GENERAL ATOMICS MQ-9 REAPER

Background, specifications and operational detail on the MQ-9 Reaper unmanned aerial vehicle.



The first MQ-9 Reaper at Creech AFB in 2007.

The General Atomics MQ-9 Reaper, sometimes called Predator B, is an unmanned aerial vehicle (UAV) capable of remotely controlled or autonomous flight operations developed by General Atomics Aeronautical Systems (GA-ASI) primarily for the United States Air Force (USAF). The MQ-9 and other UAVs are referred to as Remotely Piloted Vehicles/Aircraft (RPV/RPA) by the USAF to indicate their human ground controllers.

The MQ-9 is the first hunter-killer UAV designed for long-endurance, high-altitude surveillance. In 2006, the then–Chief of Staff of the United States Air Force General T. Michael Moseley said: "We've moved from using UAVs primarily in intelligence, surveillance, and reconnaissance roles before Operation Iraqi Freedom, to a true hunter-killer role with the Reaper."

The MQ-9 is a larger, heavier, and more capable aircraft than the earlier General Atomics MQ-1 Predator; it can be controlled by the same ground systems used to control MQ-1s. The Reaper has a 950-shaft-horsepower (712 kW) turboprop engine (compared to the Predator's 115 hp (86 kW) piston engine). The greater power allows the Reaper to carry 15 times more ordnance payload and cruise at about three times the speed of the MQ-1. The aircraft is monitored and controlled by aircrew in the Ground Control Station (GCS), including weapons employment.



MQ-1 Predator controls

In 2008, the New York Air National Guard 174th Attack Wing began the transition from F-16 piloted fighters to MQ-9A Reapers, becoming the first fighter unit to convert entirely to unmanned combat aerial vehicle (UCAV) use. In March 2011, the U.S. Air Force was training more pilots for advanced unmanned aerial vehicles than for any other single weapons system. The Reaper is also used by the U.S. Customs and Border Protection, and the militaries of several other countries.

The USAF operated 195 MQ-9 Reapers as of September 2016, and plans to keep the MQ-9 in service into the 2030s.



MQ-9 takes off in Afghanistan, 1 October 2007.

Origins

The General Atomics "Predator B-001", a proof-of-concept aircraft, first flew on 2 February 2001. Abraham Karem is the designer of the Predator. The B-001 was powered by an AlliedSignal Garrett TPE331-10T turboprop engine with 950 shaft horsepower (710 kW). It had an airframe that was based on the standard Predator airframe, except with an enlarged fuselage and wings lengthened from 48 feet (15 m) to 66 feet (20 m). The B-001 had a speed of 220 knots (410 km/h; 250 mph) and could carry a payload of 750 pounds (340 kg) to an altitude of 50,000 feet (15,000 m) with an endurance of 30 hours.

The company refined the design, taking it in two separate directions. The first was a jet-powered version; "Predator B-002" was fitted with a Williams FJ44-2A turbofan engine with 10.2 kilonewtons (2,300 lbf; 1,040 kgf) thrust. It had payload capacity of 475 pounds (215 kg), a ceiling of 60,000 feet (18 km) and endurance of 12 hours. The USAF ordered two airframes for evaluation, delivered in 2007. The first two airframes delivered with prototypes B-001 and B-002 (now in the USAF museum at Wright-Patterson AFB). B-002 was originally equipped with the FJ-44 engine but it was removed and a TPE-331-10T was installed so that the USAF could take delivery of two aircraft in the same configuration.

The second direction the design took was the "Predator B-003", referred to by GA as the "Altair", which has a new airframe with an 84-foot (26 m) wingspan and a take-off weight of approximately 7,000 pounds (3,200 kg). Like the Predator B-001, it is powered by a TPE-331-10YGD turboprop. This variant has a payload capacity of 3,000 pounds (1,400 kg), a maximum ceiling of 52,000 feet (16 km), and an endurance of 36 hours.

