)

9.3.3.3 NOSE WHEEL STEERING BUTTON

When in SRM mode, the NWS button cages/uncages the AIM-9M/X.

9.3.4 RADAR CONTROLS (MISCELLANEOUS)

9.3.4.1 LOCK/SHOOT LIGHTS

The lock/shoot lights are located on the canopy bow and illuminate under the following circumstances:

- Steady ON in STT
- Flashing ON/OFF for MRM between Rtr and Rmin.
- Flashing ON/OFF for SRM between Rmax and Rmin

9.4 RADAR MODES OVERVIEW

The AN/APG-63 provides various modes for all phases of target acquisition, track and engagement. In BMS, the primary search mode is Long Range Search (LRS) which is supplemented by Track While Scan (TWS) which can be used for search, track and engagement of up to 8 targets simultaneously (via AMRAAM). Various auto-acquisition modes are implemented which provide the pilot a method for rapidly transitioning to Single Target Track on aircraft within and beyond visual range.

9.4.1 RADAR MODE PARAMETERS

Mode Control AUTO and MANUAL (Only Auto is implemented in BMS).

WEAPON SELECT SWITCH POSITIONED: FROM....TO		RADAR RANGE	AZ SCAN	EL SCAN	TRANSMITTER MODE
SRM	MRM	NO CHANGE	NO CHANGE	RSC (A)	INLV H/MPRF
GUN	MRM	40	120°	RSC (A)	INLV H/MPRF
MRM	SRM	NO CHANGE (80 MAX)	NO CHANGE	FOUR-BAR (MIN) (A) (B)	MPRF
GUN	SRM	20	120°	SIX-BAR (2.5° BAR SPACING)	MPRF
SRM or MRM	GUN (C)	10	60°	20° (SIX-BAR, 3.4° BAR SPACING)	MPRF AUTO ACQ

NOTE: Grey options are not implemented.

INLV Interleaved Pulse Repetition Frequency
LRS Long Range Search
RSC Radar Set Control

A) If 10 NM or 20 NM range is selected, EL BAR spacing changes from 1° to 2.5°(20 NM) or 3.4°(10 NM).
B) Initializes to RSC if EL selection is greater than four-bar.
C) Search parameters cannot be changed. Scan is positioned in AZ/EL by the TDC. After lockon, bump auto acq available by selecting REJECT.

9.5 RADAR SEARCH MODES

9.5.1 LONG RANGE SEARCH (LRS)

The Long-Range Search (LRS) mode serves as the primary Air-to-Air (A/A) surveillance mode. In LRS, the radar typically operates in an interleaved mode, employing a 50% high pulse repetition frequency (HPRF) and 50% medium pulse repetition frequency (MPRF). This means that the pulse repetition frequency alternates with each bar scan: the first bar uses HPRF, the second uses MPRF, the third uses HPRF, and so on. However, if the 10 nautical mile (NM) range is selected, only MPRF is utilized.

During search, the radar employs an interleaved pulse repetition frequency upon initial entry into the 160 NM range scale. Subsequently, while in the 160 NM scale, the radar adjusts between interleaved and exclusively HPRF in response to alternate range settings.

The radar's detection range performance is highly influenced by various factors, including the target's cross-sectional area (a measure of target reflectivity), target Doppler conditions (component of the target ground speed along the radar Line of Sight), ground clutter signal strength (ground reflection coefficient), and specific tactical conditions such as lookdown versus lookup.

The utilization of dual PRF in the LRS mode is designed to maximize the potential for target detection under a wide range of conditions, encompassing both tail and frontal aspects of targets, whether they are positioned above or below the F-15 aircraft.

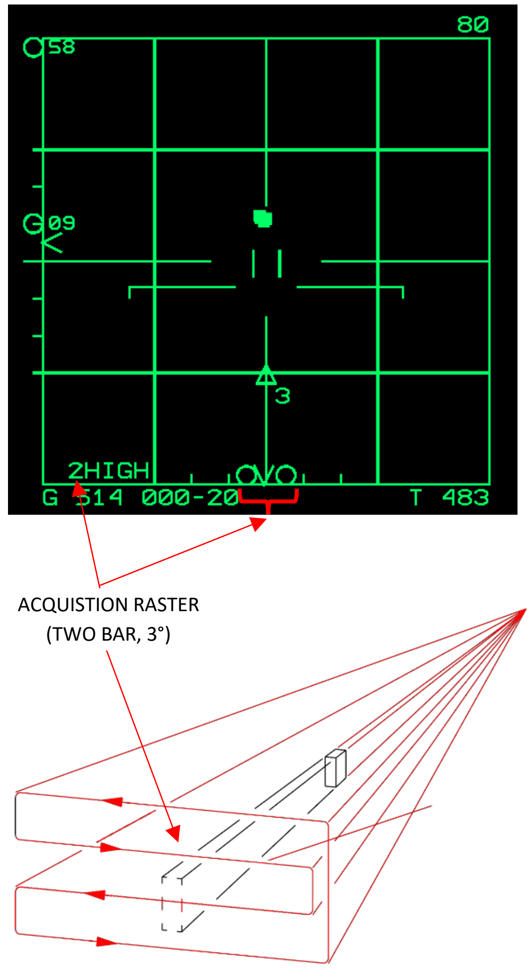
9.6 RADAR ACQUISITION MODES

9.6.1 MANUAL ACQUISITION

Manual target acquisition is carried out using the Target Designator Controller (TDC) while monitoring the acquisition symbol. The pilot aligns the target with the acquisition symbol by applying the appropriate force on the TDC. Pressing the TDC 'down' (action position) commands the radar to initiate a ±3° azimuth acquisition scan (mini-raster), centered on the acquisition symbol in azimuth, and simultaneously searches within the selected elevation bar pattern.

Releasing the TDC within 1 second commands the radar to lock onto the target. During this time, the radar attempts to correlate any stored target hits within the acquisition symbol for a maximum of 2 seconds. If correlation is successful, the radar automatically selects the Pulse Repetition Frequency (PRF) and bar that were in use at the time of the target detection. It centers a ±3°, two-bar scan at that position for a maximum of 1.5 seconds. Lock-on is achieved upon receiving the second live target hit within the acquisition symbol. If lock-on is not achieved within 1.5 seconds, the scan automatically switches to the number of selected elevation bars and the appropriate PRF interlace.

The typical Long Range Search (LRS) acquisition scan and High/Medium Pulse Repetition Frequency (H/MPRF) interlace is performed frame by frame. If lock-on is still not achieved, the radar remains in the acquisition scan with the lock-on command active. The pilot has the option to adjust the antenna's acquisition scan position using the TDC for azimuth and the elevation (EL) control for elevation positioning to focus on the target. Alternatively, the radar can be returned to the selected search mode by momentarily selecting "Return to Search" (RTS).



FOUR BAR SEARCH PATTERN
SUPERIMPOSED ON ACQUISITION
RASTER SCAN VOLUME

9.6.2 AUTOMATIC ACQUISITION (AUTO ACQ)

There are five auto acq modes: supersearch (SS), boresight (BST), vertical scan, GUN, and long-rand boresight (LR BST). All auto acq modes use MPRF except LR BST which uses IPRF. The search range display obtained in all auto acq modes is 10 NM except GUN which uses 20 NM and LR BST which uses 40 NM.

The SS, BST, and LR BST modes are selected through the forward position of the auto acq switch. The first actuation less than 1 second selects SS; the second actuation less than 1 second (while the radar is still in SS) selects BST. Forward actuation greater than 1 second commands LR BST. The aft position of the switch selects vertical scan. The GUN mode is in operation when GUN is selected on the throttle weapon select switch. The auto acq selections are disabled when track is established. The pilot must press RTS to return to the selected search mode. If the pilot selects RTS after obtaining a lockon in GUN mode, the radar returns to GUN mode. In the event an auto acq attempt fails to properly enter track, the radar returns to the auto acq mode that was previously selected rather than return to search.

9.6.2.1 SUPERSEARCH (SS) MODE

In SS, the radar scans the HUD FOV of 20° by 20° using a six-bar scan pattern until a track is established or the Return-To-Search (RTS) option is chosen. The bars are spaced apart by 3.4°. Radar lock on is automatic, and the radar tracks the first target detected within this scan pattern, provided it falls within a range of 500 feet to 10 nautical miles (NM).

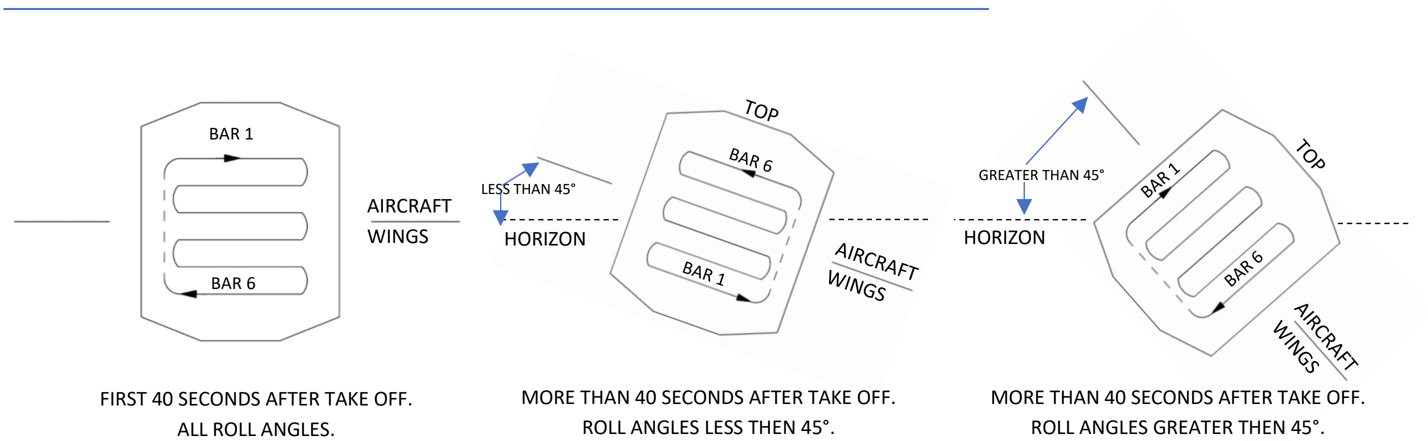
Upon initially selecting the SS mode, the HUD display presents a 20° reference circle. When angle tracking commences, the display for the selected weapon appears, and the target designator indicates the spatial location of the tracked target.

During the first 40 seconds after takeoff, the bar scan pattern remains parallel to the aircraft's wings, with the scan pattern starting at the top of the HUD FOV. Special detection threshold logic is employed to prevent false lock-ons to the ground. In all other situations and for roll angles less than 45°, the bar scan pattern still remains parallel to the wings, but it initiates from the bottom of the HUD FOV. When roll angles exceed 45°, the bar scan pattern becomes perpendicular to the aircraft's wings, starting from the left side of the HUD FOV. These variations in the scan pattern enhance the capability to establish a lock-on, especially during F-15 or target maneuvering scenarios.

The SS mode can only be entered from radar search modes (LRS) with AUTO ACQUISITION SWITCH FORWARD. SS cannot be commanded from TWS or STT.

