Multi-purpose prime mover MTLB driving simulator

Purpose

Simulator is designed to support education and training of Multi-purpose prime mover MTLB drivers under conditions of classroom with the goal to shape and maintain steady skills in control of prime mover under various conditions

Basic characteristics

✦ **Adequacy**
✦ **3D driving range model**
✦ **6DOF dynamic platform**
✦ **Full range of Driving Course exercises**
✦ **Wide spectrum of Exercise' terms and conditions**
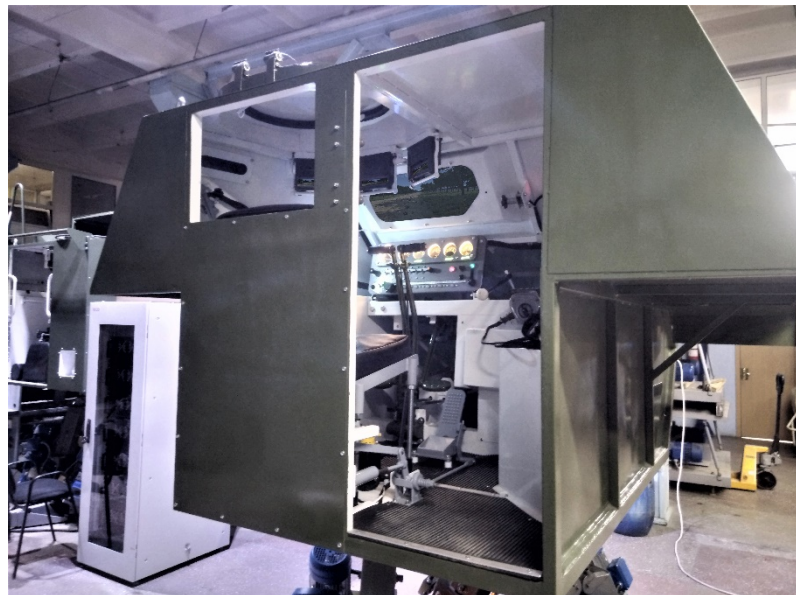✦ **Impartial evaluation of trainees' actions**
✦ **Training results documenting**

