Anti-aircraft gunner's training simulator of the portable air defense system «Igla» («Igla-1», Igla-S)

Educational-training capabilities of anti-aircraft gunner's training

The list of existing training means	*Capabilities of existing training means*
▪ electrified stand 2У438 ▪ anti-aircraft gunner's field training simulator 9Ф635 ▪ launch control set 9Ф636 ▪ educational-training set 9Ф663 ▪ simulator НРЗ 9Ф631	▪ familiarization with composition, functioning and application of PADS ▪ field training of anti-aircraft gunners (including imitation of AAGM launch with use of ejection engine) in engaging of mock-ups of air target

Limitations of existing training means
▪ high level of artificialities of replication of air targets ▪ absence of replication of thermal, smoke and aerosol restrictions, as well as various meteorological conditions, overcast ▪ Impossibility of up Sun attacking targets engagement trainings ▪ absence of AAGM flight imitation, its approaching with an air target and AAGM blasting, a missing and self destruction of AAGM

Anti-aircraft gunner's training results based on capabilities of existing training means

- ✦ Essential procedures of target engagement during combat situation (detection and identification of air targets under difficult weather and combat conditions, visual estimation of target ranges, taking decisions on target engagement under obscuration, maneuvering targets engagement, taking decisions on actuation of the battery-coolant unit (BCU), the moment of AAGM launching, and evaluation of firing results) are not trained.
- ✦ Combat operating procedures coefficient does not exceed 0.6.

The comparative characteristics of projective and helmet virtual reality systems

Projection-type and helmet virtual reality systems are applied for visualization of surroundings and target environment conditions (based on virtual reality goggles) in design of simulator. Those essentially different systems have advantages and disadvantages.

Projection-type systems	Helmet systems (goggles)
Advantages	
✦ high level of visual presentation for the anti-aircraft gunners of unit, observing the training	✦ lower cost in comparison with projective systems ✦ mobility of a training complex ✦ required small area ✦ high resolution of images ✦ absence of restrictions on anti-aircraft gunner's target engagement training (pursuit course firing, firing under conditions of big angular height)
Disadvantages	
◙ high cost ◙ operating complexity ◙ stationary execution and considerable required area for simulator placing ◙ restrictions on anti-aircraft gunner's target engagement (pursuit course firing, firing under conditions of big angular height	◙ necessity of solution of technical tasks, connected with coordination of spatial position of a launching tube and the anti-aircraft gunner's head

The helmet virtual reality system is applied in the training simulator design

Training simulator structure

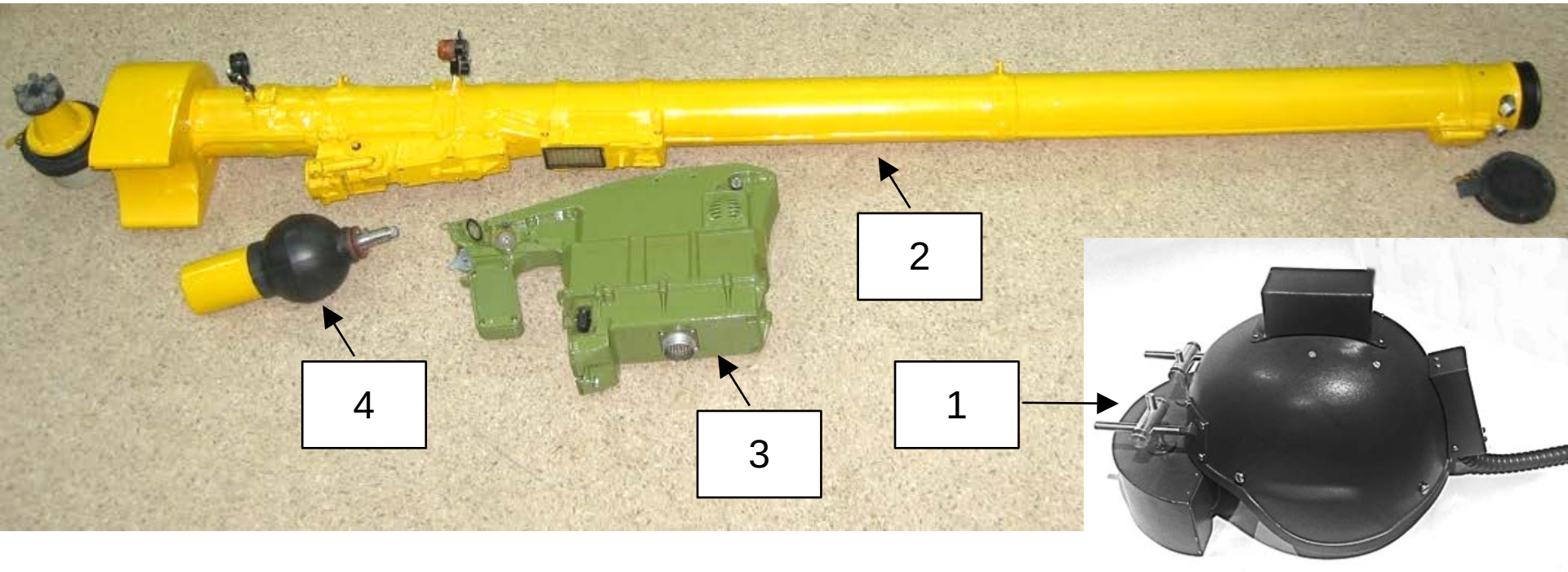
The training simulator structure includes:
1. Anti-aircraft gunner's workplace
2. Instructor's workstation
3. Spare parts, tools and accessories
4. Operating documentation
5. Transportation containers

