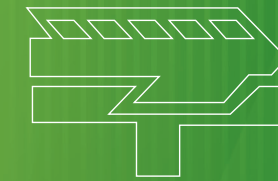
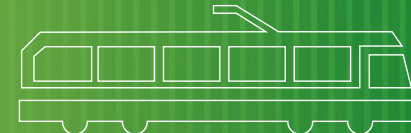
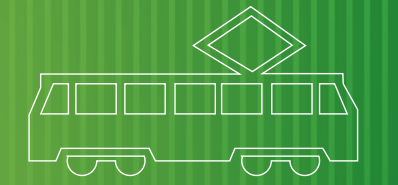
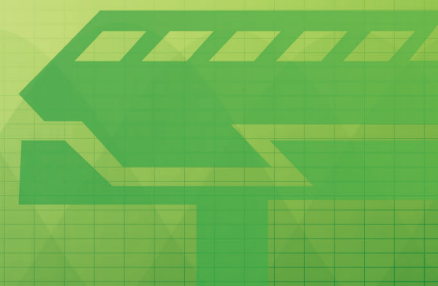


Equipment for Tram, Trolleybus, Monorail Power Supply



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Vladimir Osipov, General Director,
Candidate of Technical Science

Thank you for your interest in the products manufactured by our company. Representing this new catalog, we want to thank all those who have been trusting our equipment for many years and especially those who is only getting familiar with us. Every customer helps us improve and make our products useful to the maximum extent. We are the team of specialists who have graduated from the electrical transport department of the National Research Moscow Power Engineering Institute. All our time after graduation we dedicated to designing equipment for traction substations. We did our best to make our products extremely reliable to help you.

We care of the environment and therefore try to make our production more environmentally-friendly. Every day we work with complicated tasks in the field of subway, trolleybus and monorail power supply that have never been solved by anyone so far. We are optimistic and believe that such issues as overhead system protection, integrity and operation efficiency of the entire electrical transport network, will be solved by our joint efforts in the nearest future. We are firm that working in a friendly family of electrical transport professionals you share this view.

We manufacture equipment for traction substations, install it and debug its operation. We pay special attention to operation of own equipment. We provide all necessary support to those who operate our products. Professional advice helps us constantly improve its quality. We commit all accumulated knowledge, natural skills, and our hearts so that subway lines have no downtime due to faulty equipment in traction substations. So that passengers enjoy their ride without wondering how their comfort is based on the most reliable power supply system.

We are familiar with professionals in our field in all large cities of Russia and value our cooperation with experienced specialists from the CIS and Europe. We are open for communication and want to improve our equipment together with you and for you.



ENERGY Scientific and Production Enterprise (ZAO ENERGY SPE)
Golden Chariot Award winner in the section
Best Russian Small and Medium Company
in Transport Industry.

ZAO ENERGY SPE equipment is operated in more than 120 traction substations in 26 cities of Russia and CIS.



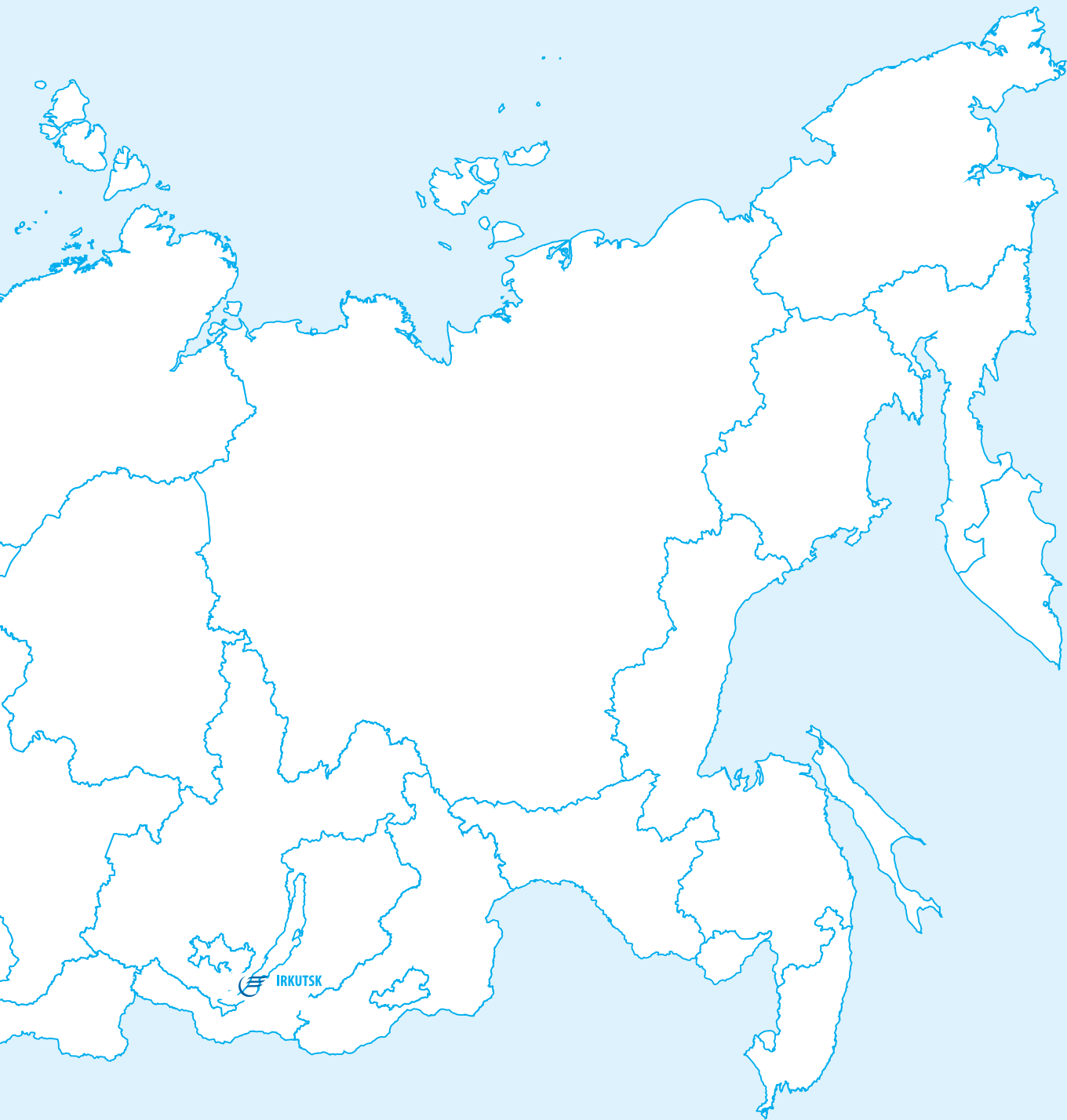










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Rectifiers

1



ZAO ENERGY SPE is the winner of the SAVE ENERGY award in the field of energy saving. The completed project for replacement of rectifying sections under the Moscow traction substation reconstruction program was acknowledged as the most outstanding in the nomination of Energy Saving in Urban Transport.

1.1

Unified series V-TPED rectifiers



V-TPED rectifiers are designed to operate in the power supply system for urban electrical rolling stock.

Converter sections of V-TPED rectifiers are fully interchangeable with converter sections of VAKLE rectifiers. They advantageously differ from the latter ones in increased reliability, better weight-size parameters, improved overload capacity, and advanced protection and diagnostics functions.

Apart from conventional automation and diagnostic functions typical of urban electrical transport rectifiers, the modern rectifier control systems allows:

- continuously controlling the condition of each diode and issue an alarm in case it is faulty;
- diagnostics of diode parameters on the valve arm and issue an alarm in case they require timely repair without reaching the emergency condition;
- control valve arm open failure and indicate the failure location to prevent hazardous surges in the rectified voltage curve;
- inform of the temperature inside the rectifier cabinet thanks to an integrated temperature sensor. Information can be presented as a diagram of temperature change for a specific period.
- maintain a rectifier operation log that is read using a compact diode-tester device or a computer connected through a standard RS232 connector.
- operate with both conventional remote control systems and modern upper level remote control systems.

Design



The rectifier represents a framed metallic cabinet with a capability of two-side maintenance and IP21 rating under GOST 14254-96. Perforation is provided in cabinet doors and roof for rectifier's natural cooling. The cabinet design provides class 0I electrical shock protection for 825V power circuits and class II for auxiliary circuits under GOST 12.2.007.0-75. Rectifiers comply with the requirements of GOST 18142.1, GOST 26284, GOST R 51321.1 (IEC 60439-1-92).

7



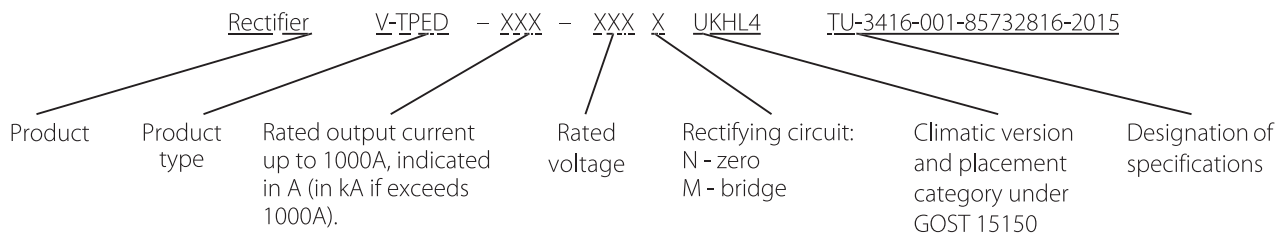


Specific Features

8

- Equipment used in primary and secondary switching circuits allows significantly reducing cabinet dimensions.
- Light indication facilities permit controlling diode status.
- Diode replacement and inspection periods are substantially reduced due to applying a special diode holder and a new clamping device with stabilization of the diode clamping force at 22 kN. When the diode is clamped, special force control devices are used.
- Remote control and transmission of all necessary information to the dispatching station via RS485 interface. Equipment operation in both the substation control system (CDCP) and in a higher-level system.
- Contact connections of power circuits are made non-maintainable. Compensating devices retain force in a contact connection irrespective of the temperature change
- Contact connections of power circuits and buses are covered with a conducting lubricant.
- Thermal indicators of contact connections (upon request).

Structural diagram of cabinet designations



Designation in documents:

Rectifier V-TPED-2,0k-600H UKHL4 TU-3416-001-85732816-2015

Short designation: V-TPED-2,0k-600H



Key technical data

	V-TPED 1000-600N	V-TPED 2,0k-600N	V-TPED 3,15k-600N	V-TPED- 1,25k-600M	V-TPED - 2,0k-600M
1. Rectifying circuit	zero			bridge	
2. Output active power, kW	600	1200	1890	750	1200
3. Output voltage, V	600				
4. Output current, A	1000	2000	3150	1250	2000
5. Nominal input frequency, Hz	50 (60)				
6. No. of converting section phase connections	6			3	
7. Cooling type	natural air cooling				
8. Auxiliary network voltage, V	~220				
9. Power coefficient (rated), p.u., minimal	0,95				
10. Efficiency (rated), %, minimal	99,32			98,75	
11. Typical power of converting transformer, kW	1000	2000	3150	1000	1600
12. Converting transformer type	TSZPU--1000/10 GT-UZ	TSZPU--2000/10 GT-UZ	TSZPU--3150/10 GT-UZ	TSZPU--1000/10 GT-UZ	TSZPU--1600/10 GT-UZ
13. Frequency and duration of permitted overcurrents, s	1.25 — 7200s 2 times per day** 1.5 — 300s once per 30 minutes** 2.0 — 60s once per 30 minutes**				
14. Testing voltage between power circuits, cabinet housing and control circuits, kV, min.	5				
15. Overall dimensions, WxHxD, mm	1000x2000x500		1000x2000x500 2 cabinets	1000x2200x700	
16. Converting section weight, kg, max.	300		600	470	

* Mean square current for any 8 hours per day shall not exceed nominal current.

* Mean square current for any 30 minutes shall not exceed nominal current; the averaging time must be 5 minutes if 100% loading takes places during these 30 minutes.

1.2

Increasing the traction substation energy efficiency by implementing V-TPED rectifying sections manufactured by ZAO ENERGY SPE

10 Through the Federal Law dated November 23, 2009 On Energy Saving and Increasing Energy Efficiency, the Russian Federation Government strives to support and stimulate measures to increase equipment energy efficiency.

Analysis of traction power supply undertaken by ZAO ENERGY SPE professionals allow concluding that there is an opportunity to increase energy efficiency of traction substations by replacing obsolete converting sections with V-TPED rectifying sections.

Primary types of rectifiers applied in traction substations are given in Table 1.

Rectifying section	BVK-2000	BVKLE-2000	VAKLE-2000	VAKLE-2000	VAKLE-2000	V-TPED-2000-N
Diodes applied	VL-200	VL-200	V-800	D-143	D-253	SD-2500
No. of diodes	72	72	24	24	24	24
Forced ventilation	+	-	-	-	-	-

Table 1

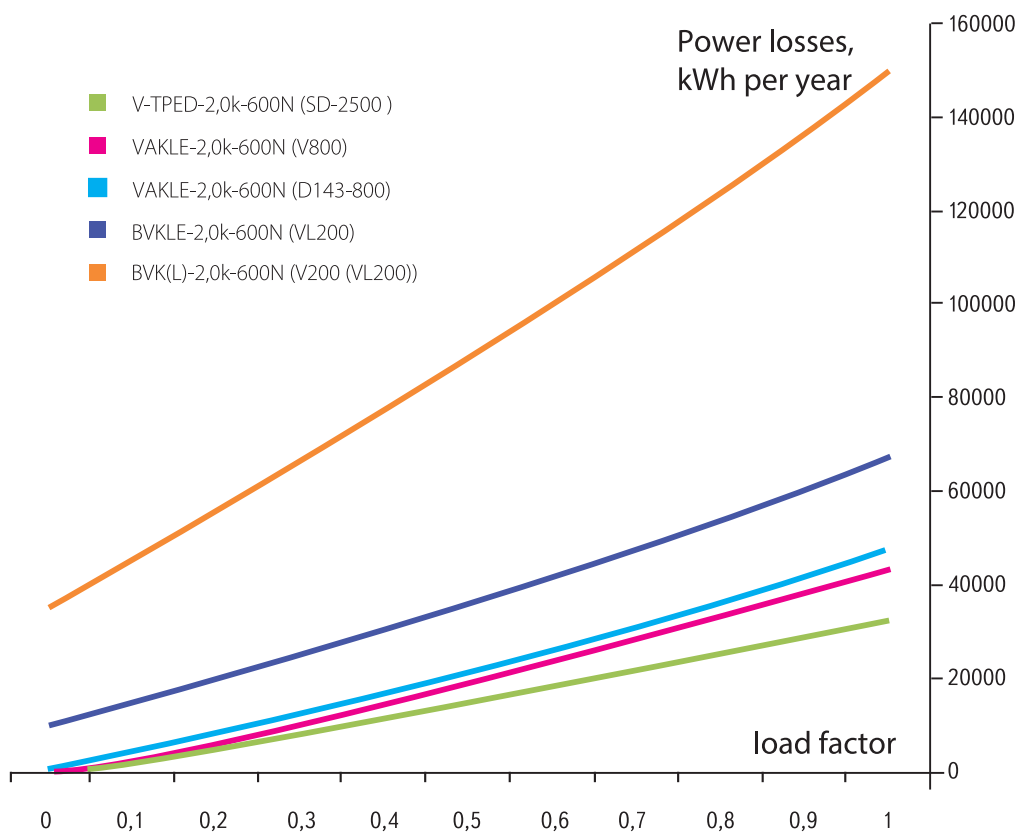
Due to imperfections of most semi-conducting instruments and high losses in shunting resistors and in the forced ventilation system, energy consumption in obsolete converting sections is significantly higher that in advanced V-TPED rectifiers. Specific features of power circuits suggest increased power consumption even when the rectifier's loading coefficient is low or there is no loading at all.

The chart of annual power losses vs. rectifier's loading coefficient sheds light on the opportunity to save power in case obsolete sections are replaced with V-TPED rectifiers.



Annual power losses in converting sections

11



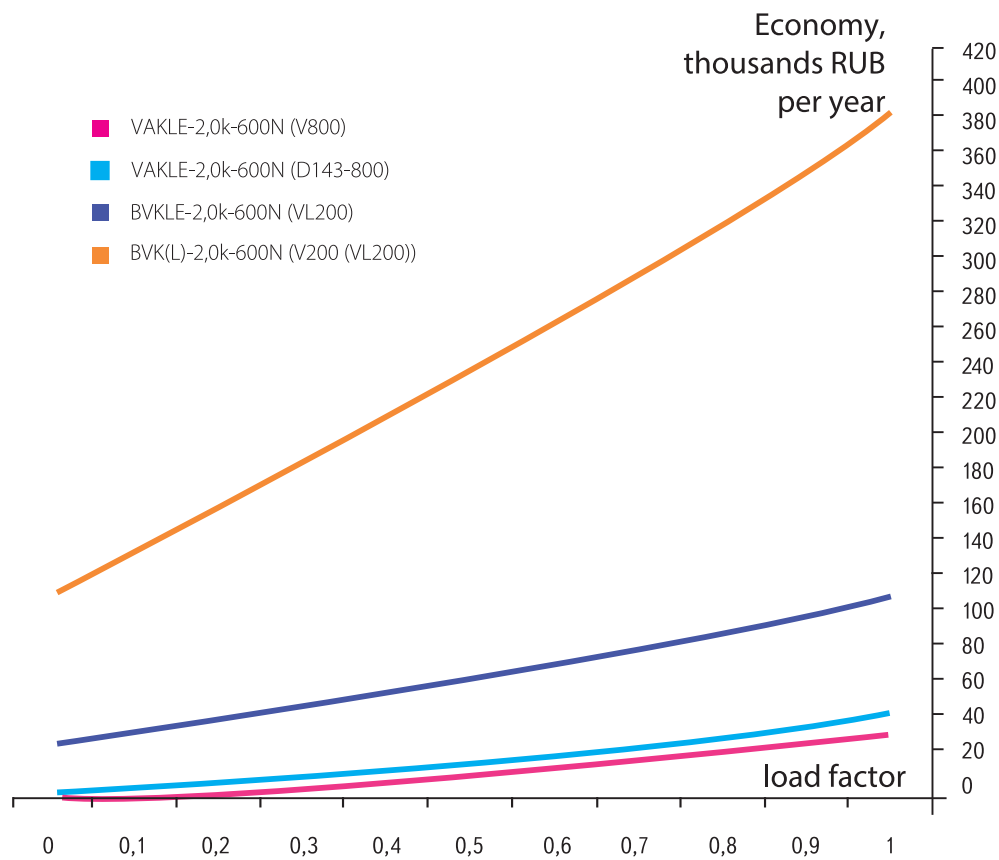
When traction substations are modernized, it is possible to replace units with V-TPED-2,0k-600N (SD2500) rectifiers, which significantly increases substation energy efficiency with minimal expenses for its refurbishment (structures remain unchanged).



12

The chart shows an economic efficiency of implementing V-TPED-2,0k-600N (SD2500) rectifiers from ZAO ENERGY SPE. The chart allows calculating their payback periods depending on the type of converting sections.

Economic effect* from replacement of obsolete converting section with V-TPED rectifiers



* — electric energy cost of 3,5 rub per 1kW-h

According to calculations, the economic effect from implementing new V-TPED rectifying sections from ZAO ENERGY SPE, in case of nominal loading, depending on the type of rectifier to be replaced, will be up to 420,000 RUB per year.



Transformers

2



2.1

TSZPU and TSZP series transformers for V-TPED rectifiers



V-TPED rectifiers are completed with advanced dry transformers with case insulation or NOMEX-type insulation rated as IP21.

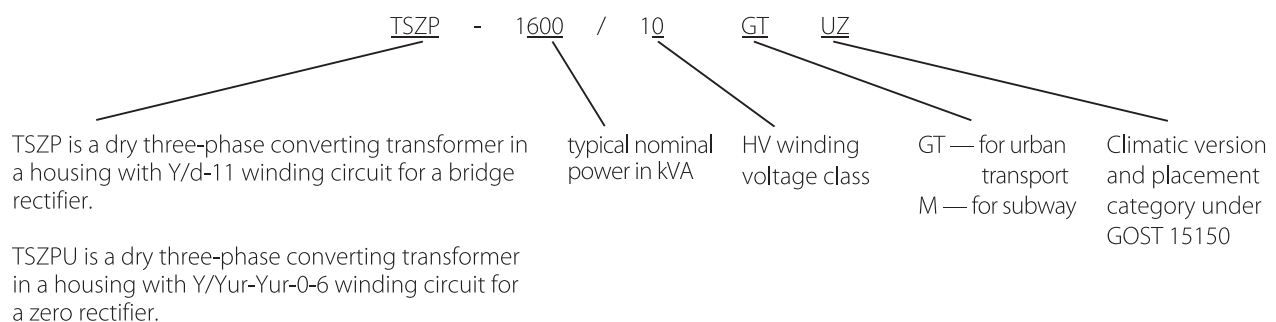
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Transformers have an increased integrity of windings due to the use of advanced insulation materials. The insulation is not flammable. NOMEX-insulation transformers are repairable.

The transformer design applies:

1. Insulators that increase the overall insulation level of transformer windings.
2. For overvoltage protection, solid-state varistors are used (surge arresters) with a fault monitoring device;
3. Two-level temperature control unit is used in the BKT-01 transformer, which is intended to protect converting transformers against overheating.

