Dynamic crew simulator of infantry combat vehicle BMP-2

Characteristics

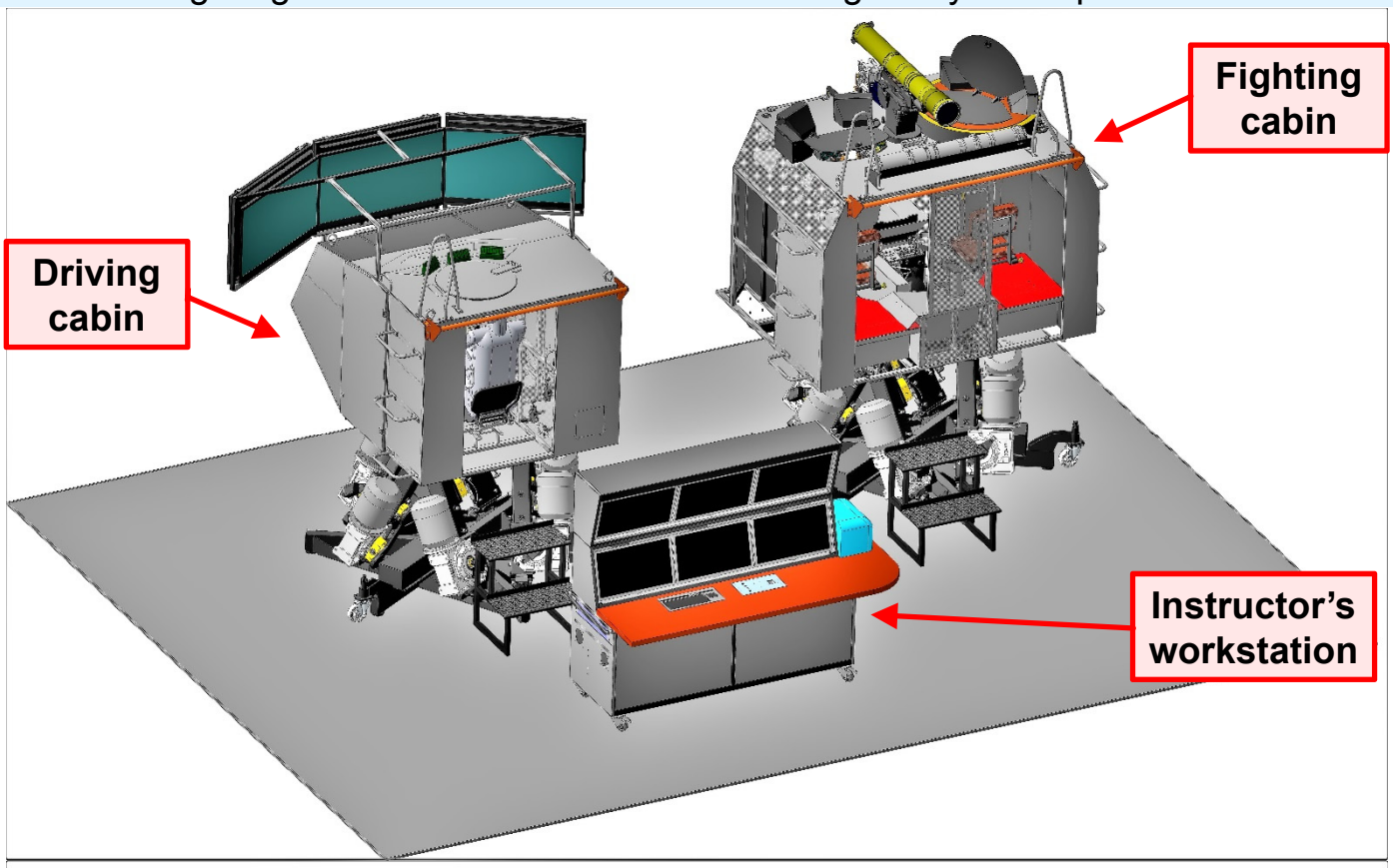
- Structural adequacy of driving and fighting compartments
- Systems and equipment operating algorithms functional adequacy
- High quality of external conditions visualization
- 3-D models of tank driving area, firing range, and tactical field
- Realistic acceleration effects due to use of 6DOF motion platforms
- Full scope of Combat Vehicles Driving Course exercises
- Full scope of Gunners' Course exercises
- Wide range of exercises developed by instructor
- Objective evaluation of trainees actions
- Results documentation (protocolling)

