History of the AH-64 Apache

The AH-64 was first known as the Hughes YAH-64. The twin-engine, two place attack helicopter was Hughes Helicopter's* entry in the U.S. Army Advanced Attack Helicopter (AAH) competition which ran from 1973 to 1976. The AAH program was initiated to develop an attack helicopter for antiarmor operations in day, night, and adverse weather conditions with emphasis on the helicopter's ability to be based with the troops in the field. The program was begun soon after the cancellation of the Lockheed AH-56 Cheyenne program. The AAH reflected a reorientation in Army thinking based on combat experience in Vietnam. Both competitors for the AAH award, the Bell YAH-63 and the Hughes YAH-64, first flew in September 1975, and two flying prototypes of each were delivered to the U.S. Army for evaluation in May 1976. The Army selected the Hughes design on 10 December 1976. Hughes was awarded a contract to begin a full-scale engineering development program which commenced in 1977.

The loosing competitor: the Bell YAH-63.

Originally, the YAH-64 featured a T-tail design with the tail rotor mounted mid-way on the vertical stabilizer. The tail was redesigned during the Phase 2 development process into the low-set, fully movable horizontal stabilizer (stabilator) and high mounted tail rotor seen in the production aircraft.

YAH-64 Prototype Number 3 (note the T-tail)

YAH-64 Firing Rockets on the Yuma, Arizona firing range.

Armed with 16 laser-guided precision Hellfire missiles, 76 70mm rockets, or combination of both, and a 30mm automatic cannon with up to 1200 rounds of high explosive dual purpose ammunition, the AH-64A was developed for the U.S. Army to help counter a numerical advantage in Warsaw Pact armored forces.

U.S. Army Apache helicopters played a key role in the 1989 action in Panama, where much of its activity was at night, when the AH-64's advanced sensors and sighting systems were effective against anti-government forces.

Apache helicopters also played a major role in the liberation of Kuwait, destroying vital early warning radar sites, an action that opened the U.N. coalition's battle plan. During Operation Desert Storm, AH-

64As were credited with destroying more than 500 tanks, armored personnel carriers, trucks and other vehicles.

Apaches also demonstrated the ability to perform when called upon, logging thousands of combat hours at readiness rates in excess of 85 percent during the Gulf War. The AH-64A's advanced sensors and sighting systems proved effective in removing the cover of darkness from opposing forces.

The AH-64D Longbow Apache is an upgraded version of the Apache which includes a Fire Control Radar and fire-and-forget Radio Frequency (RF) HELLFIRE missiles. The Longbow features many new systems that put it in the forefront of the digital battlefield. These systems include a digital modem that can data-burst target, route, and friendly and enemy situation information between AH-64D aircraft.

AH-64 Apaches also have helped keep the peace in Bosnia and have been called into service in Albania, Kosovo and Kuwait. Most recently, both AH-64A and AH-64D Apaches have seen service in the Global War on Terrorism in both Afghanistan and Iraq.

* Hughes Helicopters was purchased by McDonnell-Douglas Aircraft which was later purchased by Boeing.

Sources: *Military Helicopters of the World* by Norman Polmar and Floyd D. Kennedy Jr. (1981: Naval Institute Press), and Boeing

Contrary to popular belief, the Fire Control Radar (FCR) is not what makes an AH-64D a "D-Model" Apache. In fact, only about half of the AH-64D aircraft in a Longbow unit actually have FCRs installed. The aircraft in the unit are either DWI or DWO (D model WIth, or D model WithOut, an FCR). A DWI Longbow has the FCR installed above the rotor. A DWO Longbow has nothing above the rotor. But a DWI with the FCR temporarily removed leaves behind a short cylinder above the main rotor which is the de-rotation collar.

