T-90C tank dynamic integrated crew simulator

The main characteristics

- The design adequacy of the driving and fighting compartments
- Functional adequacy of the simulator's systems and equipment
- High quality of a visualization system
- 3D models of a tank driving range, a shooting range, and a tactical field
- 6DOF motion platforms
- Full package of exercises of the Driving Course
- Full package of exercises of the Gunnery Course
- Wide spectrum of scenarios for exercises and training events
- Unbiased evaluation of trainee's actions
- Training results documenting
- An interactive training class as part of the simulator's suite
- The capacity of combining tank units' simulators into single system

Simulator technical characteristics

№ seq.	Characteristics		Unit of measurement	Parameter's value
1	Quantity of simultaneously trained learners		---	3 (driver-mechanic, gunner, commander)
2	Minimum area of training class		m2	40
3	Premises type		---	Classroom
4	Actuation time		min	up to 5
5	Duration of continuous work,		hours	at least 12
6	Electric	Voltage	V	220±10%
		Frequency	Hz	50±1
7	Maximum consumed power		kW	18
8	The range of operating temperatures		degrees C	from +5 till +40
9	Diagnostic system		---	In-build semiautomatic
10	3D model of tank driving range		km	4x4
11	3D model of tank firing range		km	2x5
12	Tactical field dimensions		km	8x8
13	Number and types of obstacles on the tank driving range			As per the Driving Course
14	Number of driving exercises			
15	Number and types of targets at the shooting range			As per the Gunnery course
16	Quantity of the firing exercises			
17	Evaluation of trainees' actions and its documentation		Automated, following criteria and values of the Driving and Gunnery Courses	
18	The possibility to edit tactical scenarios		With the use inbuilt editor	
19	Number of video monitors at the manager's workstation		pcs.	6
20	Training scenarios (terms and conditions)		Day, night, winter, summer, dust storm, fog, various optical visibility range, temperature range from - 20° C up to +50° C	
21	Capability to enter (inject) tank equipment failures and malfunctions		---	Is implemented
22	Error-free running time		hours	at least 1000

The simulator capabilities to train crews

individual training of tank commanders and gunners:

- weapon handling
- target reconnaissance
- firing from the tank weapon with all types of ammunition, including a guided projectile, against various types of targets, in the main and emergency modes, day and night, under various weather and ballistic conditions, on various terrain, from a spot and on move

tank driver-mechanic individual training

- driving in the full scope of requirements of the Driving Course
- driving tank on an unfamiliar terrain

crew collective training

- technical, reconnaissance, fire and tactical training of tank crews in the full scope of the combat training program
- performing a practicing and record exercises under requirements the Tank Gunnery Course
- performing of advanced fire and tactical exercises on a 3D model of a terrain under conditions of enemy return fire

The simulator structure

1. Instructor's workstation (including software and hardware suite)
2. Functional driving compartment mock-up
3. Functional fighting compartment mock-up

