

CH-53K - Heavy Lift Replacement Program

Executive Summary

- The Navy's Operational Test and Evaluation Force (OPTEVFOR) conducted its operational assessment (OA) of the CH-53K at Sikorsky's West Palm Beach, Florida, facility and completed it on October 19, 2016.
- DOT&E published its "CH-53K Heavy Lift Replacement Program" OA and LFT&E report in February 2017 to support the Defense Acquisition Board CH-53K Milestone C decision.
- The OA indicated that the CH-53K has the capability to support the Amphibious Pre-Assault/Raid Operations mission, the aircraft's most stressing mission profile.
- The CH-53K demonstrated 84.8 percent mission reliability during testing up through the OA, which is greater than the required value of approximately 83 percent at that point in its projected reliability growth.
- The Defense Acquisition Executive approved the CH-53K program's Milestone C and entry into low-rate initial production (LRIP) on February 28, 2017.
- Flight testing continues, using the four Engineering Development Model (EDM) aircraft and the Ground Test Vehicle (GTV). The four EDM aircraft have flown 552.6 flight hours as of September 30, 2017. Delivery of the first of six system development test article (SDTA) aircraft is imminent. SDTA aircraft will join the test program leading to IOT&E, which will use the SDTAs.
- After completion of the fourth SDTA in West Palm Beach, final assembly of the last two SDTAs and LRIP aircraft will relocate to the Sikorsky facility in Stratford, Connecticut. All future CH-53Ks, including full-rate production aircraft, will be completed at that facility.
- The CH-53K design is not finalized. Sikorsky is working on but has not yet resolved multiple problems discovered during testing. These include airspeed indication anomalies, main rotor gearbox low reliability, hot gas impingement on aircraft structures, tail boom and tail rotor structural problems, main rotor dampers overheating, fuel system anomalies, high temperatures in the #2 engine bay, and hot gas ingestion by the #2 engine reducing available power.
- Live fire testing against the threshold threats is not complete. The Navy's analysis of data available to date indicates that the CH-53K may not meet the Survivability Key Performance Parameter (KPP) without mitigations, which the Navy is investigating. Navy analysis indicates that the CH-53K is more survivable than the legacy CH-53E aircraft.

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 greater lift capability is facilitated by increased engine power (7,500 shaft horsepower versus 4,380 horsepower per engine in the CH-53E) and a composite airframe. The composite airframe is lighter than the CH-53E metal airframe.
- The CH-53K design incorporates the following survivability enhancements:
 - Large Aircraft Infrared Countermeasures with the advanced threat warning sensors (combines infrared, laser, and hostile fire functions into a single system), an AN/APR-39D(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 Company – Stratford, Connecticut (subsidiary company since 2015)

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Activity

- The first OA using Marine Corps pilots and ground personnel completed all ground and flight events in accordance with a DOT&E-approved test plan at the Sikorsky facility in West Palm Beach, Florida, concluding on October 19, 2016.
- In February 2017, DOT&E published its “CH-53K Heavy Lift Replacement Program” OA and LFT&E report to support the Defense Acquisition Board CH-53K Milestone C decision.
- The Defense Acquisition Executive approved the CH-53K program’s Milestone C and entry into LRIP on February 28, 2017.
- The program has four EDM aircraft which continue to support integrated developmental and operational flight testing. All four EDM aircraft have been flying in the integrated test program since EDM-4 achieved first flight on August 31, 2016. The four EDM aircraft have flown 552.6 flight hours as of September 30, 2017.
- The Navy is using a Ground Test Vehicle (GTV) to qualify key dynamic components; assess aircraft stresses, vibrations, and rotor performance; and support long-term reliability testing and verification of aircraft systems performance. The GTV is a complete CH-53K that is fully representative of the EDM aircraft. The Navy is using the GTV to investigate fixes for aircraft technical problems and to provide a platform for aircrew training.
- The Navy will use the GTV for transportability demonstrations on a C-17 airlifter and as the test article for full-up system-level LFT&E projected for FY19.
- Sikorsky is manufacturing the first four of six SDTA aircraft at its facility in West Palm Beach, Florida, with delivery of the first SDTA projected for early FY18. SDTA aircraft will join the integrated test program and the SDTA aircraft will be used for IOT&E. The Program Office has incorporated retrofit periods into the master schedule to ensure these SDTA aircraft will be as production-representative as possible. Upon completion of the fourth SDTA aircraft, Sikorsky will transition final assembly of CH-53K aircraft to its Stratford, Connecticut, facility for the fifth and sixth SDTAs and LRIP aircraft. Full-rate production is planned for the Stratford plant.
- The Navy completed ballistic testing of four flight critical main and tail rotor system components in FY15 against a range of operationally relevant small arms threats under static loads representative of flight conditions. In FY17, the Navy completed post-ballistic endurance testing to assess residual flight capability for these components. The objective of this endurance testing is to evaluate the ability of these components to continue to function and thereby enable the aircraft to land before catastrophic component failure due to a ballistic event. Vendor reports on these endurance tests will be completed and sent to Sikorsky and Naval Air Systems Command (NAVAIR) for review. NAVAIR will then incorporate the post-endurance test results into a comprehensive live fire test report to be submitted to DOT&E in 2020.
- In 2QFY16, the failure of a test fixture at Naval Air Weapons Station China Lake, California, delayed the live fire testing of the horizontal tail rotor drive shaft system by 6 months. The