AH-64D without, and with, an FCR

De-Rotation Collar left behind after removing FCR

EFAB

The Forward Avionics Bays (FAB) of the AH-64A were lengthened and enlarged to accommodate more electronics and two independent Environmental Control Systems (ECS). The Extended Forward Avionics Bays (EFAB) of the AH-64D extend forward to the TADS/PNVS and to the rear behind and above the trailing edge of the wings. However, the left EFAB is larger than the right EFAB because the right EFAB retained it's level top surface as a step for the crew to get in and out of the aircraft.

AADS Probes

The AH-64A has an Air Data Sensor mounted on top of the main rotor hub. Obviously the ADSS had to be relocated in order to mount the FCR on the AH-64D. On the AH-64D the ADSS is replaced with two Airspeed And Direction Sensors (AADS) mounted on each engine nacelle.

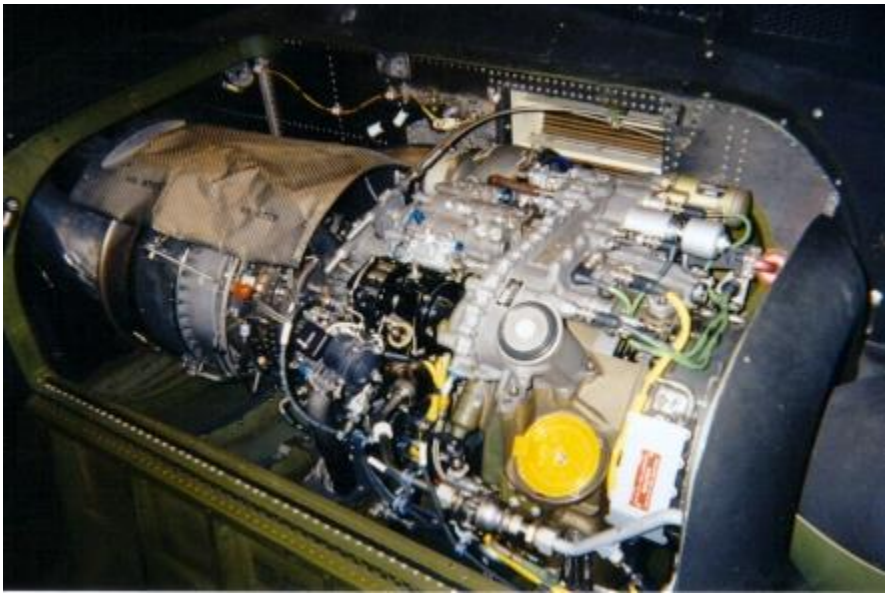
Position/Anti-Collision Lights

The position and anti-collision lights were moved from the wingtips (AH-64A) to the rear of each engine nacelle in order to facilitate installation of air-to-air missiles on the wingtips for export sales customers.

Airframe and Powerplant

GE 701 or 701C Turboshaft Engine

The AH-64 is powered by either two General Electric T700-GE-701 or two T700-GE-701C turboshaft engines. Each engine is capable of producing over 1600 shaft horsepower. Each turboshaft engine produces a rotational force (torque) through its drive shaft, which exits out the front of the engine. The engine's drive shaft ends at the nose gearbox mounted in front of the engine. The nose gear box changes the engine output 90 degrees in order to apply the power to the main transmission. From the main transmission torque is applied to the main rotor and tail rotor drive shafts.



