



Considerations of Ukrainian Unmanned Aerial Vehicles development in a global market

China
2019



National Aviation University

Motto	Vivere! Vincere! Creare! (Live!Win!Create!)
Established	1933
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Location	Kosmonavta Komarova ave., 1, Kyiv, Ukraine, 03058
Website	http://www.nau.edu.ua/
Main historical dates	1898 - Mechanical department of Kyiv Polytechnic Institute 1933 - Kyiv Aviation Institute 1947 - Kyiv Institute of Civil Air Fleet 1965 - Kyiv Institute of Civil Aviation Engineers 1994 - Kyiv International University of Civil Aviation 2000 - National Aviation University

Strategy of the National Aviation University



Directions of scientific activity

Aerospace
Technology

Information
Technologies:
Cybersecurity,
Artificial
Intelligence

Eco-
biotechnology

Energy
saving
technologies

Materials
science

Strategy of the National Aviation University



Our primary tasks:

- to develop Ukrainian system of scientific research aimed at further implementation of innovations in production and industry;
- to receive state support for the development of innovation infrastructure (research university, technopark, clusters, high-tech innovative enterprises, innovative business incubators, venture funds);
- to initiate simplification of the system of the national patents registration;
- to implement systems of artificial intelligence, including new cognitive network center technologies of transport (unmanned vehicles, management and planning of traffic flows in the city);
- to work out technologies of algorithms, software and hardware of intellectual services of domestic, medical, social purpose;
- to create cognitive military systems (soldiers of the future, mobile mine work, intelligent arms control systems, unmanned vehicles);
- to initiate intelligent image recognition systems (technical view, speech);
- to create stratospheric unmanned monitoring and communication systems;
- to develop systems of satellite communication, navigation and surveillance;
- to develop theoretical and practical principles for the creation of space crafts.



Scientific and Production Center of Unmanned Aviation 'Virazh' (SPCUV 'Virazh')



Activity of the SPCUV 'Virazh' is focused on designing and development of modern competitive unmanned aviation technology industrial mass production in order to use it for the economical benefits.

The main tasks of SPCUV 'Virazh' are:

- designing and development of unmanned aircraft (UAV) of different classes, assignments, with different layout schemes and individual on-board systems;
- designing, research and production of power plants of UAV;
- development of holistic unmanned aircraft systems (UAS);
- UAV flight tests using the corresponding certification procedures;
- technological processes development for UAV manufacturing parts with the help of modern and advanced structural materials;
- system analyses in the sphere of unmanned aviation;
- participation in the legal support improvement for the development and application of UAV in the airspace;
- training of UAV ground staff and development of their direct training programs and techniques.

Designing is conducted with the help of the following software means: "ANSYS", "SolidWorks", "AutoCAD", "Compass" and others.

To comply with European and international requirements for the development of unmanned aircraft, such standards and regulations are used in the center: АП-23, АП-25, АП-39, STANAG, ICAO documents, EASA, Eurocontrol, NATO.



Products of SPCUV 'Virazh'

MULTIMOTOR HELICOPTER FOR CARGO TRANSPORTATION

PKM-14 «SATURNIA»



Purpose and scope of use

PKM-14 «Saturnia» is an unmanned aerial vehicle used for transportation of small cargoes in automated mode. The potential users of the UAV are civil aviation companies and other civil users.

Main technical characteristics

Design technical characteristics: characteristic feature - turning the hulls of power plants into transport position; type of control system - automatic, with preliminary flight planning; take-off/landing - on the landing gear, which is retracted in flight; payload weight, kg - up to 2; radius of action, km - up to 3; maximum speed on the route, m/sec (km/h) - 8,5(30); flight altitude - up to 500 m; aerodynamic scheme - 4 electric power units.

Main advantages

Advantages of UAV PKM-14 Saturnia are the integrated fuselage (central body), which combines bearing rays, a compartment for electronic equipment, an onboard battery compartment and a payload compartment. Considering the set of properties PKM-14 Saturnia is an automatic device for servicing commercial networks. There are no analogues in the world. Analogues for use are multicopters from the "Amazon" company.

Intellectual property protection status

We received 1 patent of Ukraine for utility model.

Demand on the market

The market for UAV PKM-14 Saturnia is a global one. However, to prove that we require appropriate experimental exploitation. Probable users will be the companies servicing retail network stores of packaged goods weighing up to 2 kg.

The state of readiness

Stage of implementation: Flight tests of the prototype are carried out.





Products of SPCUV 'Virazh'

MULTIPURPOSE UNMANNED AERIAL COMPLEX M-6-3 «ZHAYVIR»

Purpose and scope of use



Multipurpose unmanned aerial complex M-6-3 «ZHAYVIR» is used for the following tasks: aerial photography, video monitoring in the real time and linear and other objects patrolling, urgent transportation of small cargoes. The potential users of the unmanned complex are civil aviation companies, force and special structures of Ukraine.

Main technical characteristics

Multipurpose unmanned aerial complex M-6-3 «ZHAYVIR» is an aerodynamically complete aircraft based on a conventional scheme, with a wing, which uses profiles with aerodynamic quality up to 160 units. The use of the V-tail empennage, the implementation of deep fissures between the wing and the fuselage, and the corresponding boning of the protruding parts - all of this has allowed to achieve aerodynamic quality 18-20 units while cruising. Main technical characteristics of UAV: take-off mass, kg - up to 17, payload, kg - up to 4, max. speed, km/h – 160, flight duration, h – up to 5, range of action, km – up to 80, max. flight height, m – up to 3000, taking-off/landing type – wheeled. UAV control mode is automated/semi-automated. Modifications: M-6-3T – cargo, for transportation of small cargoes: M-6-3K – catapulting, to be based beyond airfield.

Main advantages

Perfect aerodynamics that leads to significant fuel economy, increased resource of the propeller engine, excellent maintenance on the line of the given path, increased wind resistance that expands the boundaries of "all-weather" flight property. Models of UAV M-6-3 "ZHAYVIR" were delivered to the force structures of Ukraine in the ATO zone in 2015. World analogues of this UAV are unmanned aerial vehicles Pointer (USA), LUNA (Germany), Rafaei Sky Lite B (Israel).

