



HIGH VOLTAGE TEST VAN LVI HVT-3FAVC with computer-aided control system «ASU LVI»

The LVI HVT-3FAVC is designed for the following operations:

- Test electrical power substation equipment and distribution devices with a rated voltage up to 35 kV;
- Test high voltage power electric cables rated up to 35 kV;
- Determine the location of a failure in power electric cables rated up to 35 kV by using; equipment and devices for preliminary and precise localization.

The laboratory with the help of «ASU LVI» performs the following functions:

Insulation resistance testing;

DC high voltage testing for the monitoring of leakage current;

AC high voltage testing for the monitoring of conduction current;

Insulation testing of power cables, power transformers, electric motors and other large capacitive load equipment with very low frequency AC voltage 0.1 - 0.01 Hz.

Power cable fault diagnosis by:

- Burning down defective insulation of power cables;
- Pre-locating high voltage cable faults by the pulse echo method;
- Pre-locating high voltage cable faults by the arc reflection method.

Fault location of cable lines:

- Burn down of damaged insulation of power cables;
- Fault prelocation by pulse method;
- Fault prelocation by Arc Reflection (arch reflection method);
- Fault prelocation by Arc Reflection method during burning down;
- Fault prelocation by the method of fluctuating traveling voltage wave;
- Fault prelocation by impulse current method (method of current traveling wave);
- Precise fault location by acoustic method;
- Cable tracing and fault location by inductive method;
- Fault location of cable shield;
- Selection of testing cable from a bunch.

Measurement of capacity and $\text{tg}\delta$ (dissipation factor of a dielectric) of high voltage insulation by «direct» and «reverse» schemes.

Low voltage measurements of power transformer parameters and measurement of resistance to the DC.

I. MAIN EQUIPMENT.

A. Central automated control system of high voltage testings «ASU LVI».

Testing control system «ASU LVI». The system allows to control units and blocks of the laboratory by the computer, to measure parameters of testing voltages and currents with their fixation and allows to further process the received data. It checks the protection stage and laboratory's safety, and also collection of telemetric information about the condition of laboratory's equipment.



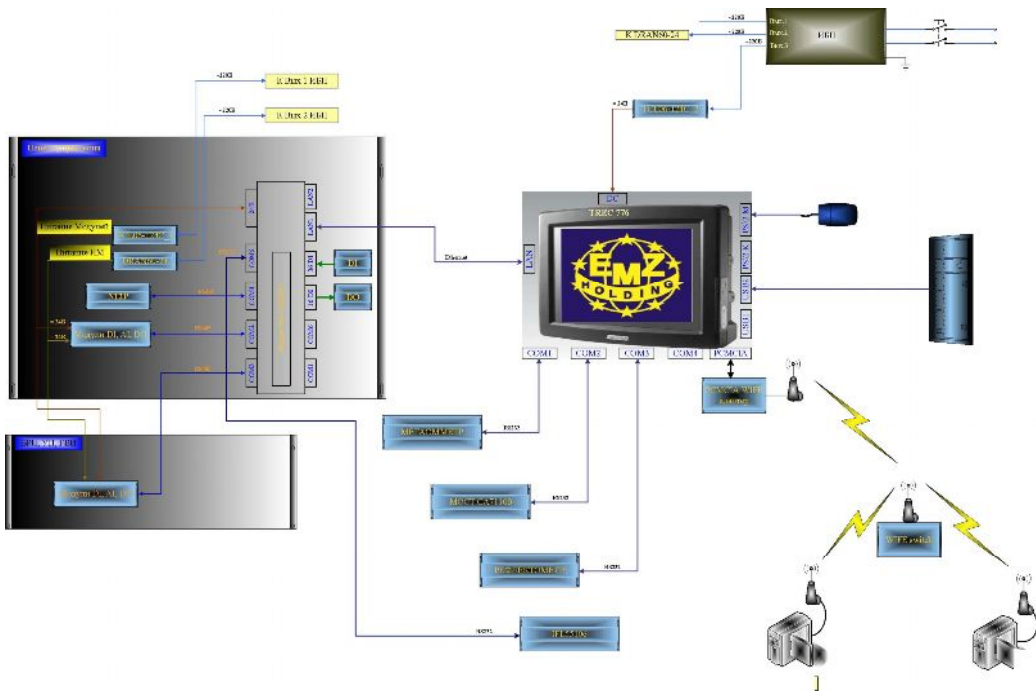
System provides:

- Control of safety system: door blocking, button «Emerg. Stop», protecting glass (in case of configuration by bridge Vector-2.0 M), resistance of working earthing loop, potential on chassis, excess of consuming current and voltage;
- Control of propriety of connecting equipment to the object;
- Control of positions of main switch;
- Selection of work modes;
- Control of power supply to the blocks.

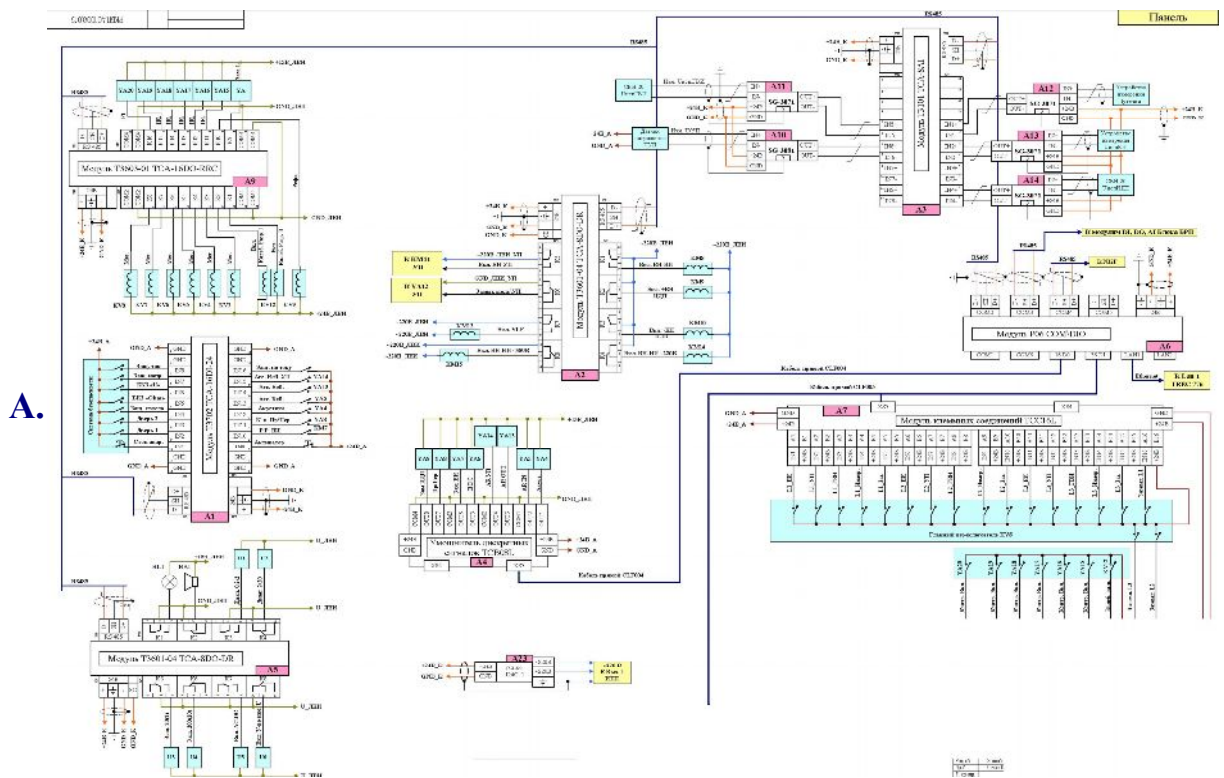
The system allows to automatically regulate and uphold the level of testing voltage, and also to switch off high voltage sources if power supply voltage exceeds the admissible value $220V \pm 10\%$.

