CAPABILITIES

ACCURATE LONG RANGE INERTIAL NAVIGATION
GROUND OR AIR ALIGNMENT
AUTO UPDATE
EASY FIXTAKING
DELIVERY FLEXIBILITY
- CONTINUOUS SOLUTION ANY TYPE DELIVERY
  - LEVEL
  - DIVE TOSS
  - OVER SHOULDER
  - STRAFE-ROCKETS
  - MISSILES
  - GUIDED

BACK-UP MODES
10 MIL DELIVERY ACCURACY
ALL WEATHER OFFSET DELIVERY INCLUDING RADAR
DISPLAY INTEGRATION (HUD)
SIMPLIFIED WEAPONS CONTROL – STATUSING
LOADING FLEXIBILITY

Navigation/Weapon Delivery System

The A-7D Navigation/Weapon Delivery System integrates many of the aircraft's avionic subsystems to provide navigation to the target, computed run on target, computed weapon release, and return navigation. Advantages and improvements over A-7A/B include increased navigational accuracy, multimode solutions, radar or visual fix update, with provisions for Loran updating, and flexible alignment provisions.

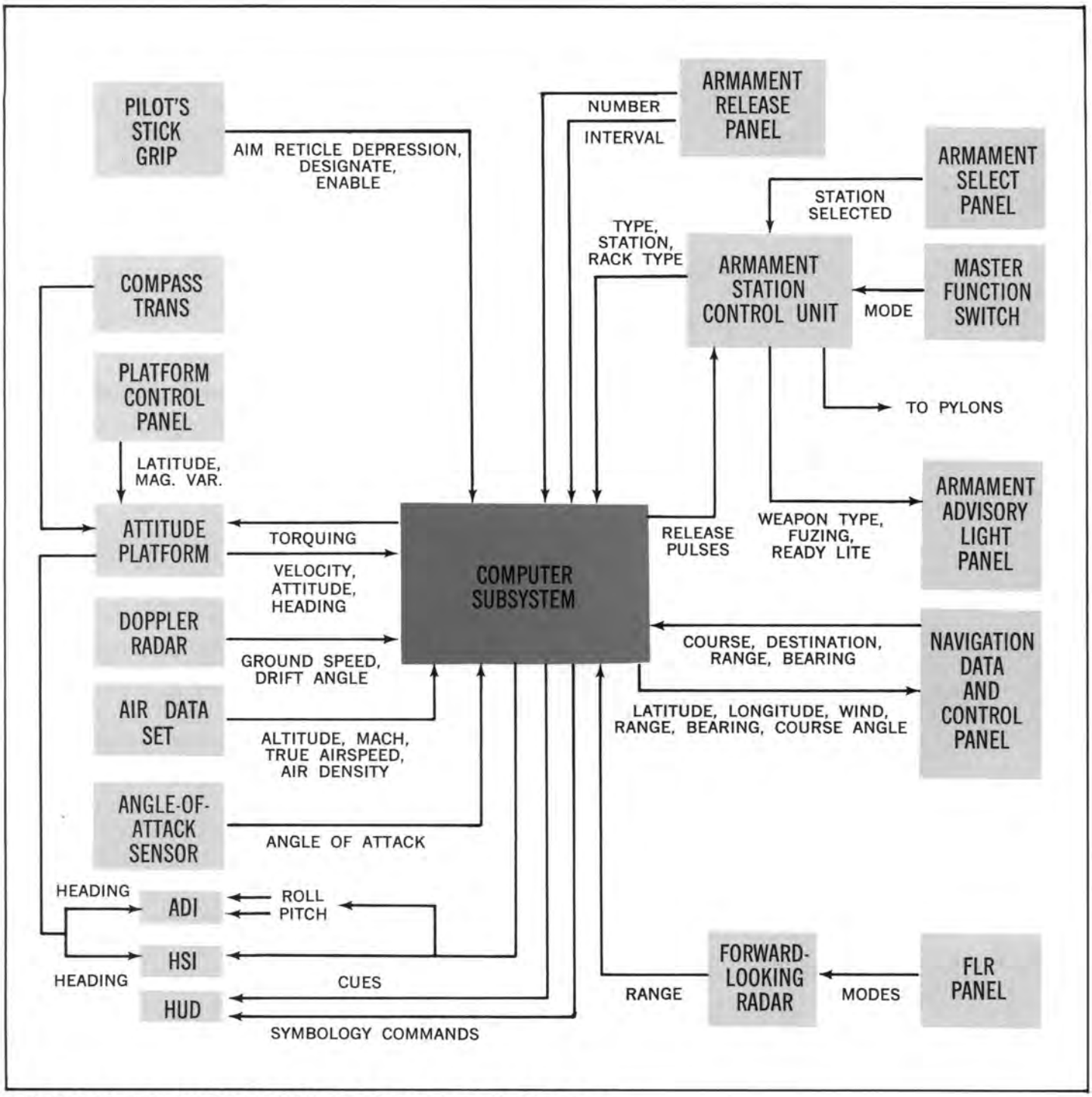
Subsystems of the NAV/Weapon Delivery system include (1) Tactical (NWDS) Computer Set, (2) Inertial Measurement Set (IMS), (3) Doppler Radar Set, (4) Forward-Looking Radar System, (5) Air Data Computer System, (6) Head-Up Display, (7) Armament Station Control Unit, and (8) Projected Map Display (provision).

NAV/Weapon Delivery Computer

The NAV/WD (Tactical) Computer, AN/ASN-91, is the primary computation element in navigation for the system. The computer also employs a self-test diagnostic routine to identify malfunctions within the computer or other components of the systems and to generate a test pattern for checking the HUD. Data, in serial digital format, is supplied to the HUD for generation of pitch, roll, flight path marker, aiming reticle, and bomb fall line displays. The NWDC accepts data from associated sensor systems, continuously computes present position, uses computed position and stores data to calculate navigation and weapons delivery solutions, and monitors the reliability of data inputs. It operates in Navigation Control, Weapon Delivery and Self-Test modes.

Inertial Measurement Set (IMS)

The IMS, AN/ASM-90, is the primary gyrocompassing platform, sensing aircraft heading, attitude and incremental velocity and providing these as outputs to associated avionics equipment. The IMS normally operates with Doppler damping, under the NWDC control, but has the capability of functioning as a self-contained attitude and heading reference system in case of computer failure.



SYSTEM BLOCK DIAGRAM NAV/WEAPON DELIVERY SYSTEM

Doppler Radar Set

The Doppler Radar, AN/APN-190, continuously measures and indicates groundspeed and drift angle while airborne. This information is used as the reference velocity for gyrocompassing. It also feeds data into the tactical computer for navigation purposes. Beam lobing is utilized to automatically eliminate the effect of sea bias error.

Forward-Looking Radar System

The Forward Looking Radar, AN/APQ-126, provides high or low altitude mapping, low altitude terrain following, low altitude terrain avoidance, and air-to-ground ranging. Two cross-scan modes allow simultaneous terrain following and terrain avoidance or terrain following and low altitude mapping. The radar provides TV display for WALLEYE, and contains a beacon mode for air-to-air rendezvous.

Air Data Computer System

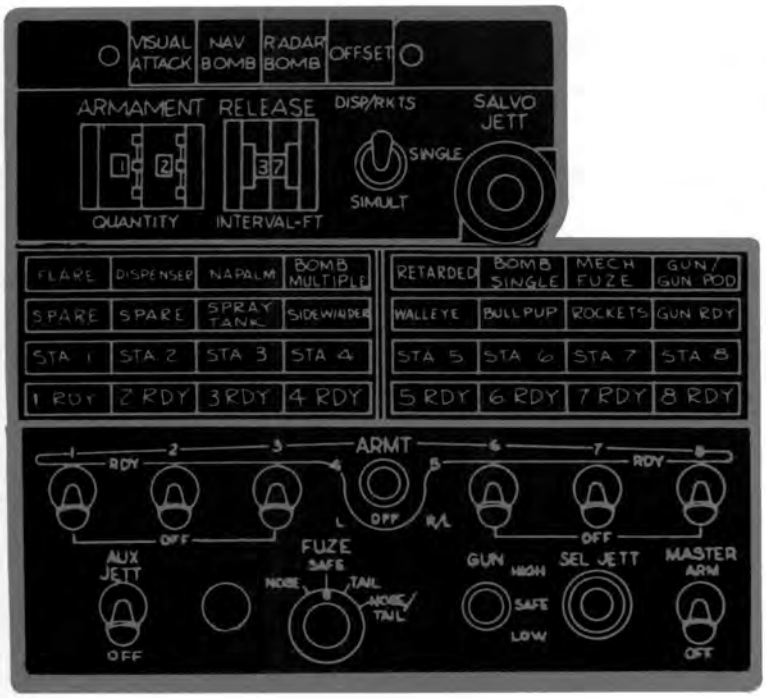
The Air Data Computer System, CP-953, develops true airspeed, indicated airspeed, Mach number, altitude, altitude hold, and encoded attitude signals from total pressure, static pressure, and total temperature inputs. The system consists of a CP-953/AJQ computer, 101F total temperature probe, and a true airspeed indicator.

Head-Up Display(HUD)

The HUD presents a combination of flight command and situation information projected onto the pilot's forward visual field of view throughout all mission phases. Flight information is presented in symbolic form and accuracy of the weapon delivery modes provided by HUD are major factors in the operational effectiveness of the NAV/WD system.

Armament Station Control Unit (ASCU)

The ASCU, when furnished with information from the other elements of the NAV/WD system, supplies the electrical outputs necessary to (1) arm (2) release or (3) jettison stores from selected weapons stations, and establishes station priority and sequence of store release.



Projected Map Display Set (Provision)

The Projected Map Display Set provides an optically projected display of standard aeronautical charts which have been reproduced on 35MM film and stored in the unit. It continuously displays airplane geographic position with respect to a moving map background.

The Projected Map Display, Horizontal Situation Indicator, and the Attitude Director are the pilot's primary head-down instruments for the display of airplane heading, geographical location with respect to the earth's surface, and attitude with respect to local vertical.

Other elements in the NAV/WD system include the AN/APN-141 radar altimeter which provides continuous, highly accurate indication of absolute altitude from 0 to 5,000 feet above terrain or water; the AN/ARN-52 TACAN airborne navigation system which operates in conjunction with a surface navigation beacon or with another aircraft equipped with a similar TACAN system; the AN/APN-154 radar beacon which extends the radar tracking range of a ground-based controller system as an aid in determining the range and azimuth of the aircraft; and an AQU-5/A standby magnetic compass which supplements the normal navigation instruments and systems. Growth capacity is provided for a LORAN receiver, which automatically performs search and track operations to provide time difference coordinates to the computer for conversion to latitude and longitude, and associated controls and antenna.