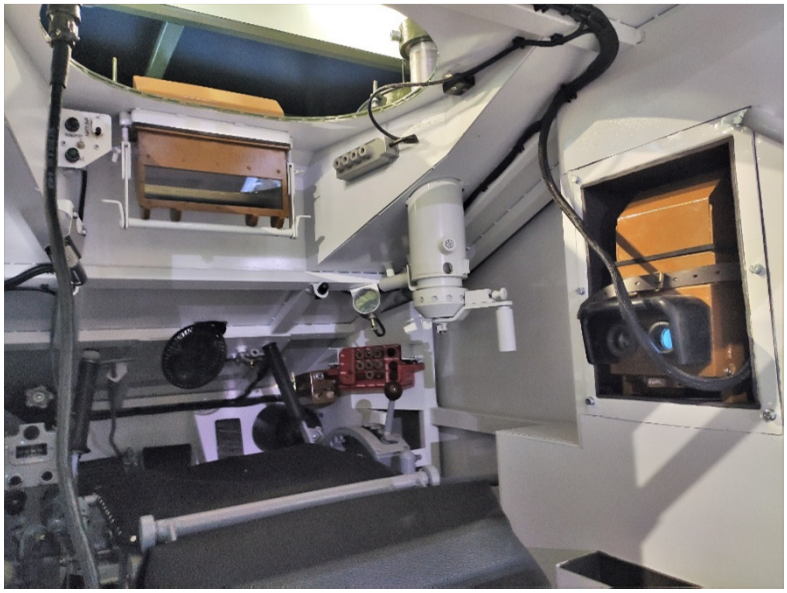
Functional driving compartment mock-up

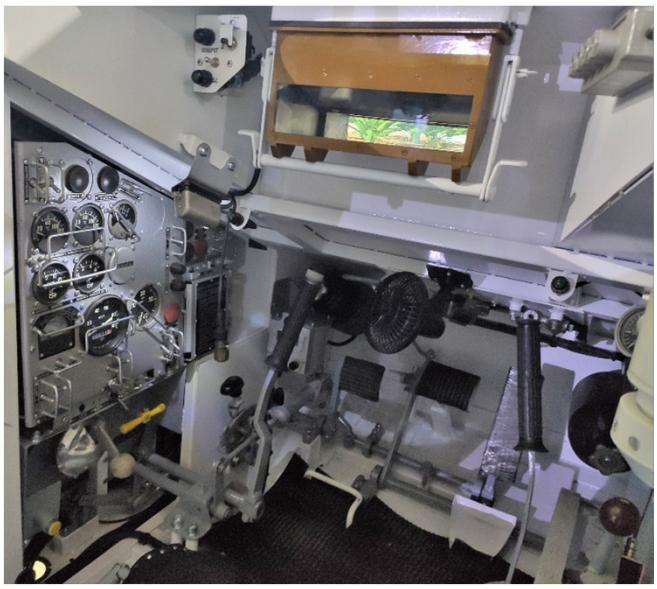
It is a cabin that is structurally and functionally adequate to the driving compartment of the T-90 tank, equipped with mock-ups of observation devices, controls, indication and signaling means.

The mock-up is mounted on a motion platform that reproduces the inclinations and accelerations characteristic of a tank movement under various terrain conditions.

The view of the functional mock-up of the driving compartment during classes

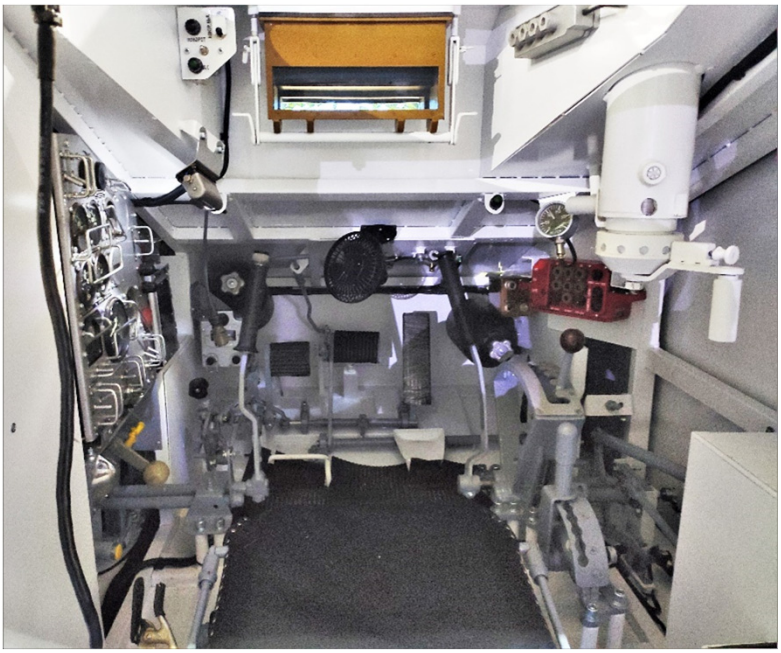
Placement of controls and indicators in the driving compartment mock-up

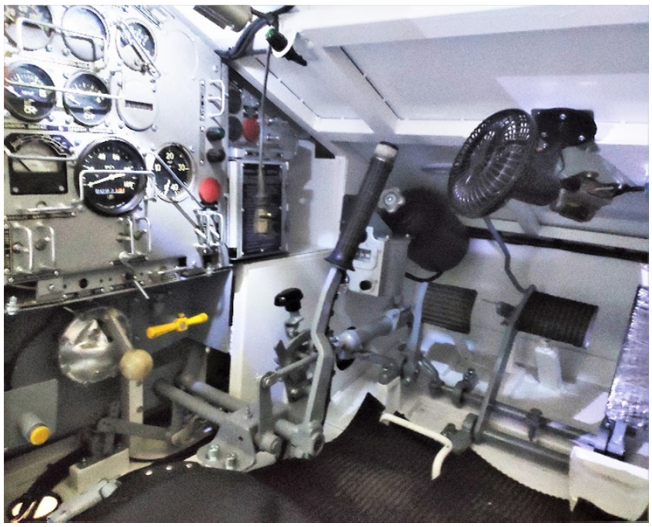




Functional driving compartment mock-up

№ seq.	Designation, title	Quantity, pcs.
1	Functional controls and instruments mock-ups, kit, including	1
	TNPO-168B prismatic observation device	1
	TVN-5 night vision device	1
	TNPA-65A observation device	2
	instruments panel	1
	air bottle	2
	hand fuel priming pump	1
	fuel supply pedal	1
	clutch pedal	1
	brake pedal	1
	steering lever	2
	manual fuel feed sector	1
	gear shifting lever	1
	parking brake lever	1
	Inlet shutters slot actuator arm	1
	fuel tank selector valve	1
2	Equipment kit, including	1
	helmet with push-to-talk button	1
	driver’s seat	1
	interior dome light	1
	fan	1





Motion platform

The 6DOF motion platform provides reproducing of tank tilts during movement following the terrain relief, gun-firing, as well as accelerating effects when pulling away, speeding up, deceleration and turns, collisions and when the tank mock-up is hit by an enemy fire