The #2 (starboard) 701C Engine

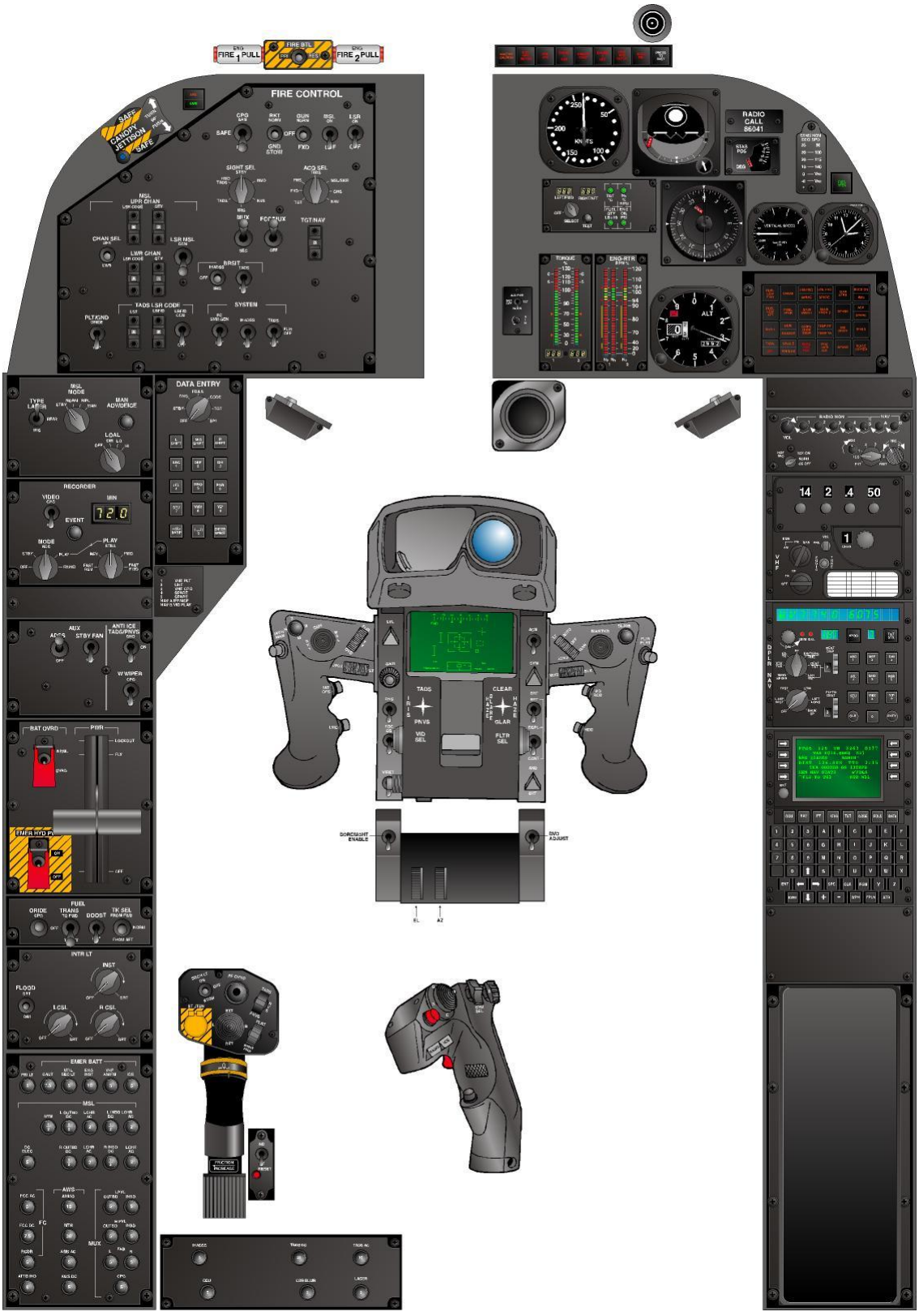
Main and Tail Rotors

The 4 main rotor blades of the AH-64 are part of a fully articulated rotor system. A fully articulated rotor system allows the rotor blades to flap up and down, lead and lag (fore and aft movement), and twist, all in response to aerodynamic forces and the control inputs made by the pilot.

