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UNMANNED COMBAT AIR VEHICLE: MQ-9 REAPER

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Abstract: Currently are increasingly we meet with the term flying unmanned aerial vehicles or also drones. Also gets are into the awareness of the notion unmanned combat air vehicles, also known as UCAV. Among the best known means of unmanned aerial vehicles in categories UCAV include MQ-9 Reaper, also known as the Predator B.

Keywords: Unmanned Combat Air Vehicle, UCAV, MQ-9 Reaper, Predator, Aircraft

1. INTRODUCTION

Unmanned combat air vehicle MQ-9 Reaper belongs to a group of defense systems and its primary purpose is finding, tracking and destruction of land and sea targets. This flying unmanned combat aerial vehicle has a wingspan of 20 meters and a length of 11 meters. Maximum weight of take-off is 4,763 kg, can carry 1361 kg load externally, ie. in underslung and 386 kg load internally in the fuselage.

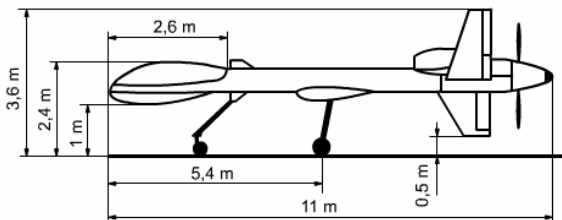


Fig.1 The Dimensions of MQ-9 Reaper

Drive provides turboprop unit from Honeywell TPE331-10, which allows this air vehicle achieve of maximum speed of 240 KTAS (445 km/h), has endurance in the air 36 hours and altitude ceiling maximum 50 000 ft (15 240 m).

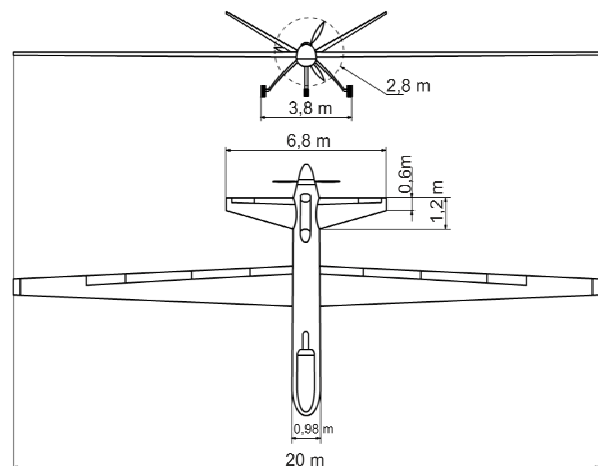


Fig.2 Drawing MQ-9 Reaper from above and from the front

The aircraft is equipped with a 6-bearing pylons for the possibility carrying of weapons and weapons systems, as well as underslung fuel tanks for increase its range. MQ-9 Reaper carries on its board 1769 kg of fuel (without underslung fuel tanks). On board there is also a multi-functional anti-ground radar LYNX ER, Multi-mode maritime radar, transmission system, electro-optical infrared system MTS-B EO/IR, laser designator of targets, electronic

support systems SIGINT/ ESM, electronic jammers, various probes and sensors. The aircraft has the developed system for the automatic take-off and automatic landing. It also contains multi-spectral tracking and targeting system (MTS-B) AN/AAS-52. Communication link is provided via SATCOM, via single channel, C-band (LOS), Ku-band SATCOM bandwidth is 1.6/3.2 Mbps. For the operation and management of the MQ-9 Reaper are required at least 2 people, 1 pilot and 1 operator.

2. CONSTRUCTION

Aircraft structure is composed primarily of advanced materials. It is a composite materials made mostly up of carbon fiber, these materials constitute up to 89% of the airframe structure. Such a high percentage of these materials contribute to the low weight of the aircraft and the prolongation of its range.



Fig.3 MQ-9 Reaper with underslung armament

Overall the construction, the shape and the materials are developed to contribute to the reduction of detectability by a radar, as well as human senses. MQ-9 Reaper is in the basic configuration 11 meters long, 3.6 meters tall and its wingspan is 20 meters, what allowing of this UCAV high ratio of buoyancy/weight.