Characteristics of the 6DOF motion platform

№	Designation		Value
1	The the type of drives of motors		Asynchronous with short-circuited rotor
2	Driving motor Controls		Frequency by speed and position
3	Pitch angle		+/- 20 degree
4	Angle of heel		+/- 20 degree
5	Heave		+/- 100 mm
6	Angle of rotation around vertical axis		+/- 30 degree
7	Surge		+/- 300 mm
8	Sway		+/- 300 mm
9	Angular speed of movement along the axes		0-20 degree/sec
10	Accuracy of control signals processing		< 0,2 degree at the corners
			<10 mm positionally
11	Maximum consumed power, kW	6PD8	9.8
		6PD11	11.4

Instructor's workstation

Instructor's enabler

Simulator turn on/off
Voice communication check

Training results printing

Instructor's workstation

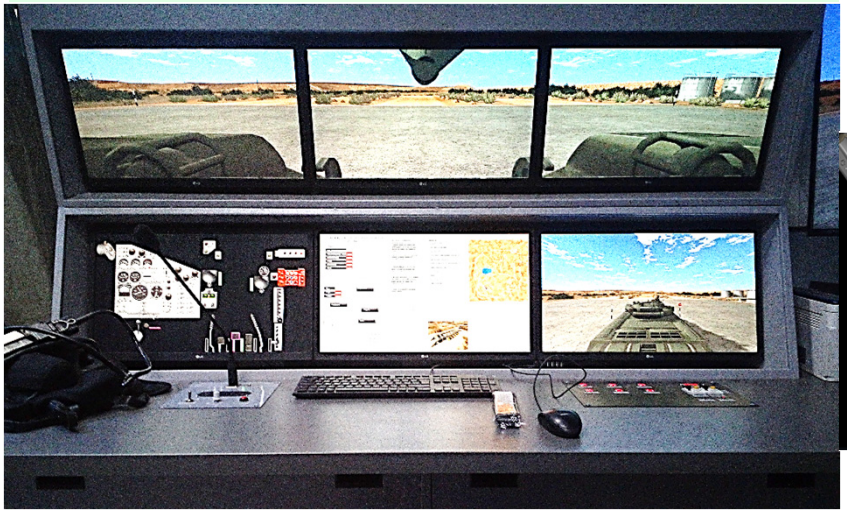
Generation of exercise evaluation results

Injection of imitated tank failures (malfunctions)

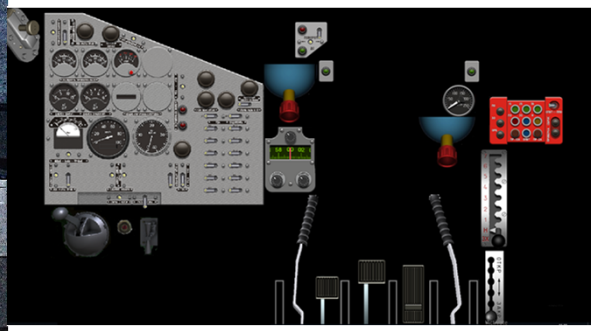
Mode selection
- Training conditions
- Training session
- The results of training session

Development of a training database for a training period

Instructor's workstation monitors



The monitor of the state of controls and indication means in the driving compartment



Monitoring of the field of view of the 1G46 sight at the instructor's workstation

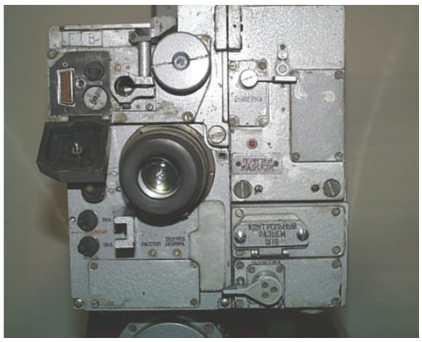
Functional fighting compartment mock-up

It is a cabin that is structurally and functionally adequate to the fighting compartments of the T-90 tank, equipped with mock-ups of observation devices, controls, indication and signaling means.

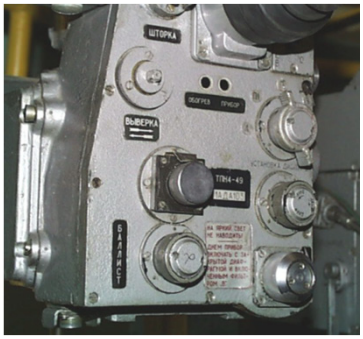
The fighting compartment mock-up is mounted on a motion platform that reproduces the inclinations and accelerations characteristic of a tank movement under various terrain conditions.