Training simulator workplaces are connected by the local computer network.

Anti-aircraft gunner's workplace

Anti-aircraft gunner's workplace includes:

1. Protective helmet with helmet virtual reality system and spatial position gauges
2. Mass-dimensional launching tube mock-up (the types of launching tube mock-ups, launching mechanism, and battery-coolant unit are defined by the type of simulated PADS) with sensors of angular position of aiming line
3. Launching mechanism mock-up
4. Battery-coolant unit mock-up



Bridging device, audio information delivery, automated adjustment system are built into the helmet of virtual reality, launching tube and launching mechanism mock-ups

Instructor's workstation

Composition:

- unified table
- system units (2 pieces)
- simulator control panel
- instructor's/trainees intercommunication means
- audio system

Functionality of a workplace

Functional capabilities

- Training conditions selection
- Exercise selection from the library
- Development of new exercise
- Control of trainee's actions in the course of lesson
- Simulator technical condition diagnostics

Assistance in training

Simulator turning-on/-off

Printing results of training

Instructor's workstation

Formation of assessment for exercise performance

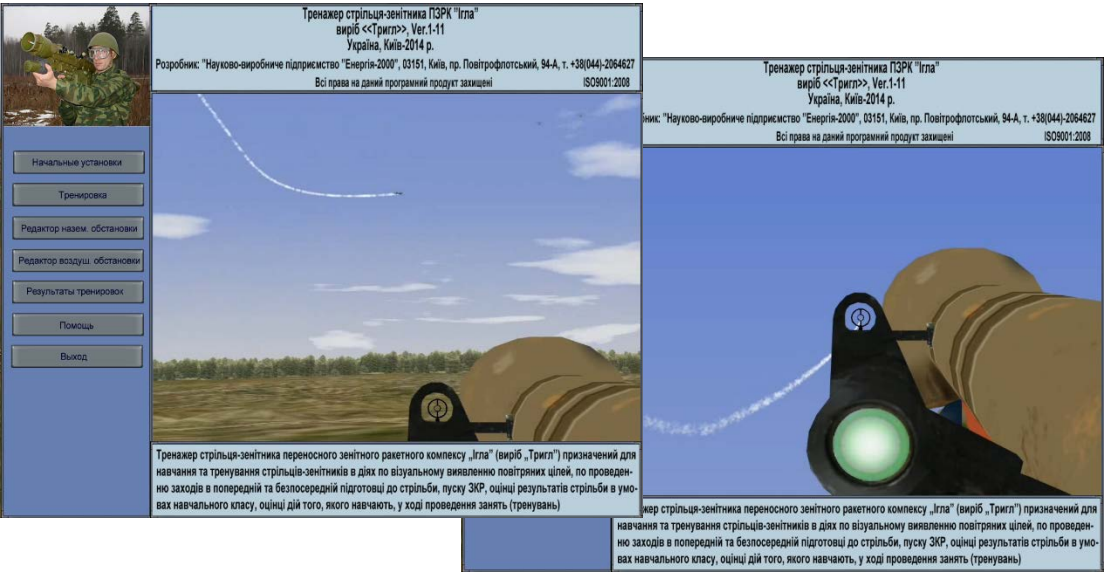
Injecting of malfunctions and failures of the simulated equipment