Simulator's technical characteristics

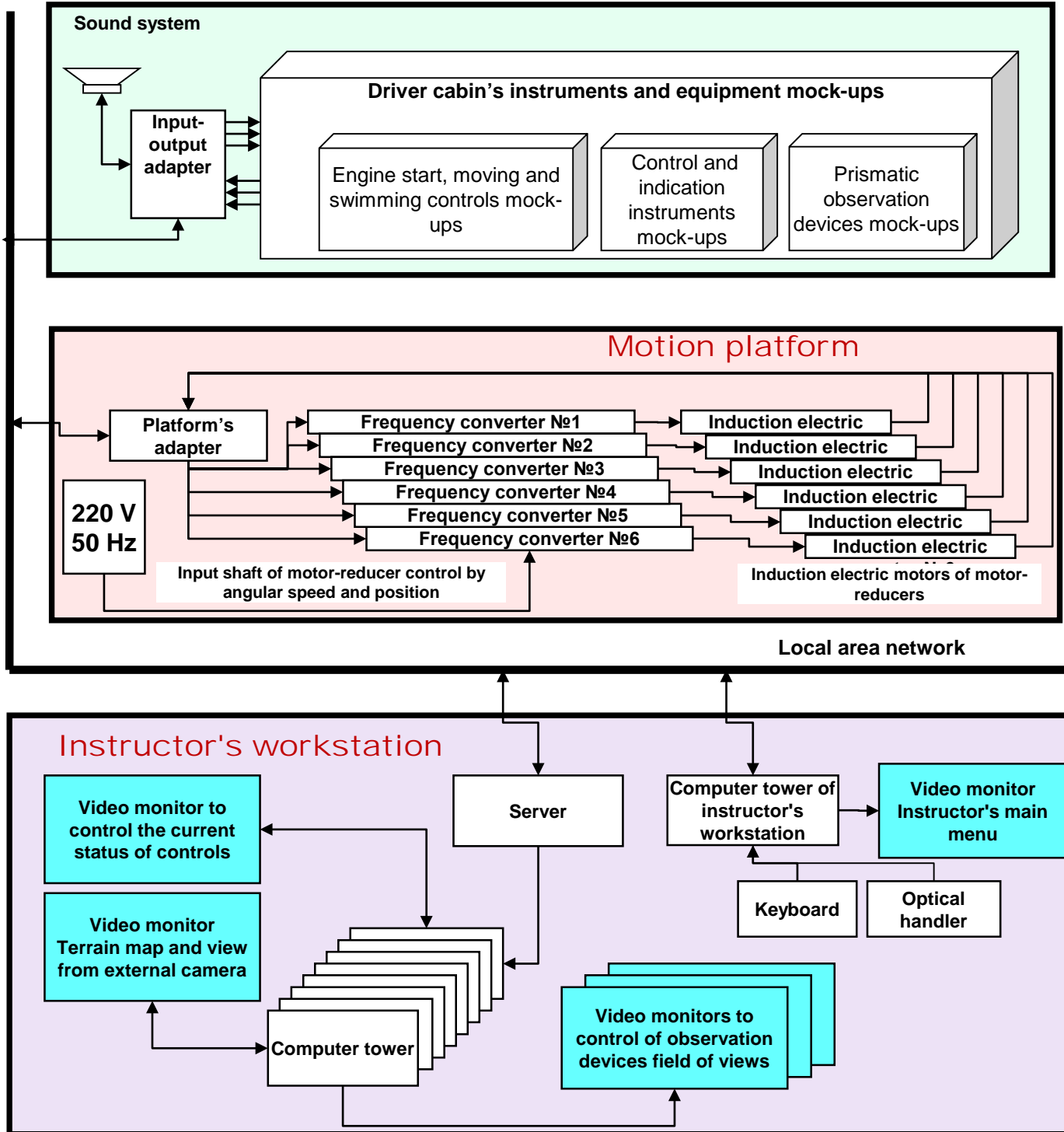| № number	Characteristics	Unit of measure	Specifications:
1	Number of simultaneously trained	---	1
2	Minimum area classroom for installation	m²	20
3	Warm-up time upon actuation	minutes	up to 5
4	Duration of continuous daily work	hours	at least 12
5	Electric power supply voltage	V	220±10%
	Frequency	Hz	50±1
6	Maximum power consumption	kW	9
7	Range of working temperatures	degrees C	from +5 up to +40
8	The type of system' diagnostics	---	Built-in semi-automatic
9	3D driving range dimensions	km	2x4
10	3D terrain sector dimensions	km	4x4
11	Simulator' switch ON/OFF control	---	Remote control of simulator from Instructor's workstation
12	Exercises terms and conditions	---	Day light, night, fog, various range of optical visibility, temperature range from -20 degrees up to +50 degrees
13	Capability to enter faults and failures of systems and equipment of simulated MTLB	---	Failures and faults input (injection) is implemented from Instructor's work station
14	Maintenance	---	Check-up, daily maintenance, Maintenance-1 (once per 6 months), Maintenance-2 (once per year)
15	Electrical safety of trainees and technical personnel	---	Dangerous voltage is absent at the working places Short-circuit relay protection from instructor's work station
16	Error-free running time	hours	at least 1000
17	Specified lifetime	years	at least 15
18	Warranty period	years	2
19	Running hours accounting	---	Operating hours programme counter
20	Simulator assembled weight	kg	1,150
21	Operational documentation	---	Logbook, Operational Manual, Maintenance and Repare Manual

Simulator's structure

1. **Instructor's work station (including software and hardware suite and general view screen)**
2. **Driver's cabin mock-up mounted on 6DOF motion platform**
3. **SPTA, suite**
4. **Operating documentation**
5. **Transportation package**

General view of driver's cabin mock-up mounted on 6DOF motion platform

Simulator's structural diagram

MTLB Driver's cabin compartment mock-up

Sound system

Input-output adapter

Driver cabin's instruments and equipment mock-ups

Engine start, moving and swimming controls mock-ups	Control and indication instruments mock-ups	Prismatic observation devices mock-ups