Navigation

The four dead-reckoning navigation modes dependent on sensor availability are (1) Doppler-Inertial Gyrocompassing (DIG), (2) Doppler-Inertial (DI), (3) Inertial, and (4) Doppler/Air Mass. Doppler-Inertial is the primary navigation mode; automatic reversion to backup navigation modes occurs in case of navigation sensor failure. The navigation systems will automatically assume, or can be manually selected to, a pure inertial mode if the Doppler is unreliable. The Doppler/Air Mass mode will be assumed automatically if the IMS fails. Should the air-data computer fail, this latter mode will continue on Doppler data and magnetic heading. Should the Doppler fail, the mode will use true airspeed, magnetic heading and last computed wind from storage.

The DIG and DI dead-reckoning modes utilize the Doppler, IMS, NWDC and associated controls and displays. North and east velocity data from the IMS is damped by ground speed data from the Doppler and continuously integrated to provide present position latitude and longitude. The present wind velocity vector is continuously computed and stored.

If the NWDC receives a "Doppler Unreliable" or memory mode signal from the Doppler, the system automatically assumes a pure inertial navigation mode using platform derived velocity data, and a "Doppler Memory" warning light is energized on the airplane advisory panel.

The Doppler/Air Mass dead-reckoning mode is automatically assumed on receipt of an IMS-failed signal. In this mode the pilot must enter local magnetic variation. Provisions have been made for entry of this data through the IMS control panel in this mode.

The navigation computation can be updated by determining the aircraft's position relative to one of the nine (prestored) selectable destinations which will be called the fixpoint. This can be accomplished by use of one of the four following techniques: If fixpoint is a prominent landmark, readily identifiable from the air (1) Fixpoint flyover – designating at the time of fly-over. (2) Obtaining range and bearing to fixpoint by use of the HUD for aiming and Forward Looking Radar for air-to-ground ranging. If fixpoint is a prominent landmark, readily identifiable on the Radar PPI (3) Obtain range and bearing to fixpoint by Radar PPI aiming and Radar ground map ranging. If fixpoint is a transmitting TACAN transmitter (4) Computer uses TACAN derived range and bearing. (Provisions have been made for LORAN updating when the LORAN equipment becomes available.)

Standard navigation aids, the Horizontal Situation Indicator (HSI) and Attitude Director Indicator (ADI), are supplemented by the Flight Director Computer (FDC) to make up the Heading Mode System (HMS).

Horizontal Situation Indicator (HSI)

The HSI provides the horizontal view of the navigation situation with respect to the airplane. It provides an integrated display of navigation data from various sources and presents this information in a symbolic-pictorial display for quick and easy observation.

Attitude Director Indicator (ADI)

The ADI provides an aircraft attitude and heading reference display. In addition, pointers and flags display azimuth and elevation steering commands, ILS and FDC reliability data.

Flight Director Computer (FDC)

The FDC controls all pointers and associated flags on the ADI and HSI in the TACAN and MAN heading mode options as well as during ILS master function option. The FDC steering commands are displayed on the ADI main steering pointers and on the HUD. These commands, called "Zero-Reader Commands," cause the ADI steering display to indicate the direction that the pilot should steer to fly the desired path. These command signals are nulled when the pilot is making the correct control action to capture or to track the desired path.

Heading Mode Options

The pilot can select three guidance modes on the Heading Mode Switch: AUTO NAV, TACAN, and MAN. The functions of the HMS control panel instruments in these guidance modes are as follows:

"AUTO NAV" – Display NWDC COMPUTER derived navigation information on:

HSI

1. Aircraft heading
2. Ground track heading
3. Bearing to destination
4. Range to destination

ADI

1. Steering

"TACAN"

HSI

1. Enter the desired TACAN course via "Course Set" knob
2. Enter desired course intercept heading via "Heading Set" knob
3. Display
   a) Pilot input, selected TACAN course and intercept heading
   b) Range to transmitter
   c) Relative bearing to transmitter
   d) Aircraft heading
   e) Course deviation

ADI

1. Steering display
   a) Intercept heading
   b) FDC command steering (selected course)

"MAN"

HSI

1. Enter desired heading via "Heading Set" knob
2. Display
   a) Selected heading
   b) Aircraft heading

ADI

1. Heading command (steering)

(NOTE: Regardless of the position of the HDG MODE switch, the HUD is in the navigation mode and enroute HUD symbology is displayed.)

In addition to the three guidance modes available in the HMS, the pilot can select Landing (LDG) or Terrain Following (TF) modes by depressing the appropriate Master Function Switch.

The TF mode operates in conjunction with all guidance modes, providing Forward Looking Radar input to the Elevation Steering Command displayed on the ADI and HUD.

The LDG mode overrides all other Heading Mode Displays, and incorporates input and displays of landing information on the HSI, ADI and the HUD as follows:

HSI

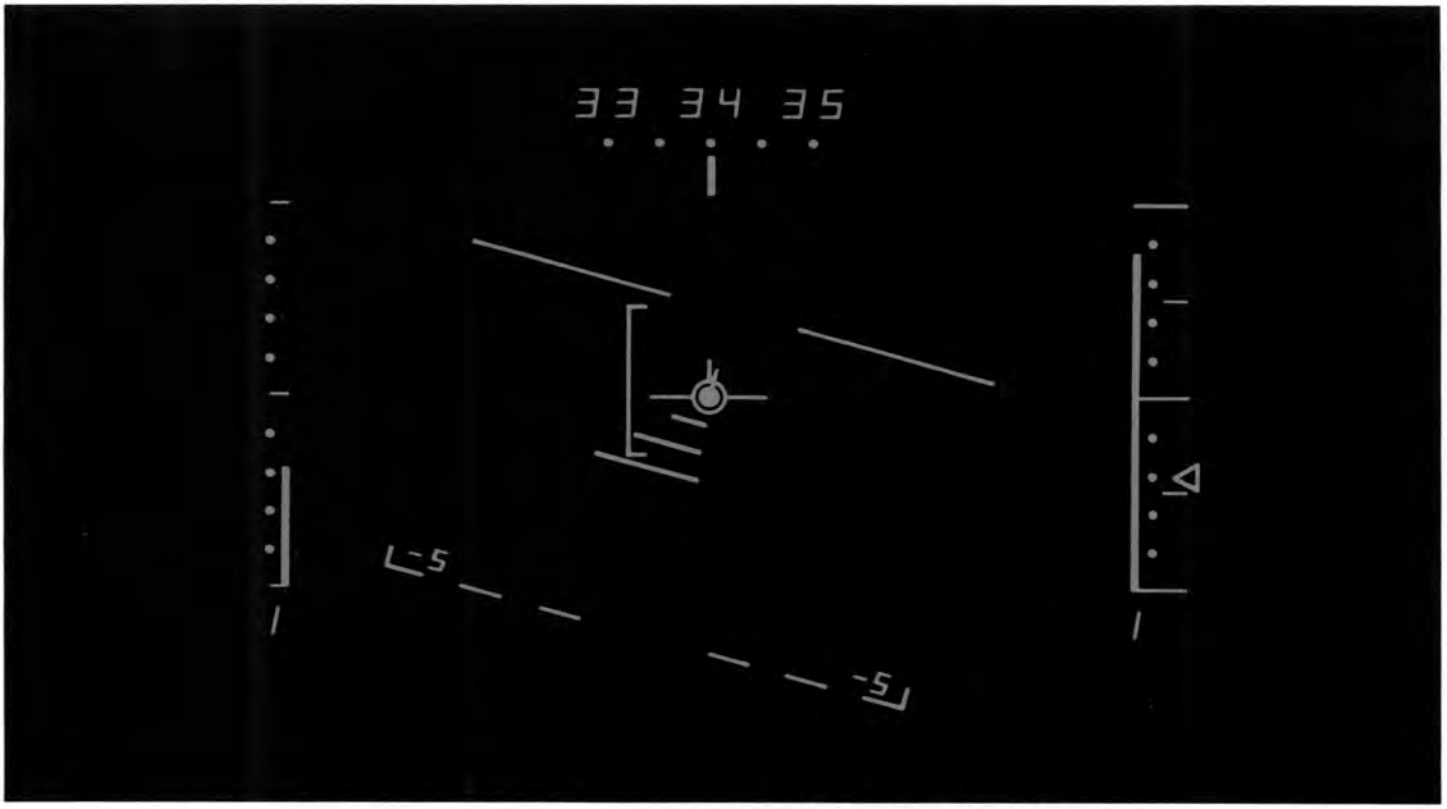
1. Input and display runway approach heading
2. Input and display localizer intercept heading
3. Display raw localizer

ADI

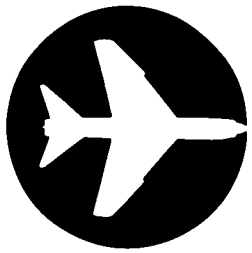
1. Display
   a) Raw glide slope
   b) FDC localizer and glidescope steering command

HUD

1. Display
   a) Raw localizer and glidescope
   b) FDC localizer and glidescope steering command



HUD Landing Symbology



Weapon Delivery

The A-7D Navigation/Weapon Delivery system allows maximum versatility in weapons carried and their modes of delivery, computed or manual. (The digital multimode computer furnishes computations for bombing and firing guns and rockets.) The computed attack modes are Normal or Normal Offset, Navigation Bombing, and Radar or Radar Offset.

The Computed modes delivery sequence is (1) visual target identification, (2) aiming; overlaying of the target with HUD aiming reticle (accomplished by steering the aircraft and/or slewing the aiming reticle), (3) target designation (which enters the target location into the digital computer) and (4) following HUD azimuth steering and solution cues (projected in space in pilot's field of view) to release.

The flight path of the aircraft is unconstrained except for required azimuth steering. Thus level, glide, toss, loft, and over-the-shoulder attacks are simultaneously available as is the capability to change from one tactic to another during attack.

The primary mode of weapon delivery is the Normal Bomb Mode. This mode (visual) is initiated by selection of (1) "Norm Attack" on the master function switch, (2) appropriate weapon station(s) on the armament select panel, (3) weapon quantity (single/pairs) and drop interval on the armament release panel and (4) depressing the master arm switch. For reattack, the stored target location is used by the NWDS computer to provide steering signals to the HUD for second, and subsequent, pass at the target.

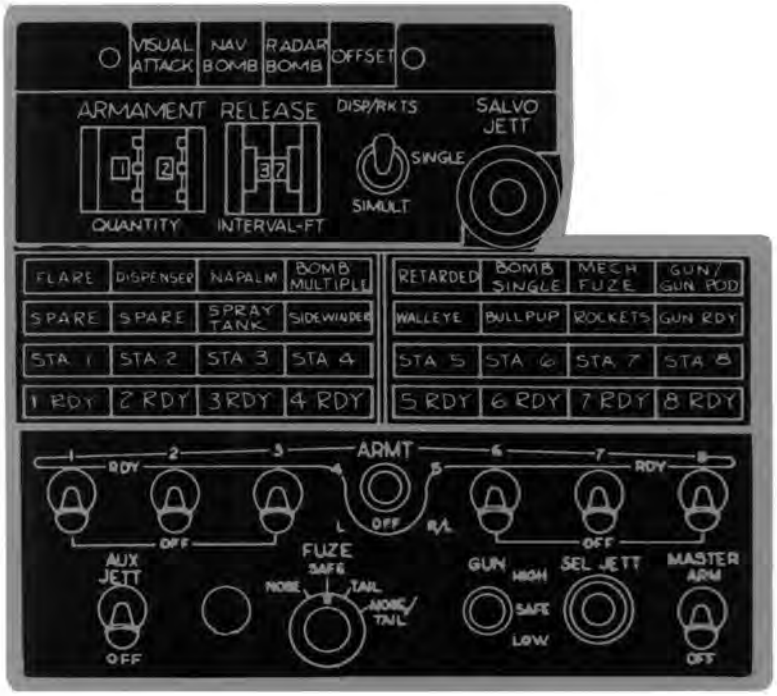
Normal Offset Bomb Mode is the same as the Normal Bomb Mode except that the aiming point is a prominent landmark (IP). The range and bearing from IP to target is known and has been input to the computer prior to mode select. At target designate, azimuth steering information is displayed such that the pilot can steer from the IP to the target.