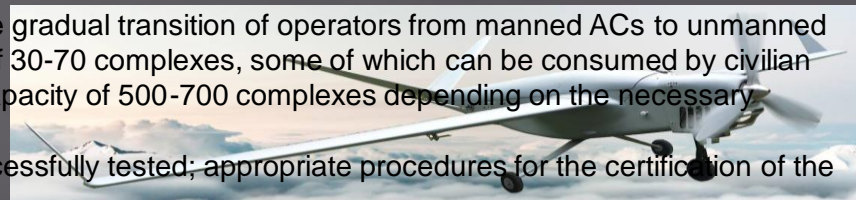
Intellectual property protection status

6 patents of Ukraine were obtained for the utility models.

Demand on the market

The global UAV market: the demand for them is formed by countries due to the gradual transition of operators from manned ACs to unmanned aerial vehicles. The Ukrainian market has capacity for M-6-3 within the limits of 30-70 complexes, some of which can be consumed by civilian airlines, and another part by special services. The global market can have a capacity of 500-700 complexes depending on the necessary modifications of UAV M-6-3.

The state of readiness Several prototypes have been manufactured and successfully tested; appropriate procedures for the certification of the type of aircraft are taking place in the SAS of Ukraine.





Products of SPCUV 'Virazh'

DOUBLE ENGINE UNMANNED AIRCRAFT M-7V5 «NEBESNIY PATRUL'»



Purpose and scope of use

Unmanned aerial vehicle (UAV) is used for aviation activities in different branches of economy. It can be used for cartography and aerial photography, video surveillance in the real time, patrolling linear and other objects etc. The specified UAV is supplied with a ground control station. Potential users of UAV are civil airlines, force and special structures of Ukraine.

Main technical characteristics

M-7V5 "Nebesniy patrol" is a high wing double engine aircraft of a normal scheme. For access to the payload compartment, the front and rear parts of the gondola are made in the form of removable trimmings. The front of the gondola has an opening for the front view camera. UAV's basic technical characteristics: take-off mass, kg – up to 200; mass of the payload, kg - up to 70; max. speed, km/h – 250; max. altitude of flight, m- up to 6000; max. duration of flight, hours – up to 10; type of take-off and landing – as an airplane; control modes – automatic/semiautomatic.

Main advantages

UAV M-7V5 has high flight characteristics, which is favourable for a runway with ground cover / high altitude aerodromes; two engines provide high flight reliability; the tail beam deviates and provides small dimensions of the UAV in the transportation position; modular design allows you to quickly get modifications to the UAV. Given the low probability of failure of two power units at the same time, the UAV M-7V5 is much more reliable than single-engined UAV such as AAI Shadow 400 (USA), IAS Raffaello (Italy) etc.

Intellectual property protection status. We received 8 patents of Ukraine for utility models.

Demand on the market

The market for UAV is global: the need for them is formed by countries due to the gradual transition of operators from manned aircraft to unmanned aerial vehicles. The Ukrainian market has a capacity for M-7V5 within 10-15 complexes, some of which may be used by civil airlines, and some - by special services. The intended life of the UAV is 6 years before major repairs. The world market can have a capacity of 150-200 complexes, depending on the necessary modifications of the UAV M-7V5.

The state of readiness

Status: at this stage UA is in the process of obtaining an aircraft certificate (order №164 from 27.02.2018 the State Aviation Administration of Ukraine)

1. The successful completion on 03.08.2018 of the first stage of certification of aircraft type. The fulfillment of the planned activities of the stage No. 2 according to the Part-21





Products of SPCUV 'Virazh'

MOBILE UNMANNED AERIAL COMPLEX M-10 «OKO 2»



Purpose and scope of use

Mobile unmanned aerial complex M-10 «OKO 2» is used for the following tasks: remote surveillance of objects by air (separate buildings, roads, bridges, vehicles, oil and gas pipelines, transmission lines, etc.); monitoring of airspace in emergency situations (fires, earthquakes, floods, man-made disasters); search and rescue works; telemetry and video data transmission in on-line mode. Potential users of the unmanned complex are civil airlines, force and special structures of Ukraine.

Main technical characteristics

UAV M-10 "OKO 2" is a single-engined lightweight medium plan with a "V" -like empennage. The glider is made of fiberglass and carbon fiber, some loaded elements of the design are made of aluminum high-strength alloys. The main technical characteristics of the M-10 "OKO 2": max. take-off mass – up to 4,95 kg; payload mass – up to 0,8 kg; flight duration – up to 120 min.; flight distance – up to 150 km; max. speed of flight – 150 km/h; max. height of flight – up to 2000 m; range of action (online video broadcast)– 22 km; digital data channels are protected; type of control system - semi-automatic / automatic.

Main advantages

The ability to operate without a base makes it possible to operate the M-10 "OKO 2" in virtually any location. Thanks to the design features and small size, the UAV M-10 " OKO 2" has a small optical, acoustic and radar sensitivity. A significant load per unit area of the wing allows keeping the top operational value of the wind component up to 22 m / s. The world's analogs of this UAV are: Dragonfly Tango; Micropilot CropCam (Canada); EMT Aladin (Germany); Aeronautics Orbiter, IAI Bird Eye 400 (Israel) and others. Samples of UAV M-10 " OKO 2" were supplied to the force structures of Ukraine in the ATO zone in 2015-2016.

Intellectual property protection status

4 patents of Ukraine were obtained.

Demand on the market

The market for UAV is global: the need for them is formed by countries in connection with the gradual transition of operators from manned aircraft to unmanned aerial vehicles. The Ukrainian market has a capacity for the M-10 within the range of 100-150 complexes, some of which may be used by civil airlines, and part by special services. The world market can have a capacity of 700-1000 complexes.

The state of readiness

Completion of preliminary and defining departmental tests of the prototype.





Products of SPCUV 'Virazh'

TRAINING UNMANNED AERIAL VEHICLE M-22D «AEROTESTER»



Purpose and scope of use

M-22D "Aerotester" is a training unmanned aerial vehicle (UAV) designed for external pilots training. The basis of the development is the results of research on the training of external pilots and other staff for unmanned CA aircraft, as well as the need for a relatively cheap means of ascending experimental aircraft devices and systems. Potential users of UAV are Training Units (Flight Training Organisations - FTOs) for the training of external UAV pilots. UAV M-22D "Aerotester" can be used by organizations associated with raising the scientific devices to a height ("flying laboratory").

Main technical characteristics

Max. take-off mass, kg – up to 21; max. payload mass, kg – 8; max. speed of flight, km/h – 160; max. height of flight, m – up to 5000; type of engines – two-cycle piston fuel engine; range of action, km – 20; flight duration, h – 1; control modes – automatic/semiautomatic; taking-off type – as an aircraft; landing type – as an aircraft.

