Integrated “BM OPLOT” crew simulator

Main characteristics

- Structural (design) adequacy, including availability of functional mock-up of auto loading mechanism and simulation of gun loading
- Functional adequacy (adequacy of equipment, components and devices mock-ups and their operating algorithms)
- High quality visualization of surroundings in the field of view of optical observation devices and sights mock-ups
- 3-D detailed models of firing and driving ranges, and tactical field
- 6-DOF motion system (dynamic platform)
- Full scope of exercises from Driving Course
- Full scope of Firing Course exercises with tactical scenarios
- Wide range of conditions of exercises and training events
- Objective evaluation of trainee’s actions
- Results recording

SIMULATOR SPECIFICATIONS

No	Specification	Measurement	Value
1	Number of simultaneously trained personnel	person	3 (driver, gunner, commander)
2	Minimum space of training area	m^2	30
3	Type of a room	---	Closed space (preferably fundamental structure)
4	Actuation time	min	Up to 5
5	Continuous operating time	hour	At least 12
6	Power supply: voltage	V	220±10%
	frequency	Hz	50±1
7	Maximum consumed power	kW	40
8	Average consumed power	kW	15
9	Range of working temperatures	deg. C	from +5 to +40
10	Diagnostics system	---	In-built, semi-automatic
11	Size of 3D model of tank driving range	km	4x4
12	Size of 3D model of firing range	km	5x5
13	Size of tactical field	km	5x5
14	Evaluation of trainee's actions and results recording	Computerized, in accordance with criteria of Driving and Gunnery Course	
15	Capability of tactical scenarios development	In-built editor on the instructor's workstation	
16	Conditions of training scenarios	Day/Night, All seasons, tropical downpour, fog, different optical visibility range, temperature range from 0 up to 50°	
17	Development of 3D models of any kind of the terrain	---	Feasible (subject to customer requirements)
18	Injection of malfunctions and failures of imitated tank equipment		With assistance of Instructor's workstation interface
19	The types of angle, position and close/unclose sensors	Noncontact transducers	
20	Time to failure	hour	Minimum 500
21	Specified life cycle	year	Minimum 8
22	Warranty period	year	2

INTENDED USE AND FEATURES OF SIMULATOR

INTENDED USE: Effective accomplishment of combat training tasks for units equipped with “BM OPLOT”.

Capabilities of simulator:

a) commander’s and gunner’s individual training

- armament operating training
- surveillance
- “BM OPLOT” armament shooting during day and night with use of all types of ammunition, under various regular and emergency modes, weather and terrain conditions