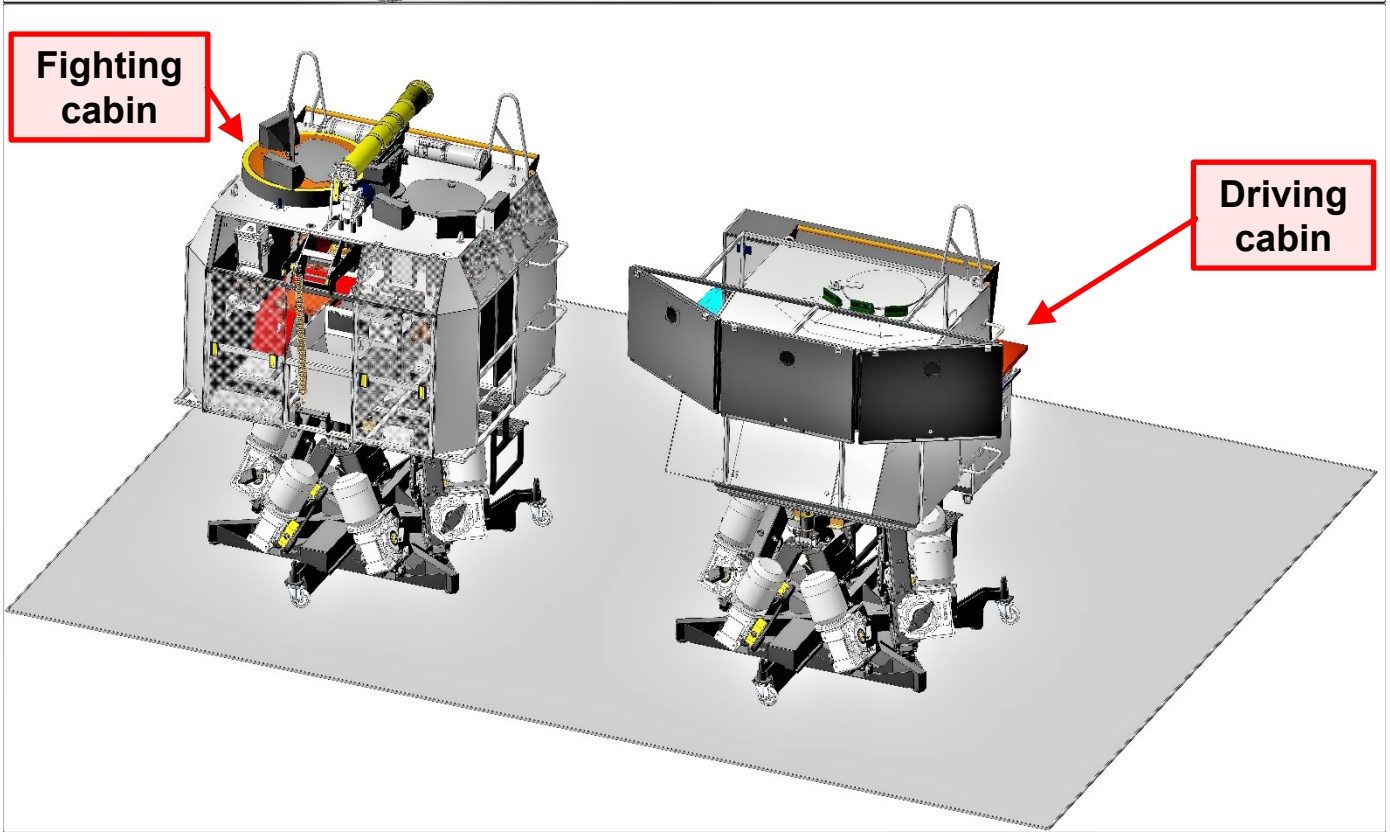
Simulator's specifications

No.	Specification	Unit of measurement	Specification value
1	Simultaneously trained crew members	Personnel	3 (driver, gunner, commander)
2	Minimum space of training area	m^2	30
3	Actuation time upon turn-on	min	5
4	Running continuously	hours	No more than 12
5	Electric supply capacity: voltage	V	220±10%
	frequency	Hz	50±1
6	Maximum consumed power	kW	25
7	Range of working temperatures	Deg. C	from +5 to +40
8	Diagnostics system	---	Integrated semi-automatic
9	Dimensions of 3-D tank driving range model	km	2x4
10	Dimensions of 3-D firing range model	km	4x4
11	Dimensions of tactical field	km	8x8
12	Simulator turn-on/off control	---	Remote, from instructor's workstation
13	Conditions of exercises	---	Day, night, fog, various range of optical visibility, temperature range from -20^0 to $+50^0$ C
14	Possibility to inject BMP-2 equipment failures and faults	---	Injection of failures and faults is implemented from the instructor's workstation
15	Maintenance (M)	---	Check, Daily M, M-1 (once in 6 months), M-2 (once a year)
16	Electrical safety of trainees and technical personnel	---	Absence of a dangerous voltage at trainees workplaces. Short circuit protection at manager workstation
17	Error-free running time	hours	More than 1000
18	Assigned life time	years	More than 10
19	Warranty period	years	2
20	Operating time counting	---	Operation time program counter
21	Total Simulator weight	kg	2 450
22	Operating documentation	---	Logbook, operating instructions, repair manual