Main advantages

The advantage of the M-22D "Aerotester" is, first of all, the full realistic reproduction of a two-engine unmanned aircraft flight, which makes it attractive for aviation training organizations. At the same time, the consumption of fuel during flights is lower than 4-5 times from real samples of UAV. By the mechanization of the wing, steering surfaces, undercarriage location and most of the M-22D systems, "Aerotester" fully complies with the UAV class "Nebesniy patrol".

Intellectual property protection status

2 patents of Ukraine were obtained.

Demand on the market

The market for two-engined training UAVs is not well developed due to the initial formation of civil airlines - UAV operators, and therefore, the lack of proposals for these aircraft. The forecast for supplying M-22D "Aerotester" to Ukraine can be 5-10 units.

The state of readiness

Implementation stage: experimental exploitation.





Products of SPCUV 'Virazh'

UNMANNED LOITERING MUNITION M-56 "MODULE"



Purpose and scope of use

M-56 "Module" refers to unmanned aerial vehicles with an electric motor and a launch weight of up to 20 kg that are used to cruise / patrol the territory in order to ensure debarment of enemy objects by detecting and destroying them. Potential users of the M-56 "Module" are force and special structures.

Main technical characteristics

M-56 "Module" serves as a guardian, which defends the territory from attack. The vehicle is "intelligent" as it determines the type of a target and / or decides to strike, or "asks the ground control: What should I do next? " In addition, the M-56 "Module" is a high-precision weapon + scout + artillery fire corrector. M-56 "Module" contains ammunition on board.

On-board computer has software for the following "intellectual" work: recognition and identification of targets; selection of optimal heights for a strike; bypass obstacles, etc. After performing the task, the M-56 "Module" returns "home" and lands with the help of a parachute. Main technical characteristics of the M-56 "Module": wingspan, m – 4,58; max. take-off mass, kg – 13; payload mass, kg – 4; duration of flight, h. – 4; technical range of action, km – 120; route distance, km – 246.

Main advantages

One of the significant advantages of the M-56 "Module" is the multiple execution of "combat work" during one flight, which no competing vehicle is capable of. In addition, due to the typical design of the supporting part (fuselage), the M-56 "Module" is easily modified by the application of various bearing planes (wings). The on-board software contains elements of artificial intelligence. Analogue on the market: loitering munition Orbiter 1K (Israel)

Intellectual property protection status

1 application for obtaining a patent of Ukraine for a utility model is submitted.

Demand on the market

The market for UAV M-56 "Module" is world-wide and it is military-oriented. The Ukrainian market has 300-500 complexes. The world market can have a capacity of 5000-7000 complexes depending on the price.

The state of readiness

Manufacturing prototype and preparation for ground and flight tests.





Products of SPCUV 'Virazh'

MOBILE UNMANNED AERIAL COMPLEX M-57 «SVITANOK»



Purpose and scope of use

Unmanned aerial complex M-57 «Svitanok» is designed for video surveillance and taking pictures of linear and plane objects from the air. Potential users of M-57 are the force and special structures of Ukraine.

Main technical characteristics

M-57 «Svitanok» is an unmanned aerial vehicle (UAV) of the "flying wing" scheme of a large elongation. UAV is equipped with a color video camera with a digital transmitter. Basic technical characteristics of the UAV: maximum takeoff weight - up to 10 kg; payload mass - up to 2 kg; flight duration - up to 180 min. using lithium polymer batteries; maximal flight speed - 120 km/h.; maximal altitude - up to 3000 m; type of control system - automatic/semi automatic, flight planning using Google maps; start - from hand/with a rubber shock absorber; landing - under parachute; range of action - up to 70 km.

Main advantages

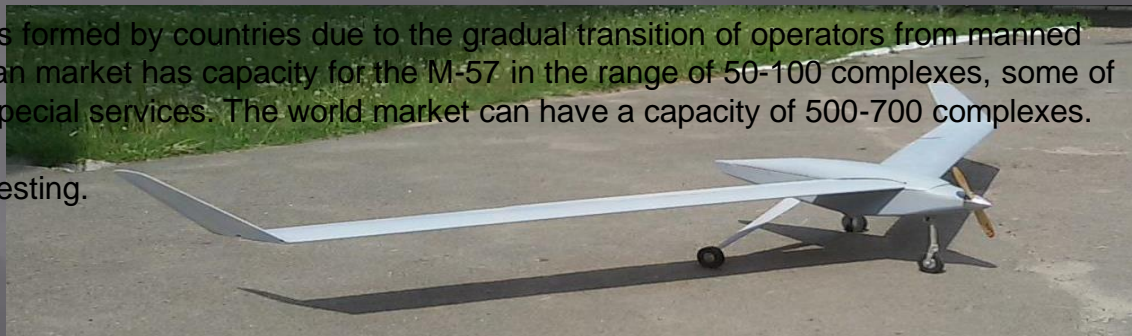
In the class of electric unmanned aircraft with a flight time of 3 hours, UAV M-57 Svitanok can compete with UAV Spectator (Ukraine), Orbiter (Israel) and others. The undeniable advantages of UAV -M-57 are its low material content, low optical, acoustic and radar visibility. Also, the specified UAV has a high level of maintenance in the field and can be operated in combat situations.

Intellectual property protection status

The market for UAV is global: the need for them is formed by countries due to the gradual transition of operators from manned aircraft to unmanned aerial vehicles. The Ukrainian market has capacity for the M-57 in the range of 50-100 complexes, some of which may be used by civil airlines, and part by special services. The world market can have a capacity of 500-700 complexes.

The state of readiness

A prototype manufactured is undergoing factory testing.





Products of SPCUV 'Virazh'

MULTICOPTER NAU PC-08



Purpose and scope of use

Multicopter NAU PC-08 is an unmanned aerial vehicle (UAV) designed for aerial photography, cartography, real-time video surveillance, point-to-point patrols, and more. Potential users of UAV are civil aviation companies, force and special structures of Ukraine.

Main technical characteristics

Starting mass – up to 4 kg; load capacity - up to 1,5 kg; flight duration – up to 30 minutes; flight distance – up to 4 km; flight altitude - up to 500 m; speed – up to 30 km/h; number of rays – 6; specifics – folding; take-off / landing – on the landing skid; type of control system – automatic/semiautomatic, with planning of flight using Google maps. Standard payload - gyrostabilized daytime CCD - camera.

