

Republican Unitary Enterprise
**“SCIENTIFIC-AND-PRODUCTION CENTRE
OF MULTIFUNCTIONAL UNMANNED SYSTEMS”**
of the National Academy of Sciences of Belarus



Republican Unitary Enterprise

**“SCIENTIFIC-AND-PRODUCTION CENTRE
OF MULTIFUNCTIONAL UNMANNED SYSTEMS”**

We develop, organize batch manufacturing, deliver and provide maintenance service of: multifunctional unmanned aircraft systems of various purposes and effective ranges; target and firing range equipment; testing and simulating semirealistic benches; training devices and sets; flight-navigation systems (autopilots); gyrostabilized television, infrared and photographic high-resolution camera systems, antenna positioning systems and other equipment.

The Enterprise provides training of operators of unmanned aerial vehicles as well as transfer of technologies used to manufacture devices for various applications.

The supply of goods presupposes further operators training, technical support, all types of repair and warranty service

LONG-RANGE UNMANNED AIRCRAFT SYSTEM “BUREVESTNIK”



Application:

UAS “Burevestnik” is used for strategic supervision of extended terrain areas and objects, for tracking moving objects and for target designation. The system is also provided with data on-line transmission station which allows transmitting live videofeed from UAV to the GCS and remote users.

Capabilities:

Depending on payload (TV-, photo and IR-cameras, aerial radiation monitoring equipment), UAS “Burevestnik” with the flight range up to 290 km can be used for trailing; state border control; emergency situations detection and assessment of their development; oil-and-gas pipelines condition monitoring; anti-poaching activities; agricultural lands monitoring; radiation monitoring, etc., in day- and nighttime.

System contents:

- UAV (up to 5);
- Stationary or mobile GCS;
- Set of payload (electro-optic and radiation monitoring module, etc.);
- Ground support facilities;
- Ground receiving and transmitting complexes used for relaying communication signals guarantee stable radio reception at a broader area.

Performance

Unmanned aerial vehicle weight, kg	up to 310
Maximum effective range without communication failure, km	
- provided GCU and UAV communicate by line-of-sight radio;	100
- with one or two GRTC on the flight track	up to 290
Altitude, km	0,2-5
Flight speed, km/h	80-120
Endurance, h (depending on weather conditions, with the fuel pods)	8-10
Payload weight, kg	up to 60
Ground control station type	fixed, portable or mobile based on a cross-country vehicle
Flight-navigation system	GPS, GLONASS and the automatic control system (fully automatic UAV flight in case of jamming GPS/GLONASS satellite navigation, or spoofing)
Take-off/landing	running (with the parachute upon emergency landing)

FAMILY of UNMANNED AIRCRAFT SYSTEMS “BUSEL M”, “BUSEL M40” and “BUSEL M50” for terrain monitoring



*Unmanned
aerial vehicle “Busel M”*



*Unmanned
aerial vehicle “Busel M50”*



Ground control station

Application:

Unmanned aerial vehicles (UAV) are used for onboard terrain and objects videomonitoring, moving objects identification and tracking and for transmitting live videofeed from a UAV to the ground control station (GCS) and other remote users via the radio channel.

Capabilities:

Depending on payload featuring various optical systems mounted on the gyrostabilized platform, unmanned aircraft systems (UAS), belonging to a “mini” class with the flight range from 30 to 70 km, can perform photo, video (TV), infrared (IR) and multispectral recording of terrain and objects in day- and nighttime. A wide range of payload capabilities and high aerodynamic qualities of UAV enable the use of “Busel M”, “Busel M40” and “Busel M50” UASs for reconnaissance, state border control, emergency situations detection, oil-and-gas pipelines condition monitoring, anti-poaching activities, animal census, traffic stream monitoring (with air-to-ground tracking), power lines and agricultural lands condition monitoring, etc.