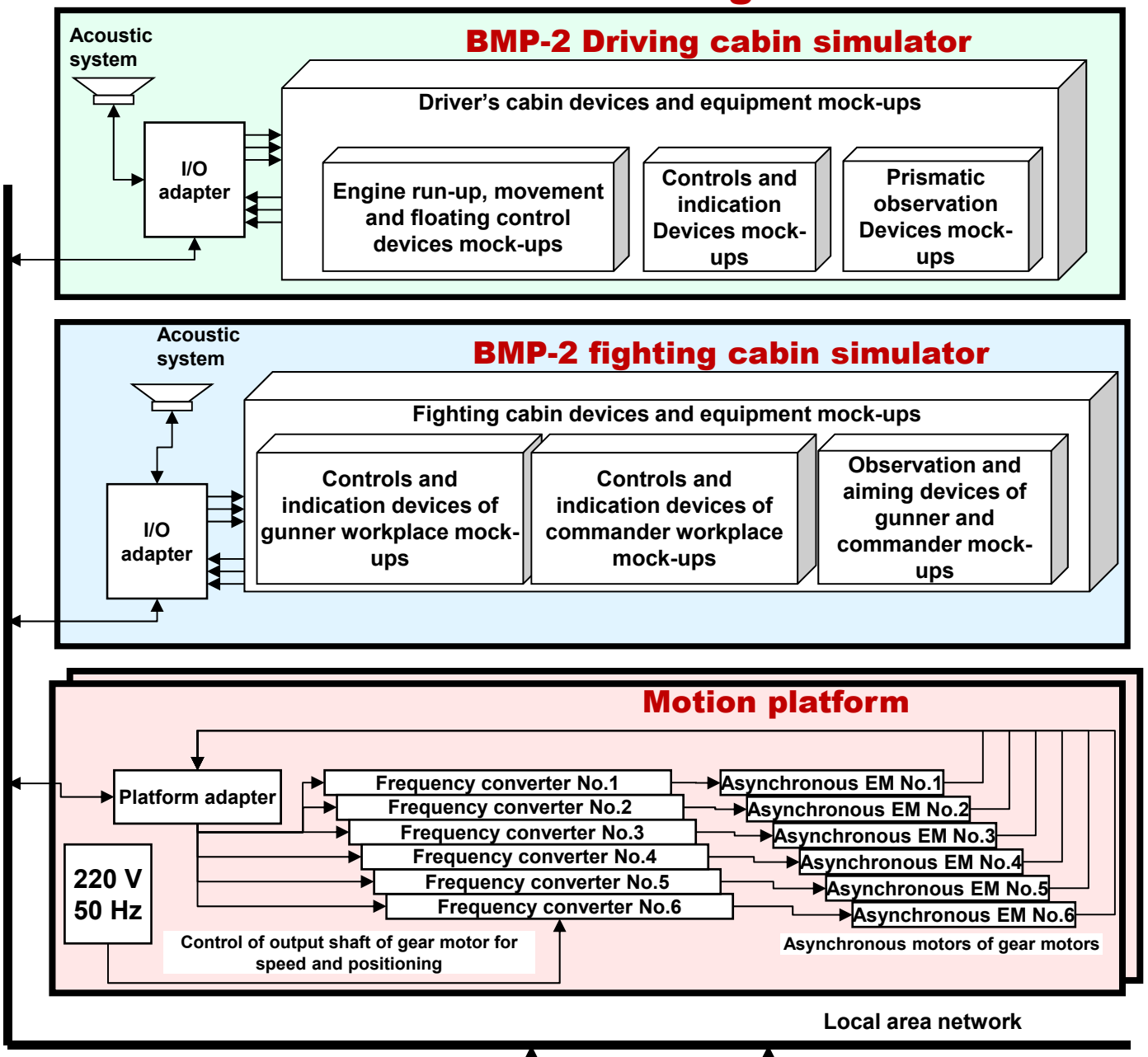
BMP-2 Simulator composition

1. Instructor workplace (incl. server cabinet and hardware-software set)
2. BMP-2 driving cabin simulator mounted on 6-degree dynamic platform
3. BMP-2 fighting cabin simulator mounted on 6-degree dynamic platform