b) driver’s individual training

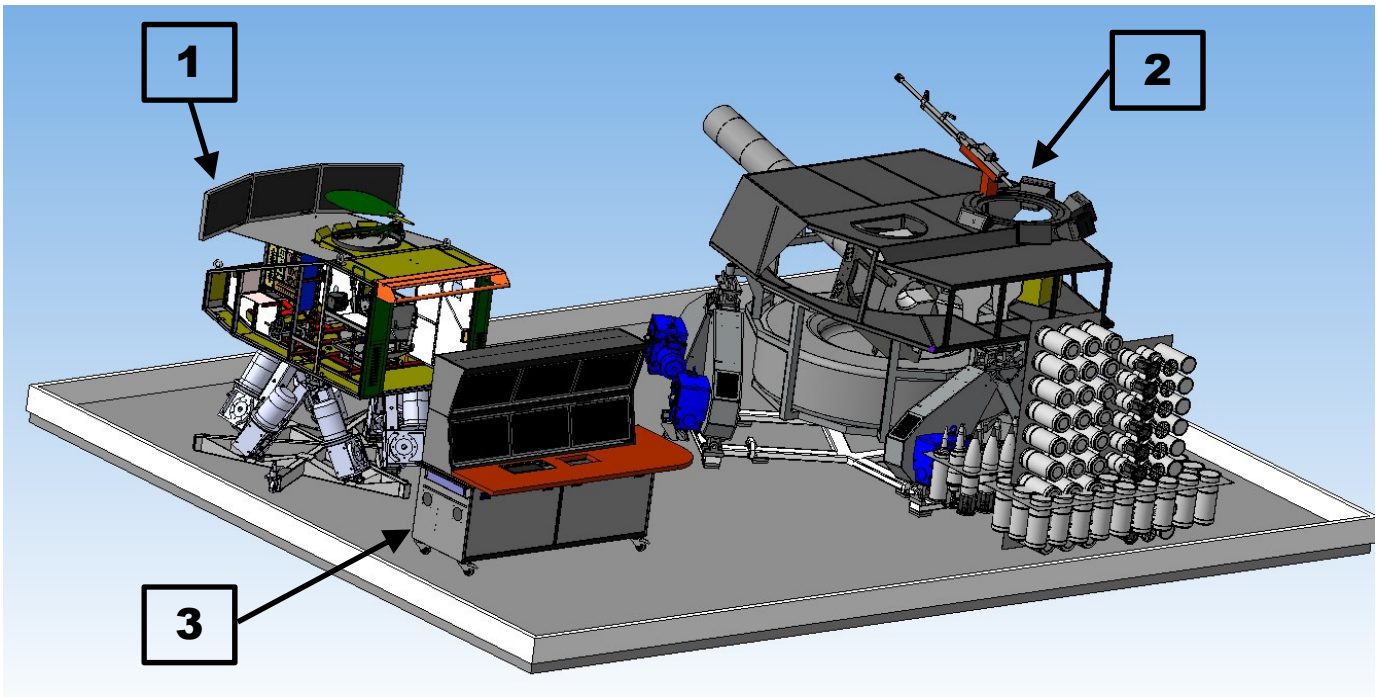
- execution of full scale of Driving Course exercises at tank driving range;
- unfamiliar terrain driving

c) collective training and shaping of crew cohesion

- technical, reconnaissance, surveillance and target acquisition training, firing and tactical training of tank crews
- execution of full scale of Gunnery Course exercises, including training and qualification shooting exercises
- fire training under difficult conditions with elements of tactics

SIMULATOR STRUCTURE:

1. Driving cabin mounted on 6DOF motion system
2. Fighting cabin with automatic loader mock-up mounted on 6DOF motion system
3. Instructor’s workstation



