KC-46A

Executive Summary

- The Air Force Operational Test and Evaluation Center (AFOTEC) conducted a second Operational Assessment (OA-2) from December 2014 through July 2016. The Air Force accomplished testing in accordance with the DOT&E-approved Test and Evaluation Master Plan (TEMP) and the OA-2 test plan. DOT&E produced a KC-46A OA-2 report in August 2016.
- Initial air refueling (AR) testing in January and February 2016 uncovered unanticipated axial loads in the boom that approached the boom's structural limits, resulting in temporary suspension of further AR testing. Boeing redesigned the boom control system to address this problem and completed demonstration flights of the boom refueling system in July 2016.
- The KC-46A is trending to be an effective AR platform. It demonstrated a limited capability to refuel receiver aircraft (its primary mission) and to be refueled from tanker aircraft during OA-2. However, the demonstrations to date have been at a single point of the operational envelope for only five different receiver aircraft, during daylight only, and no aircraft have completed certification as a receiving platform. The AR boom receivers were the F-16, C-17, and A-10; the probe-drogue receivers were the F/A-18C and AV-8B.
- During OA-2 testing, the air refueling operators (AROs) identified a problem that can occur when the ARO station is set to "dual" operation such that the controls at both the primary and instructor station are active. When both positions apply a flight control stick command, the boom will move to a summed position due to the system's summation logic. There are situations where this could result in a rapid boom movement to the instructor-commanded position; if the receiver aircraft is in the path, the potential exists for the boom to inadvertently strike the receiver aircraft.
- The AROs also noted the long-wave infrared cameras produced an undesirable effect when interacting with the sun and clouds. For example, a solar trail occurs when the sun moves across the screen (such as during a turn) and leaves a persistent afterimage forming a line. Additionally, the ARO station screen overlays – which provide boom envelope position and other information – interfere with the ARO's ability to view and monitor AR operations.
- Testing during OA-2 did not identify any critical deficiencies with the cargo handling or aeromedical evacuation missions – though testing did identify deficiencies the Air Force should address.
- The KC-46A demonstrated satisfactory progress for operational suitability. The program is tracking better than planned on the reliability growth curve, as measured by Mean Time Between Inherent Failures. Several metrics are worse than thresholds, such as the aerial abort rate, cannot-duplicate rate for failures, Mean Time Between Unscheduled Maintenance, and break rate; however, these results are not surprising. The program is not planning to meet these requirements until 50,000 fleet flight hours, which will not occur until 2 to 3 years after Initial Operational Capability (IOC).

- During OA-2, testers discovered several cybersecurity vulnerabilities. The program plans to correct some of them prior to IOT&E. Corrections to others that are related to government-furnished equipment are under discussion.
- DOT&E evaluated the KC-46A survivability against kinetic and non-kinetic threats in four scenarios. Live fire test results, laboratory results, hardware-in-the-loop testing, and numerous vulnerability and susceptibility analyses provided source data for these evaluations. Results of these evaluations are in the classified annex to DOT&E's OA-2 report.
- DOT&E has previously assessed and continues to assess the KC-46A schedule as aggressive and unlikely to be executed as planned. At Milestone B, in February 2011, the Air Force had planned to be 66 percent complete by Milestone C. However, upon accomplishing Milestone C in August 2016, Boeing had completed only 30 percent of the total Engineering and Manufacturing Development (EMD) testing. Execution of the current schedule assumes historically unrealistic test aircraft fly and re-fly rates.

System

- The KC-46A aerial refueling aircraft is the first increment of replacement tankers (179) for the Air Force's fleet of more than 400 KC-135 tankers.
- The KC-46A design uses a modified Boeing 767-200ER commercial airframe with numerous military and technological upgrades, such as the fly-by-wire refueling boom, the remote AFO's station, 787 cockpit, additional fuel tanks in the body, and defensive systems.