T-90 tank gunner's workplace

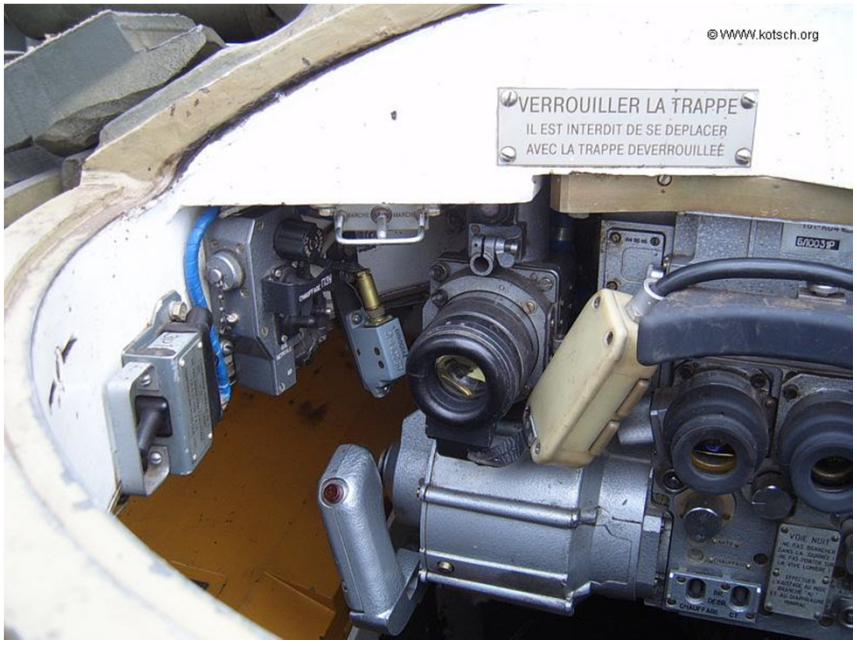
1G46 sight simulator



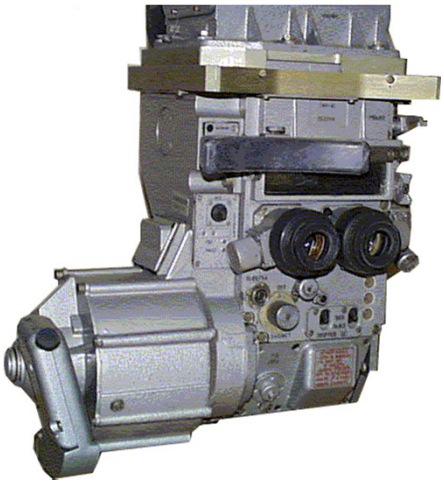
TPN4-49 night sight simulator



T-90 tank commander's workplace



TKN-4C sight simulator



The composition of the functional mock-up of the fighting compartment

№ seq.	Designation, title	Quantity, pcs.
1	Functional controls and instruments mock-ups, kit, including	1
	Gunner's workplace, kit, including:	1
	The 1G46 sight-rangefinder with a control console	1
	The 9C516 information unit and control console	1
	NP185-2C gunner's panel	1
	ESSA thermal weapon sight	1
	The scanning device of the Essa thermal sight, control panel	1
	TNP-165A prismatic observation device	1
	distribution box-left	1
	optical-electronic suppression system control panel	1
	control panel of the smoke grenades launching system	1
	Hand-wheel of a gun lifting mechanism with a worm gear pair unlocking mechanism	1
	hand wheel of turret traversing mechanism	1
	turret stopper	1
	azimuth indicator	1
	2A46M breech assembly with the breech block wedge handle	1
	the elements of the autoloader (cassette lifting mechanism, rammer)	1
	Commander's workplace, kit, including:	1
	PNC-4C panoramic sighting and observation complex	1
	The scanning device of the Essa thermal sight, control panel	1
	The 902A system's control console	1
	autoloader control console	1
	distribution box - right	1
	automation unit	1
	radio	1
	tank intercom system devices	1
	BV-1 box	1
	BPV-29 box	1
	The 1V216 switch box	1
	The 1V216 switch box	1
	"ZU-VN" switch	1
	TNPO-160 observation device	1
	PZU-7 sighting device	1
	CPZ control panel	1
	PKT receiver	1
2	Equipment, kit, including	1
	helmet with push-to-talk button	2
	commander's seat	1
	gunner's seat	1
	interior dome light	2

Adequacy

The simulator ensures the performance of at least 90% of the actions of the driver, commander and gunner of the T-90 tank

The design adequacy

- the correspondence of geometric dimensions of the compartments and the placement of mock-ups of observation and aiming devices, units and equipment of the T-90 tank simulator
- full resemblance of the front panels of devices and equipment mock-ups to the real ones, correspondence of equipment illumination, instrument scales, and tags to the T-90 tank
- the correspondence of ranges of movement, efforts and reaction of levers, pedals, switches, flywheels in the simulator to the characteristics of the T-90 tank
- the reproduction of tilt angles of the tank hull during movement and acceleration effects when speeding up, braking and turning, hull oscillations when overcoming obstacles and colliding with objects using the 6DOF motion platforms
- the use of a circular rotation turret race ring in the design of the motion platform of the fighting compartment cabin, which, in combination with 6DOF, ensures complete similarity of the rotation of a tank turret and an operation of a weapon stabilizer during scanning for targets, target designation and firing
- physical recoil effects of a gun breech-block during firing in combination with the swinging and the functioning of the cassettes hoisting mechanizm and rammer provide full realistic operation of the mechanisms of the tank during automatic gun loading and firing
- Implementation of all tank's optical prism observation devices and sights, including night vision devices