The laboratory has the automatic control of temperature condition of laboratory components. If the temperature exceeds the allowed level, the system limits the usage of laboratory blocks until they come back to the normal condition.

System software makes test reports, which are entered to the database for the certain kind of equipment. System allows analyzing results of testings and measurements and issues results in a form of records.



Block – scheme of automated control system of high voltage testings «ASU LVI» of laboratory LVI HVT-3FAVC.



Functional scheme of automated control system of high voltage testings «ASU LVI» of laboratory LVI HVT-3FAVC.

A. HIGH VOLTAGE TESTS BY RAISED VOLTAGE

1. MAIN EQUIPMENT. Equipment of the laboratory conventionally subdivided to the main (mounted) and additional (not mounted) equipment. Fully functional usage of the laboratory is possible only at full completion of main and additional equipment.

1.1 Network switch

It is intended for commutation of units and modules of the laboratory on the supply circuits, and also for the control of lighting and heating of the laboratory's saloon.



1.2 Voltage regulator

It is intended for the smooth control of the voltage supply level, which is supplied to the module BVI-100M, BNI-M and IDP-10. If regulator is not in zero mode, it is impossible to make testings.

1.3. Control module BI

Control of high voltage testings with the measurement of testing voltage on the high side with the usage of high voltage measurement system SVN – 100, which has a certificate type approval measuring device (accuracy 3%).

A.1. High voltage testings by high DC volts

1.4. Module of high voltage testings BVI-100M

Functions of BVI:

- Testings by high DC voltage up to 60 kV of dischargers, cable lines etc. leakage test objects within the range 0,2 mA, 2 mA, 20 mA.

During testings by high DC voltage of dischargers or other objects with small capacity it is used smoothing capacitor with the capacity 0,4uF.

A.2. High voltage testings by high AC voltage with industrial frequency 50 Hz.

- Testings by high AC voltage up to 100 kV of bushings, insulators, and also voltage surge arresters with the control of conduction current within the range 2 mA, 20 mA, 200 mA.

14.1. Source of testing voltage IIN 100/60

Maximum AC testing voltage – 100kV at the maximum current 200 mA.

Maximum DC testing voltage – 60 kV at the maximum current 200 mA.



A.3. Module of high voltage testings by high AC low frequency voltage 0,1 Hz.

1.4.2. Module of high voltage low frequency testings 0.1Hz.

For testing of cables with the XLPE (cross-linked polyethylene) insulation (Standard IEEE 400.2-2004) it is best to use units, which are producing very low frequency AC voltage – from 0,1 Hz and lower



In laboratory it is mounted Hipot VLF-4022, which is producing AC VLF voltage and it is intended for testings of power cables with XLPE and paper-oil insulation up to 25kV, powerful transformers, electrical engines and other objects with big capacity. Hipot VLF-4022 tests approximately up to 15 km of cable depending from the type.

Hipot has a superset of capabilities:

- Charge current meter and load capacitance,
- Kilo voltmeter of output voltage,
- Timer of test time referencing,
- Polarity indicators of output voltage.

Input 230V, 50/60Hz, 8A peak value, 4A,

Output 0..40kV peak value, frequency 0,1/0,05/0,02Hz, Sinusoidal

Mode Continuous

Maximum load 1.1uF/0,1Hz; 2,2uF/0,05Hz; 5,5uF/0,02Hz

Measuring devices

Voltmeter: 0..40kV, peak value

Measurer of charging current:

0...100mA, peak value.

Measurer of loading capacitance: 0...6uF

Timer Sets the test period



View to the VLF-4022CMF

B. Cable fault location

3. B.1. Cable fault prelocation

3.1 Surge generator GVI-2000M

It is intended for energy accumulation in high voltage condensers and for sending high voltage pulses of different frequency to create conditions for fault location by acoustic method in power cables with voltage up to 35 kV.

