MQ-9 Reaper Armed Unmanned Aircraft System (UAS)

Executive Summary

- The Air Force Operational Test and Evaluation Center (AFOTEC) completed FOT&E of the MQ-9 Block 5 Remotely Piloted Aircraft (RPA), Block 30 Ground Control Station (GCS), and Operational Flight Program (OFP) 904.6 software suite revision K in accordance with the DOT&E-approved test plan. The results from the FOT&E demonstrated the following:
  - The MQ-9 Unmanned Aircraft System (UAS) configuration tested is not operationally effective and not operationally suitable. The system was unable to conduct the all-weather hunter mission role operations using onboard systems.
  - The MQ-9 UAS evaluated in the FOT&E is not capable of conducting wide-area searches to hunt fixed or moving targets with the Lynx Synthetic Aperture Radar (SAR) system. The MQ-9 Lynx SAR does not provide a useful operation for the Block 5 RPA/Block 30 GCS due to unstable and unmanageable aircraft and GCS software configuration problems; human machine interface complexity; inadequate and incomplete technical orders; and persistent in-flight radar mode failures.
  - The Block 5 RPA/Block 30 GCS MQ-9 UAS retains the legacy MQ-9 capability to conduct cued area searches for fixed and moving targets with the Multi-spectral Targeting System (MTS) B electro-optical/infrared sensor, and to employ legacy AGM-114 HELLFIRE II missiles and GBU 12 laser guided bombs. Additionally, the FOT&E results demonstrated the MQ-9 UAS can effectively employ GBU-38 JDAM bombs against stationary targets, as long as target coordinates are provided by off-board sources.
  - The Block 5 RPA and Block 30 GCS are not operationally suitable. Testing showed these systems experience high abort rates and break often.
- The MQ-9 Block 5 RPA is subject to overheating problems in operationally relevant environments.
  - Block 5 RPA subsystems may overheat in hot weather prior to take-off, leading to mission aborts. The installation of an aircraft cooling plenum and addition of a new, more powerful ground-cooling cart in FY15 mitigates some of the RPA avionics bay overheating problems identified in FY14. However, these measures do not eliminate all overheating problems in hot weather operating environments.
  - Inherent Block 5 RPA design limitations lead to thermal management problems that were not fully resolved by the aircraft cooling plenum or the new ground-cooling cart. As highlighted in the DOT&E FY15 Annual Report, although these measures mitigated RPA forward avionics bay redundant control module and transmitter overheating shortfalls, power and thermal management problems that can preclude charging batteries on the ground can lead to depleted batteries prior to take-off and may force mission aborts.

- In FY15, the Air Force adopted a hybrid acquisition strategy for the MQ-9 program of record. The Air Force intended for the acquisition strategy to provide a series of bundled MQ-9 software/hardware releases under an accelerated development and testing schedule. The first release of planned capabilities under this construct envisioned for FY17 delivery is expected to deliver in FY18.
- The final configuration of the MQ-9 Increment One UAS continued to evolve. As of the end of FY16, the Air Force indicated it plans to incorporate an improved MTS-B electro-optical/infrared sensor, additional weapons, new avionics hardware, and further system software revisions into the existing program of record.
- General Atomics delivered the last of 195 Block 1 RPAs to the Air Force in 2QFY15, and then transitioned the production line to Block 5 RPAs. As of 3QFY16, General Atomics had delivered 12 of 155 planned Block 5 RPAs. Total Air Force MQ-9 deliveries as of 3QFY16 include 207 of 350 planned MQ-9s (Block 1 and Block 5 combined). General Atomics plans to deliver the final Block 5 RPA in FY21.
- The Air Force plans to field the Block 5 RPA and Block 30 GCS in 1QFY17, and will complete delivery of the MQ-9 program of record fleet under low-rate initial production.

System

- The MQ-9 Reaper UAS is a remotely piloted and armed aircraft system that uses optical, infrared, and radar sensors to locate, identify, target, and attack ground targets.
  - The MQ-9 RPA is a medium-sized aircraft that has an operating ceiling up to 50,000 feet, an internal sensor payload of 800 pounds, an external payload