3. DRIVE

Drive of unmanned combat air vehicle MQ-9 Reaper provides turboprop engine unit TPE331-10 from company Honeywell, which provides maximum power 944 hp (712 kW) and allows the air vehicle to reach maximum speed of 240 KTAS (445 km/h). Maximum

turbine speed is 41730 rpm, the maximum limit of speed propeller is 2000 rpm.

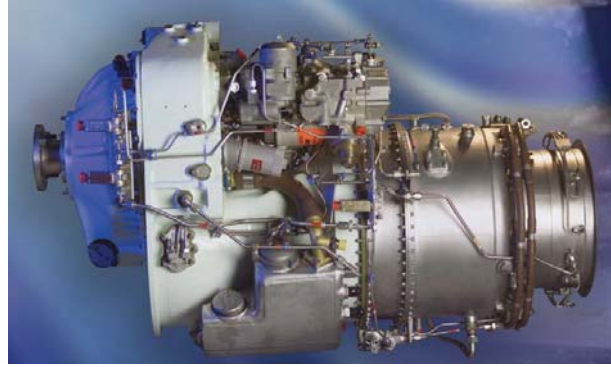


Fig.4 Turboprop engine TPE331-10 of Honeywell company

As fuel for this power unit is most commonly used fuel JP-8 or also JP-4. Weight of the entire power unit is 174,63 kg.



Fig.5 Showing power unit TPE331-10 with propeller in the cut

4. ARMAMENT

The primary armament which are uses for unmanned combat air vehicle MQ-9 Reaper is constituted of missiles AGM-114R known as Hellfire II which weighing 100 pounds and are designed to destroy armored objects on land and sea. Using modern semi-active laser head allows the launch also from great heights, which is for the unmanned aerial vehicles very important in view of their higher operational flight levels. Due to higher flight levels is reached even higher angle of impact of the missile to target which increases her effectiveness and thanks to the new navigation unit is more accurate. Another frequently used armament in MQ-9 Reaper are laser-guided 500-pounds aerial bomb termed as GBU-12 Paveway II. These bombs using modern advanced semi-active laser-guidance warhead



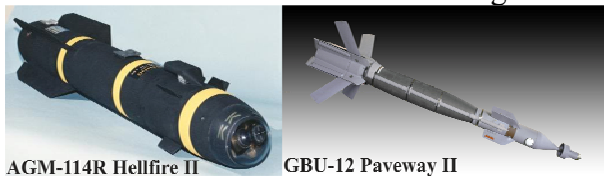
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to the effective destruction of solid-static targets, mobile targets and moving targets. With the new dual navigation units INS/GPS are accurate and destruction of targets is more efficient with reduced collateral damage.



AGM-114R Hellfire II GBU-12 Paveway II

Fig.6 Demonstration of a possible armament MQ-9 Reaper

Between the further armament may be included bombs GBU-38 JDAM and GBU-49 laser-JDAM. Aerial bomb GBU-38 JDAM and its design is based on the Mk-82 bomb, but has JDAM guidance system. Thanks tail part bombs, which contains navigation system with GPS/INS is becomes accurate guided weapon, the which of accuracy is approximately 9.6 m. Weight GBU-38 JDAM is 500 pounds (227 kg), it may be drain her up to 28 km from the selected target, through day and night and in all weather conditions. Construction of GBU-49 laser-JDAM is based at bomb GBU-12 with JDAM guidance system that includes dual guidance system with laser and GPS-guidance (Bomb GBU-12 was also developed from the Mk-82).



Fig.7 Munition GBU-38 JDAM

The accuracy of the bomb is about six meters, the maximum launch is 15,000 m from the target, this aerial bomb can also be found under designation EGBU-12 Paveway II.