System contents:

- UAV (up to 5);
- Mobile or portable GCS;
- Set of payload mounted on gyrostabilized platform (removable IR-, TV, photo- or multispectral camera);
- Tools and spares kit;
- Operational documentation.

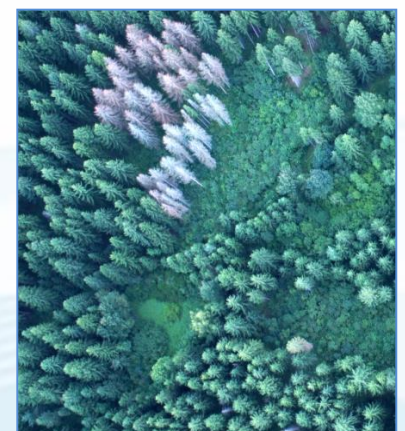
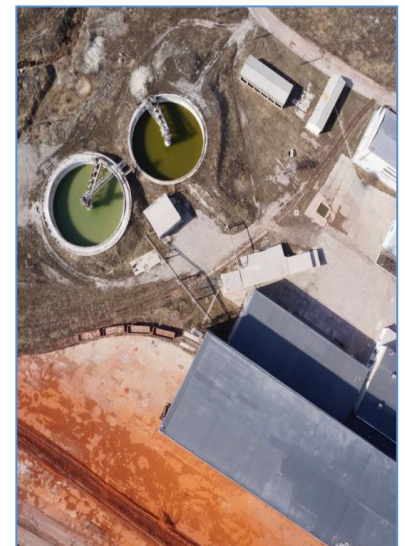
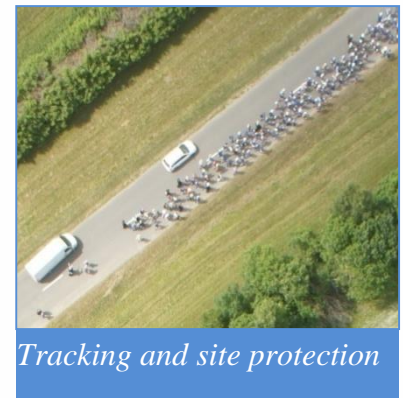


Take-off by hand (UAV “Busel M40”)

Performance of UAV family for terrain monitoring “BUSEL M”, “BUSEL M40” and “BUSEL M50”

Performance	“Busel M”	“Busel M40”	“Busel M50”
Power unit	2 electric motors		
Take-off mass, kg	up to 10	up to 12	up to 14
Wing span, mm	2335	2750	3470
Endurance, min	up to 70	up to 120	up to 150
Speed, km/h	60–120	60–110	60–100
Altitude, m	up to 3000	up to 4500	up to 5000
Flight range, km	30	50	70
Payload	Gyro-stabilized platforms with embedded TV-, IR-, photo- or multispectral camera		
Flight-navigation complex	GPS, GLONASS and the automatic control system (fully automatic UAV flight in case of jamming GPS/GLONASS satellite navigation, or spoofing)		
Take-off/landing	By hand or catapult / parachute with an airbag		

At the request of the Customer, the UAS can be supplied with the hardware-software complex (HSC) “Shlyuz”. The HSC "Shlyuz" receives the terrain and objects monitoring data from the UAV and then transmits it to remote users via public land communication lines by the Internet (a separate VPN channel) with the speed up to 1000 Mbit/s (1GE).



UNMANNED AIRCRAFT SYSTEM based on airship

Application:

The airship UAS is used for detailed monitoring of terrain and objects including in fully stocked woods through tops of trees, and for tracking moving and fixed objects. The airship UAS is also provided with data on-line transmission station which allows transmitting live videofeed from the UAS to the GCS and remote users.



Capabilities:

The airship UAS with the flight range up to 50 km provides detailed monitoring at speed up to 40 km/h in day- and nighttime. The airship is equipped with payload mounted on gyro-stabilized platform (IR-, TV- and photo cameras). Depending on payload, the UAS can be used for emergency situations detection; oil-and-gas pipelines condition monitoring; land cadaster and mapping solution; state frontier control including fully stocked woods; agricultural lands monitoring; power lines and atmosphere condition monitoring; video films and natural landscapes recording; media placement on the airship's sides.