Motion platform

Platform's adapter

220 V 50 Hz

Frequency converter №1	Induction electric
Frequency converter №2	Induction electric
Frequency converter №3	Induction electric
Frequency converter №4	Induction electric
Frequency converter №5	Induction electric
Frequency converter №6	Induction electric

Input shaft of motor-reducer control by angular speed and position

Induction electric motors of motor-reducers

Local area network

Instructor's workstation

Video monitor to control the current status of controls

Video monitor Terrain map and view from external camera

Server

Computer tower

Computer tower of instructor's workstation

Video monitor Instructor's main menu

Keyboard

Optical handler

Video monitors to control of observation devices field of views

Driving compartment mock-up structure

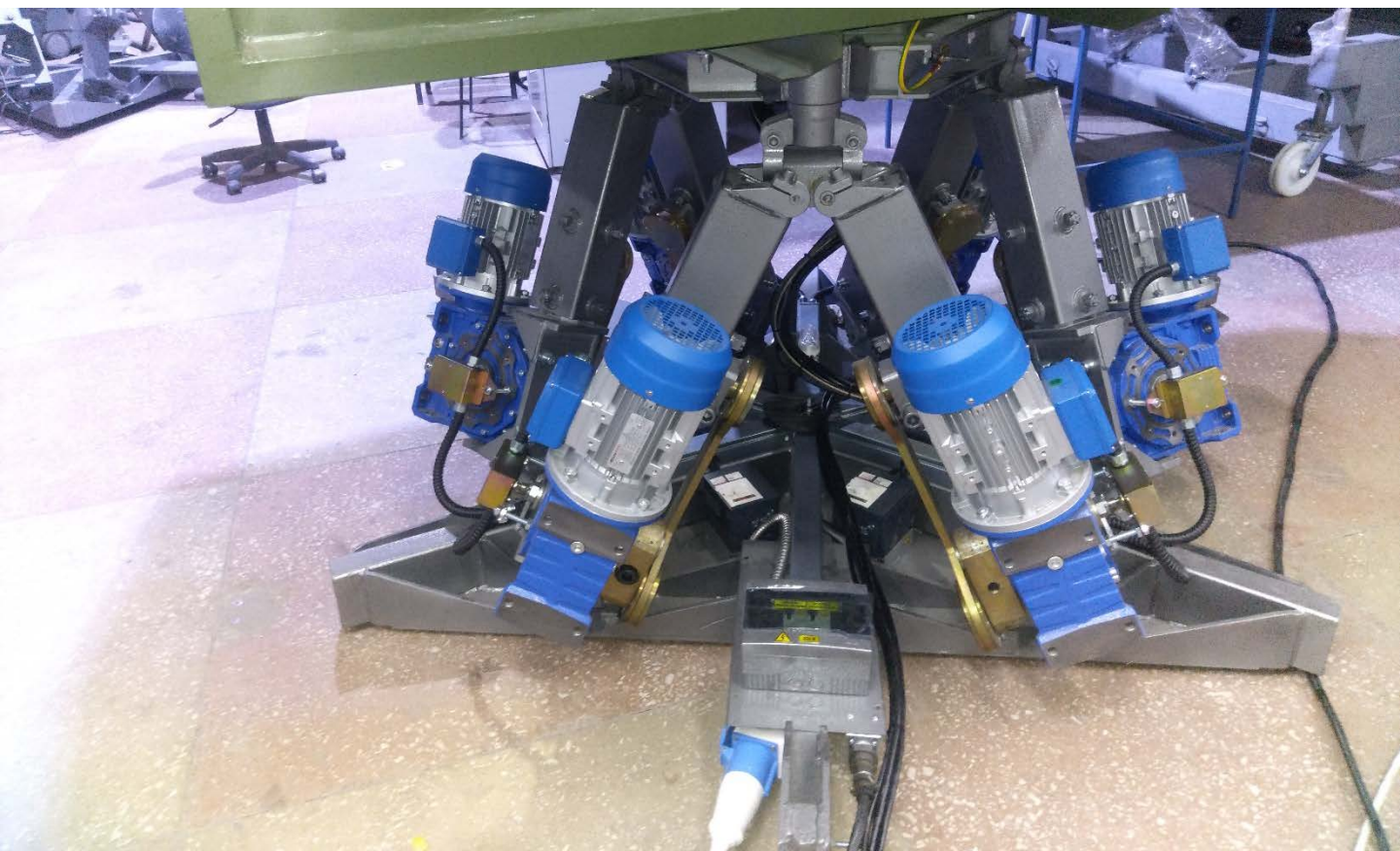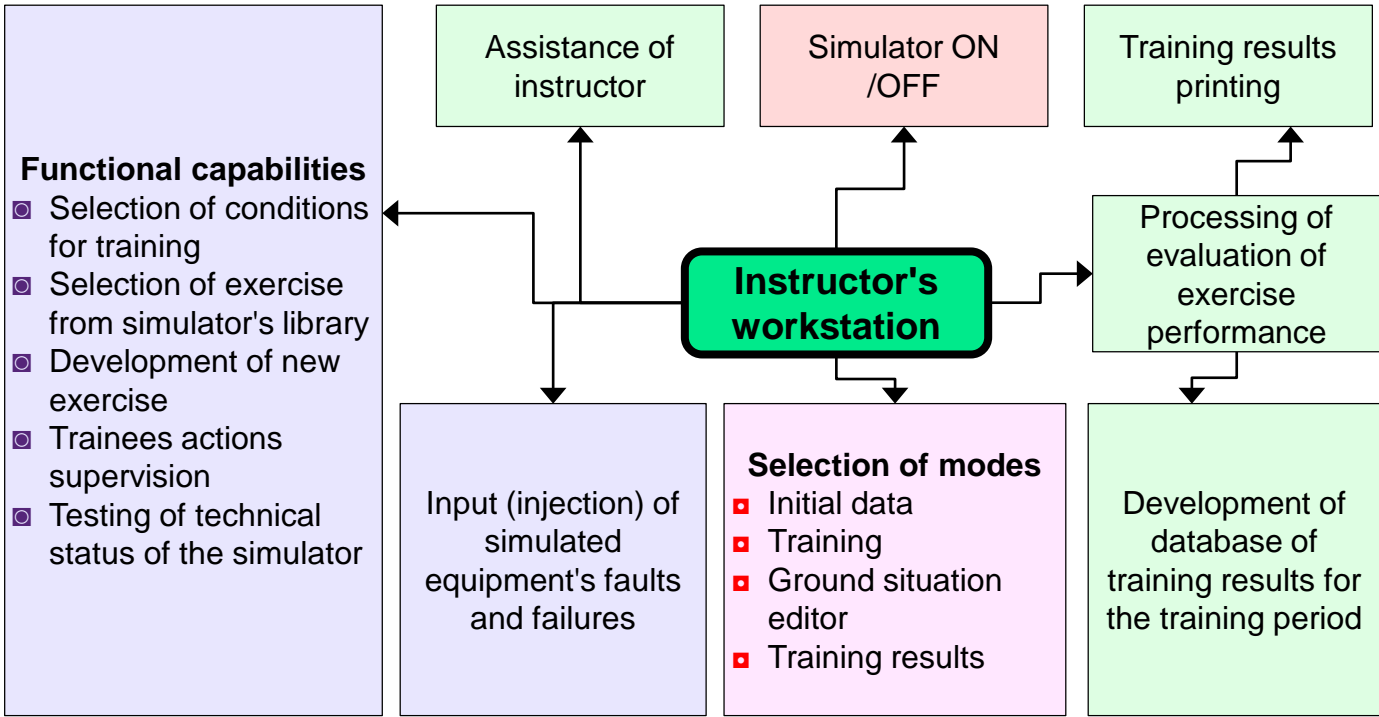| №	Instruments and equipment mock-ups names	Quantity, pcs.
1	lookout hatch and lookout hatch handle of driver	1
2	TNPO-170F observation device	3
3	instruments dashboard	1
4	jalousie's handle	1
5	pre-heater dashboard	1
6	turning handles (right and left)	2
7	parking brake pneumatic drive pedal	1
8	clutch pedal	1
9	The handle of parking brake system	1
10	The handle of gears shifter	1
11	manual fuel feed lever with hand fuel supply sector	1
12	brake tightening lever	1
13	compressed air cylinders	2
14	gauge of pneumatic system	1
15	low-light night vision device TVN-2B and power box	1
16	Headlight-projector control handle	1
17	glass temperature adjuster	1
18	fuel distributing cock	1
19	Hand fuel supply pump	1
20	wind shield wiper control box	1
	Equipment	
1	Driver's seat	1
2	master switch of vehicle	1
3	ventilation port handle	1
4	headset	1