Simulator Block Diagram



BMP-2 integrated crew simulator composition

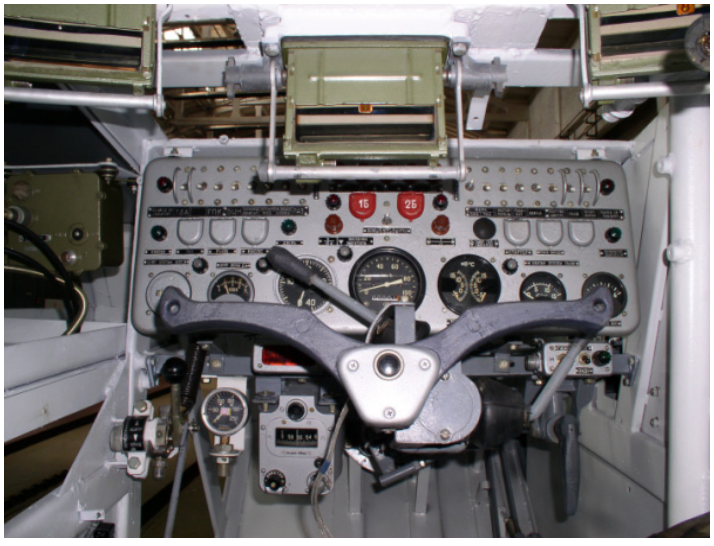
General view of simulator

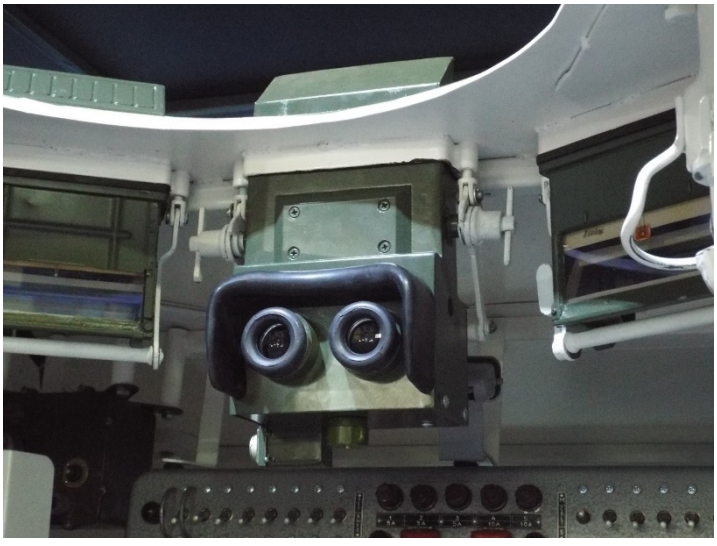
View of BMP-2 driving cabin mounted on 6-DOF dynamic platform

Composition of BMP-2 driving cabin

No.	Name, designation	Q-ty, pcs.
1	**Devices and equipment mock-ups**	
	Observation device TNPO-170	3
	Steering bar with gear shift lever, gear down shift lever, horn button, turning signal switch	1
	Night vision power supplier	1
	Driver's instrument panel of with folding illuminators and display "Hand brake"	1
	Intercommunication device A-3	1
	Fuel-feeding pedal	1
	Clutch pedal	1
	Brake pedal	1
	Stopping brake drive handle	1
	Inlet shutters gate drive lever	1
	Air cylinder with valve	1
	Manometer of compressed air supply system	1
	Fuel tap	1
	Traffic signal board	1
	Water and oil treatment system condensate drain	1
	Heater fuel supply system tap	1
	Blocked pneumatic actuator cock handle	1
	Water deflection shield control cock handle	1
	Gyre direction indicator GDI-59	1
2	**Equipment**	
	Interphone headset	1
	Driver's seat	1
	Interior lamp	1
	Fan	1
	Audio system	1