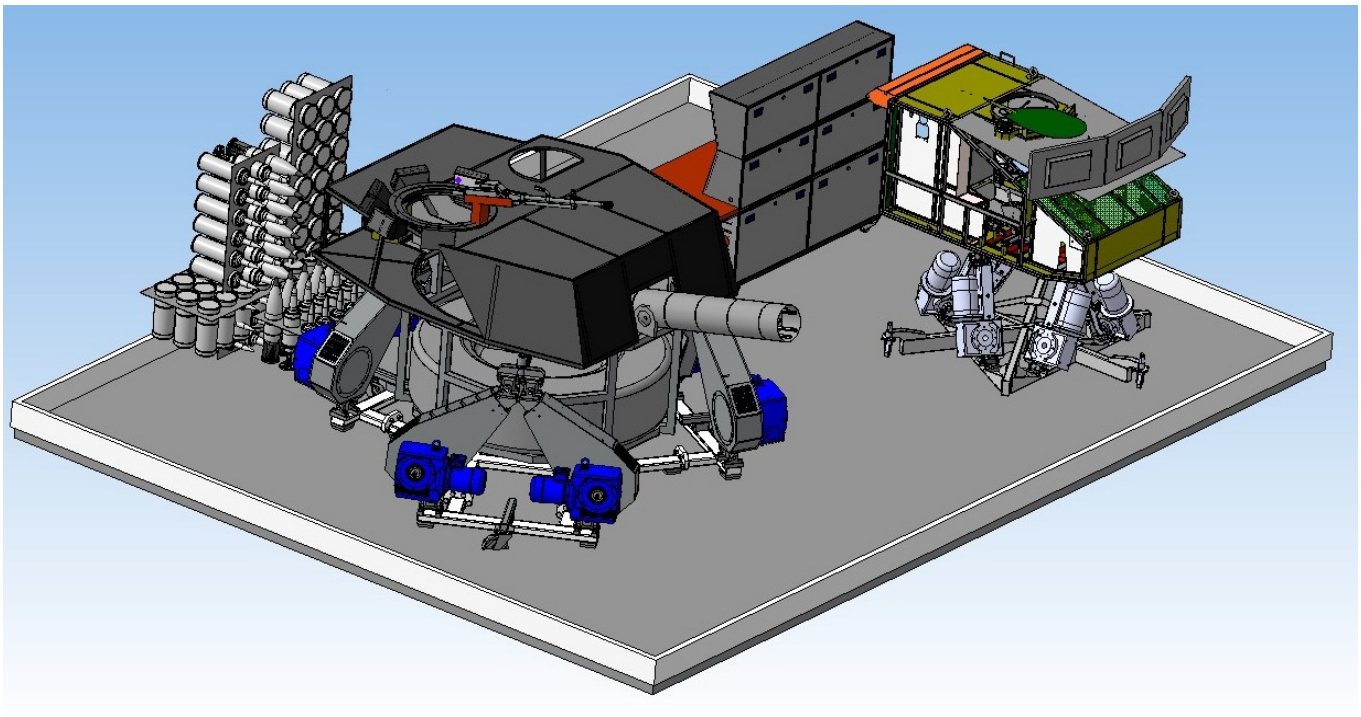
SIMULATOR'S DESIGN

The design of an integrated tank "BM OPLOT" crew simulator includes number of features that distinguish it from most modern simulators:

A. ***Visualization of ambient environmental conditions*** for providing of "travel mode" driving

B. ***Functional auto-loading mechanism and the gun breech swing mechanism*** in the design of fighting compartment simulator to replicate procedures of ammunition loading and gun firing.

C. Driving and fighting cabins of simulator are mounted on ***6DOF motion systems*** to ensure the ***adequacy of motion characteristics*** of the imitated tank during movement and shooting



Simulator's driving compartment terrain visualization system consists of 3 widescreen HD LCD displays. The driver observes environment both through periscope while driving in combat mode, and directly when driving in "travel mode" position. The image depends on inclinations of the driving cabin.

A gun auto-loading mechanism is fully functional, except for the extraction of discarding sabot.

A crew performs loading of ammunition to the auto-loading mechanism, and is able to use automatic or manual loading of shells and charges from non-mechanized storage.

DRIVING CABIN MOCK-UP

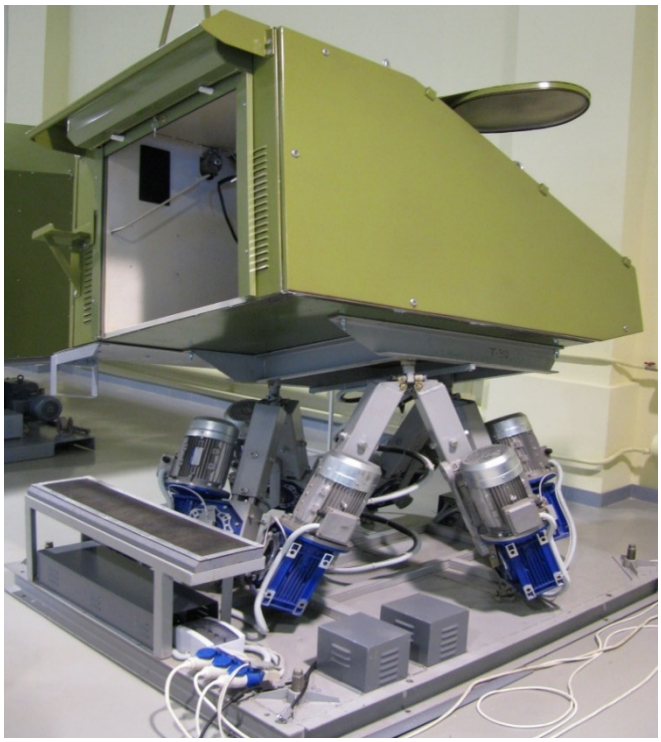
- ❑ replicates size and arrangement of the equipment of the real tank driving compartment
- ❑ equipped with full set of devices and controls mockups
- ❑ Is mounted on 6DOF motion system reproducing of tank inclinations specific to running over various terrains under different season's conditions