System contents:

- UAV based on an airship;
- Backup facilities;
- Equipment for data transmission and reception;
- Set of payload mounted on a gyro-stabilized platform (TV-, IR-, photo- or multispectral camera or combined TV- and IR- modules);
- GCS;
- Tools and spares kit.

Performance	Type 1	Type 2
Power unit	2–4 electric motors	2 ICE
Take-off mass without gas, kg (on take-off with helium has a “null” floatability)	23–30 or more	75
Envelope length*, m	8,7	12,7
Envelope diameter*, m	2,25–2,63	3,19
Speed, km/h	0–40	0–40
Altitude, m	up to 500	up to 500
Flight range, km (line-of-sight radio and normal weather)	up to 50	up to 50
Endurance, h (at air speed from zero up to 7 m/s)	up to 4	up to 6
Payload capability, kg	up to 1,5	5,0

* The airship UAS can be manufactured with the envelope of any length and diameter

AUTOTRACKER

Application:

Autotracker as a part of UAS allows to:

- select and automatically follow a moving (fixed) ground object with the definition of its current position and motion parameters;
- generate control signals into the flight control and navigation system of the UAV and into the payload control system whilst auto-tracking the selected ground object;
- use digital (electronic) stabilization of the onboard video image on the monitor of the ground control station.
- simplify and automate the UAV operator's work, increase the efficiency of UAV application while fulfilling specific tasks.



Performance

Surveillance objects classes	Fixed, moving objects
The minimum size of a surveillance object, pixel	4×4
The maximum value of discrete moving of the captured surveillance object for the time between the adjacent shots of video sequence	up to 20% of the image shot size
The maximum time of the surveillance object loss (due to shading or loss of a shot), s	5
The number of the surveillance objects simultaneously tracked by the board unit	1
The number of simultaneously tracked surveillance objects shown in a video shot on a ground control station (GCS)	100 and more
Accuracy of determining the coordinates of the surveillance object, not more than, m	20
Accuracy of determining the speed of an object, not more, m/s	1
Weight of the onboard special equipment, not more than, g	150

SEMIREALISTIC TEST BENCH FOR SIMULATION OF UNMANNED AERIAL VEHICLE FLIGHT

Application:

Semirealistic test bench is a hardware-software system used for:

- Functional check of UAV's autopilot flight-navigation system (FNS);
- Functional check of UAV airborne equipment controlled by FNS, and for FNS adjustment;
- FNS adjustment for a particular type of an airframe;
- Development and testing of FNS software;
- Carrying out investigations of the UAV flight control;
- Simulation of mathematical models of the UAV airborne equipment, etc.

Content of rig:

- PC processing unit – 2 pcs;
- Monitor – 3 pcs;
- Custom software – 1 set;
- Set of switching equipment used to link up the UAV airborne equipment.

The custom stand software includes program modules that ensure:

- UAV flight simulation under the atmospheric turbulence conditions;
- Possibility to connect the real FNS and operator's automated work station (AWS) of a ground control unit to the stand;
- Simulation of transmitting data from a receiver of a satellite radio- navigation system;
- Simulation of transmitting data from sensors (accelerometers, gyroscope, magnetometer, pitot-static tube, etc.);
- Reception, processing, storage and graphic display of parametrical information produced by FNS;
- Three-dimensional visualization of the spatial position of a UAV during simulation of its flight, etc.



AUTONOMOUS SIMULATOR FOR TRAINING UNMANNED AERIAL VEHICLE OPERATORS

Application:

- training the UAV and payload operators, keeping their skills in UAV piloting, navigation and using UAV equipment and systems in flight;
- live recording of the UAV flights.

