

CH-47F Block II Chinook

Executive Summary

- The Army plans to execute the CH-47F Block II Limited User Test (LUT) in 3QFY21.
- The Program Office has been using three CH-47F Block II Engineering Development Model aircraft as test platforms. The Program Office has used a System Integration Laboratory (SIL) for software testing and a ground test vehicle (GTV) for dynamic testing of aircraft components.
- The CH-47F Block II completed a total of 387 developmental flight testing hours in FY20.
- The most recent Advanced Chinook Rotor Blade (ACRB) design is meeting increased power requirements during both in and out of ground effect hover testing. The ACRBs demonstrated a 2,300-pound increase at 95 degrees, 4,000 feet pressure altitude. This ACRB is producing excessive vibrations in various flight profiles across the Block II's performance envelope. Aircrews reported prolonged fatigue and other physiological conditions due to excessive vibrations.
- The CH-47 Block II LFT&E program is behind schedule. Design changes needed to correct performance deficiencies, parts availability, and the availability of a specialized test facility will delay multiple live fire test events until after Milestone C.
- The redesigned Block II fuel cell failed the Phase II qualification testing and the fuel system contractor must redesign and manufacture a new fuel cell for qualification prior to future live fire evaluation of the fuel systems.

System

- The CH-47F is a twin-turbine, tandem-rotor, heavy-lift transport helicopter designed to transport 31 combat troops, artillery, and equipment up to 16,000 pounds.
- General Support Aviation Battalions assigned to Combat Aviation Brigades use the CH-47F to support operational requirements across the battlespace. Each Combat Aviation Brigade is authorized 12 CH-47F helicopters.
- The CH-47F Block II is a modernization of the CH-47F Block I. The CH-47F Block II is a consolidation of post-production modifications made on CH-47F Block I production aircraft as well as new advancements unique to the CH-47F Block II.
- Major system improvements include:
 - Reduced weight ballistic protection system



- Redesigned flight control system; Digital Automatic Flight Control System (DAFCS)
- Upgraded drive train system; Improved Drive Train (IDT)
- New rotor blade design; ACRB
- Redesigned fuel system; Lightweight Fuel System (LFS)
- Updated Common Avionics Architecture System (CAAS)
- The Army's objective is to purchase 464 CH-47F aircraft.

Mission

The CH-47F Block II supports the Army's requirement for a heavy lift helicopter to execute full spectrum operations. A unit equipped with the Chinook provides heavy lift capability to accomplish critical tasks across the operational environment including air assault, air movement, casualty evacuation, aerial recovery, and area resupply. The Chinook's range, speed, and lift capacity allows for operational flexibility. Depending on mission requirements, the CH-47F can be employed individually, in multi-ship formations, or as a company.

Major Contractors

- Aircraft: Boeing Helicopter Company – Ridley Park, Pennsylvania
- Software: Rockwell Collins – Cedar Rapids, Iowa
- Fuel System: Meggitt Polymers and Composites – Rockmart, Georgia