- Navy completed this testing in December 2016. The Navy completed subsequent testing of the tail rotor gearboxes and transmissions using the same fixture in May 2017.
- Live fire ballistic testing of the main and tail rotor servos was completed in October 2017 at the manufacturer’s facility in the United Kingdom. Post-ballistic endurance testing to assess residual flight capability of these components is scheduled to begin in December 2017.
 - The Navy is modifying aircraft survivability equipment (ASE) to address cybersecurity requirements (data at rest protection), mitigate obsolescence (removable media and computer processors), and reduce life-cycle cost (via elimination of components). The Navy is upgrading the infrared countermeasure subsystem and adding hostile fire indication.
 - Due to ASE program delays, the Navy has deferred deployment and testing of the updated ASE and it will not be available for IOT&E. The Navy will use legacy ASE during IOT&E and will employ legacy ASE for Initial Operational Capability, which is projected for late 2019. The Navy intends to examine updated ASE in FOT&E and retrofit it to the fleet as it becomes available.
 - The Program Office completed Revision C of the U.S. Marine Corps CH-53K Heavy-Lift Replacement Program Test and Evaluation Master Plan (TEMP) to reflect programmatic changes and updates to the cybersecurity test strategy for Milestone C. Revisions included new emphasis on cybersecurity including incorporation of a Cooperative Vulnerability and Penetration Assessment and an Adversarial Assessment. DOT&E approved Revision C of the TEMP on February 23, 2017.
 - The Navy is continuing testing in accordance with the DOT&E-approved TEMP and a DOT&E-approved 2010 Alternative LFT&E plan.

Assessment

- The OA indicated that the CH-53K has the capability to support the Amphibious Pre-Assault/Raid Operations mission, the aircraft’s most stressing mission profile.
- The CH-53K demonstrated 84.8 percent mission reliability during testing up through the OA, which is greater than the required value of approximately 83.0 percent at that point in its projected reliability growth.
- The original test flight schedule is 10 percent complete as of September 2017 and continues to slip due to technical problems discovered during testing.
- Pressure is increasing to meet a late December 2019 Initial Operational Capability (IOC), but current projections estimate that the planned 6-month IOT&E will have started 1 month prior to this desired IOC. Schedule compression has the potential to adversely affect training for the IOT&E aircrews and maintainers.
- Design of the CH-53K is not finalized. Sikorsky is working on but has not yet resolved problems discovered in developmental testing.

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- The aircraft pitot-static system is giving unreliable airspeed indications in various flight regimes. Sikorsky is investigating relocating the pitot-static sensors but has not finalized a solution. The flight control computers receive airspeed inputs from the pitot-static system and airspeed is a vital input parameter for the algorithms used to aid control of the aircraft.
- Service life projections for the main rotor gearbox are falling short of the requirement. Sikorsky is pursuing solutions involving modification of internal gears and their interfaces.
- Engine #2 and auxiliary power unit hot gas impingement on the aircraft structure during some flight regimes has not been solved. On several test flights, telemetry indicated temperatures on the composite skin of the aircraft were approaching structural limits. This necessitated termination of some maneuvers to prevent aircraft damage.
- Testing has revealed anomalies in the CH-53K tail boom design. The tail structure has experienced unexpected vibrations and resonances, and redesign efforts are in progress to mitigate vibration-induced damage to hydraulic lines and other components in the tail.
- The tail rotor flex beam, which connects the tail rotor blade to the hub, has experienced material delamination and cracking. A redesign of the flex beam is in progress.
- Main rotor dampers are overheating. The contractor has proposed a new rotor damping configuration involving lower damping action, which has been installed on EDM-1. Sikorsky is gathering and analyzing flight test data, but evaluation of the change's effectiveness is not complete throughout the CH-53K flight envelope.
- Sikorsky has not finalized the fuel system configuration; the original design called for a suction-only fuel feed to reduce vulnerability to ballistic threats and the contractor has not identified a non-boost pump solution. If boost pumps are required, additional live fire testing may be required.
- The #2 engine bay is experiencing high temperatures that could jeopardize components in that bay. The contractor has not yet identified a permanent solution.
- Under certain wind conditions while hovering, the #2 engine ingests hot gasses from the #1 and/or #2 engine exhausts. This can reduce #2 engine available power, which could prevent lifting the 27,000-pound external load. This can be avoided by the pilot turning the helicopter if circumstances permit. The CH-53E experiences similar degradations under similar hover conditions.
- Live fire testing against the threshold threats is not complete. The Navy's analysis, incorporating the data available to date, indicates that the CH-53K is more survivable than the legacy CH-53E against small-arms, automatic weapons fire, and legacy man-portable air defense system threats. However, the CH-53K may not meet the CH-53K Survivability KPP without mitigations, which the Navy is investigating.
- Live fire testing against objective threats is not funded, but the Navy must complete this testing for an adequate survivability assessment against expected threats. Component tests for the main rotor assembly and tail rotor hub are also scheduled to occur after IOC as part of this Phase II testing. As a result, any deficiencies identified after IOC will need to be addressed later with engineering change proposals.

Recommendations

- Status of Previous Recommendations. The Navy has completed the FY15 recommendations. The Navy should continue to address the following FY16 recommendations.
 1. Finalize the CH-53K configuration while remediating problems identified in developmental testing.
 2. Continue testing and finalize the CH-53K design.
 3. Consider re-baselining the program to an event-based schedule instead of fixed calendar dates, thereby providing sufficient time for training and operational testing.
- FY17 Recommendations. The Navy should:
 1. Ensure live fire testing against objective threats is fully funded and accelerated to minimize the probability of problem discovery post-IOC, which would need to be addressed with engineering change proposals.
 2. Continue to investigate mitigations to improve CH-53K survivability.
 3. Address all recommendations in DOT&E's February 2017 OA and LFT&E report.

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