Location of equipment in control compartment of simulator





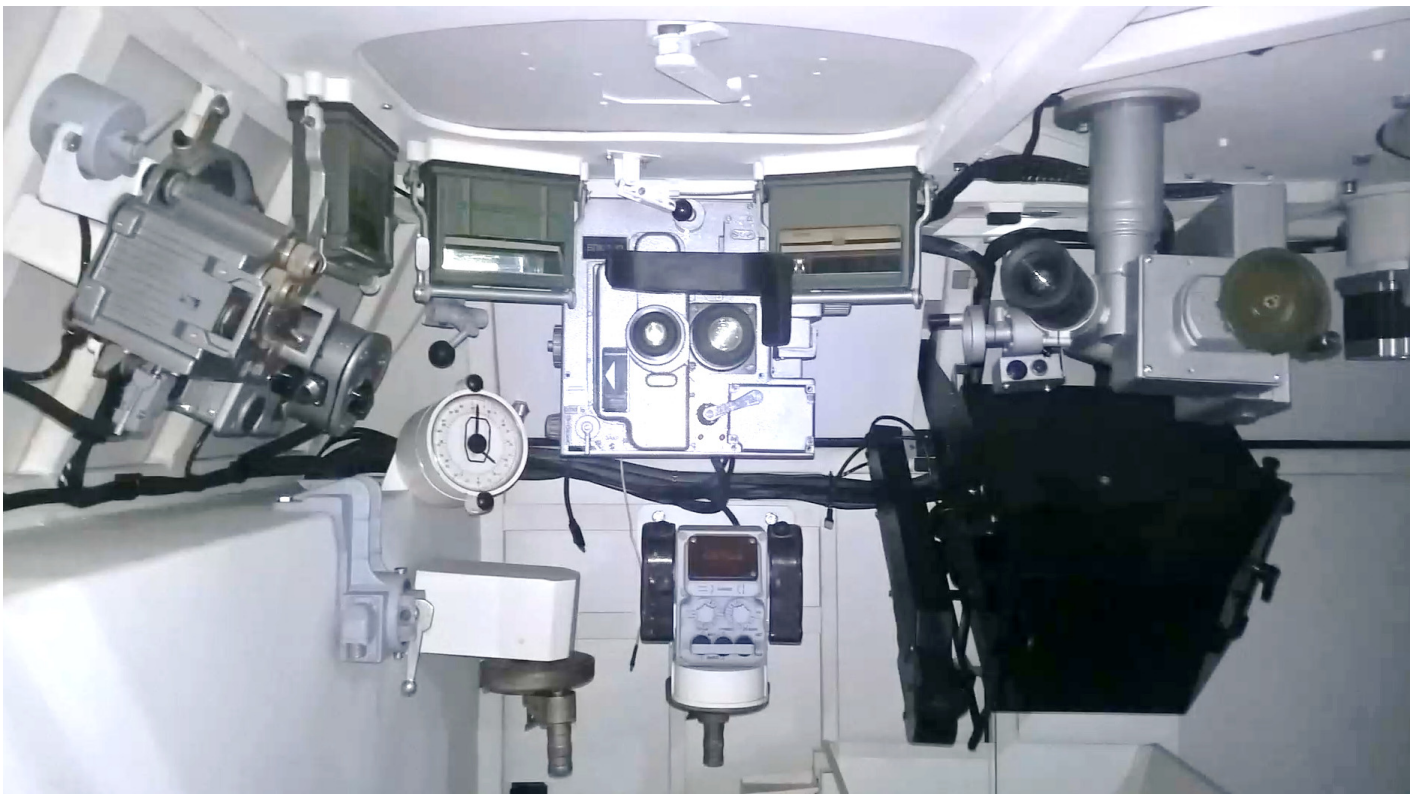
BMP-2 fighting cabin

General view of BMP-2 fighting cabin mounted on 6DOF dynamic platform

Location of equipment in fighting cabin

Composition of fighting cabin

No	Name, designation	Q-ty pieces
1	**Devices and equipment mock-ups**	
	BPK-2-42 Sight	1
	Stabilizer control panel	1
	9SH119 Guidance unit	1
	BU-25-2C Unit	1
	Turret locker	1
	Smoke grenade launcher control panel	1
	Gun lifting mechanism hand wheel	1
	Turret traversing handle	1
	Azimuth indicator	1
	Gun breech	1
	Commander's observation device TKN-3B	1
	1П3-3 Sight	1
	Stabilizer control panel	1
	PKT cartridge bag	1
2	**Equipment**	
	Audio system	1
	Interphone headsets	2
	Intercommunication boxes	2
	Gunner's and commander's seats	2
	Interior lamps	2
	Fans	2
	Radio station full-scale mock-up	1