of 3,000 pounds, and an endurance of approximately 12 hours.
  - Aircraft sensors include the MTS-B electro-optical and infrared targeting sensor and the Lynx SAR system.
  - The GCS commands the MQ-9 RPA for launch, recovery, and mission control of sensors and weapons. RPA launch and recovery operations use C band line-of-sight datalinks, and RPA mission control uses Ku band satellite links.
- The fielded Block 1 MQ-9 RPA carries AGM-114 HELLFIRE II anti-armor precision laser-guided missiles, and GBU-12 500-pound, laser-guided bombs.
- The Air Force is using an evolutionary acquisition approach for meeting Increment One Capability Production Document requirements, with Block 1 and Block 5 RPAs and Block 15 and Block 30 GCSs.
- The Air Force is currently fielding the Block 1 RPA and the Block 15 GCS and will field the Block 5 RPA and Block 30 GCS in 1QFY17.
- The Air Force designed the Block 5 RPA to incorporate improved main landing gear, an upgraded electrical system with more power, an additional ARC-210 radio, encrypted datalinks, a redesigned avionics bay and digital electronic engine control system, the BRU-71 bomb rack, high-definition video, and upgraded software to allow the two-person aircrew to operate all onboard sensors and systems.
- The Air Force designed the Block 30 GCS to incorporate upgraded flight control displays and avionics, secure digital datalinks, Integrated Sensor Control System, Continuous Look Attack Management for Predator, Control of Lynx and Analysis Workstation software, and high-definition multi-function displays.

Mission
- Combatant Commanders use units equipped with the MQ-9 to conduct armed reconnaissance and pre-planned strikes. When provided wide-area search cues from off-board sources, units equipped with MQ-9s can execute cued searches to find, fix, track, target, engage, and assess critical emerging targets (both moving and stationary).
- MQ-9 units can also conduct aerial intelligence gathering, reconnaissance, surveillance, and target acquisition for other airborne platforms.

Major Contractor
General Atomics Aeronautical Systems Inc. – San Diego, California

---

Activity
- The Air Force conducted MQ-9 testing in accordance with the DOT&E-approved Test and Evaluation Master Plan (TEMP) and test plan.
- AFOTEC completed FOT&E of the Block 5 RPA, Block 30 GCS, and OFP 904.6 in 4QFY16 in support of Air Force 1QFY17 planned operational fielding. Testing evaluated the MQ-9 all-weather, wide-area search capability across multiple operational mission sets to determine the system's ability to hunt and kill fixed and moving targets using system capabilities and weapons. Additional testing included a cybersecurity Adversarial Assessment and hot and cold weather tests.
  - During the FOT&E, AFOTEC discovered a deficiency in the ability of the MTS-B to track targets without breaking lock, and declared a test pause. During the pause, the Air Force determined the root cause of the deficiency was due to a software anomaly. The Air Force corrected the problem and evaluated the fix in subsequent developmental regression testing. Upon software fix incorporation, AFOTEC resumed the FOT&E and re-accomplished the MTS-B-related FOT&E test points.
  - AFOTEC terminated MQ-9 Lynx SAR FOT&E testing without completing the scope of planned Lynx SAR test events. Persistent GCS configuration problems, incomplete technical orders, and software complexities precluded contract maintainers from effectively configuring and troubleshooting, and precluded aircrews from effectively employing the system.
- In conjunction with the FY16 FOT&E, AFOTEC and the 57th Information Aggressor Squadron conducted a cybersecurity Adversarial Assessment of the MQ-9 Block 5 RPA/Block 30 GCS.
- In FY15, the Air Force adopted a hybrid acquisition strategy for the MQ-9 program of record. The Air Force intended for the acquisition strategy to provide a series of bundled MQ-9 software/hardware releases under an accelerated development and testing schedule. The first release of planned capabilities under this construct is expected to deliver in FY18.
- The final configuration of the MQ-9 Increment One UAS continued to evolve. As of the end of FY16, the Air Force indicated it plans to incorporate an improved MTS-B electro-optical/infrared sensor, additional weapons, new avionics hardware, and further system software revisions into the existing program of record.
- General Atomics delivered the last of 195 Block 1 RPAs to the Air Force in 2QFY15, and then transitioned the production line to Block 5 RPAs. As of 3QFY16, General Atomics had delivered 12 of 155 planned Block 5 RPAs. Total Air Force MQ-9 deliveries as of 3QFY16 include 207 of 350 planned MQ-9s (Block 1 and Block 5 combined). General Atomics plans to deliver the final Block 5 RPA in FY21.
- The Air Force plans to field the Block 5 RPA and Block 30 GCS in 1QFY17, and will complete delivery of the MQ-9 program of record fleet under low-rate initial production.