Designation scheme



↑ TSZPU 1000/10- GTUZ overview




Key technical data of transformers for V-TPED surface urban transport rectifiers under zero rectification circuit

16



Parameter↓	Transformer type →	TSZPU 3150/10- GTUZ	TSZPU 2000/10- GTUZ	TSZPU 1000/10- GTUZ	
1. Typical power, kVA		3150	2000	1000	
2. Nominal power, kW	power winding (HV)	2181	1385	692	
3. Nominal voltage, V	power winding (HV) valveside winding (LV) rectifier	10000/6300	10000/6300 979 600	10000	
4. Nominal currents, A:	power winding	for $U_{hv}=10000V$ for $U_{hv} =6300 V$ for $U_{hv} =6000 V$	126 200 210	80 126,9 133,3	40 63,4 66,6
	valveside winding (LV)		910	577	290
	rectifier		3150	2000	1000
5. Rated frequency, Hz		50			
6. Designation of circuit and winding connection group		U/Unr Unr-0-6			
7. Voltage adjustment range, %		$(\pm 2 \times 2,5) U_{nom}$.			
8. Transformer short-circuit voltage in converter mode, % _{max} .		7	6,5	5,7	
9. Short circuit losses (with no respect to losses in reactor windings), W _{max} .		22000	13000	5100	
10. Idle losses (with no respect to losses in reactor windings), W _{max} .		4700	3350	2100	
11. Idle current, W _{max} .		1,0	1,25	1,5	
12. Power-frequency test voltage, kV					
a) applied	HV-ground		20 5		
b) induced	LV-ground		2Unom		
13. Transformer winding heat resistance class		H			
14. Insulation type		NOMEX			
15. Cooling system type		Natural air			
16. Equalizing reactor parameters	Typical power, kVA	160	100	63	
	Nominal branch voltage, V:		141		
	Reactor branch nominal current, A:	1575	1000	500	
	Rated frequency, Hz		150		
	Losses in copper, W	3000	2000	1400	
Losses in steel, W %	500	310	200		
17. Transformer overall dimensions/transformer dimensions in manufacturer's package, max., mm:	length, width height	2894/3300 1314/1700 2966/3350	2810/3110 1300/1500 2640/3000	2260/2560 1200/1400 2110/2400	
18. Transformer weight/weight in manufacturer's package, kg _{max} .		7870/8470	6250/6750	3650/4050	

Key technical data of transformers for V-TPED subway rectifiers under bridge rectification circuit



Parameter ↓	Transformer type →	TSZP 630/10-GTUZ	TSZP 1000/10-GTUZ	TSZP 1600/10-GTUZ	
1. Typical power, kVA		630	1000	1600	
2. Nominal power, kW		537	839	1342	
3. Nominal voltage, V	power winding (HV)		10500 10000 6300 6000		
	Valveside winding (LV) Rectifier		475 600		
4. Nominal currents, A:	Power winding	for U _{hv} = 10500 V	29,5	46,1	73,8
		for U _{hv} = 10000 V	31	48,4	78
	for U _{hv} = 6300 V	49,2	77	123	
	for U _{hv} = 6000 V	51,7	80,7	129,1	
	Valveside winding (LV)	653	1020	1632	
	Rectifier	800	1250	2000	
5. Rated frequency, Hz			50		
6. Designation of circuit and winding connection group			Y/Δ-11		
7. Voltage adjustment range, %			(±2×2,5) Unom.		
8. Transformer short-circuit voltage in converter mode, % max.		6,0		5,8	
9. Short-circuit losses, W, max.		5100	6800	9900	
10. Idle losses, W, max.		1200	1700	2350	
11. Idle current, W, max.		1,5		1,9	
12. Power-frequency test voltage, kV	a) applied		20 5		
	b) induced	HV-ground LV-ground		2Unom	
13. Transformer winding heat resistance class			H		
14. Insulation type			NOMEX		
15. Cooling system type			Natural air		
16. Transformer overall dimensions/ length in manufacturer's package max., mm:	length,		2150/2450	2020/2300	
	width height		1370/1570 2280/2540	1250/1500 2190/2590	
17. Transformer weight/weight in manufacturer's package, kg, max.		2540/2900	3260/3620	4550/5053	

DC switchgear

3



3.1

KRU-600 DC switchgear

KRU-600 series includes the following cells: KRU-600K, KRU-600Z and KRU-600L for centralized power supply systems, and KRUO-600SK, KRUO-600L cells for decentralized power supply systems.

19

The KRU-600K cathode switch cell is designed to provide rectifier connection to a (+) 600V bus and protect the rectifier against inverse currents.

The KRU-600Z backup switch cell is designed for redundancy of any positive power lines of subway traction substations for trams and trolleybuses.

The KRUO-600SK sectional cell (of the sectional switch and cathode disconnecter) is designed for redundancy, switching and protection of any of two positive power supply lines and for rectifier's connection to a (+) 600V bus.

KRU-600L and KRUO-600L linear switch cells are designed for connection and switching of positive power supply cables to a (+) 600V bus of tram and trolleybus traction substations.

KRU-600Z, KRU-600L and KRUO-600L cells are equipped with SDTS-1 traction network diagnostics and protection systems.



↑ [KRU-600 overview](#)



- 20 Using an advanced microprocessor system of control and management allows for the following functions:
- controlling units from both the central dispatcher control panel (CDCP) and an LCD touchscreen panel;
 - recording the KRU-600 operation log in the non-volatile memory with further identification of personnel erroneous actions and analysis of events preceding the failure;
 - organizing the cycle of automatic re-closing (ARC) providing an opportunity to change the ARC time within a wide range;
 - integral current-time protection (ICTP) by computer modeling of heating/cooling of a contact wire and momentary switch tripping when the ICTP setpoint is reached;
 - protecting the overhead system by analyzing such parameters as dl/dt , $\Delta I/\Delta t$, ΔU , I_{max} , etc.;
 - recording current and voltage graphs in case of the momentary switch automatic tripping with an opportunity to further process and analyze the curves;
 - analyzing the condition of the overhead system by testing it with an improved system of short-circuit tester (SCT);
 - automatic feeder transfer from a linear cell to a backup cell and back by controlling the necessary conditions of successful transfer;
 - control over KRU-600 components failures with an opportunity to decode failure types on the LCD touchscreen of the KRU-600Z cell and record it into the KRU-600 operation log.

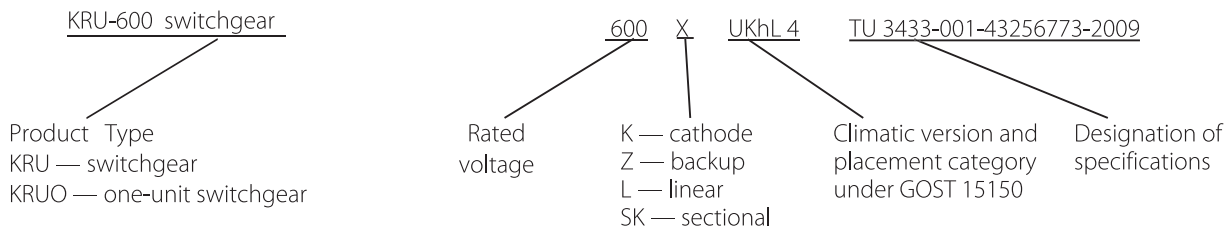
Design



KRU-600 is manufactured as individual metallic cells of framed design with an opportunity of one-side (compact series) or two-side (optimum series) maintenance that allow for one-row installation. The rating of a set of cells in its standard position is at least IP43, except for the footing and cable lead-in ports. The cell design provides class 0I electrical shock protection for 600V power circuits and class II for auxiliary circuits under GOST 12.2.007.0-75.

Using advanced momentary switches of UR, IR, VAB, VB series allowed significantly reducing weight and dimensions of cells increasing their operational integrity. Using motorized disconnectors made it possible to abandon magnetic-fugal drives causing head-ache for maintenance personnel.


Structural diagram of cabinet designations





Designation in documents:
KRU-600K UKhL 4 TU 3433-001-43256773-2009


Short designation:
KRU-600K


Specific Features


- 


High mechanical integrity of momentary switches (non-emergency switchings) requiring no maintenance, cleaning or lubrication.
- 


Equipment used in primary and secondary switching circuits allows significantly reducing cabinet dimensions.
- 


Inspection holes allow monitoring the position of disconnectors
- 


Design and circuit solutions allows blocking access to conducting parts of the cabinet and prevent erroneous actions of repair and maintenance personnel.
- 


The disconnectors and switch can be manually controlled in case of no 220V input voltage.
- 

Contact connections of power circuits are made non-maintainable. Compensating devices retain force in a contact connection irrespective of the temperature change.
- 

For convenient control, the power circuit diagram is given on the cabinet switch compartment door.
- 

Movable and fixed contact connections of disconnectors' and buses' power circuits are covered with a conducting lubricant.
- 

Cabinets provide two RJ45 connectors (RS485 interface) for communication with a high-level system for remote control and reading the cabinet operation log.
- 

The cabinet design ensures convenient installation and maintenance of the cable connection.
- 

It is possible to install heat indicators for contact connections with memory.

A motorized pull-out element on telescopic guides provides for quick and convenient access to the momentary switch, advanced system of the short-circuit tester (SCT) and to the measuring shunt. Plug-in power contacts in combination with non-maintainable contact connections based on compensating clamping washers allow reducing operational expenses for maintaining the switchgear.

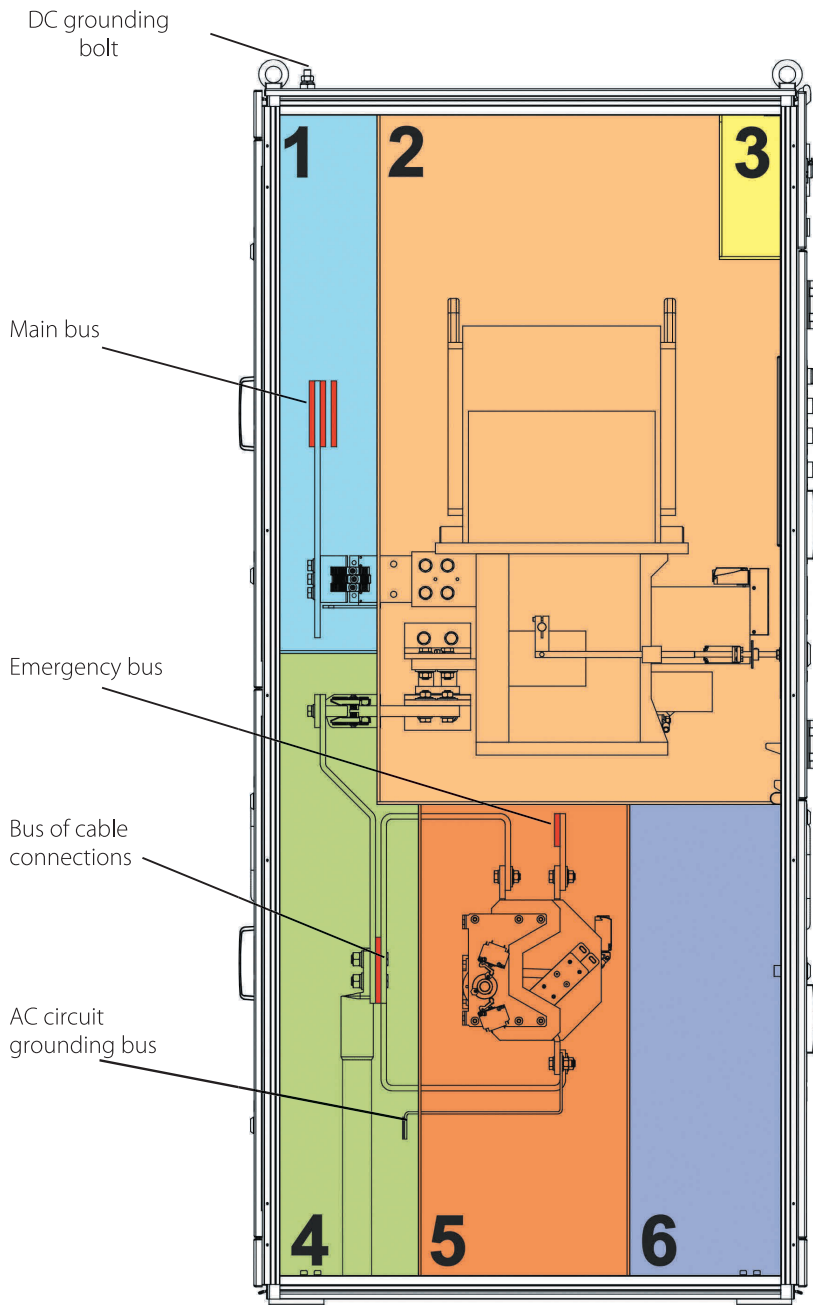
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KRU-600 DC switchgear Optimum series

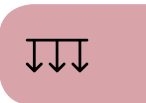
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KRU-600 Optimum series are designed for construction of new traction substations and modernization of existing ones.

To increase the convenience and safety of maintenance, KRU-600 cabinets are divided into compartments isolated from each other.

- 1. Main bus compartment
- 2. Momentary switch compartment
- 3. Control and diagnostics compartment +600B
- 4. Cable connections compartment
- 5. Emergency bus and disconnectors compartment
- 6. Automation and secondary connections compartment



Key technical data

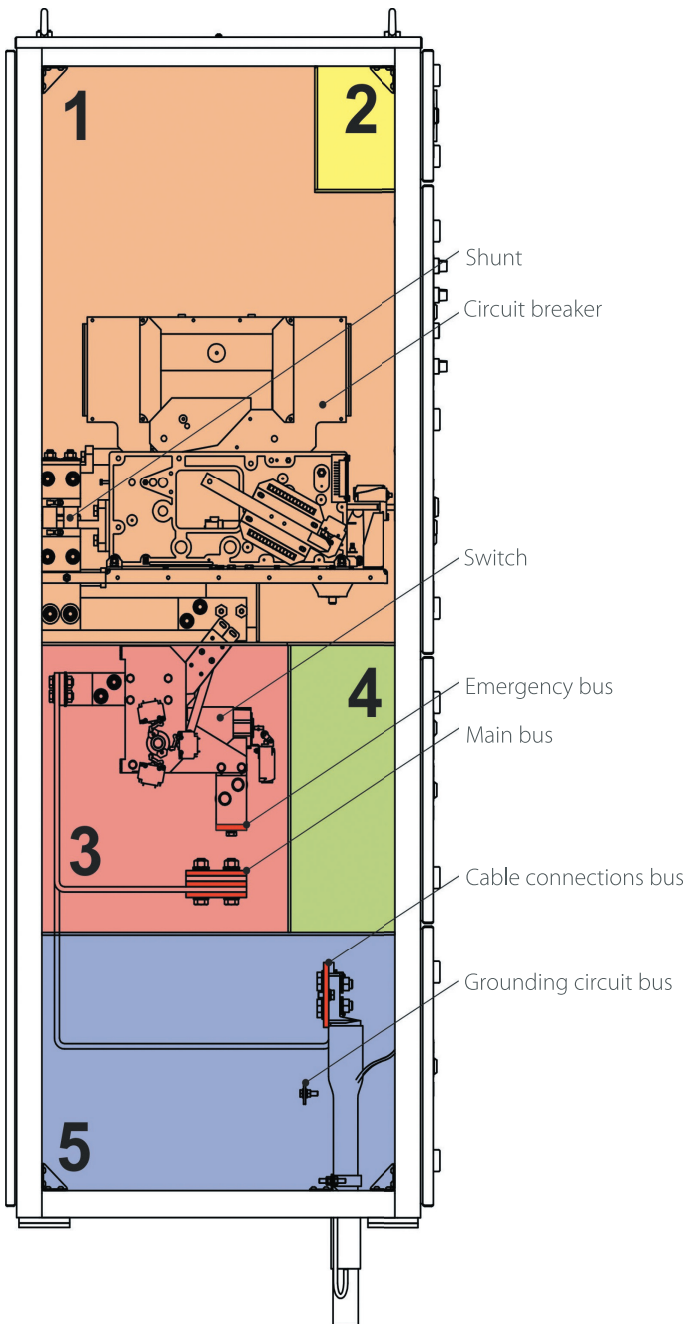


Parameter	Parameters and characteristics for the following cell types:				
	cathode KRU-600K	linear KRU-600L	backup KRU-600Z	sectional KRUO-600SK	linear KRUO-600L
1. Power circuit nominal voltage, V	= 600				
2. Power circuit nominal current, A	2000				
3. CB type	UR40, IR3030, VB-22, VAB-209	UR26, IR3030, VB-24, VAB-211			
4. Switch design	pull-out, with telescopic guides, and manual or motorized drive				
5. No. and maximum cross-section of connected cables, mm ²	2(1x800)	2(1x800)	—	2(1x800)	2(1x800)
6. Disconnecter type	—	R15-1250M1	—	R15-2000M1	—
7. Motor drive parameters	—	= 220 V; 90 W			—
8. Disconnecter drive	—	motorized, with manual control			—
9. Full turn on/off time, max., sec	—	3			—
10. Nominal current (DC), A	—	1250	—	2000	—
11. Cabinet control circuit	microprocessor				
12. Nominal voltage of circuits, V	control, V signaling, V lighting, V	= 110; = 220 =24; =110; =220; ~36 50 Hz ~36 50 Hz; ~220 50 Hz			
13. Maintenance	two-side				
14. Cabinet overall dimensions, max., mm	600x2200x1000				
15. Weight, kg, max.	300	330	310	320	310



KRU-600 DC switchgear Compact series

24

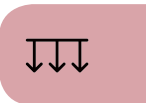


KRU-600 Compact series switchgear are designed for construction of small and modular (container) traction substations and for modernization of new ones.

To increase the convenience and safety of maintenance, KRU-600 cabinets are divided into compartments isolated from each other.

- switch compartment;
- +600V control and diagnostics compartment;
- collecting bars and switch (disconnecter) compartment;
- automation and secondary connections compartment;
- cable connections compartment.





Key technical data



Parameter	Parameters and characteristics		
	cathode KRU-600K	linear KRU-600L	backup KRU-600Z
1. Power circuit nominal voltage, V	600		
2. Power circuit nominal current, A	2000	1000 (2000)	
3. CB type	IR3030F		
4. Switch design	pull-out, with telescopic guides		
5. Maximum cross-section of connected cable, mm ²	3(1x400), 2(1x800)	2(1x800)	–
6. Switch (disconnect)	R15-2000M2	P15-1250M2	R15-1250M2
7. Motor drive parameters	= 220 V; 90W		
8. Type of switch (disconnect) integrated into cabinet:	motorized, with manual control		
9. Full turn on/off time (with drive), sec, max.	3		
10. Nominal current (DC), A	2000	1250	
11. Cabinet control system	microprocessor		
12. Nominal voltage of circuits: control, V signaling, V lighting, V	= 220 ~36; 50Hz ~220; 50Hz		
13. Maintenance	one-side or two-side		
14. Cabinet overall dimensions (WxHxD), max., mm	600 x 2200 x 800		
15. Weight, kg, max.	300	320	310

3.2

SG+600 modernization

26

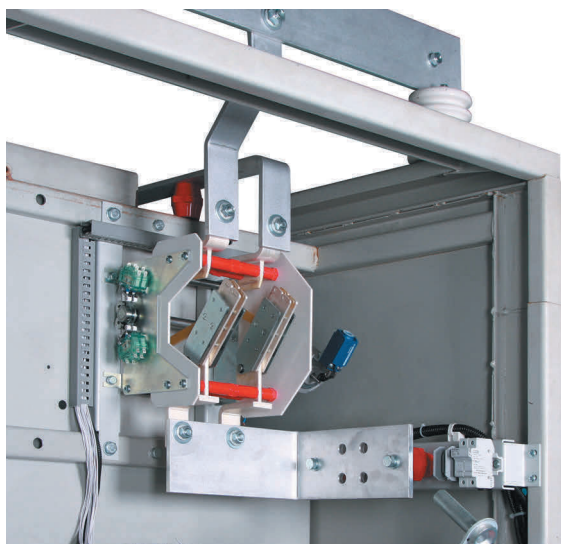
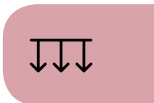
ZAO ENERGY SPE replaces equipment of obsolete +600V switchgear cells with minimal improvements to the cabinet design. Modernization is done by replacing individual units and the switch without dismantling the cell itself. New units are made as individual cabinets for quick installation and safe access of personnel during maintenance. As compared to complete replacement, +600V switchgear modernization is economically profitable. The cost of modernized equipment is reduced due to using existing housings and cell bus arrangement.

The modernization process includes any of the below items (as desired by the customer):

- replacement of the emergency bus switch (EBS): instead of a disconnector with a magnetic-fugal drive, a disconnector with a DC drive is installed;
- replacement of the circuit breaker with the control station: it is possible to install new switches of VAB, VAT types of UR26 and UR40, IR 3030, VB22, VB24 switches;
- replacement of the cabinet control and signaling system (including a high-voltage compartment);
- installation of the advanced traction network diagnostics system (SDTS-1);
- installation of the new system of the short-circuit tester (SCT);
- installation of the SKAT-1 control, automation and telecontrol system.



← Overview of the modernized linear cell of a +600V switchgear



↑ Emergency bus switch



↑ High-voltage compartment with NL disconnector

SCT

It is also possible to equip the modernized SG+600 cell with an upgraded efficient system of the short-circuit tester (SCT). This system differs from previously known SCT systems in its quality and allows determining the resistance of an overhead system segment with high precision and issuing a permission/prohibition for automatic re-closing.

EBS

EBS replacement with an unreliable magnetic-fugal drive for a two-position switch manufactured by ZAO ENERGY SPE with a motorized drive allows smoothly and noiselessly operating the disconnecter by keeping the manual control capability using a knob in case of no input voltage.

Advantages of a disconnecter with a motorized drive:

- requires no setting-up and adjustment of power contact and end switches;
- high mechanical strength (20 000 on/off cycles)
- low drive capacity (nominal current up to 1.1A, 220V);
- disconnecter drive is controlled using a driver providing disconnecter protection against failure in case of power contact jamming (or failure of end switches) and implementing a number of interlocks.

Control system

Modernization may include replacement of the existing cabinet control and signaling system. The new control unit is made in an individual housing using advanced elements. The control and signaling unit is installed on the cabinet's front part and connected to the existing SG+600V circuit. If necessary, control system operating algorithms are changed with required signals issued to the teleautomatics and telemetering system. The high-voltage compartment can also be replaced with the traction network advanced system (SDTS-1) installed, which provides continuous monitoring, using the integral current-time protection, over the overhead system condition and ensures reliable protection against remote short-circuits, to which the circuit breaker is insensitive.

The SKAT system is installed on devices as a central control, protection and remote signaling module to expand functionality, increase reliability and extend the service life of equipment without its replacement.



3.3



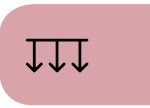
RUOSh-600 negative bus switchgear

Functional equipment included in the RUOSh-600 switchgear is divided into:

- unit disconnectors (used in RUOSh-600A) are designed for connection and no-current switching of negative power cables of a rectifying unit to a (-)600V negative bus.
- linear disconnectors (used in RUOSh-600L) are designed for connection and no-current switching of overhead system negative power cables to a (-)600V negative bus.
- grounding disconnectors (used in RUOSh-600Z) are designed to ground a (-)600V negative bus in order to ensure safety of overhead system repair.



← RUOSh-600 overview



Specific Features



Equipment used in primary and secondary switching circuits allows significantly reducing cabinet dimensions.



Inspection holes allow monitoring the position of disconnectors



A mnemocircuit is given on the cabinet for clear and convenient control.



Remote control and transmission of all necessary information to the dispatching station via RS485 interface. Equipment operation in both the substation control system (CDCP) and in a higher-level system.



Design and circuit solutions allow blocking disconnector control in case of threshold currents (set within 20-2000A) in direct or reverse direction and prevent erroneous actions of repair and maintenance personnel.



The disconnectors and switch can be manually controlled in case of no 220V input voltage.



Contact connections of power circuits are made non-maintainable. Compensating devices retain force in a contact connection irrespective of the temperature change



Movable and fixed contact connections of disconnectors' and buses' power circuits are covered with a conducting lubricant.



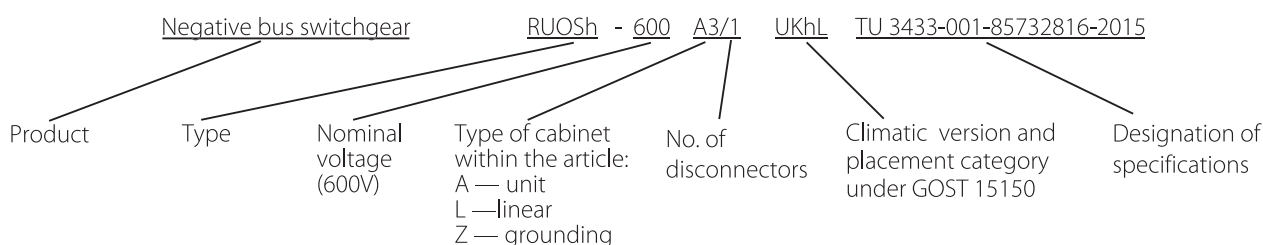
Thermal indicators of contact connections (upon request)

Design



The RUOSh-600 negative bus switchgear is manufactured as individual metallic cabinets of framed design with an opportunity of one-side maintenance that allow for one-row installation. The cabinet design provides class 0I electrical shock protection for 600V power circuits and class II for auxiliary circuits under GOST 12.2.007.0-75. The cabinet is rated as IP21 under GOST 14254-96, except for versions with upper lead-in of cables. RUOSh-600 complies with the requirements of GOST R 51321.1

Structural diagram of cabinet designations



Designation in documents:

RUOSh-600A UKhL negative bus switchgear TU 3433-001-85732816-2015

Short designation: RUOSh-600A

Design options are defined in the data sheet.