Name of parameter

Power supply voltage, 50 Hz (V)

Parameters of pulse surge generator:

Range of output voltage adjustment

Pulse frequency

Steps of voltage output

Maximum stored energy

Maximum power, consumed by generator in network not more than

Value of accumulated capacity

Time of connecting of accumulated capacity to the cable line

Time of continuous work of generator with the further break of 1 hour, not more than

Value

220±22

0...5;0...10;0..20 kV

3-15 s

5,10, 20 kV

2000 J

1,5 kVA

4 x 40,0 uF

400 ms

1 hour



3.2 Voltage connector (Decay method)

To determine the distance to the place of complicated (high resistance) or transient fault, when transient resistance in the place of fault is much higher than the wave resistance of line and is commensurable with the value of insulation resistance, it is used a **method of oscillatory discharge (Decay method)**. The method is based on the measurement of half-period time of

oscillatory electro-magnetic process, which appears during insulation failure of charged cable and has 2 modifications:

- Method of voltage traveling wave;
- Wave method of pulse current.

To apply the **method of traveling voltage wave** together with the source of testing voltage it is used a voltage connector (photo). Voltage connector is a capacitance divider with the division ratio, which provides voltage on wave input of reflectometer not more than 60V.

Pulse reflectometer is connected through the voltage connector. This method can be used for fault location in cables with paper-oil insulation. For cables with XLPE insulation this method is forbidden since application of high DC voltage breaks XLPE cable insulation.



3.3 Current connector

At the **wave method of pulse current** surge generator gives pulses to the cable line. It breaks the weak place of insulation, which initiates the reflection. Reflected signal returns to the beginning of cable and is reflected from it to the side of fault since the input resistance of surge generator is equivalent to the short circuit. Re-reflected wave comes to the break and again returns to the beginning of cable etc.

For the purpose of this method it is used a surge generator, current connector, and reflectometer with the possibility of work in the appropriate mode. The current connector is a current transformer which provides signal with the amplitude not more than 60V on the wave input of reflectometer.

While applying a method of **oscillatory discharge** the pulse reflectometer is connected to the socket «U/I».

3.4. Connecting device AR-20 (for stabilization of electric arc)

It allows finding distance to the defect both by classic **pulse**, and by **high voltage method** with the use of pulses reflected from the arc in cable (**method Arc Reflection**). It gives the possibility to quickly find distance not only to the low resistance, but also to complicated high resistance faults in power cables without usage of burn down unit (in RF it got a name «**non-burning method**»). Connecting device is used for the application of this method (photo up right).



3.5. Reflectometer (by agreement)

B.2. Exact cable fault location

4. Equipment for cable fault location

4.1. Burn down instrument UP-7M

It is intended for transforming of high resistance or swelling damages of power cables 0,4 – 35 kV to low resistance in order to make conditions for:

- Determine a distance to a failure by pulse method;
- Exact fault location by acoustic devices

Name of the parameter
Supply voltage 50 Hz (V)

Value
220±22

Parameters of burn unit:

1. Current used by unit in the network in «idle» mode, not more than	3A
2. Current used by unit in the network in short circuit mode, not more than	57A
3. Output voltage of the hipot in the «idle» mode step (AC ± 15%)	0.17 kV
step (AC ± 15%)	0.5 kV
step (AC +15%)	1.4 kV
step (DC +15%)	5.5 kV
step (DC ± 15%)	11 kV
step (DC ± 15%)	22 kV
4.Short circuit current on the output of the hipot	
step (AC ± 15%)	64 A
step (AC + 15%)	22 A
step (AC ± 15%)	7.8 A
step (DC + 15%)	2.3 A
step (DC ± 15%)	1.4 A
step (DC + 15%)	0.7 A
5. Maximum capacity consumed by the hipot in the net. kW not more than	12 kVA
6. Time of continuous work of the hipot in the burn mode (at intervals 20 min.) not more than (min.)	20 min



4.2 Reflectometrical burning method.

Laboratory also has *Arc Reflection Method when the burning is used*. Usage of this method allows to observe on the reflectometer screen changes in the place of fault during burning and to automatically do the preliminary distance finding to the fault location. The distance is determined by peak discharge voltage in the burning cable since the first stage of burning cable is accompanied by pulse discharges (during burning in the place of fault it is formed an arc).