In October 2001, the USAF signed a contract for an initial pair of Predator Bs (001 and 002) for evaluation. Designated YMQ-9s due to their prototype role, they were delivered in 2002. The USAF referred to it as "Predator B" until it was renamed "Reaper". The USAF aimed for the Predator B to provide an improved "deadly persistence" capability, flying over a combat area night-and-day waiting for a target to present itself, complementing piloted attack aircraft, typically used to drop larger quantities of ordnance on a target, while a cheaper RPV can operate almost continuously using ground controllers working in shifts, but carrying less ordnance.

Operation

Satellite antenna and sensors of an NOAA-NASA flight demonstrator, 2005

MQ-9 Reaper crews (Pilots, Sensor Operators and Mission Intelligence Coordinators), stationed at bases such as Creech Air Force Base, near Las Vegas, Nevada, can hunt for targets and observe terrain using multiple sensors, including a thermographic camera. One claim was that the on-board camera is able to read a license plate from two miles (3.2 km) away. An operator's command takes 1.2 seconds to reach the drone via a satellite link. The MQ-9 is fitted with six stores pylons; the inner stores pylons can carry a maximum of 1,500 pounds (680 kg) each and allow carriage of external fuel tanks. The mid-wing stores pylons can carry a maximum of 600 pounds (270 kg) each, while the outer stores pylons can carry a maximum of 200 pounds (91 kg) each. An MQ-9 with two 1,000 pounds (450 kg) external fuel tanks and 1,000 pounds (450 kg) of munitions has an endurance of 42 hours. The Reaper has an endurance of 14 hours when fully loaded with munitions. The MQ-9 carries a variety of weapons including the GBU-12 Paveway II laser-guided bomb, the AGM-114 Hellfire II air-to-ground missiles, the AIM-9 Sidewinder, and the GBU-38 Joint Direct Attack Munition (JDAM). Tests are underway to allow for the addition of the AIM-92 Stinger air-to-air missile.

By October 2007, the USAF owned nine Reapers, and by December 2010 had 57 with plans to buy another 272, for a total of 329 Reapers. Critics have stated that the USAF's insistence on qualified pilots flying RPVs is a bottleneck to expanding deployment. USAF Major General William Rew stated on 5 August 2008, "For the way we fly them right now"—fully integrated into air operations and often flying missions alongside manned aircraft—"we want pilots to fly them." This reportedly



The tail end of a Reaper. Note the highly polished propeller spinner.



Nose wheel detail.



Propeller detail. Note the clear contrast between the upper and lower surface colours.

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The Reaper's Sat Comms.



A fully loaded Reaper taxis. GBU-12 Paveway II bombs and Hellfire missiles are in board.

has exacerbated losses of USAF aircraft in comparison with US Army operations. In March 2011, U.S. Department of Defense Secretary Robert Gates stated that, while manned aircraft are needed, the USAF must recognize "the enormous strategic and cultural implications of the vast expansion in remotely piloted vehicles..." and stated that as the service buys manned fighters and bombers, it must give equal weight to unmanned drones and "the service's important role in the cyber and space domains."

In 2013, the Air Force Special Operations Command (AFSOC) sought the ability to pack up an MQ-9 in less than eight hours, fly it anywhere in the world aboard a C-17 Globemaster III, and then have it ready to fly in another eight hours to support special operations teams at places with no infrastructure. MQ-1 and MQ-9 drones must fly aboard cargo aircraft to travel long distances as they lack the refuelling technology or speed to travel themselves; the C-17 is large enough to carry the aircraft and support systems and can land on short runways. Pilots traveling with the Reaper will use the ground control station to launch and land the aircraft, while most of the flying will be done by US-based pilots.

Testbed and Upgrades

In November 2012, Raytheon completed ground verification tests for the ADM-160 MALD and MALD-J for integration onto the Reaper for an unmanned suppression of enemy air defences capability. On 12 April 2013, a company-owned MQ-9 equipped with a jamming pod and digital receiver/exciter successfully demonstrated its electronic warfare capability at Marine Corps Air Station (MCAS) Yuma, performing its mission in coordination with over 20 participating aircraft. A second electronic warfare test, fitted with the Northrop Grumman Pandora EW System, was conducted on 22 October 2013 with other unmanned aircraft and Northrop Grumman EA-6B Prowlers, showing effectiveness in a multi-node approach against a more capable IADS.