It is possible to manufacture individual cabinets and cabinets adjoining each other in front by 400 mm (for 1 disconnector), 600 mm (for 1–2 disconnectors) and 1200 mm (for 3–4 disconnectors).

Design options: 400: A, L, Z

600: A, L, Z, A2, A/L, A/1, L2, L/1

1200: A3, A2/1, A4, A3/1, A2/L2, L3, L4, L2/1, L3/1.



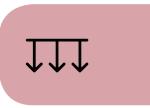
Primary technical data of RUOSh-600 components

30

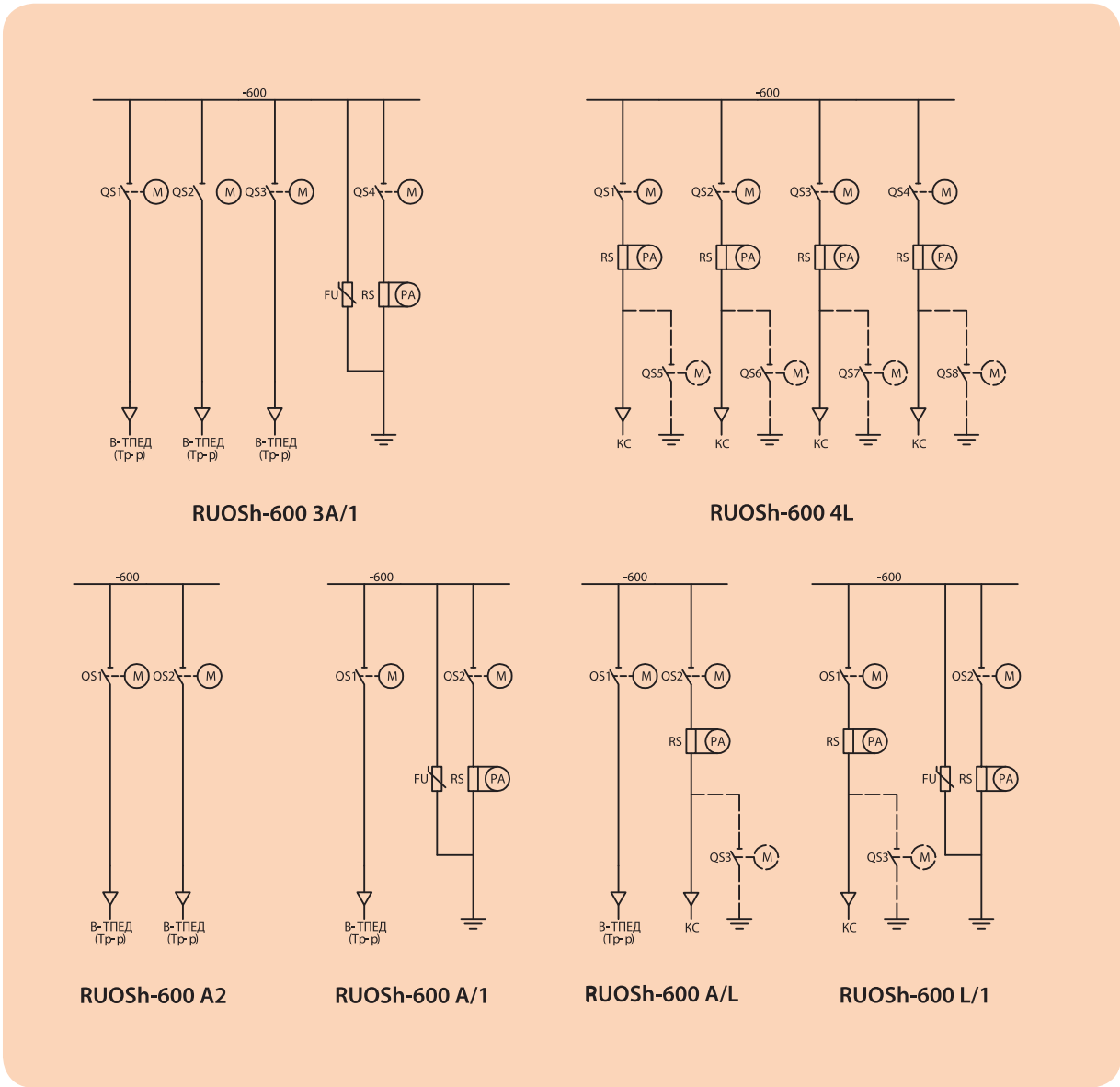


Parameter	Значения параметров и характеристик :		
	RUOSh-600A	RUOSh-600L	RUOSh-600Z
1. Power circuit nominal voltage, V	=600		
2. Nominal current, number and brand of collective buses	on request		
3. Cabinet power circuit nominal current, A	2000	1000	1000
4. Maximum cross-section of connected cable, mm ²	2(1×800)	2(1×800)	—
5. Type Main disconnector Grounding disconnector*	R15-2000M1	R15-1 250M1 R15-1 250M1*	R15-1250M1 —
6. Nominal current, A Main disconnector Grounding disconnector	2000 —	1250 1250	1250
7. Full turn on/off time, max., sec	3		
8. Load-break switch drive, disconnector drive	Motorized, with manual control		
9. ПDisconnector drive parameters	=220V; 90 W		
10. Nominal voltage of circuits, control circuits V, signaling circuits, V lighting circuits, V	~ 220 ~36		
11. Testing voltage between power circuits, cabinet housing and control circuits, kV, min.	5		

* — installed upon request



Possible schemes of RUOSh cabinet main circuits





R15, R30 disconnectors

33

Specific Features



Compact size.



Self-cleaning power contacts.

Ag

Movable and fixed contacts of power circuits are silver-plated.



Emergency manual control (for motorized drive only).



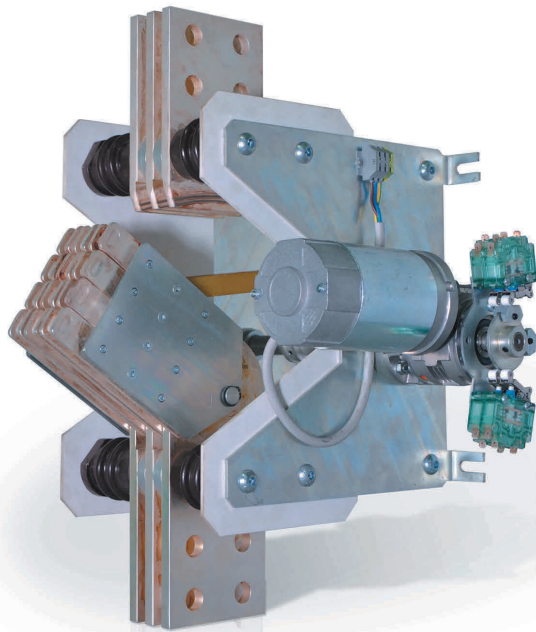
Movable contacts of the power circuits are covered with a conducting lubricant.



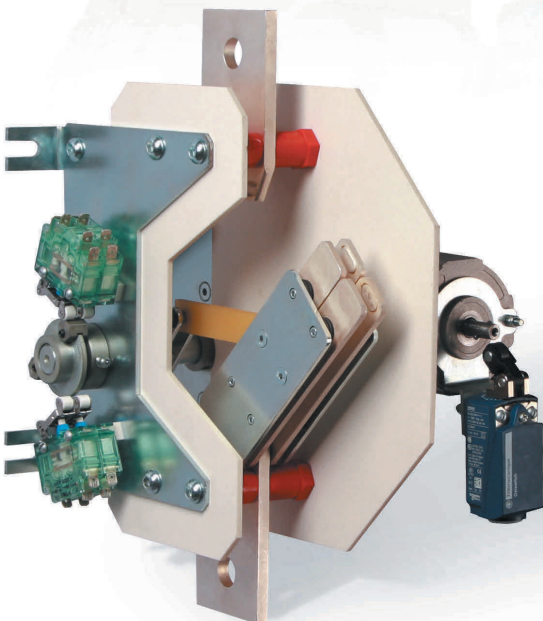
Disconnector position auxiliary contacts.



Calibrated clamping force of power contacts ensuring reliable electrical connection.



↑ Disconnector R30-6300M1 overview



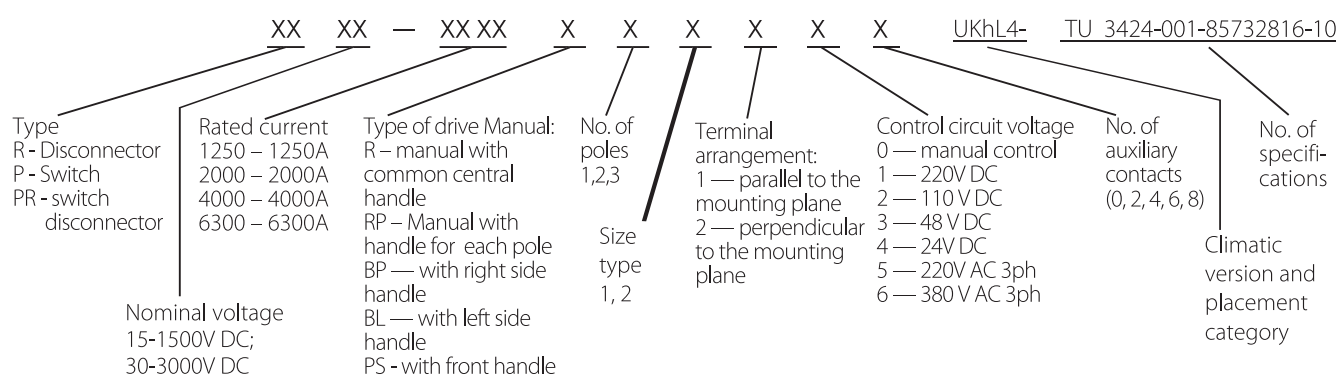
← R15-1250M1 overview



R15, R30 disconnectors are designed to switch electrical circuits with no loading.

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Structural diagram of designations



Exemplary designation in documents when ordering:

R15-1250Sh12100-UKhL4 disconnector TU 3424-001-85732816-10

Exemplary short designation in documents: R15-1250Sh1

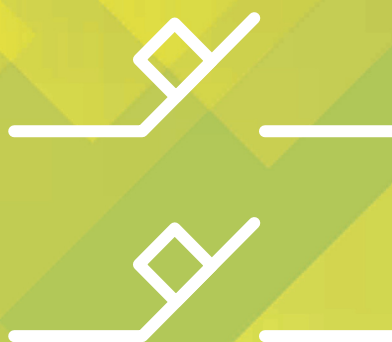
Key technical data

Parameters ↓	Type →	R15; R30; P15; P30; PR15; PR30	R15; R30; P15; P30; PR15; PR30	R15; R30; P15; P30	R15; R30; P15; P30
1. Operating frequency, Hz		0			
2. Rated operating DC voltage, Ue, V		1500; 3000			
3. Nominal pulse withstand voltage, Uimp, kV		11		17	
4. Nominal long-term current Iu and nominal operating current, Ie, A; DC		1250	2000	4000	6300
5. Nominal short-term withstand current Icw, kA		43	44	50	60
6. Electrodynamics stability, kA		100	102	115	140
7. Testing voltage between power circuits, grounded parts and control circuits, kV, min.		6			
8. Electrical drive power, W		90			
9. Full turn on/off time with motor drive, sec, max.		5			
10. Mechanical stability, No. of switchings, min.		20000			



Substation auxiliary power supply equipment

5



5.1

ShSN auxiliaries cabinet



The ShSN auxiliaries cabinet is designed to control, transmit convert and distribute power for supplying auxiliaries of urban electrical transport traction substations (tram, trolleybus, monorail).

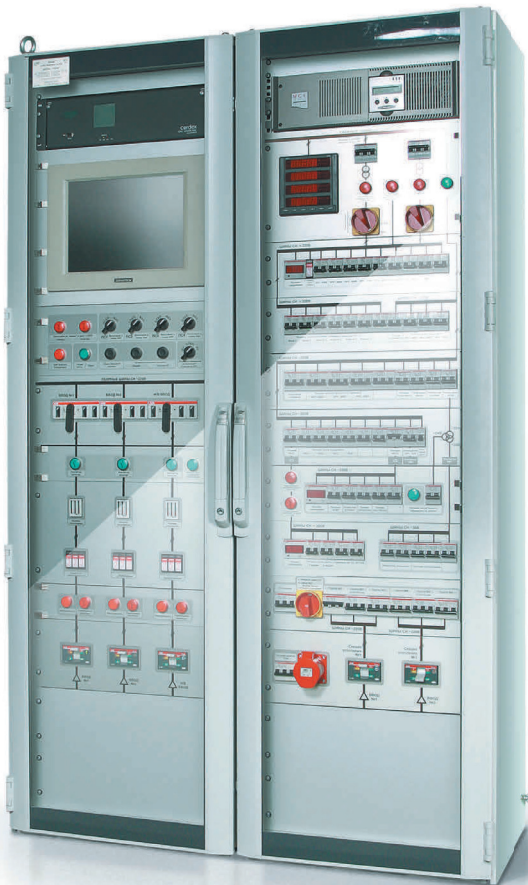
37

Specific Features

ShSN cabinets manufactured by ENERGY SPE have advantageous differences from existing auxiliaries cabinets showing higher reliability, better weight and dimensional characteristics and uninterrupted power supplies, expanded control, protection and diagnostics functions.

Nominal voltage of duty, standby and low-voltage input of a three-phase network with insulated neutral - 220V; 50Hz. Design option with 380V nominal voltage. 50Hz with a dead-grounded neutral.

The cabinet accommodates two uninterrupted power supplies (UPS) to supply 220V power for protection circuits and vacuum switch drives. Nominal voltage at the UPS output is changed by software using the UPS controller. The controller also protects against overvoltage and output short circuit.



Equipment used in circuits allows significantly reducing cabinet dimensions.



A mnemocircuit is given on the cabinet for clear and convenient control.



The uninterrupted power supply ensures performance of protection and control circuits of KRU-6(10) kV high-voltage switches chambers for at least 30 minutes (higher time upon request).

← ShSN overview



38

An integral part of ShSN cabinets is a microprocessor control unit that, in particular, provides:

- control over condition and quality of voltages on each of the three ShSN power terminals;
- control over insulation condition;
- power input ALT circuits operation;
- ALT of units, excluding the annular ALT mode;
- maintaining the electronic log for operation and events;
- acoustic (voice) common station signaling;
- acoustic (voice) signaling of no voltage on DC lines;
- generation of required command control signals;
- transmitting necessary signals to the high-level tele-signaling system via RS485 interface.

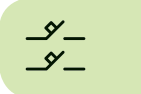
The cabinet is equipped with a backup power terminal ALT 220V system not related to the cabinet controller.

Acoustic and visual alarms and chamber illumination are on/off via a radio channel (using a side-mounted transmitter) and with a key from the cabinet control panel.

For measurements on AC buses, ShSN cabinets use a digital programmed multimeter as a measuring instrument, with a display, which ensures:

- voltage measurement up to 870V between phases;
- measurements of 2nd to 20th harmonics;
- measuring AC current values (for each phase);
- maximum and minimal values of power, current and voltage;
- measuring active and reactive power consumption;
- setting date and time;
- setting current transformer transformation coefficient;
- measuring $\cos \varphi$;
- frequency measurement;
- storing data in current memory, memory for maximum and minimal measured values with the storage period of three months to one year.

To measure voltages on AC buses, digital voltmeters are used.



Key technical data

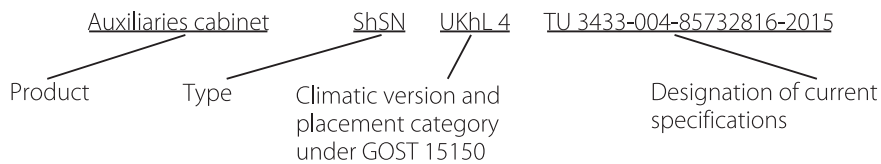
1. Nominal voltage of three-phase circuit duty, standby and low-voltage input with insulated neutral, V with dead-grounded neutral, V	220 380
2. Power circuit frequency, Hz	50
3. Auxiliaries voltage, V AC DC	24, 36, 220 220
4. Overall dimensions, W×H×D, mm	1200×2000×600
5. Weight, kg	650

Design



The cabinet design represents a metallic cabinet with one-side or two-side maintenance (as defined in the data sheet) that provides IP43 rating under GOST 14254-96. The cabinet design ensures class II electrical shock protection under GOST 12.2.007.0-75. The cabinet complies with the requirements of GOST R 51321.1-2000.

Structural diagram of cabinet designations



Designation in documents:

Auxiliaries cabinet ShSN UKhL4 TU 3433-001-85732816-2015

Short designation: ShSN



5.2

380/220 input switching device



A cabinet with an input cut-out/switch/disconnector is designed to receive and account for electrical energy in AC networks with a dead-grounded neutral 380(230)V, 50 Hz, for converting voltage for supplying power to the auxiliaries network of the urban electrical transport traction substations (tram, trolleybus) with an insulated neutral 230V, 50 Hz.

Specific Features

It has advantageous features as compared to existing cabinet through enhanced reliability and better weight and dimensional parameters.



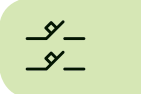
Applied equipment allows significantly reducing cabinet dimensions.



The cabinet design ensures convenient installation and maintenance of the cable connection.



The transformer is installed inside the cabinet.



Key technical data

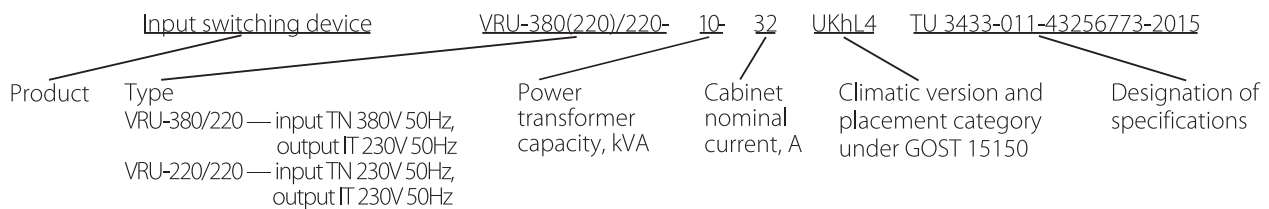
1. Nominal voltage of power circuit with dead-grounder neutral at the ISD input, V	380 or 220
2. Power circuit frequency, Hz	50
3. Output nominal voltage for mains with insulated neutral at the ISD input, V	220
4. Nominal currents of input devices, A	160
5. Nominal short-term withstand short-circuit current for input unit and input device collective buses, kA	10
6. Nominal power of dry three-phase power transformer, kVA	10
7. Cabinet nominal current, A	32
8. Overall dimensions	600 x 400 x 2000
9. Weight, kg	200

Design



The ISD represents a metallic cabinet of one-side maintenance that provides IP43 protection with door closed, and IP00 on the side of the footing adjoining the floor under GOST 14254. The cabinet is equipped with removable side panels to facilitate installation of input and output cables.

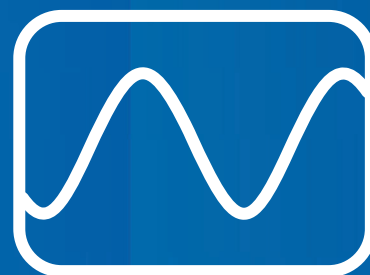
Structural diagram of cabinet designations



Designation in documents:
 Input switching device VRU-380(220)/220-10-32 UKhL4 TU 3433-011-43256773-2015
 Short designation: VRU-380/220

Equipment for protection and automation

6



6.1

ShZK cable protection cabinet



The ShZK cable protection cabinet is designed to ensure protection of DC cables in urban electrical transport traction substations using test wires.

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The cabinet fulfills the following functions:

1. Cable condition control for the following parameters:
 - impaired insulation between test and main wires;
 - cable breakage;
 - cable's test wire short circuiting with the main wire;
 - main wire short circuiting with the cable sheath
2. Diagnostics of up to 24 DC cables simultaneously.
3. Potential protection of cables in the system with a grounded negative pole.
4. Permission or prohibition for negative bus grounding contactor activation (during repairs in trolleybus overhead system).
5. Maintaining the cabinet operation log in the non-volatile memory: recording the time and events, cable condition, insulation level in various times, analyzing and recording maximums and minimums recording any unbalanced insulation of positive and negative poles relative to earth.
6. The system functions can be changed as desired by the Customer and modernized by changing the system software.





Specific Features

44



Equipment used in control and protection circuits allows significantly reducing cabinet dimensions.



Visual indication devices allow monitoring of DC cable condition and 600V voltage on traction substation buses.



Transmission of all necessary information to the dispatching station via RS485 interface. Equipment operation in both the substation system (CDCP) and in a higher-level system.



Access to the high-voltage compartment is possible only when 600V voltage is removed.

Design

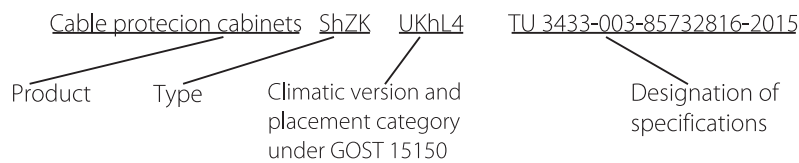


The cabinet design represents a metallic cabinet of one-side or two-side maintenance (as defined in the data sheet) that provides IP43 rating under GOST 14254-96.

The cabinet design provides class 0I electrical shock protection for 600V power circuits and class II for auxiliary circuits under GOST 12.2.007.0-75.

The ShZK cabinet complies with the requirements of GOST R 51321.1-2000.

Structural diagram of cabinet designations



Designation in documents:

Cable protection cabinet

ShZK UKhL4 TU 3433-003-85732816-2015

Short designation: The ShZK cabinet

Key technical data

1. Nominal power consumption, W	500
2. Nominal supply voltage, V	~220
3. Nominal power voltage frequency, Hz	50
4. Range of voltage measured on 600V DC buses of traction substation, V	20...800
5. Overall dimensions, WxHxD, mm	600x2000x400
6. Weight, kg	150

SDTS-1 traction network



SDTS-1 overview

This system is designed for installation in DC switchgear up to 1000V in order to diagnose the condition and protection of the traction network.

45

Key functions

1. Measuring current and voltage magnitude and form in a traction network in various modes, including short circuits.
2. Transmitting measured current and voltage values to the high level system (remote measurement, signaling systems, central dispatcher control panel, etc.).
3. Recording and transmission (when requested) of amplitudes of measured values.
4. Protection of the traction network against SC currents, including low SC currents.

Protection is provided by modeling contact wire heating and cool-down. According to the heat balance equation and contact wire parameters, the SDTS system calculates temperatures and builds a wire heating chart depending on the flow time of various currents. Current temperature is transmitted to the high level system.

The system allows implementing additional protection by introducing an electronic setpoint for the traction network current and contact wire temperature. When the setpoint and the temperature are exceeded, an output signal is supplied to deactivate the DC momentary switch, which is accompanied by indication on SDTS signaling LEDs.