Main advantages

The main advantage of the NAU PC-08 is its small size in the transportation position, as well as the high level of maintenance in the field. The samples of NAU PC-08 were supplied the force structures of Ukraine in the ATO zone in 2014. The world's analogues of this UAV are: Aeryon (Canada) and AR-100B (Germany).

Intellectual property protection status

We received 4 patents of Ukraine for utility models. Appropriate NAU PC-08 certification procedures to be considered as an aircraft for civil aviation, are being conducted.

Demand on the market

The market for the project is global. There are quite a lot of models of multicopters on the market, a large number of which are intended for amateur use and can not be used in civil aviation. With the acquiring of a NAU PC-08 type certificate, it may be needed in the amount of 500-1000 units for the Ukrainian market and in the amount of 1000 to 5000 for the world market.

The state of readiness

Stage of implementation: experimental operation, procedures for obtaining a type of aircraft certificate in the SAS of Ukraine.





Products of SPCUV 'Virazh'

MOBILE UNMANNED AERIAL COMPLEX «Ovod» M106

Purpose and scope of use

Mobile unmanned aerial complex «Ovod» M106 is used for the following tasks: remote surveillance of objects by air (separate buildings, roads, bridges, vehicles, oil and gas pipelines, transmission lines, etc.); monitoring of airspace in emergency situations (fires, earthquakes, floods, man-made disasters); search and rescue works; telemetry and video data transmission in on-line mode. Potential users of the unmanned complex are civil airlines, force and special structures of Ukraine.

Main technical characteristics

UAV «Ovod» M106 is a single-engined lightweight medium plan with a "V" -like empennage. The glider is made of fiberglass and carbon fiber, some loaded elements of the design are made of aluminum high-strength alloys. The main technical characteristics of the «Ovod» M106: max. take-off mass – up to 4,95 kg; payload mass – up to 0,8 kg; flight duration – up to 180 min.; flight distance – up to 180 km; max. speed of flight – 140 km/h; economic speed - 62-65 km/h; technical range of action, km - up to 90; max. height of flight – up to 3500 m; range of action (online video broadcast)– 22 km; number of digital protected data channels - 2; type of control system - semi-automatic / automatic.

Main benefits

The ability to operate without base stations and high aerodynamic characteristics allow us to operate the M106 "Ovod" in almost any location in the temperature range from -22°C to + 40°C.

Thanks to the design features and small size, the UAV «Ovod» M106 has a small optical, acoustic and radar sensitivity.

A significant load per unit area of the wing allows keeping the top operational value of the wind component up to 22 m/s.

The world's analogs of this UAV are: Dragonfly Tango; Micropilot CropCam (Canada); EMT Aladin (Germany); Aeronautics Orbiter, IAI Bird Eye 400 (Israel) and others.

Intellectual property protection status

4 patents of Ukraine were obtained.

Demand on the market

The market for UAV is global: the need for them is formed by countries in connection with the gradual transition of operators from manned aircraft to unmanned aerial vehicles. The Ukrainian market has a capacity for the «Ovod» M106 within the range of 100-150 complexes, some of which may be used by civil airlines, and part by special services. The world market can have a capacity of 700-1000 complexes.

The state of readiness

Completion of preliminary and defining departmental tests of the prototype.





Products of SPCUV 'Virazh'



UNMANNED STRATOSPHERIC PSEUDOSATELLITE SPM-30 (M-70-3)

Purpose and scope

The unmanned stratospheric pseudosatellite SPM-30 is intended for receiving photographs of territories competing with satellite images of photographs, performing tasks of monitoring objects (separate structures, roads, bridges, vehicles, oil and gas pipelines, power lines, etc.), carrying out of the spectacular exploration of the ground situation during emergencies (fires, earthquakes, floods, man-made disasters) and conducting search and rescue works. The received telemetry and video (photo, IR) data can be transmitted on-line or recorded on an on-board drive.

Potential users of the SPM-30 complex are civil airline, power and special structures of Ukraine.

Basic specifications

The SPM-30 pseudosatellite is a high wing plane and a V-like plume and a propelling propeller. The construction is made of glass and carbon fiber, some of the loaded elements of the construction are made of aluminum high-strength alloys. The main technical characteristics of SPM-30: maximum take-off mass, kg - 95; weight of the target load, kg - up to 15; wingspan, m - 30; flight time - from one week; economic speed at an altitude of 20,000 m - 98 km / h; maximum flight altitude, m - up to 22 000; range of video transmission in on-line mode, km - 100; technical range, km - up to 200; number of digital protected data channels - 2; type control system - automatic / semi-automatic.

Main benefits

The main advantage of the SPM-30 is the on-board power source, which consists of more than 3000 solar films that provide power to the airplane systems and its power plant. The analogs of SPM-30 in the world are: Zephyr-7/8 (Great Britain), Pathfinder (USA) and others.

Intellectual Property Protection Status

An application for 1 patent of Ukraine is filed.

Market demand

The market for pseudo satellite SPM-30 is world: the need is formed by countries in connection with the gradual transition of operators from manned aircrafts to unmanned aerial vehicles. The Ukrainian market has a capacity for SPM-30 within 2-3 complexes per year, some of which may be consumed by civilian airlines, and part of the power and special services.

The world market can have a capacity of 30-50 complexes.

The state of readiness of development. Manufacturing prototype





Products of SPCUV 'Virazh'

CONVERTIBLE AIRCRAFT NAU-KM 3 «KUBOK»

Purpose and scope of use



Convertible aircraft NAU-KM 3 «Kubok» is a 3500 kg class twin engine aircraft with rotary external screw on the wingtips. This type of aircraft performs vertical take-off and landing, enabling it to operate flights in hard-to-reach geographic and climatic zones, including areas with complex landscape, mountainous areas, islands, polar zones, tropics, etc. The convertible aircraft can be involved in exploration, patrolling of oil, gas pipelines and other linear objects; execution of various types of aerial photography, delivery of humanitarian aid, protection of state borders, transportation of patients between hospitals and specialized medical centers, irregular commercial flights, doing a lot of a wide range of works in disaster areas, fighting piracy, protection of national waters and fisheries, control and preventing smuggling operations, etc. Possible customers of the convertible aircraft: Ministry of Defense, Ministry of Emergency Situations, Ministry of Agriculture, Ministry of Infrastructure, etc.; individual enterprises, including enterprises of the oil and gas industry; civil airlines; private individuals.