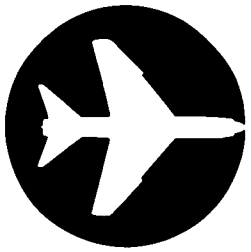
The radar bombing modes provide for limited all-weather attack against a target designated from radar data. The target location and target data are entered in the NWDS computer via the NWDS control panel. Mode engagement is selected via the master function switch. Armament settings are made as in the normal bomb mode. When within radar mapping range, or as desired, the pilot places the master function switch in the radar bomb mode thus putting the radar in the ground mapping mode.

Designation may be on the target or known initial point with respect to the target (these are the RADAR and RADAR Offset Modes respectively), and no restrictions are placed on delivery options.

Navigation bombing is a "navigate to target and release" mechanization sometimes referred to as "bomb on coordinates." The computer delivery is based on target data (latitude, longitude, range,bearing, MSLP, delta height, and bomb burst height) which has been stored in the computer through the NWDS panel.

In any mode, weapon release is compensated for wind, eliminating a major source of weapon delivery errors. Guns and rockets can be fired in any delivery mode. (When guns or rockets are in priority, the HUD aiming reticle indicates the projectile impact point.) Automatic reversion to back-up delivery calculations is provided in event of failure of any weapon delivery sensors.





Communications

The A-7D provides all necessary and auxiliary communications capabilities, including VHF/FM radio for contact with ground troops, two-way UHF voice contact, and automatic direction finding from UHF stations. In addition, one unit provides Identification Friend-or-Foe and altitude reporting.

The primary air-ground voice communication system is the AN/ARC-51, a 3500-channel AM voice transceiver with both manual and preset tuning. This unit also functions as an auxiliary automatic direction finder. Two-way air-to-air and air-to-ground voice communication is provided by the FM-622A VHF set.

The AN/ARR-69 is an emergency UHF receiver with selectable preset channels available. Under normal conditions, this unit serves an auxiliary Automatic Direction Finder (ADF) function. For emergencies, it can be used for limited one-way voice contact.

The AN/ARA-50 UHF/ADF unit works in conjunction with either the ARC-51 BX or ARR-69 to provide bearing to a signal source to which the appropriate receiver is tuned.

The AN/APX-72 IFF receiver-transmitter is used with auxiliary equipment to provide automatic radar identification to all suitably equipped challenging aircraft, surface ships and ground facilities within line-of-sight range of the system. This system is equipped with transponder self-test capabilities. During aircraft emergency or distress conditions it may be used to transmit specially coded emergency signals.

Intercommunication with ground maintenance personnel is provided by the AN-AIC-26 audio system. In addition this system provides multi-channel monitoring of all audio signals derived from, or delivered to, associated electronic equipment (except ECM).

For secure voice communication, the Juliet 28 voice scramble unit is used in conjunction with the UHF and VHF radio sets.

For maintenance considerations, all communications equipment is installed as individual units and located in waist-high bays so that each unit may be removed for service by one man standing on the ground.

EQUIPMENT	FUNCTIONS
FM 622A VHF VOICE TRANSCEIVER	• COMMUNICATIONS WITH GROUND TROOPS
ARC-51 BX UHF RADIO	• TWO-WAY VOICE COMMUNICATION WITH OTHER UHF STATIONS
ARA-50 UHF ADF	• AUTOMATIC DIRECTION FINDING TO UHF STATION
ARR-69 UHF AUXILIARY RECEIVER	• RECEIVER FOR USE WITH ARA-50 • EMERGENCY RECEIVER FOR ARC-51
APX-72 IFF WITH SIF	• IDENTIFICATION – FRIEND OR FOE • ALTITUDE REPORTING
JULIET 28 VOICE SCRAMBLER	• SECURE COMMUNICATIONS
AIC-26	• AUDIO SYSTEM • INTEGRATES AUDIO SIGNALS

Radar

The Forward Looking Radar provides high or low altitude mapping, low altitude terrain following, low altitude terrain avoidance, air-to-ground ranging and two cross-scan modes which allow simultaneous terrain following and terrain avoidance or terrain following and low altitude mapping.

The ground mapping shaped beam permits detection of natural and man-made land forms. (At close range, large building complexes, airfields and bridges are distinguishable). The pencil beam has available the option of using weather return rejection by selection of circular polarization.

In terrain avoidance, the radar antenna is programmed to scan plus or minus 45 degrees in azimuth along the aircraft line of flight. In terrain following, radar antenna scans from plus 7 to minus 18 degrees in an elevation plane determined by the aircraft flight path. Climb/dive commands are displayed and adequate control is provided to prevent collision with ground or tower type structures. Clearance altitudes of 200, 500, 1,000, 1,500 and 2,000 feet are provided.

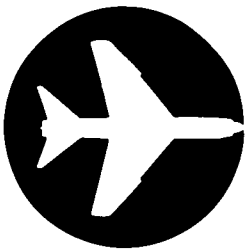
Air-to-ground ranging is against a distributed (clutter) target or an isolated (point) target. The range tracker searches on boresight with lock-on occurring upon clutter or return from target of sufficient reflectivity.

The beacon mode for air-to-air ranging provides for interrogation of reception of Ku band beacon signals for navigation and rendezvous. A coded image which indicates slant range and azimuth to the beacon source is shown on the radar indicator scope. Ranges are 5, 10, 20, 40 and 80 nautical miles.

Television Display is automatically initiated upon receipt of an external discrete signal when a Walleye armament station is selected.

The Doppler Radar Set (DRS) provides drift angle and ground speed, which is used as the reference velocity for airborne gyrocompassing. The outputs are provided in digital and analog form for the NWDC and cockpit display, respectively. The DRS transmits narrow beams of electromagnetic energy to the ground and receives back a portion of this energy, which is processed to determine doppler shifts. It employs unique features of beam lobing and a triple tracker to provide a high degree of accuracy with a small land/sea calibration shift plus a special feature to track velocity with high accuracy during acceleration or maneuvers. If the signal to noise ratio drops below the predetermined value at which the set will operate within the specified accuracy and performance, the unit automatically reverts to a memory mode of operation. In this case, the outputs consist of the last valid information and a discrete signal illuminates an advisory light in the cockpit.

The antenna is pitch and roll stabilized to provide accurate velocity data over the range of plus or minus 20 degrees in pitch and plus or minus 30 degrees in roll.



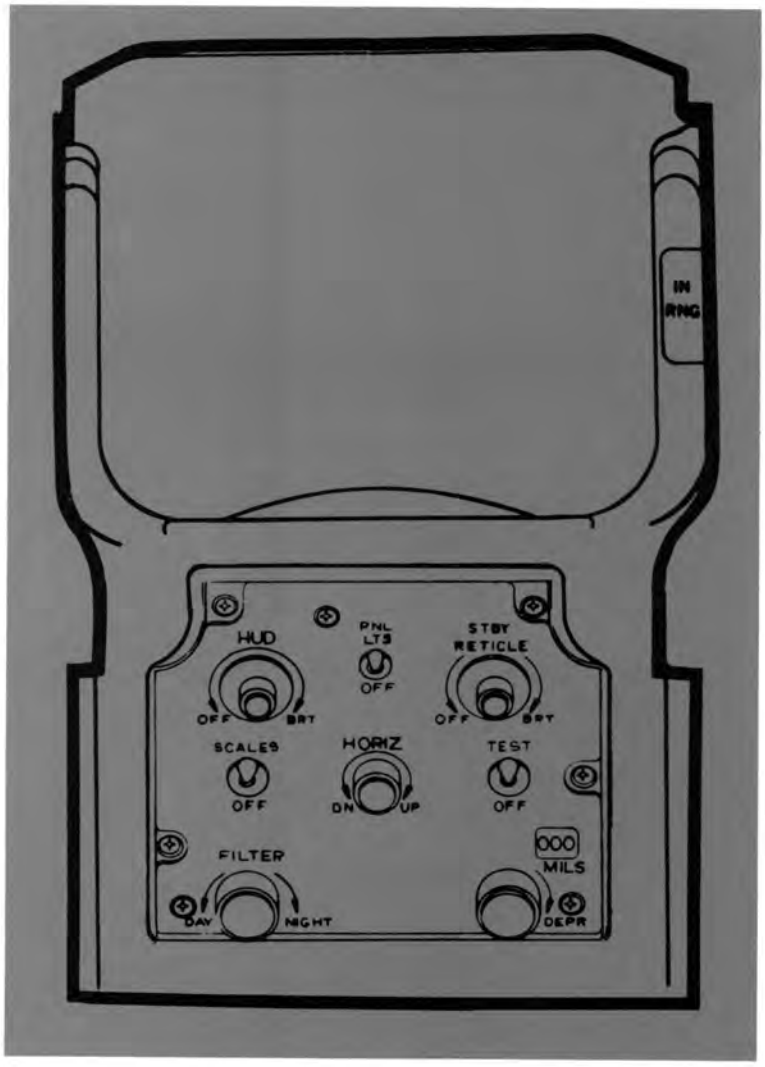
Electronic Countermeasures

The A-7D ECM system provides a complete passive detection capability against hostile threat radars having diverse characteristics.