5. SYSTEMS

5.1 AN/AAS-52 System

Multi-spectral surveillance and targeting system (MTS-B) AN/AAS-52 includes electro-optical, laser and infrared sensors for detecting, tracking and labeling of objects and targets. Allows remote monitoring of targets in high resolution, determine their distance, coordinates and label for Hellfire missiles, as well as for all laser-guided munitions NATO. The whole system is composed of two main parts and namely from rotating tower unit, which is located in the inferior front part of the MQ-9 Reaper and electronic optical unit, which is located in fuselage UCAV. This system also allows for lighting targets, is designed to be modular and can be complemented with various optical sensors for different wavelengths, as well as additional electronic circuitry, allowing wide-spectral use of the system and as well its development.



Rotating turret unit (WRA-1) contains laser rangefinder, infrared cameras, electro optical camera, high resolution cameras, as well as laser designator and illuminator



Elektronic unit (WRA-2) of system AN/AAS-52 (MTS)

Fig.8 Turret unit WRA-1 with electronic unit WRA-2 of system AN/AAS-52 (MTS)

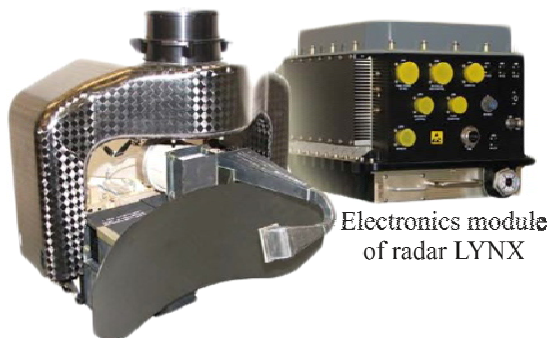
5.1 SIGINT/ESM System

System SIGINT / ESM allows conducting radio-electronic warfare and supports the distribution of actions at capture, identify and locate sources of electromagnetic energy. ESM system provides information you how to avoid menace, targeting and guiding of potential missiles. Information on electronics systems

can be used for creating signal intelligence - SIGINT. <85kg).

5.2 Radar LYNX ER

Multifunction radar Lynx ER provides selectable resolution, operation in all weather conditions, day and night. This radar has to the fight certificate, the ability to change detection and as well can capture images SAR in high resolution. Thanks to the latest electronics and sensor delivers images of photographic quality of objectives through the clouds, dust, smoke, fog and total darkness. These its features are crucial for detecting and tracking targets at greater distances and poor visibility when it is not possible to use electro-optical and infrared sensors. Radar is composed of the two systems, namely from the radar antenna and the electronics module. Also allows to work in maritime search mode, also in mode the search ground moving targets and is able to work in so called mode of indication of movement on the ground (GMTI).



Radar antenna LYNX

Fig.9 Radar Lynx ER with antenna and with electronics module

Radar range is 80 km, and its resolution is in the range 0,1 to 0,3 m for mapping images - objects at surface depending on the mode selected. Can detect the even small vehicles moving with speed up to 70 km/h. At maximum airspeed MQ-9 Reaper 445 km/h can this radar to map the surface from a altitude of 13700 m land area of approximately 60 square kilometers per minute. In mode SPOT is capable radar to map in detail the area 300x170m from a distance of 40 km. On these images may view objects smaller than 10 cm. AN/DPY-1 Block 30 radar may detected of the car movement in real-time (system weight

6. Control

Drone MQ-9 Reaper disposes a modern management system and autopilot. The aircraft can operate fully autonomously without pilot-operator during the entire mission, so as can take off, fly to the target of the mission, go back and land safely without human-pilot intervention to control. Such management requires careful programming of the entire mission of the aircraft to be able to fly fully autonomous.



Fig.10 Control panel of MQ-9 Reaper

Pilot-operator, however may intervene at any time into control and take control. In the event that the aircraft is in autonomous mode, command signals are received from ground control stations. Control of the aircraft is possible with using multiple systems, such as direct management (LOS) using small portable stations consisting of laptops and antennas that may use ground troops, also is possible to control UCAV using small mobile control stations (OSRVT/ ROVER). For full control of the aircraft and the manage of operations, it is necessary in most cases uses of the system SATCOM respectively Wideband Global SATCOM (WGS).