The tail rotor of the Apache has a very unique look. The blades are not oriented 90° (perpendicular) from each other as they are in most helicopters. The rotor system consists of two sets of blades mounted one set in front of the other at a 55° angle. Some say this design makes the blades more efficient. Others say the Apache's tail rotor system was designed to be quieter. However, the unusual arrangement is required because the two sets of blades use a "Delta-Hinge" which allows the blades to simultaneously flap and feather. With this type of hinge, the two sets of blades cannot be mounted perpendicular from each other and still allow for the pitch change links for the outer blades to pass by the the inner blades.

Cockpits

Unlike a two-seat fighter jet where the pilot sits in the front (for better visibility) and the weapons operator sits in the back, the Apache's primary flight station is the backseat. This was necessitated by the long train of optics from the TADS to the copilot/gunner's Optical Relay Tube (ORT). Placing the gunner in the backseat would have required a much longer and complex optical path. Both crew-stations have a complete set of flight controls (although the CPG's cyclic can be stowed). The copilot/gunner's ORT includes both a head's-down (shrouded) and head's-out display. On either side of the ORT are hand grips that mount a variety of TADS sensor, weapons, and target tracking function switches as well as the laser fire trigger and a weapons fire trigger. Each of the crew-station cyclic control stick hand grips also include a weapons fire trigger.



The Copilot/Gunner's (Frontseat) Cockpit

The Pilot's (Backseat) Cockpit

Auxiliary Fuel System

The external fuel tanks were originally designed to give the Apache the capability of self-deploying long distances without the need for refueling. However, combat operations during Desert Storm proved the usefulness of mounting a single external fuel tank while mounting missiles and/or rockets on the other three wing pylons.

Forward Avionics Bay (FAB)

The Apache's unique appearance is due in large part to the FABs which are mounted like cheeks on either side of the aircraft fuselage, (just under the cockpits). These avionics bays house many of the Apache's "black boxes."

Air Data Sensor System (ADSS)

The air data sensor system provides air temperature, and wind speed and direction information to the fire control computer (FCC). The FCC uses this information to make firing corrections (ballistic solutions) for the 30mm cannon and the rockets. This provides for very accurate targeting regardless of any winds.

The sensor is mounted on top of the AH-64A main rotor system. It consists of a temperature probe and a rotating sensor. The sensor rotates at a constant rate. A change in pressure at any point along the rotation of the probe is due to the direction and speed of any external wind.

Sensors, Sights, and Displays

Pilot Night Vision Sensor (PNVS)

The Pilot Night Vision Sensor (PNVS) gives the pilot the capability to fly the Apache at night. The PNVS is a FLIR (Forward Looking InfraRed), or thermal night vision system. Unlike Night Vision Goggles (NVG), a FLIR does not magnify starlight. Instead, it collects the thermal (infrared) energy radiated and reflected from objects. Therefore, the Apache pilot can see at night regardless of the amount of starlight or moonlight.

The PNVS is mounted in a rotating turret on top of the Apache's nose. The IHADSS allows the pilot to command the turret to follow his helmet movement (i.e. look where he is looking), while displaying the PNVS imagery to his eye.

The energy wavelength that the PNVS "sees" is reflected by normal glass and many other visually transparent materials. Therefore, the PNVS and TADS FLIRs use a material called Germanium for their outer lenses. This appears to the human eye to be a highly polished dark gray crystal. But it is transparent to infrared energy.

When not in use, the PNVS turret stows facing to the rear and slightly to the left.

Target Acquisition and Designation Sight (TADS)

The Target Acquisition and Designation Sight (TADS) is the CPG's tool for locating, identifying, and tracking targets. It is a large barrel shaped turret mounted below the PNVS. It is divided into the *Day-Side* and the *Night-Side*. The Night-Side houses a FLIR sensor similar to the PNVS. The TADS FLIR however has a magnification capability. The CPG uses the TADS FLIR to find and engage targets at night. The TADS Day-Side houses a day TV camera (with 125x magnification), direct view (telescope) optics, a laser rangefinder/designator, and a laser spot tracker.

