CH-53K – Heavy Lift Replacement Program

Executive Summary
- The CH-53K program has four Engineering Development Model (EDM) aircraft to support integrated developmental and operational flight testing. All four aircraft have been flying in the test program since EDM-4 achieved its first flight on August 31, 2016.
- Additionally, the CH-53K program is using a Ground Test Vehicle (GTV) to qualify key dynamic components and assess aircraft stresses, vibrations, and rotor performance. The GTV is a complete CH-53K that is fully representative of the EDM aircraft. Previous main gear box testing on the GTV revealed gear box failures and required engineering changes to correct deficiencies.
- The CH-53K design is not finalized. Some problems discovered during testing have not been solved by Sikorsky. These include high temperatures in the #2 engine bay, main rotor damper overheating, and #2 engine flameouts. The flameouts are caused by fuel system anomalies, necessitating the use of fuel boost pumps for prevention. Fuel boost pumps are not planned for fielding.
- Live fire tests have fallen behind schedule by 6 to 9 months, due in large part to the failure of an H-53 test fixture at China Lake, California. The test fixture has been rebuilt and live fire tests restarted in December 2016.

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. This composite airframe is lighter than the CH-53E metal airframe.
- The CH-53K design incorporates the following survivability enhancements:
  - Aircraft Survivability Equipment (ASE) to include Large Aircraft Infrared Countermeasures with the advanced threat warning sensors (combines infrared, laser, and hostile fire functions into a single system), AN/APR 39D(V)2 radar warning receiver, and 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 logistics shipboard footprint equivalent to that of the CH-53E.

Mission
- Commanders will 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 Corporation (owned by Lockheed Martin since November 2015) – Stratford, Connecticut

Activity
- The program has four EDM aircraft to support integrated developmental and operational flight testing. Sikorsky is manufacturing the first of six system development test article aircraft at its facility in West Palm Beach, Florida; delivery of the first four is projected for FY17.
- 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 221.2 hours as of October 25, 2016.

- The first operational assessment using Marine Corps pilots and ground personnel completed all ground and flight events at the contractor facility in West Palm Beach, Florida, concluding on October 19, 2016.
- The Navy has used ongoing GTV testing to qualify design changes to key dynamic components and assess aircraft stresses, vibrations, and rotor performance. The GTV is supporting long-term verification and reliability testing. After 72.8 hours of running under representative flight loads, the GTV was torn down for detailed inspection of dynamic components. Inspections revealed no anomalies.
- The GTV will be used for transportability demonstrations on a C-17 airlifter and it will be the test article for full-up system-level LFT&E projected for FY19.
- The pilots' armored seats experienced thermal cracking during initial environmental qualifications and had to be redesigned in FY13. The new design was qualified by analysis and has been part of the qualification program to date. Final environmental and live fire testing of the redesigned pilot seat armor against the specification small arms threat occurred in November 2015.
- In FY15, the Navy completed ballistic testing of four flight-critical main and tail rotor system components. Testing was conducted against a range of operationally relevant small arms threats and under static loads representative of flight conditions. Two of these damaged components were subjected to post-ballistic endurance testing in FY16 to assess the residual flight capability representative of get-home flight and landing conditions. The remaining two components will be tested in FY17.
- In October 2016, the Navy completed live fire testing of the main rotor gear box. Testing was conducted against a range of operationally relevant small arms threats.
- Due to the failure of a test fixture at Naval Air Weapons Station China Lake, California, the live fire testing of two major drive system components, originally scheduled for FY16, was delayed approximately 6 to 9 months. The test fixture has been rebuilt and testing restarted in December 2016.
- Live fire testing of the main and tail rotor servos have been delayed due to problems with arranging testing at the manufacturer's facility in the United Kingdom. Testing of these components has now slipped into FY17.
- The Navy is modifying ASE to address cybersecurity requirements (data at rest protection), mitigate obsolescence (removable media and computer processors), and reduce life cycle cost (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. Legacy ASE will be used during IOT&E and will be employed for Initial Operational Capability, which is projected for FY19. Updated ASE will be tested in follow-on tests and retrofitted to the fleet as it becomes available.
- The Navy has continued testing in accordance with a DOT&E-approved Test and Evaluation Master Plan (TEMP) and a DOT&E-approved 2010 Alternative LFT&E plan.
- The Program Office is revising the TEMP to reflect programmatic changes and updates to the cybersecurity test strategy for Milestone C to include a Cooperative Vulnerability and Penetration Assessment and an Adversarial Assessment. Completion of the revised TEMP has slipped into FY17.

Assessment

- Previous main gear box testing on the GTV revealed gear box failures. The required engineering changes and additional testing have contributed to the schedule slip.
- Design of the CH-53K is not finalized. Problems discovered in developmental testing have not been solved.
  - The #2 engine bay is experiencing temperatures high enough to trigger the engine fire light. The contractor has not yet identified a permanent solution.
  - 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. Flight test data are being gathered and analyzed to evaluate the effectiveness of the change.
  - The fuel system configuration has not been finalized in that the original design called for suction-only fuel feed to reduce vulnerability to ballistic threats. When the #2 engine has been run without using a fuel boost pump, prolonged hovering for at least 15 minutes with a 6 degree nose-up attitude has caused the #2 engine to flame out on landing. The contractor has not identified a non-boost pump solution. If boost pumps are required, additional live fire testing may be required.
- Preliminary assessment of the sponson fuel cell qualification test data indicates acceptable performance against small arms threats. Additional live fire ballistic tests will be performed on the GTV in FY19.
- The program successfully completed ballistic qualification testing of the redesigned cockpit armored seats in November 2015. The copilot seat wing armor is being redesigned. This should not invalidate the ballistic results. Once the seat wing armor final design is known, additional qualification testing will be done to evaluate the changes.
- Three of the four flight-critical main and tail rotor system components tested to date demonstrated the required ballistic damage tolerance to the specified projectile. Structural cyclic endurance testing of two of these components in operationally representative conditions has been completed. The Navy will report on any consequent effect of the observed damage on aircraft survivability and fly-home capability in FY17.

Recommendations

- Status of Previous Recommendations. The Navy should continue to address the FY15 recommendations.
  1. Review data resulting from a DOT&E-funded joint live fire program to assess CV-22 armor performance against threats that the Navy did not address in the CV-22 Advanced Ballistic Stopping System LFT&E program. This will enable the Navy to better understand the effectiveness of the similar seats and armor used in CH-53K against additional operationally realistic threats, and to adjust the CH-53K tactics, techniques, and procedures, as needed.
  2. Finish TEMP Revision C, which has slipped from FY16 into FY17.
- FY16 Recommendations. The Navy should
  1. Finalize the CH-53K configuration while remediating problems identified in developmental testing.
  2. Continue testing and finalize the CH-53K design.
  3. Hold Milestone C after the testing has provided confidence in the CH-53K design and data for reliability growth have been collected against the final design.
  4. Consider re-baselining the program to an event-based schedule instead of fixed calendar dates.