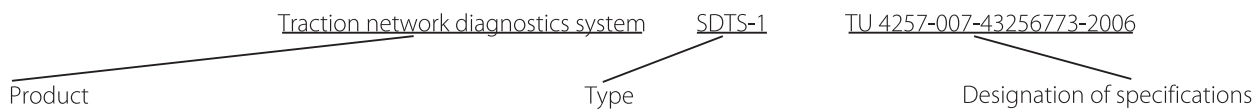




- 46
5. Measuring the rate of current and voltage rise and fall in the traction network.
In order to increase the probability of finding remote short-circuit, a setpoint for protection actuation upon di/dt is introduced, which allows implementing protection of the traction network upon several parameters.
 6. Ensuring precise control (0.5÷1% of the required setpoint) and duplicating the DC momentary switch setpoint and issuing a noncompliance signal.
 7. Oscillography and memorizing the values and forms of currents and voltages in case of short circuit, their further transmission to the high level system for statistical analysis in order to correct the current setpoint.
 8. Galvanic decoupling of circuits under potential up to 1000V

Decoupling is provided by a high-frequency transformer with the insulation testing voltage of 5 kV (AC, 50 Hz). Data transmission circuits are implemented through fiber-optic communication that ensures insulation above 60 kV. Output relays for controlling external devices ensure 10 kV insulation.

Structural diagram of cabinet designations



Designation in documents:

SDTS-1 traction network diagnostics system TU 4257-007-43256773-2006

Short designation: SDTS-1



Key technical data

1. Power voltage, V	~220 (50/60 Hz) or =24
2. Power consumption, max., W	5
3. Voltage measurement range, V	±983
4. Current measurement range with digitization increment of 2A, measurement range (from shunt)	±4096
5. Current measurement range with digitization increment of 32A, measurement range (from shunt)	±65536
6. Current measurement range with digitization increment of 32A, measurement range (from shunt)	51200
7. Communication interface with high-level system	RS232 и RS485
8. Baud rate, Kbaud	115200
9. Communication protocol	MODBUS
10. No. of outputs with galvanic isolation (solid-state relay):	
– for threshold overcurrent;	2
– for protection failure;	1
– for threshold overtemperature.	2
11. No. of relay outputs:	
–for threshold overtemperature.	1
12. Operating temperature range, ° C	0÷40
13. Testing voltage between 600V circuits and low-voltage circuits, kV, min.	5
14. Controller dimensions, LxWxH, mm	175x125x80
15. Control unit dimensions, LxWxH, mm	165x125x80
16. Divider dimensions, LxWxH, mm	115x125x80
17. Converter dimensions, LxWxH, mm	71x125x80
18. Max. system weight, kg	2

Design



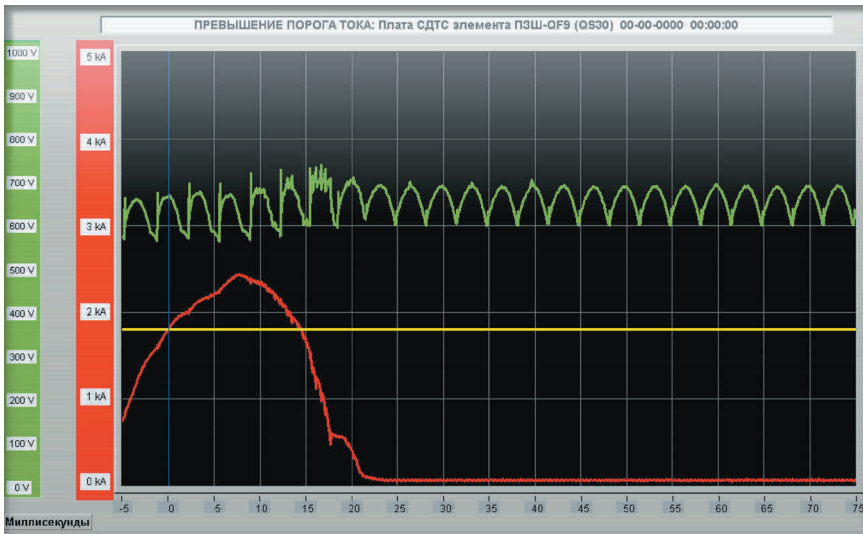
The SDTS system includes: central processor, interface converter, divider and power unit.

Traction network diagnostics system
GOST R IEC 60950; GOST 21552 ;
GOST R 51318.22; GOST R 51318.24;
GOST R 51317.3.2 and GOST R 51317.3.3.

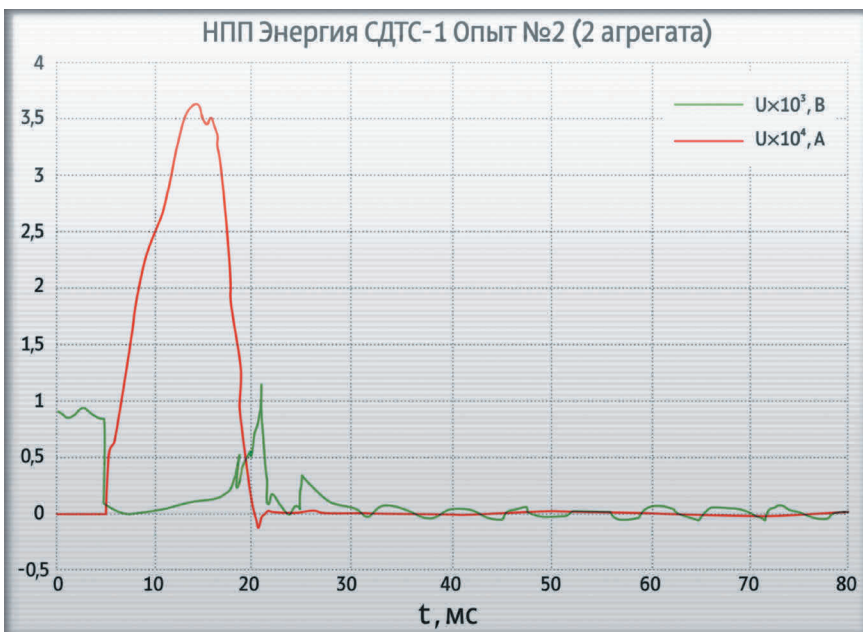


The SDTS-1 traction network diagnostics system is a special-purpose control equipment that does not pertain to the area of responsibility state metrological surveillance and is subject to regular calibration under the manufacturer's methodology.

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Example of a current and voltage chart recorded by the SDTS system in case of short circuit on Moscow trolleybus traction substation buses



Current and voltage curve recorded by SDTS in case of short circuit on the Moscow subway T4 traction substation. Short-circuit tripping is done by the NRV60-81 switch.

SKAT-1 control, automation and telecontrol system



↑ SKAT CM overview

Purpose

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The SKAT system is designed to be used in SG+600V DC switchgear of urban electrical transport traction substations (trolleybus, tram) as a central control, protection and remote signaling module to expand functionality, increase reliability and extend the service life of equipment without replacing it.

Design and principles of operation

The SKAT system includes two primary modules: a central module (CM) and the traction network diagnostics system (SDTS)

The central module is mounted directly on the cabinet panel and connected to controls, actuating mechanisms, remote control signals and end switches. The CM is integrated based on the programmable logical controller that ensures high reliability and faultless operation of the system in severe conditions of the traction system. The controller complies with the requirements of IEC 61000-6-5 in terms of noise immunity. The CM accommodates an LCD color touchscreen displaying primary information on the cell condition and allowing for fast configuration of system parameters without connecting it to the PC.

The SDTS traction network diagnostics system consists of two DIN-mounted modules located in the high-voltage zone. The SDTS and CM are connected with two fiber-optical cables, which ensures reliable galvanic isolation of the central module from high voltage.

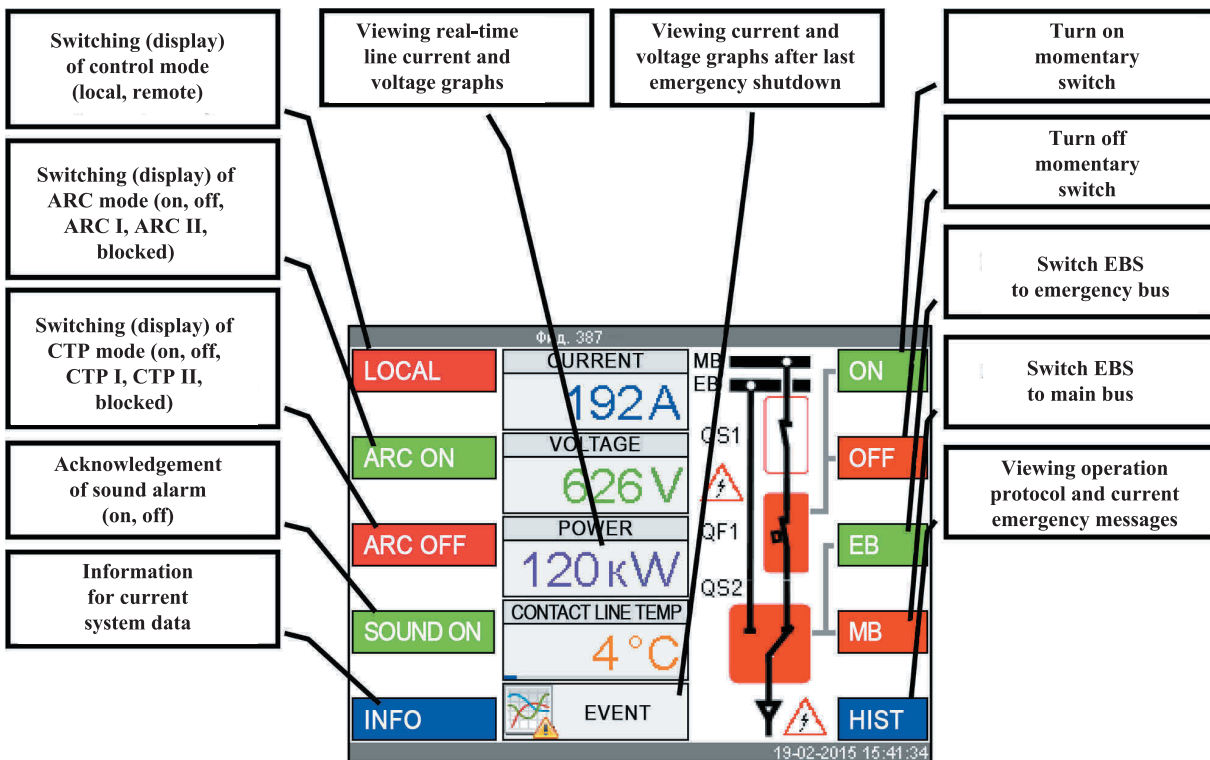
To control measured parameters, the SDTS is connected to a shunt and a -600V negative pole.



50 Key functions

- Local and remote control over circuit breaker, emergency bus switch (EBS), linear disconnector (LD) (if electrical drive is available).
- Position indication of all controls and switching devices.
- Fault signaling of switching devices and emergency trippings.
- Accounting for the number of switchings (including emergency ones) to estimate frequency of maintenance and generate an inspection message.
- Displaying on the screen and saving the operation protocol on a removable medium, recording all faults and operative switchings.
- Displaying current and voltage values, contact wire temperature, and energy consumption meter values.
- Control over local warning acoustic alarm.

- Condition diagnostics of the momentary switch, EBS, LD with position control.
- Automatic re-closing (ARC) with configurable parameters (No. of ARCs, ARC cycle times).
- Identification of SCs on the line, ARC interlocking and issuing a warning signal.
- Measuring and displaying current and voltage magnitude and form in a traction network in various modes, including short circuits with recording of values.
- Integral current-time protection (CTP) of the contact wire with feeder deactivation when the set maximum contact wire temperature is reached.
- Maximum current protection and remote protection with configurable parameters.
- Current cutoff (electronic setpoint).
- ARC when the operates with configurable parameters.



↑ Controls on the main SKAT screen



SKAT technical characteristics

SKAT CM	
CPU	B&R 4PP065.0571 GeodeLX800, 32-bitx86, 500 MHz
Screen	LCD touchscreen
Interfaces	Ethernet, RS422/RS485, CAN, USB
No. of input signals	32 (can be increased)
Nominal voltage of input signals	24V DC
No. of output signals	16 (can be increased)
Nominal voltage of output contacts	250V AC/DC
Nominal current of input contacts	6 A
Power voltage	220V AC/DC
Power	20 W
Overall dimensions WxHxD, mm	265x370x125
SDTS	
Power voltage, V	250V AC/DC
Voltage measurement range	±983 V
Current measurement range with digitization increment of 2A, measurement range (from shunt 2000A-75mV), A	±4096 A
Current measurement range with digitization increment of 32A, measurement of current surges (from shunt 2000A-75mV), A	±65536 A
Current and voltage sampling rate	51 200 Hz
Communication interface with high-level system	RS232/RS485
Overall dimensions WxHxD, mm	68x115x125

Modular traction substation

7



Modular traction substation

Modular traction substations are designed for power supply of tram and trolleybus overhead system segments with DC 600V. Modular substations are used when it is required to reduce installation period and ensure its dismantling and relocation to another place. As compared to classic substations made of bricks or reinforced concrete panels and built at the place of future operation, the installation period of modular traction substations is significantly reduced.

The MTS represents two or more heat insulated containers installed on the foundation with electrical connections fully integrated into each module. All external elements are made of sheet steel with alu-zinc coating and painted with powder enamel. When ordered separately, containers can be covered with front panels to enhance the appearance. Buildings serve as a protective shell for equipment installed within, where respective operating conditions are maintained. Heating and ventilation (conditioning) are turned on manually or automatically when climatic conditions go above or below the specified limits.





Modular traction substation

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The modular building includes an internal grounding circuit and provides a connection to the substation external grounding circuit. Each container includes lighting using wall and ceiling luminaries, with ventilation (conditioning), security alarm (ordered separately) and a fire detection system.

MTSs contain internal maintenance corridors that allow for maintenance activities to be undertaken for equipment at any season. All approximation dimensions comply with the requirements of the Electrical Installation Code.

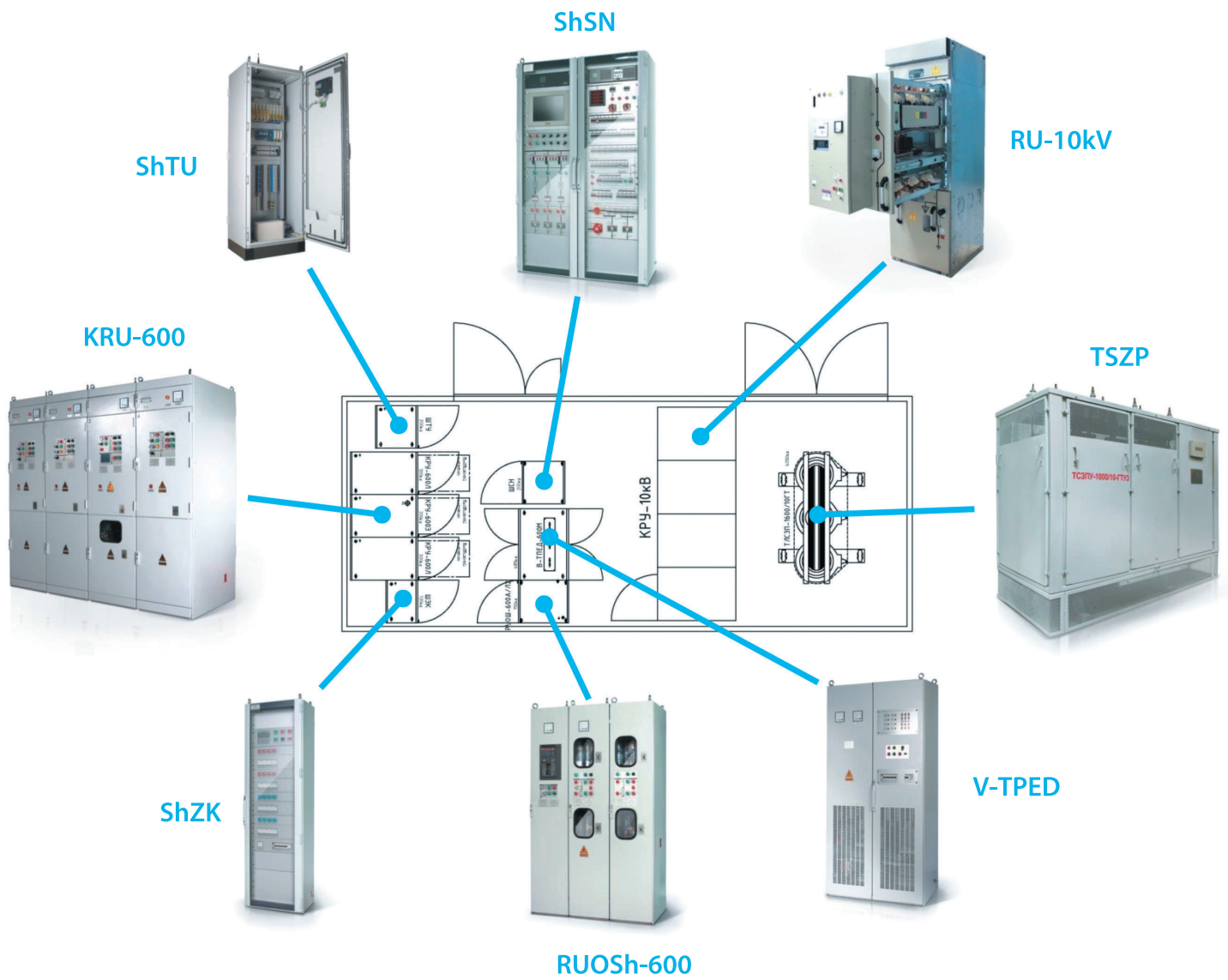
In a common case, the number of modules within MTSs depend on the equipment installed as per the order, and their dimensions are defined by technical specifications and the design.

MTS foundations are developed by a design contractor depending on surveys undertaken in accordance with the requirements of SNiP 2.02.01-83 Footing of Buildings and Structures and SNiP 2.02.03-85 Pile Foundations. A modular footing is placed on a pile or continuous foundation. The foundation top mark is taken as +0.5–1.5m above the ground level.

MTSs are supplied fully assembled (within each module), with a complete package of documents. The substation is finally installed (connection of modules, installation of transformers, placing inter-module utilities) at the place of operation. MTSs are transported by railroad or automobile transport.



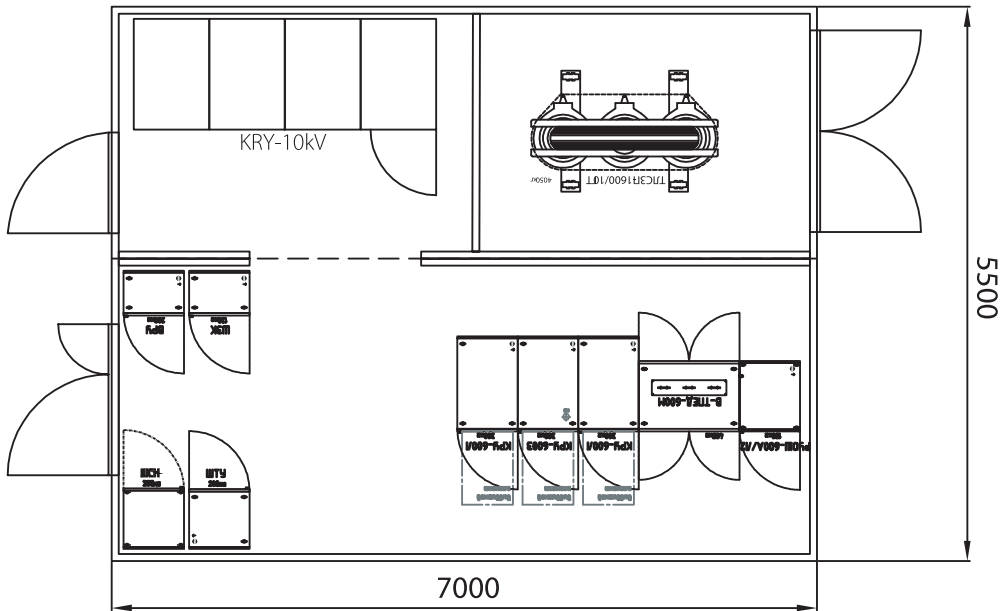
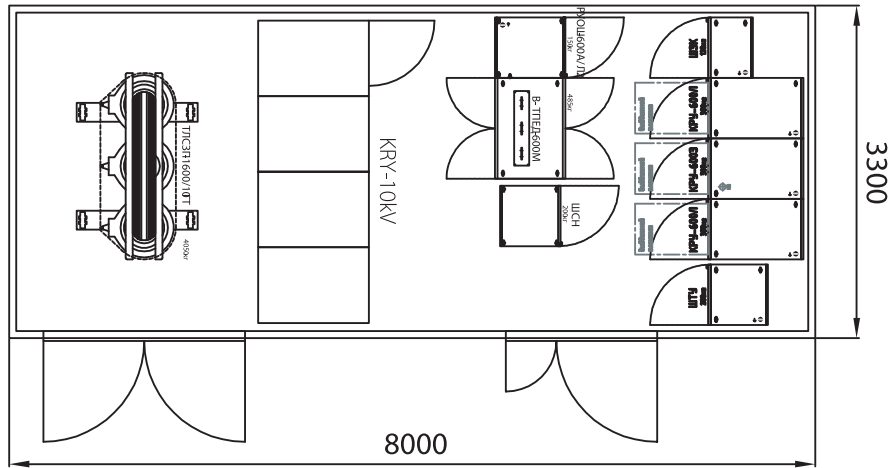
Substation equipment





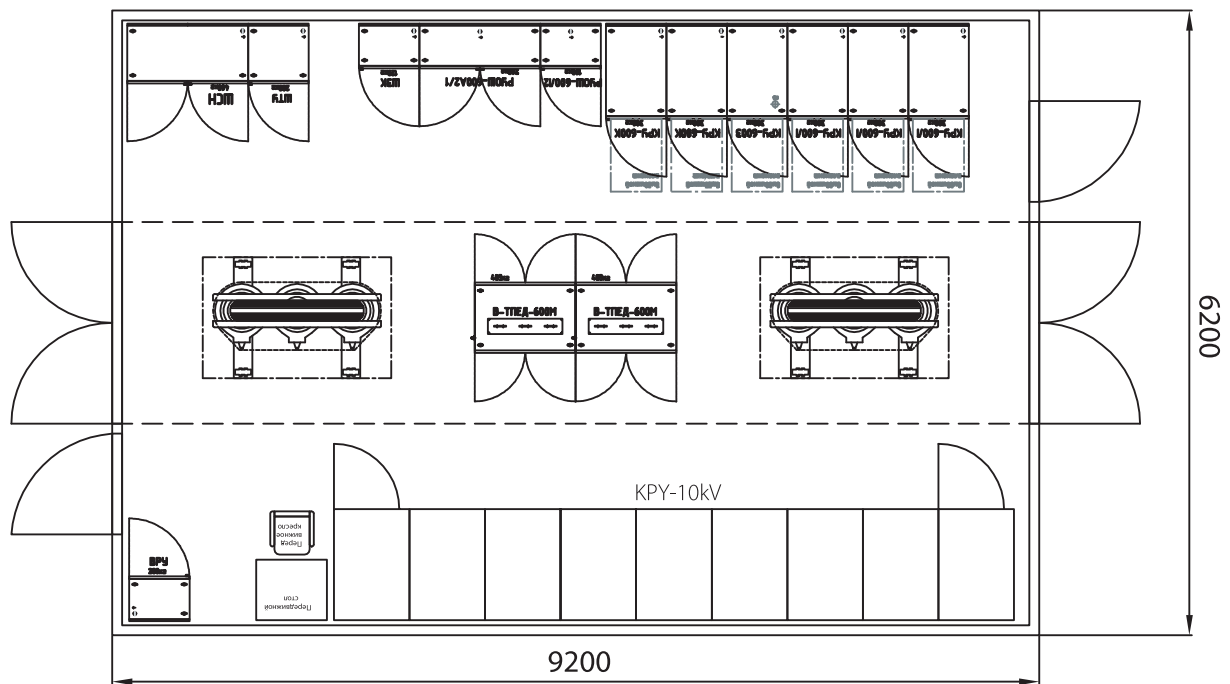
Planning of modular 1-unit traction substations