- The KC-46A will provide both a boom and probe-drogue refueling capabilities. The KC-46A is equipped with an AR receptacle so that it can also receive fuel from other tankers, including legacy aircraft.
- The KC-46A is designed to have significant palletized cargo and aeromedical capacities; chemical, biological, radiological, and nuclear survivability; and the ability to host communications gateway payloads.
- Survivability enhancement features are incorporated into the KC-46A design.
  - Susceptibility is reduced with an Aircraft Survivability Equipment suite consisting of Large Aircraft Infrared Countermeasures (LAIRCM), a modified version of the ALR-69A Radar Warning Receiver (RWR), and a Tactical Situational Awareness System. The suite is intended to correlate threat information from pre-flight planning, the RWR, and other on- and off-board sources and to prompt the crew with an automatic re-routing suggestion in the event of an unexpected threat.
  - Vulnerability is reduced by adding a fuel tank inerting system and integral armor to provide some protection to the crew and critical systems.

Mission

Commanders will use units equipped with the KC-46A to perform AR to accomplish six primary missions to include nuclear operations support, global strike support, air bridge support, aircraft deployment, theater support, and special operations support. Secondary missions will include airlift, aeromedical evacuation, emergency AR, air sampling, and support of combat search and rescue.

Major Contractor

The Boeing Company, Commercial Aircraft in conjunction with Defense, Space & Security – Seattle, Washington

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Activity

- The KC-46A program successfully accomplished a Defense Acquisition Board Milestone C decision in August 2016.
- DOT&E approved the Milestone C TEMP in November 2016, with concerns about adequate calendar time for correction of discrepancies or deficiencies between the end of developmental testing and the beginning of IOT&E.
- AFOTEC conducted OA-2 from December 2014 through July 2016. The Air Force accomplished testing in accordance with the DOT&E-approved TEMP and the OA-2 test plan. DOT&E produced a KC-46A OA-2 report in August 2016.
- Initial AR testing in January and February 2016 uncovered unanticipated axial loads in the boom that approached the boom's structural limits, resulting in temporary suspension of further AR testing. Boeing redesigned the boom control system to address this problem and completed demonstration flights of the boom refueling system in July 2016.
- Only Boeing and subcontractor laboratory testing on the Tactical Situational Awareness System and the modified ALR-69A RWR system has been completed to date; initial flight testing on these systems began in the spring of 2016, and will not be completed until shortly before IOT&E.
- LAIRCM testing provided hit point distribution data to inform the vulnerability assessment and to verify that LAIRCM performance on the KC-46A has not been degraded from previously demonstrated performance on other aircraft. Both system configurations (Block 20 with ultraviolet missile warning system and Block 30 with two-color infrared missile warning system) were included in the evaluation.
- Boeing and the Air Force still need to complete several tests that assess areas that significantly influence the aircraft's survivability. These include ground and flight testing of the On-Board Inert Gas Generation System, Electromagnetic Pulse (EMP) (delayed until April 2017), and thermal testing of the nuclear flash curtains.

Assessment

- DOT&E has assessed and continues to assess the KC-46A schedule as aggressive and unlikely to be executed as planned. At Milestone B, in February 2011, the Air Force had planned to be 66 percent complete by Milestone C. However, upon accomplishing Milestone C in August 2016, Boeing had completed only 30 percent of the total EMD testing. Many subsystems have only been tested in the laboratory. Execution of the current schedule assumes historically unrealistic test aircraft fly and re-fly rates.
- The KC-46A is trending to be an effective AR platform. It demonstrated a limited capability to refuel receiver aircraft (its primary mission) and to be refueled from tanker aircraft during OA-2. However, the demonstrations to date have been at a single point of the operational envelope for only five different receiver aircraft, during daylight only, and no aircraft have completed certification as a receiving platform. The AR boom receivers were the F-16, C-17, and A-10; the probe-drogue receivers were the F/A-18C and AV-8B.
- The current boom is a prototype designed to solve boom axial load problems encountered in early testing and is not production-representative. Wing refueling pods that meet all Federal Aviation Administration qualification requirements will not be available for two years.
- During OA-2 testing, the AROs identified a problem that can occur when the ARO station is set to "dual" operation such that the controls at both the primary and instructor station are active. When both positions apply a flight control stick command, the boom will move to a summed position

due to the system's summation logic. There are situations where this could result in a rapid boom movement to the instructor-commanded position; if the receiver aircraft is in the path, the potential exists for the boom to inadvertently strike the receiver aircraft. The Air Force and Boeing are working to resolve this deficiency.