Modes

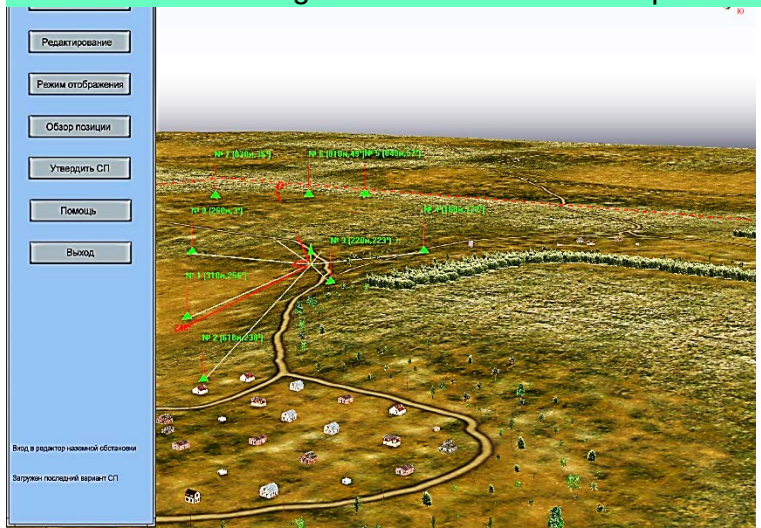
- Initial data
- Training
- Editor of air conditions
- Editor of ground conditions
- Results of training

Filling of training results database during the training period

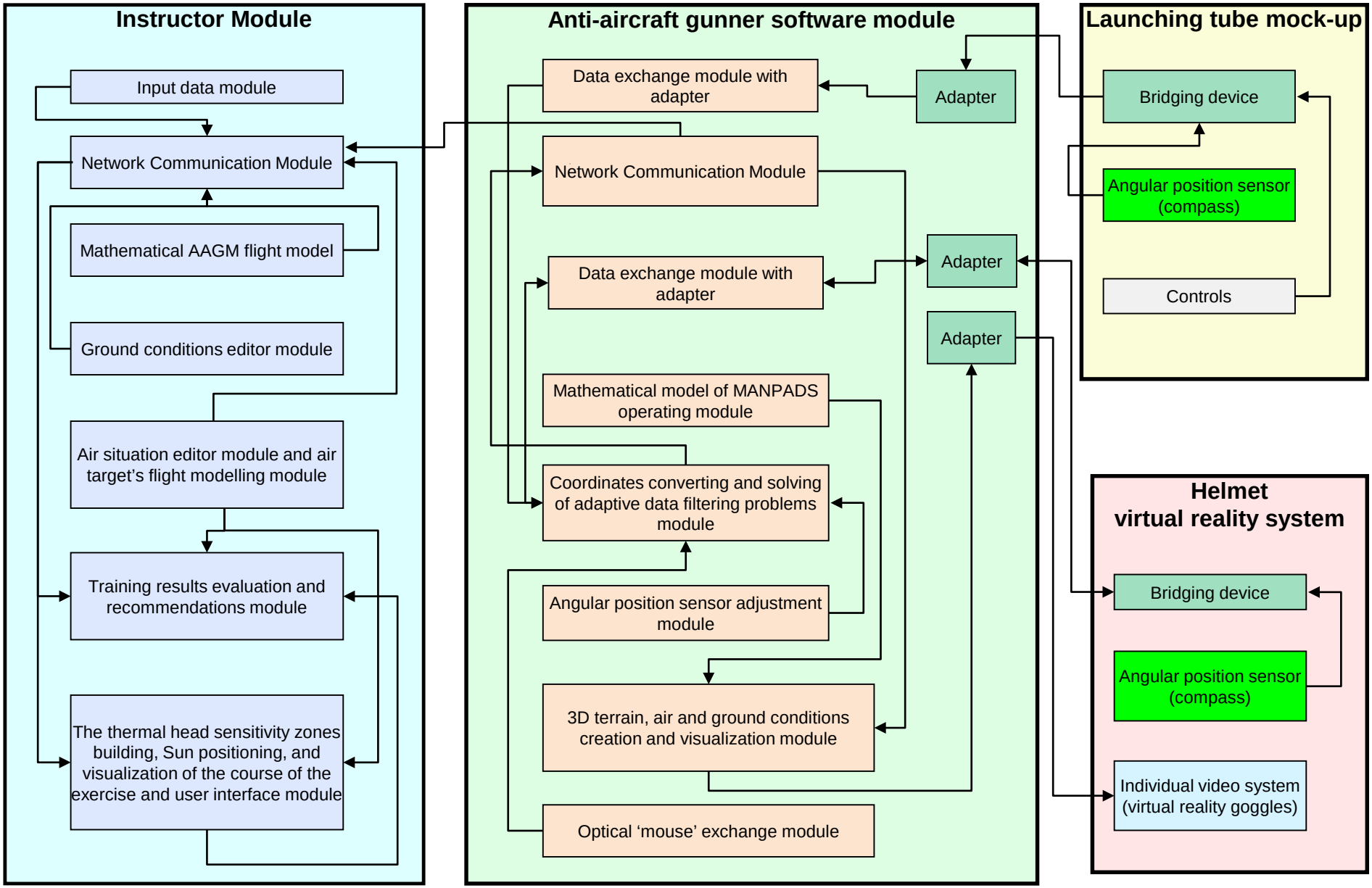
The Instructor's main menu with the operating modes selection panel