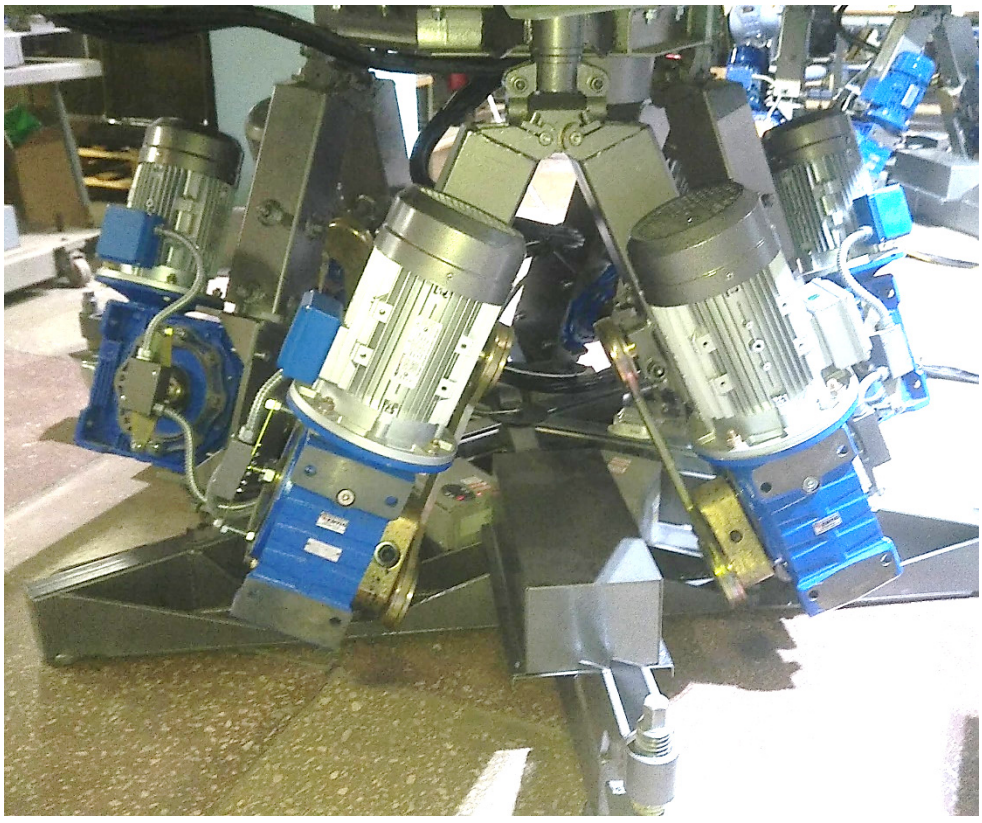
Motion platform

6-DOF motion platform ensures adequacy of cabin slopes and acceleration effects on crewmembers during engine start, acceleration, deceleration, turning of ICV in accordance with terrain and road conditions

Main characteristics of motion platform

Index	Value
Type of drive motors	Asynchronous with short-circuited rotor
Type of reduction gear	Worm
Drive motor control	Frequency as per the velocity and as per the position of reducer output shaft
Pitch angle	+/- 20 deg
Roll angle	+/- 20 deg
Vertical movement	+/- 100 mm from neutral position
Turning rate around vertical axis	+/- 30 deg from “zero” position
Longitudinal displacement value	+/- 300 mm from neutral position
Traverse displacement value	+/- 300 mm from neutral position
Angular velocity of axis motion	0-20 deg/sec
Accuracy of control signals execution	<0,2 deg as per the angles
	<10 mm as per the position
Power consumption (average)	4,5 kW

Motion platform



Instructor's Workstation

Functional features
- Selection of training conditions
- Selection of pre-set exercises from library
- Development of new exercises
- Supervision of trainee's actions in the course of training
- Diagnostics of technical condition of simulator

Operational assistance to the instructor

Simulator turning on (off)

Training results printout

Instructor's workstation

Assessment of exercise results

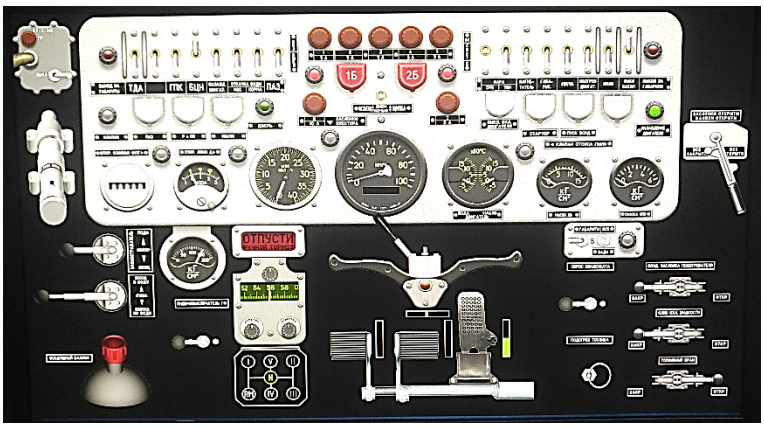
Simulated equipment failures and faults injection

Mode selection
- Restart
- Training
- Ground conditions editor
- Training results

Generation of training results database for certain period

General view of Instructor's workstation

Monitoring of driver's instruments and controls



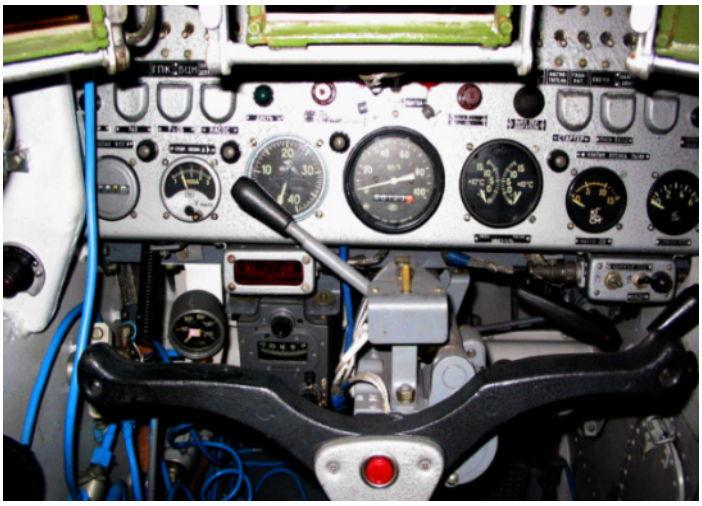
BMP-2 view from an external controlled camera