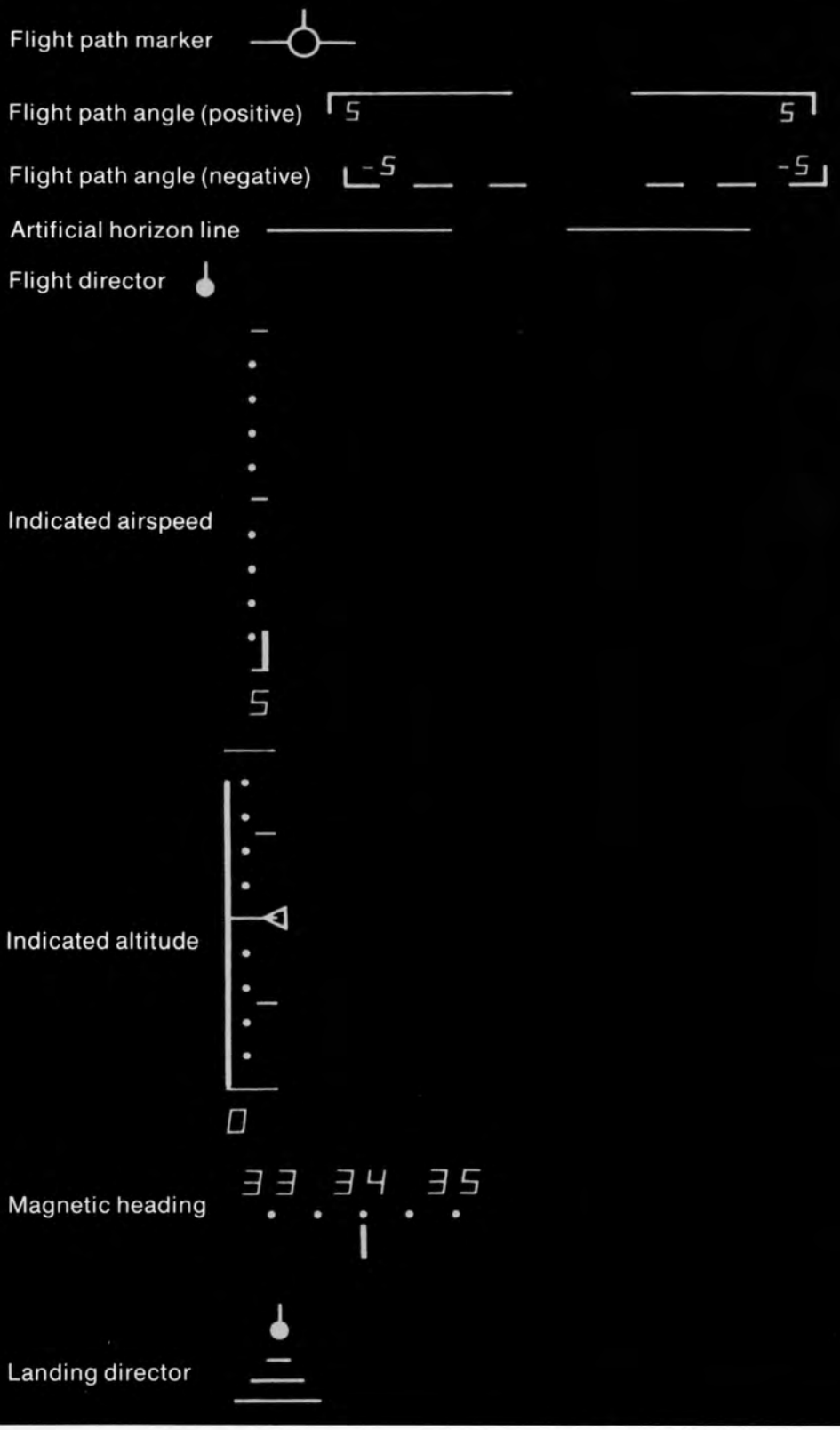
Head-Up Display

The Head-Up Display (HUD) provides the pilot with pertinent flight information displayed at eye level in line with the flight path. The display is transparent, focused to infinity, and optically merges to become part of the pilot's forward view.

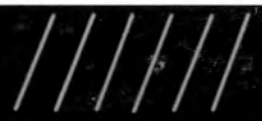
The HUD is used in attack, enroute navigation, and landing modes of flight, presenting information pertinent to the applicable mode in symbol form overlayed to supplement normal visual flight.



HUD Symbology



Warning indicator



Angle-of-attack indicator

Pull-up command (flashing)

Aiming reticle ◇

Bomb fall line
(Reduced to ½ size)

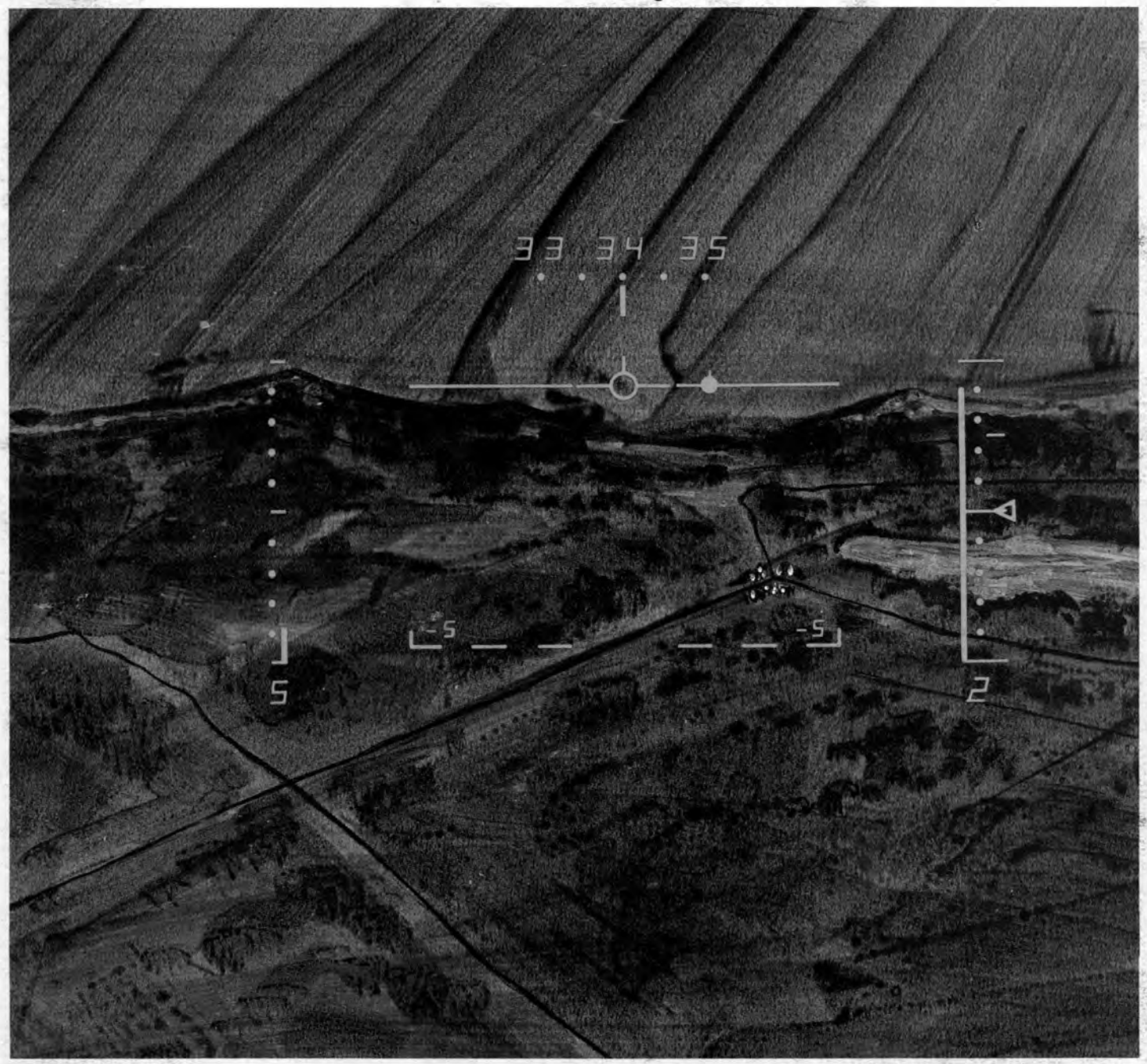
Pullup anticipation cue

Side-Slip Indicator (Yaw) ϕ

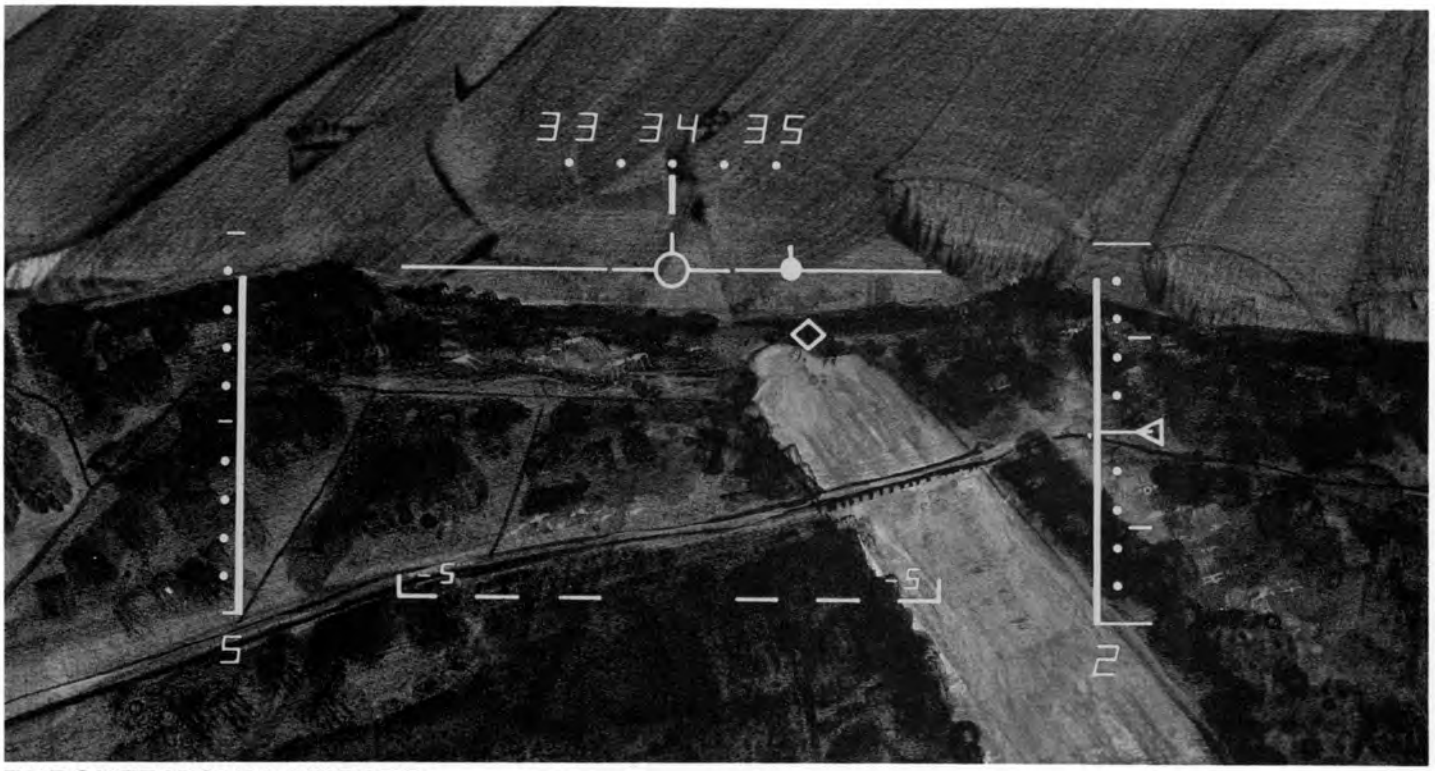
Standby aiming reticle (backup)
(Reduced to ¼ size)

