CH-53K – Heavy Lift Replacement Program

Executive Summary

- The Navy continues CH-53K flight testing, using the four Engineering Development Model (EDM) aircraft, three system demonstration test articles (SDTA), and the Ground Test Vehicle (GTV). The seven flyable aircraft have flown 1,536.3 flight hours as of September 30, 2019.
- The CH-53K Test and Evaluation Master Plan (TEMP) revision C indicated IOT&E would occur in 2019. Current projections estimate that IOT&E will start in 2021. The Navy is working through and implementing corrections to multiple design deficiencies discovered during early testing. These include: airspeed indication anomalies; low reliability of main rotor gearbox; hot gas impingement on aircraft structures; tail boom and tail rotor structural problems; overheating of main rotor dampers; fuel system anomalies; high temperatures in the number 2 engine bay; and hot gas ingestion by the number 2 engine.
- The Program Office reduced flight test productivity due to reallocation of funding in FY19. The Program Office has since received additional funding to complete enough developmental testing to enter IOT&E with a Key Performance Parameter (KPP) compliant system.
- The Program Office deferred the remainder of the LFT&E program until 2QFY20 due to insufficient funding. Preliminary assessment indicates the CH-53K is on track to meet the survivability KPP and that CH-53K is more survivable than the legacy CH-53E aircraft for a subset of operationally representative threats. The assessment of the CH-53K survivability across the expected combat engagement envelope is contingent upon the completion of the LFT&E program as described in the LFT&E strategy.

System

- The CH-53K is a new-build, fly-by-wire, dual-piloted, three-engine, heavy-lift helicopter slated to replace the aging CH-53E. The CH-53K is designed to carry 27,000 pounds of useful payload (three times the CH-53E payload) over a distance of up to 110 nautical miles, climbing from sea level at 103 degrees Fahrenheit to 3,000 feet above mean sea level at 91.5 degrees Fahrenheit.
- The CH-53K design incorporates the following survivability enhancements:

  - Large Aircraft Infrared Countermeasures with advanced threat warning sensors (combines infrared, laser, and hostile fire functions into a single system), an AN/APR-39C(V)2 radar warning receiver, and an AN/ALE-47 countermeasure dispensing system
  - Pilot armored seats, cabin armor for the floor and sidewalls, fuel tank inerting, self-sealing fuel bladders, and 30-minute run-dry capable gear boxes
- The Navy intends the CH-53K to maintain a shipboard logistics footprint equivalent to that of the CH-53E.

Mission

Commanders employ the Marine Air-Ground Task Force equipped with the CH-53K for:

- Heavy-lift missions, including assault transport of weapons, equipment, supplies, and troops
- Supporting forward arming and refueling points and rapid ground refueling
- Assault support in evacuation and maritime special operations
- Casualty evacuation
- Recovery of downed aircraft, equipment, and personnel
- Airborne control for assault support

Major Contractor

Sikorsky Aircraft (a Lockheed Martin subsidiary company) – Stratford, Connecticut

Activity

- The Navy is testing in accordance with the DOT&E-approved TEMP and a DOT&E-approved 2010 Alternative LFT&E plan. The program has seven flyable aircraft to support integrated developmental and operational flight testing. The contractor has delivered three of the four SDTAs, all of which are participating in the test program. The seven flyable aircraft have flown 1,536.3 flight hours as of September 30, 2019. SDTA-4 will arrive at Marine Corps Air Station New River, North Carolina, in January 2020.

- The Program Office reduced flight test productivity due to insufficient funding in FY19. The Program Office has since received additional funding to complete enough developmental testing to enter IOT&E with a KPP compliant system. Technical problems have delayed IOT&E by 25 months to 2021.
- The Navy transported the GTV via a transportability demonstration on a C-17 airlifter to China Lake, California. The Navy is developing live fire test plans to support testing of the GTV and cabin armor at China Lake. The GTV will be the test article for system-level LFT&E projected for 3QFY20.
- Final assembly of all CH-53K aircraft has transitioned from West Palm Beach, Florida, to its Stratford, Connecticut, facility for the low-rate initial production (LRIP) and full-rate production aircraft. Sikorsky halted production of SDTA-5 and SDTA-6.
- The Navy has initiated several design changes to address deficiencies discovered during testing:

Engine Integration

- The Navy has identified engine exhaust gas re-ingestion (EGR) as a significant technical deficiency to be solved prior to IOT&E. In addition to EGR, the program is addressing exhaust gas impingement on the skin of the aircraft. A third challenge related to EGR is engine bay overheating, which requires improved airflow to cool without adversely affecting the ability to extinguish potential engine fires.
- The CH-53K Integrated Test Team (ITT) collected baseline aircraft airwake and thermal data that closely matched predictions made by a government-owned Helios computational fluid dynamics (CFD) model. DOT&E conducted a deep dive with the members of Naval Air Warfare Center – Aircraft Division who write and use the modeling code to review the model and its results.
- The program selected several prototypes for fabrication and installation on flight test aircraft. Aircraft modifications began in October 2019, and initial developmental flight test events will begin in December 2019. The prototype designs will be installed on the aircraft that operational testers will fly during IOT&E.

Main Gearbox (MGB)

- The program improved the design of the MGB after qualification tests found the first EDM MGB designs to be much less durable than required. The ITT installed the improved design MGB on one aircraft, and resumed flight testing in May 2019. The ITT will install an additional MGB on a second aircraft by November 2019.