Specifications

Adequacy → **Simulator provides execution of at least 90% of driver's, commander's and gunner's actions**

- Correspondence of cabin's dimensions and location of nodes and equipment mock-ups to the real BMP-2
- Maximum similarity of instruments dashboard and equipment mock-ups, correspondence of equipment illumination, scales, transparency to the real BMP-2
- Complete list of reproducible functions of observation and aiming devices of BMP-2
- Correspondence of ranges, forces and reactions of wheel, levels, pedals to the characteristics of the real BMP-2 (correspondence of ergonomic characteristics and sensory motor field of trainees in the simulator to the workplaces of BMP-2)
- Correspondence of devices' and equipment functional algorithms in all modes and reaction of control and detection devices to the real BMP-2
- Calculation of visibility of ground objects with respect to optical characteristics of observation devices
- Keeping all main characteristics of BMP-2 in the motion model (various engine operating condition, transmission characteristics, ICV weight etc.), as well as features of terrain (relief, type of soil, road surface condition)
- Keeping BMP-2 motion principle in the model of floating
- Correspondence of operating sound effects of engine and components to the real
- Simulation of BMP-2 hull slope angels during movement and acceleration effects while speeding up, braking and making turns, hull vibrations while overcoming obstacles and in case of collision with objects
- Bullet and missile flight trajectory calculation based on the ballistic characteristics of 7,62-mm PKT machine-gun and 30-mm 2A42 (2A72) gun and ammunition used
- Antitank guided missile flight trajectory calculation based on the characteristics of semi-automatic guidance loop
- Keeping vulnerability of ground targets in simulated firing

Location of equipment in real BMP-2



Location of equipment in driving cabin

Quality of visualization of target environment

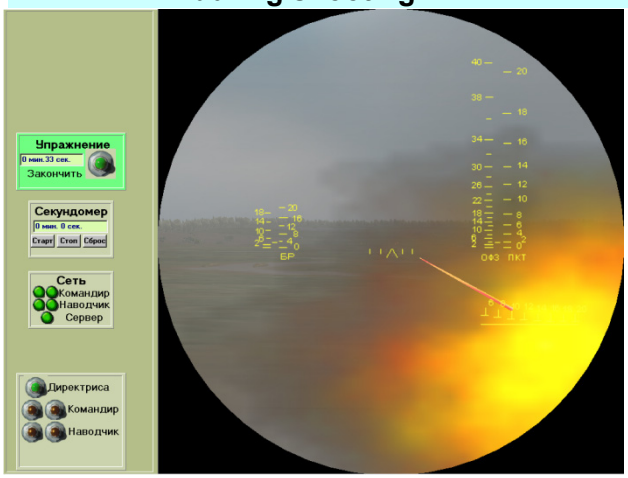
Simulator provides possibility to conduct visual reconnaissance and firing with respect to optical visibility, range and type of targets, and weather conditions

High quality of visualization of target environment is achieved by:

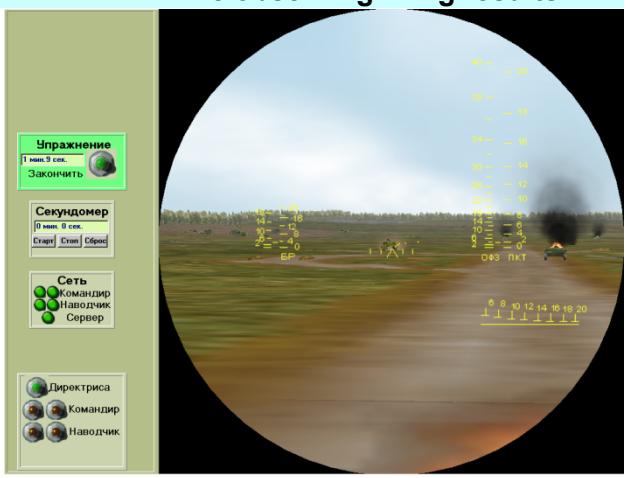
- Use of LCD monitors and high-resolution matrices in the observation devices
- Detailing and drawing of terrain texture
- Compliance of color range of terrain textures and objects with the real colors and contrast
- Correspondence of the angular size, form, local objects, vegetation, land targets to the real objects in the field of view of observation devices
- Simulation of physical effects (dust, traces of tracks) in the course of BMP-2 movement