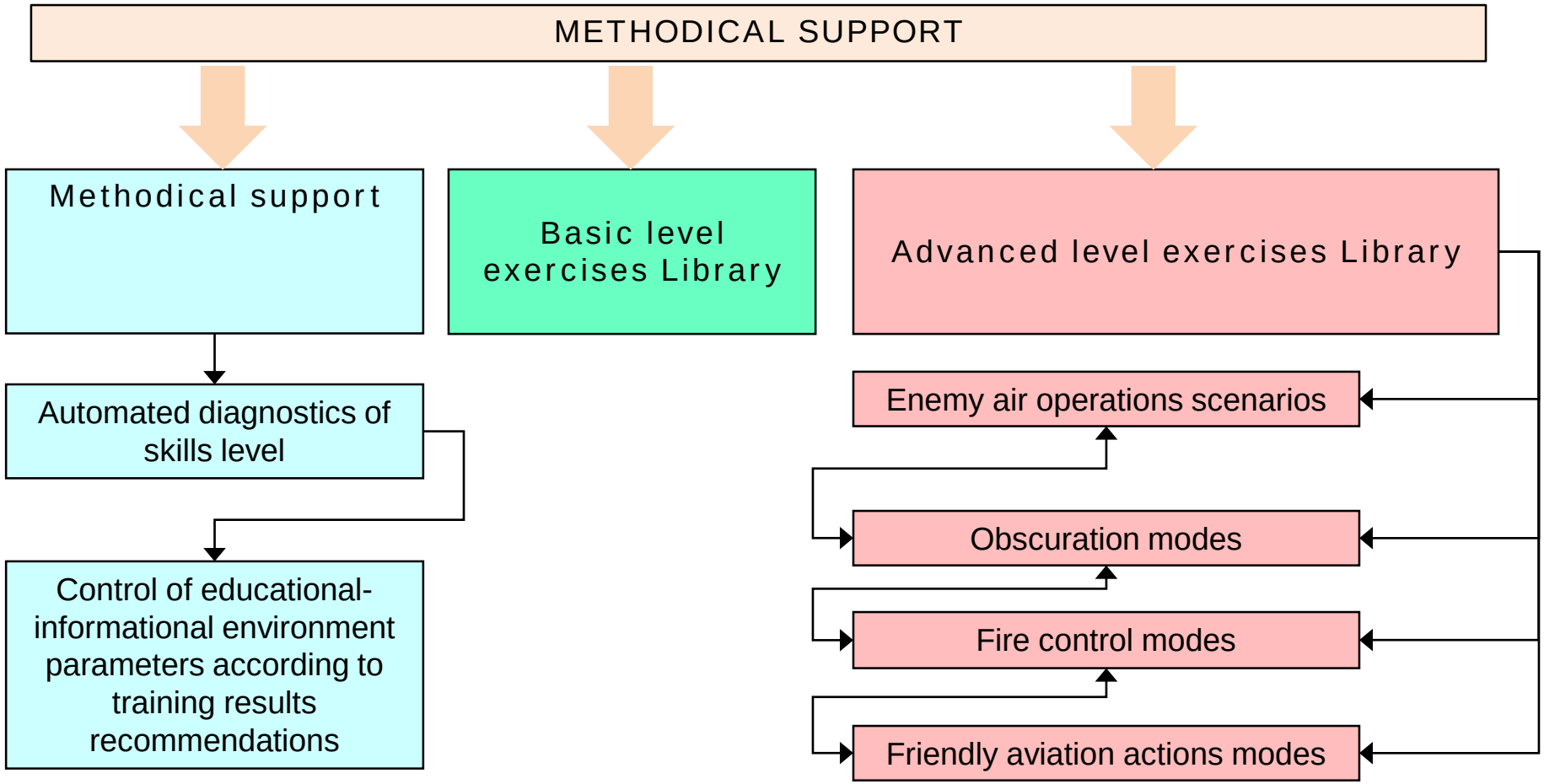
The picture of the ground conditions editor with the chosen launching site and land reference points