Motion platform

6DOF motion platform provides adequacy of hull inclinations and acceleration effects on trainees when starting from rest, speeding up, braking, and turning according to characteristics of mover, terrain relief, and road conditions/

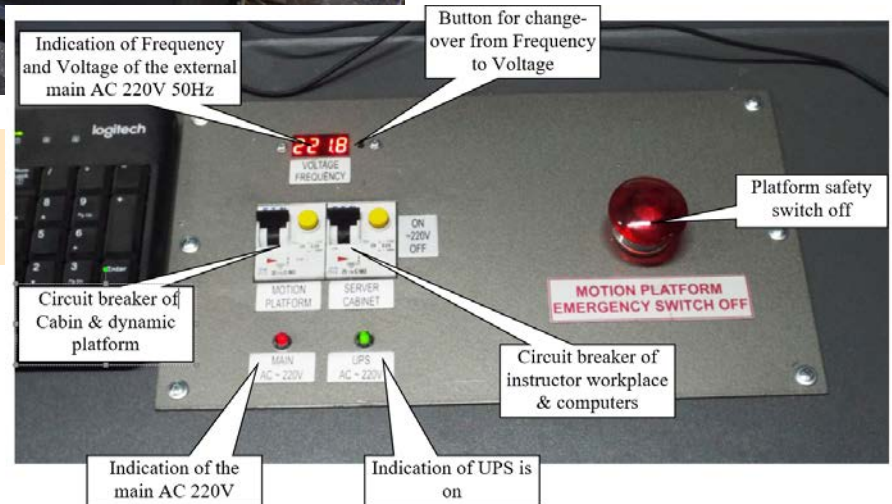| The main characteristics of motion platform	
Feature	**Value**
Driving motors type	Non-synchronous with short-circuited rotor
Reducer type	Worm
Driving motor control	Frequency-response according to speed and position of reduction gear output shaft
Pitch angle	+/- 20 degrees
Roll angle	+/- 20 degrees
Heave	+/- 100 mm from middle position
Yaw angle	+/- 30 degrees
Surge	+/- 300 mm from middle position
Sway	+/- 300 mm from middle position
angular velocity of displacement along the axis	0-20 degrees/sec
Accuracy of control signals tracking	<0,2 degree by angles
	<0 mm by position
Power consumption (average)	4,5 kW

Instructor's workstation

Assistance of instructor

Simulator ON /OFF

Training results printing

Functional capabilities
- ◉ Selection of conditions for training
- ◉ Selection of exercise from simulator's library
- ◉ Development of new exercise
- ◉ Trainees actions supervision
- ◉ Testing of technical status of the simulator

Instructor's workstation

Processing of evaluation of exercise performance

Input (injection) of simulated equipment's faults and failures

Selection of modes
- ◻ Initial data
- ◻ Training
- ◻ Ground situation editor
- ◻ Training results