The laser rangefinder/designator is a high powered laser used to give the Apache's Fire Control Computer (FCC) accurate range information for ballistic solutions for firing the 30mm chain gun and rockets. Furthermore, it provides the laser guidance for the HELLFIRE missiles. The laser spot tracker is used to find specific laser energy on the battlefield. One aircraft can "point" to something (e.g. a target) and direct another aircraft to use its laser spot tracker to "look" at the same spot.

The CPG will also use the TADS FLIR in conjunction with his IHADSS in the same way as the pilot uses the PNVS in order to navigate at night and provide a back-up for the PNVS. Because the large TADS turret is slower then the PNVS turret, and because its FLIR image is not as good as that of the PNVS, it is not the primary night vision system for flying the aircraft.

While performing target engagements, the CPG uses his Optical Relay Tube (ORT) to view the imagery provide by the TADS. For more information about the ORT, read about the CPG's cockpit.

When not in use, the TADS turret stows facing to the rear.

Integrated Helmet and Display Sight System (IHADSS)

The Integrated Helmet and Display Sight System (IHADSS) is probably the most unique feature of the Apache. Unlike Night Vision Goggles (NVG) which are mounted on a pilot's helmet in front of his eyes (like wearing very big glasses), a FLIR is a relatively large and heavy system that cannot be helmet

mounted. Therefore, the imagery from the FLIR must be presented to the pilot's eyes using a separate display system. Furthermore, the pilot must be able to direct where the FLIR is pointing.

The imagery from the FLIR is presented to the pilot through a 1 inch TV picture tube mounted on the right side of his helmet. The image from the TV tube is reflected off a small lens in front of the pilot's right eye. Therefore, the pilot flies with one eye night vision "aided" while the other eye is unaided.

In order to command the movement of the sensor turrets (PNVS and TADS), each of the cockpits has two infrared scanners mounted behind and above each side of the crew seats. These scanners sweep the cockpit interior with timed infrared energy. Four small receivers mounted on the crew helmets detect the infrared energy. A computer calculates the position of the helmet by comparing the reception time of each receiver with the transmission time (sweep) of the scanners. The PNVS or TADS turret is then commanded to move in elevation and azimuth to match the position of the applicable crew member's helmet position. In this way the sensor looks where the pilot or CPG looks.

(This same system is used to command the 30mm chain gun to move with the pilot's or CPG's visual line-of-sight. This enables either crew member to simply look at a target and squeeze the trigger to put rounds on the target.)

In order to learn how to fly the Apache using this unusual night vision system, students first fly during the day in "The Bag." The pilot's cockpit is enclosed by a tarp which allows no outside light to come into the cockpit. The instructor pilot meanwhile remains unhampered in the CPG's cockpit. The student must rely entirely on the imagery and symbology provided by the FLIR and IHADSS to fly the aircraft. It is a great confidence builder (although everyone has their own horror story to tell). Furthermore, it is much safer to train when at least one crew member is operating under daylight conditions.

THE BAG!

AH-64 Weapons and Armament

AGM-114 HELLFIRE Missile

The HELLFIRE missile is the primary weapon system of the AH-64 Apache. The HELLFIRE is a laser guided antitank missile capable of destroying armored and other hard targets at ranges up to 8 kilometers. Coded laser energy for missile guidance can be provide by a ground laser designator, or an airborne laser from an OH-58D or the AH-64 itself.

