

COMANCHE (RAH-66)



Army ACAT ID Program

Total Number of Systems:	1,213
Total Program Cost (TY\$):	\$47.8B
Average Unit Cost (TY\$):	\$30.3M
Full-rate production:	1QFY07

Prime Contractor

Boeing/Sikorsky

SYSTEM DESCRIPTION & CONTRIBUTION TO JOINT VISION 2020

The RAH-66 Comanche is a twin-engine, two-pilot light attack/armed reconnaissance helicopter being developed for the U.S. Army by a joint venture comprising Boeing Defense and Space Group, Helicopters Division, and Sikorsky Aircraft Division of the United Technologies Corporation. The Comanche features a five-bladed bearingless main rotor, a shrouded tail rotor, a low Radar Cross-Section (RCS) composite fuselage with retractable weapons pylons, a fly-by-wire flight control system, and a fully integrated cockpit. The Mission Equipment Package (MEP) incorporates a radar and forward-looking infrared and image-intensified television sensors for night flying and target acquisition. The Comanche will initially be armed with the Hellfire missile, the air-to-air Stinger missile, 2.75-inch aerial rockets, and a turreted 20mm gun.

The Comanche is intended to replace OH-58 helicopters in attack and most cavalry units and the AH-64 Apache in the reconnaissance role in the heavy attack units. The Comanche is a highly survivable, *dominant maneuver* platform that leverages *information superiority and precision engagement* to provide an element of *full-dimensional protection* to the ground maneuver force.

BACKGROUND INFORMATION

The development of the Comanche helicopter began in 1983 when it was first called the Light Helicopter Experimental (LHX). In the early 1980s, the LHX was envisioned to be a family of low-cost, lightweight helicopters that could come in a scout, utility, or attack version. Originally, all versions were to be single-seat aircraft, but by 1988, the Army chose a two-seat concept, decided on a single version (combined armed reconnaissance and attack), and reduced the planned acquisition from 4,292 to 2,096. Force structure changes and increased costs subsequently decreased the acquisition quantity to 1,213.

The Milestone (MS) I ADM (1988) and TEMP envisioned an operational evaluation of an integrated system before MS II. However, the program has been subsequently restructured several times, primarily as a result of funding reductions. The most severe reduction in funding occurred in the 1994-1995 timeframe. As a result, the program schedule was extended significantly. Although some funding has been returned, the program has never fully recovered from the turbulent funding stream. Many developmental activities were delayed and over the course of time compressed up against MS III. Many of the program issues experienced today are predictable results of the 1995 "survival mode" restructure. Consequently, testing up to now has been largely restricted to individual sub-systems or surrogates of those sub-systems.

First flight of one of the two prototype aircraft constructed during PDRR occurred in January 1996. A fully integrated aircraft is not currently scheduled to be available until FY05. An updated TEMP was approved by OSD in February 2000. The program entered the EMD stage following a DAB-level MS II decision in April 2000; MS III and Initial Operational Capability are scheduled for December 2006.

The Comanche program was designated an LFT&E system in November 1989. The LFT&E strategy was approved in fall 1995, and was recently revised as part of the updated TEMP in February 2000.

TEST & EVALUATION ACTIVITY

Test and evaluation activities, which focused on supporting the program's MS II DAB review, consisted of a TEMP update and a series of technical demonstrations, largely at sub-component level, conducted at the end of 1999 and in early 2000 primarily to show that MS II exit criteria were met. (The MS II exit criterion categories were Vertical Rate of Climb (VROC), Forward Looking Infrared Recognition Range, Radar Cross Section, Infrared Signature, Ballistic Vulnerability, Supportability, and Comanche Radar (CR) performance.) The associated tests, designed and conducted by the system contractor and witnessed by the government, were expected to prove a degree of sub-system maturity prior to the MS II decision.

Although not a test and evaluation activity *per se*, system evaluators observed a 3-week Force Development Experiment that used a simulator called the Comanche Portable Cockpit to develop and refine crew tactics, techniques, and procedures for the aircraft.