Interior of driving cabin simulator

No	Description	Q-ty, pcs
1	***Driving cabin simulator, including***	**1**
2	***Devices and controls mock-ups***	
	TNPO-160 observation device	**3**
	TVN-5 night vision device	**1**
	Digital instruments board of driver	**1**
	Air cylinders	**2**
	Hand fuel supply pump	**1**
	Throttle pedal	**1**
	Steering control lever located on the internal side of glacis plate	**1**
	Clutch pedal	**1**
	Brake pedal with actuator catcher of braking pedal	**1**
	Transmission gear selector with reverse box sector	**1**
	Hand fuel feed lever	**1**
	Bypass flue valve actuator	**1**
	Fuel distributing cock	**1**
	Control and alarm control panel of fire-fighting system	**1**
	Directional gyro GPK-59	**1**
	Radiological monitoring and survey unit PRHR-M1	**1**
3	***Equipment set, including***	
	Headset	**1**
	Driver's seat	**1**
	Interior lamp	**1**
	Fan	**1**
	Audio system	**1**

6DOF MOTION SYSTEM 6PD8

Motion system provides imitation of vibration (inclination) of tank hull during movement with respect to relief of terrain, during gun shooting, as well as acceleration effects during start, acceleration, deceleration, and turning of the tank

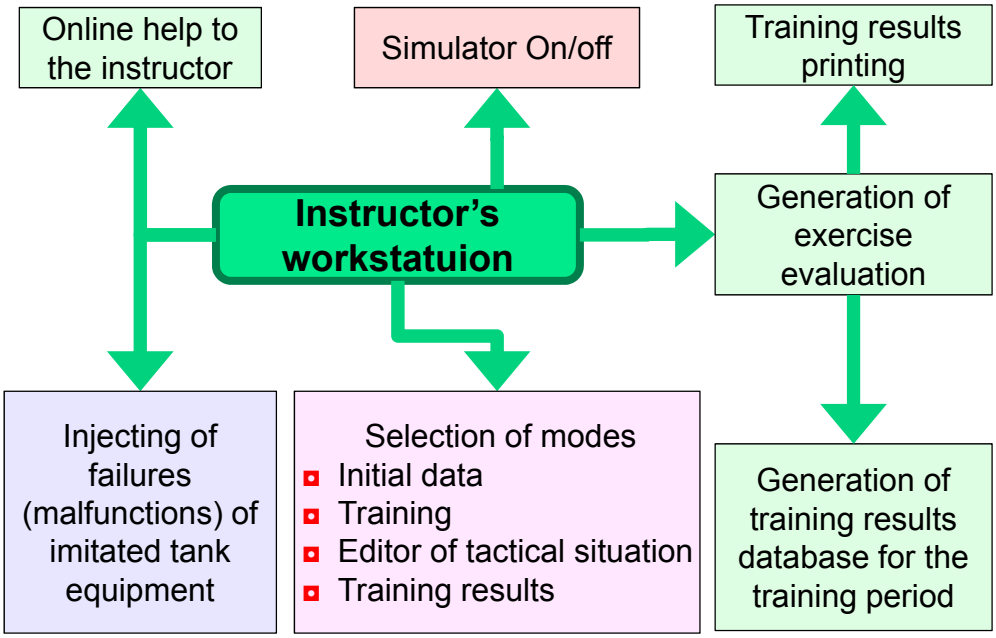


Specification	Value
Type of drive motors	Asynchronous with short-circuited rotor