For application of *Arc Reflection Method during burning* the burn down instrument is connected to the cable line through the connector AR-20.

4.3. Generator control module IFL-55106

It is intended for application of inductive method of cable fault location. It allows for operator to manage the process of inductive search connecting the low frequency generator to the testing cable from the control panel.

4.2.1 Inductive fault locator IFL-55106:

Generator is integrated to the laboratory. Operator connects it to the testing cable through the control panel.

It is intended for:

- Tracing and finding depth of cable;
- Search and exact fault location of cable lines insulation;
- Selection of cable – selecting of needed cable out of strand of cables;
- Fault location of cable shield.



Set IFL-55106 includes:

Low frequency generator	IFL-55106
Receiver	SR-01
Inductance pickup	IP-01
Inductance pickup (for selecting of cable out of strand)	IP-08
Trace defect locator	PO – 06
Headphone	
Insertion (plug?) A5	
Charger	
Accumulator	7D - 0,125
Network cable	
Connecting cables	
Remote control	IFL-55106
4.3. Acoustics	
Microphone (acoustic detector)	AP-01



C. Measurements

C.1. High voltage measurements

2.1 Block of measurements of dielectric losses IDP-10.

The set includes a standard device for measurements of $\text{tg}\delta$.

C.2. Low voltage measurements

2.2. Module of low voltage measurements BNI-M

It is intended for low voltage measurements with the use of external devices.

It has an in-built source of smoothly adjusted voltage 0-220V, 0-380V.

Low voltage measurements are applied for characterization of idle running and short circuit of power transformers; and also for measurement of transformation ratio and resistance to DC.

The set of equipment for low voltage measurements includes the following units:

- Voltage regulator (general for LVI);
- Loading transformer with power 1,6 kVA with output voltage 220 and 380 V;
- Sensors of voltage, current and power;
- Measuring terminals for connecting of milliohmmeter (MU-3 zone NI);
- 4-wire measuring cable (for connection with the testing object).

Voltage from the transformer is fed to the object by two wires of the measuring cable.

Reaction of the object is coming to the corresponding sensors by other pair of wires, which are located in the module of power supply distribution.

Measuring results of transformation ratio, idling losses, short circuit resistance are shown on the monitor of industrial computer and are entered to the measuring records.

The laboratory is packed by standard devices for measuring of:

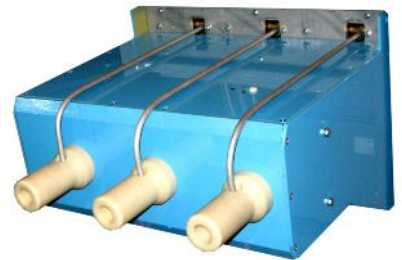
- transformation ratio (tr);
- current (I_{xx}) and losses (ΔP_{xx}) of idle running at low voltage;

- resistance of short circuit (Z_k);
- resistance to bridge method;
- insulation resistance;
- grounding resistance;
- current in conductor;
- general low voltage measuring (R, I, U).

D. High voltage commutation and connection equipment.

4. Main switch HVS-75/3

High voltage switch HVS-75/3 is applied for choosing phases of testing cable and for commutation of equipment outputs. It is located in the right side of the control panel. HVS-75/3 has input ports for connection of functional modules and output ports for connection of high voltage testing cables of the laboratory. It is also connected with the measuring terminals for connection of different devices. On the main switch there are switches which automatically contact high voltage output to «ground» after the job is finished. It has manual control and air barrier insulation.



View to the high voltage three phase switch HVS-75/3

5. Blocks of cable reels

External connections of **LVI HVT-3FAVC** are done by 3-phase reel with power supply cable, grounding cable reel and 3 reels with high voltage cable. The length of the high voltage cable on the reel is 3x25 m.

6.1 Block of cable reels YEM 7.137.003

- reel of low voltage measuring cable (4 threads);
- reel with power supply cable;
- grounding cable reel with section 25 mm², length of cable 25m;
- reels with high voltage shielded cable for DC voltage testing up to 60 kV, length of cable 3x25m.