The simulator is a hardware-software system. The special software of the standard automatic work stations of the UAS operator and the instructor is integrated into the flight simulator. The operating system is Linux. The simulator consists of the modules which adapts it for training operators of various UAS as well as for changing the number of trainees' work stations.

Capabilities:

- training carried out by full and partial UAS crews;
- automatic assessment of the UAS crew actions;
- drawing up, entry, storage, display, correction and record of the flight mission;
- registration, processing, storage and display of flight parameters and images of the UAV flight simulation;
- UAV and payload control during flight simulation;
- the payload operator to track the indicated objects in a video shot and determine their coordinates at the automatic work station;
- entering and simulating at the instructor's automatic work station the UAV failures and the environmental influence on the UAV flight;
- display of the flight-and-navigation, parametric and visual information during the flight simulation, as well as display of the operators' actions on the instructor's automatic work station;
- processing, storage and display of the data of the real UAV flights;
- based on the registered UAS telemetry, processing, automatically and manually, the real flights' live recordings for their further analysis and documenting.

Simulator contents:

- instructor's automated work station (AWS);
- UAV operator's AWS;
- payload operator's AWS;
- AWS for the head of the UAS crew;
- AWS for analyzing flight data.
- power supply systems;
- operational SPTA (spare parts, tools and accessories);
- operational documentation with the general and special software.



PAYLOADS CREATED IN-HOUSE – GYRO-STABILIZED MICRO PLATFORMS (GSMP)

Depending on payload, all types of UAS can perform photo, video, thermal (IR) recording, determine coordinates of objects in day- and nighttime:

- GSMP-TV (providing a high quality image during daytime);
- GSMP-IR (providing a high-quality colour / black & white thermal image around-the-clock);
- GSMP-Photo (providing remote imaging during daytime and visual meteorological conditions);
- FVS (providing high-resolution videofeed of the remotely observed terrain during daytime and visual meteorological conditions).

TV SYSTEM / GSMP-TV



Camera name	SONY FCB-EV7320
Effective picture elements	2,13
Optical zoom	×20
Gimbal	2-axis BLDC with active damping
Stabilization	0,07°
Linear resolution at 300 m, m	0,25
Rolling rig	360°
Pitch rotation	0 to minus 90°
Weight, g	less than 1250

FRONTAL VIDEOSYSTEM / FVS

Camera	GoPro HERO4
Spectral band, μm	0,4-0,7
Definition(video)	FullHD 1440p / 80 fps (including record on the flashcard)
Lens	from 0,5 m till infinity
Angle of view, deg	120
Weight, g	Not more than 760



INFRARED SYSTEM/ GSMP-IR

IR-camera	SMART CORE 640
Display format, pixel	640x480
Lens, mm	35
Spectral band, μm	8-14
Watching camera	Sony ExView CCDII
Full frame rates, Hz	25 (50)
Horizontal resolution, TVL	700
Gimbal	2-axis BLDC with active damping
Stabilization	0,07°
Rolling rig	360°
Pitch rotation	0 to minus 90°
Linear resolution at 300 m, m	0,14
Weight, g	less than 1100



PHOTOSYSTEM / GSMP- PHOTO



Camera	SONY ALFA ILCE-6000
Lens, mm	35
Digital zoom, x	10
Picture elements, pixels	6000x4000
Image format	JPEG, RAW
Stabilization	0,07°
Rolling rig	360°
Pitch rotation	$\pm 45^\circ$
Watching camera	Ex View CCDII
Weight, g	less than 980

FLIGHT-AND-NAVIGATION SYSTEM FOR UAV CONTROL



Application:

The FNS for the automatic control of the unmanned aerial vehicle (code "BEAM.186.000.00.000") is designed for automatic, automated and manual controls of:

- UAV heavier than air with electrical power plant; takeoff by hand and parachute landing;
- UAV heavier than air with ICE; running takeoff and landing;
- UAV lighter than air (airship), equipped with cruise and (or) lifting electric motor.