Drive motor control	Frequency as per the velocity and as per the position
Pitch angle	+/- 20 deg.
Roll angle	+/- 20 deg.
Yaw angle	+/- 30 deg.
Heave displacement	+/- 100 mm
Surge displacement rate	+/- 300 mm
Sway displacement rate	+/- 300 mm
Angular velocity of axis motion	0-20 deg./sec
Accuracy of reproduction of control signals	0.2 deg. as per the angles
	10 mm as per the position
Consumed power, kW	Max.9,5 kW
	Average 4,5 kW

INSTRUCTOR'S WORKSTATION

The simulator's software suite is developed on the base of Microsoft Windows OS and includes:

- ✓ models of algorithms and functional logic of tank equipment
- ✓ ballistic firing models for various types of shells and bullets
- ✓ guided missile flight model
- ✓ tank movement model on 3D terrain
- ✓ sound patterns of tank components and devices
- ✓ 3D models of terrain
- ✓ visualization of ambient environment in the fields of view of observation devices and sights, including external camera visual picture

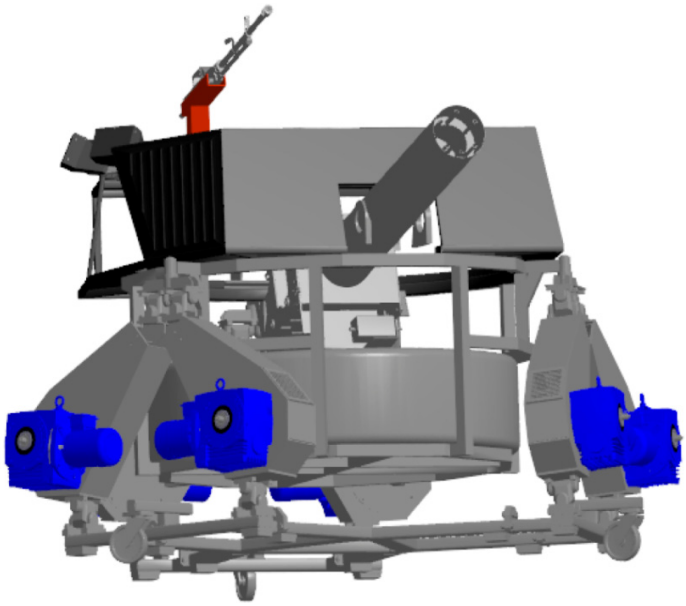


Visual picture of imitated tank from the external controlled camera

FIGHTING CABIN MOCKUP

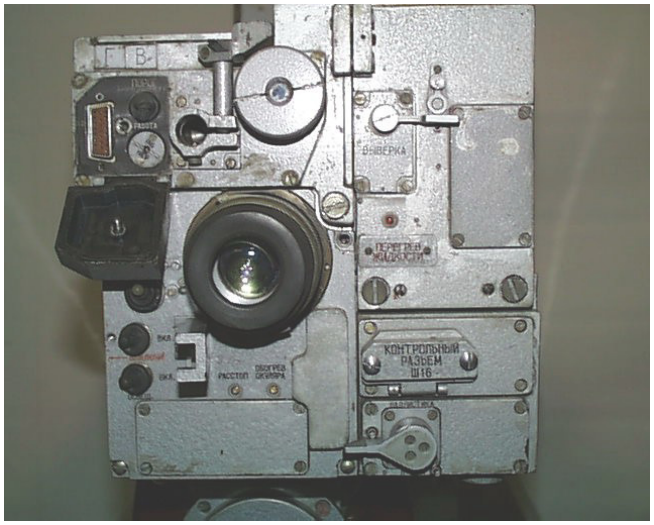
- ❑ cabin with commander's and gunner's seats, equipped with mockups of sighting systems, devices and equipment
- ❑ gun auto-loading mechanism
- ❑ motion system (dynamic platform)