56

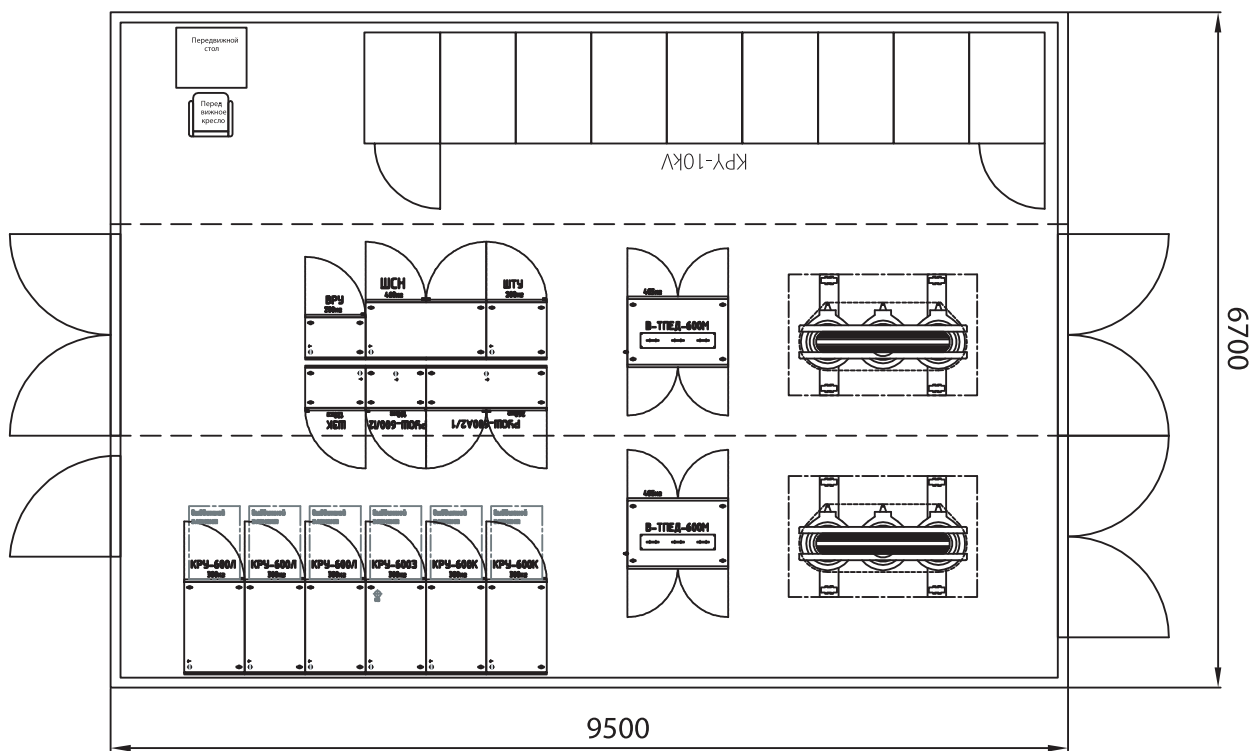




Planning of modular 2-unit traction substations



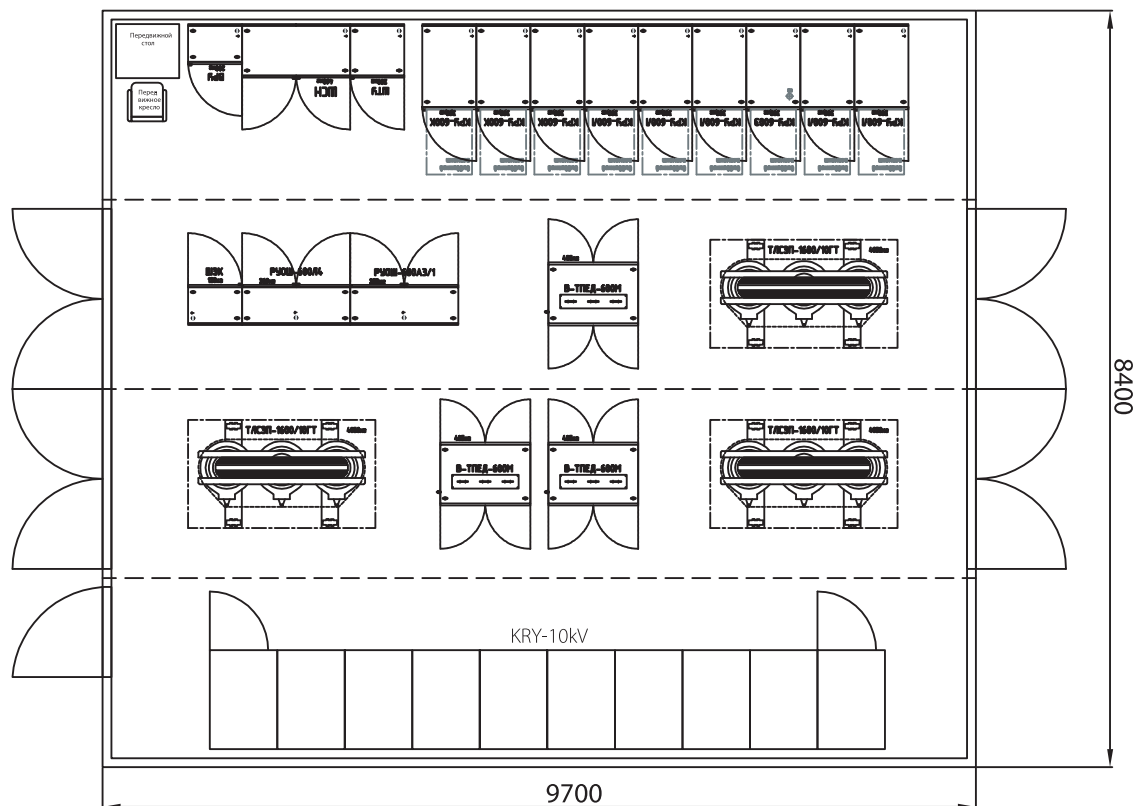
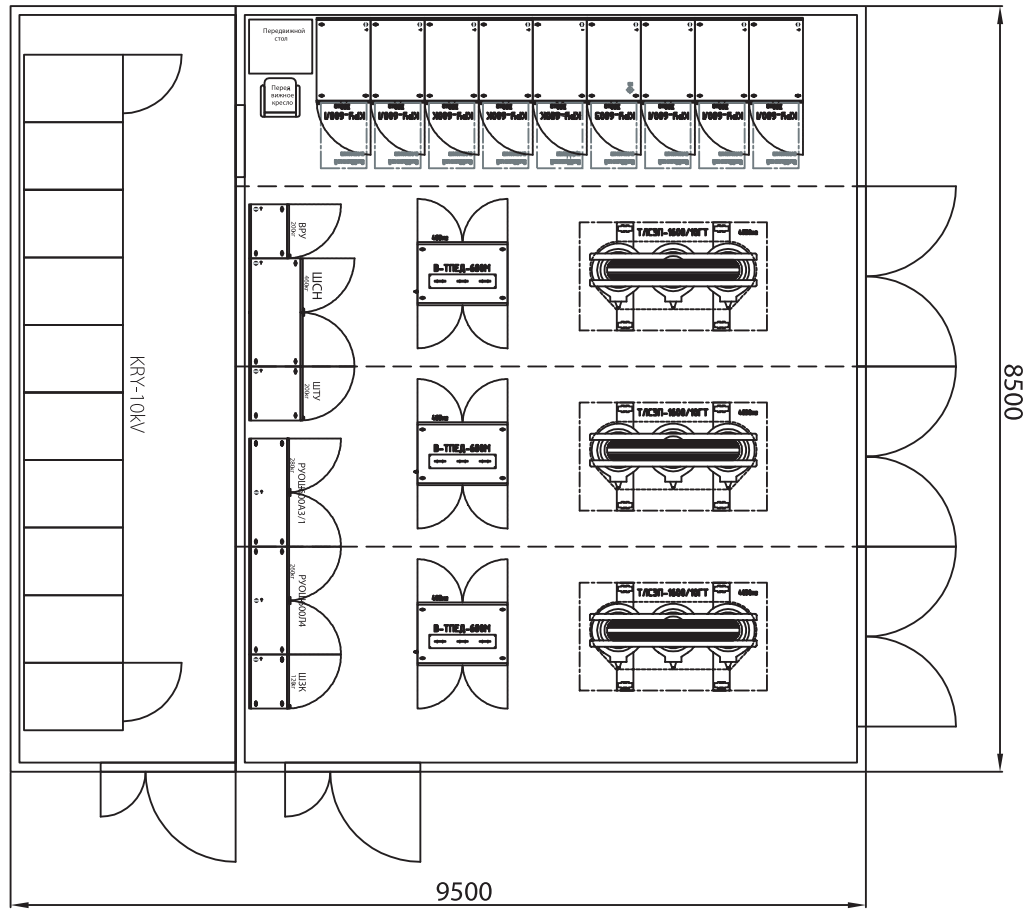
57

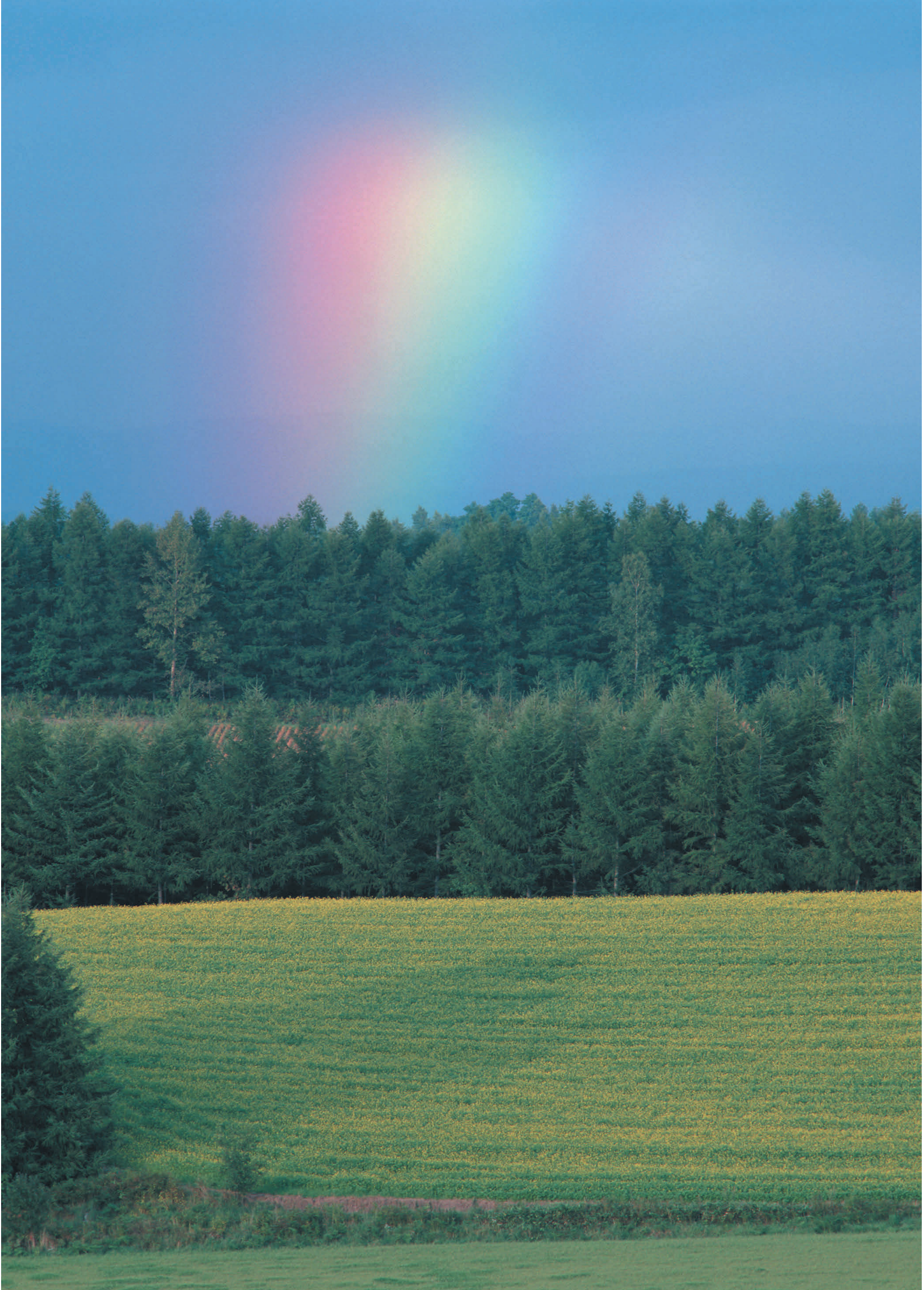




Planning of modular 3-unit traction substations

58







8

Designing



ZAO Energy Scientific and Production Enterprise has been operating in the field of designing urban electrical transport facilities for more than 20 years. The enterprise has quality management system compliance certificates in the field of designing automation and power supply systems for power sector enterprises and transport facilities and the competency certificate for design documentation development activities that affect safety of capital construction facilities N 67-II-09122009.

61

Energy SPE is a member of the self-regulated organization League of Construction Designers.

The following projects have been implemented:

- Surgut traction substations;
- Almetьевsk traction substations;
- Khimki traction substations;
- Nizhniy Novgorod traction substations;
- modernization of 50 traction substations in Moscow.



Installation, debugging and maintenance of equipment

9



9

Installation, debugging and maintenance of equipment

Upon requests from operating companies and equipment purchasers, ZAO ENERGY SPE provides services for installation, debugging, installation supervision and maintenance of equipment supplied.

63

The enterprise has the competency certificate for design documentation development activities that affect safety of capital construction facilities, including extremely hazardous and technically complex facilities (except for nuclear facilities) and is a member of the self-regulated organization Non-Commercial Partnership Of Construction Companies "Capital Repair and Construction".

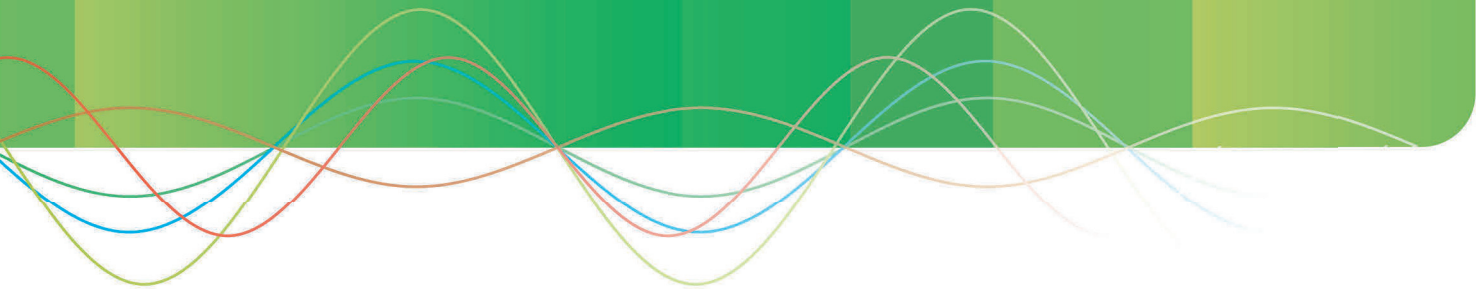
The company has a special certified high-voltage laboratory with respective certificates and approvals where electrical equipment insulation is inspected at the company and at the site of installation and in traction substations.

Activities are approved by the quality management system certificate under GOST R ISO 9001-2008 and MS ISO 9001:2008.

Activities are undertaken for individual equipment and on a turn-key basis for all equipment of a traction substation. Activities and equipment are covered by the warranty for 3 years after equipment commissioning. In the following years, ZAO ENERGY SPE supervises the equipment operation, supplies spare parts, provides repairs, updates software and, if necessary, maintains the equipment.

The company also maintains and repairs supplied equipment on a permanent contractual basis or against individual requests from operating companies. During startup and commissioning periods, the company provides personnel training for operating the supplied equipment in various modes.







Training and professional improvement for employees operating electrical transport traction substation

Primary elements of the training program are based on customers feedback.

Together with the MOSGORTRANS state unitary enterprise and the electrical transport department of the Moscow Energy Institute, ZAO ENERGY SPE constantly provides training and professional improvement for MOSGORTRANS staff and MEI students. Training is provided at the place of equipment operation in Russian and CIS cities. Training courses are organized for personnel with accommodation provided in Moscow.

Training courses for professionals are constantly given. Practical training for MEI last-year students is provided at the ZAO ENERGY SPE production and operational base. Diploma designing is supervised. Laboratory lessons, lectures and practical lessons are given at the production and research base.

With active participation of ZAO ENERGY SPE in 2007, an electrical equipment laboratory of urban electrical transport traction substations was established based on

electromechanical college no. 55 (Moscow, Mikhalkovskaya str., 52) where all AC and DC ENERGY SPE equipment is represented. The laboratory is equipped with the most advanced equipment and diagnostic devices for traction substations.

ZAO ENERGY SPE has prepared both operating equipment and methodological guidelines and laboratory lessons for the training process. Lessons are given at four sites: ZAO ENERGY SPE production base, MOSGORTRANS traction substations, electrical transport department of the Moscow Energy Institute, and electromechanical college no. 55. Training makes use of methodological guidelines and study books, instructions, video materials prepared by ZAO ENERGY SPE together with MEI teachers and MOSGORTRANS staff. Special attention is paid to practical training for new technique and skills of troubleshooting and handling emergencies and abnormal situations in equipment



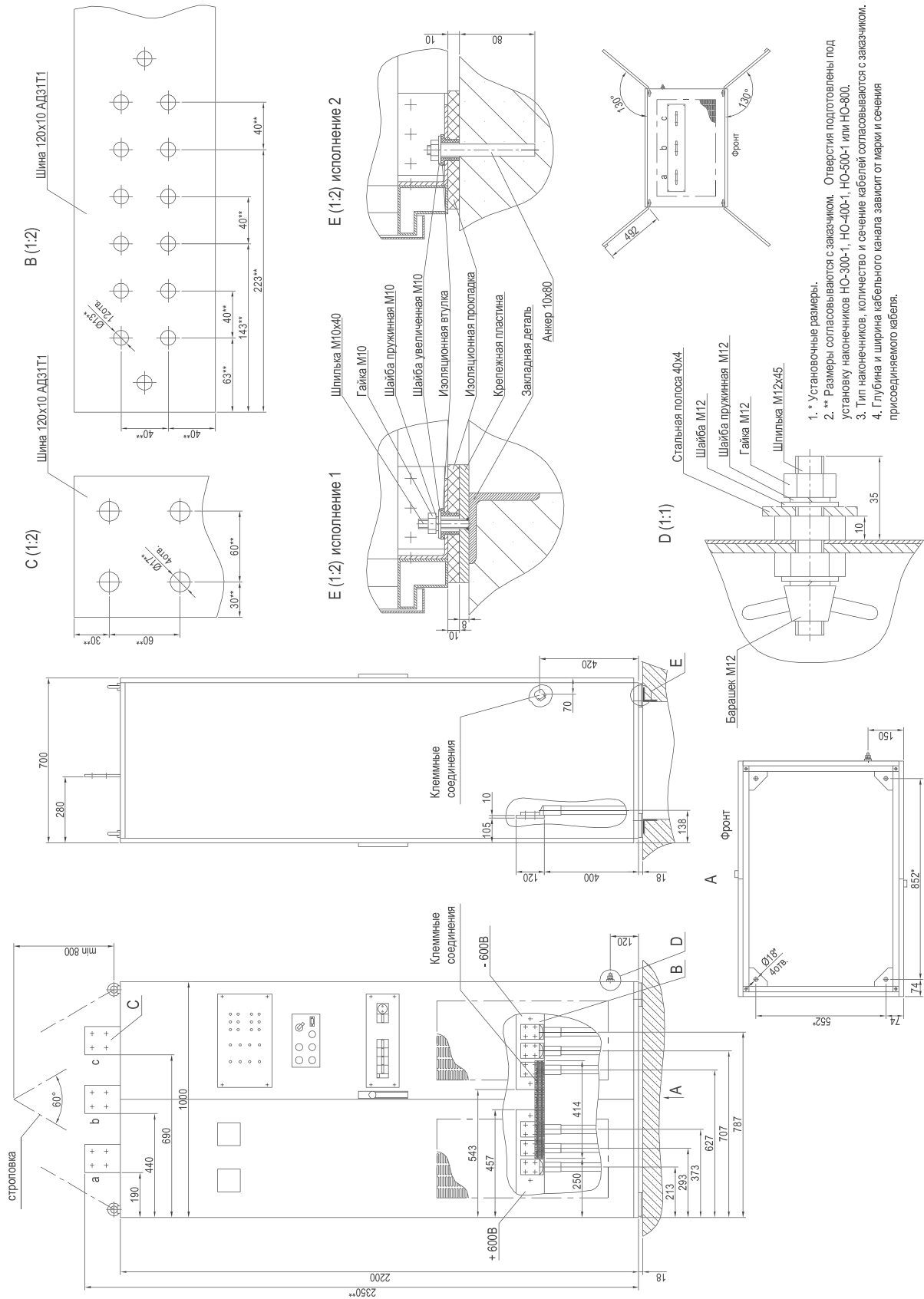
Outline and overall dimensions of equipment