BEAM.186.000.00.000 contents:

BEAM.186.000.00.000 is a complex autonomous soft - hardware system consisting of equipment installed in an aerial vehicle (monoblock consisting of the satellite navigation system, airborne central processor, device for data reception and transmission; airborne antenna, pitot-static tube (PST), PST data processing unit) and ground control unit (computer, ground data reception and transmission unit, antenna, extended control panel, custom software).

Technical characteristics:

- Sensor types: accelerometers, gyroscopes, magnetometers, pitot-static tubes, temperature sensor;
- Type of navigation receiver: GPS/GLONASS. Frequency of data refreshing is no less than 5 Hz;
- Height range: from 0 to 6000 m;
- Speed range: from 0 to 700 km/h;
- Range of UAV orientation angle measurement: heading from 0 to 360°, roll $\pm 180^\circ$, pitch $\pm 90^\circ$;
- Range of measurement of UAV angular speed: $\pm 200^\circ/\text{s}$;
- Range of measurement of UAV linear acceleration: $\pm 6 \text{ m/s}^2$;
- Accuracy of UAV orientation angle: no more than 0.3° ;
- Error of UAV co-ordinate identification in the SRNS correction mode: no more than 10 m;
- Accuracy of flight height stabilization: no more than 3–5 m;
- Quantity of flight mission points: 100;
- Power supply voltage: from 9 to 30 V.

Capabilities:

fully automatic UAV flight in case of jamming GPS/GLONASS satellite navigation, or spoofing.

SIMULATOR OF HEAT FLOW OF AIR TARGET

Application:

As infrared target and signaling device.

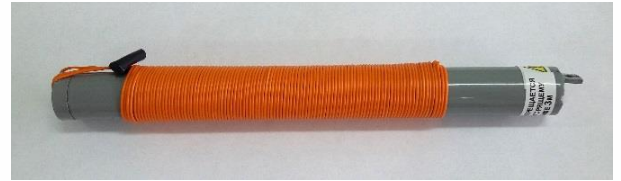
Objectives:

- Imitation of the heat radiation of an aerial (ground) object intended for training AA snipers of man-portable air defense systems such as “Strela-2”, “Strela-3”, “Stinger”, “Mistral”, “Iгла”, “Iгла-1”, of air defense system “Strela-10” and other ADS that have missiles with thermal homing heads;
- Increase of target visibility for AA missile and gun system “Tunguska”, air defense system “Osa-AKM», self-propelled AA vehicle ZSU 23-4 ”Shilka”.

Technical characteristics:

- Overall dimensions, mm:
 - length 215
 - diameter 20
 - wall thickness 1.0
- Maximum height of flame jet, mm – 200
- Average time of item burning, s – 40
- Type of igniter – electrical igniter
- Quantity of igniters, pc – 2

Visual sighting distance (at meteorological optical range no less than 10 km) is 5.0 km.



Application of the tracer ammunition of the aerial target

CATAPULT

Application:

Catapult is designed for accelerating the UAV to a safe takeoff speed.

Capabilities:

- ensuring easy implementation of all mandatory preflight operations;
- reliable retention of UAV in the starting spatial position;
- UAV release in the moment of take-off;
- UAV accelerating to a safe takeoff speed while ensuring a required angle of attack and UAV movement stability in the acceleration segment
- reliable and rapid separation of the launcher components from the UAV following the acceleration.



Performance

UAV speed at the time of separation from the catapult, m/s	8-10
UAV take-off angle, degrees	15
Maximum headwind speed during UAV take-off, m/s	10
Length, mm	2200
Height, mm	850
Width, mm	630
Weight, kg	19,2
Catapult deployment time, min	5
Preparation time for UAV launch, min	2

GROUND RECEIVING AND TRANSMITTING COMPLEX (GRTC)

Application:

Ground receiving and transmitting complex (GRTC) is used for on-line transmission (relaying) of :

- control commands, generated with remote ground control unit (GCU), to an unmanned flying vehicle (UAV);
- telemetry data and airborne payload data from UAV to the remote GCU.