In 2011, the U.S. Missile Defense Agency (MDA) reported its interest in using the Reaper and its MTS-B sensor to provide firing quality data for early interception of ballistic missile launches. The MDA is exploring concepts to use the UAV's EO/IR sensor to achieve "launch-on-remote" capabilities with missile interceptors before detection by Aegis radars. At least two aircraft would be needed to triangulate a target to provide high-fidelity data. The MTS-B includes short and mid-wave IR bands, optimal for tracking launch and rocket burn. In 2013, the MDA terminated plans to build a follow-on to the two orbiting Space Tracking and Surveillance System (STSS) satellites due to near-term costs, opting to continue testing the Reaper for ballistic missile target discrimination. The MDA planned to test the improved MTS-C sensor, which adds a long-wave IR detector optimized for tracking cold bodies such as missiles and warheads after booster burnout, or plumes and exhaust. The goal is to use data from multiple high-flying UAVs to provide an off-board cue to launch an SM-3 missile from an Aegis ship. Two Reapers demonstrated their ability to track ballistic missiles using their MTS-B EO/IR turret during a test in late June 2016.

In June 2015, a study by the USAF's Scientific Advisory Board identified several improvements for operating the Reaper in contested airspace; adding readily available sensors, weapons, and threat detection and countermeasures could increase situational awareness and enable riskier deployments. Suggestions included a radar warning receiver (RWR) to know when it's being targeted, air-to-air and miniature air-to-ground weapons, manned-unmanned teaming, multi-UAV control, automatic take-offs and landings, and precision navigation and timing systems to fly in GPS-denied areas. Another idea was redesigned ground control stations with user-friendly video game-like controllers and touchscreen maps to access data without overwhelming operators.



A Royal Air Force MQ-9 Reaper, 1 November 2010

In October 2015, Air Force deputy chief of staff for ISR Robert Otto suggested redesigning the MQ-9's GCS to be operated by one person for most missions rather than two (to fly and work the sensors) to simplify operations and reduce manpower requirements by hundreds of sensor operators. Introducing an auto-land capability would also reduce the Reaper's manpower requirements to staff launch and recovery teams. Automatic take-off and landing capabilities are already present in the RQ-4 Global Hawk and MQ-1C Gray Eagle, and are planned to be provided to the MQ-9 in 2017. The Air Force requires the manually loaded Reaper to operate from a runway at least 5,000 ft (1.5 km) long, but automated take-offs and landings would enable it to operate from a 3,000 ft (0.91 km) runway.

In April 2017, an MQ-9 Block 5 flew with a Raytheon ALR-69A RWR in its payload pod to demonstrate the aircraft's ability to conduct missions in the proximity of threat radars and air defences, the first time this capability was demonstrated on a remotely piloted aircraft. In September 2020, a Reaper was flown carrying two Hellfire missiles on each of the stations previously reserved for 500 lb bombs or fuel tanks. A software upgrade doubled the aircraft's capacity to eight missiles

Design

A typical MQ-9 system consists of multiple aircraft, ground control station, communications equipment, maintenance spares, and personnel. A military flight crew includes a pilot, sensor operator, and Mission Intelligence Coordinator.[5] The aircraft is powered by a 950 horsepower (710 kW) turboprop, with a maximum speed of about 260 knots (480 km/h; 300 mph) and a cruising speed of 150–170 knots (170–200 mph; 280–310 km/h). With a 66 ft (20 m) wingspan, and a maximum payload of 3,800 lb (1,700 kg), the MQ-9 can be armed with a variety of weaponry, including Hellfire missiles and 500-lb laser-guided bomb units. Endurance is 30 hours when conducting ISR missions, which decreases to 23 hours if it is carrying a full weapons load. The Reaper has a range of 1,000 nmi (1,150 mi; 1,850 km) and an operational altitude of 50,000 ft (15,000 m), which makes it especially useful for long-term loitering operations, both for surveillance and support of ground troops.