Fighting cabin mockup view

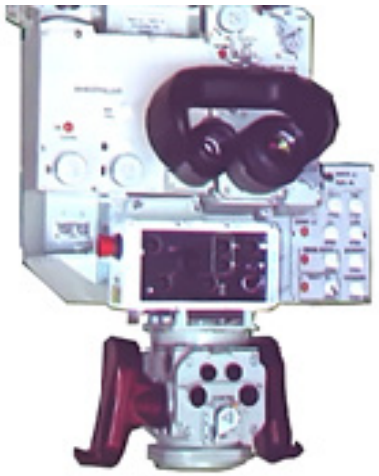


Auto-loading mechanism under development

<u>Gunner's workplace</u>
1G46-M sight mock-up



<u>Commander's workplace</u>
PNK-6 sight mock-up



FIGHTING CABIN SIMULATOR STRUCTURE

List of equipment of fighting cabin simulator

No	Description	Q-ty, pcs
1	***Fighting cabin simulator with gunner's and commander's hatches***	1
2	***Devices and controls mock-ups, set, including***	
	1G46-M sight system with control console of weapon stabilizer	1
	PTT-2 thermal vision gunner sight system	1
	information input data and control device BV1-M of ballistic computer	1
	ballistic computer display module	1
	PK43-2M commander's loading mechanism control panel	1
	PN43-2SM gunner's loading mechanism dashboard	1
	commander's aerosol screen system control panel	1
	smoke grenades discharger control panel	1
	gun lifting mechanism hand wheel	1
	turret traversing hand wheel	1
	turret lock	1
	azimuth indicator	1
	KBA-3 gun breech block with breechblock wedge handle	1
	PNK-6 commander's sight	1
	control panel of optical-electronic suppression station	1
	R-030U and R-163-50K radio stations mock-ups	1
	AS-34, AS-35, AS-37 intercom and control equipment boxes ASVK-1 set	1
	PKT receiver	1
	TPN-165A observation device	5
3	***Equipment, set, including***	
	headset with breast switch	2
	commander's seat	1
	gunner's seat	1
	interior lamp	2
	fan	2

Simulator reliability program is based on following principles:

- only proven, the best quality and reliable parts are used, as well as its incoming testing during manufacturing process
- software is developed upon solutions, which exclude collisions between special and general software and hardware
- engineering solutions are passed through multiple tests
- engineering solutions are used, that ensure longtime operation of mechanical assemblies
- functional and phased quality control is used during mechanical and electrical assembling
- only contactless rotation and motion angle sensors are used (based on magnet sensitive microcircuits)
- printboard protectors from external impact are used for electronic devices, PCBs and connector pins
- only industrial (protected) computers are used
- uninterrupted power supply for computers is used
- necessary temperature conditions for simulators are maintained
- providing the reserve power for power supply

SIMULATOR FUNCTIONAL ADEQUACY

Simulator *ensures* full compliance of characteristics with simulated tank, including