Assessment

- The FY16 MQ-9 FOT&E was intended to evaluate deferred Increment One system and operational mission capabilities not evaluated during the 2007 IOT&E. During IOT&E, the MQ-9 Lynx SAR system integration was immature, and the MQ-9 hunter mission role was not evaluated due to this shortfall. The Air Force intended to satisfy the hunter mission role through the acquisition of the Block 5 RPA and Block 30 GCS, and this configuration entered production in 2011. However, the MQ-9 Block 5 RPA as tested in the FY16 FOT&E and that will field to operational units in FY17 cannot conduct an all-weather hunter mission role using the Lynx SAR system.
  - FOT&E results demonstrated the MQ-9 Increment One UAS is not operationally capable of conducting wide-area searches to hunt fixed or moving targets with the Lynx SAR radar. The MQ-9 UAS is not operationally effective in this mission role.
  - Operational aircrews were not able to successfully conduct radar search and targeting tasks due to Lynx SAR radar instability, persistent aircraft and GCS software configuration problems, human machine interface complexity, inadequate and incomplete technical orders, and in-flight radar mode failures.
  - Deficient technical order publications further precluded aircrews and contractor maintainers from troubleshooting radar problems when they occurred during FOT&E missions.
  - Aircrews could not reliably execute legacy radar tasks that had been successfully demonstrated in 2013 Block 1 RPA operational testing (SAR spot imaging to support target location determination and ground moving target indicator detection and cueing) with the Block 5 RPA/Block 30 GCS system. As described above, software complexity, technical order deficiencies, and maintainer inability to troubleshoot radar problems precluded mission accomplishment using the radar system.
  - Based on the shortfalls realized in FOT&E, the MQ-9 Lynx SAR as tested does not provide an operationally useful capability to search for targets for the Block 5 RPA and Block 30 GCS UAS configuration.
- The MQ-9 Block 5 RPA demonstrated adequate MTS-B cued-search, track, and laser-guided weapons support capabilities during operational mission tasks executed in the course of FY16 FOT&E.
- The FY16 FOT&E confirmed the Block 5 RPA/Block 30 GCS system can successfully employ GBU-38 JDAM bombs (when target coordinates are provided by off-board sources), and can employ legacy AGM 114 HELLFIRE II laser-guided missiles and GBU 12 laser-guided bombs.
- FOT&E results established that the Block 5 RPA and Block 30 GCS are not operationally suitable. Testing showed this system breaks more often and is harder to maintain than the legacy Block 1 RPA and Block 15 GCS.
- The MQ-9 Block 5 RPA is subject to overheating problems in operationally relevant environments.
  - Block 5 RPA subsystems may overheat in hot weather prior to take-off, leading to mission aborts. The installation of an aircraft cooling plenum and addition of a new, more powerful ground-cooling cart in FY15 mitigates some of the RPA avionics bay overheating problems identified in FY14. However, it does not eliminate all overheating problems in hot weather operating environments.
  - Inherent Block 5 RPA design limitations led to thermal management problems that are not fully resolved by the installed aircraft cooling plenum or the new ground-cooling cart. As highlighted in the DOT&E FY15 Annual Report, although these measures mitigated RPA forward avionics bay redundant control module and transmitter overheating shortfalls, power and thermal management problems that can preclude charging batteries on the ground can lead to depleted batteries prior to take-off and forcing mission aborts.
- Aircrew Block 5 RPA and Block 30 GCS technical orders do not support proper system operations. Some areas of the technical orders are too long and complex (e.g., preflight checklists). Other areas lack proper instructions for accomplishing mission tasks (e.g., Lynx SAR operations) and problem resolution (e.g., fuel tank overheating cautions).
  - Contractor personnel maintained the Block 30 GCS during FOT&E. The Air Force plans to field the Block 30 GCS in 1QFY17 and maintain the system with only Air Force personnel. It is likely that Air Force personnel will encounter the same maintenance challenges that contractor maintenance personnel experienced during testing.
- The Air Force originally intended to fulfill the MQ-9 Increment One requirements with a final UAS configuration consisting of the Block 5 RPA, Block 30 GCS, and OFP 904.6. The Air Force currently plans to complete the MQ-9 Increment One system with a Block 50 GCS and a future system OFP. The Air Force delayed Block 50 GCS development, and initial production of Block 50 GCS units will not occur until FY19. Subsequent AFOTEC FOT&E of the Block 50 GCS and the system capabilities being developed under the Air Force hybrid acquisition strategy may not occur until FY21. A new TEMP will be required to document the incorporation of new program of record content, and the test strategy and resources necessary to develop and evaluate the Block 50 GCS and associated MQ-9 capabilities.

Recommendations

- Status of Previous Recommendations. In FY16, the Air Force completed the FOT&E. The Air Force made progress toward but did not satisfy the FY15 recommendations to resolve the hot weather operating shortfalls.
- FY16 Recommendations. The Air Force should:
  1. Correct the Block 5 RPA/Block 30 GCS Lynx SAR shortfalls identified during FY16 FOT&E. Once the radar problems are resolved, re-accomplish formal FOT&E to confirm the MQ-9 UAS ability to conduct wide-area search

tasks to hunt moving and fixed targets in a hunter mission role, and to demonstrate the ability to generate own-ship precision coordinates necessary for JDAM employment.
2. Resolve the remaining Block 5 RPA power and thermal management operating shortfalls to meet Air Force operating environment requirements.
3. Correct MQ-9 operator and maintainer technical orders deficiencies to enable effective system operation and maintenance.
4. Develop and submit a new TEMP for DOT&E approval, documenting the incorporation of new program of record content (e.g., the Block 50 GCS) and the T&E strategy and resources required to mature and test these capabilities and systems.