6.2. Reel of high voltage wire

Reel with cable (25m) for AC voltage testing up to 100kV.

Reel with cable for measuring tgδ (dissipation factor of dielectric).

E. Power supply of van's circuit

7. **Power supply of van's circuit** is done through the external source by voltage 230 V.

F. Electrical safety

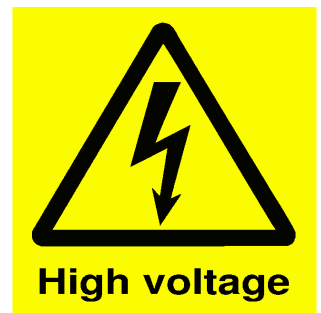
8. System providing electrical safety of laboratory's personnel:

Module of grounding control

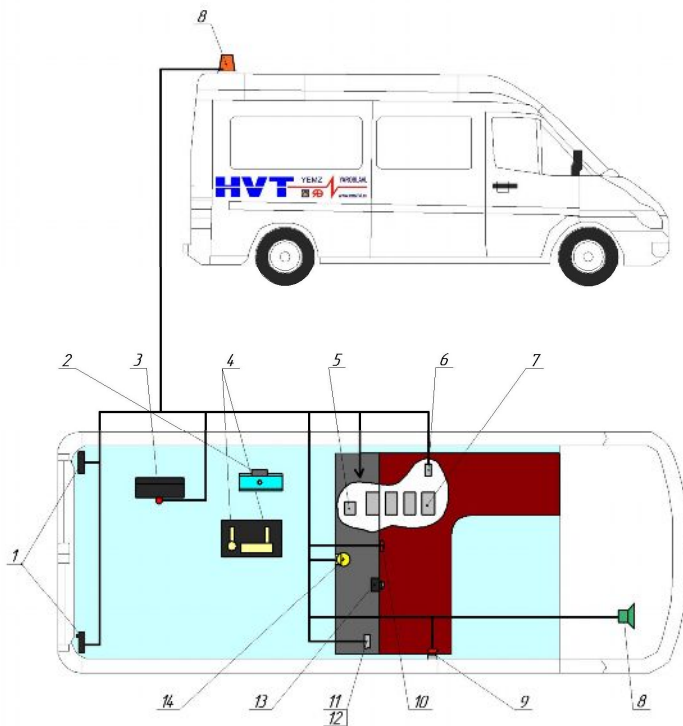
Module of grounding control (further MGC) is intended for monitoring of connections quality in the circuits of protective and working grounding and prohibition of switching of functional modules in case of fault in grounding circuit.

For additional control it is used a special grounding rod, which is put in the ground near the LVI. It is connected by insulated wire with terminal «AuE».

- Resistance of circuit between terminals of working and protective grounding of module MKZ (summarized resistance of wires of protective and working grounding and also places of their junctions), which must not exceed 10 Ohm. If the value is bigger than this it is actuated a blocking relay and on the control panel the indicator **Grounding Control** blinks off;
- Potential of terminal «Protective grounding» towards the potential of control grounding rod (actually – potential of LVI body towards ground), which must not be more than 25 V. At the excess of this potential the blocking relay is also actuated, and on the control panel the indicator **Ground Potential** blinks off.



Scheme of safety elements a location in Cable Test Van



№	The name of a kind of protection
1	Blocking of external doors of a high-voltage compartment
2	The control of a continuity of a circuit of grounding and emergency potential on a body of laboratory
3	Blocking of a socket on a drum with a cable of protective grounding
4	Automatic an output(exit) on the main switch
5	Automatic замыкатель an output(exit) in the generator of high-voltage pulses GVI
6	Blocking from excess of a target pressure(voltage) in block GVI
7	The automatic category of memory capacities in block GVI
8	Presence of the protective signal system
9	Presence of the readily available button of emergency switching-off
10	Blocking of the switch of a choice of works on the network board
11	Blocking from excess of a current of outflow through object of tests
12	Blocking from excess of a target pressure(voltage) in block BVI
13	Application entrance with seen break of contacts
14	Blocking of initial position of a regulator of a pressure(voltage)

9. System providing electrical safety of laboratory

Protection module controls the following parameters:

- Resistance of loop «protective grounding – working grounding». At increase of resistance for more than 10 Ohm the switching of high voltage is impossible;
- Potential of protective grounding bar of laboratory towards the control grounding rod. At the increase of potential to more than 25V it is impossible to switch the high voltage.