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Activity

- The CH-47F Block II program has conducted all testing in accordance with the DOT&E-approved Test and Evaluation Master Plan to include the LFT&E Strategy.
- The coronavirus (COVID-19) pandemic has had a minor effect on the CH-47F Block II program. The Program Office adjusted some test events, but the overall program schedule has not been affected.
- The Program Office has been using three CH-47F Block II Engineering Development Model aircraft as primary test assets, which include all Block II modifications. The program has been using the SIL to support software testing, and a GTV to support dynamic testing of aircraft components.
- The CH-47F Block II completed a total of 387 developmental flight testing hours in FY20.
- The CH-47F Block II Program Office has tested the aircraft across the flight envelope to understand the performance of the improved drive train, the new ACRB, redesigned rotor assembly, and numerous structural changes. The aerodynamic effects of these design changes vary across the Block II's flight envelope.
- Previously, the Army conducted the following testing in accordance with the LF strategy.
 - In FY18, the Army performed the following testing:
 - Qualification and live fire testing of two versions of lighter-weight Cargo On/Off Loading System (COOLS) integrated floor armor. The lightest-weight armor was designed to match the performance of the currently fielded armor, while the other armor was designed to defeat a more energetic threat.
 - Ballistic testing of static segments of the ACRB to characterize the type and extent of damage caused by combat representative threats. The Army plans to begin quasi-static testing of ACRB segments under representative loads in March 2021. The Army will develop detailed test plans for dynamic blade testing on the GTV in FY21 based upon the results of the quasi-static tests.
 - In FY19, the Army conducted ballistic testing of the Ferrium® C61™ steel increased strength rotor shaft test coupons.
- In December 2019, the Army conducted ballistic testing of the rotor pitch control links for both Block I and Block II CH-47F configurations.
- In August 2020, the contractor executed Phase II qualification testing of the new fuel cell design.
- In coordination with DOT&E, the Army completed the live fire test plan to evaluate the drive shaft vulnerabilities to kinetic threats. Testing is scheduled to start in 1QFY21.
- In July 2020, in coordination with the Common Infrared Countermeasures (CIRCM) program, the Program Office supported the developmental testing of CIRCM, the Army's next generation of aircraft survivability equipment. For more information on the CIRCM program, see the article on page 75.

- In August 2020, the CH-47F Program Office completed a cooperative vulnerability identification event intended to identify potential cybersecurity attack vectors to be explored during the cooperative vulnerability and penetration assessment scheduled in conjunction with the CH-47F Block II LUT in 3QFY21.

Assessment

- The ACRB has undergone multiple redesigns during developmental testing of the CH-47F.
 - The initial ACRB designs were stable but did not provide the power improvements predicted by computational models.
 - The most recent ACRB design is meeting increased power requirements during both in and out of ground effect hover testing. The ACRBs demonstrated a 2,300 pound increase at 95 degrees, 4,000 feet pressure altitude environmental conditions compared to the legacy CH-47F fiberglass rotor blades.
 - The most recent ACRB design produces excessive vibrations in ground, hover, and forward flight that may cause a safety of flight risk. Aircrews reported prolonged fatigue and other physiological conditions due to excessive vibrations following a developmental test flight using the redesigned ACRB's. The Program Office is examining the issue and determining the potential effect of the program's LUT in 3QFY21.
- Both weights of the COOLS armor performed better than the original COOLS armor, and both outperform the CH-47F design specification.
- Preliminary analysis indicates that rotor shaft and pitch control links provide at least equivalent resistance to kinetic threats as the legacy hardware.
- The fuel cell failed to self-seal during Phase II qualification testing and the sponson sustained substantial damage. The CH-47F fuel system contractor needs to redesign and requalify the fuel cell and the sponson needs to be repaired prior to any live fire testing of the fuel system on the ballistics fuselage test article.
- The GTV incurred structural damage during dynamic drive train testing. Unless adequately repaired, this may limit the extent of the dynamic ballistic testing of the ACRB blades.
- The LFT&E program is behind schedule due to design changes to correct performance deficiencies, parts manufacturing and availability, and specialized contractor test facility availability:
 - Required fatigue and dynamic GTV testing of the ACRB will not be complete until after Milestone C (April 2021).
 - Engine fire suppression system testing is not currently scheduled but is expected after Milestone C.
 - Dry bay fire testing is not currently scheduled.
- Combined with the results of fuel cell qualification testing, the delay of several live fire tests until after Milestone C increases program risk.

Recommendations

The Program Office should:

1. Determine the root cause of ARCB-related aircraft vibrations and make any necessary changes to the blade or aircraft design.
2. Complete the approved LFT&E program in a timely fashion so all required data are available for continued program development.
3. Implement the necessary design changes to the fuel cell and sponson and requalify the design prior to live fire testing on the GTV.

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