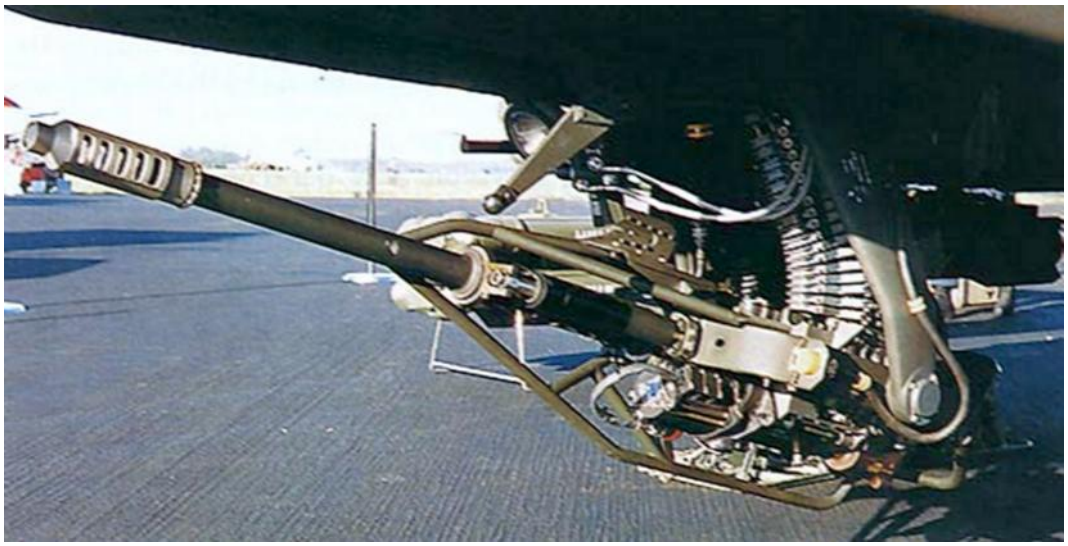
A complete complement of 16 missiles (8 on each wing). Note the nose glass dome protecting the laser seeker.

Often, Apaches will carry dummy or training missiles. Dummy missiles are the same size and weight of the real missile and are used to simulate a combat load for weight, center-of-gravity, and aircraft performance. Training missiles have a fully operational laser seeker and allow Apache crews to simulate launching a missile.

A HELLFIRE on its way!

30 mm Chain Gun (M230)

The Apache's 30mm gun is an area fire weapon used to suppress targets at close (up to 4 kilometer) ranges, it is capable of destroying lightly armored targets like armored personnel carriers (APCs) and air defense artillery (ADA) systems. The gun fires a High Explosive Dual Purpose (HEDP) ammunition. The gun fires 650 rounds per minute (fast for a single barrel gun), and can carry a maximum of 1200 rounds in the magazine located in the belly of the aircraft. The gun is capable of moving left and right in azimuth up to 86 degrees from the nose of the aircraft, as well as elevating 11 degrees and depressing 60 degrees. The gun can be aimed by the copilot gunner using the TADS day or night sensors, or by either pilot using the IHADSS helmet mounted sight. The term "chain" gun refers to the chain drive that drives the gun's firing cycle.



The expended 30mm shell casings fall away as the gun fires.

2.75" Rockets (FFAR)

The 2.75 inch Folding Fin Aerial Rockets (FFAR) are an area target weapon system. Rockets are used to suppress the enemy as well as destroy light skinned vehicles and other "soft" targets at ranges out to 7.5 kilometers. The rockets can be fired as singles, pairs, or in quantities of 4, 8, 12, and all. The 2.75" refers to the diameter of the rocket and is also known as the Hydra 70 (70mm) rocket. The rockets can carry a variety of warheads including high explosive, smoke, and the more common multi-purpose submunition (MPSM). The MPSM warhead delivers 9 high explosive dual purpose "bomblets" that rain down on the target area. The submunitions "burn" through light armor as well as produce a fragmentary explosion.

Each rocket pod can hold 19 rockets. Normally, each Apache will carry a maximum of two rocket pods for a total of 38 rockets.

An AH-64A fires 2.75" FFARs in a dive.

Stinger Missiles

Although US Army units currently do not employ Stinger air-to-air missiles on the Apache, they can be mounted on the wing tips with minor modifications. The Stinger is a small infrared anti-aircraft missile (heat seeker) most often deployed as a man-portable shoulder launched missile.