TEST & EVALUATION ASSESSMENT

Considering the history of the program as described in the Background Section of this review and the MS II Exit Criteria test data, it is highly unlikely that the Service can deliver the expected system performance within the current budget and schedule. Lacking an operational assessment of an integrated system, it is difficult to predict with any degree of confidence whether the individual subsystems can be successfully integrated, whether the subsystems will function properly in an operational environment, or whether, in concert, they will provide the anticipated benefits in operational performance.

For this assessment, the MS II exit criteria data were analyzed in terms of their contributions to the objectives of the developmental program and to address other areas of technical risk that could significantly affect achieving the program objectives. The results of the MS II exit criteria testing were encouraging, but areas of concern remain. One of the MS II exit criteria for the CR was not demonstrated, and the CR's performance against stationary targets is a particular concern. Other important issues include the potential impact of: (1) aircraft weight growth on flight performance, (2) vibration and lack of directional stability and the effect of these on flight performance and target acquisition, (3) aircraft reliability, and (4) the ability to integrate the many MEP components effectively.

Comanche Radar Performance. During the program restructure in 1998, the Service moved the development of the CR forward in time five years and added MS II exit criterion for radar development. The CR MS II exit criterion was for Comanche to achieve the specified probability of detection (P_d) and probability of correct classification (P_{cc}) of at least 80 percent of the moving target performance range specified for "typical threat vehicles." An expedient test article was assembled, consisting of the one-of-a-kind developmental electronically steered antenna (ESA) and an early model Longbow radar. This system was a development testbed, not a production prototype of the objective system, and it is expected that few components of the test article (hardware or software) will be common to the objective system. To reduce cost and disruption to system development activities, the test was performed with the radar mounted on a tower located near Baltimore-Washington International Airport. The use of these expedient facilities allowed only helicopters as moving targets and, for reasons of availability, a UH-1 helicopter was used as a surrogate for all air and ground moving targets. In this test, the CR failed to meet the P_d exit criterion, achieving 49 percent (vice 80 percent) of the required range because of excess losses in the ESA and lower target RCS than predicted. During subsequent testing at Yuma Proving Grounds using tank targets, the CR did demonstrate performance that exceeded the MS II exit criterion for P_d . Because only one target type was available for each test, the P_{cc} estimates that were produced were not meaningful and could not be compared to the P_{cc} exit criterion.

Although the contractor is on a path to identify ESA problems and improve moving target detection performance, stationary target detection performance is a significant, and yet untested, program issue. A validating data collection campaign has been planned for 2002.

Weight Growth Impact on Flight Performance. There is a concern that weight increases will prevent the aircraft from meeting its VROC requirement. Provided the production aircraft does not exceed the predicted empty weight of 9,300 pounds by more than (approximately) 115 pounds, it should achieve the MS III VROC requirement (500 feet per minute), if weight growth exceeds that which is now forecasted then it will not. DOT&E's assessment of the Comanche's weight projections found several questionable areas, including overly optimistic expected weight reductions and questionable estimates of future weight growth. Overall, DOT&E concluded that, although the contractor may achieve 80 percent of their projected weight savings, the helicopter's weight will grow more than anticipated, and thus the final weight may be approximately 9,500 pounds. If this occurs, DOT&E estimates that the aircraft's

VROC under the stated conditions will be approximately 430 feet per minute, rather than the required 500 feet per minute.

Vibration and Directional Stability. Flight-testing associated with envelope expansion has gone well. The prototype aircraft's demonstrated flight envelope significantly exceeds that of the OH-58D, which should result in improved operational capability. As an example, increases in forward, rearward, and lateral airspeeds would allow the Comanche to take off and hover at higher crosswind speeds than the OH-58D, with attendant improvements in maneuverability and controllability.