Main technical characteristics

Project technical characteristics of the convertible aircraft: max. take-off mass, kg - 3500; payload mass, kg - 850; fuel mass, kg – 850; max. speed, km/h – 500; flight duration, h – 5; technical range, km – 2100; number of passengers - 1 pilot + 5 passengers; ferry range, km - 2900; flight altitude, m – up to 6000.

Main advantages

To date, the 3500 kg class is not occupied by any convertible aircraft in the world, therefore the competitive environment is favorable. As a type, the serially presented convertible aircraft is V-22 (st. mass 24 000 kg) made by Bell Boeing. In addition, the certification examinations of the convertible aircraft BA.609 Bell-Boeing-Agusta (st. mass 7500 kg) are underway.

Intellectual property protection status

We received 1 patent of Ukraine for utility model.

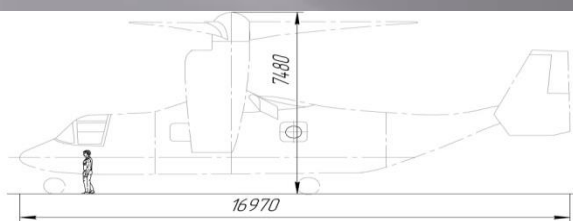
Demand on the market

The world market can have a capacity of 500-700 aircraft of the type KM 3 "Kubok" to meet the needs of local civil aviation airlines.

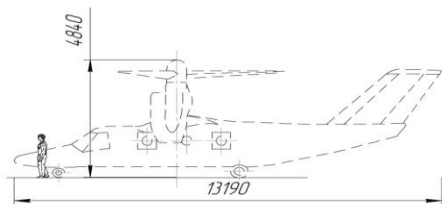
The state of readiness

The project is on the stage of "technical proposal" according to DSTU 3974-2000. In addition, there is a business plan for obtaining samples of KM 3 "Kubok" for the certification of KM 3 "Kubok" as a type of aircraft in the SAS of Ukraine.

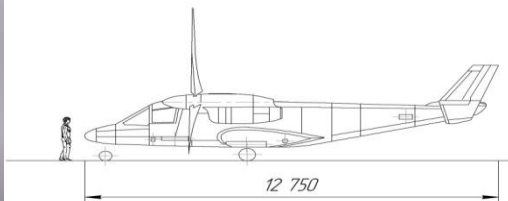




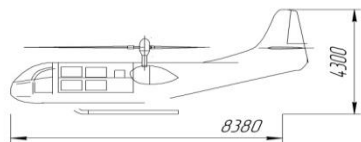
V-22



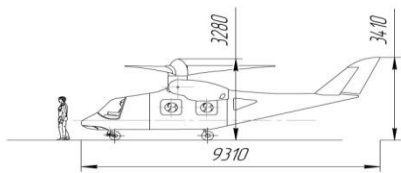
BA-609



Bell-XV15



Bell-XV3



KM-3-1

Dimension and configuration comparison of well-known tilt-rotors and concept NAU-KM 3-1 «Kubok»

The most important (for correction) characteristics of well-known examples, and their comparison to the NAU-KM 3-1 «Kubok»

1. Specific loading (MTOV/ Neng) kg/h.p.: V-22 - 1,93/ KM-3 - 4,4// **should be decreased**
2. Specific power of rotor per unit area, h.p./ sq. m.: BA609- 37,6/ KM-3 - 31// **should be increased**
3. Static longitudinal stability coeff. - V-22- 1,3/ KM - 3 - 1,1// **should be increased**
4. Static directional stability coeff. - V-22 - 3,55/ KM - 3 - 3,1// **should be increased**

In addition, along with the 55 characteristics, obtained by statistical and calculations were analyzed the type and location of the landing gear, sweepback wing, type of tail unit, type of onboard systems, etc.

Ways of APC correction of KM-3-1 concept

Power plant engines replacement

Originally was proposed engines AI-450M (Ukraine).

Overall power – 2 x 400 h.p.= 800 h.p. Weight of single – 110-120 kg.

Because of **the high** value of the specific load (MTOV/ Neng.= kg/h.p.) in KM-3 – 4,4 versus 2,1 in BA609, power require to be doubled and have 1800 h.p. in the take-off moment. This is **key** characteristic of tilt-rotor for take-off/landing helicopter like in hot weather and high altitudes. It is known that the density of the air changes from **1.42** kg/m.cub. (-25 deg.C) to 1,01 kg/m.cub. at +35 deg.C and up to **0,78** kg/m.cub. at altitude 5 km.

2. Replacement alternatives (maintaining weight and size if possible):

a) PW210 – up to 1000 h.p. (Canada) – the most powerful in the class, has almost the same size and structure as AI-450M; PW210 service is well developed in the world.

б) Arriel 1E2 - up to 750 h.p.(France). Arriel 1E2 has unsatisfactory size on length and 25% less power than PW210.

Conclusion. It is advisable to replace engine AI-450M with PW210: specific loading in CAT-68 will decrease from 4,4 kg/h.p. to 1,94 kg/h.p. (V-22 has given value at level 1,95 kg/h.p.)

Other changes, introduced in the project KM-3-1

Fuselage:

- extended tail beam – **increase** of static stability; **reduction** of the air volume required for one passenger to level 1 m. cub./pas. (economclass);
- elongated forebody - you can set the Radio Electronic Equipment (REE) and place front landing gear strut, that is retractable;
- increased track and the base of landing gear– **increased** stability during takeoff and landing in airplane mode and on taxing;
- used retractable landing gear – **decreased** fuel consumption on cruise mode by 5-7%;
- front strut is **two wheeled** – decreased roll drag during taxing;
- shock absorber strut – **helicopter type** with a large stroke (up to 400 mm);
- application of side **sponsons** – landing gear retraction is made in them, not in the usable volume of fuselage and obtaining **additional** usable volume (REE, fuel, etc.)