Simulator's software flowchart



Simulator methodical support diagram



Technical characteristics

Adequacy → The training simulator provides correspondence of performance of not less than 90% of actions of the anti-aircraft gunner

- Correspondence of mass-dimensional characteristics of the launching tube, starting mechanism and the battery-coolant unit mock-ups to characteristics of PADS
- The maximum similarity of the launching tube, starting mechanism and the battery-coolant unit mock-ups to real
- The full list of reproduced functions of controls and indication of PADS
- Correspondence of travel ranges, efforts and reaction of controls in the training simulator to characteristics of real PADS (including ergonomic characteristics and a sensory-motive field of trainee's workplace in a training simulator to anti-aircraft gunner's workplace)
- Correspondence of equipment functioning algorithms in all modes, and reaction of controls and indication on trainees actions to real PADS
- Calculation of land objects and air targets visibility range with respect to observation conditions
- Accounting of all basic characteristics in the AAGM model of the control loop (aiming method used, and characteristics of seeker head, launching and cruise engine etc.)
- Correspondence of sound effects of the simulator to real
- Visualization of land and air environment, flight of an anti-aircraft missile, hit (miss), self-liquidation AAGM, falling of an air target, collision of AAGM with land
- Consideration of background conditions

Anti-aircraft gunner with combat PADS

Trained anti-aircraft gunner with training simulator of PADS

Quality of target environment visualization

The simulator provides surveillance mode with respect to optical visibility, range and type of targets, meteorological conditions, time of a day

High quality of visualization of target background conditions is achieved by:

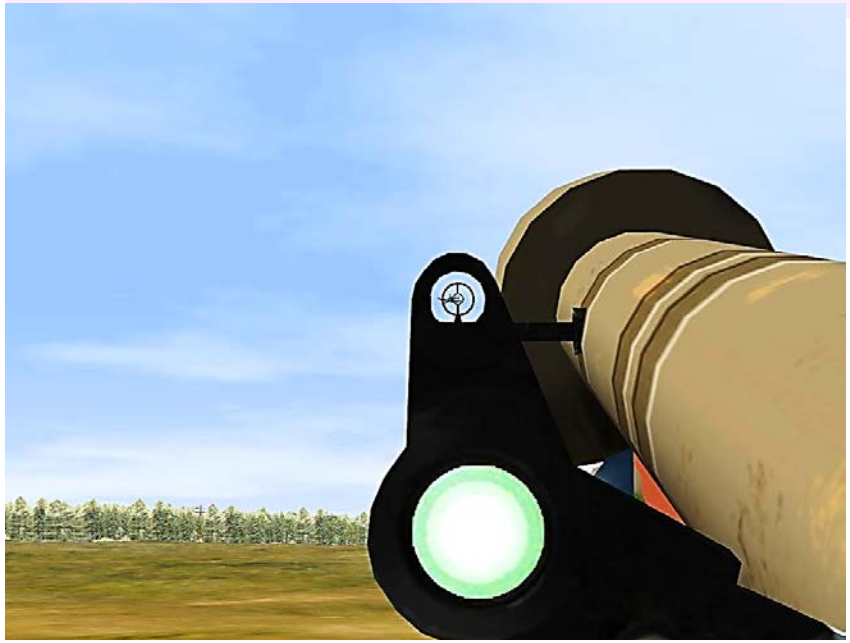
- Application of a high resolution virtual reality goggles
- Detailing drawing of terrain texture
- Correspondence of color scale of terrain texture and objects to real colors and contrast
- Correspondence of the angular sizes, forms, local objects, vegetation, land and air targets to real objects in the course of observation

Anti-aircraft gunner's field of vision in the course of observation of air environment

Visual target tracking by anti-aircraft gunner (trigger is not pressed).