Projected HUD Displays

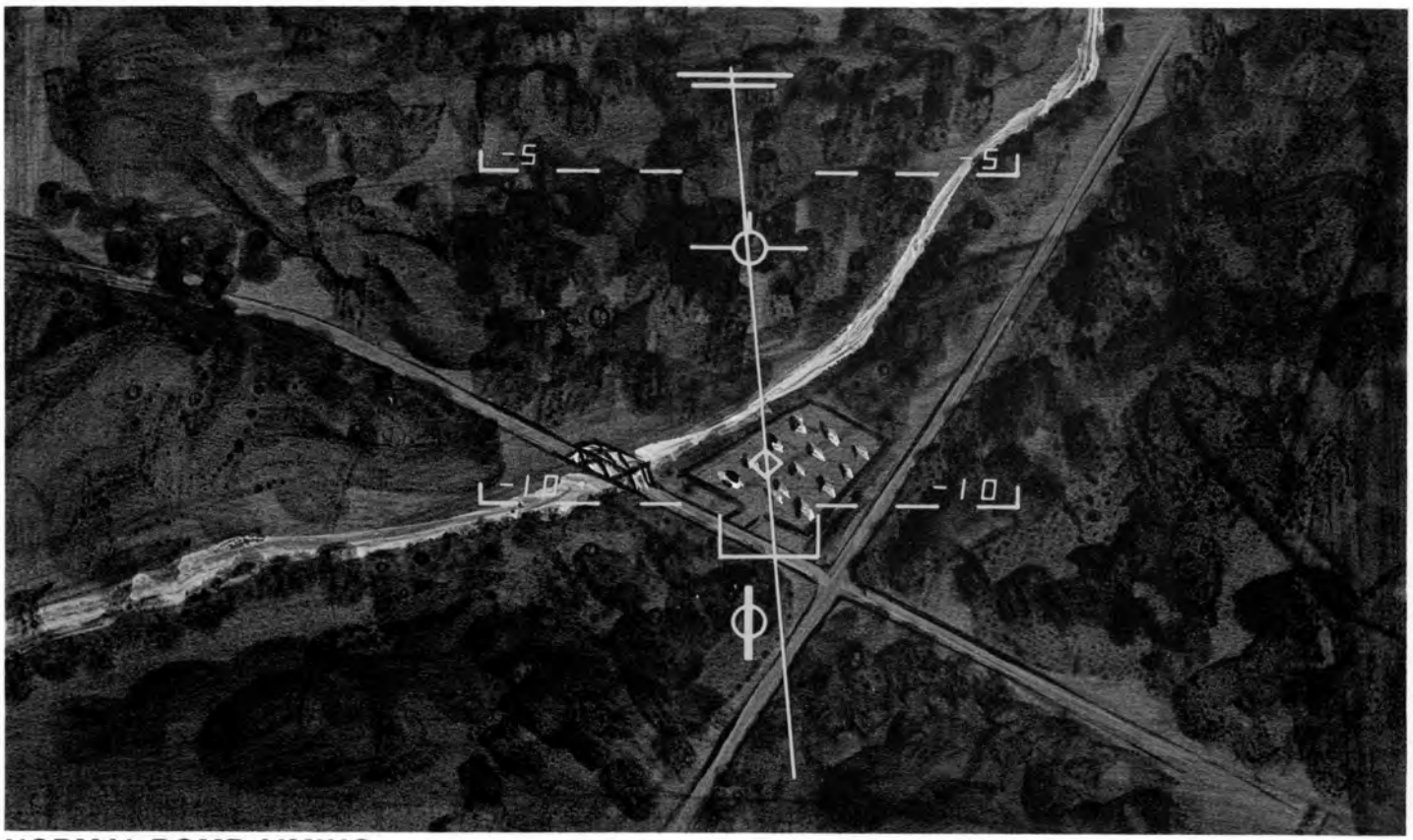
The HUD symbology displayed on this and following pages is provided to give the reader a feel for what the pilot sees on his windscreen. Several different modes are shown to illustrate briefly the changes in symbology that occurs. A comprehensive description of the use of the HUD and detailed explanation of the symbology is contained in current A-7D Flight Manuals.