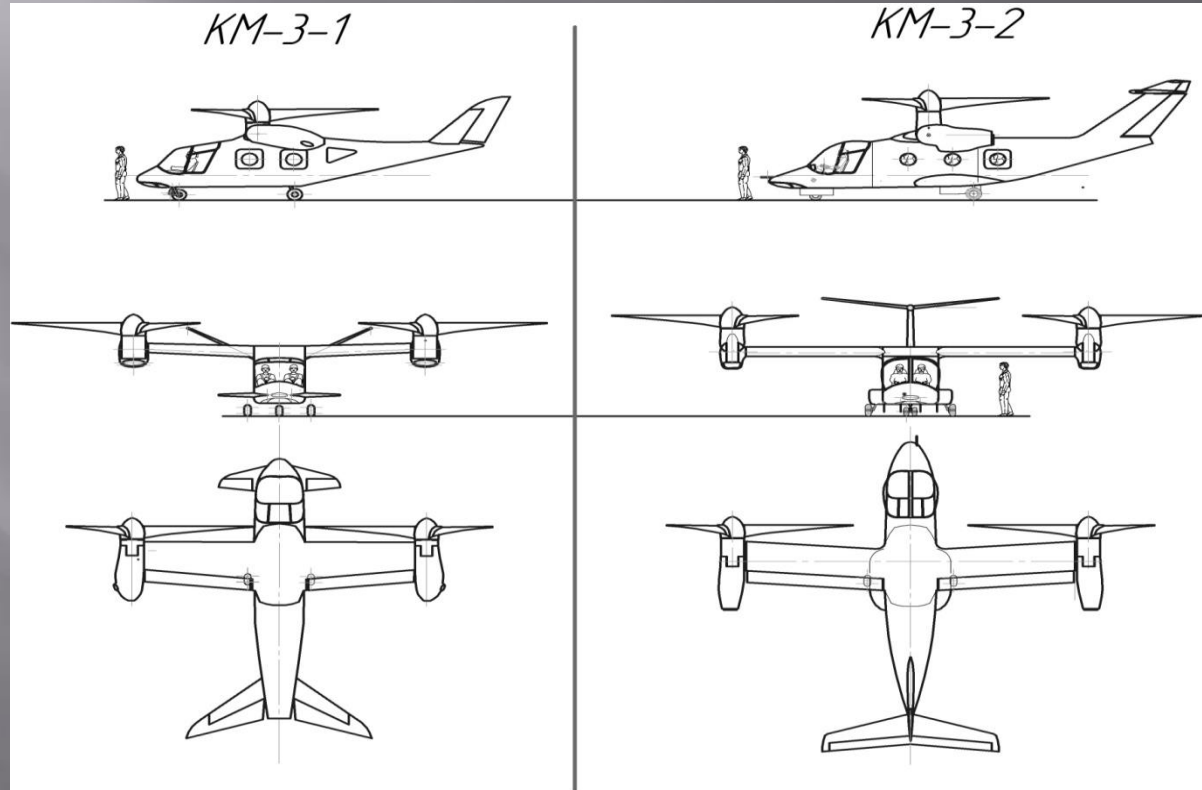
Tail unit:

- replacement V-shape on T – shape – decrease angular moments on extended tail beam also obtain **large** additional usable volume in large rudder; effective “performance” of control surfaces separated by channels pitch and yaw;
- elimination of horizontal canards as inefficient; it **is not located** in aircrews airflow zone.

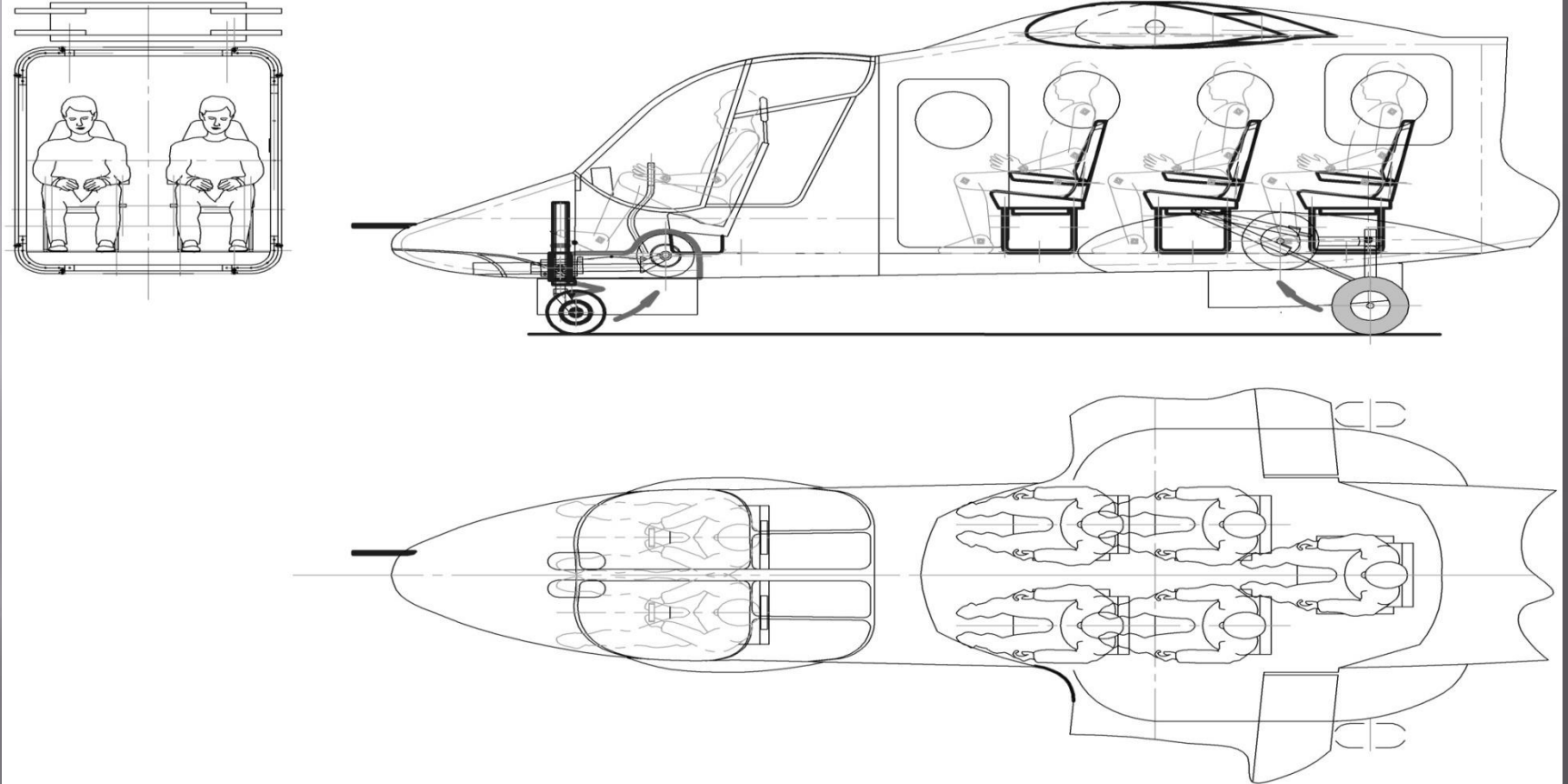
Wing:

- area redistribution – increasing span and chord decrease; obtain higher aerodynamic quality K ;
- providing reverse sweepback wing– avoiding impacts on wing by propeller blades;
- constant chord along the span– wing manufacturing simplification.