Quality of target environment visualization

Field of view when capturing an air target



The field of view after launching a guided missile

The field of view when the guided missile is flying towards the target

Visual assessment of the results of shooting

Operating characteristics

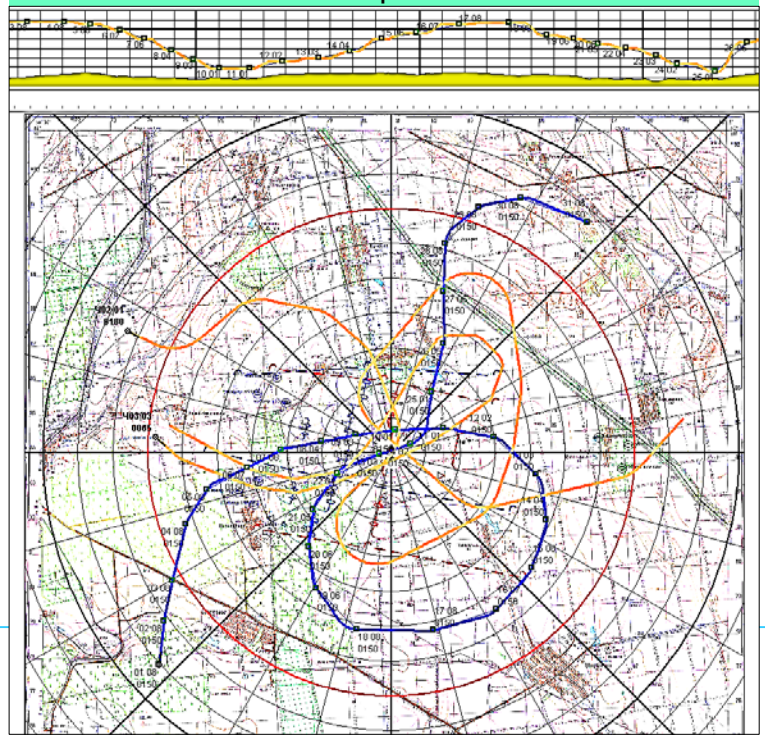
The simulator is designed to be used in the units, is simple in operating and maintaining

Item No.	Parameter name	Unit of measurement	Parameter value
1	Minimum required area for placing	m2	15
2	Premise type	---	Educational class
3	Actuation upon turn-on	min	Not more than 5
4	Duration of daily continuous work	Hours per day	Not less than 12
5	Power supply: voltage	V	220±10%
	frequency	Hz	50±1
6	Power consumption	kW	1,5
7	Increased and utmost working temperature	°C	up to +35
	Reduced working temperature		up to +5
8	Relative humidity at temperature of +25°C	%	up to 80
9	Diagnostics system	---	Built-in semi-automatic
10	Time before failure	hour	Not less than 500
11	Management of turning-on and turning-off	---	Remote, from the head's workplace
12	Spare parts	---	Single and group set (for 4 simulators)
13	Maintenance	---	Check, daily maintenance, maintenance No. 1 every 6 months, maintenance No. 2 once a year
14	Electrical safety of trainees and servicemen	---	Exclusion of dangerous voltage on the trainee's workplace. Protection against short circuit on head's workplace
15	Registering of operating time		Program counter of motor-hours
16	Total weight	kg	130
17	Operating documentation	---	logbook, operating manual, installation and adjustment and repair manual, spare parts sheet

Educational and methodical capabilities

- Visual surveillance under various visibility conditions
- Execution of firing exercises under various conditions (regular, mountain, and desert areas, under day and night, winter and in summer, various meteorological conditions)
- Execution of firing exercises under various operating modes, on the head-on and pursuit courses, against maneuvering and still targets
- Keeping of the training principle “from simple to difficult”, individual approach to shape anti-aircraft gunners combat skills
- Organizational and methodical interrelation of trainings events with field drills and life-firing
- Objective assessment of training level of skills of each anti-aircraft gunner in the unit, determination of skills acquisition dynamics within the whole spectrum of obscuration conditions
- Controllability of the training process, high intensity of training
- Lowering of conditionality of training, approaching of training conditions to combat ones.

View of the editor of air conditions on instructor’s workplace



Simulator capabilities concerning development of training conditions:

- Anti-aircraft gunner positioning on the ground
- Display of land and air environment on maps M:50 000
- Formation of a route and profile of flight of air targets (quantity of simultaneously displayed targets – up to 16)
- Shaping (setting) of background conditions and obscuration (thermal, smoke and aerosol, sun, clouds, optical-electronic interference)
- Selection of air targets type (helicopters AH-64, Mi-8, Ka-26, attack aircrafts A-10, Su-25, UAV, cruise missile ALCM, tactical air-fighters MiG-29, Su-27, F-15, transportation aircraft AN-24, “Hercules")
- Types of terrain – regular, mountain, desert (3D terrain model of any real area can be developed, subject to customer request)
- Time of the day – daylight, twilight, night
- Weather conditions – sunny, overcast, wind of various speed and direction
- Season – summer, winter (under requirements of the Customer according to conditions of geographical area of lessons and trainings)

Processing and storing of training results capabilities:

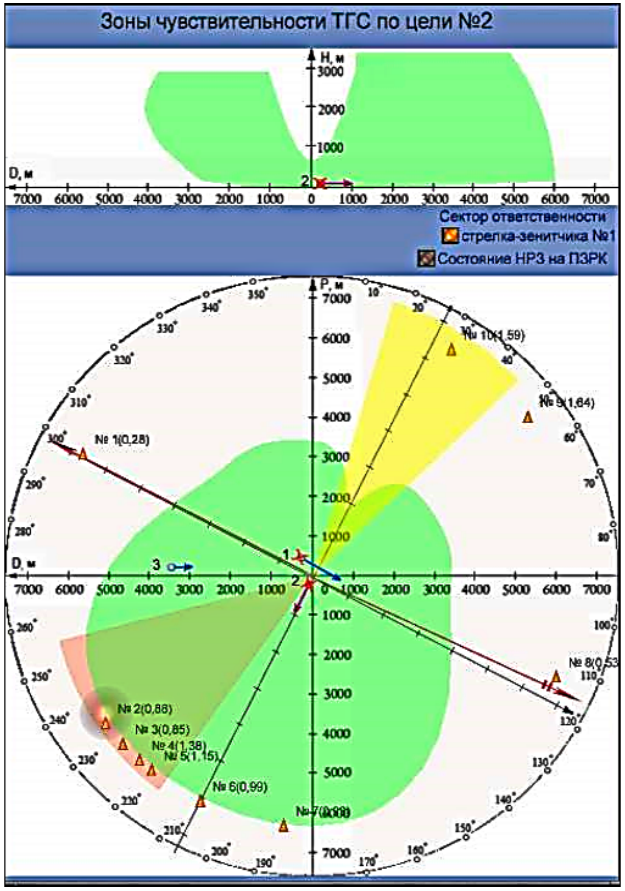
- Electronic documenting (printing) of training results in the specific format
- Archiving of training results for a day or for a period of training
- Integration of the simulator into the system of centralized accounting and processing of training results

Supervision of trainees actions capabilities

Instructor's capabilities to control trainee's actions:

- By current state of controls and indication of PADS
- By the duplicated field of vision of the anti-aircraft gunner sight
- By the report of errors during exercise execution
- By reports of trainees

Instructor's current sensitivity zone of the thermal seeker head, obscuration and interference conditions control panel



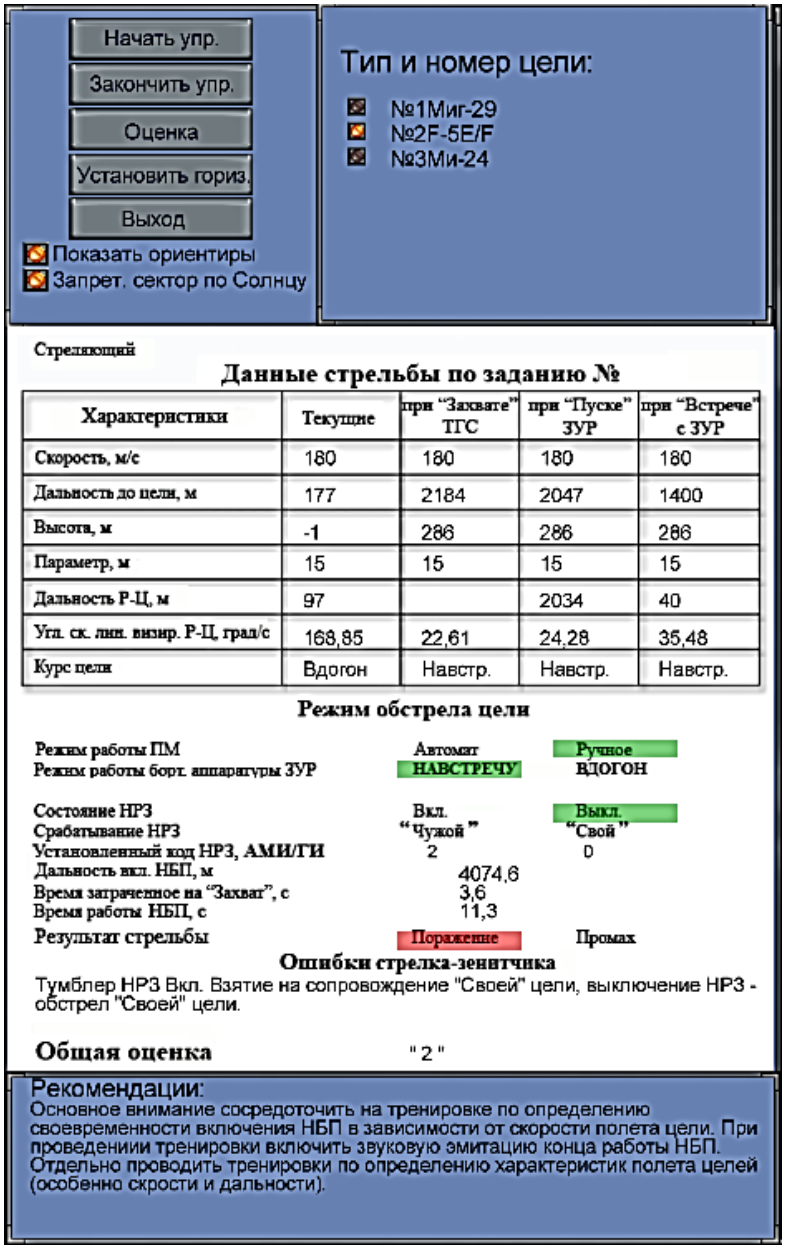
Trainee's actions evaluation capabilities:

- Automatic evaluation of trainee's actions in the course of exercise with respect to its complexity, according to indicators and the list of critical errors (according to «Firing Rules»)
- Automatic development of recommendations on management of training process

Evaluation criteria

1. Timeliness of turning-on of the battery-coolant unit
2. Correctness of target engagement priority on the head-on or pursuit courses
3. Stability target acquisition
4. Correctness of AAGM moment of launch decision

Training progress and trainee's actions control panel at the Instructor's workstation



Efficiency of the simulator usage during training

Simulator allows to train anti-aircraft gunners, to shape and maintain steady skills in execution of following operations:

- Search and detection of air targets under various air, meteorological, visibility, season and time of day conditions, deliberate smoke, aerosol and thermal obscuration, and on a ground with various features;
- Visual recognition (identification) of target types ;
- Visual estimation of distance to the target;
- “Friend-of-foe” identification of the target with use of simulator’s ground-based interrogator;
- Selection of a firing mode (“HEAD-ON –PURSUIT”);
- Selection of operating mode of the launching mechanism (“MANUAL-AUTOMATIC”);
- Assessment of a launching zone, determination of the AAGM launching moment, as well as targets, flying under conditions of interference (obscuration) engagement, imitation of system working sound effects and surrounding background effects;
- Imitation of AAGM launching and flight according to characteristics of a missile control loop;
- Supervision over target AAGM aiming;
- Evaluation of firing results.

Results of introduction of Simulator into anti-aircraft gunners training in conjunction with existing educational and training aids:

- ★ Enhancement of operating procedures coverage up to 0.94. Anti-aircraft gunners training to use effectively capabilities of PADS under difficult operational conditions.
- ★ Development of trainings conditions close to the combat ones. Providing methodical interrelation of simulator and field training.
- ★ Objective evaluation of anti-aircraft gunners training level.
- ★ Controlled process of lessons and trainings.
- ★ Possibility to conduct collective training of anti-aircraft sections.

Reliability

The simulator ensures reliable use during the whole period of exploitation (warranty and post-warranty periods)

Maintaining of reliability program is based on following principles:

- Using of proofed components, and incoming parts control in manufacturing process
- Development of program solutions excluding conflicts of the special software with general, and also with hardware
- Multiple repeated check of design solutions
- Adoption of design solutions ensuring long life time of mechanical nodes
- Ensuring step-by-step and phased mechanical and electric components quality checks of the simulator
- Exclusive application of noncontact angle of rotation and travel sensors (on the basis of magnet-sensor microcircuits) in structures of nodes of the simulator
- Application of protected from influence of external environment printed-circuit boards of electronic devices and contacts of sockets
- Use of industrial (protected) computers
- Using of uninterrupted power supply units for computers
- Maintaining of necessary thermal operating modes of equipment of simulators
- Providing of power supply sources back-up capacity

Warranty and service life

- The warranty period of the simulator is 1 year under condition of strict adherence of operating rules and maintenance service according to the Operating Documentation.
- Service life of the simulator is not less than 8 years under condition of strict adherence of operating rules and maintenance service according to the Operating Documentation.

® The training simulator provides continuous work for 12 hours a day

® Time before failure is not less than 500 hours

The developer and manufacturer of the simulator:
LLC "Research and Production Enterprise «Energy 2000»
Ukraine, Kiev, avenue Vozduhoflotsky, 94-A
www.simulator.ua

The developer and manufacturer of the simulator provides:

- manufacturing of the simulator and its delivery to the place of use for the intended purpose
- assembly, adjustment (tuning) and acceptance tests of the simulator on the site of use
- training of technical personnel of the Customer
- warranty service
- post-warranty service, subject to a separate contract
- author's supervision and modernization of the simulator software package during whole exploitation period