When entering the SS, the radar range changes to 10nm and to 20x20°.

9.6.2.1.1 SUPERSEARCH SCAN PATTERN



9.6.2.1.2 POSITIONABLE SUPERSEARCH

The supersearch antenna scan is positionable vertically via pilot action on the TDC. (All other scan features remain as stated in the preceding paragraphs.) A full up motion on the TDC causes the SS scan pattern to shift up-center (+28°). A full down motion causes a scan shift down-center to -19°. Momentarily moving the TDC in an opposite direction returns the scan to the center (-4°) position. Holding the TDC in an opposite position moves the scan from its present (up or down) extreme to the center position for 1 second, and then to the selected position as the TDC is held. If SS mode is exited and then reentered, the mode initializes in the center position. In the extreme up or down positions, a partial SS circle is displayed on the HUD approximately as shown by HUD SYMBOLS – A/A – SUPERSEARCH (SS) MODE (SRM, MRM, GUN) (This partial circle is not an indication of the actual scan pattern.)

9.6.2.1.3 BORESIGHT (BST) MODE

The BST mode is an auto acq mode for targets located along the Radar Bore Line (RBL). The antenna slaves to the boresight position and the radar continually searches in range from 500 feet to 10 NM along the antenna LOS until a target is acquired or until RTS is selected. The pilot maneuvers to place the target within a 4° BST steering circle on the HUD. When lock-on occurs, the radar begins automatic tracking and the attack steering presented on the HUD is a function of the A/A weapon selected.

BST mode is commanded via a second press of AUTO ACQUISITION SWITCH – FORWARD from the super search auto acq mode.

9.6.2.1.4 LONG RANGE BORESIGHT (LR BST) MODE

The long-range boresight is an auto acq mode for long range targets located along the RBL. The antenna slaves to the BST position and the radar continually searches in range from 3000 feet to 40 NM along the antenna LOS until a target is acquired or until RTS is selected. A 2.5° steering circle is displayed on the HUD and LR BST is displayed in the BIT window. If a target is acquired in LR BST, the radar automatically enters MSTT or HSTT, depending on the detection waveform. During LR BST, the radar range scale is changed to 40 NM.

LR BST mode is commanded via a long press of AUTO ACQUISITION SWITCH – FORWARD.

9.6.2.1.5 VERTICAL SCAN MODE

In vertical scan auto acq, the radar antenna scans vertically, from +5° to +55° above FRL, and 7.5° in azimuth using a two-bar azimuth scan. The radar has a lock-on capability from 500 feet to 10 NM in range. The scan is aircraft stabilized, and continues until lock-on or until RTS is selected.

Vertical scan mode is commanded via AUTO ACQUISITION SWITCH – AFT.

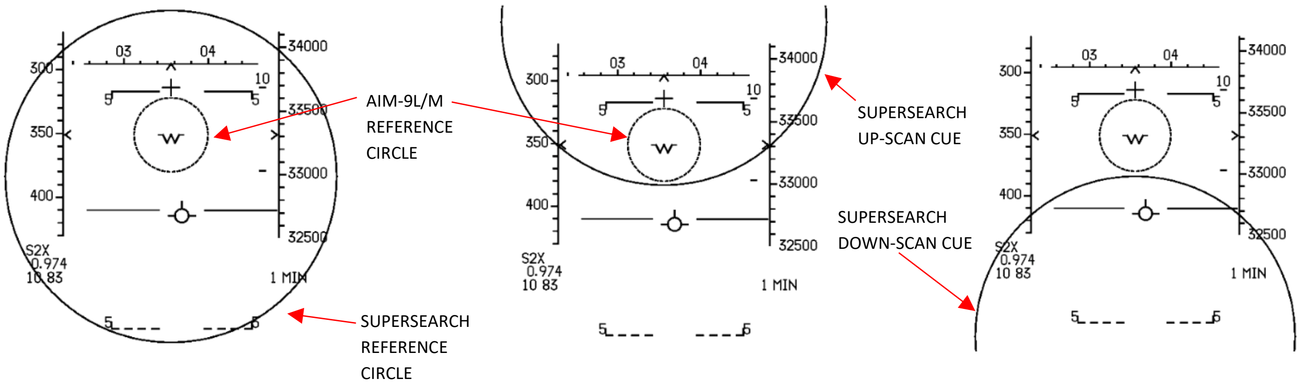
9.6.2.1.6 GUN MODE

The GUN mode provides a scan pattern with the auto acq capability between 0.5 and 15 NM. The scan pattern is 60° in azimuth, 20° (six-bar) in elevation, 3.4° bar spacing. The center of the pattern, indicated by the GUN acq symbol (+). The scan center is positioned at 0° AZ and EL when the mode is initialized or when RTS is selected during the scan. The BST, SS, or vertical scan modes may be selected during the GUN scan.

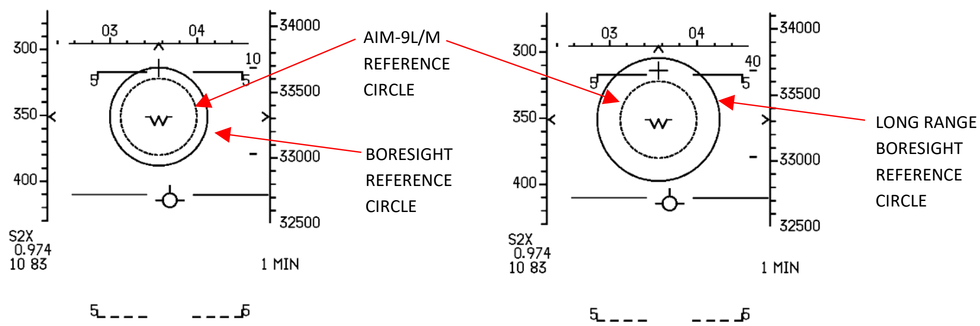
NOTE: GUN auto acquisition mode is not fully implemented. Future iterations will offer a positionable scan via TDC and radar elevation control.

Selecting GUN while in track inhibits TWS entry; selecting GUN while in DTWS causes exit to STT. Selecting GUN in NDTWS causes the radar to return to search and enter GUN scan.

9.6.3 AUTO ACQ MODES – HUD DISPLAYS

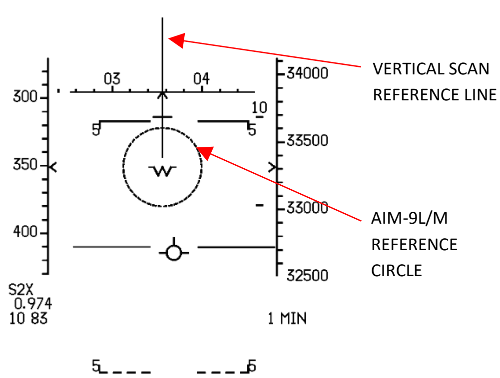


1. SUPERSEARCH, SRM SELECTED
2. SUPERSEARCH UP-SCAN
3. SUPERSEARCH DOWN-SCAN



5. BORESIGHT, SRM SELECTED

4. LR BORESIGHT, SRM SELECTED



6. VERTICAL SCAN, SRM SELECTED

9.7 TRACK-WHILE-SCAN (TWS) MODE

The Track While Scan (TWS) mode offers the ability to detect and track multiple targets within a designated area, providing several benefits for enhancing situational awareness (SA):

a. Swift altitude sampling between targets.
b. Visualization of target formations with heading vectors.
c. Increased confidence in final target sorting.
d. Extensive volume search while preserving targets with heading vectors.
e. Expedited target updates through High Data Rate TWS (HDTWS) *(N/I)*.

The capabilities of TWS mode encompass:

- A target-level turn maneuvering capacity of up to 6 G, enabling effective tracking of targets near the radar's beam without generating false track files.
- Improved resistance against false track files through enhanced correlation logic and the prevention of data mis-correlation between track files. The logic for building track files is more rigorous, reducing the likelihood of displaying persistent false track files.
- Enhanced immunity to false target effects caused by Electronic Countermeasures (ECM), along with improved detection of ECM signals and more informative ECM displays for the pilot.
- Capabilities for tracking course velocities and greater resistance to the impact of Jamming Emitter (JEM) lines.
- Expanded utilization of Medium Pulse Repetition Frequency (MPRF) in TWS mode to enhance range accuracy for AIM-120 missile cueing and bolster immunity against ECM interference.

9.7.1 TWS SCAN PATTERN

TWS mode is capable of tracking up to 10 targets and relaying their track data to the CC and the VSD. It can simultaneously continue detecting and displaying additional targets. When the track files reach their capacity, an additional 18 observation files, represented by symbols at half intensity, can be displayed for one frame. A track file comprises those targets within the radar's scan volume that it can maintain in terms of range (pertaining to skin track), angles, and rates.

To access TWS mode, it can be entered from any air-to-air search mode, or from Single Target Track (STT) mode. TWS modes can only be entered when the weapon select switch is set to Medium Range Missile (MRM) or Short Range Missile (SRM). It's important to note that TWS mode entry is blocked if the GUN mode is selected.

The following TWS scan patterns are available:

a. Wide pattern: two-bar/60° scan -> For co-altitude targets with wide separation in azimuth. *(N/I)*
b. Medium pattern: four-bar/30° scan -> For general surveillance of widely spaced targets. *(N/I)*
c. Narrow pattern: six-bar/15° scan -> For vertically stacked targets. *(N/I)*
d. High data rate scan: two-bar/30° -> For co-altitude maneuvering targets.

9.7.1.1 NON-DESIGNATED TWS (NDTWS)

Non-designated TWS refers to any TWS mode where no radar track file is currently designated as the Primary Designated Target (PDT). Pilot action is required to make a designation.

9.7.1.1.1 NON-DESIGNATED TWS ENTRY/EXIT

NDTWS Can be entered by from search by designating space on the VSD - **Depress and HOLD** TDC action (TDC DEPRESS) and simultaneously pulling the **auto acq switch AFT** for less than 1 second. NDTWS can be entered from DTWS by pressing COOLIE DOWN to un-designate a track.

9.7.1.2 DESIGNATED TWS (DTWS)

Designated TWS refers to any TWS mode where a radar track file has been designated as the PDT. Only one designated target may be made the PDT but up to 7 other track files can be stored as Secondary Designated Targets (SDT) for rapid designation and engagement.

9.7.1.2.1 DTWS ENTRY/EXIT

DTWS can be accessed through various methods:

1. DTWS is entered from Single Target Track (STT) mode by briefly selecting the auto acquisition (auto acq) switch aft. The radar transitions to DTWS mode with a track file initiated using the target data from STT.

2. DTWS entry from NDTWS is achieved by designating any of the displayed targets using the Target Designator Control (TDC). The designated target becomes the Primary Designated Target (PDT).

3. DTWS may also be entered from NDTWS by activating Quick Step via COOLIE SWITCH UP. The radar's ranked target (shortest missile TOF) in NDTWS is designated as the PDT in DTWS.

9.7.1.3 TWS MULTI-TARGET DESIGNATION / AUTOMATIC TARGET DESIGNATION

On the DTWS display, designated target track parameters are displayed at the top of the VSD. The PDT is an open UFFO symbol with golf tee (Refer 9.6.5.2 'DTWS Display') and long vector stick. Up to seven additional targets are automatically designated as SDTs when a primary designation is made. SDTs are UFFO symbols with long vectors but do **not** have golf tee symbol.