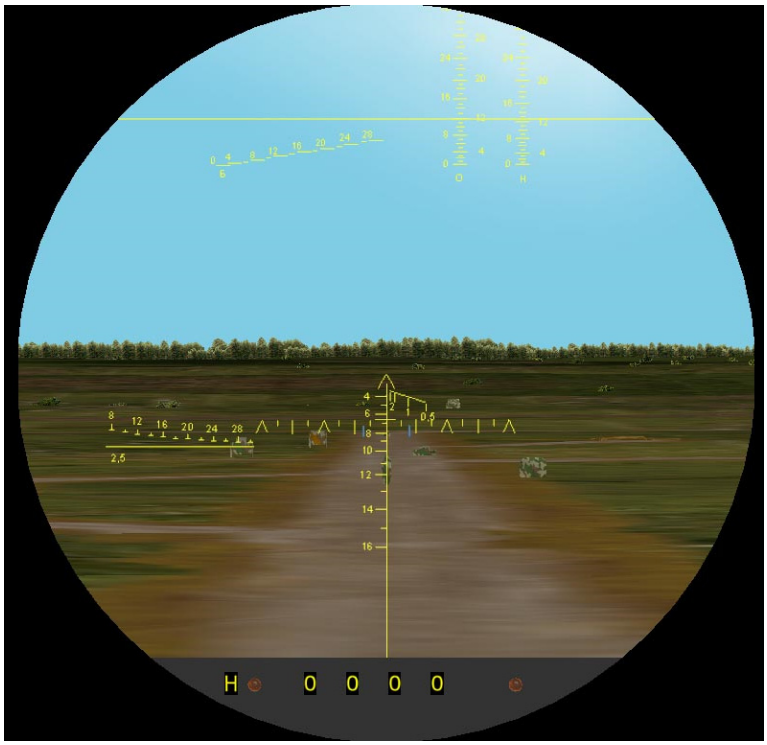
- adequacy of functional algorithms of devices and equipment in regular and emergency modes
- adequacy of the simulator response on the trainee's controlling actions;
- adequacy of tank motion model with respect to terrain relief, type of soil, friction ratio of tracks with the ground;
- correct accounting of barrel wear and bending effects, the type of ammunition, wind speed and direction, atmosphere pressure, air and charge temperature to the flight range of shells and bullets;
- adequacy of optical and electro-optical devices mock-ups with respect to optical visibility, line of sight obscuration, tank hull vibrations during firing and movement;
- adequacy of ground and air targets (dimensions, colors, motion pattern and parameters, records of hit or miss during weapon shooting);
- taking into account of terrain conditions, season, time of the day, air temperature.

SIMULATOR ENSURES AT LEAST 90% COVERAGE OF COMBAT OPERATIONS OF CREW

High quality of target environment visualization is based on

- detailing of terrain relief, compliance of image color range with the real background
- compliance of angular sizes, shapes, colors, contrast of local objects, vegetation, ground and air targets with the real objects within the line of sight of electro-optical devices
- adequacy of motion characteristics of moving objects (targets) and simulated weapon
- adequacy of visual effects of simulator functioning during firing with all types of ammunition considering dynamics of simulated tank

Field of view of 1G46-M sight

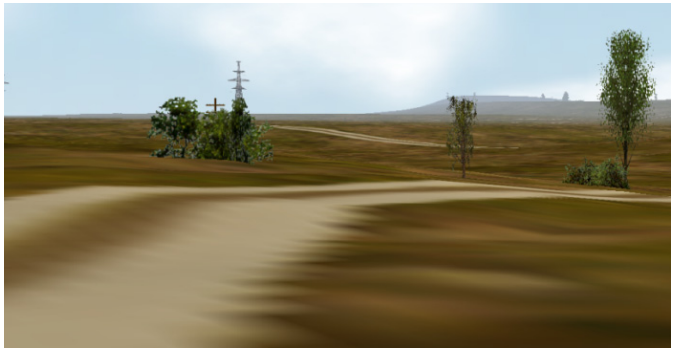


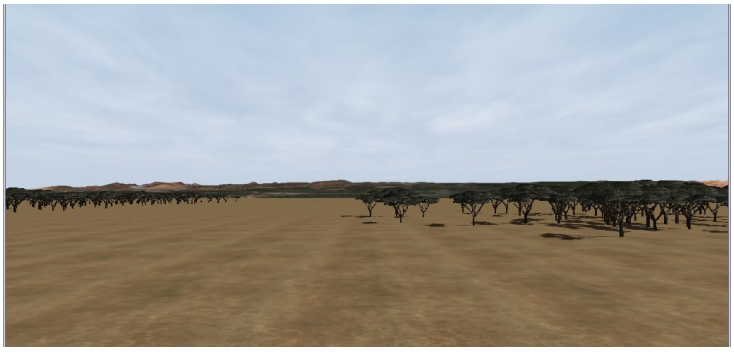
Examples of visualization of terrain and objects in the field of view of optical observation devices and sights

