

## KC-46A

### Executive Summary

- The Air Force Operational Test and Evaluation Center is currently conducting a second KC-46A operational assessment (OA) to support the Milestone C decision. DOT&E expects it to end February 2016, after the completion of Milestone C receiver flights.
- Delays in Engineering and Manufacturing Development (EMD) aircraft production and manufacturing have delayed program test milestones to include the Milestone C decision. DOT&E estimates April 2016 for Milestone C and May 2017 for the start of IOT&E. The first EMD aircraft (EMD-1), a 767-2C variant, began daily flight testing at the end of July 2015. First flight of the second EMD aircraft (EMD 2), the first fully configured tanker variant, began flights in late September 2015. Aerial refueling certification of 11 of the 18 different receiving aircraft planned for EMD will not be complete until after the start of the IOT&E.
- Testing in the Boeing lighting lab and wet fuels lab, each containing full-up installations of the respective aircraft systems is anticipated to complete in 2QFY16.
- The Air Force successfully completed the ballistic test phase of the live fire test program. Ballistic testing in FY15 investigated the KC-46A's response to dry bay fires and structural damage to the engines and engine pylon due to impact from man-portable air-defense systems (MANPADS). Preliminary review of the data did not reveal any unknown vulnerabilities to the threats tested.

### System

- The KC-46A aerial refueling aircraft is the first increment of replacement tankers (179) for the Air Force's fleet of KC-135 tankers (more than 400).
- 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 air refueling operator'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 air refueling 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, 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, the ALR-69A Radar Warning Receiver (RWR), and a Tactical Situational Awareness System. The suite is intended to compile threat information from the ALR-69A 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 fuel tank inerting 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 air refueling 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 aerial refueling, air sampling, and support of combat search and rescue.
- Operate in day/night and adverse weather conditions globally to support U.S., joint, allied, and coalition forces.
- Operate in a non-permissive environment.

### Major Contractor

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

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## Activity

- DOT&E approved the post-Milestone B Test and Evaluation Master Plan (TEMP) in January 2013, with concerns about adequate calendar time for correction of discrepancies or deficiencies between the end of developmental testing and the beginning of IOT&E. DOT&E has taken this into account while working with the program to develop the Milestone C TEMP.
- DOT&E approved the Air Force Operational Test and Evaluation Center's second KC-46A OA-2 plan in May 2015 to support the Milestone C decision. This plan included revised survey methodology consistent with DOT&E's guidance. Delays in EMD aircraft production and manufacturing have led to two extensions in the completion date for OA-2; DOT&E expects OA-2 to end February 2016, after the air refueling demonstration flights in support of Milestone C.
- Developmental and Federal Aviation Administration (FAA) test planning is substantially complete. The Air Force accepted the contractor's Stage 4 (final build) test plans in January 2015. Some test plans have been revised throughout the year due to FAA test planning or to improve test schedule efficiency.
- First flight of the first EMD aircraft occurred December 28, 2014, 6 months late, primarily due to electrical wiring design problems. After a single flight, the aircraft was down for planned finishing work; this down period was extended by a necessary redesign of the fuel pump manifold. The aircraft began near daily flight testing at the end of July 2015.
- EMD 2, the first fully configured tanker variant, began flying in late September. The planned first flight date was January 2015 as documented in the post-Milestone B TEMP.
- Testing in the lighting lab and wet fuels lab, each containing full-up installations of the respective aircraft systems, is anticipated to complete in 2QFY16.
- The Air Force used a standard Air Force MJ-1 weapons loader to install a boom on a KC-46 to show the feasibility of using current Aerospace Ground Equipment rather than developing new, unique equipment. The Air Force completed a refueling surge pressure test on a KC-135 and on a KC-10 to develop baseline data for comparison to surge pressures in the KC-46A. The technical order verification process is approximately one quarter complete and should be finished prior to IOT&E.
- All parties have agreed upon the open-air test venues for the ALR-69A RWR and the AAQ-24 Large Aircraft Infrared Countermeasures (LAIRCM) system and detailed test planning for each venue is near completion.
- Testers have completed laboratory tests of the defensive systems including the ALR-69A RWR and the AAQ 24 LAIRCM. Flight test planning for LAIRCM is nearly complete, while flight test planning for the RWR remains to be completed. Both flight tests are planned for fall 2016.
- The program conducted three live fire test series completing the ballistic test portion of the LFT&E program. The

Air Force conducted testing in accordance with the DOT&E-approved LFT&E strategy.

- The Air Force is nearing completion of the KC-46A survivability assessment against radar guided surface-to-air missiles and the performance of the ALR-69A RWR against selected threats. Survivability evaluation against other operationally relevant threats, crew casualty assessment, and non-kinetic threat vulnerability analyses also remain to be completed.
- Boeing prepared a test plan for Electromagnetic Pulse (EMP) testing based on the contract specified design margin of 6 decibels (dB).
- The program accomplished an initial cybersecurity Cooperative Vulnerability Penetration Assessment (CVPA) in one of the Boeing system integration labs in August 2015. Future cybersecurity test plans include additional CVPAs accomplished in the system integration labs and on the aircraft, followed by an Adversarial Assessment accomplished on the aircraft during the IOT&E.