TWS automatic designation (AUTO DES/ADE) is enabled at startup and currently cannot be turned off in BMS, this will be implemented in a future version.

9.7.1.3.1 QUICK STEP

Pulling the coolie switch up changes the PDT out to the designated target next in range or from left to right in azimuth. Quick step to the secondary target moves the PDT symbol (golf tee) to that target, changes prelaunch TTA(N/I)/TTI to reflect that target for the next missile in launch priority, and therefore enables launch at that target. This can be done with as many as eight designated targets.

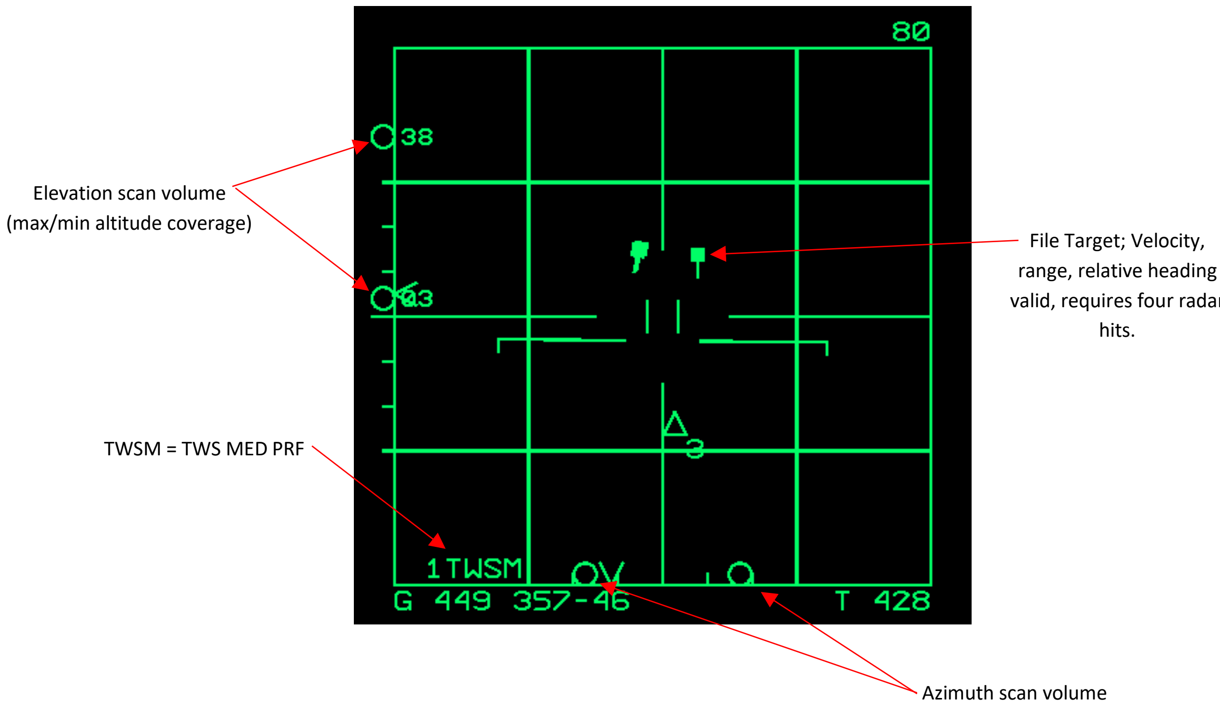
9.7.1.3.2 QUICK PICK

Any designated or undesignated TWS target can be selected as the PDT via quick pick. The TDC is positioned over a TWS track file just as in manual acquisition process and depressed for less than 1 second. PDT symbology will appear on the track file to indicate successful designation of the new PDT.

This procedure allows selective designation while in TWS modes for rapid engagement of desired target.

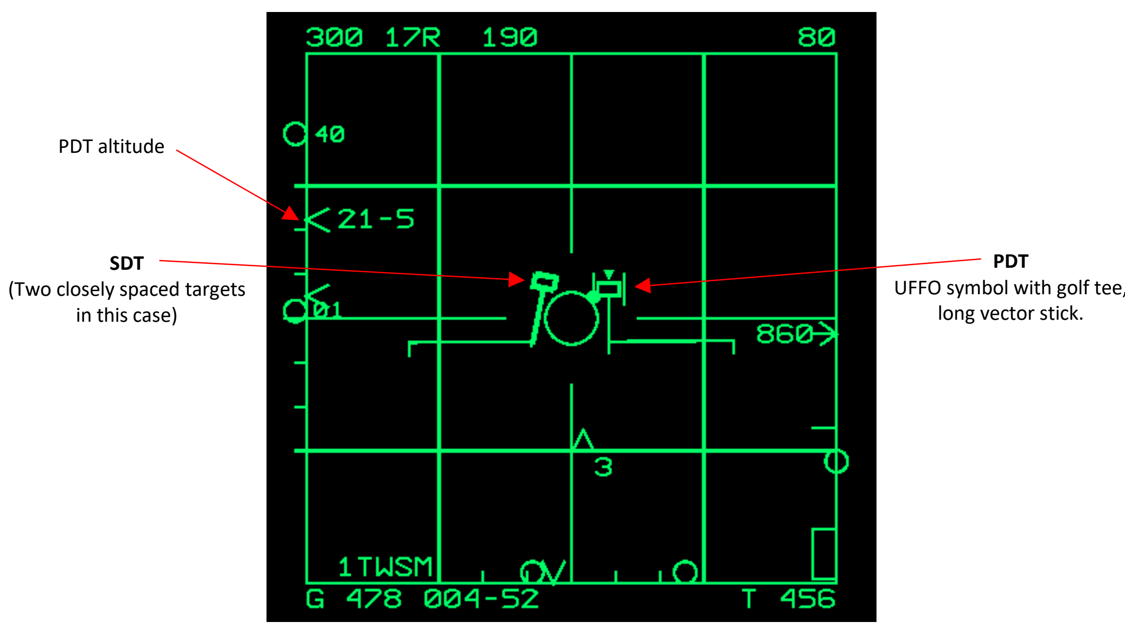
9.7.2 TWS DISPLAYS

9.7.2.1 NDTWS



Scan is centered under TDC cursor and elevation control.

9.7.2.2 DTWS



9.8 RADAR EMPLOYMENT

During air-to-air engagements, the pilot undergoes three crucial radar operational phases: target detection, acquisition, and tracking. The subsequent process of selecting and launching a weapon depends on the outcomes of the tracking phase.

9.8.1 TARGET DETECTION PHASE

The High Pulse Repetition Frequency (HPRF) waveform is effective for long-range detection but primarily against targets with a frontal aspect, whether they are positioned above or below the radar. In contrast, the Medium Pulse Repetition Frequency (MPRF) is optimized for detecting targets with either a nose or tail aspect, regardless of whether they are above or below the radar. When the radar is set to a range of 40 or 80 nautical miles (NM), MPRF bars are fine-tuned to be more sensitive in detecting tail aspect targets. However, when you select a range of 10 or 20 NM, MPRF's sensitivity is somewhat compromised, making it equally capable of detecting targets with either a frontal or tail aspect.

Nevertheless, it's important to note that the detection range performance of MPRF, for both frontal and tail aspect targets, is notably less than that of HPRF when it comes to detecting nose aspect targets. Therefore, if a reported target is determined to have a frontal aspect, the pilot can opt for the "HI" mode to benefit from the faster detection rate provided by having HPRF active during all bar scans. These considerations are crucial in situations where changing conditions affect the aspect angle of the target.

9.8.1.1 RANGE SELECTION

The pilot should choose the shortest possible range based on their knowledge of the actual target distance. This choice provides the finest display range resolution and improves the ability to interpret and respond to displayed information, particularly after establishing a track.

In an interleave mode involving both High Pulse Repetition Frequency (HPRF) and Medium Pulse Repetition Frequency (MPRF), if the pilot selects a 10 NM range, the radar operates exclusively in MPRF. When a range of 160 NM is chosen, and the "HI" mode is selected, the radar deploys HPRF throughout.

When operating within a 10 or 20 NM range, the scan rate increases from 70° to 90° per second. The goal is to minimize the time between radar contacts, especially in close engagements. The slower scan rate is maintained for all HPRF operations to enhance sensitivity, as this mode is primarily intended for small target scenarios.

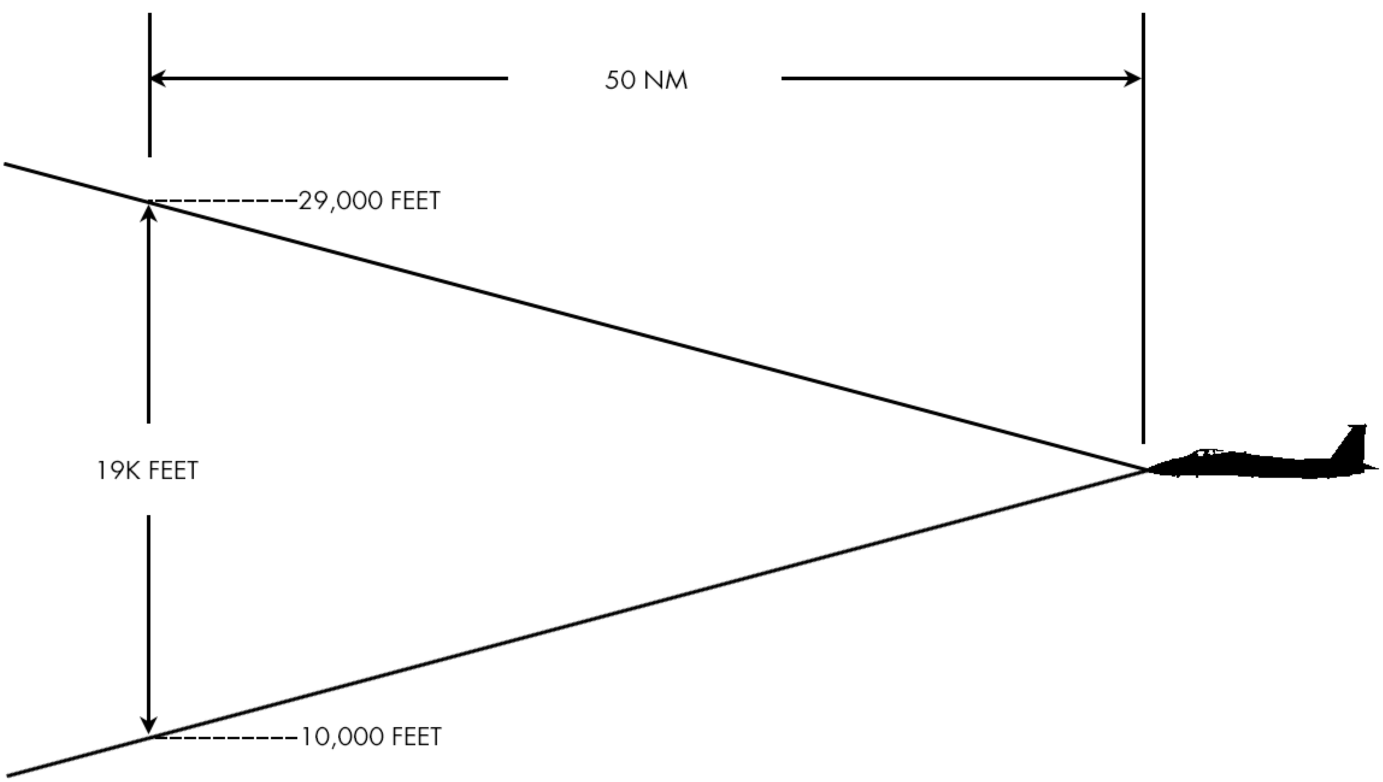
In situations where 10 or 20 NM range scales are chosen, with 3.4° and 2.5° bar spacing and a 90°/second scan rate, MPRF's capability to detect small radar cross-section (RCS) targets may be diminished, especially if the target's altitude places it between two adjacent bars. If small RCS targets pose a threat, it is advisable to maintain a 40 NM range scale to improve MPRF detection. A 70°/second scan rate and 1.0° bar spacing can enhance target detection in such cases.