11



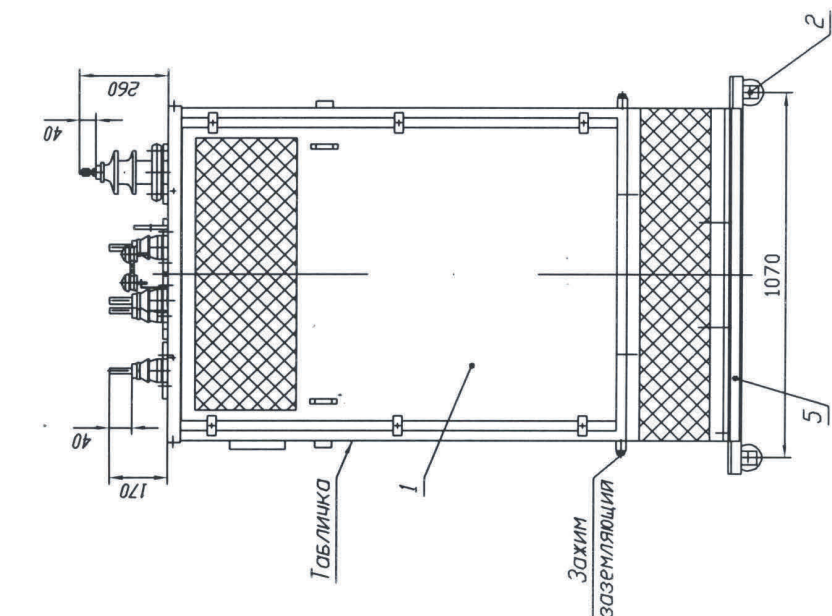


Outline, installation and overall dimensions of V-TPED-1,25 (2,0)k-600M

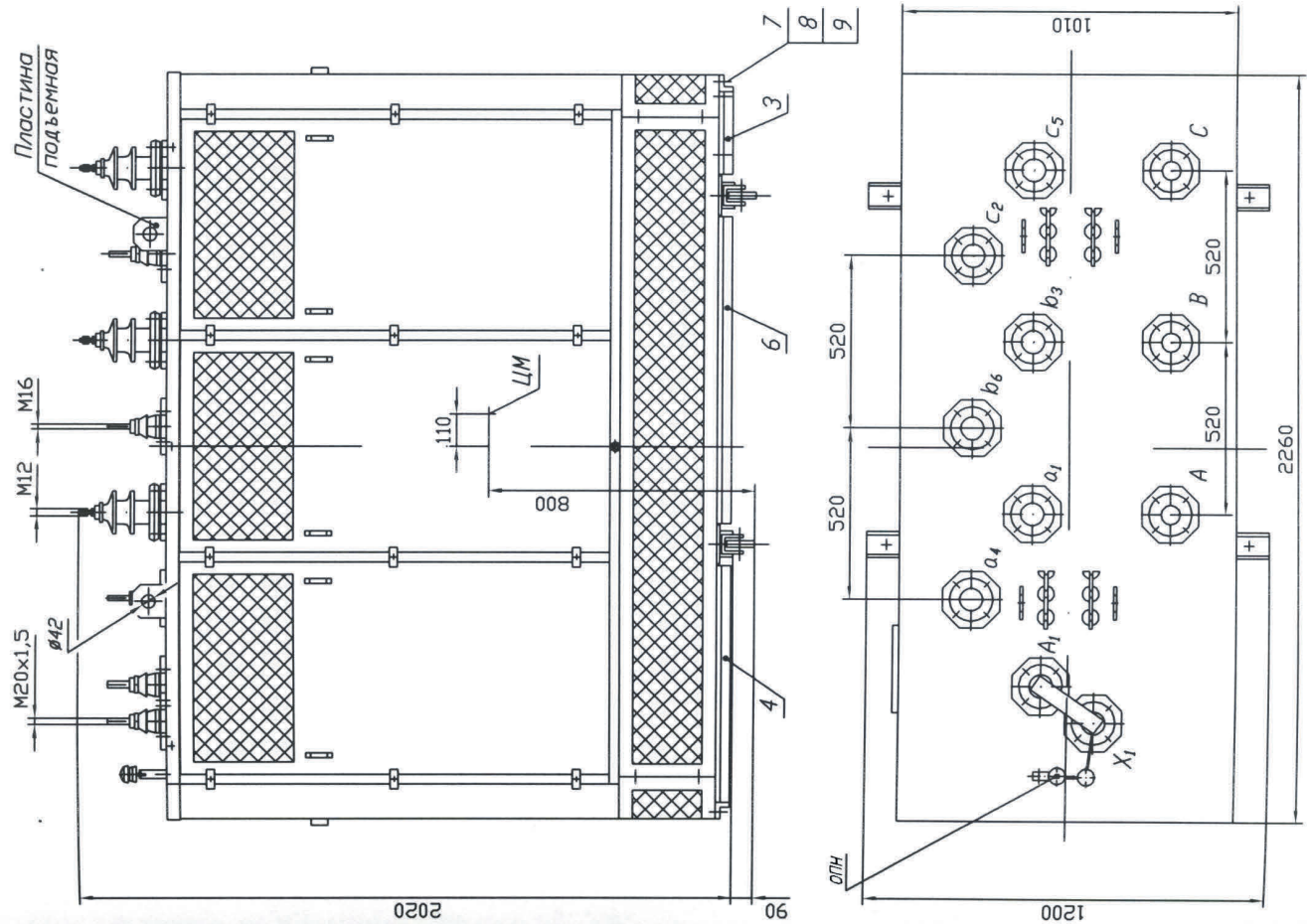




Outline, installation and overall dimensions of TSZPU-1000/10 GTUZ



1. Размеры для справок.
2. При монтаже трансформатора снять коток поз.2 и установить угольники поз.3, 4, 5, 6.

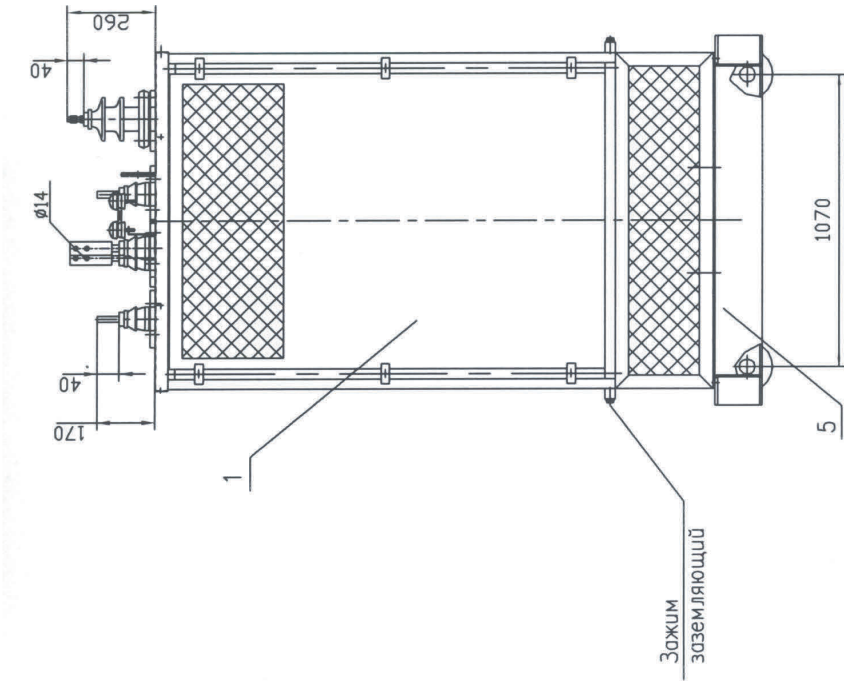




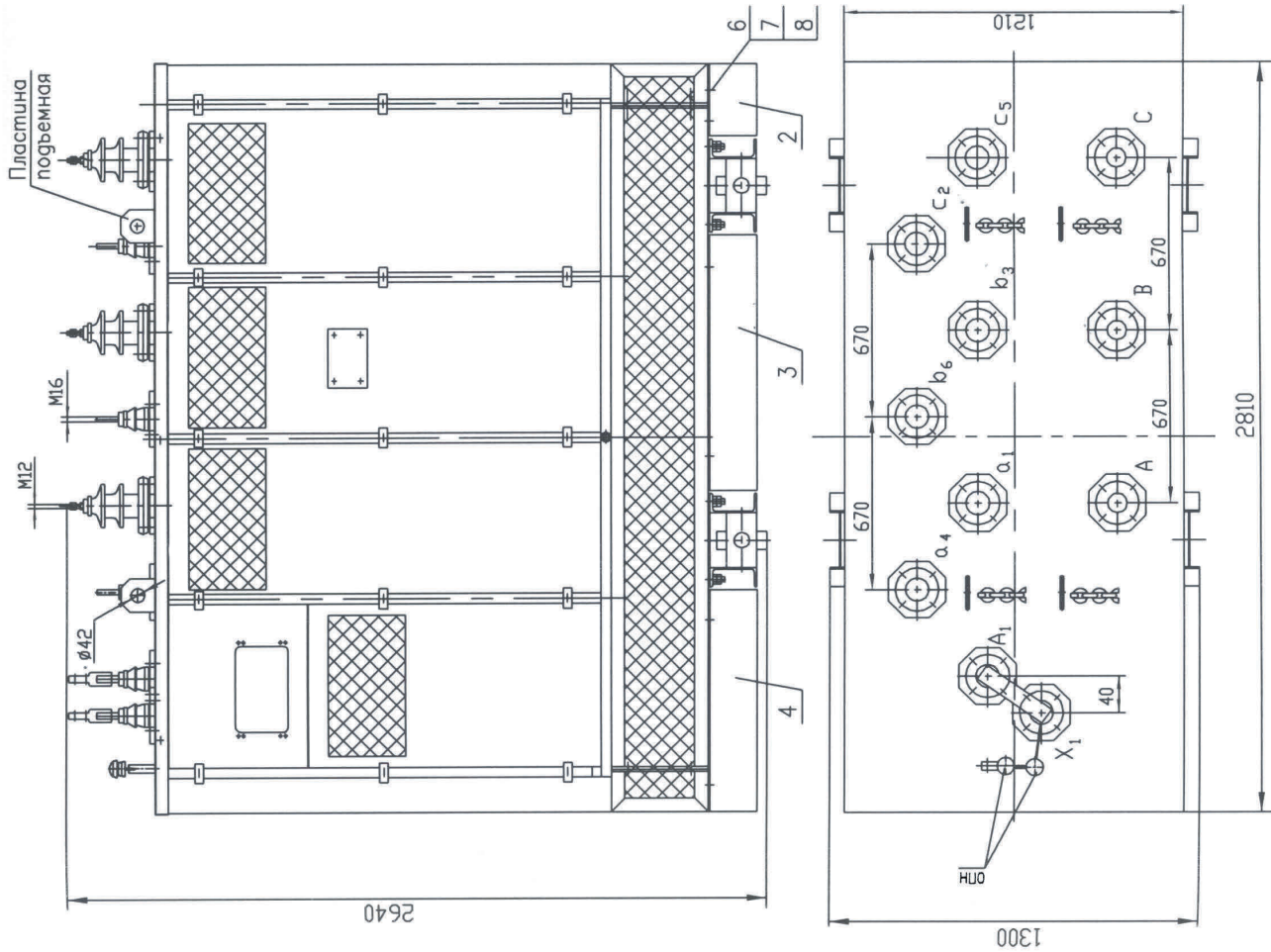
Outline, installation and overall dimensions of TSZPU-2000/10 GTUZ



70

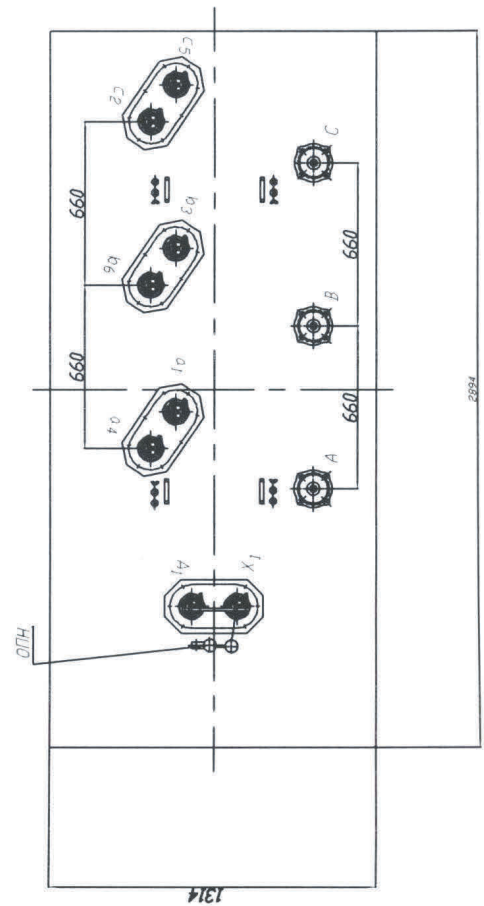
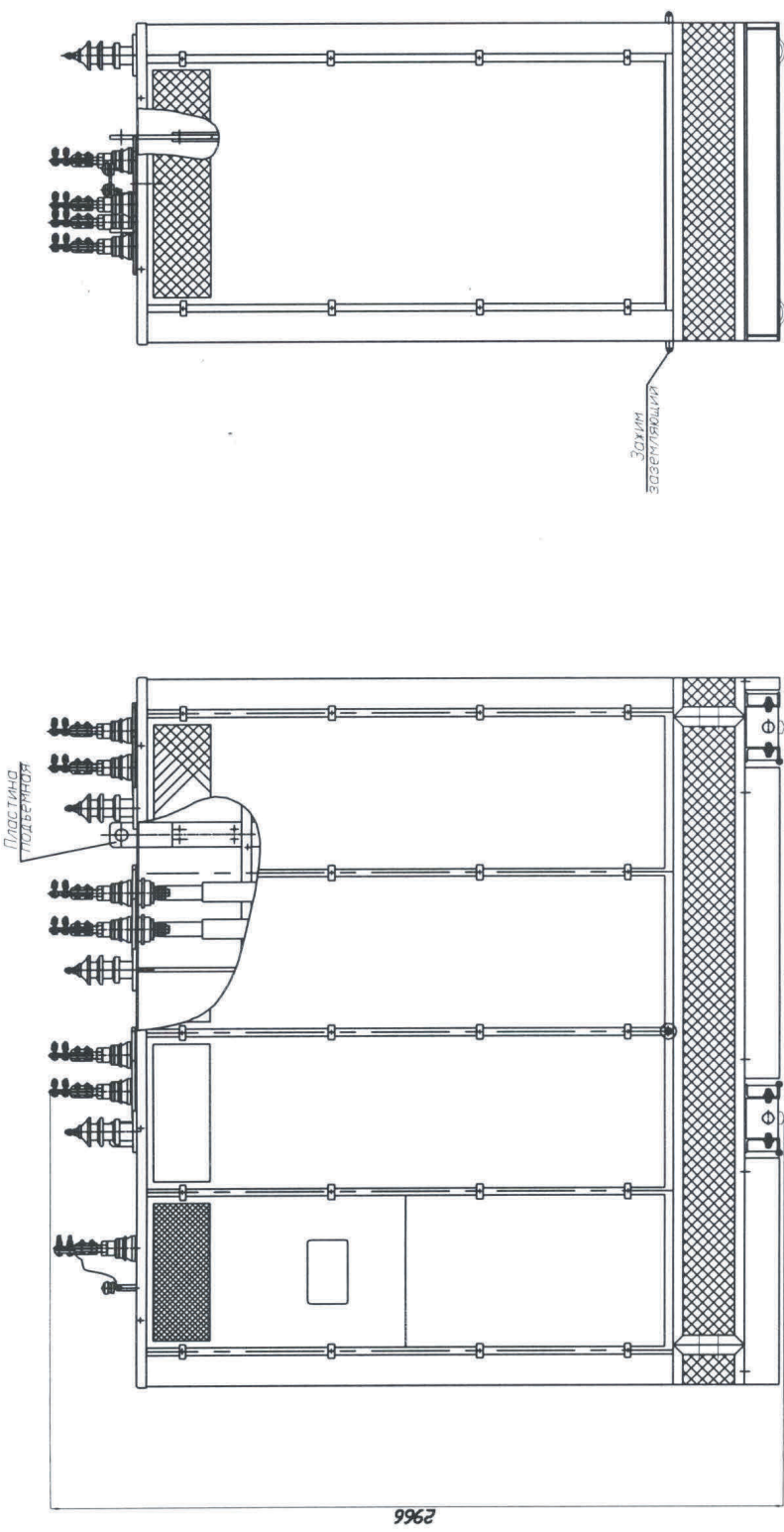


- 1. Размеры для справок
- 2. При монтаже трансформатора установить угольники поз.2, 3, 4, 5.





Outline, installation and overall dimensions of TSZPU-3150/10 GTUZ





Outline, installation and overall dimensions of TSZP-1000/10 GTUZ



ТРАНСФОРМАТОР
ТСЗП-1000/10-ГТУЗ

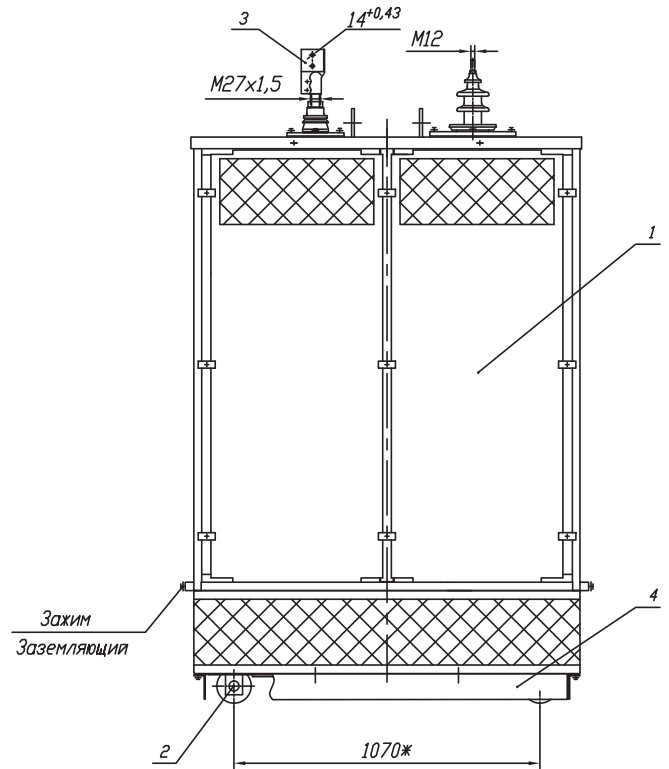
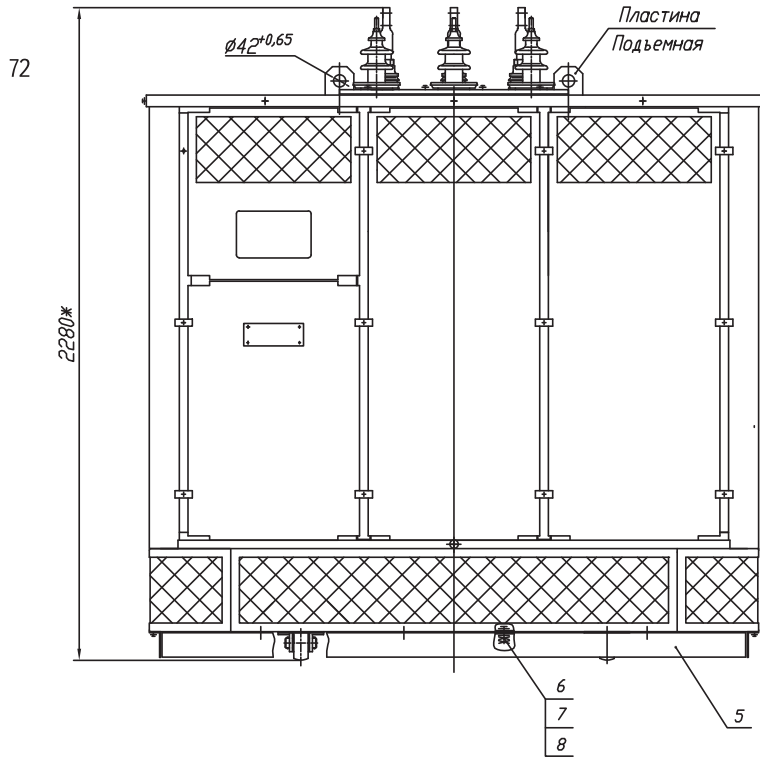
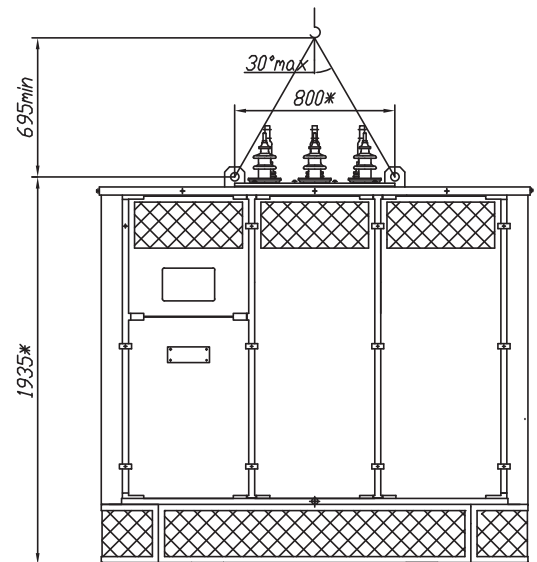
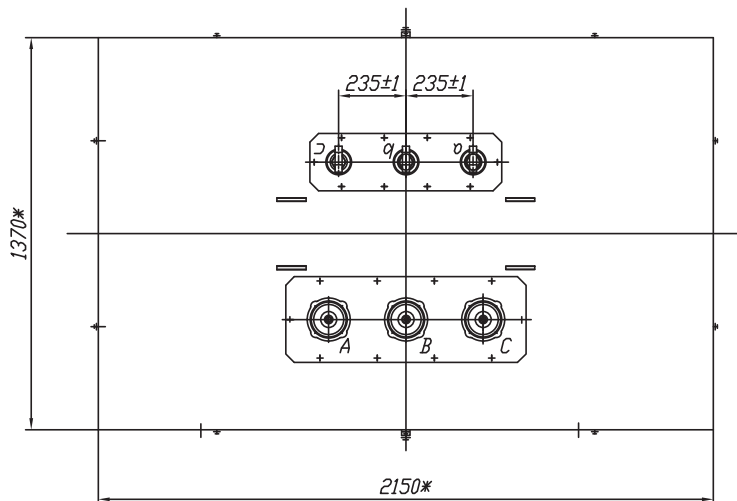


Схема подъема
трансформатора

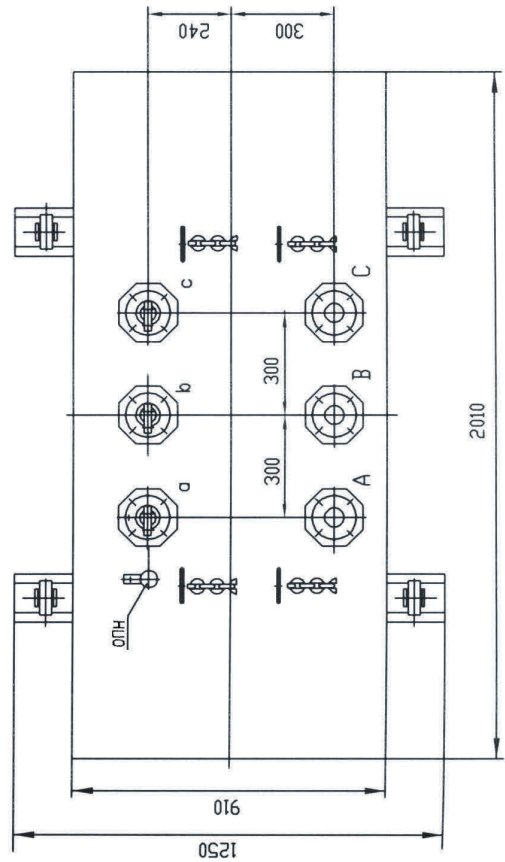
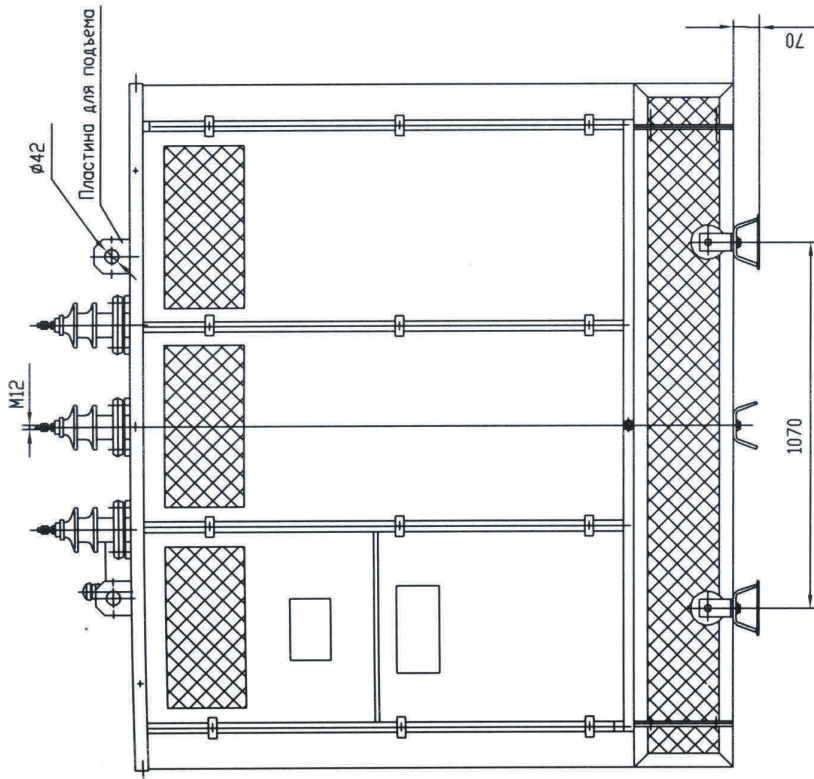
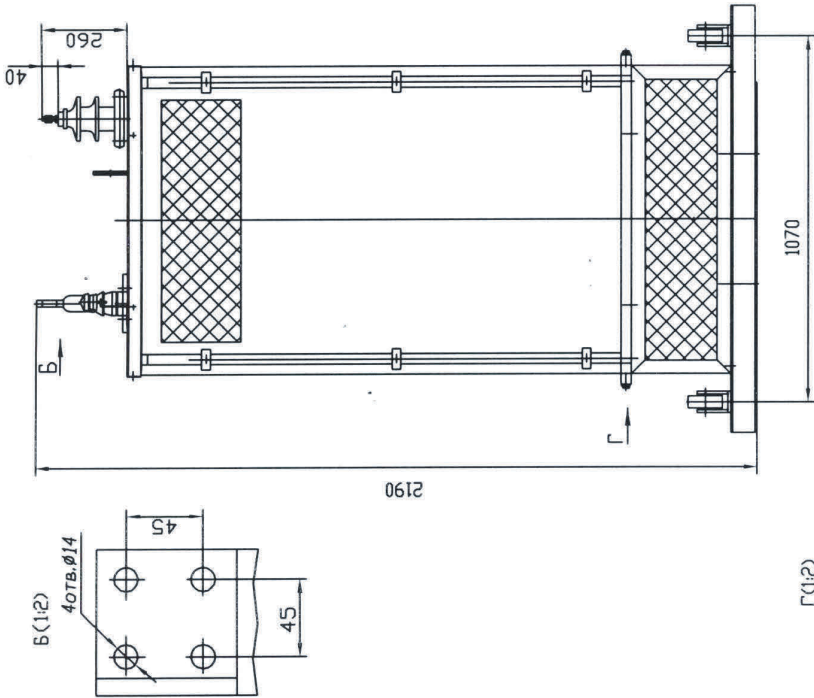


1. *Размеры для справок.