Tail Rotor Flexbeam

- Early flexbeam composite material designs delaminated during flight test efforts. Sikorsky has improved the flexbeam manufacturing process, and recent analyses are favorable that the new flexbeams may meet the requirement. The ITT installed the new flexbeam in May 2019 and returned to flight test.

Main Rotor Damper

- The dampers, which are designed to reduce vibration loads in the main rotor system, experienced load spikes due to several design characteristics. Sikorsky is redesigning the dampers, and the ITT anticipates installing and testing the new dampers in January 2020.

Intermediate Ground Mode during Aircraft Launch

- A failure condition occurred during flight test events when the aircraft transitioned from ground to flight. This condition could result in the pilots losing control of the aircraft. The program completed several design changes in the flight control software, and will add an override switch to allow the pilots to select the flight control laws manually prior to takeoff. The ITT intends to begin flight test events in February 2020.

- The program has made a design change to the Aircraft Survivability Equipment (ASE) that relocates the Guardian Laser Turret Assemblies (GLTA) infrared jammers due to interference from the aircraft engine exhaust plume. The design change will not be available for IOT&E. The Navy will use an incomplete ASE suite that lacks GLTAs during IOT&E and subsequent Initial Operational Capability decision. The Navy intends to test the full ASE suite in FOT&E and retrofit it to the fleet as it becomes available. The first deployment of CH-53Ks will have the full ASE suite installed. DOT&E is collaborating with the Navy and other stakeholders to determine the specific IOT&E entry criteria.
- The test team discovered maintenance procedure shortcomings that the program corrected for future use in the test program. The test team also discovered that components in the fuel system were repaired with processes that may contribute to premature failure of the components. The program is analyzing the repair procedures in collaboration with Sikorsky.
- In FY19, the Program Office halted the LFT&E program due to a reallocation of funding. Phase I of the approved LFT&E program is scheduled to resume in 2QFY20. Phase II of the LFT&E program, testing objective and more operationally relevant threats, has not yet been funded.

Assessment

- Rebaselined projections estimate that IOT&E will begin in 3QFY21 due to technical problems that have extended System Development and Demonstration (SDD) beyond original projections.
- IOT&E entry criteria should describe which capabilities must be available for IOT&E and which may be deferred to FOT&E. While it is not unusual for programs to make corrections and improvements to systems after IOT&E, those additions need to be tested during an FOT&E period prior to deployment.
- The Helios CFD represents a “Best in Class” modeling tool with extensive processing capacity and rapid analytical results. The Navy’s design strategy and prototype selections offer the greatest potential to solve EGR while mitigating the risks

of design uncertainty and schedule by conducting flight test events with the installed prototype designs.
- Transmission Time-Between-Overhaul will increase as the ITT conducts test events with the new MGB design installed and subsequent maintenance inspections are completed.
- CH-53K will not have the solution available for every technical deficiency before IOT&E. The program intends to incorporate corrections for 106 of 126 known technical problems into the CH-53K to support IOT&E. IOT&E aircraft are required to be production representative. Some of these missing corrections will be represented by prototype installations, such as EGR components that are fabricated from stainless steel instead of the intended final materials. Other corrections will not be available, such as full defensive electronic countermeasures functionality and relocation of the GLTAs.
- CH-53K ITT is in the process of recovering the Sikorsky manpower it lost earlier in the fiscal year. At the September 13, 2019, bi-weekly update to the Program Executive Office, Air, ASW, Assault, and Special Mission Programs (PEO(A)), Sikorsky presented ITT manpower staffing plans that show their maintenance personnel requirements will be fully staffed by January 2020. Work force shortfalls are mitigated by the extensive use of temporary duty personnel and overtime.
- Government ITT manpower losses have fully recovered.
- Maintenance and component repair deficiencies have resulted in lower flight test productivity. The ITT depends on consistent flight test execution, not only to maintain progress toward IOT&E, but also to allow newer flight test pilots and engineers to gain the experience necessary to conduct more complex flight test events.
- Preliminary assessment of the available Phase I LFT&E revealed some design vulnerabilities but largely demonstrated that the CH-53K is more survivable than the legacy CH-53E against most small-arms, automatic weapons fire, and legacy man-portable air-defense system threats. The CH-53K is on track to meet the survivability KPP if mitigations to address deficiencies uncovered in testing are successful. This includes a self-sealing coating for the main gearbox lubrication sump, which the Navy is currently investigating.
- Phase II of the LFT&E program is essential for a survivability assessment of CH-53K against other, stressing yet operationally relevant threats. This phase also includes component tests for the main rotor assembly and tail rotor hub against threshold threats, originally scheduled to support the Milestone C decisions. Any deficiencies identified in this phase of testing will need to be addressed after Initial Operational Capability, likely with engineering change proposals.

Recommendations

The Navy should secure additional funding to:

1. Complete the SDD phase of the program.
2. Complete the LFT&E program as described in the LFT&E strategy.
3. Develop a sustainable FOT&E test program to evaluate deployment capabilities that will not be tested in IOT&E. The FOT&E test program should also verify that any changes to the aircraft to correct deficiencies are effective and suitable.
4. Continue to investigate mitigations to address design deficiencies identified in test.