The functional adequacy

- adequacy of instruments' and equipment's functional algorithms on the T-90 simulated tank in the operating and emergency modes and the simulator responce on controlling actions of trainees;
- the adequacy of the tank movement model, following a terrain features, type of soil, condition of the road surface; the adequacy of the dynamic characteristics of moving objects (targets) and the simulated tank
- the adequacy of a main gun and machine gun firing models, based on the correct accounting for the effect of barrel wear, type of ammunition, wind speed and direction, atmospheric pressure, air temperature and charge on the range of projectiles and bullets;
- conduct of surveillance with use of optical and optoelectronic devices and all kinds of ammunition firing following optical visibility, obscuration of optical observation devices field of vision, the hull inclinations during movement and gun firing;
- adequacy of visual, sound and dynamic effects of simulator operating and firing of various types of ammunition
- accounting of terrain conditions, time of a day, season, air temperature

Reliability

The simulator ensures reliable operating during whole exploitation period (warranted and post-warranted period)

Reliability-assurance program is based on the following principles:

- use of proven by exploitation, the best quality and reliable components together with their incoming control
- program solutions development that exclude conflicts between specific and general software, as well as conflicts between software and hardware elements
- multiple repeated check of design solutions that provide long-term lifecycle of mechanical nodes
- Application of design solutions, ensuring protracted work of mechanical nodes
- functional and phased check of quality of mechanical and electrical simulator assembly
- use of non contacting angle of rotation sensors (based on magneto sensitive microchips)
- use of protective means of print boards of electronic devices and connectors from environmental affects
- use of industrial computers
- Use of uninterrupted power supply units
- ensuring of required simulator hardware thermal conditions
- providing power margin of power supply equipment

Service life and warranty period

- Service life of Simulator (the life cycle of Simulator) is 3 years, under condition of strict adherence of Operational Rules, and proper maintenance and repair in accordance with Operational Documentation.
- Service life of Simulator is 10 years, under condition of strict adherence of Operational Requirements, proper maintenance and repair in accordance with Operational Manual.

® Simulator ensures continuous operations for 12 hours a day

® Error-free running time is 1000 hours

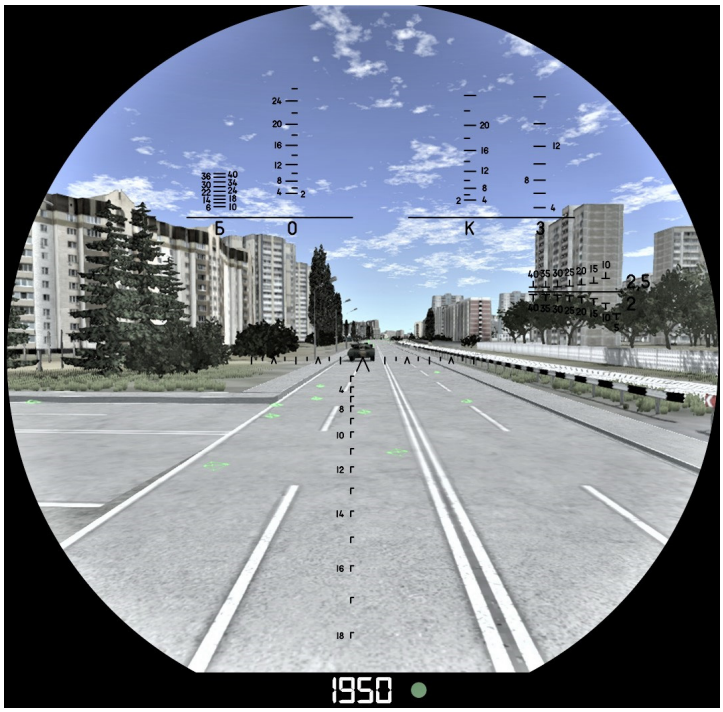
Visualization

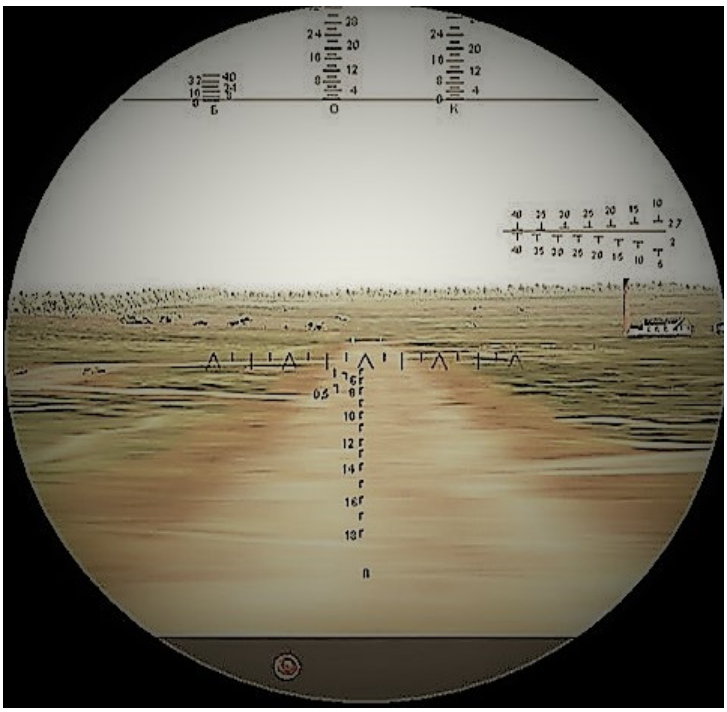
The simulator provides the possibility of visual observation and shooting, taking into account optical visibility, range and type of targets, weather conditions