9.8.1.2 ALTITUDE COVERAGE

EL BAR SCAN *	ANGULAR COVERAGE	APG-63 RADAR BEAM ELEVATION COVERAGE IN FEET						
		10 NM	20 NM	30 NM	40 NM	50 NM	60 NM	80 NM
TWO-BAR SEARCH	3.5°	3700	7400	11100	14800	18500	22300	29700
	5.9°/5.0°	6300	10600					
TWO-BAR TWS	4°	4250	8500	12700	17000	21200	25400	33900
FOUR-BAR SEARCH	5.5°	5800	11700	17500	23300	29200	35000	46800
	12.7°/10.0°	13400	21200					
FOUR-BAR TWS	7°	7400	14800	22200	29600	37000	44400	59200
SIX-BAR SEARCH	7.5°	7900	15900	23800	31700	39700	47700	63600
	19.5°/15.0°	20600	31800					
SIX-BAR TWS	10°	10600	21200	31700	42200	52800	63300	84400

* 3.4 AND 2.5° EL BAR SPACING IS USED IN ALL A/A SEARCH MODES, 10 NM AND 20 NM RANGES RESPECTIVELY.

Example



AT 50 NM, RADAR BEAM COVERAGE OF 2 BAR SCAN IS APPROXIMATELY 19,000 FEET.

9.8.1.3 ELEVATION SELECTION

Upon receiving a reported target, initiate a search within the target's altitude region by referring to the VSD altitude coverage data. This data provides information about the maximum and minimum beam elevation coverage above Mean Sea Level (MSL) for the currently selected bar/elevation scan and the range indicated by the acquisition symbol on the display.

If necessary, adjust the antenna's elevation control until the VSD altitude coverage encompasses the reported target's altitude. Additionally, consider lowering the bar scan setting, as this enhances the radar's detection capability within the scanned area.

During patrol missions, it's advisable to allocate specific altitude coverage areas among flight members. For instance, the lead aircraft might focus on scanning an altitude range between 25,000 and 50,000 feet, while the wing element scans from 0 to 25,000 feet.

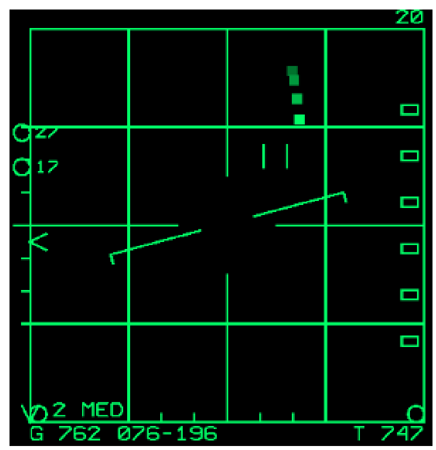
Normally, bar spacing is set at 1° on the 40 NM, 80 NM, and 160 NM range scales. However, for 10 NM and 20 NM range scale selections in all air-to-air search modes except Vertical Scan (VS), and Vector (VCTR), the spacing is typically adjusted to 3.4° and 2.5°, respectively.

9.8.1.4 AZIMUTH SCAN SELECTION

The choice of azimuth scan should be based on the pilot's prior knowledge of the target's position, aiming for the smallest scan range possible. This decision reduces the time it takes for the antenna to complete a full frame rotation and enhances detection capability. In situations where there is no reported target, the default setting is a 120° scan.

If a more focused 20° scan is needed, the pilot can manually select it through the TDC (Target Designator Control) azimuth bumping.

9.8.1.5 FRAME STORE SELECTION



The choice of target data aging typically depends on the prevailing flight conditions. In situations where the pilot's focus is on instrumentation displays, opting for a lower aging setting helps prevent confusion between older target data and any newly detected targets. On the other hand, in scenarios where the pilot predominantly relies on head-up displays and may not frequently check the Vertical Situation Display (VSD), a higher aging setting may be more advantageous.

When dealing with targets at longer ranges, the increased time gap between detections signifies a higher relative target closing velocity when compared to targets at shorter ranges.

To address these considerations, a Heading Stabilized Display (HSD) and three-frame storage are employed. HSD adjusts the stored targets on the VSD by shifting them in azimuth to compensate for changes in the F-15's heading. This adjustment provides a clear indication of a target's relative position during F-15 maneuvers.

9.8.2 TARGET ACQUISITION PHASE

9.8.2.1 MANUAL ACQUISITION

Manual target acquisition follows a consistent procedure across all modes. During the search phase, all detected and displayed targets are recorded in terms of their target range, azimuth, and the elevation bar on which the detection occurred. This stored data is subsequently used in the following steps:

a. Use the TDC to encompass the target with the acquisition symbol.

b. Press the TDC, directing the radar to execute a ±3° scanning pattern (referred to as a "miniraster") centered on the acquisition symbol, all within the selected bar scan.

c. Release the TDC to initiate lock-on*. At this point, the system actively seeks a correlation between the acquisition symbol and the target data stored in memory. Once a correlation is established, the radar antenna swiftly performs a two-bar, ±3° scan on the precise bar/Pulse Repetition Frequency (PRF) where the target was initially detected. Upon receiving a second live hit, tracking of the target is officially established.

If lock-on is not achieved within 1.5 seconds, the radar scan continues in the miniraster pattern within the selected bar scan (never fewer than two bars) until the Return-To-Search (RTS) function is activated.

*Currently bugged in U4. TDC lock is commanded on TDC press, not release.

9.8.2.2 AUTO ACQUISITION (SUPERSEARCH)

When the standard Supersearch (SS) mode is engaged, the radar automatically scans within the Head-Up Display (HUD) Field of View (FOV) in a range of ±10° in azimuth and 20° in elevation. The pilot's responsibility is to keep the target within the 20° circle displayed on the HUD when this mode is selected. Successful lock-on in SS mode is most dependable when the target maintains a relatively stable position within the HUD FOV.

However, situations involving significant angular rates, a near head-on (beam) aspect condition, or both fighter and target maneuvers can potentially hinder or delay the lock-on process in SS mode. In cases where multiple targets are visible, it may be challenging to determine which target will be acquired first. Once acquisition takes place, the HUD Target Designator (TD) box highlights the target that is currently being tracked.

Depending on the attack geometry, elevated or depressed SS scans can be employed, offering a vertical scan capability while maintaining the broader area coverage of the SS mode.

9.8.2.3 TARGET RETENTION

Following the establishment of a track, search targets can be maintained on the track display at half intensity for the initial 3 seconds, a feature referred to as "target retention." This capability enables search and acquisition targets or Track While Scan (TWS) track records to linger on the track display momentarily after achieving lock-on. It offers the pilot a brief window to confirm whether the intended search or track targets are indeed the same. During this phase, the tracked target symbol aligns with the retained search, acquisition, or TWS track record that's part of the transition. Additionally, when transitioning from a track to another mode, the tracked target symbol remains visible on the display for 3 seconds.

