

AAI RQ-7 Shadow

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The **RQ-7 Shadow** unmanned aerial vehicle (UAV) is used by the United States Army, Marine Corps, Australian Army and Swedish Army for reconnaissance, surveillance, target acquisition and battle damage assessment. Launched from a trailer-mounted pneumatic catapult, it is recovered with the aid of arresting gear similar to jets on an aircraft carrier. Its gimbal-mounted, digitally-stabilized, liquid nitrogen-cooled electro-optical/infrared (EO/IR) camera relays video in real time via a C-band line-of-sight data link to the ground control station (GCS).

In the US, The Army's 2nd Battalion, 13th Aviation Regiment at Fort Huachuca, AZ, trains soldiers, Marines, and civilians in the operation and maintenance of the Shadow UAV. The training program is mainly undertaken by civilian instructors.

Contents

- 1 Design
- 2 Development
- 3 Operational history
 - 3.1 RQ-7 in civilian airspace
- 4 Variants
 - 4.1 RQ-7A Shadow
 - 4.2 RQ-7B Shadow
 - 4.2.1 Armed Shadow
 - 4.3 Shadow 600
 - 4.4 SR/C Shadow
- 5 Incidents and accidents
- 6 Specifications (200 Family)
- 7 Operators
- 8 See also
- 9 References
- 10 External links

RQ-7 Shadow



Shadow UAV in Iraq

Role	Tactical reconnaissance UAV for ground maneuver forces
Manufacturer	AAI Corporation
First flight	1991
Introduction	2002 ^[1]
Status	Active, in production
Primary users	United States Army 9 other users
Number built	100+ ^[2]
Unit cost	Per system: US\$15.5 million (2011 dollars) ^[3] Per aircraft: US\$750,000 (2011 dollars) ^[3]
Developed from	RQ-2 Pioneer

Design

The RQ-7 Shadow 200 unmanned aerial vehicle is of a high-wing, constant chord pusher configuration with a twin-tailboom empennage and an inverted v-tail elerudder. The aircraft is powered by a 38 bhp (28 kW) AR741-1101 Wankel engine manufactured by UAV Engines Ltd.^{[4][5]} Onboard electrical systems are powered

by a GEC/Plessey 28 volt, direct current, 2,000 watt generator.^{[4][5]} Currently, the primary payload for the aircraft is the Israeli Aircraft Industries POP300 Plug-in Optical Payload which consists of a forward-looking Infrared camera, a daytime TV camera with a selectable near-infrared filter and a laser pointer.^{[5][6]} The aircraft has fixed tricycle landing gear. Takeoffs are assisted by a trailer-mounted pneumatic launcher which can accelerate the 375 pound aircraft to 70 knots (130 km/h) in 50 feet (15 m).^[5] Landings are guided by a Tactical Automatic Landing System developed by the Sierra Nevada Corporation which consists of a ground-based micro-millimeter wavelength radar and a transponder carried on the aircraft.^{[5][7]} Once on the ground, a tailhook mounted on the aircraft catches an arresting wire connected to two disk brake drums which can stop the aircraft in less than 170 feet (52 m).^[5]



A RQ-7 in Iraq.

The aircraft is part of a larger system which currently uses the M1152-series of Humvees for ground transport of all ground and air equipment. The system consists of four aircraft, three of which are transported in the Air Vehicle Transporter (AVT). The fourth is transported in a specially-designed storage container to be used as a spare. The AVT also tows the launcher. The AVT Support Vehicle and trailer contain extra equipment to launch and recover the aircraft, such as the Tactical Automatic Landing System. Maintenance equipment for the aircraft is stored in the Maintenance Section Multifunctional (MSM) vehicle and trailer as well as the M1165 MSM Support Vehicle and its associated trailer. The system also contains two HMMWV-mounted Ground Control Stations (GCS) which control the aircraft in flight. Each GCS has an associated Ground Data Terminal (GDT). The GDT takes commands generated by the GCS and modulates them into radio waves which are received by the aircraft in flight. The GDT also receives video imagery from the payload as well as telemetry from the aircraft and sends them to the GCS. Each GDT is stored for shipping on a trailer which also houses a 10 kW Tactical Quiet Generator which powers its associated GCS. Each trailer is towed by a M1165 GCS Support Vehicle. Each system also contains one Portable Ground Control Station (PGCS) and Portable Ground Data Terminal (PGDT). The PGCS and PGDT are stripped-down versions of the GCS and GDT and are designed to be used as a backup to the two GCSs.^[5]