High quality visualization of the target and background environment is achieved due to:

- extensive capabilities of the visualization program for creating dynamic scenes
- the use of liquid crystal monitors and high-resolution matrices in simulators of optical aiming and observation devices
- creating three-dimensional detailed models of real terrain areas with summer and winter textures, as well as detailed three-dimensional models of tanks, IFV and APC, infantry groups, anti-tank systems and artillery pieces, grenade launchers and machine guns
- matching the color gamut of terrain textures and objects to real colors and contrast, matching angular dimensions, shapes, local objects, vegetation, ground targets to real objects in the field of view of optical observation devices
- close to the real display of the external situation in the field of view of optical observation devices and aiming of the driver, gunner and commander in statics and in dynamics at the driving range, a shooting range, at the tactical field
- displaying aiming marks and service information in the field of view of optical sights and observation devices, taking into account their optical characteristics, visibility range, weather conditions, time of year and day
- reproduction of physical effects (dust, traces of caterpillars, flame of a shot, tracers of shells) during simulation of the movement of tank firing on the terrain

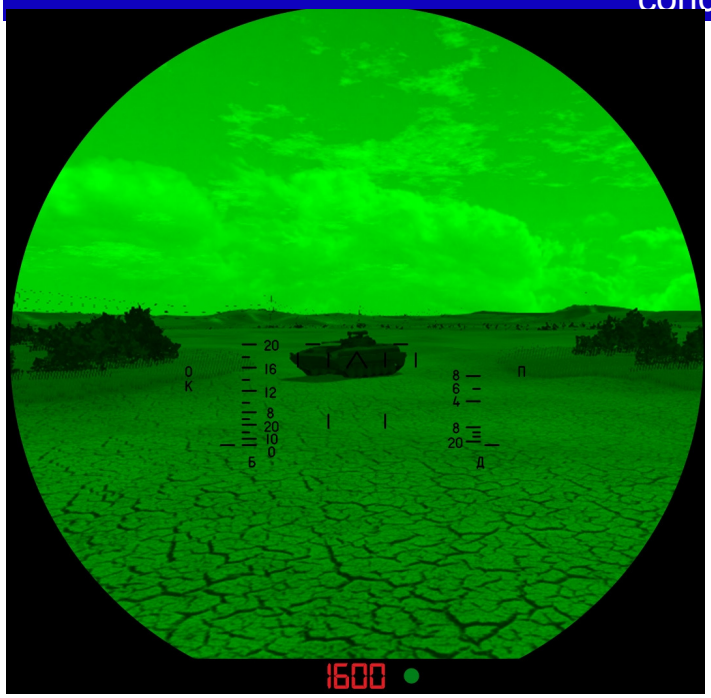
The field of view of the TKN-4S commander's sight mock-up under day-light conditions





Examples of visualization in the simulator

The field of view of the TKN-4S commander's sight mock-up under day-light conditions



EDUCATIONAL AND METHODICAL CAPABILITIES OF THE SIMULATOR

To support crews training:

- T-90 tank driver-mechanic individual training
- T-90 tank gunners individual training
- collective firing and tactical training of T-90 tank crews
- collective training of a tank platoon, consisting of 3 crews

To develop conditions for exercises and training events, namely:

- selection of the terrain sector from the simulator's library
- setting the time of day (day-light, night, twilight);
- selecting meteorological conditions (sunny, cloudiness,fog, wind of various directions and speed)
- season - summer, winter (according to the conditions of the geographical area of the user and required training scenarios)
- selection of meteorological and ballistic conditions for firing;
- selection of standard or generating of the improvised firing or tactical exercise
- selection of particular enemy activities
- repetition (multiple when required) of exercise (or exercise phase) or event
- entering of T-90 equipment faults and failures during the training

Education and training of driver-mechanics:

- performing of the full list of the Driving Course exercises with the automated assessment of trainees' actions
- driving under various road and off-road conditions in the course of gunfire and execution of tactical tasks

Education and training of crews:

- execution of the full list of the Gunnery Course (KVBM) exercises with the automated assessment of trainees' actions
- performance of advanced fire and tactical missions within a crew

Supervision of trainees' actions:

- current state of the driver's, commander's and gunner's controls and indication means
- duplicated field of view of the driver observation devices
- by duplicated fields of view of 1G46, TPN4-49, TKN-4, PZU-7 sights
- by a position of a tank on the driving range, firing range or tactical field
- driving and fire training exercises protocol
- by the reports of the trainees via communication means