## Assessment

- DOT&E assessed the ALR-69A RWR as installed on the C-130H as not operationally effective but operationally suitable based on tests conducted by the Air Force in October 2012.
  - The system did not consistently provide the aircrew timely and accurate threat information and the system demonstrated a random threat symbol splitting deficiency. Threat symbol splitting occurs when one threat signal received by the system produces multiple threat symbols at different azimuths on the cockpit display. This degrades the aircrew's situational awareness as to which displayed threats are "real" and where those real threats are located, and inhibits the aircrew's ability to appropriately react to the threat(s) in a timely manner. The details are presented in DOT&E's classified IOT&E report dated October 2012.
  - Although the Air Force System Program Office and Raytheon conducted hardware-in-the-loop (HWIL) tests to demonstrate the threat signal splitting deficiency has been resolved, DOT&E does not think HWIL testing by itself is adequate to verify the deficiency has been resolved and that the software update did not induce any other adverse system performance.
- The delay in first flight of the KC-46A has altered the planned certification schedule of air refueling receiving aircraft and accomplishment of the 26 Milestone B Acquisition Decision Memorandum Technical Performance Measures entrance criteria. This, in turn, will delay the August 2015 Milestone C decision (based on the post-Milestone B TEMP schedule) until April 2016.
- DOT&E identified several shortfalls in the planned test program that require resolution prior to Milestone C TEMP approval.
  - A current schedule based on reasonable test efficiencies must be included.

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- Planning should allow the operational test aircrew and maintenance personnel adequate time to develop system proficiency to support IOT&E.
  - Sufficient calendar time must be allotted for correction of discrepancies and/or deficiencies discovered during developmental testing prior to the planned start of operational testing.
  - Cyber vulnerability and penetration testing to date has not tested vulnerabilities on a production representative aircraft. Tentatively scheduled events are expected to fulfill this requirement, but need to be formally coordinated and scheduled.
  - The expected IOT&E start date has been delayed 10 months from the post-milestone B TEMP schedule. DOT&E analysis of Boeing progress and schedules with regard to aerial refueling certifications and operator/maintainer training indicates that operational testing will likely be delayed a total of 12 months. This is in line with previous DOT&E estimates. Planning since Milestone B has moved air refueling certification of 11 of the 18 different receiving aircraft until after the start of IOT&E.
  - Testing completed to date and planned testing of LAIRCM should be adequate to determine system effectiveness and suitability. Analyses of LAIRCM analytic model and laboratory test results are ongoing. To date, no significant discrepancies from expected performance have been noted.
  - Flight testing of the RWR now includes testing at a government electronic warfare test range in addition to a training range. Initial planning for this test has begun.
  - Preliminary analyses of live fire test data:
    - Confirmed the vulnerability of the KC-46A to threat-induced dry bay fires, including the wing-leading edge, wing-trailing edge, center wing dry bay, and fuselage body tank dry bays. The Air Force assessed the vulnerability to several threats including small arms and missile fragments. All live fire ballistic test results will be incorporated into the vulnerability analysis to confirm whether the KC-46A meets the 30-minute controlled flight vulnerability specification in FY16.
    - Quantified the threat-induced structural limitations of the KC-46A wings for selected engagement conditions. The Air Force will assess the survivability of the wing structure to a range of small arms, anti-aircraft artillery threats, and MANPADS engagements.
    - Demonstrated the vulnerability of the engine and the engine pylon to two specific MANPADS engagement conditions. Further analyses will assess the resultant aircraft survivability for engagement conditions, not tested.
    - Demonstrated the expected cockpit and boom operator station armor effectiveness against the specification threat with 80 percent confidence and assessed the effectiveness of the installed armor against the specification threat and two other operationally representative threats. The program will complete an evaluation of the effects of these data on the overall crew protection assessment in FY16. Live Fire ballistic test results incorporated into the vulnerability analysis confirms the KC-46A is meeting the crew station armor vulnerability specification against the specification threat.
  - Supported the updates to the initial aircraft vulnerability assessment, which quantified the aircraft's vulnerabilities to the specification and other expected threats for a range of operationally relevant engagement conditions, not tested. Boeing is scheduled to deliver their final analysis to the Air Force in FY16.
  - 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 to meet a 20 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 the CVPA, testers discovered several vulnerabilities. The program plans to correct some of them shortly while corrections to others that are related to government furnished equipment are under discussion.
  - The integrated test team is working a cybersecurity strategy consistent with DOT&E guidance; however, specific details to conduct an adequate operational test are not yet defined.
- ## Recommendations
- Status of Previous Recommendations. The Air Force addressed two of the FY12 recommendations to incorporate realistic assumptions in test plans and provide a plan for air refueling receiver certification; however, additional work is still needed. The Air Force still needs to address the remaining FY12 and FY13 recommendations to:
    1. Submit a TEMP with a schedule mitigating the shortfalls that may adversely affect IOT&E.
    2. Provide an approach to correct the ALR-69A RWR shortfalls prior to integration on the KC-46A.
    3. Plan to begin IOT&E at least 12 months later than the post-milestone B TEMP indicates to allow for completion of developmental test and initial training.
    4. Formally plan testing against realistic cybersecurity threats conducted on a production representative aircraft to identify vulnerabilities for correction. In addition, plan follow-on penetration testing to assess performance in terms of protect, detect, react, and restore functions.
  - FY15 Recommendations. The Air Force should:
    1. Ensure all air refueling 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.

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