10 AIM-120 EMPLOYMENT

WIP

11 AIM-7 EMPLOYMENT

WIP

12 AIM-9 EMPLOYMENT

WIP

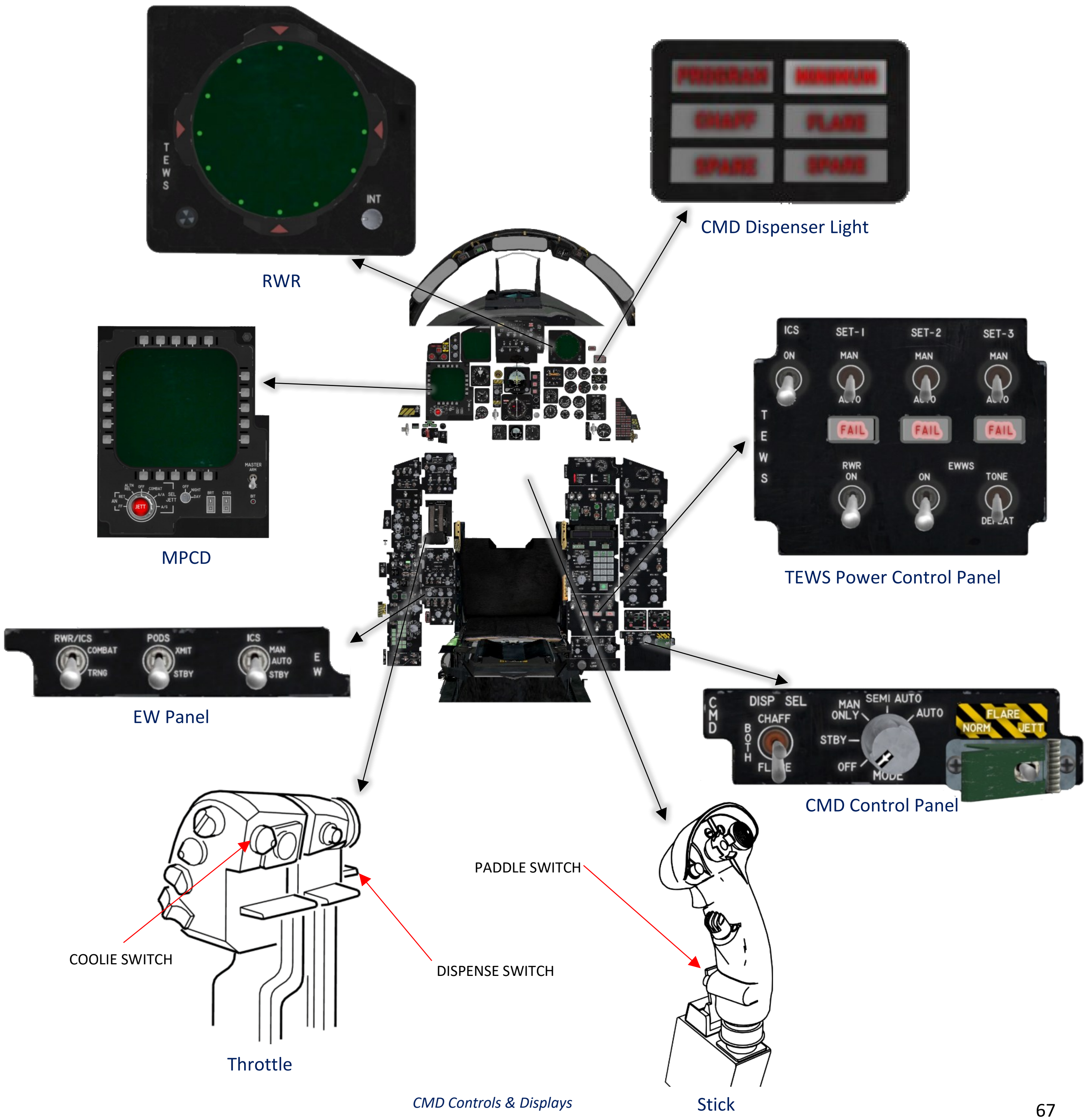
13 GUN EMPLOYMENT

WIP

14 TACTICAL ELECTRONIC WARFARE SYSTEM (TEWS)

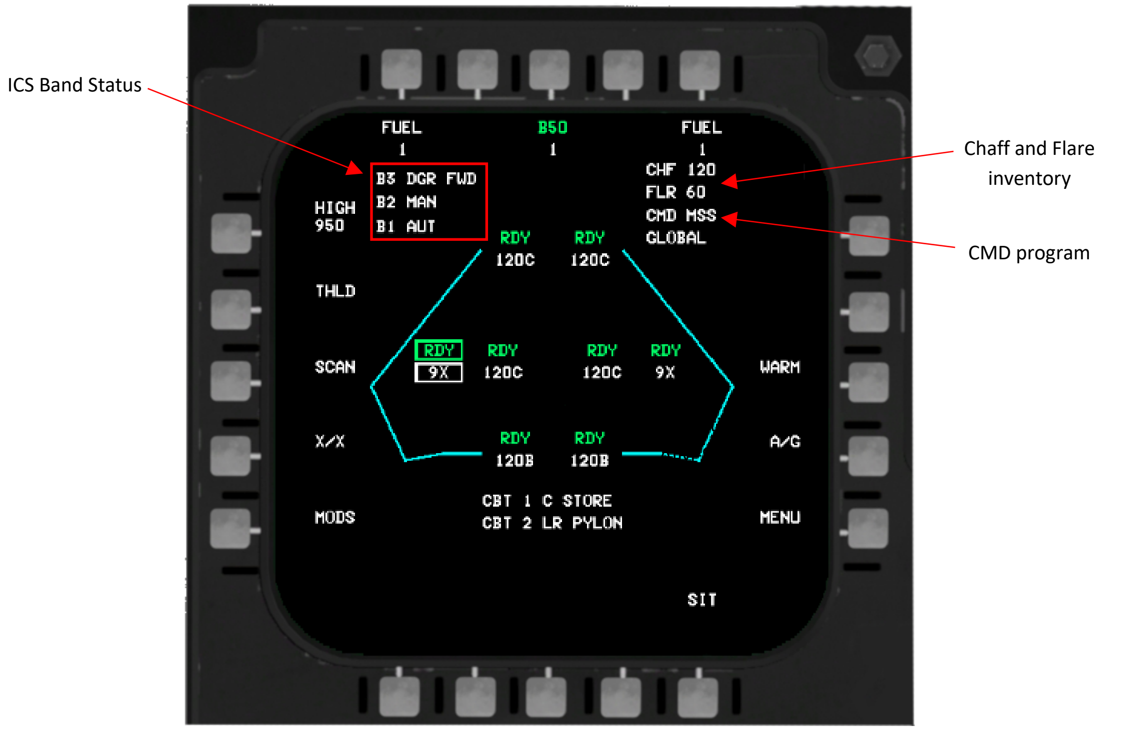
The TEWS is a suite of equipment, receivers, transmitters and displays that collectively provide the F-15C a full spectrum of defensive capabilities against the radar guided threat environment. TEWS provides electronic detection and classification of surface and airborne threats and enables activation of appropriate countermeasures. The pilot is provided enhanced situational awareness through various displays and aural warnings. The TEWS comprises of the AN/ALE-45 Countermeasure dispenser, AN/ALQ-135 Internal Countermeasure set and the AN/ALR-56C radar warning receiver.

14.1 TEWS CONTROLS, INDICATORS, AND DISPLAYS

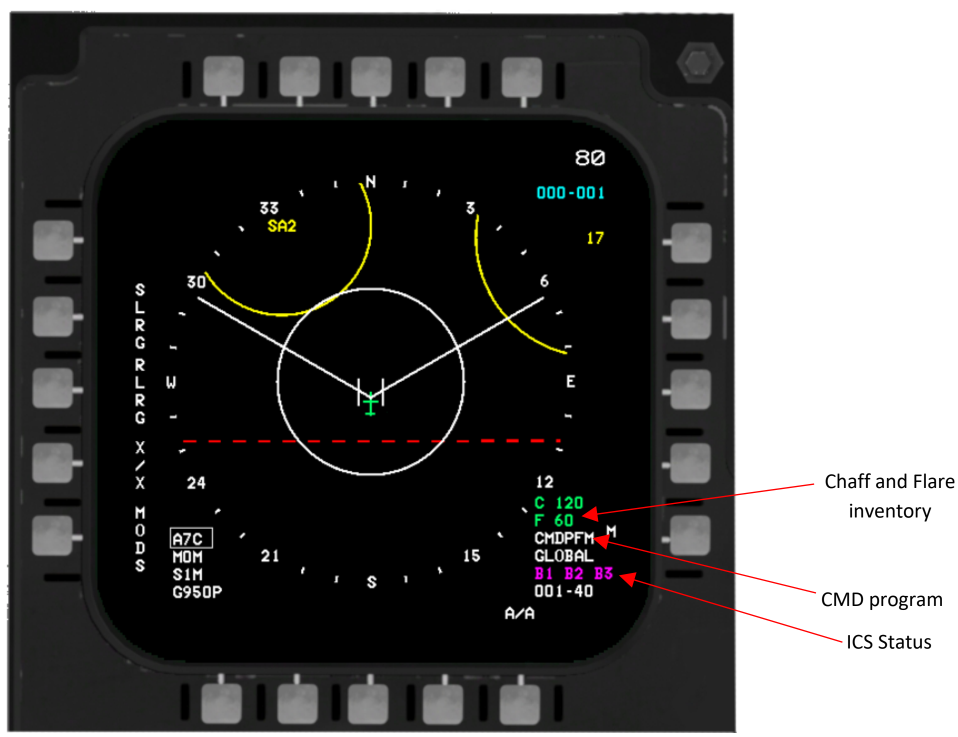


CMD Controls & Displays

CMD Controls, Indicators, And Displays (Continued)



MPCD ARMT PAGE

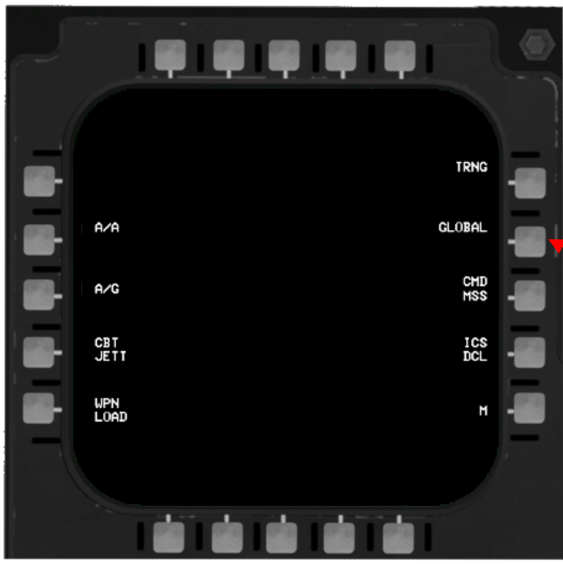


MPCD SIT PAGE

14.2 AN/ALR-56C RADAR WARNING RECEIVER

In BMS, The ALR-56C uses the basic ALR-56M (RWR for the F-16C) symbols plus additional options to prioritize types of displayed threats. The Missionized Pre-flight Message (MPFM) sets are stored in the RWR and accessed by the PACS top level ARMT page. OSB7 will cycle the available MPFM sets so the pilot can adjust the RWR display as desired.

The ALR-56C operates in C/D band (0.5-2 GHz) and E through J band (2 to 20 GHz).
Direction-finding accuracy: 15 degrees (E through J band); omnidirectional (C/D band).



• GLOBAL	All symbols.
• NONAVY	No naval emitters.
• NOSI	No search radars.
• WF0	Air threats only (Wing Form 0).
• GNDPRI	Surface emitters.
• AIRGND	Air and Surface emitters.

14.3 TEWS POWER CONTROL PANEL

An operational RWR sensor receives command (CMD) input containing threat information, and through consistent updates (via CC), the RWR incorporates velocity and altitude data of the host aircraft to enhance dispensing strategies. Additionally, the RWR interacts with the CMD, continually refreshing the inventory data for the TEWS BIT (Built-In Test) display. Each set (1-3) is responsible for a specific radar band. The current implementation is WIP and as such, all bands (1-3) are linked and operate simultaneously.

ICS switch Provides power to the Internal Countermeasures Set (ICS) AN/ALQ-135 (V).
Please refer to the AN/ALQ-135(V) chapter for more information.

SET-1/-2/-3 Switches between AUTO and MAN mode for Band 1-3 (all bands are linked)

SET-1/-2 Radar bands for FCR of surface emitters.
SET-3 Radar bands for FCR of airborne emitters.

RWR switch Provides power to the Radar Warning Receiver (RWR) AN/ALR-56C.

EWWS switches Provides power to the Electronic Warfare Warning System (EWWS) *(WIP)*.
The Tone/Defeat switch is fixed to DEFEAT for now.

14.4 AN/ALE-45 ELECTRONIC COUNTERMEASURES DISPENSER (CMD) SET

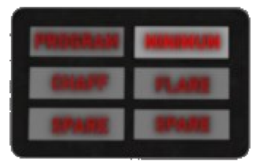
The CMD, or Countermeasures Dispenser, comprises several key components, including the electronic command signal programmer (programmer), the Dispense Control Panel (DCP), and four Dispensing Switch Assemblies (DSAs). The CMD interfaces with various other elements, such as the throttle dispense switch, control stick paddle switch, TEWS panel and AN/ALR-56C Radar Warning Receiver (RWR) Set. The primary role of the CMD is to effectively dispense and oversee the on-board chaff and flare expendables.

14.4.1 CMD DISPENSER SWITCHES

Paddle Switch Stick (MAN 1) Dispenses countermeasure program 1. If pressed and held, the dispensing program will not repeat (the switch must be released and pressed again).

Left Throttle Switch (MAN 2) Dispenses countermeasure program 2. If pressed and held, the dispensing program will not repeat (the switch must be released and pressed again).

14.4.1.1 CMD DISPENSER LIGHT



If chaff/flare is being actively dispensed, the respective chaff/flare light will blink.

If chaff or flare are deselected via the CMD control panel DISP SEL switch, the deselected unit light will be on steady.

Minimum light will be activated if either chaff or flare reaches the minimum value set via data cartridge.