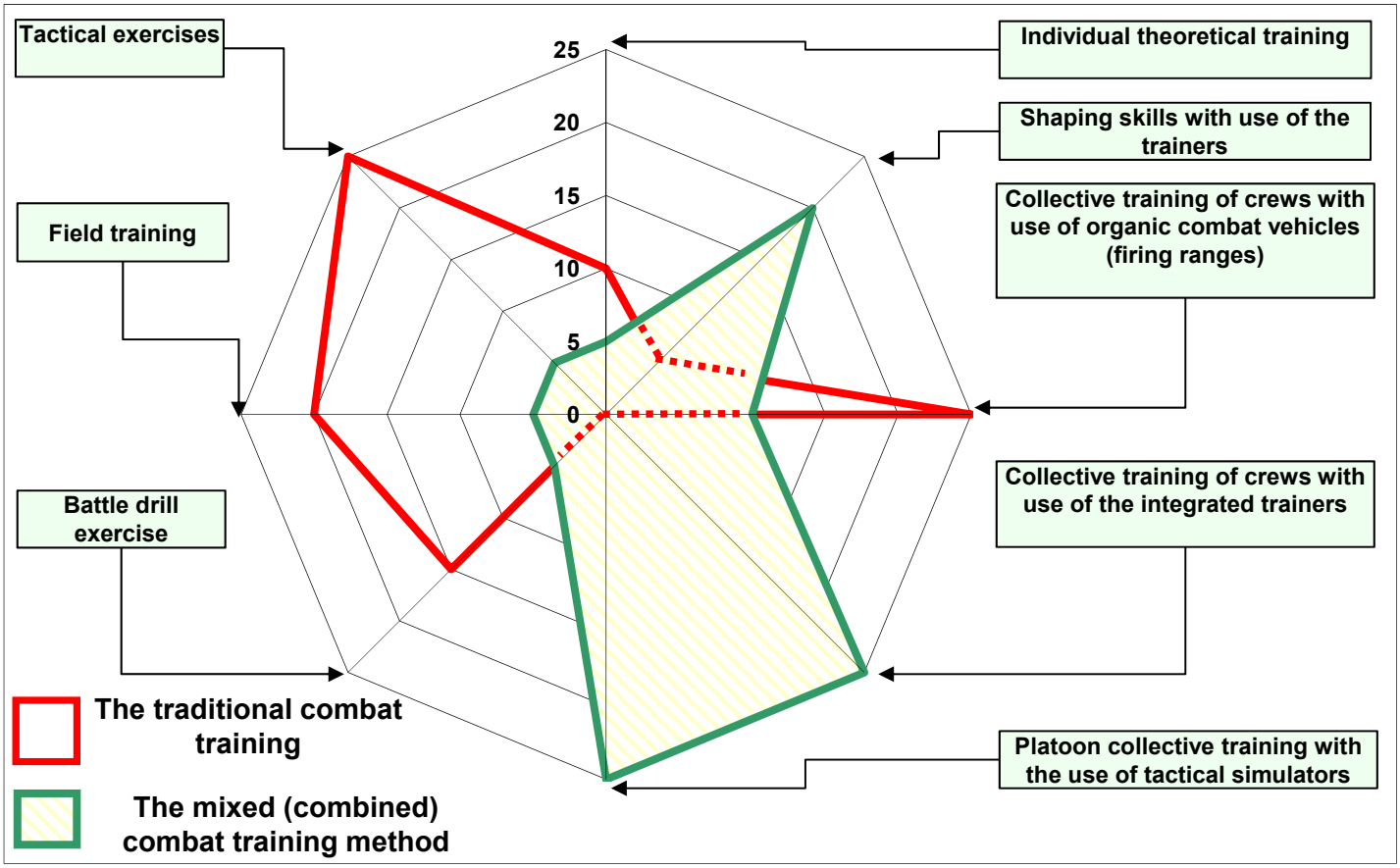
The training results processing and storing

- training results e-documenting (printing)
- training results archiving for a day or specified training period