2. При монтаже трансформатора установить угольники поз.4,5.



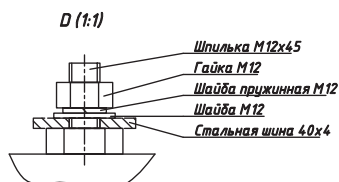
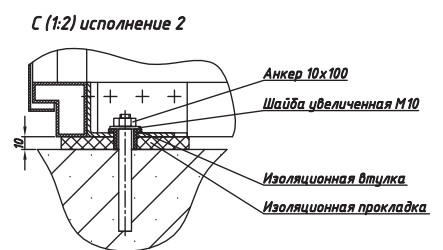
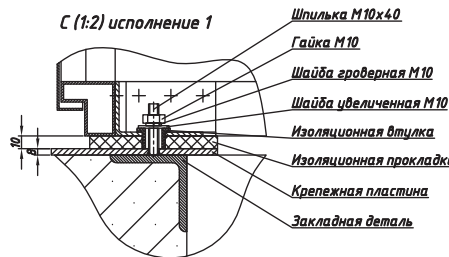
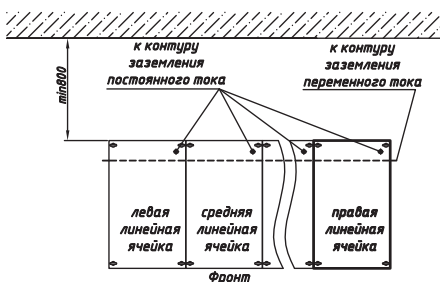
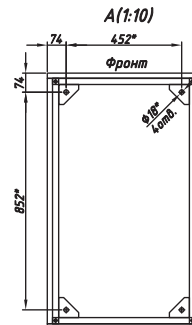
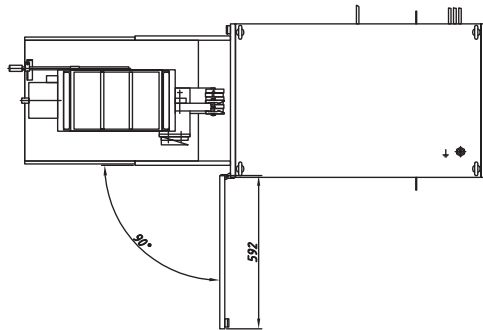
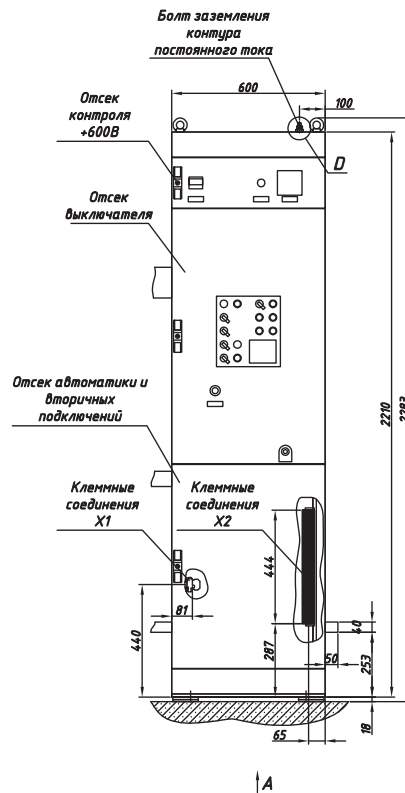
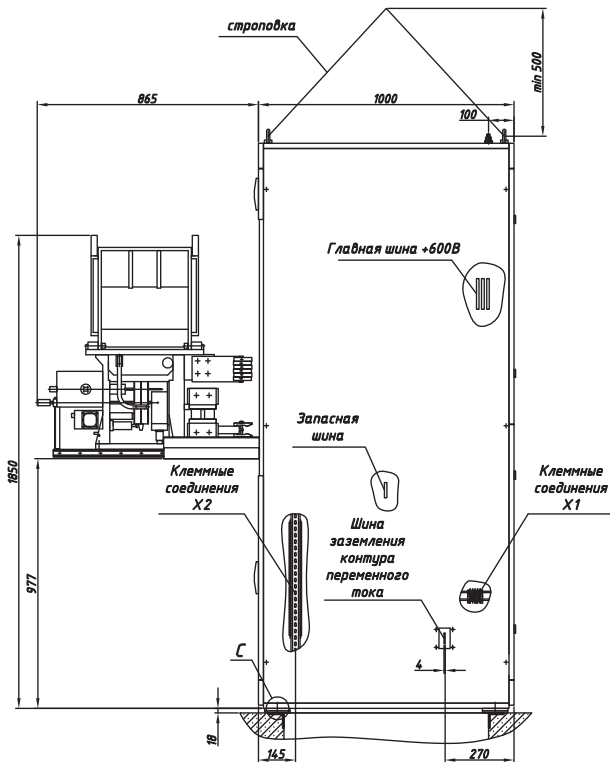
Outline, installation and overall dimensions of TSZPU-1600/10 GTUZ





Outline, installation and overall dimensions of KRU-600Z Optimum series switchgear

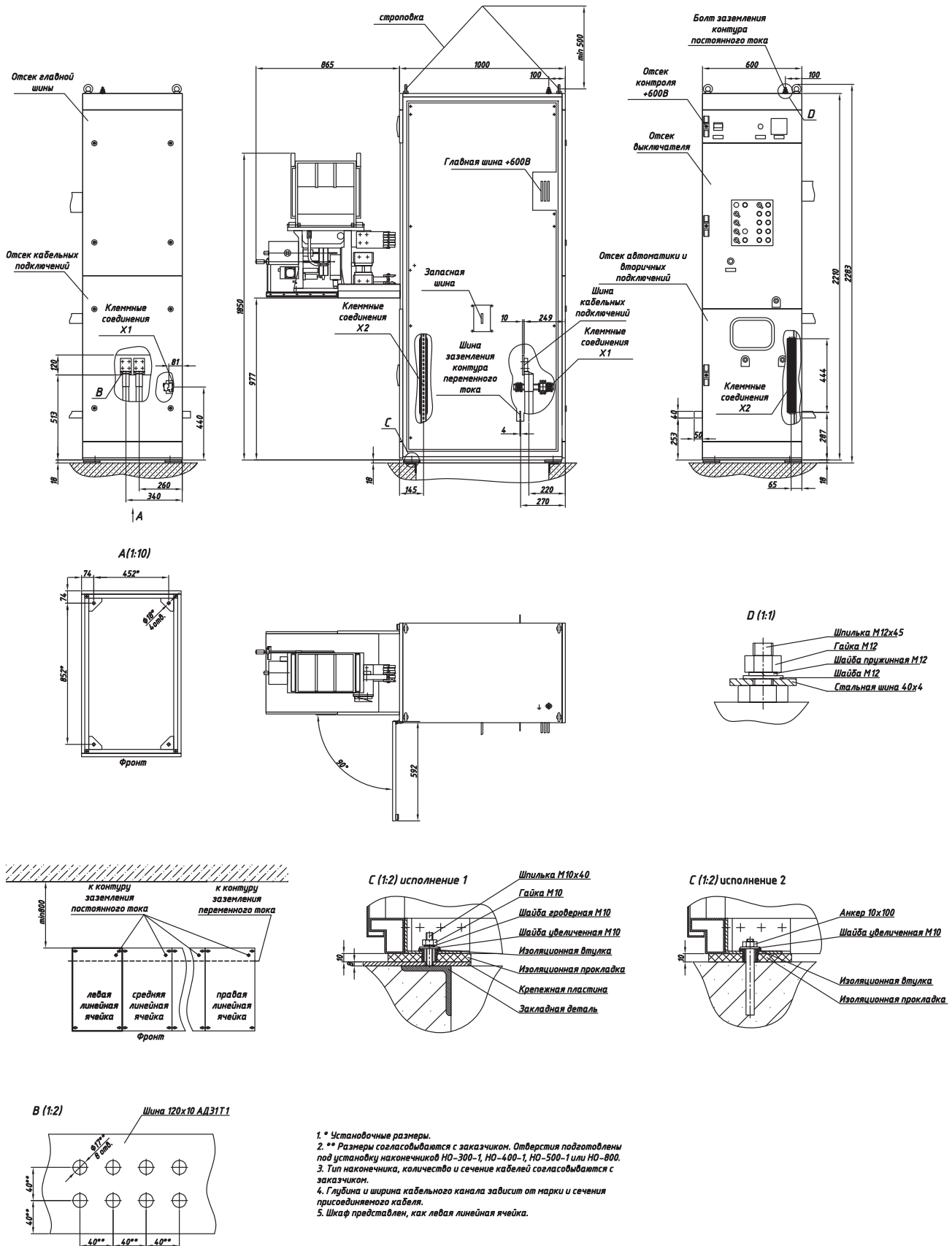
74



1. * Установочные размеры.
2. ** Размеры согласовываются с заказчиком. Отверстия подготовлены под установку наконечников НО-300-1, НО-400-1, НО-500-1 или НО-800.
3. Тип наконечника, количество и сечение кабелей согласовываются с заказчиком.
4. Глубина и ширина кабельного канала зависит от марки и сечения присоединяемого кабеля.
5. Шкаф представлен, как правая линейная ячейка.



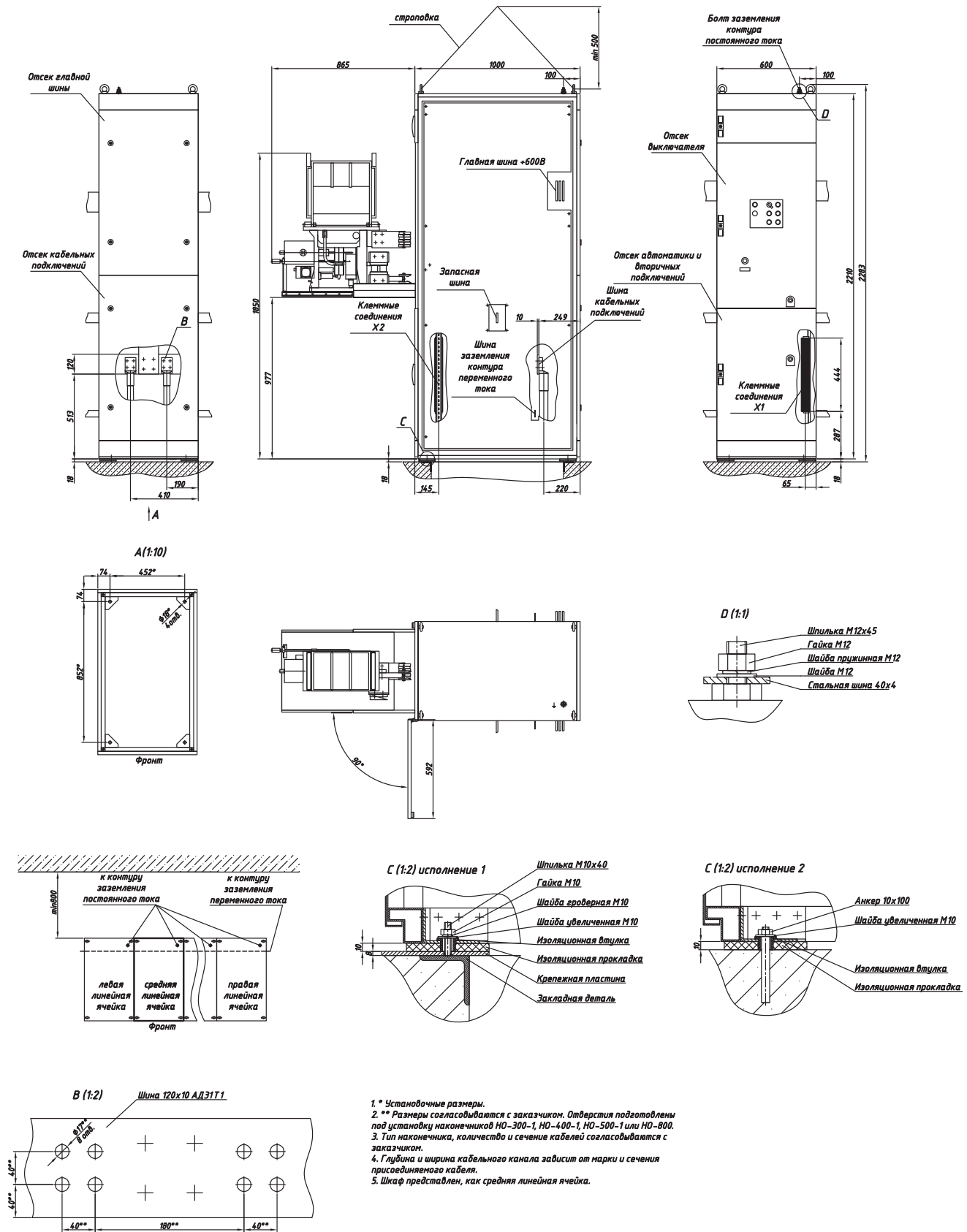
Outline, installation and overall dimensions of KRU-600L Optimum series switchgear





Outline, installation and overall dimensions of KRU-600K Optimum series switchgear

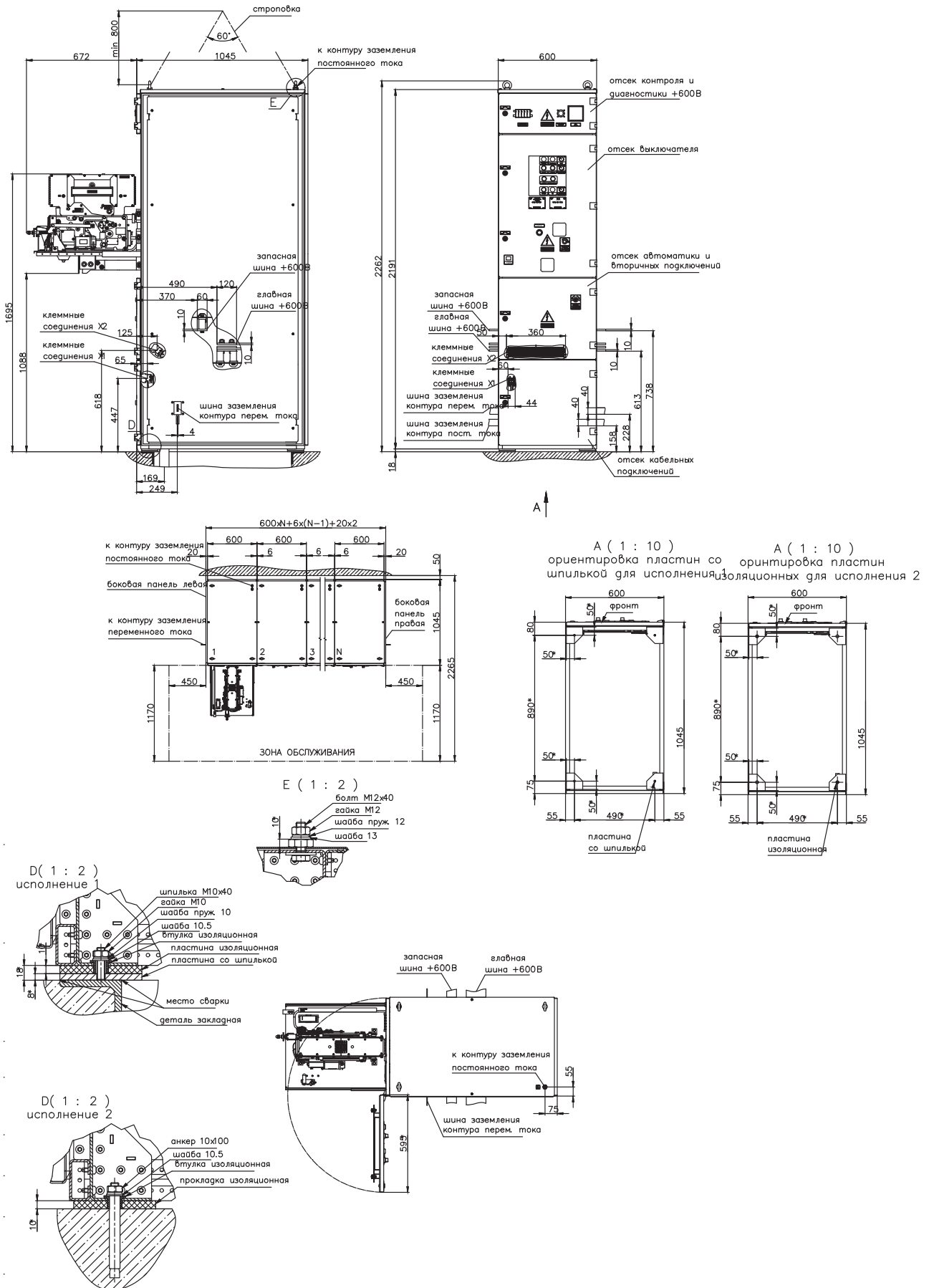
76



1. * Установочные размеры.
2. ** Размеры согласовываются с заказчиком. Отверстия подготовлены под установку наконечников НО-300-1, НО-400-1, НО-500-1 или НО-800.
3. Тип наконечника, количества и сечения кабелей согласовываются с заказчиком.
4. Глубина и ширина кабельного канала зависит от марки и сечения присоединяемого кабеля.
5. Шкаф представлен, как средняя линейная ячейка.