Development of database of training results for the training period

General view of Instructor's workstation

Power and fuse of instructor's work station control unit

Indication of Frequency and Voltage of the external main AC 220V 50Hz

Button for change-over from Frequency to Voltage

Platform safety switch off

Circuit breaker of Cabin & dynamic platform

MOTION PLATFORM EMERGENCY SWITCH OFF

Circuit breaker of instructor workplace & computers

Indication of the main AC 220V

Indication of UPS is on

Technical characteristics

Adequacy → **Simulator ensures at leasts 90% of driver's actions**

➡ **correspondence of geometrical dimensions of simulator's cabin and location of equipment and assemblies replica to the real MTLB, possibility to occupy working place through the hatch**

➡ complete replication of frontal instruments board and equipment mock-ups with real panel lighting, scales, banners and nameplates and legend of real MTLB

➡

➡ full range of simulated functions of observation devices, controls and indication of tractor

➡ correspondence of travel range, efforts and reaction of levers, pedals of simulator to real MTLB (correspondence of ergonomic characteristics and sensory-motor field of trainee's working place to driver's seat in MTLB)

➡ correspondence of simulated functional algorithms of instruments and equipment in all modes and reaction of controls and indicators on trainees controlling actions

➡ computation of visibility of ground objects with respect to optical characteristics of observation devices

➡ accounting of all main characteristics of MTLB (power capacity at various gears, transmission characteristics, weight of hull and equipment), as well as terrain conditions (terrain features, soil, pavement surfacing etc.)

➡ accounting of MTLB motion principles when swimming

➡ correspondence of sound effects of operating engine and other components in simulator to real ones

➡ reproduction of inclinations of MTLB hull when moving and acceleration effects when speeding up, braking, and turning; hull vibration when crossing obstacles or collision with other objects

Quality of visualization of background conditions

Simulator supports conduct surveillance under daylight conditions with use of TPNO-170A observation device and through driver-mechanic's lookout hatch with respect to optical visibility, distance, and types of objects, meteorological conditions; and during the night - with use of night vision observation device TVN-2 mock-up

High quality of background environment visualization is achieved by:

➡use of LCD monitors and high-resolution matrices in mock-ups of optical observation devices

➡detailed drawing of terrain textures

➡correspondence of colour range of terrain textures and objects to real colours and contrast

➡compliance of angular dimensions, and shape of local objects, vegetation, ground targets to real objects within field of vision of optical observation devices

➡reproduction of physical effects (dust, caterpillar tracks) in motion mode of MTLB movement

Example of visualisation of terrain sector within field of vision of driver's lookout hatch

Terrain visualisation samples
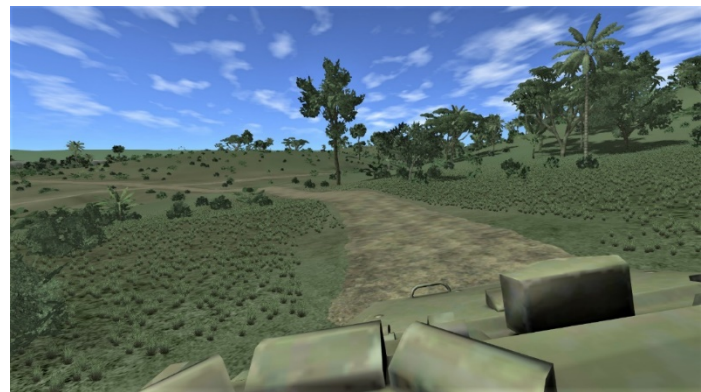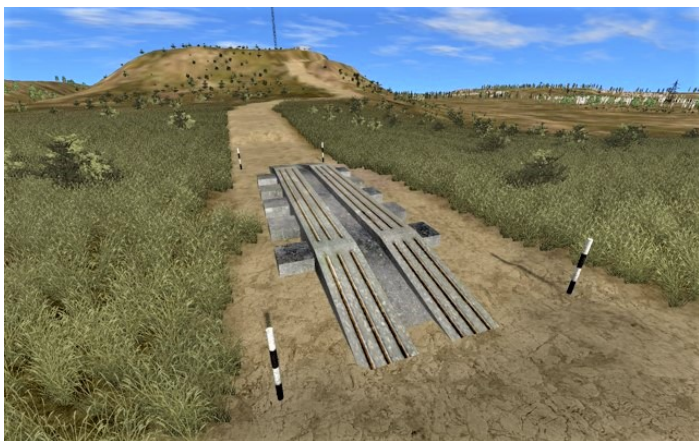
Reliability