A fielded Shadow 200 system requires 22 soldiers to operate it. Army modelling indicates that crew workload is highest at takeoff, and second-highest at landing.^[8]

Development

The RQ-7 Shadow is the result of a continued US Army search for an effective battlefield UAV after the cancellation of the RQ-6 Outrider aircraft. AAI Corporation followed up their RQ-2 Pioneer UAV with the similar but refined Shadow 200, and in late 1999 the army selected the Shadow 200 to fill the tactical UAV requirement, redesignating it the RQ-7. The army requirement specified a UAV that used a gasoline engine, could carry an electro-optic/infrared imaging sensor turret, and had a minimum range of 31 miles (50 kilometers) with four hour endurance on station. The Shadow 200 offered at least twice that range, powered by a 38 hp (28.5 kW) rotary engine. The army requirement dictated that it be able to land in an athletic field.^[9]

Operational history

By July 2007, the Shadow platform accumulated 200,000 flight hours, doubling its previous record of 100,000 hours in 13 months.^{[10][11]} The system then surpassed 300,000 flight hours in April 2008,^[12] and by May 2010,

the Shadow system had accumulated over 500,000 flight hours.^[13] As of 2011, the Shadow had logged over 709,000 hours.^[3] The Shadow platform has flown over 37,000 sorties in support of operations in Iraq and Afghanistan by US Army and Army National Guard units.^[12] On 6 August 2012, AAI announced that the Shadow had achieved 750,000 flight hours during more than 173,000 missions.^[14]

Shadow did not see service in the Afghanistan campaign of 2001–2002, but it did fly operational missions in support of Operation Iraqi Freedom. The operating conditions in Iraq proved hard on the UAVs, with heat and sand leading to engine failures^[citation needed], resulting in a high-priority effort to find fixes with changes in system technology and operating procedures. Shadow UAVs have since flown more than 600,000 combat hours in support of the Wars in Iraq and Afghanistan.^[15]

In 2007, the United States Marine Corps began to transition from the RQ-2 Pioneer to the RQ-7 Shadow.^[16] VMU-1, VMU-2 have completed their transition from the RQ-2 to the RQ-7 and ScanEagle while VMU-3 and VMU-4 have been activated as Shadow and ScanEagle elements.^{[17][18][19]} VMU-3, was activated on 12 September 2008 and VMU-4 conducted its inaugural flight on 28 September 2010 in Yuma, AZ.^{[19][20]} In October 2007, VMU-1 became the first Marine Corps squadron to see combat in Iraq.^[16] VMU-2 deployed a Shadow detachment to Afghanistan in 2009, with VMU-3 following in January 2010.^{[18][19]}

The Navy provided personnel for four Shadow platoons in support of army brigades deployed in Iraq. The first two platoons returned from 6-month tours in Iraq in January and February 2008. The Navy personnel went through the Army's training program at Fort Huachuca, AZ.^[21]

RQ-7 in civilian airspace

The Shadow system has also received a special airworthiness certificate (experimental) from the Federal Aviation Administration authorizing operations at Benson Municipal Airport, a general aviation facility in southeastern Arizona. This airworthiness certificate is the first issued by the FAA permitting an unmanned aircraft to operate at a public-use airport that serves general aviation, and the first FAA certificate covering the system's technologically sophisticated automated landing system.^[citation needed] This is currently the only FAA certification category available to UAS manufacturers.