Duplex data transmission (relaying) between GRTC and remote GCU is performed on Ethernet channels (VPN channels) via general or departmental network ;

Several GRTCs and communication lines constitute distributed network of broadcasters in the UAV flight zone, that ensure line-of-sight radio between the UAV and a GRTC.

GRTC facilitates:

- automatic pointing of receiving and transmitting antennas to the UAV and its tracking in the GRTC effective range (radio line-of-sight zone between the UAV and a GRTC);
- receiving UAV coordinates data from the UAV via radio channel or from a remote GCU by communications network;
- receiving UAV control commands from a remote GCU by communications network and relaying them to the UAV by radio channel;
- receiving telemetry and payload data from UAV by radio channel and relaying it to the remote GCU by communications network;
- relaying data from UAV payload to the terminal (computer) of a remote authorized user by communication network.

Contents:

antenna post (antenna rotator, navigation equipment, antenna system, telescopic mast); automatic unit of switching and communications; a set of maintenance tools (technological PC, operational spare parts set, gasoline generator).



Performance	
Radio channel range (with line-of-sight radio), not less than, km	70
Working frequency ranges of the radio channels:	
- channel for receiving telemetry data and transmitting control commands (TM and CC), MHz	902-928
- channel for receiving payload data (video), MHz	1142-1163
Distance between GRTCs in the distributed network, ensuring blanket coverage, no more than, km	120
Response of TM and CC channels receiver, at least, dB/mW	minus 108
Response of payload channel receiver, at least, μ V	5
Standards of video information, received via the payload channel	PAL, NTSC, HD, Full HD
Range of azimuthal pointing of antenna system, deg	0 – 360
Range of elevation pointing of antenna system, deg	minus 5 – +55
Interface of access to the general or departmental networks.	10/100/1000BASE-T
Operational conditions:	
- ambient temperature	minus 35 °C – +55 °C
- relative ambient humidity at a temperature of 25 °C:	98 %
- air pressure, mm Hg:	570 - 800

COMPLEX DYNAMIC TEST BENCH



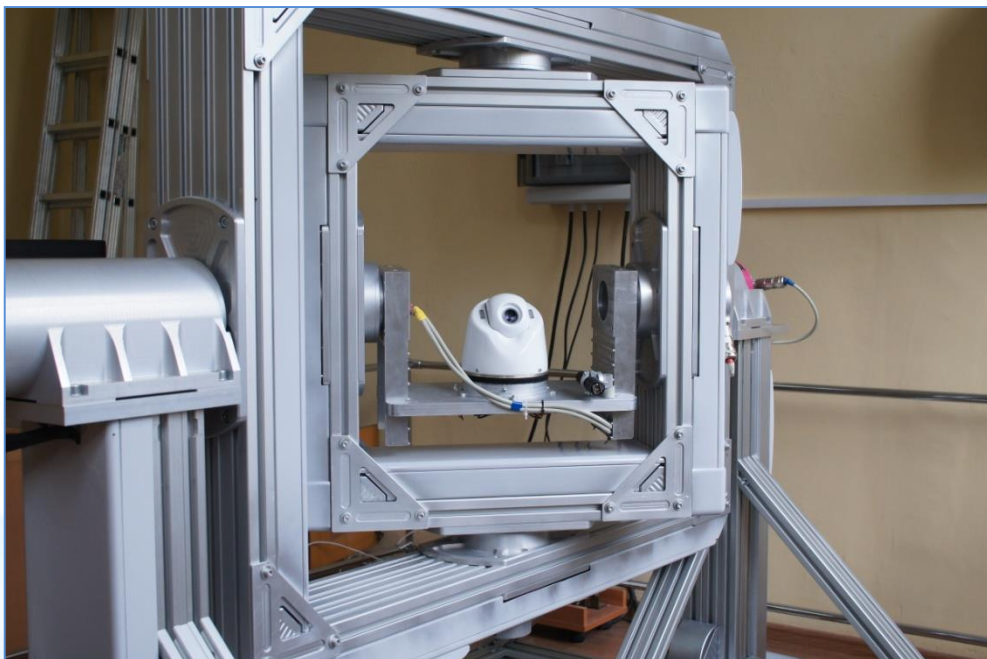
Application:

Testing and adjusting gyro-stabilized videosystems and devices included in flight and navigation complex.