14.4.1.2 CMD CONTROL PANEL

The COUNTERMEASURES DISPENSER CONTROL PANEL purpose is to enable certain modes to the ALE-45 dispenser set.

DISPENSER SELECTOR

CHAFF	Only Chaff will be used
FLARE	Only Flare will be used
BOTH	Chaff and Flare will be used

MODE SELECTOR

OFF	CMD is not operational
STBY	Facilitates both warm-up and complete CMD BIT operations using the Warm-On-the-Way (W-ON-W) method.
MAN ONLY	The system receives dispensing commands through either the throttle switch (MAN 2) or the paddle switch (MAN 1). Dispensing patterns are determined using programs such as AN/ALR-56C, PFM, or Programmed through the DTC/BMS 2D UI. While on the ground with W-ON-W enabled, dispensing is prevented.
SEMI AUTO	The CMD uses RWR threat and aircraft parameter data to create the most efficient dispensing plan. When the dispense program is prepared, the green PROGRAM light illuminates. Dispensing is initiated using the MAN 2 throttle switch. If a MAN 1 command or another MAN 2 command is given, the manual program supersedes the RWR-based program.
AUTO	The system processes RWR threat and aircraft parameter inputs to create the most effective dispensing program, which is then automatically activated for dispensing. Should a MAN 1 or MAN 2 command be executed, the manual program takes precedence over the RWR-based program. As of now, the PFM program is in use.

14.5 AN/ALQ-135(V) INTERNAL COUNTERMEASURES SET (ICS)

The AN/ALQ-135 is an electronic countermeasure (ECM) jamming system produced by Northrop Grumman for the F-15 TEWS suite. The system can effectively jam and degrade the FCRs of threat aircraft and surface to air missile systems. The ALQ-135 is fully integrated with the APG-63 and AN/ALR-56C RWR.

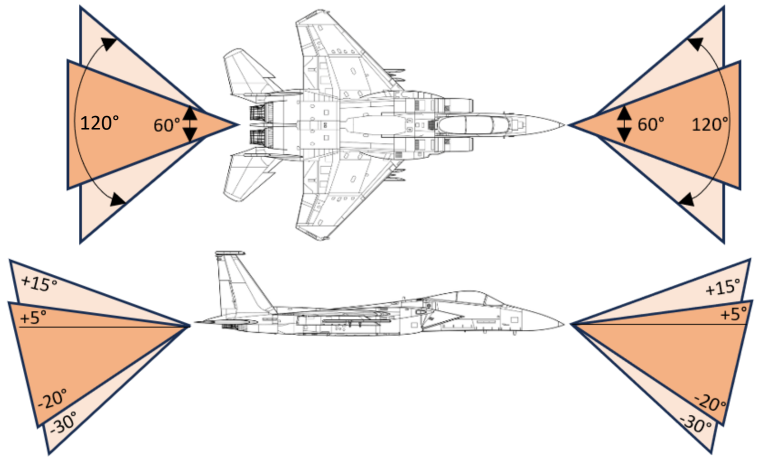
Currently in BMS, the ALQ-135 is WIP and borrows the functionality of the F-16 ECM system.

14.5.1 ICS OPERATION

The ICS operates through forward and aft antenna, offering full effectiveness within 60 degrees azimuth of the aircraft longitudinal axis. From +/- 60° to +/-120°, ECM effectiveness fades from 100% to zero.

In elevation, the ECM offers full effectiveness from +5° to -20° reference the aircraft longitudinal axis. Beyond full effectiveness, the ECM power fades to zero % effectiveness beyond +15° or -30°.

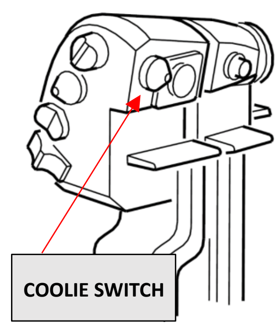
The ALQ-135(V) operates three bands which cover the full spectrum of frequencies.



14.5.2 ECM TRANSMIT SETS & CONTROLS

With ICS sets 1, 2 and 3 In MANUAL mode (refer to TEWS Power Control Panel), the ECM transmitters are activated via the **COOLIE SWITCH – RIGHT (INBOARD)** action. In this mode, the ECM is active but will only transmit (JAM) when the TEWS detects a threat emitter attempting to track. Subsequent actions of the COOLIE INBOARD will toggle the ECM between STANDBY and ACTIVE.

In AUTOMATIC mode, ECM will be active at all times and will transmit when the TEWS detects a threat emitter attempting to track. The coolie switch has no function with the ICS sets in automatic mode.



14.5.3 ECM TRANSMIT MODES

The AN/ALQ-135(V) can transmit through one of three modes identified as XMIT1, XMIT2 and XMIT3 respectively. These modes offer different tactical applications. These modes are selected via the EW panel ICS Switch.

XMIT 1 ‘Automatic Avionics Priority’ mode, transmits only through the aft ECM antenna. This prevents any ECM interference with the APG-63. XMIT 1 is an automatic mode, which means that the transmitters will only activate when the TEWS suite detects a threat emitter attempting to track the ownship.

XMIT 2 ‘Automatic ECM Priority’ mode, transmits through both the forward and aft ECM antenna. This mode results in a 30% penalty to the APG-63 power in all modes. XMIT 2 is an automatic mode, which means that the transmitters will only activate when the TEWS suite detects a threat emitter attempting to track the ownship.

XMIT 3 ‘Constant Transmit’ mode, transmits noise jamming continuously when activated.

14.5.4 EW PANEL

RWR/ICS		Only “Combat” is implemented for now.
PODS		Not implemented.
ICS	STBY	XMIT1 (AVIONICS PRIORITY)
	AUTO	XMIT2 (ECM PRIORITY)
	MAN	XMIT3 (CONSTANT TRANSMIT)

For more information about the ECM implementation, refer to the F-16 Dash-34, chapter 2.7.4.

14.5.5 ICS STATUS DISPLAYS

SIT Display

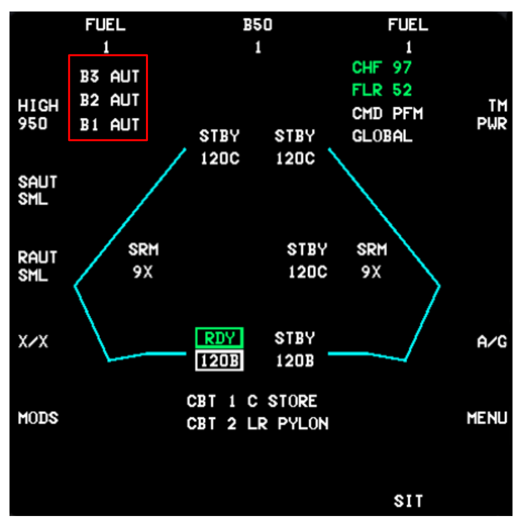
The SIT display features a single line displaying three distinct symbols to convey the ICS status. B1 corresponds to band 1, B2 to band 2, and B3 to band 3. The color green signifies that the band is operating normally amber indicates that the band is degraded but still operational, and magenta signifies that the band is non-operational/in standby.

ICS status Magenta
(Non-operational)

ICS status Green
(Operational)

A/A Display

The A/A display presents the ICS status across three separate lines, each dedicated to a specific band. Within each line, the first field designates the band, while the second field depicts the status of the band in order of priority, with the highest priority displayed at the top.



OFF The status "B1 OFF, B2 OFF" indicates that either band 1 or band 2 is currently not establishing communication with the CC through the RWR. Additionally, "B3 OFF" signifies that band 3 is either unable to communicate with the CC or the communication is invalid.

MAN B1, B2 or B3 is in manual mode.
(Selected via TEWS Power control panel)

AUT B1, B2 or B3 is in auto mode.
(Selected via TEWS Power control panel)

JAM B1, B2 or B3 is actively jamming a threat emitter.

15 JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM (JTIDS) / LINK-16

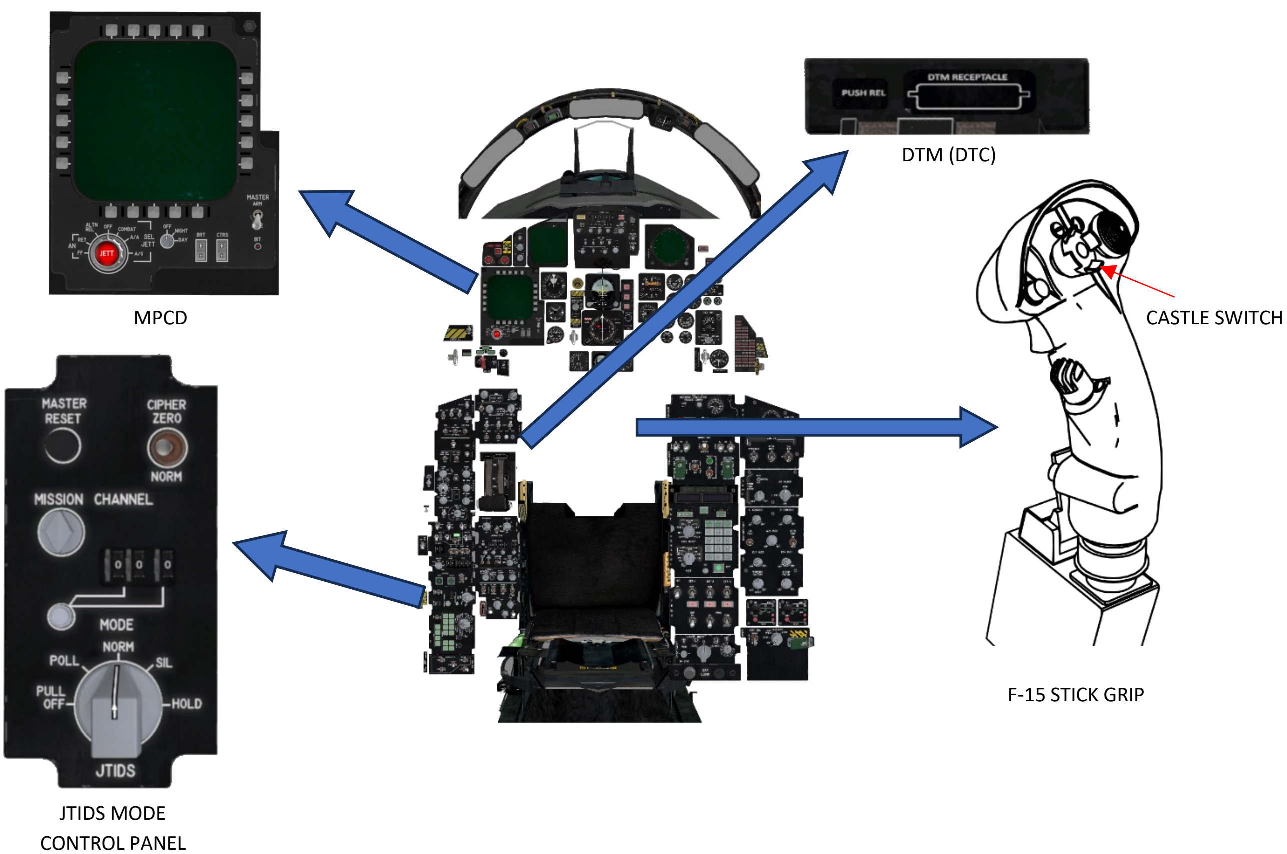
Terminology for the data link network has evolved from JTIDS to LINK-16, however, BMS models an F-15C iteration equipped with hardware annotated as JTIDS.