Layout comparison of KM-3-1 and KM-3-2

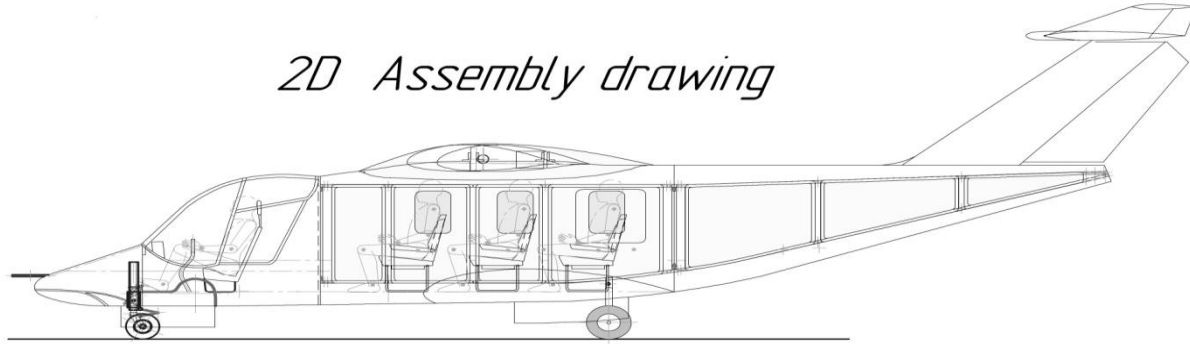


Elements of design appearance of cabin and landing gear

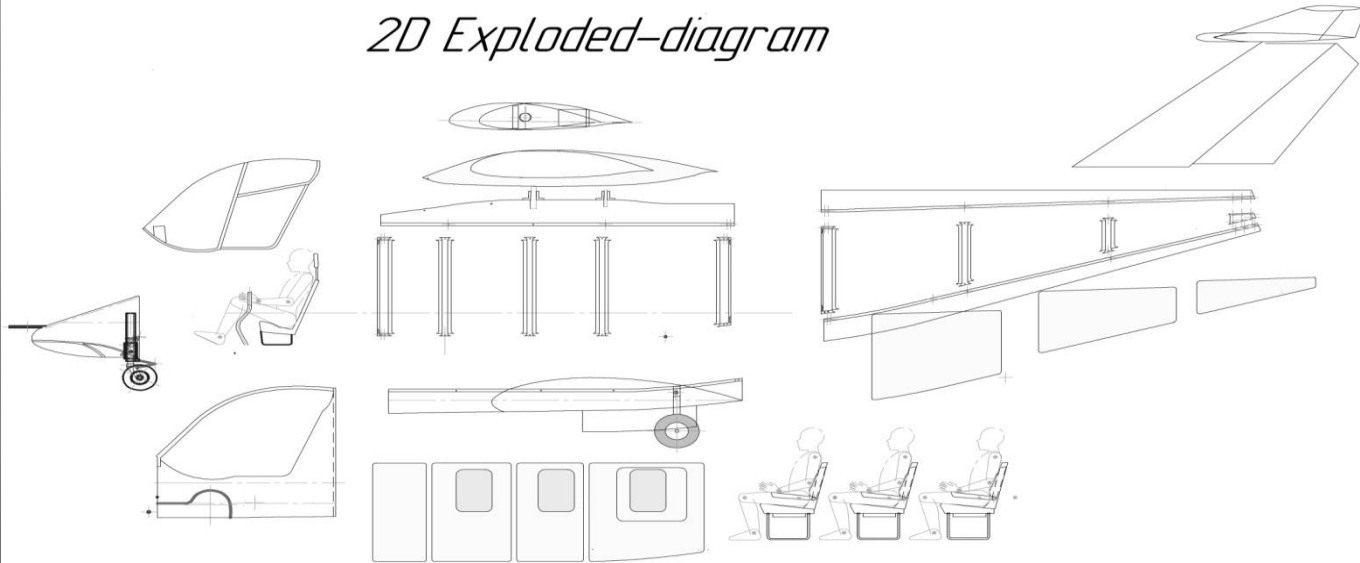


Structural layout (SLS № 01) KM-3-2

2D Assembly drawing



2D Exploded-diagram



Characteristics and functions of some board systems of KM-3-2

Characteristics of KM-3-2 control system:

- the main type of control system– **fly-by-wire**;
- the main control modes of KM-3-2 - semi-auto and automatic;
- **triple** redundancy (3 circuits, 3 autopilots, 3 sets of hydro servomechanisms);
- primary sensors– inertial, 2 PST, magnetic compass, gyro compass altimeter and others;
- two board computers: three data bus;
- power plant control is nominally with dual redundancy;
- navigation type – inertial, satellite , meteoradar and other types.

ACS main functions:

- ACS maintains altitude, speed and position and ensures compliance coordinated maneuvers;
- automatically removes asymmetry thrust, prevents inclination of the plane of external disturbances; slacking damping;
- keeps tilt-rotor within the permitted angles etc.;
- ACS performs automatic conversion (heli-plane; plane – heli);
- provides pre-plan route on a map and automatic aircraft flight;
- provides automatic synchronization of motion control rudders (flapperons, rudder, elevator), rotor tilt etc.

Additional influence of introduced changes on APC and size of KM-3

1. Engines replacement on powerful will **guaranteed** allow to obtain **high** APC of KM-3 in all climatic zones and high altitudes; replacement does not lead to changes in the drive kinematics and gears.
2. Powerful engines will allow to wide application of “semi-airplane-semi-helicopter” configuration; MTOV KM-3 then **increase** from **3500** to **4300** kg.
3. Tilt-rotor **size changes**:
 - increasing the length from **9310**mm to **10 490** mm;
 - increasing span (between rotor centers) from **7 340** mm to **8 880** mm;
 - increasing propellers diameters (rotors) from **6 050** mm to **6150** mm;
 - increasing the height while parked from **3 410** mm to **3 980** mm.
4. Aerodynamic layout of airplane changes from “**longitudinal triplane with V-type tail unit**“ to “**upwing of normal layout with T-type tail unit**”.