Capabilities:

The test bench ensures:

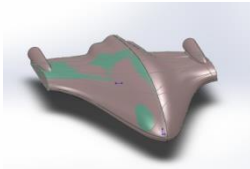
- movement along pre-programmed paths into the given angular positions with a set variation pattern of angular velocity and 3-axes acceleration;
- creating paths with high velocity steadiness for testing angular velocity sensors;
- simulation of real angular movements of a flying vehicle according to the telemetry data of the UAV flight;
- easy fastening, alignment of axles and payload bearing areas with spin axes of the gimbal;
- semirealistic UAV flight simulation, video system is placed on a moving carrier in order to determine the accuracy of automatic and semiautomatic systems for objects tracking.



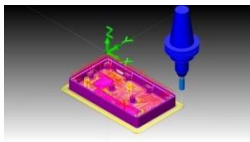
Production and technological complex for development of 3D models of intricate-shape items and their manufacturing with subsequent control of processing accuracy and quality



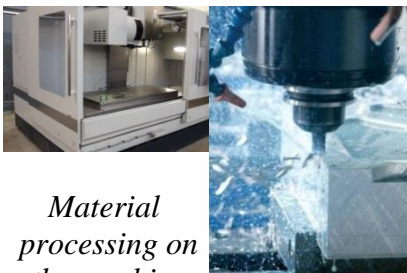
Scanning of parts



Development of 3D model on the basis of obtained data



Development of processing program for a machine



Material processing on the machine



Control of finished item quality

The company fabricates parts of any forms and sizes using milling and engraving machine, **CNC - Stealth 2040**.

- Processed volume (X Y Z): 4000 × 2000 × 200 mm
- Maximum travel speed is up to 1000 mm / s
- Repeatability +/- 0.05 mm
- Motor power is 5.6 kW, 24 000 rpm.

Application:

Application: data to design a 3D model of an item; 3D processing of material and quality control of the finished item.

Complex contents:

- Inspection and measuring machine FARO Edge Arm with a scanner Laser Line Probe, accuracy is 4–6 μm;
- 3D-machine with CNC Shpinner MVC 1600, accuracy is 6 μm.

Technical characteristics:

FARO Edge Arm:

Operating zone (with unlimited extension), m	1.8 m
Repetitiveness of one point, mm	±0,024
Error of linear measurements, mm	±0,002

LaserLine Probe:

Measurement error, mm±0,01

Shpinner MVC 1600:

Table working surface, mm	1800×800
Maximum table load, kg	2000
X axis, mm	1600
Y axis, mm	800
Z axis, mm	700
Positioning accuracy, mm	0.004
Repetitiveness of positioning, mm	0.002

Description of the technological process:

- Scanning and measuring parts using the inspection and measuring machine;
- Processing of obtained data and cloud of scanned points, correction with the aid of a custom software;
- Development of a 3D model on the basis of obtained data;
- Development of a processing program for a machine and processing material on a machine according to a set program;
- Accuracy inspection and quality control of an obtained item using the inspection and measuring machine.