Field of view of BPK2-42 gunner's sight

during shooting



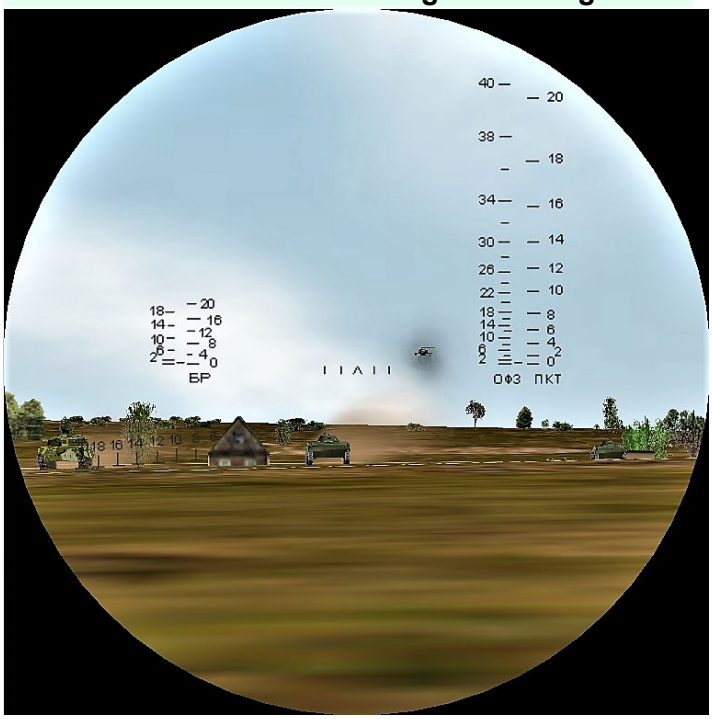
while observing firing results



View from the external controlled camera on the tactical field situation

Quality of visualization of target environment

Field of view of BPK2-42 gunner's sight



Field of view of 9SH119 sight

Field of view of 1PZ-3 sight

Field of view of TKN-3 sight

Reliability → Simulator provides reliable operating during the entire operation period (warranty and post-warranty periods

Simulator reliability program is based on the 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
- using of industrial (protected) computers
- using of uninterruptable power supply units
- maintaining of necessary thermal regime of simulator equipment
- providing of power supply sources back-up capacity

Warranty and service life

- Warranty period of the simulator is 2 years under condition of strict adherence of operating rules and maintenance cervices according to the Operating Documentation.
- Service life of the simulator is at least 8 years, under condition of strict adherence of operating rules and maintenance cervices according to the Operating Documentation.

® The simulator ensures daily continuous operation for 12 hours

® Simulator error-free running time is at least 500 hours

Simulator training capabilities

Training capabilities of the simulator:

- Individual driving proficiency training of BMP-2 drivers
- Individual firing proficiency training of BMP-2 gunners
- Collective fire and tactical training of crew members

Capabilities to create conditions for education and training:

- The size of 3D area model – 4x4 km
- Types of terrain – regular, mountain, desert (3D model of any real area of terrain with size of 8x8 km can be created, subject to Customer's request)
- Types of roads – ground, hard-surfaced, cross-country
- Time of a day – daylight, twilight, night
- Weather conditions – sunny, cloudy, rain, snow, wind of various velocity and direction
- Season – summer, winter (subject to Customer's request with respect to conditions of customer needed geographical area)

Driving training capabilities:

- Execution of the full list of driving exercises from Driving Course with automatic evaluation of trainee's actions
- Driving under various road conditions and cross-country driving during the execution of fire and tactical missions

Commander's and gunner's training capabilities:

- Execution of the full list of firing exercises from the Gunner's Course with automatic evaluation of trainee's actions
- Accomplishment of fire and tactical missions

Coaching capabilities

Trainee's actions supervision capabilities as per:

- current status of controls and observation devices of driver, commander and gunner (with use of control monitor)
- duplicated field of view of observation devices of driver
- duplicated fields of view of BPK2-42, 9SH119, 1PZ-3, TKN-3
- positioning of BMP-2 from the external controlled camera
- position of BMP-2 on the tank driving range
- protocol of driving, firing and tactical exercises
- trainee's reports via communication means

Trainee's actions evaluation capabilities:

- computerized evaluation of driver's actions during standard training in accordance with terms and conditions of the Driving Course
- computerized evaluation of commander's and gunner's actions during standard training in accordance with terms and conditions of Gunner's Course
- subjective evaluation of trainee's actions as per the results of analysis of all means of control

Training conditions development capabilities:

- Selection of weather conditions for shooting
- Selection of standard and development of unspecified firing and tactical exercises
- Selection of types of terrain, time of the day and year
- Selection of types of enemy activity
- Repetition (multiple if required) of exercise or situation
- Injection of failure and faults of BMP equipment

Processing and storage of training results capabilities:

- Results e-documenting (including printout)
- Results archiving per day and training period
- Integration of simulator into centralized recording and processing system

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)**