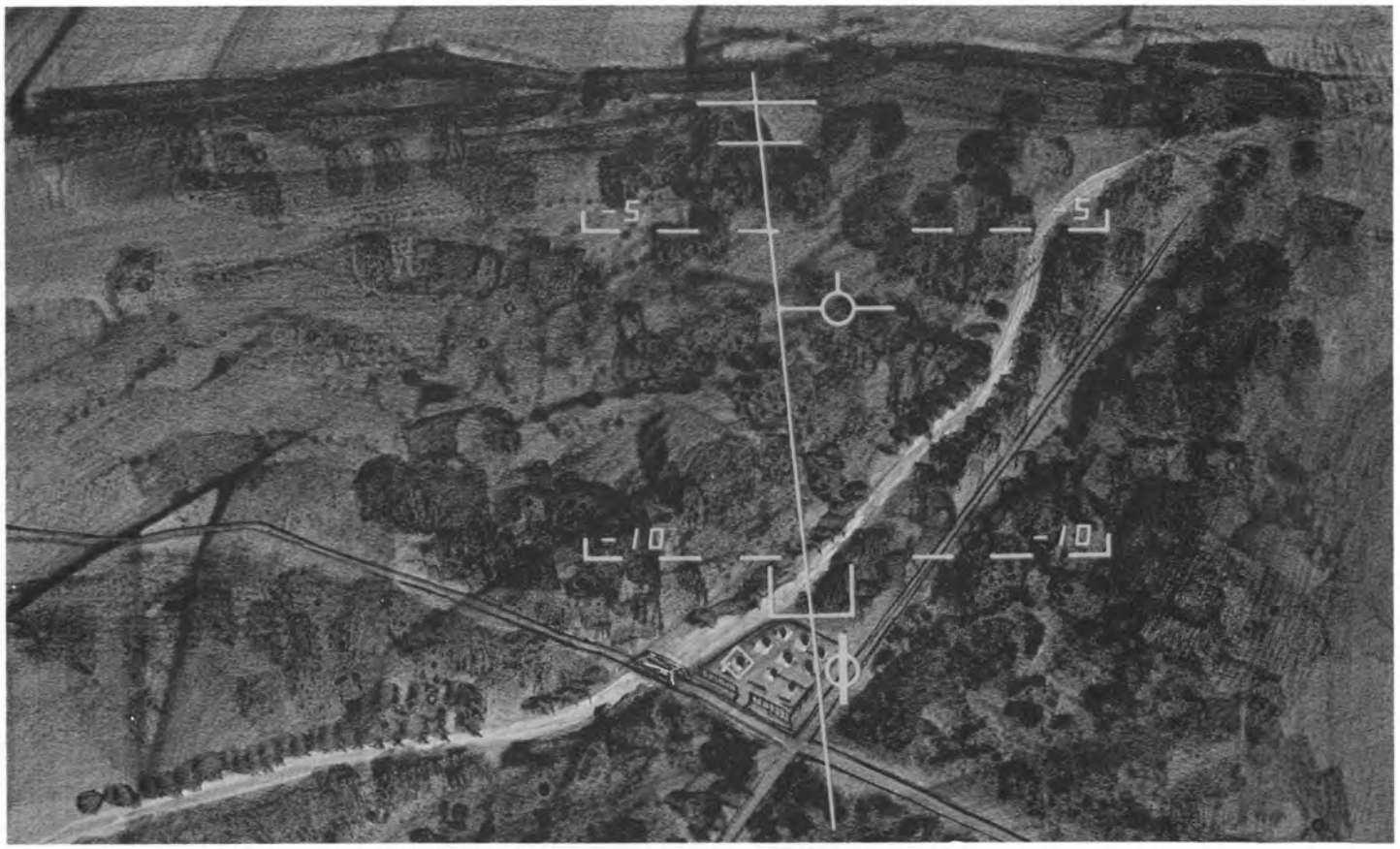
ENROUTE



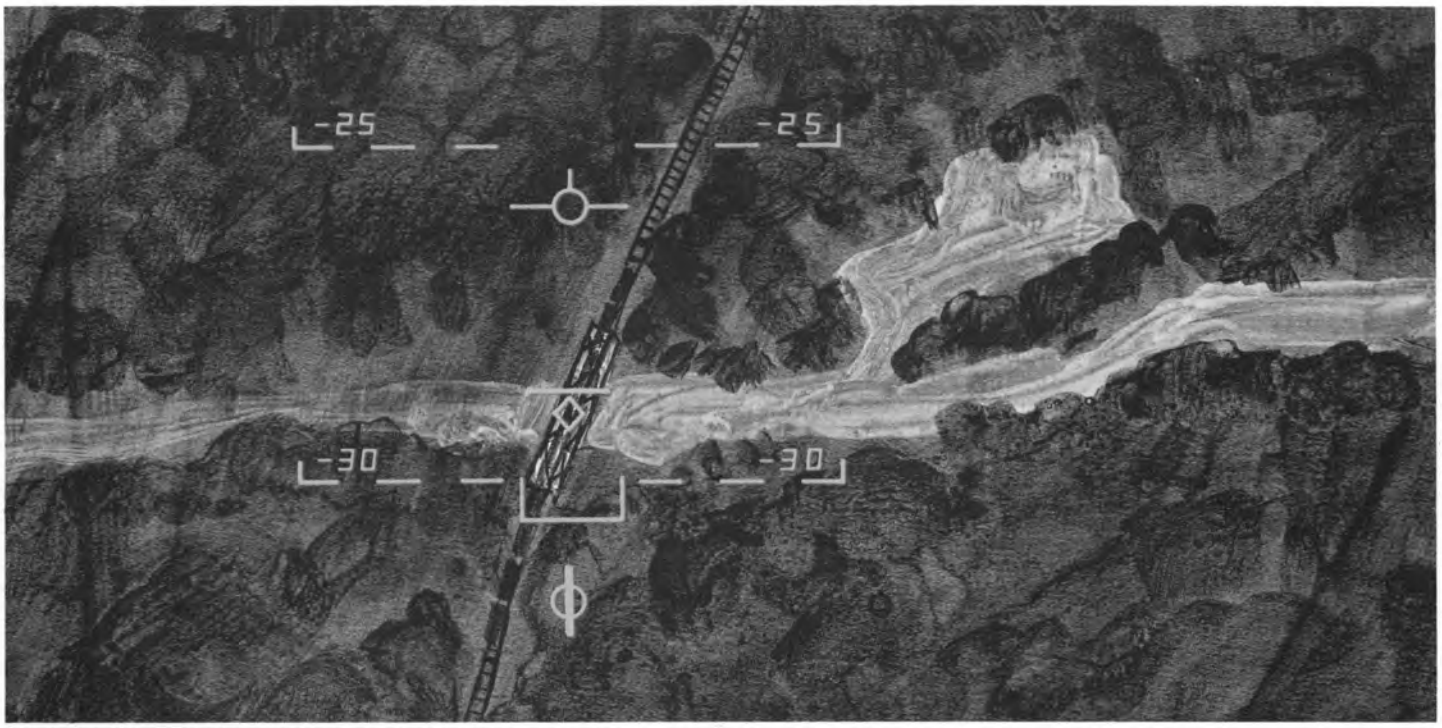
ENROUTE VISUAL UPDATE



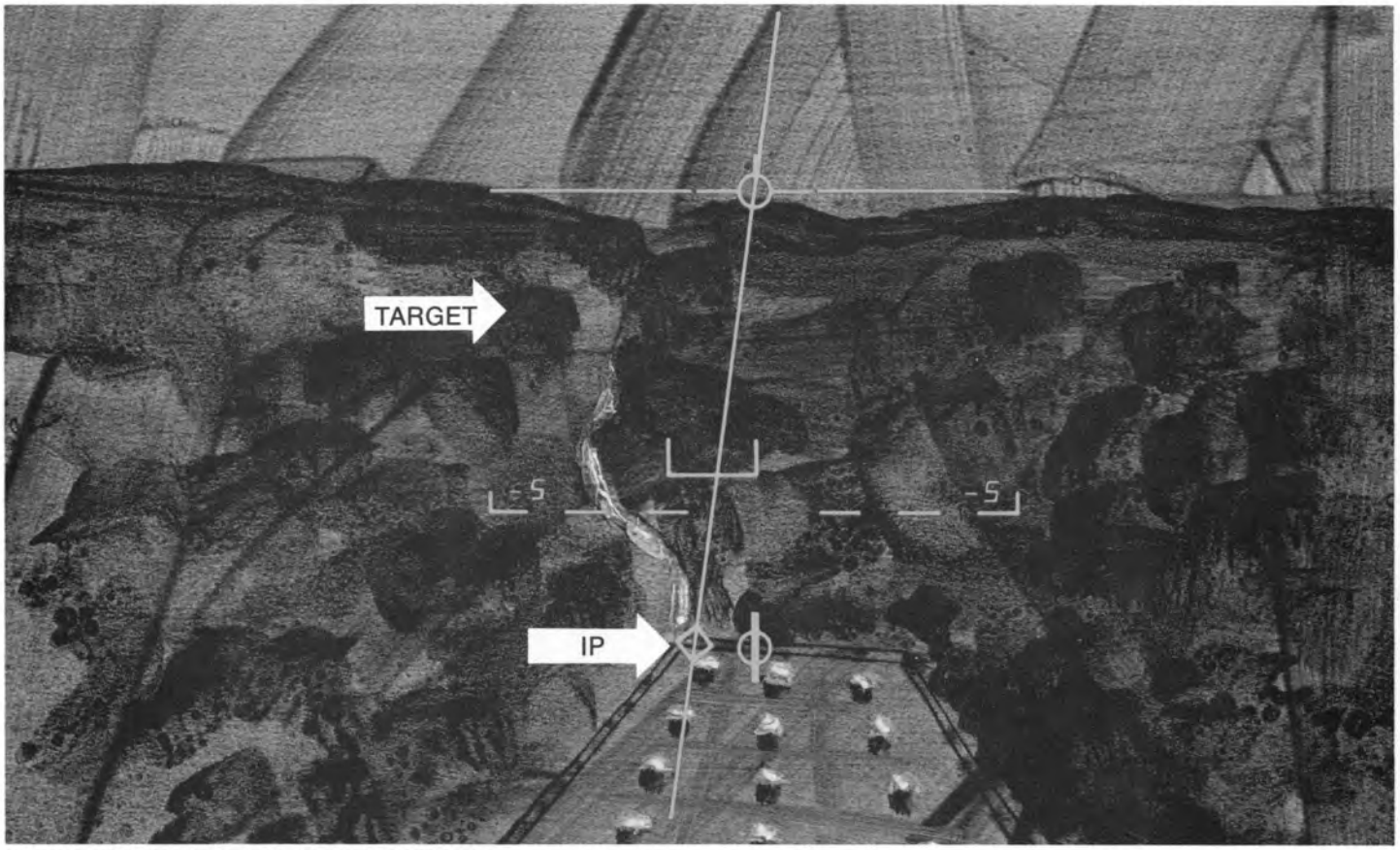
NORMAL BOMB AIMING



NORMAL BOMB AFTER DESIGNATE

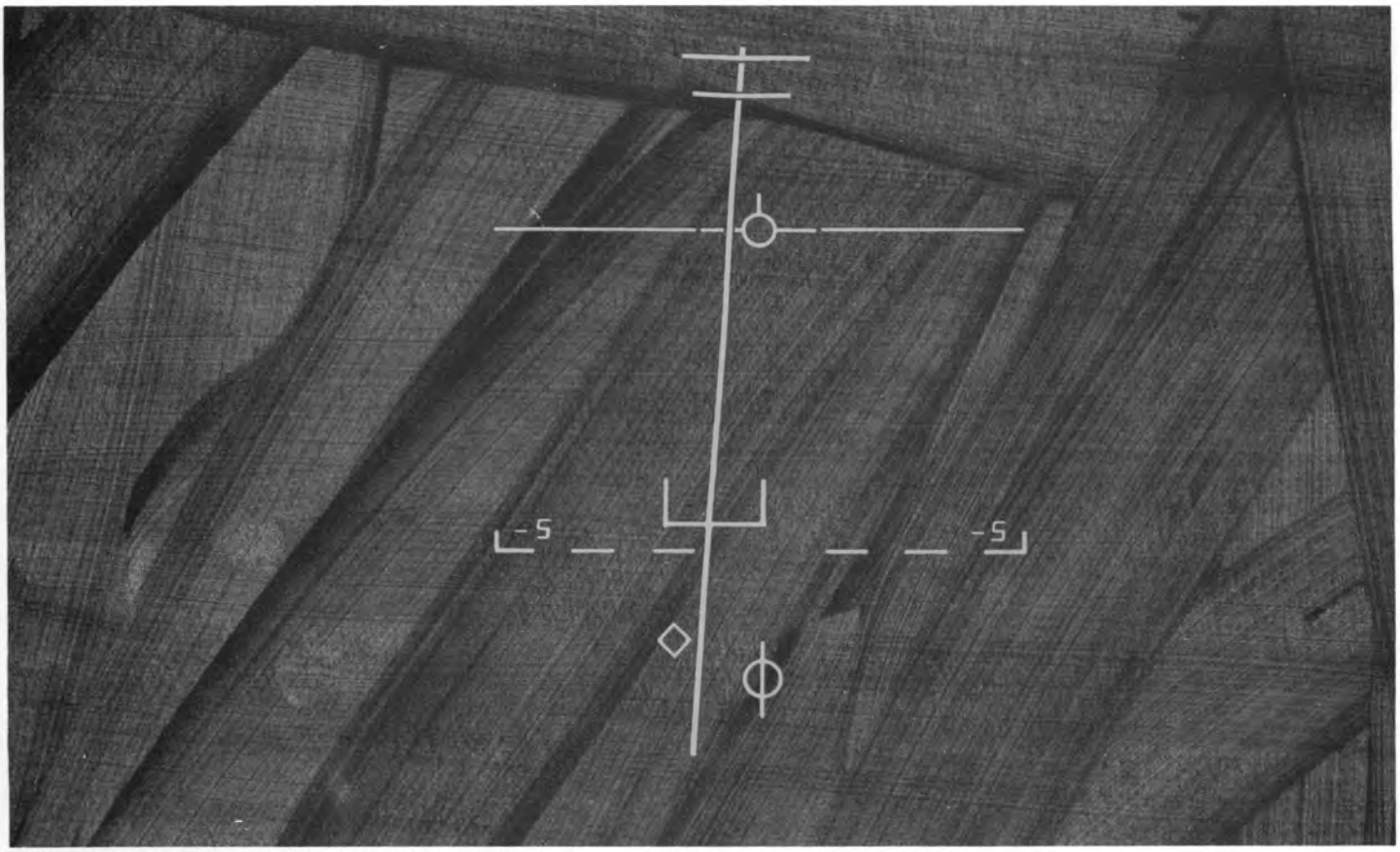


NORMAL GUNS AND ROCKETS

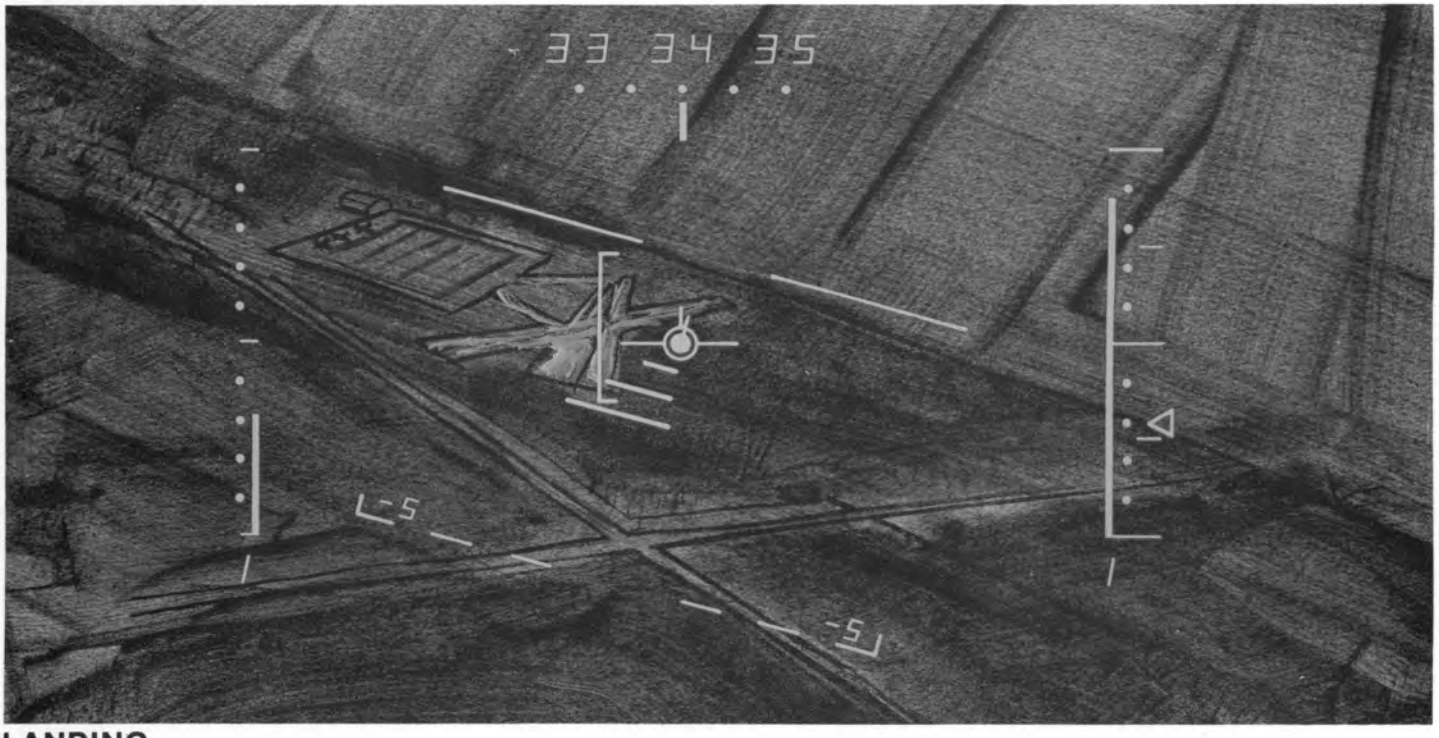


NORMAL OFFSET BOMB AIMING

NORMAL OFFSET BOMB AFTER DESIGNATE

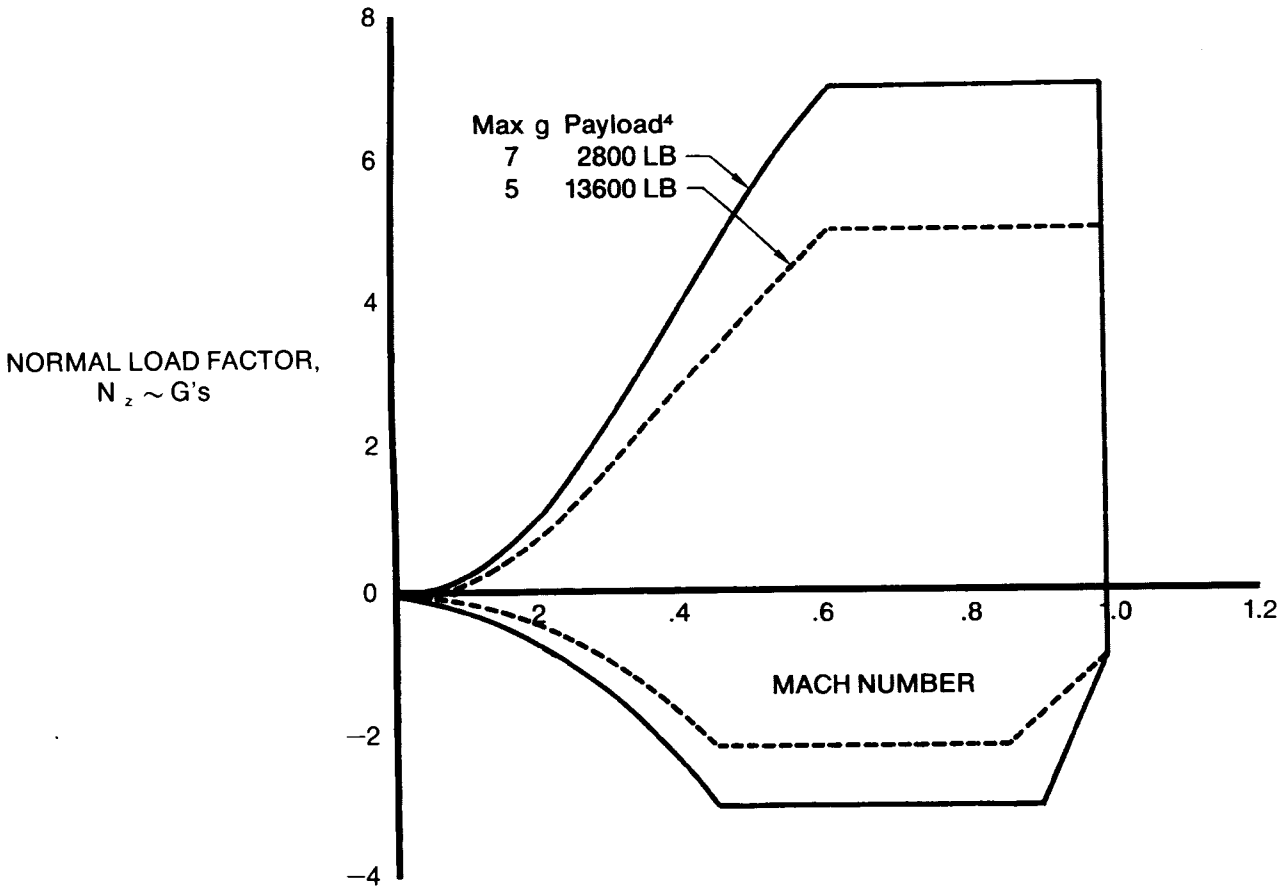


RADAR BOMB AFTER DESIGNATE



LANDING

Payload Capabilities at Various Load Factors



Notes:

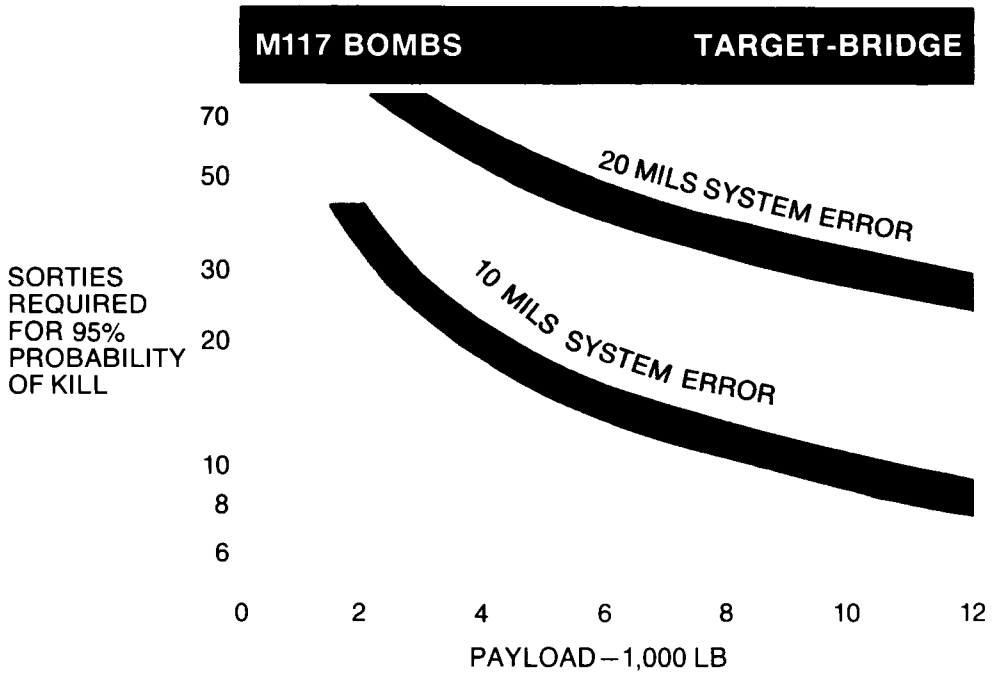
1. Sea Level. Standard Day