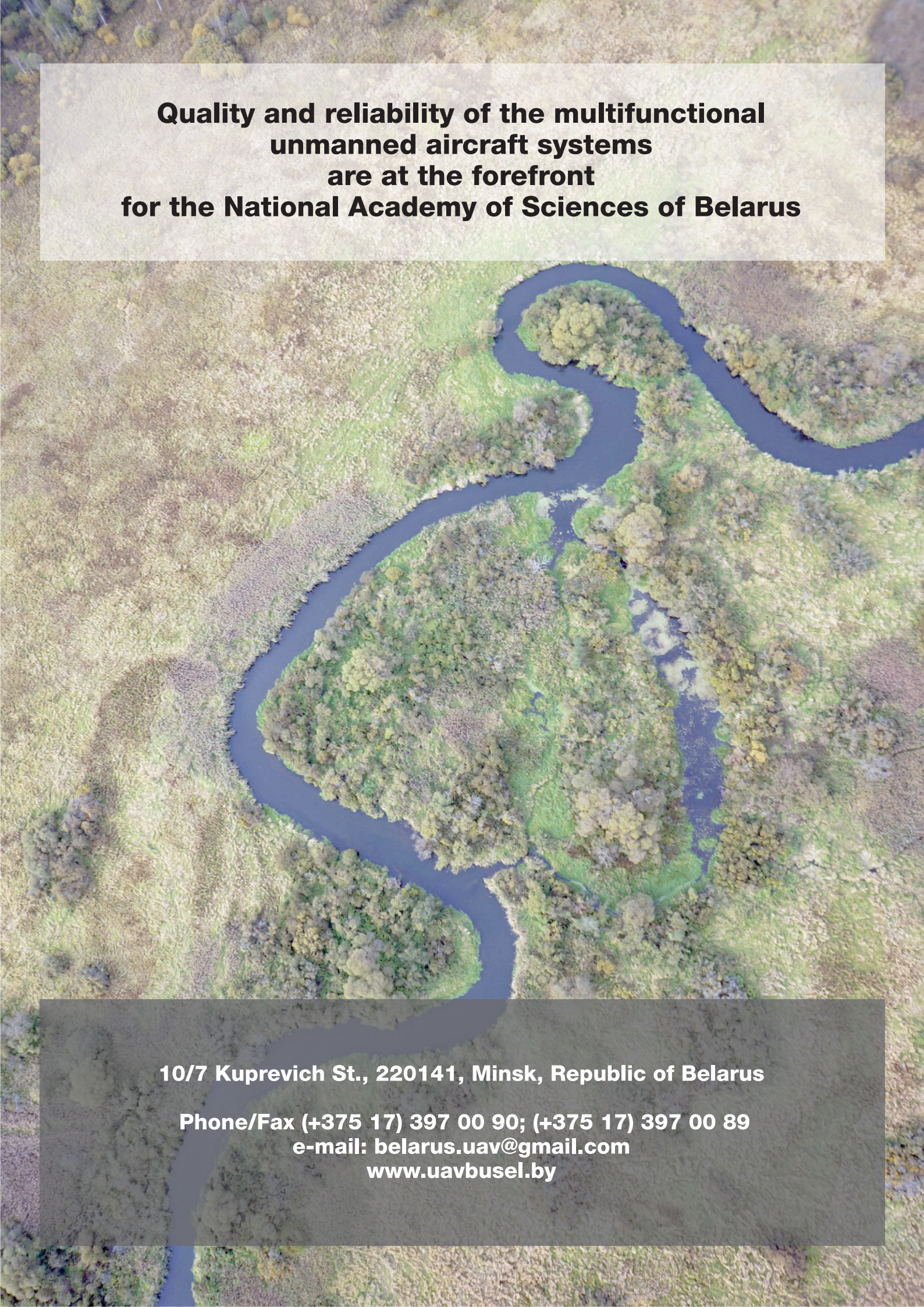
*UAV "Busel M" is performing a bad-weather flight
in Central Asia*



Training area of MES of Russia



UAV «Burevestnik»

An aerial photograph of a winding river flowing through a lush, green forested landscape. The river meanders through the trees, creating a series of loops and curves. The surrounding vegetation is dense and vibrant green, with some areas showing signs of autumnal change. The overall scene is a natural, scenic view of a river valley.

**Quality and reliability of the multifunctional
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are at the forefront
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