Variants

RQ-7A Shadow

The **RQ-7A** was the initial version of the Shadow 200 UAV developed by AAI. The first low-rate initial-production systems were delivered to the US Army in 2002 with the first full-scale production systems being delivered in September 2003.^[9] The RQ-7A was 11 ft 2 in (3.40 m) long and had a wingspan of 12 ft 9 in (3.89 m) with a 327 lb (148 kg) max takeoff weight.^[9] The aircraft's endurance ranged between 4 to 5.5 hours depending on mission. The "A" model aircraft also had the AR741-1100 engine which could use either 87 octane automotive gasoline or 100LL aviation fuel.^[5] The "A" model also featured IAI's POP200 payload.^{[5][6]}

RQ-7B Shadow

Production of Shadow aircraft shifted to a generally improved **RQ-7B** variant in the summer of 2004. The RQ-7B features new wings increased in length to 14 ft (4.3 m). The new wings are not only more

aerodynamically efficient, they are "wet" to increase fuel storage up to 44 liters for an endurance of up to 6 hours.^[5] The payload capability has been increased to 45 kilograms (100 pounds).^[9] After reports from Iraq that engines were failing, in 2005, the Army's UAV project manager called for the use of 100LL, an aviation fuel, rather than the conventional 87 octane mogas. Avionics systems have been generally improved, and the new wing is designed to accommodate a communications relay package, which allows the aircraft to act as a relay station. This allows commanders or even the aircraft operators themselves to communicate via radio to the troops on ground in locations that would otherwise be "dead" to radio traffic.



The RQ-7B leaves its launcher.

Other incremental improvements to the system include replacing the AR741-1100 engine with the AR741-1101 which increases reliability through the use of dual spark plugs as well as limiting the fuel to 100LL. Also, the older POP200 payload was replaced with the newer POP300 system.^[5]

In February 2010, AAI began a fleet update program to improve the Shadow system. The improvements include installing the wiring harnesses and software updates for IAI's POP300D payload which includes a designator for guiding laser-guided bombs. Other improvements in the program will include an electronic fuel injection engine and fuel system to replace the AR741-1101's carbureted engine. The most visible improvement to the system will be a wider wing of 20 feet (6.1 m) in span which is designed to increase fuel capacity and allow for mission endurance of almost 9 hours. The new wings will also include hardpoints for external munitions.^[22]

Preliminary TCDL testing conducted at Dugway Proving Ground was a success. This led to an estimated fielding date of May 2010 for TCDL.^[9]

A joint Army-Marine program is testing IED jamming on a Shadow at Yuma. Another joint effort is to view a 4x4km ground area from 12,000 feet.^[23]

A test version called STTB has been flown in Summer 2011. AAI is developing a bigger version called M2 with a blended wing to include a 3-cylinder 60 hp Lycoming heavy fuel engine,^{[24][25]} and began flight testing in August 2012.^[26]

The Army is now proposing the upgraded Shadow 152A, which includes Soldier Radio Waveform software, which allows both the command post and their troops to see the images that the UAV is projecting, as long as they are on the same frequency. It also increases the distance and area of communication.^[27]

Armed Shadow

On 19 April 2010 the Army issued a "solicitation for sources sought" from defense contractors for a munition for the Shadow system with a deadline for proposals due no later than 10 May 2010.^[28] Although no specific munition has been chosen yet, some possible munitions include the General Dynamics 81 mm 10-pound^[29]^{[30][31]} air-dropped guided mortar, as well as the QuickMEDS system for delivering medical supplies to remote and stranded troops. The Army subsequently slowed work, and the Marine Corps then took the lead on arming the RQ-7 Shadow. Raytheon has conducted successful flight tests with the Small Tactical Munition,^[32] and Lockheed Martin has tested the Shadow Hawk glide weapon from an RQ-7.^[33] On November 1, 2012, General Dynamics successfully demonstrated their guided 81 mm Air Dropped Mortar, with three launches at 7,000 ft hitting within seven meters of the target grid.^[34]

As of August 2011, the Marine Corps has received official clearance to experiment with armed RQ-7s, and requires AAI to select a precision munition ready for deployment.^[35] AAI was awarded \$10 million for this in December 2011, and claims a weapon has already been fielded by the Shadow.^{[36][37]}

Shadow 600

AAI has also built a scaled-up Pioneer derivative known as the "Shadow 600". It also resembles a Pioneer, except that the outer panels of the wings are distinctively swept back, and it has a stronger Wankel engine, the UAV EL 801, with 52 hp (39 kW).^[38] A number of Shadow 600s are in service in several nations, including Romania.^[39]