2. 60% Fuel (855 Gal.)
3. Full Load 20mm Ammo
4. Payload is Weight Below MAU-12 B/A Rack

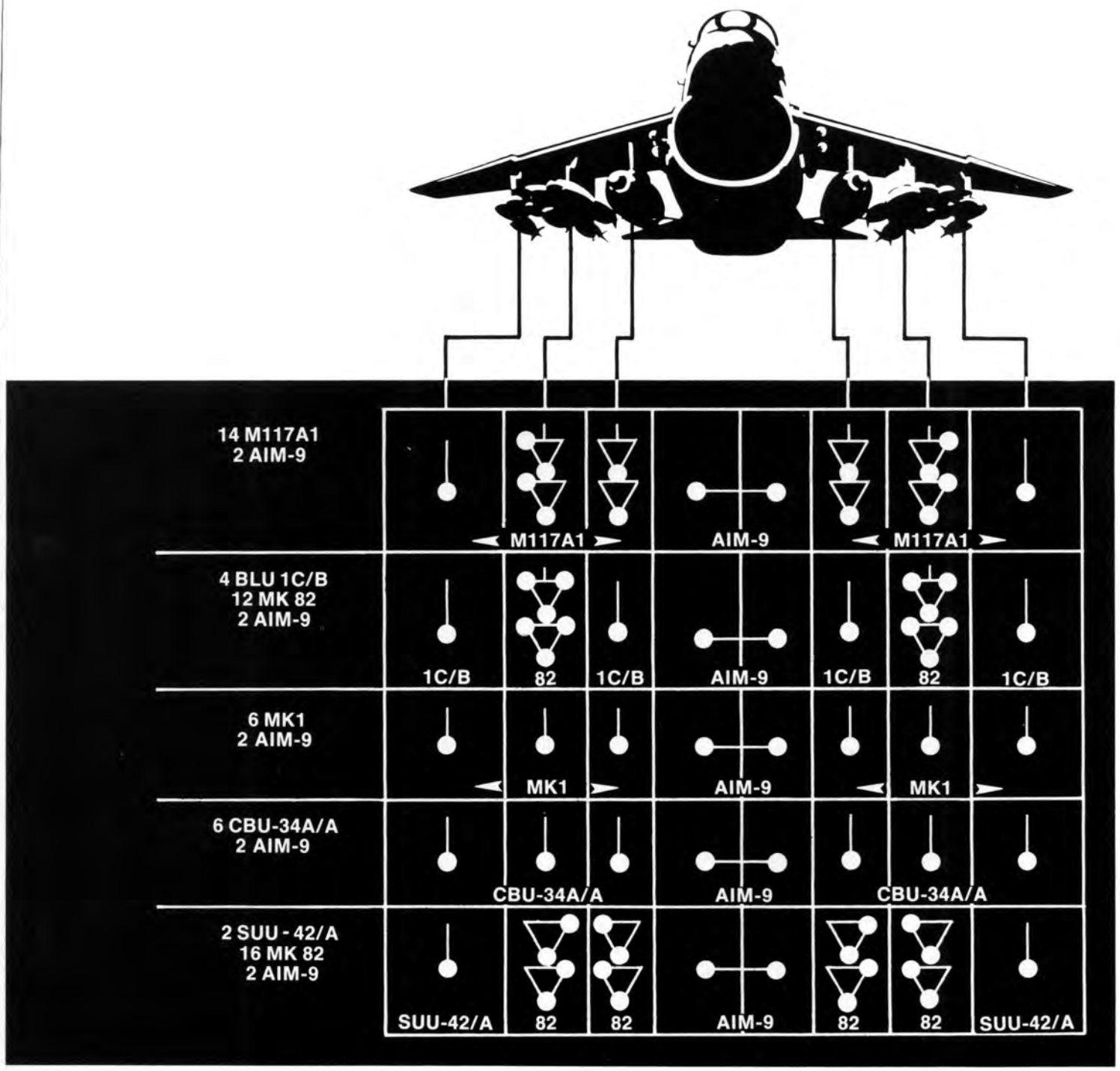
Target Accuracy

The weapon system is designed for 10-mil accuracy. The A-7D avionics system ensures the following precision in weapon delivery:

- Level laydown accuracy at delivery altitudes of 240 to 1200 feet is between 125 and 200 feet circular error probability (CEP).
- The strafing CEP with 2.75/5-inch rockets and the M61 cannon is not to exceed 10 mils about the target.
- Dive-toss delivery accuracy with dive angles of 10 degrees to 60 degrees is 10 to 12.5 mils.