LINK-16 is an advanced radio system that provides information distribution along with location and identification capabilities in an integrated form for application to tactical military operations. These capabilities result from the ability of the system to distribute information at high rates, encrypted to provide security, and with sufficient jam resistance to yield high reliability in a hostile electromagnetic environment. LINK-16 provides a capability to interconnect many wide spread sources and users of information. Through its relative navigation feature, it also provides land, surface, and airborne elements with a position location capability within a common position reference grid. LINK-16 is a digital data link system that operates in the L-band radio frequency range between 960 and 1215 megahertz (MHz) and requires LOS between the sender and receiver. Information is conveyed on 51 discrete frequencies within the L-band, using spread spectrum fast frequency hopping techniques. The 200-watt transmitter in the JTIDS F-15 allows use in ranges from 300 to 500 NM depending on the network in use.

LINK-16 is based on an access technique called Time Division Multiple Access (TDMA) where small intervals of time are allocated to each system participant for the purpose of either the transmission or reception of digital data. The small interval, called a time slot, in which the transaction is completed is 7.8 msec. These time slots are assigned based on the quantity and type of information conveyed and the update rates required to keep the data current. By providing platforms access to the system, each with their own assigned times to receive or send data, and by coordinating the assignments in such a way that connectivity is maintained between those with the information to send and those needing the information, data is conveyed throughout the community.

The practical application of LINK-16 in the BMS F-15C is to provide enhanced situational awareness. This is achieved through the SIT page by displaying friendly aircraft locations and C² broadcast 'surveillance tracks' of other friendly/unknown and hostile aircraft positions.

15.1 JTIDS/LINK-16 CONTROLS AND DISPLAYS



15.1.1 JTIDS MODE CONTROL PANEL (MCP)

The MCP allows the pilot to select the terminal operating mode, current mission channel, master reset and to zero the crypto variables (or keys) in the terminal via the cipher switch.

MODE KNOB:

OFF System is powered off

POLL JTIDS/FDL power is ON. Polling is a receive only mode with the transmission limited to (JTIDS) digital voice, and responses to specific received messages. The message responses may be generated automatically by the terminal or as a result of pilot input. This mode differs from the radio silent mode in that in radio silent all transmissions require pilot switch action (i.e., key the JTIDS voice) and, although severely restricted in polling, some transmissions are still possible without pilot consent. *(NOT IMPLEMENTED).*

NORM JTIDS power is ON. NORM permits full participation with the LINK-16 community.
All transmit and receive capability is provided.

SIL (Silent) Power is ON; all transmissions are prohibited except JTIDS digital voice which must be initiated by the pilot *(NOT IMPLEMENTED)*.

HOLD Battery power (a second battery in the JTIDS/FDL terminal) is supplied to retain initialization data and crypto variables. Variables can be zeroed via cipher switch action. HOLD must be selected to load new crypto variables.

VOICE GROUP SWITCH: The voice group switch disables the tacan when in the A position and enables the tacan when in B. The switch should be left in the B position.

CIPHER SWITCH: The cipher switch is guarded to the NORM position. All crypto variables within the JTIDS Secure Data Unit (SDU) or FDL receiver/transmitter are zeroed when the switch is placed in the ZERO position. Tacan operation is possible without the SDU or receiver/transmitter attached, but JTIDS/FDL operation is not.

MISSION CHANNEL KNOB: The mission channel knobs allow the pilot to select from 128 different subnets (controller operating channels 000 thru 127). Much the same as selecting the controller's radio frequency, the selection of the proper mission channel allows digital communication with the agency. It is of critical importance to note the mission channel from the BMS 2D briefing UI for later input during aircraft startup. Otherwise, communication with desired C² agencies cannot be established.

15.2 JTIDS / LINK-16 PRE-FLIGHT ACTIONS

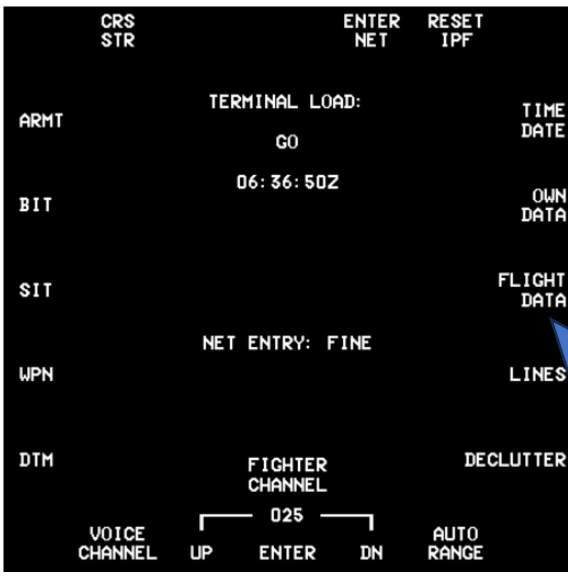
F-15 JTIDS/Link-16 is in development, currently The Data Transfer Module (DTM) will load all necessary Link-16 data into the aircraft upon a successfully DTM read operation. In case of DTM failure, be sure to note mission Link-16 data so that it can be directly input into the aircraft as an alternative. These items include:

- **Mission channel (MC)** The subnet for C2 aircraft operations, this network participation group (NPG) enables C² aircraft to broadcast surveillance tracks for display on the F-15 SIT page.
- **Fighter channel (FC)** The subnet for intraflight comms, this NPG is often referred to as the fighter-to-fighter net which allows fighters to broadcast/share information, radar data and targeting information within the flight *(WIP)*.
- **Flight Source Track Numbers (STNS)** The 5-digit unique identifier for all L-16 network participants.

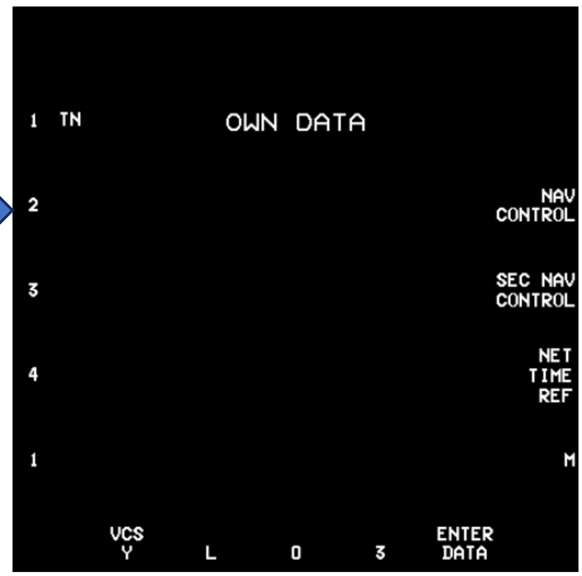
15.3 JTIDS MPCD DISPLAYS (WIP)

The MPCD main menu now contains some link-16 options. Currently, TERMINAL LOAD and NET ENTRY status are simulated and are required to be monitored for JTIDS/Link-16 power-up. Once the JTIDS mode knob is placed to NORM, monitor the MPCD main menu for TERMINAL LOAD to display INITIALIZE. Only once INITIALIZE is displayed can the DTM successfully load the link-16 data required for L16 net entry and system synchronisation. Upon successful DTM load, TERMINAL LOAD status will display GO and NET ENTRY status will display INPROG > COARSE > FINE. FINE indicates system is synchronised and operating normally.

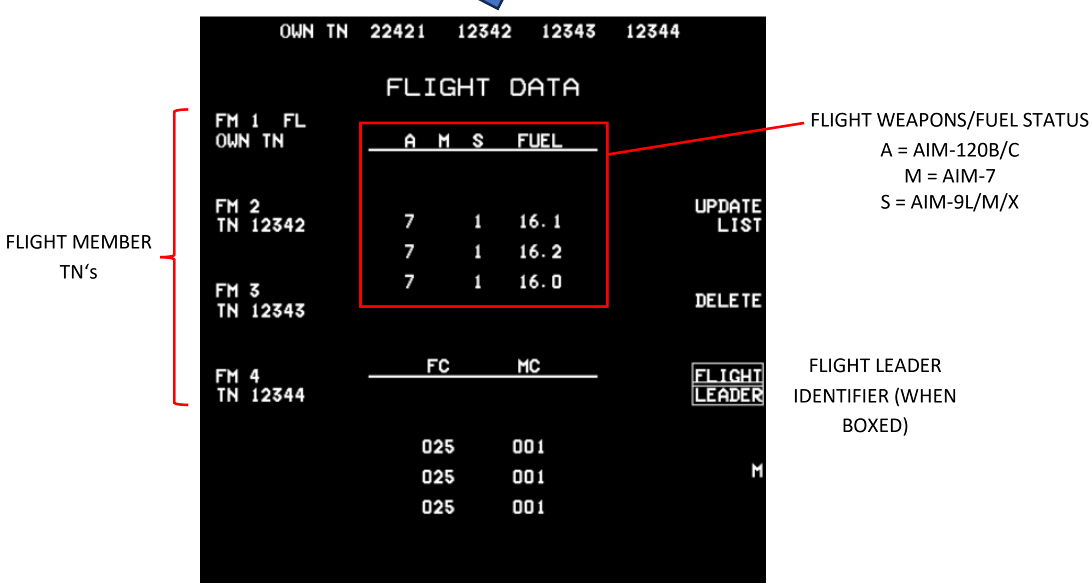
From the MPCD main menu, two additional JTIDS/L-16 pages are available – OWN DATA and FLIGHT DATA. All other link-16 options are not yet implemented and all data is automatically loaded via the DTM in this iteration.



MPCD MAIN MENU



JTIDS OWN DATA MENU



FLIGHT DATA MENU

OWN DATA — Provides the option to enter ownship track number (TN). All other options are WIP. OSB16-19 cycle available numbers, when a number is changed, ENTER DATA (OSB11) will flash until pressed. This confirms the update to ownship TN.

FLIGHT DATA — Provides the pilot with ability to view initialized TNs identified as members of the flight. Additional information is available as each member enters the net and is communicating with the ownship. This information includes weapons load and fuel state.

15.4 LINK-16 SIT DISPLAY

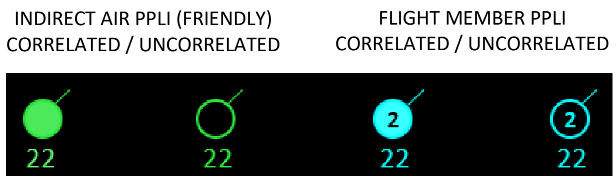
Link-16 data is presented to the pilot via the MPCD Situation (SIT) display.