Simulator provides reliable operation during the entire operation period (warranted and post-warranted periods)

Simulators reliability program is based on following principles:

- usage of proven by exploitation reliable components with their incoming control
- program development that exclude conflicts between specific and general software, as well as conflicts between software and hardware elements
- multiple repeated check of design solutions
- use of proved design solutions ensures long-term life-cycle of mechanical nodes
- functional and phased check of quality of mechanical and electrical simulator assembly
- exclusive usage 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 effects
- use of industrial computers
- use of uninterrupted power supply units
- providing of required simulator hardware thermal conditions
- providing power margin of power supply equipment

Warranty and Life Time

▶Warranty period of simulator operating is 2 years, subject to strict adherence of operating rules and maintenance works held in accordance with maintenance documentation.

▶Simulator life time is 8 years, subject to strict adherence of operating rules and maintenance and repair works held in accordance with maintenance documentation.

® **Simulator running continuously constitutes 12 hours per day.**

® **Error-free running time is at least 1000 hours**

Educational and methodological capacity

MTLB <u>individual driver's training</u>

✦ performing of a driving exercises under various training conditions (rough, mountainous, and deserted terrain, day and night, winter and summer, various weather conditions)

✦ adherence to training principle "from simple-to-difficult", implementation of individual approach, ensuring training continuity

✦ organisational and methodical interrelation of simulator-based training exercises with practical driving exercises at driving range or tactical field

✦ impartial evaluation of training level of each trainee, assessment of training level progress in driving under different conditions

✦ manageability of training process, and high intensiveness of training events

✦ avoiding of pro forma in training, ensuring training conditions close to real ones

Capability to develop training conditions

■ the size of 3D model of terrain – 4x4 km

■ types of terrain – moderately rugged, mountainous, deserted (based on Customer's request 3D geo-tied any required terrain sector can be created)

■ types of roads – ground, hard-surfaced, cross-country

■ time of a day – day, twilight, night

■ weather conditions – sunny, cloudy, rain, wind of various velocity and direction

■ season – summer, winter (upon the Customer's request according to conditions of geographical area of training)

Trainee's actions evaluation capability

◉ automated evaluation of driver's actions when executing standard exercises, in compliance with Driving Course requirements and criteria

◉ subjective trainee's actions evaluation based on analysis of results obtained from all available monitoring sources (or selected)

Trainee's actions supervision capability by:

◉ current positions of controls and indication means at monitor

◉ duplicated field of view of driver's observation device

◉ MTLB position from the viewpoint of external controllable camera

◉ by MTLB position at driving range route

◉ by protocol of driving exercise performance

◉ by reports of trainees via communication means

Training results processing and storing capabilities

◉ results e-documenting (and printing)

◉ results archiving for a day or training period

◉ incorporation of simulator into centralised accounting and processing system

Simulator's training effectiveness

Fielding of simulator into combat training allows

Implementation of basic training principles

- ◉ **to make MTLB driver training the real basis of units routine activity, ensure manageability of training process**
- ◉ **exclude simplification in the course of training events**
- ◉ **create training conditions close to real combat**
- ◉ **provides intensiveness of training process**
- ◉ ensure organisational and methodical link between simulator-based training and practical field training
- ◉ **ensure impartial evaluation of driver's training level**
- ◉ to implement training principle "from simple-to-difficult", individual training approach, guarantee continuous education and training process

Achievement of training objectives

- ◘ ensure real possibility to shape and maintain required skill's level of drivers in operating under various conditions
- ◘ **to teach drivers to effectively apply MTLB capabilities under difficult combat conditions, day and night**
- ◘ effectively prepare drivers to control MTLB at the driving range and during tactical exercises in the field
- ◘ to ensure driver's required level of training throughout training period

Reduction of expenditure of resources by 50-70% while gaining and maintaining required training level