With its 10-mil system, the A-7D requires only one-third the sorties to kill a hard target as does the typical 20-mil system. Thus, fewer A-7 sorties decrease the aircraft's exposure to enemy firepower and, correspondingly, lower attrition rates.




14 M117A1
2 AIM-9
M117A1
AIM-9
M117A1
4 BLU 1C/B
12 MK 82
2 AIM-9
1C/B
82
1C/B
AIM-9
1C/B
82
1C/B
6 MK1
2 AIM-9
MK1
AIM-9
MK1
6 CBU-34A/A
2 AIM-9
CBU-34A/A
AIM-9
CBU-34A/A
2 SUU - 42/A
16 MK 82
2 AIM-9
SUU-42/A
82
82
AIM-9
82
82
SUU-42/A

Alternate Loading Configurations

The A-7D can carry ordnance payloads on extended low-altitude radius-of-action missions without external fuel. The weapon load is distributed among eight store stations—six on the wings and two on the fuselage. The aircraft was designed with an ordnance versatility that permits its adaptation to a wide variety of offensive and defensive weapons.

In the illustrated alternate loading configurations, internal M61A1 gun and ammunition are installed. All loadings assume that all 6 wing pylons and 6 MAU-12 racks are installed. The following are samples of the type stores which can be carried:

AIM-9	Sidewinder Missile
M117A1	750-lb Bomb
BLU-1C/B	Fire Bomb
Mk82	500-lb Bomb
Mk1	Walleye
CBU-34A/A	Mine Dispenser
SUU-42/A	Flare Launcher

Currently an Air Force Seek Eagle program is being executed to determine the compatibility of the A-7D with the full range of Air Force munitions.

SURVIVABILITY

ARMOR IN CRITICAL AREAS
FOAM IN ALL FUEL CELLS
SELF-SEALING CELLS
LINE SEPARATION
ALTERNATE FUEL FEED SYSTEM
THREE PC SYSTEMS
DEFENSIVE CAPABILITY
- 20MM GUN
- SIDEWINDERS
- LOW ALTITUDE TURNING MANEUVERABILITY

FAN ENGINE – SMALL GAS GENERATOR
NO FUEL AFT OF FIREWALL
SYSTEM REDUNDANCY

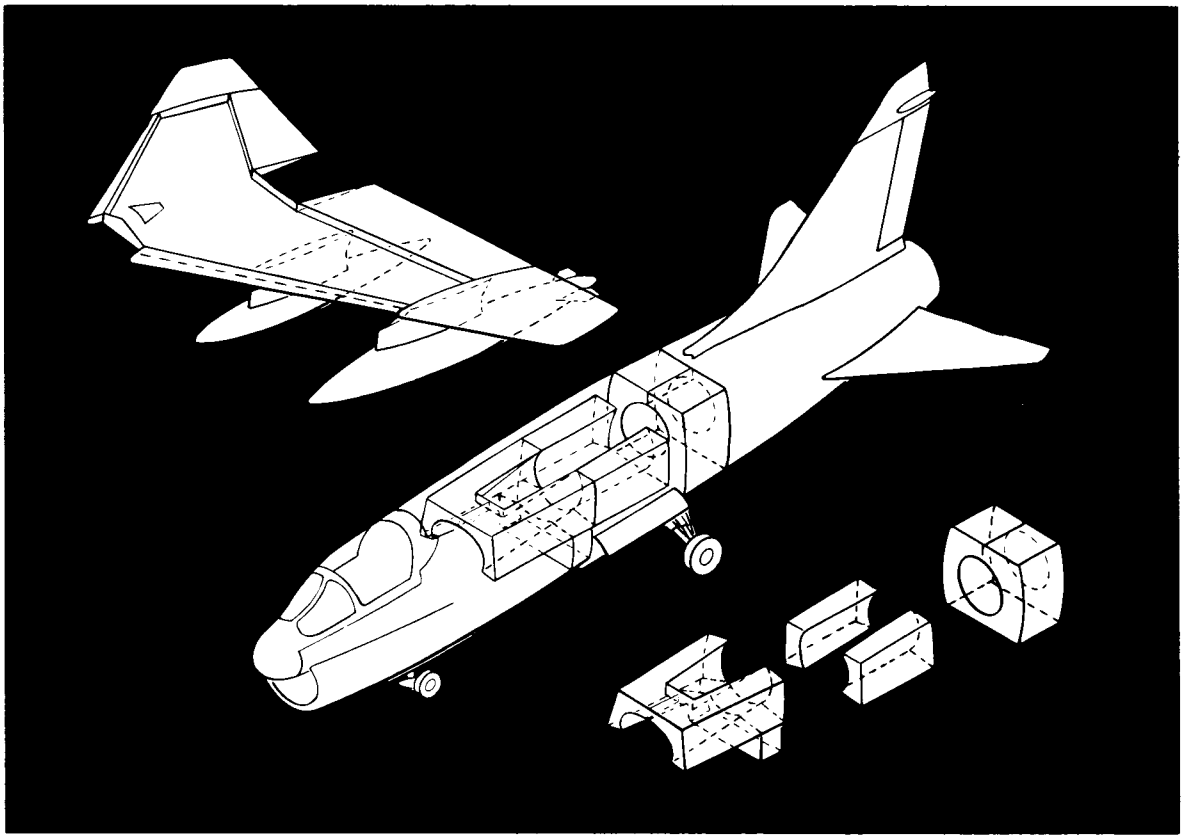
Survivability

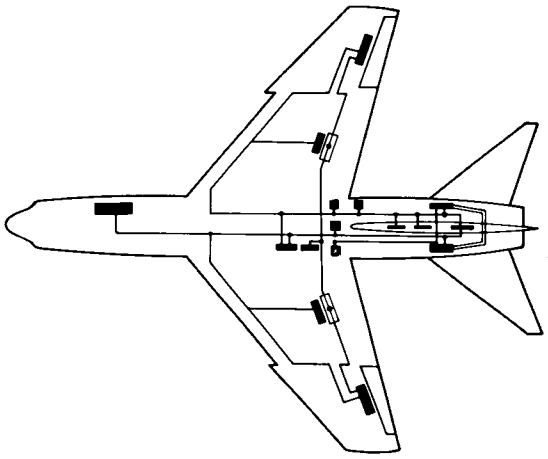
The excellent maneuverability afforded by the 7g basic structure and high roll rates of a 180° per second with 90° of bank in the first second; air-to-air missiles (Sidewinder); an M61 cannon; and ECM systems, are active defense factors.

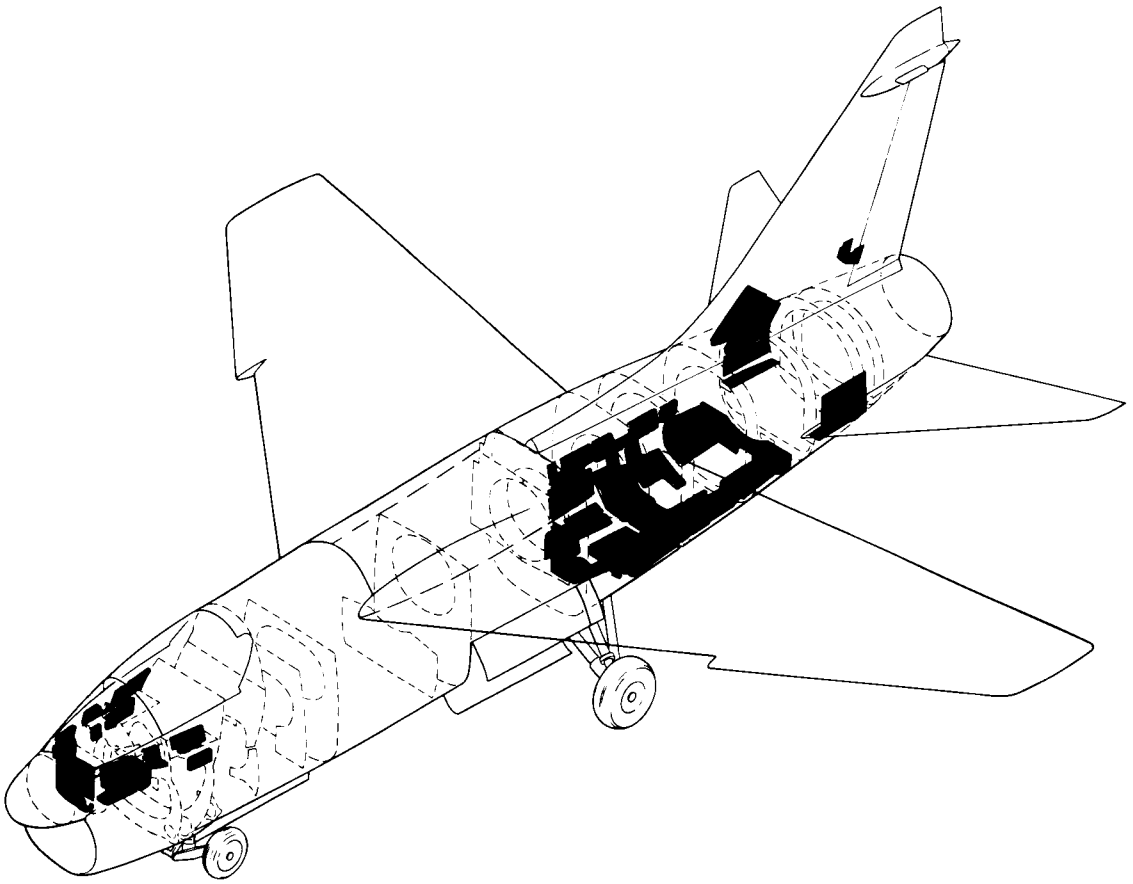
Dual property steel armor is located forward of the pilot and is also employed to protect the roll feel isolation actuator, UHT actuator, and the rudder and horizontal tail feel and control mechanism. Ceramic composite armor is provided on each side and below the pilot, and forward, below, behind and beside the engine.

All fuel cells are foam-filled, with a self-sealing sump cell and lower one-third of the aft fuselage cell, and self-sealing wrap for the main fuel line. There is no fuel aft of the fire wall.

Passive defense factors include armor, fuel and hydraulic features (shown). In addition, the A-7D is equipped with radar threat warning and launch-alert ECM systems. The rugged configuration, optimum routing of vital hydraulic and electrical lines, and system and structural redundancy contribute greatly to the aircraft's survivability.







System Safety

System Safety design characteristics expected to result in low attrition:

Major accident rate is predicted to be less than 8 per 100,000 flying hours. This is less than half of the rate for century series aircraft.

- Low landing approach speed
- Excellent low speed flight control and stability
- Uncluttered forward and over-the-side visibility
- Self-retaining bolts in critical control locations
- Antiskid brake system
- No flight controls disconnected for engine removal
- Electrical "Hard/Harness" in critical locations
- Split lockwashers on all electrical terminals for improved security
- Escape system performance considerably better than "zero-zero"
- Extensive use of proven qualified components throughout
- Maintainability considerations in design minimize possibilities of maintenance errors
- High sink landing gear design.