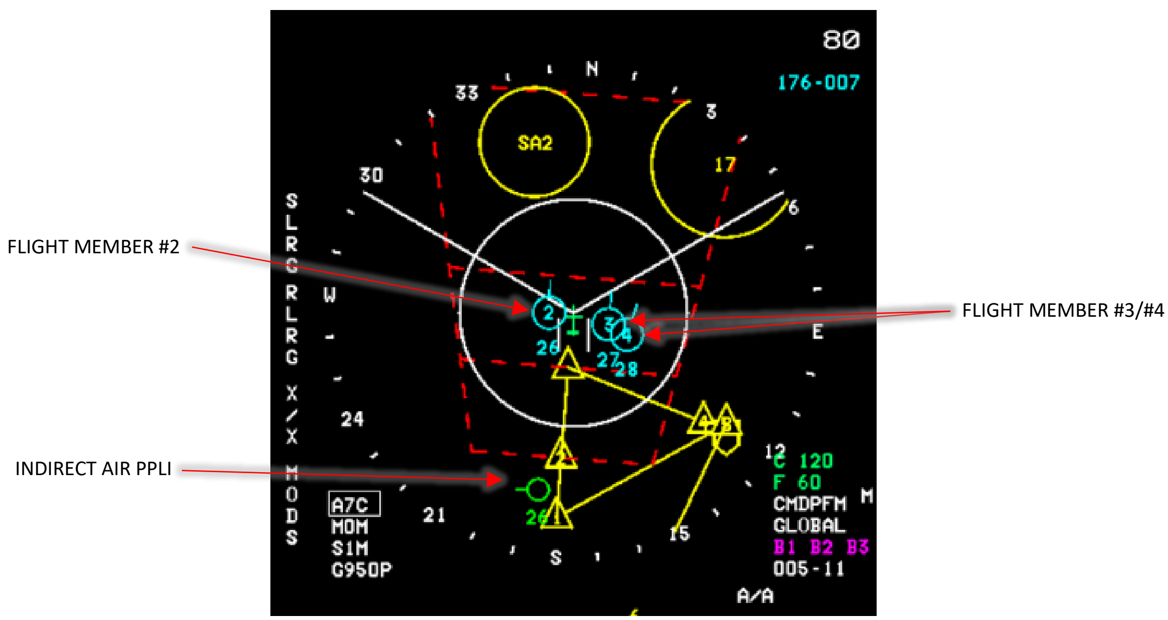
Currently implemented L-16 symbols include Precise Participant Location Identifiers (PPLI) and surveillance (SURV) air tracks.

15.4.1 PRECISE PARTICIPANT LOCATION IDENTIFATION (PPLI)

PPLI symbols differ depending on whether they are a flight member or other friendly aircraft on the network. Indirect air PPLI refers to a friendly asset that is a participant of the Link-16 network, these can be any number of friendly aircraft and will display as a green circle with heading vector and altitude (in thousands of feet). If an indirect air PPLI is correlated with an APG-63 radar track, it will display as a green filled in circle.

A flight member PPLI will display as a larger cyan PPLI symbol. Flight members are defined via the DTM and aforementioned MPCD Flight Data page. Flight member PPLIs can also show ‘filled in’ correlation symbology and will always display their number in the flight.





PPLIs are updated every two seconds with symbols being extrapolated between updates. Air PPLI are removed after 13 seconds if no updates are received.

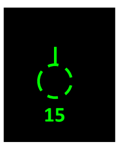
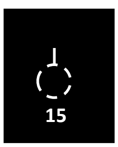
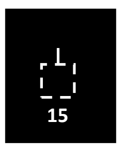
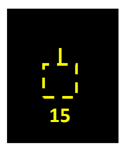
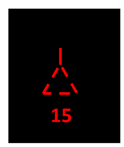
15.4.2 SURVEILLANCE AIR TRACKS (SURV)

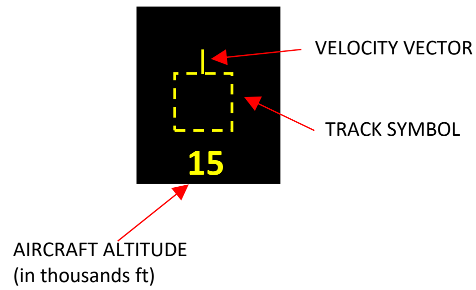
Surveillance air target tracks are transmitted by surveillance and C2 platforms via the Link 16 network to enhance situational awareness for all network participants. SURV track data encompass the location, speed, heading, identity (e.g., friend, hostile, neutral, etc.)

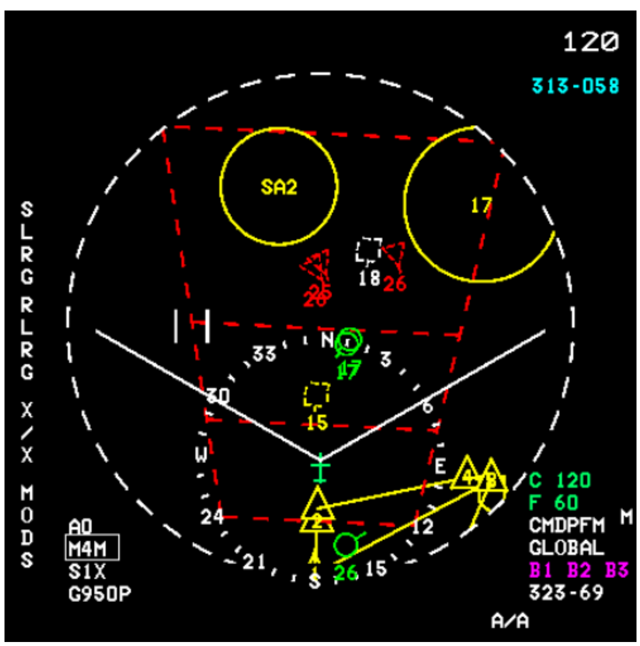
Surveillance tracks are typically updated every 12 seconds. During intervals between the reception of updates, the track positions are extrapolated and sustained for up to 20 seconds to mitigate excessive fluctuations in displayed track positions. Air surveillance tracks are removed if no update has been received for 20 seconds.

SURV track display accuracy is subject to multiple factors including distance from donor station, line-of-sight/terrain considerations and C2 asset capabilities. Track qualities (TQ) are assigned a value and range from TQ1 to TQ15 where the higher number indicates the higher the quality/accuracy of the track. TQ values are not displayed in the F-15 but still play a role in the accuracy of displayed SURV tracks. Care should be taken to understand that the position of a SURV track on the MPCD SIT page, may not be perfectly correlated to an ownship radar track.

Surveillance track symbols are as follows:

FRIEND	NEUTRAL	UNKNOWN/ ASSUMED FRIEND/ PENDING	SUSPECT/ ASSUMED HOSTILE/ PENDING	HOSTILE
				





TYPICAL SIT DISPLAY WITH SURV TRACK PRESENTATION.

16 AIR TO AIR INTERROGATOR (AAI) SET – (WIP)

The AAI set, in conjunction with the radar set and the VSD, provides A/A target identification capabilities. The interrogator set transmits challenge signals and receives target AAI replies through the L-band antennas mounted on the main radar antenna. The system evaluates the reply and generates display symbols on the VSD at the correct target range and azimuth position. The AAI set is in early development and is only a basic implementation at present.

16.1 AAI CONTROLS

The AAI set comprises of the AAI Control panel (located on the left console) and the throttle coolie switch. An interrogation is commenced by pressing **COOLIE SWITCH – OUTBOARD (LEFT)**.

The AAI Control Panel provides the following controls:

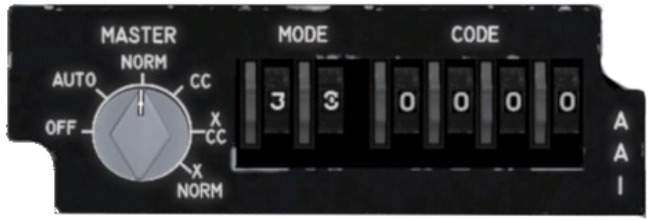
OFF Interrogator is inoperative.

AUTO Selects the mode interrogation sequence preset in the IFF Reply Evaluator (IFE). *

NORM N/I

CC N/I

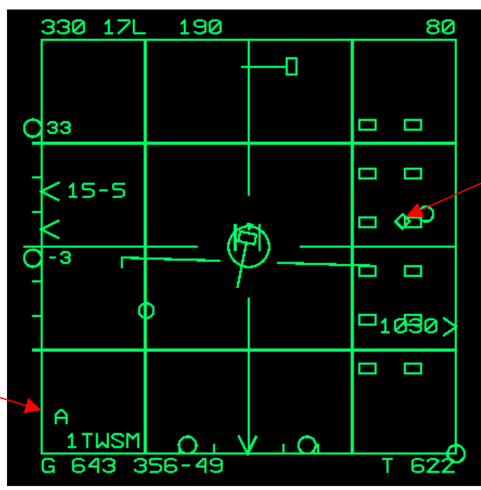
X N/I



*Current AAI implementation only provides for mode 4 interrogation in AUTO. This provides the pilot with sufficient IFF responses to determine friendly aircraft in combat scenarios.

16.2 AAI DISPLAYS

Mode 4 IFF returns are displayed on the Vertical Situation Display (VSD). A high confidence (HC) return is indicated by a **O** symbol, a low confidence (LC) return is indicated by a **◊**.



AAI STATUS

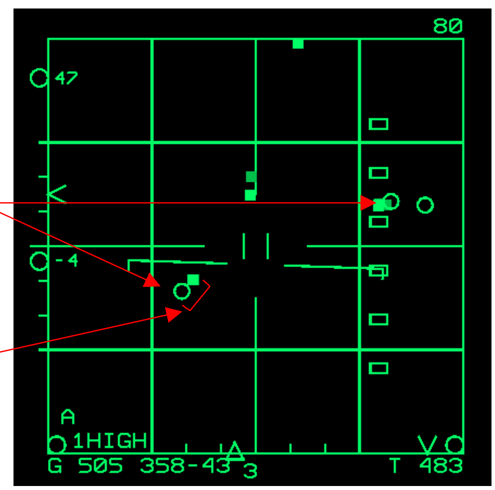
DTWS AAI SYMBOLS

HC M4 REPLY

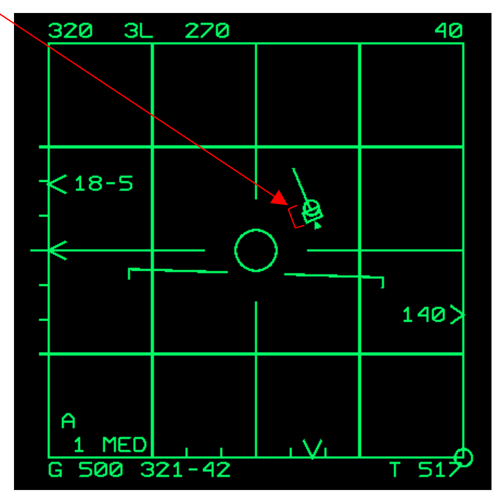
LC M4 REPLY

AAI CORRELATION AT ~40nm

AAI CORRELATION AT ~20nm



RADAR SEARCH AAI SYMBOLS



STT AAI SYMBOLS

IFF return symbol accuracy will depend on range to target. Interrogation returns at long range will be difficult to accurately correlate to respective radar track file.

This implementation is WIP.

GLOSSARY

WIP