Outcome of an introduction of tank dynamic simulators into training process

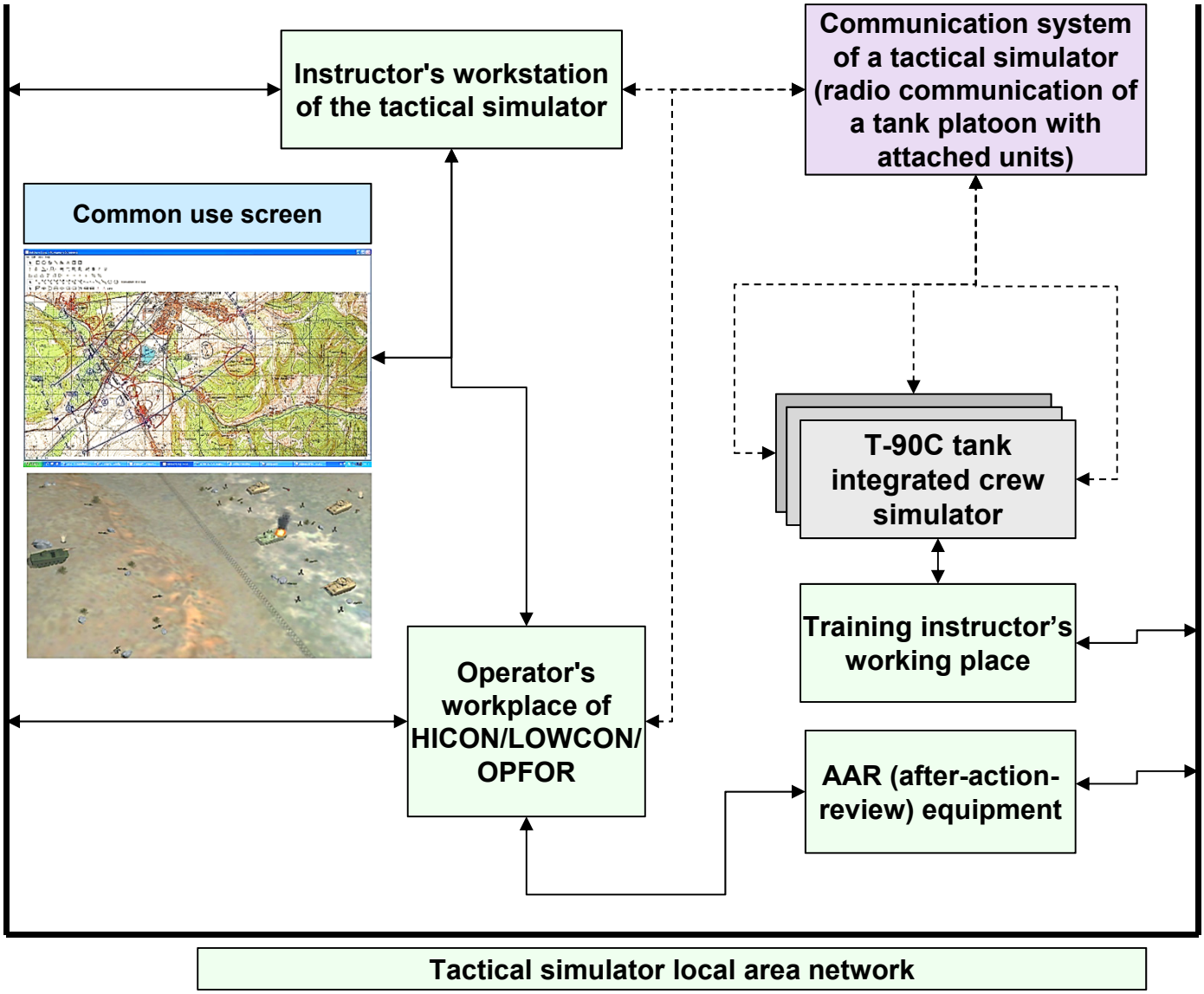
The use of simulators significantly changes the allocation of time for different forms of combat training:

- 75-80% of time is allocated for shaping and maintaining weapon operating skills at required level and units with use of simulation systems
- 20-25% of time is given for testing of individual skills and collective proficiency during firing exercises, as well as units collective training during tactical exercises



1. Effective solution of 80% of the combat training objectives
2. Practicing the training tasks of fire and tactical training under various conditions (mid-rugged, mountainous, swampy and desert terrain in day and night conditions, winter and summer, various weather conditions).
3. Ensuring the stages of combat training - individual, collective, and combat coordination (cohesion) within a platoon
4. Support of 'crawl-walk-run' training methodology, individual approach to trainees, continuity of training process.
5. Arrangement and methodical interrelation of training events and exercises with use of simulators and field training exercises.
6. Unbiased evaluation of the training level of each crew member apart and units as a whole, determination of progress ratio in skills level and unit cohesion
7. Manageability of the education and training process, modification of the intensiveness of training process .
8. Reduction of degree of pro forma of training, approximation of training conditions to combat ones

The T-90 tank platoon simulator



EDUCATIONAL AND METHODICAL CAPABILITIES OF THE PLATOON SIMULATOR

- ★ Performing training in shooting and fire control, force-on-force tactical exercises of platoons using integrated simulators in various conditions
- ★ Modeling the actions of attached and interacting forces
- ★ Modeling enemy units activity
- ★ Achievement of various tactical training objectives - from a platoon approach march up to simulated force-on-force fight (offense, defense, meeting engagement, reconnaissance in force, combat security)
- ★ Ensuring realistic platoon command-and-control radio-net operating during tactical events and exercise
- ★ Control of crew actions and fire during the battle
- ★ Portraying of close fight dynamics on an e-map
- ★ Supervision of leaders' and crews' actions
- ★ Integration of company and battalion level units into simulation systems

Developer and manufacturer:
LCC «Research and Production Company «Energy 2000»
Povitrophlotsky, 94-A, Kiev, Ukraine
www.simulator.ua

Developer and manufacturer provides:

- manufacturing the simulator
- assembly, adjusting, commissioning and acceptance testing at the site of intended use
- training of customer's technicians
- warranty service for 3 years
- Post-warranted maintenance (subject to separate contract)