Development of convertible aircraft with takeoff weight under 1200 kg

Aim of the project: development of the convertible aircraft (CA) prototype of tail configuration in class 1000 kg with average (close to high) takeoff/landing aircraft performance and high aircraft performance in cruising flight.

Clarification:

- «plain» UAV is an aircraft developed as simplified, unmanned, and cannot be competitive on the market of ultra light and light piloted aircraft;
- convertible aircraft (CA) is an aircraft that is designed simultaneously for the piloted and unmanned modifications.

Problem statement

Main contradiction. It is known that the market of “pure” UAVs is “capricious” and is active. Thus, the immediate, free sales of the aircraft types that are even better than RQ-1 are hardly probable because of the “closed nature” of the topic, complexity of its implementation in practice by the operator (unknown personnel, ground control station, complicated maintenance procedure, etc.). Time (approximately 4-6 years) is necessary for the people “to adapt”, to get used to visiting the airshows with demonstrations which incurs **significant cost** and fighting the “giants”, i.e. large corporations from the USA, Israel and other leading countries around the world that have a reputation on the market of “pure” UAVs and strongly hold it.

Way to overcome the contradiction. In case the cost for the project is **optimized**, it is reasonable to create a “convertible” (transforming) aircraft when the glider and the PU (power unit) are single for the entire family of aircraft, both piloted and unmanned. Then the producer significantly reduces the risks of “unsold” products: if the demand for the piloted version of the aircraft is high the equipment “for human” is installed; conversion into “unmanned” aircraft is done in the similar way: PU together with the equipment for «unmanned» flights is mounted on the “bare” glider. Unification of glider and PU during “converting” can reach 90-95%.

Working hypothesis

A convertible aircraft allows to conquer new markets according to the procedure: first, the simplest and the largest market of non-commercial piloted aircraft (class ELA1); then the smaller market of piloted commercial aircraft in the segment under 1000 kg; and finally, comes the hardest and the smallest market, the market of UAVs (according to STANAG 4671).

- aircraft ELA1 (Part-21-(f)) is a piloted European light aircraft (European Light Aircraft) which encompasses the following aircraft types: aircraft with Maximum Take-off Mass (MTOM) under 1200 kg that is not classified as motor aircraft of complex structure.

- STANAG 4671 – UAV System Airworthiness Requirements for UAVs with MTOM from 150kg to 20 000 kg.

Reasons for forming of the working hypothesis

The most sufficient reason for forming the working hypothesis is the trend of increase in the amount of convertible aircraft on the global market. Today the identified approach was implemented in the following projects:

Piloted aircraft	Unmanned aircraft (UAV)	Date of UAV production
J-5 Marco	BAE Systems Herti	2004
Stemme ASP S15	SAGEM Patroller	2009
DA42 Twin Star	Dominator XP	2010
Stemme SK 202 A	Stemme SK 202 B	2013

There are other projects like Surveyor 2500, Viper 1000C, etc.

Example of transformation of the aircraft Stemme ASP S15 into the UAV SAGEM Patroller

Stemme ASP S15



SAGEM Patroller



Selection of Aerodynamic Configuration for the Aircraft

1 . Analysis of Benefits and Drawbacks of Aerodynamic Configuration of Single-Engine Aircraft with Front-Mounted and Rear-Mounted Engine Prop Location

Aircraft Performance Characteristics	Front-Mounted Engine	Rear-Mounted Engine
Effect of the wing blown at the start and due to this obtaining of an additional increase in the lifting power and, thus, a decrease in the takeoff run or increase in high-rise of the takeoff airport being obtained	«+»	« -> none
Inertia moment from the mass of engine which exercises a negative effect on aircraft controllability in the pitch channel	«+» smaller	« -> greater
Cabin heating (equipment units)	«+» simple	« -> complex
Applying «fleur» of 6 ⁰ -8 ⁰ during landing to decrease the landing run	«+» possible	« -> impossible
Protection of the propeller from impact with ice, aircraft parts or objects on the runway	«+»	« -> none
Possibility for people to evacuate from the plane or to drop light objects that move towards the tail of aircraft	«+»	« -> impossible because of impact with propeller
Application of rescue parachute for the whole aircraft	«+»	« -> complicated because of impact with propeller
Cooling of engine	«+» simple	« -> complex and inefficient
Minimization of mass and size of landing gear	«+»	« -> impossible because of high undercarriage
Obtaining of reduced fuel loss in cruising flight	« ->	«+» friction of the propeller strap against the fuselage is absent
Additional measures against «mowing» of the engine due to inertia and aerodynamic moments during turning	« -> necessary	«+» not required
Additional mass to reinforce the tail beam where the engine is mounted	«+» not required	« -> necessary
Psychological perception by the regular buyer of the aircraft	«+» positive	« -> incurs suspicion and aggression
Total: benefits	«+» = 11	«+» = 2
Total: drawbacks	« -> = 2	« -> = 11

2. Comparison of design performance characteristics of convertible aircraft M-1000 and UAV “RQ-1 Predator”

Performance characteristics	Value			
	M – 1000 piloted AC	M – 1000 UAV 1 (civil aircraft)	M – 1000 UAV 2 (military)	RQ-1
MTOW, kg	1100	1100	1100	1020
Wing area, sq.m	18,3	18,3	18,3	11,5
Wing span, m	14,7	14,7	14,7	14,83
Engine power, hp/kWt	130/99,2	130/99,2	130/99,2	105/75,8
Max. load per area unit, kg/sq.m	60,1	60,1	60,1	87
Fuel weight, kg	180	190	290 (400)	330
Fuel tank capacity, l	240	255	380 (530)	410
Empty weight of UAV, kg	620	510	510	520
Max. cargo load, kg	1 pilot+3 pass.+ +50 kg	400	300 (190)	205
Flight duration, h	6	6	18 (25)	20
Cruising speed, km/h	200 -220	180	150	130
Max. speed, km/h	250	250	220	215
Ultimate range of flight, km	1000 - 1200	1000-1100	3600 (5000)	2600
Max. flight altitude, m	4000	6000	5500-6000	7000
Takeoff run, m	170	170	170	300
Radius of communication (direct visibility), km	-	100 on altitude 1200m	200 on altitude 6000m	200 on altitude 6000m
Recommended flight altitude, m	1200	1200	-	-

3. Probable exterior of the aircraft M-1000; modified transport, unmanned aircraft.
Application: cargo transportation of goods under 400 kg on routes between million cities. Mode of loading: side cargo door and tail ramp.



Thank you
for attention