5. Communication

Unmanned combat air vehicle MQ-9 Reaper uses blos C2 data lines in the range of ultra high frequency UHF (300MHz) for the Ku band (15 GHz). Data lines Ku band of system SATCOM are often used blos C2 system (system of indirect command and control), this band is used for UAV means,



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because has of the high resistance to interference. Uses the frequency range from 11,7 to 12,7 GHz for downlink and 14-14,5 GHz for uplink. For maintaining domination in the conflict is needs to be effectively command and control (C2). Blos C2 system is designed to build own network management and control, capable of self-interference suppression and encryption.

For this aircraft can also be used so called Common data line (CDL) and also tactical CDL (T-CDL). There are two technologies for CDL lines, the first data line uses the I-band SATCOM second data line uses Ku-band at frequencies from 14,5 to 15,38 GHz for to increase the available bandwidth.

6. CONCLUSIONS

Unmanned combat air vehicle MQ-9 Reaper represents in many aspects of the revolution in military aviation. This aircraft was among of the first unmanned flying means which were armed and used in real conflicts.

These experiences and information helped at develop unmanned combat air vehicles (UCAV) in the world and also UAV systems. Properties of this UCAV, as well his stamina in the air, modern tracking systems, the option to equip it exactly abetting ammunition as well as its price predetermine it for use in military conflicts in various regions of the world. It is thanks to the fact that this system is managed automatically or remotely and eliminates the risk of losing the crew in case of shooting down, as well as other potential costs and risks associated with the tracing actions intended to rescue the crew. Also provides support to ground and naval forces, is an excellent tool for guarding the border on land, and at sea, in day or night, in all weather conditions. With a wide range of uses, its accuracy destruction of

targets, makes it from unmanned combat air vehicle MQ-9 Reaper one of the most sophisticated aviation weapons systems of 21st century, which is able to attack anywhere in the world without finding was its presence. Development and modernization of systems this UCAV are will expand the already so wide range of uses, as well as the possibility of using other weapons systems. Aircraft MQ-9 Reaper has in currently been stable place in the several armed forces different countries of the world and its use, as well as reports of him even more rise.

REFERENCES

1. Bréda, R. – Čižmár, J. – Soták, M. – Beňo V.: *Letecké prístroje*, Vysokoškolská učebnica, Technická Univerzita Košice, Letecká Fakulta, ISBN: 987-80-553-0626-1. (2011)
2. Adamčík, F. – Adamčík, F. jr: *Spacecrafts electrical power systems*,. Acta Avionica 2010. ISSN 1335-9479. – Roč. 12, č. 20, S. 76-78. (2010)
3. Adamčík, F. : *Artificial Intelligence Technology on Board of Aircraft*, Advances in Military Technology, Vol. 1, No. 1, pp.137-142, (November 2006)
4. Valavanis, K. P. - Oh, P. - Piegl L.A.: *Unmanned Aircraft Systems*, International Symposium on Unmanned Aerial Vehicles, UAV '08. Springer, USA. ISBN 978-1-4020-9136-0. (2008)
5. General Atomics Aeronautical Systems, Inc.: *MQ-9 REAPER/PREDATOR B*, Persistent Multi-mission ISR and Strike Aircraft: Brochure. Poway, California, USA. Available: http://www.gasi.com/products/aircraft/pdf/Predator_B.pdf (2012)

6. Austin, R: *Unmanned Aircraft Systems, UAVS DESIGN, DEVELOPMENT AND DEPLOYMENT*, Wiley, USA, ISBN 978-0-470-05819-0. (2010)
7. Cullen M, T.: *The MQ-9 Reaper remotely piloted aircraft: Humans and machines in action*. Massachusetts Institute of Technology, USA. (2011)
8. Raytheon Company, Missile Systems: *Enhanced PavewayTM II Dual Mode GPS/Laser Guided Bombs: Dual-Mode Precision-Guided Weapon*. Tucson, Arizona, USA. Available: www.raytheon.com (2009)