If voltage goes to the limit of protective grounding (more than 25V) or if the resistance of the loop «protective grounding – working grounding» exceeds the value 10 Ohm the laboratory switches off!

Devices and equipment of the laboratory are connected to the earth bar by copper conductors.

The value of transient resistance between the terminals of grounding devices and equipment and grounding limit must not be more than 0,05 Ohm.

The value of resistance of insulation of secondary electrical circuits to the voltage up to 1000 V must be not less than 1 MOhm.

The laboratory has sound and light signaling, which is triggered at switching on and switching off the high voltage sources.

Back doors of LVI has blocking which switches off voltage supply of high voltage sources if door opens to some specified size.

Provision of environment working parameters inside the laboratory is reached by heat insulation of car walls and by air conditioner.

The laboratory is packaged by security facilities, posters and safety signs according to the instruction on application and testing of security facilities used in electrical installations. It also corresponds to the road traffic regulations.

G. Documentation package for the laboratory

10. INSTRUCTION MANUALS (conformity certificates for the laboratory and devices are included).

10.1. Operation manual of the laboratory

10.2. Logbook

10.3. Album of electrical circuit diagrams

10.4. Program and technique of scheduled certification of the laboratory

H. Vehicle

11.1. Vehicle Vehicle GAZ-27057

Vehicle GAZ-27057 is used as a base car. It allows the laboratory to work not only in city but also in rough terrains because of good cross-country ability of the vehicle.



External view of the High Voltage Test Van LVI HVT -3FAVC on GAZ27057

Vehicle body

Equipment of the LVI is located in the vehicle body. Inside the laboratory is divided in two compartments:

- Operator compartment;
- High voltage compartment.

Separation line of the compartments is formed by the back side of the control panel and by the protective glass.

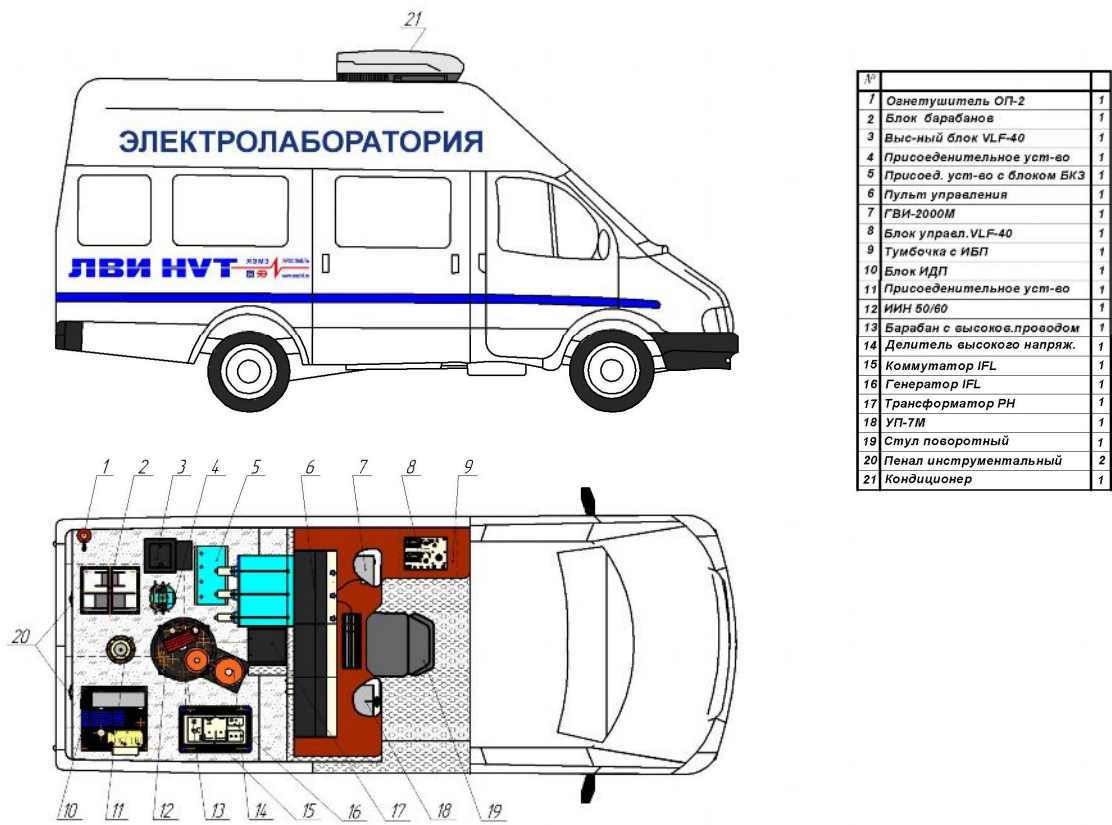
11.2 High voltage compartment and operator compartment