3D models of armored vehicles (as targets for “BM OPLOT”)

“BM OPLOT” 3D model

Field of view of driver’s observation device TNPO-160





TRAINING AND EDUCATIONAL FEATURES

Educational and training features:

- Individual training of drivers
- Individual training of gunners
- Collective fire and tactical training of tank crews (including enemy counterfire conditions)

Development of training conditions:

- The size of 3D model of terrain sector– 4x4 km
- Types of terrain – moderately rugged terrain, mountain, etc. (3D model of any geo-specific terrain with size of 8x8 km can be developed, subject to customer request)
- Types of roads – soil road, hard surface, off-the-road
- Time of the day – day, twilight, night
- Weather conditions – sunny, cloudy, rain, snow, wind of different velocity and direction
- Season – all seasons (according to conditions of the geographical region, subject to customer request)

Driver's training capabilities:

- Execution of full range of exercises from Driving Course with computerized objective evaluation of trainee's results
- Driving under various road and on off-the-road conditions during accomplishment of tactical tasks

Commander's and gunner's training capabilities:

- Execution of full range of exercises from Gunnery Course with computerized evaluation of trainee's results
- Execution of fire and tactical tasks

Supervision of trainees actions:

- as per current status of controls and instruments of driver, commander and gunner (displayed on the instructor's screen)
- as per the duplicated field of view of observation devices of driver
- as per the duplicated field of view of sights 1G46-M, PTT-2, PNK-6
- as per the tank position from the external camera
- as per the position of a tank on a tank driving range, firing range or tactical field
- as per the protocol of execution of driving, firing and tactical exercises
- as per the reports of the trainees via intercommunication devises

Evaluation of trainee's actions:

- computerized evaluation of driver's actions during execution of standard exercises in accordance with criteria of the combat vehicles Driving Course
- computerized evaluation of commander's and gunner's actions during execution of standard exercises in accordance with criteria of the Gunnery Course
- subjective evaluation of trainee's actions as per the results of the analysis by the entire (or selected) means of control

Development of training scenarios:

- selection of weather conditions
- selection of pre-set or development of improvised firing and tactical exercises
- selection the type of terrain, time of a day and season
- selection of enemy actions
- replay (if required) of the exercise or particular situation
- injection of tank equipment failure (malfunction)

Processing and storage of training results

- training results records keeping in an electronic form (printout)
- backup of the results per day and for a period of training

Simulator developer and manufacturer:
Research and Production Company "Energy 2000“
94A Povitroflotskyi ave., Kyiv, 03151, Ukraine
info@simulator.ua
www.simulator.ua

Manufacturer provides:

- Production and delivery of simulator to the place of intended use
- Assembly, commissioning and acceptance testing at the site of intended use
- Training of technical personnel
- Simulator warranty service for 1 years
- After-sales service
- Author's supervision and software reengineering for the entire period of operation of simulator (subject to specific agreement)

SUPPLY SET OF SIMULATOR

Description	Q-ty
Equipment	
Instructor’s workstation	1
“BM OPLOT” fighting cabin mockup mounted on motion system	1
“BM OPLOT” driving cabin mockup mounted on motion system	1
SPTA (set)	1
Operational documents	
List of operating documents	1 set
Technical description and operating manual. Volume 1 and 2	1 set
Logbook	1 set
Installation, start-up and on site commissioning manual	1 set
Repair manual	1 set
Software recovery and testing manual	1 set
SPTA list	1 set
Motion system 6PD8 certificate	1 set
Motion system 6PD30 certificate	1 set