However, challenges remain. Flight-testing revealed a noticeable tail buffet as the aircraft's speed reached 80 to 100 knots. Although this does not immediately and directly affect flight safety, it is clearly undesirable from the user's perspective (vibration levels may interfere with weapon targeting, and buffet loads can contribute to tail structural fatigue). A reshaped pylon, first flight tested in 1999, reduced tail buffeting but compromised directional stability. Additional corrective changes have been identified and evaluated in wind tunnel testing, but have not been flight-tested. Furthermore, these corrective actions may have unintended consequences such as increased aircraft weight or increased RCS. Also, later aircraft will be equipped with larger rotors (an increase of one foot in diameter) and blades fitted with anhedral tips. At this point, it is difficult to predict what effects the CR, larger rotor, and blade tip changes will have on the tail buffeting/directional stability problems.

MEP Integration. Overall, the Comanche has a risky test and evaluation strategy for integrating the MEP components on the aircraft. Most testing involving the integration of the complete MEP on the aircraft will not occur until the end of the EMD phase. The resulting schedule compression allows little reserve in the timetable, thereby increasing the impact of unforeseen events/delays.

Comanche Reliability. Given the importance of reliability to the eventual assessment of the Comanche's operational suitability, this issue received considerable scrutiny at the MS II review. Although the program office/contractor has put into place a comprehensive system to identify and correct failure modes, corrective actions for identified failure modes generally will not be implemented except at several discrete points in time, because of the compressed developmental schedule. Because of this lag in applying fixes, it will be difficult to demonstrate improvements in aircraft's reliability by means of testing. Consequently, there will be little evidence that Comanche will meet its reliability requirements before the MS III decision.

Ballistic Vulnerability. The LFT&E MS II Exit Criteria Ballistic Vulnerability tests demonstrated structural damage tolerance potential for five critical components via ballistic impact, followed by structural fatigue testing and/or analysis. The MS II exit criterion called for damage tolerance potential, to be demonstrated via ballistic testing against the primary threat and engineering analysis for the main rotor flexbeam, fuel tank panel, composite panels, main rotor mast, and fantail drive shaft. The goal was to demonstrate component ability to maintain safe operation, following ballistic impact, for a minimum of 30 minutes. The plan was to conduct ballistic testing against the primary API threat under static loading, and to perform post-impact fatigue and residual strength tests. The initial ballistic damage characterization and subsequent damage growth was to be determined both visually and using ultrasonic, non-destructive inspection (NDI) techniques.

The main rotor flexbeam and the fantail drive shaft components were tested under simulated flight loads during ballistic impact, evaluated for post-impact fatigue and residual strength, and subjected to NDI of the damaged articles. The fuel tank panel test consisted of a ballistic impact into the fuel tank of the full-scale static test article filled (two-thirds level) with water to determine the hydrodynamic ram effects on the fuel tank structure and surrounding support structure. A visual inspection was made

subsequent to the ballistic impact. The remaining two components (main rotor mast and composite panels) were supported in a realistic representation of the actual vehicle configuration, but were not loaded at the time of impact. Structural damage during the ballistic tests was monitored visually. These components did not include a post-test structural investigation. The composite panels included ultrasonic NDI. The post-impact investigation of these two components consisted of a review of the damaged specimen and a correlation of this damage against the contractor's predictive methodology to determine residual strength.

More recently, the contractors initiated an additional series of Risk Reduction ballistic and structural tests on evolving design configurations for several major components (i.e., main rotor blade and mast, tailcone and shroud, composite panels and Fantail) against larger caliber threats. The purpose for the redesign of these components is to reduce weight and cost.

The remainder of the LFT&E program includes component qualification and subsystem level ballistic testing for 27 critical components, as well as full-up system level dynamic testing on a pre-production-configuration aircraft. However, because of the compressed nature of the EMD phase, it will be extremely difficult to correct any weaknesses discovered during the LFT&E, and there is a schedule risk to accomplish the stated goals of the ORD.

Risk Mitigation. To help manage these risks, OSD directed that there would be two OIPT-level Interim Decision Reviews for the Comanche program: the first in January 2003 and a second in January 2005. These reviews will focus on MS II concerns (weight growth, flight performance, CR performance, reliability, and MEP integration), test results, and schedule execution.