The vehicle body is made of solid metal which is heat-insulated with plastic finishing. It is heated by heater type «RAF» and also by air conditioner which works in the modes «heat-cold». The vehicle body is divided to the high voltage compartment and operator compartment. In the doorways there are handles for easy entering of the compartments. In the high voltage compartment these are assembled the high voltage equipment which is intended for cable testing; block of cable reels; and tool cases for storing of tools and accessories necessary for work. In the operator compartment it is mounted operator's desk, operator's chair and control panel of the laboratory, and also drawers for storing of devices.





**Views to the high voltage compartment of the laboratory
LVI HVT-3FAVC on GAZ-27057**



Lay-out of equipment in the laboratory LVI HVT-3FAVC on GAZ-27057

The laboratory has the following main distinctive features:

6.1. The equipment is mounted in the noise and heat insulated vehicle body from plastic-glass sandwich panels with foam filler. This creates a comfort work conditions for the operator both in cold and hot climate.

6.2. In the operator compartment it is mounted a working table of Eurodesk type which creates comfort conditions for measurements and their further processing and registration.

6.3. In order not to touch the conducting parts the special partition separates the operator compartment from the high voltage compartment.

6.4. The partition separates and working table of Eurodesk type from the high voltage compartment.

6.5. Leading out of cables to the object is done through the special cable outlet hatch.



View to the operator compartment of the laboratory LVI HVT-3FAVC on GAZ-27057

6.6. The vehicle body is heated by the diesel heater.

6.7. Drawers for accessories are mounted in the operator compartment.

In the vehicle body there is the following lighting:

6.8. Indoor, 230 V AC;

6.9. Indoor, 12 V DC.

6.10. Laboratory has the sliding tool sheds for storing of electrician and driver tools. It provides higher industrial culture, better working conditions and the laboratory in general has favorable working environment.

6.11. The main equipment is mounted in frame.

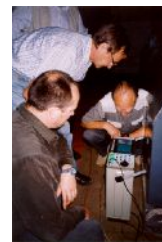
6.12. The cable is laid in special cable channels.

I. Seminars

12. TRAINING (seminar) for the specialists of the customer

For the specialists of the customer it is offered training on operating instructions for the laboratory LVI. It is conducted in the training center LLC «YEMZ» which is equipped by training classrooms and has two educational bench-top laboratories.

The duration of the training is 1 week.



Practical training

J. Guarantee

13. The guarantee period of the laboratory is 12 months. When the guarantee period finishes the manufacturer, if the customer wishes, performs the post-warranty service of the supplied equipment.

K. Contacts

14. Please send your REQUESTS to the e-mail: sales@emzlv.ru; lvi@emzlv.ru

or by tel/fax: +7(4852) - 32-69-25; 32-72-63; 49-05-85; 21-57-54

Web page: www.emzlv.ru

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