The Predator and Reaper were designed for military operations and not intended to operate among crowded airline traffic. The aircraft typically lack systems capable of complying with FAA See-And-Avoid regulations. On 18 May 2006, the Federal Aviation Administration (FAA) issued a certificate of authorization allowing MQ-1 and MQ-9 UAVs to fly in U.S. civil airspace to search for survivors of disasters. In 2005, requests were made for MQ-9s to be used in search and rescue operations following Hurricane Katrina but, as there was no FAA authorization in place at the time, it was not used.

An MQ-9 can adopt various mission kits and combinations of weapons and sensors payloads to meet combat requirements. Its Raytheon AN/AAS-52[citation needed] multi-spectral targeting sensor suite includes a colour/monochrome daylight TV, infrared, and image-intensified TV with laser rangefinder/laser designator to designate targets for laser guided munitions. The aircraft is also equipped with the Lynx Multi-mode Radar that contains synthetic aperture radar (SAR) that can operate in both spotlight and strip modes, and ground moving target indication (GMTI) with Dismount Moving Target Indicator (DMTI) and Maritime Wide-Area Search (MWAS) capabilities. The Reaper was used as a test bed for Gorgon Stare, a wide-area surveillance sensor system. Increment 1 of the system was first fielded in March 2011 on the Reaper and could cover an area of 16 km2 (6.2 sq mi); increment 2, incorporating ARGUS-IS and expanding the coverage area to 100 km2 (39 sq mi), achieved initial operating capability (IOC) in early 2014. The system has 368 cameras capable of capturing five million pixels each to create an image of about 1.8 billion pixels; video is collected at 12 frames per second, producing several terabytes of data per minute.

In January 2012, General Atomics released a new trailing arm design for the Reaper's main landing gear; benefits include an over 30 percent increase in landing weight capacity, a 12 percent increase in gross take-off weight (from 10,500 pounds (4,800 kg) to 11,700 pounds (5,300 kg)), a maintenance-free shock absorber (eliminating the need for nitrogen pressurization), a fully rejected take-off brake system, and provisions for automatic take-off and landing capability and Anti-lock Brake System (ABS) field upgrades. In April 2012, General Atomics announced possible upgrades to USAF Reapers, including two extra 100 US gallons (380 l) fuel pods under the wings to increase endurance to 37 hours. The wingspan can also be increased to 88 feet (27 m), increasing endurance to 42 hours. The USAF has bought 38 Reaper Extended Range (ER) versions, carrying external fuel tanks (which don't affect weapon capacity), the heavy-weight landing gear, a four-bladed propeller, a new fuel management system which ensures fuel and thermal balance among external tank, wing, and fuselage fuel sources, and an alcohol-water injection (AWI) system to shorten required runway take-off length; these features increase endurance from 27 to 33–35 hours, while the company is still pitching the lengthened wing option. The Reaper ER first flew operationally in August 2015. The aircraft also has the sensor ball replaced with a high-definition camera, better communications so ground controllers can see the higher quality video, software to enable automatic detection of threats and tracking of 12 moving targets at once, and the ability to "super ripple" fire missiles within 0.32 seconds of each other.

On 25 February 2016, General Atomics announced a successful test flight of the new Predator-B/ER version. This new version has had the wingspan extended to 79 feet, increasing its endurance to 40 hours. Other improvements include "short-field take-off and landing performance and spoilers on the wings which enable precision automatic landings. The wings also have provisions for leading-edge de-ice and integrated low- and high-band RF antennas." ■

Body text and images adapted from Wikipedia https://en.wikipedia.org/wiki/General_Atomics_MQ-9_Reaper

Reaper in flight. This offers a nice view of the upper surfaces.



Reaper UAV takes to the skies of southern Afghanistan.