- The AROs also noted the long-wave infrared cameras produced an undesirable effect when interacting with the sun and clouds. For example, a solar trail occurs when the sun moves across the screen (such as during a turn) and leaves a persistent afterimage forming a line. Additionally, the ARO station screen overlays – which provide boom envelope position and other information – interfere with the ARO's ability to view and monitor AR operations. The Air Force and Boeing are working to resolve this deficiency.
- Testing during OA-2 did not identify any critical deficiencies with the cargo handling or aeromedical evacuation missions – though testing did identify deficiencies the Air Force should address. Other secondary missions have not been tested.
- The KC-46A demonstrated satisfactory progress for operational suitability; however, it is premature to make definitive conclusions. The program is tracking better than planned on the reliability growth curve, as measured by Mean Time Between Inherent Failures. Several metrics are worse than thresholds, such as the aerial abort rate, cannot-duplicate rate for failures, Mean Time Between Unscheduled Maintenance, and break rate; however, these results are not surprising. The program is not planning to meet these requirements until 50,000 fleet flight hours, which will not occur until 2 to 3 years after IOC. Other metrics, including availability, mission-capable rate, sortie generation rate, and maintainability, cannot be estimated at this point in the program. Boeing owned, operated, maintained, and supplied the aircraft rather than the Air Force. Consequently, operational aircrew had minimal involvement in aircraft operations and there was no operational maintenance.
- DOT&E evaluated the KC-46A survivability against kinetic and non-kinetic threats in four scenarios. These threats include ballistic threats, light anti-aircraft artillery, man-portable air defense system missiles, radar-guided surface-to-air and air-to-air missiles, chemical and biological weapons, high power microwave, low power lasers, and EMP. Detailed results of these evaluations are in the classified annex to DOT&E's OA-2 report.
- The KC-46A EMP design margin was based on Military Standard (MIL-STD) 464 and the threat defined in MIL-STD 2169. After the fixed-price contract was awarded, the DOD instituted a new MIL STD 3023 that requires tanker aircraft supporting the nuclear deterrent mission to meet a 20-decibel (dB) EMP design margin versus the contractually required 6-dB EMP design margin. Unless additional tests are resourced, the Air Force or the U.S. Strategic Command will not know if the KC-46A meets the 20-dB EMP hardening requirement in MIL STD 3023.
- During OA-2, testers discovered several cybersecurity vulnerabilities. The program plans to correct some of them prior to IOT&E. Corrections to others that are related to government-furnished equipment are under discussion. Details are presented in the classified annex to the DOT&E OA-2 report.

Recommendations

- Status of Previous Recommendations. The Air Force has addressed all FY12 through FY14 recommendations. The Air Force still needs to address the following FY15 recommendations:
  1. Ensure all AR receiver aircraft are certified for use by operational aircrew early enough in IOT&E to permit sufficient operational testing.
  2. In conjunction with U.S. Strategic Command, determine whether its personnel can conduct the nuclear deterrence and strike missions with a KC-46A only having 6-dB EMP shielding as per the contract. If additional EMP shielding is deemed necessary, the Air Force should conduct testing as part of FOT&E to determine the actual KC-46A EMP design margin.
- FY16 Recommendations. The Air Force should:
  1. Develop an executable schedule that is based on historical fly and re-fly rates.
  2. Address the recommendations presented in the unclassified DOT&E KC-46A OA-2 report.
  - Verify boom loads are satisfactory under all operational conditions.
  - Address deficiencies with the ARO cameras, ARO station screen displays, and instructor control stick logic.
  - Address cybersecurity vulnerabilities.