SR/C Shadow

AAI intends to modify two Shadows with a Carter rotor on top for vertical take-off and landing, eliminating the need for the recovery and pneumatic launcher systems, while increasing payload and endurance. AAI is working with Textron sister company Bell Helicopter on the project.^{[40][41]} It is expected to fly in 2012.^[42] AAI also expected to use the SR/C technology for the Shadow Knight, a powered-rotor two-propeller surveillance aircraft for the US Navy MRMUAS program.^{[43][44]} However, the program was cancelled in 2012 to save \$1.5 billion.^{[45][46]}

Incidents and accidents

On 15 August 2011 a US Air Force C-130 cargo plane collided with a RQ-7 while on approach to FOB Sharana. The C-130 made an emergency landing with damage to two engines and one wing, while the RQ-7 was destroyed completely.^[47] The collision caused the cargo aircraft to be grounded for several months while being fixed, while the RQ-7 wreckage was never recovered. Early reports indicating that the mishap occurred when the C-130 took off without clearance were incorrect. The investigating board determined that the mishap was largely due to poor local air traffic control training and supervision.

Specifications (200 Family)

General characteristics

- **Length:** 11.2 ft (3.4 m)
- **Wingspan:** 14 ft (4.3 m)
- **Height:** 3.3 ft (1.0 m)
- **Empty weight:** 186 lb (84 kg)
- **Gross weight:** 375 lb (170 kg)
- **Powerplant:** 1 × Wankel UAV Engine 741 used only with Silkolene Synthetic Oil , 38 hp (28 kW)

Performance

- **Maximum speed:** 127 mph; 204 km/h (110 kn)
- **Cruising speed:** 81 mph; 130 km/h (70 kn)
- **Range:** 68 mi (59 nmi; 109 km)
- **Endurance:** 6 h/ 9 h Increased Endurance
- **Service ceiling:** 15,000 ft (4,572 m) ELOS (Electronic Line Of Sight)

Note: When outfitted with IE (Increased Endurance) Wings, the CRP (Communications Relay Package) and the 1102 engine, the specifications change dramatically. Under the new configuration, endurance time is increased to 9 hours, wing span is increased to approx. 22 feet (6.7 m), and the service ceiling is 18,000 ft (only with authorization).

Operators

Australia

- **Australian Army**; The Australian Government has bought 18 aircraft to supplement the current use of ScanEagles,^[48] and began using them in Afghanistan in May 2012.^[49]

Italy

- In July 2010, the Italian army ordered four Shadow 200 systems.^[50]

Pakistan

- **Pakistani Air Force**; 12 aircraft (3 systems) have been ordered for Pakistan^[2]

Romania

- **Romanian Air Force**; The Romanian Air Force has purchased 11 Shadow 600s,^[39] a larger, fuel injected Shadow variant. Some of these Romanian machines have been used in support of Polish troops serving in Iraq.^[*citation needed*]

Sweden

- **Swedish Army**; 8 aircraft (2 systems) have been ordered and will be delivered early in 2011. However these units will be modified by SAAB to create a system that is more suited for Swedish use. It will be a different version from the RQ-7 Shadow, named UAV03 Örn^[51]

Turkey

- **Turkish Air Force**; The Turkish Air Force also operates the RQ-7 Shadow 600.^[52]

United States

- **United States Army** - 450 RQ-7Bs, 20 more on order^[53] plus additional 68 ordered^[54]
- **United States Marine Corps** - 52 RQ-7Bs^[53]
- **United States Navy**

See also

- Unmanned Aerial Vehicle
- Unmanned Combat Air Vehicle
- Dragon Eye

Related lists

- List of active United States military aircraft

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External links

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- AAI Corporation (development/manufacturing) (<http://www.aaicorp.com/>)
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Categories: Unmanned aerial vehicles of the United States

| United States military reconnaissance aircraft 1990–1999 | Airborne military robots | Twin boom aircraft

| AAI aircraft | Single-engined pusher aircraft

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