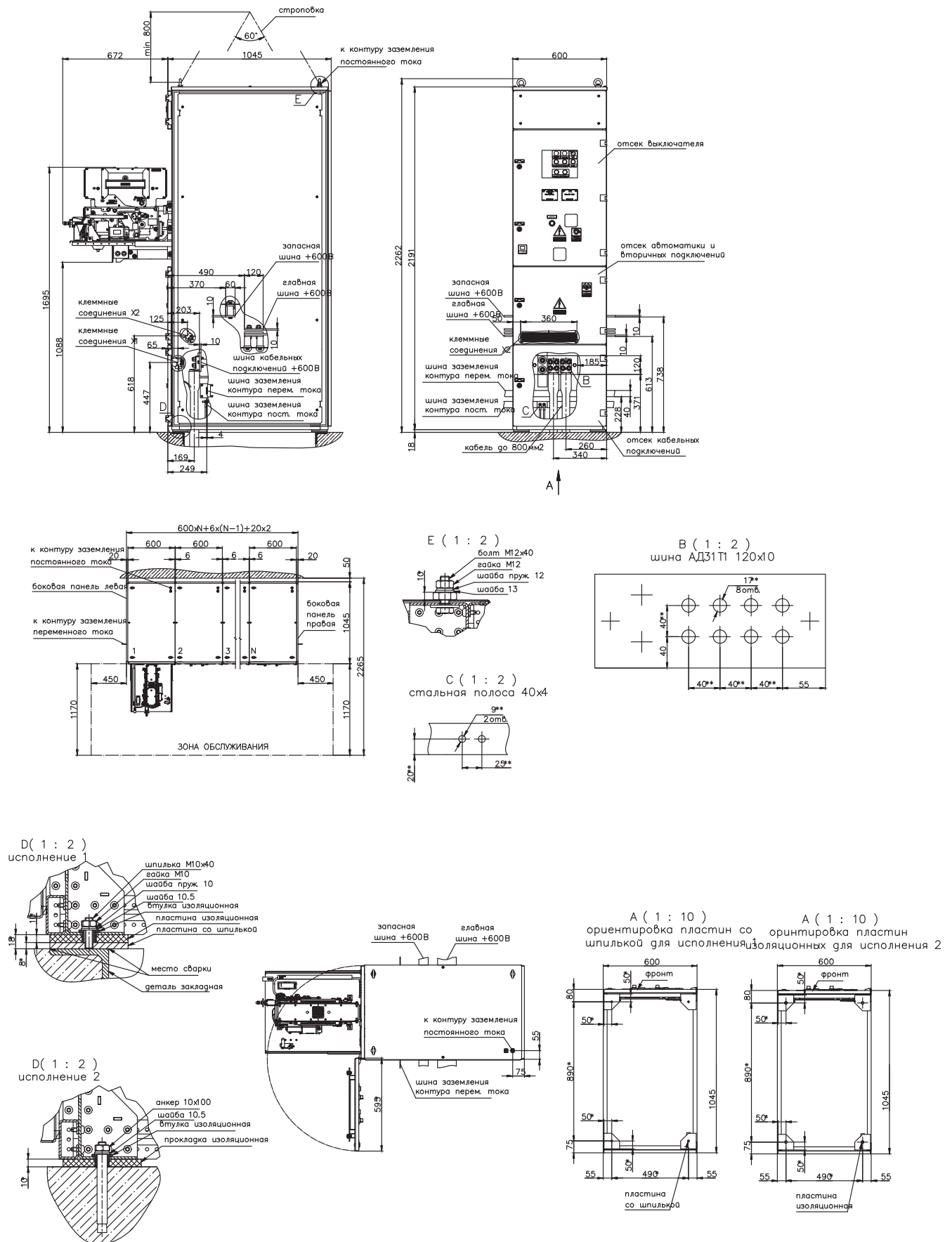
Outline, installation and overall dimensions of KRU-600Z Compact series switchgear





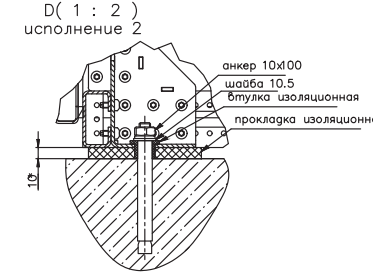
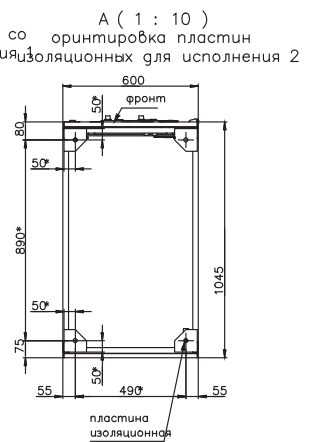
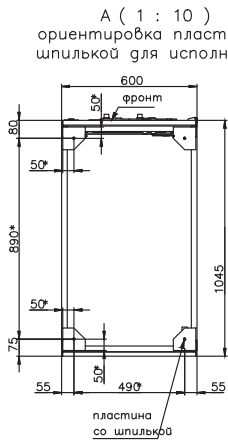
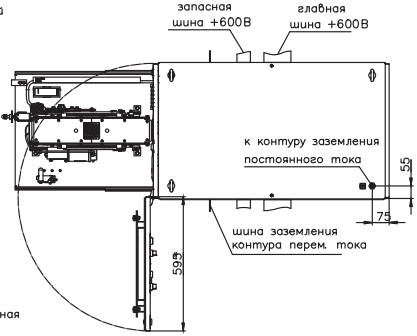
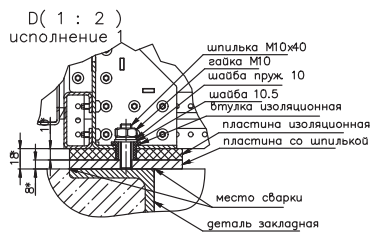
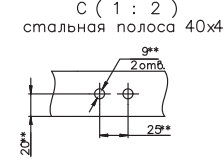
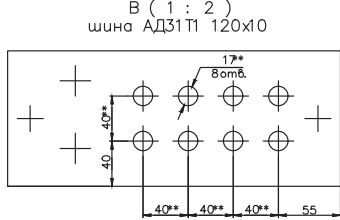
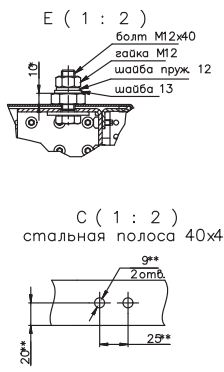
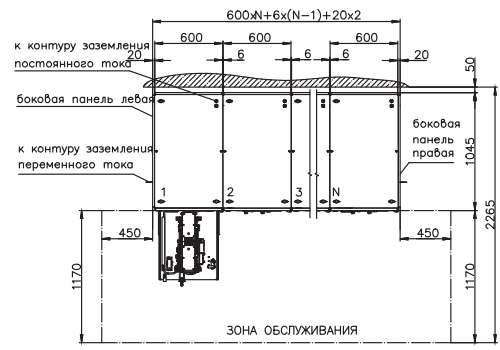
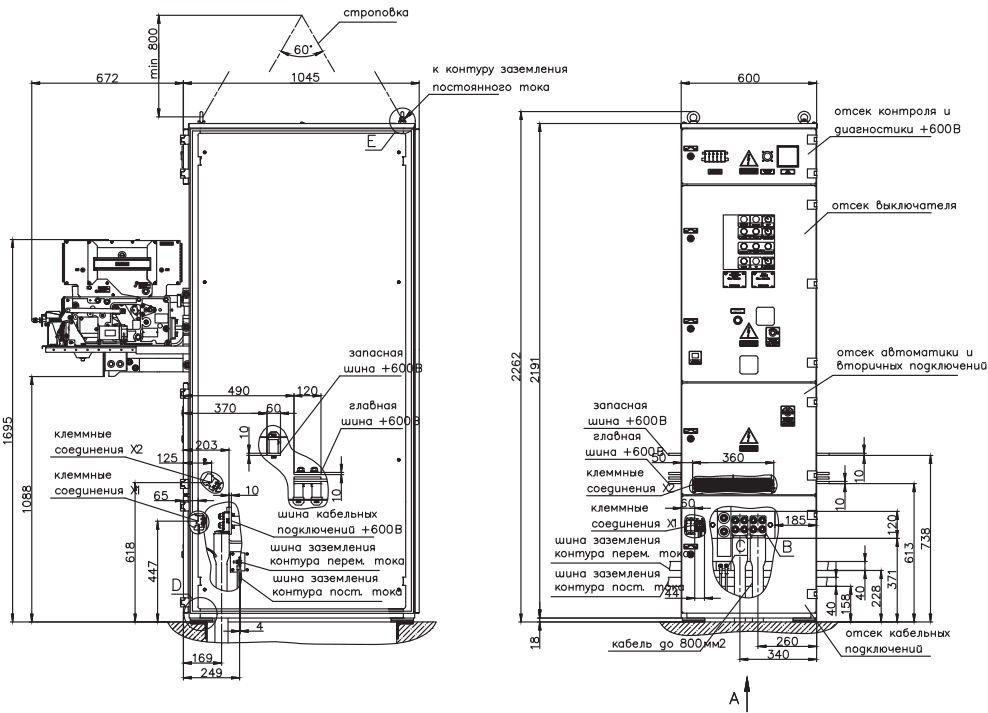
Outline, installation and overall dimensions of KRU-600K Compact series switchgear

78





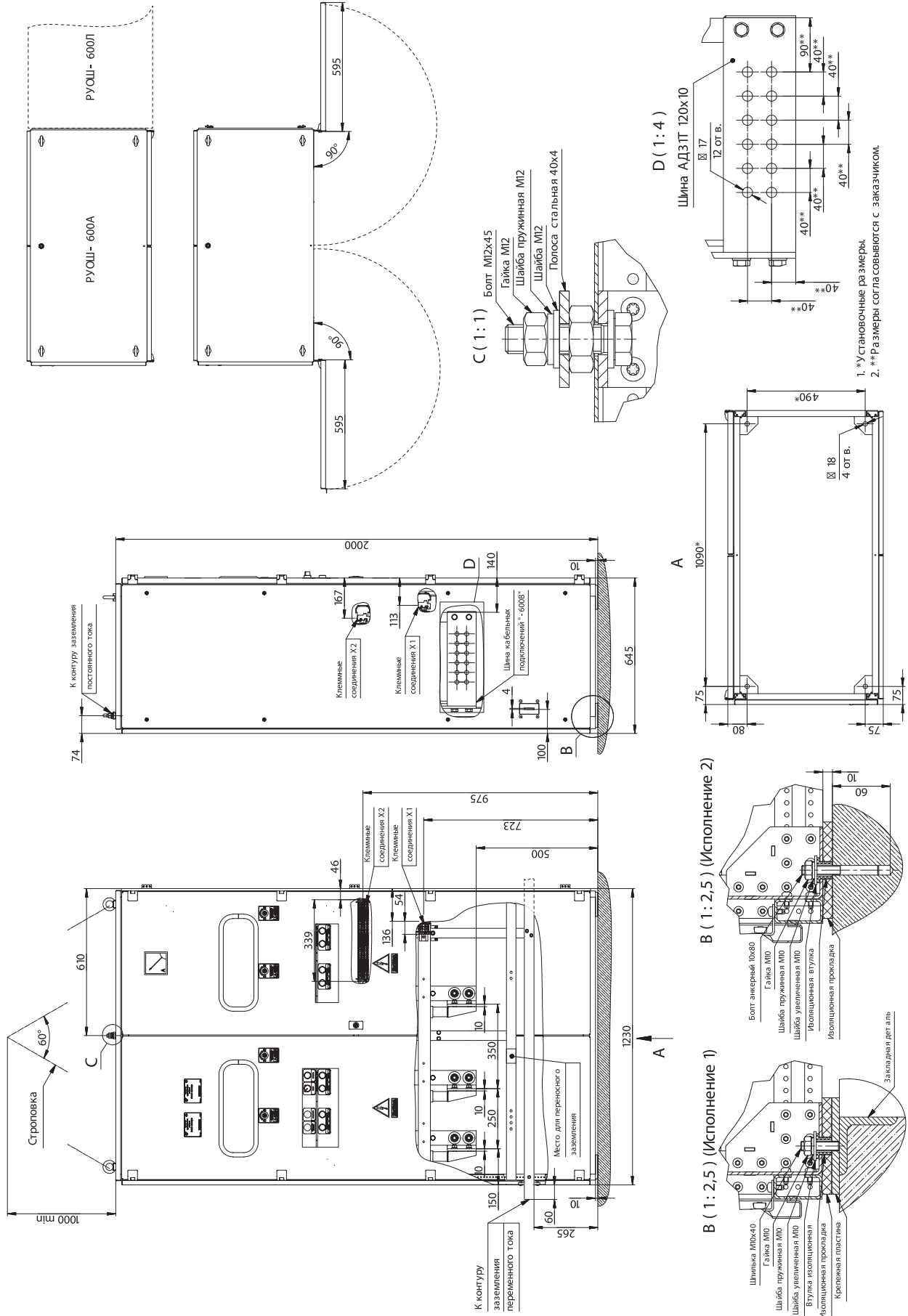
Outline, installation and overall dimensions of KRU-600L Compact series switchgear





Outline, installation and overall dimensions of RUOSh-600 (A3/1) cabinet

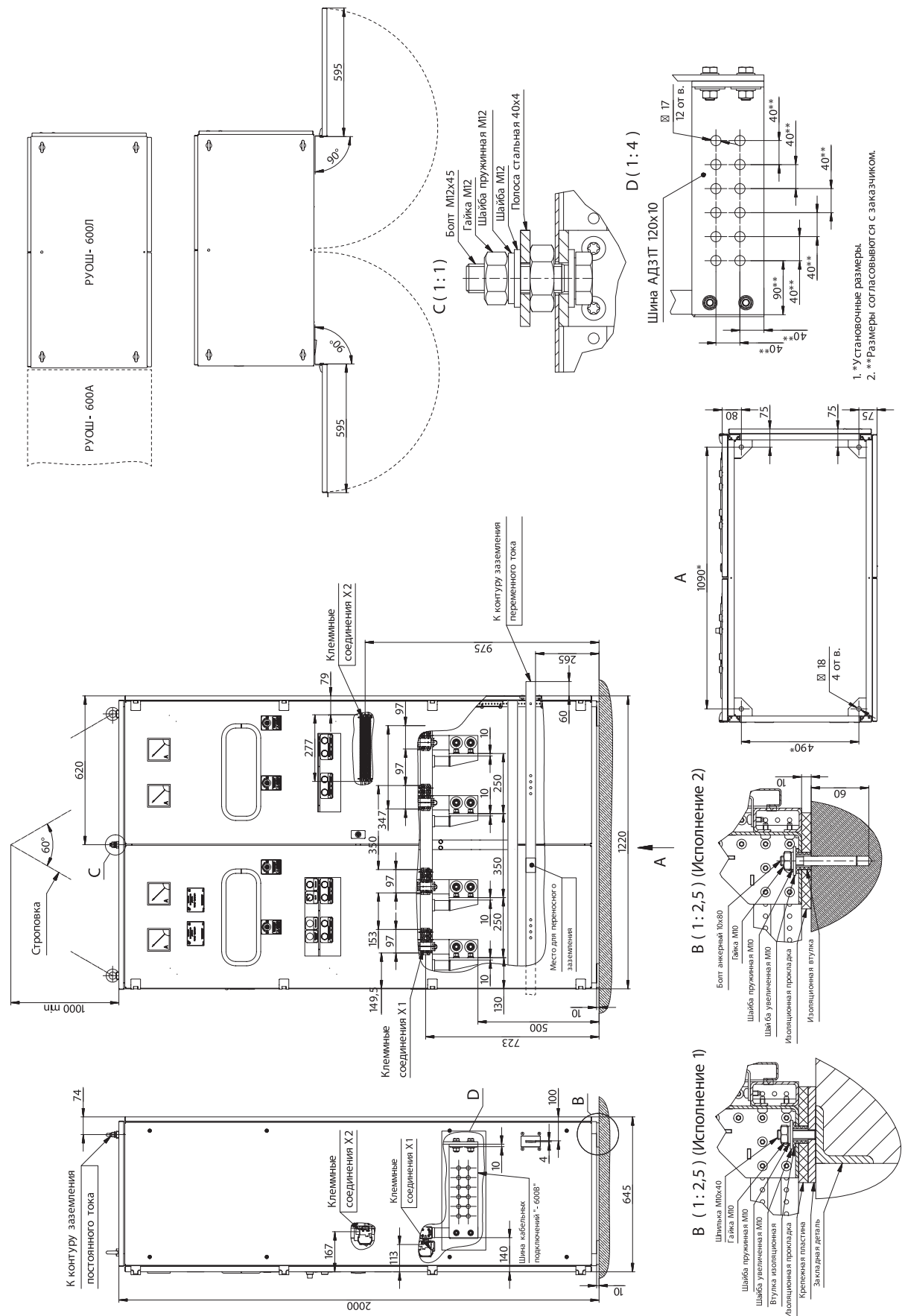
80



1. *Установочные размеры.
 2. **Размеры согласно заказчику.



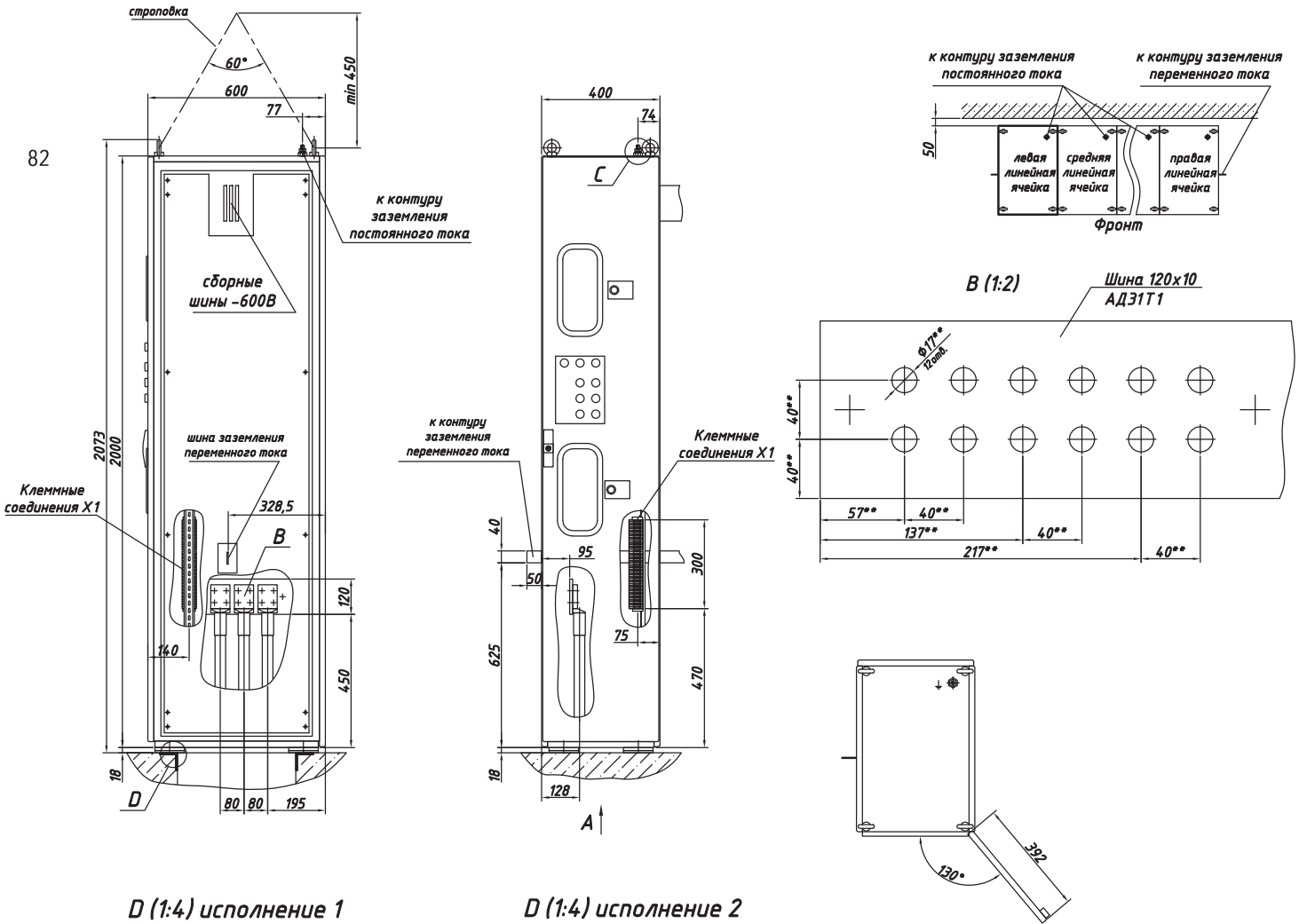
Outline, installation and overall dimensions of RUOSH-600 L4 cabinet



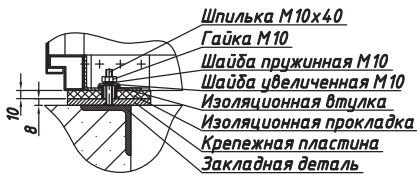
1. *Установочные размеры.
2. **Размеры согласовываются с заказчиком.



Outline, installation and overall dimensions of RUOSh-600A cabinet



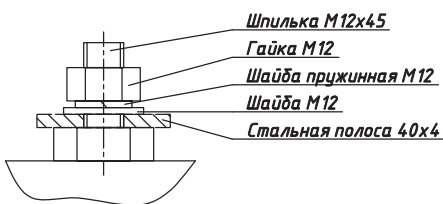
Д (1:4) исполнение 1



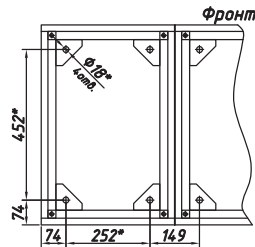
Д (1:4) исполнение 2



С (1:2)



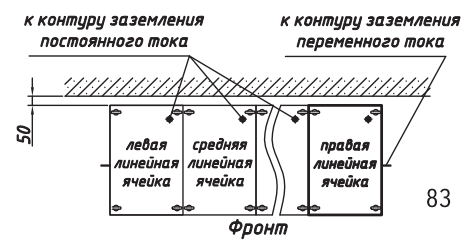
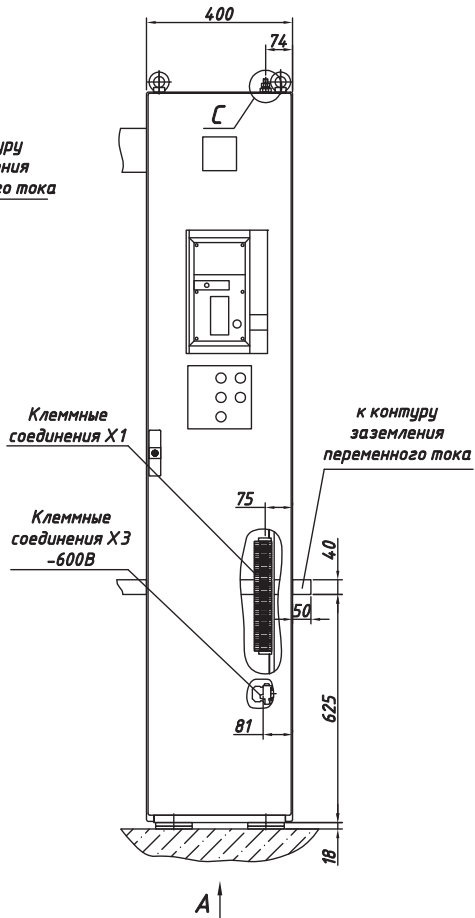
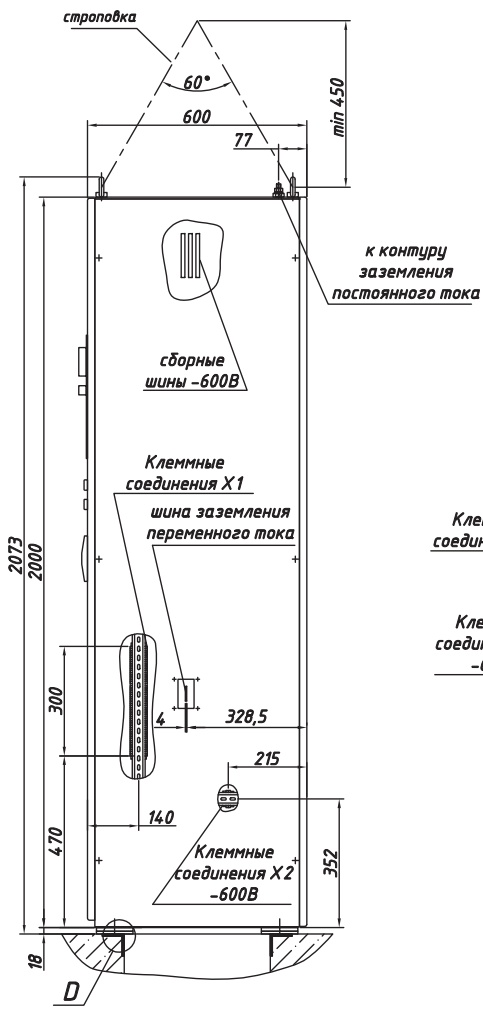
А (1:10)



1. * Установочные размеры.
2. ** Размеры согласовываются с заказчиком. Отверстия подготовлены под установку наконечников НО-300-1, НО-400-1, НО-500-1 или НО-800.
3. Тип наконечника, количество и сечение кабелей согласовываются с заказчиком.
4. Глубина и ширина кабельного канала зависит от марки и сечения присоединяемого кабеля.
5. Шкаф представлен, как левая линейная ячейка.



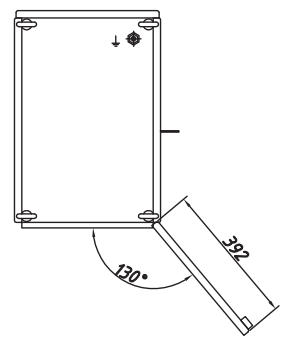
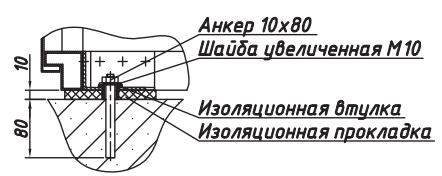
Outline, installation and overall dimensions of RUOSh-600Z cabinet



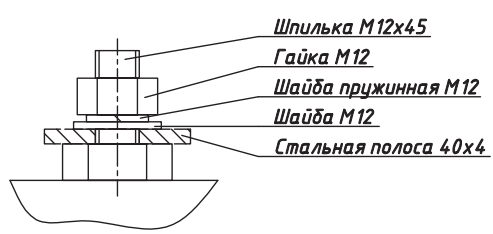
D (1:4) исполнение 1



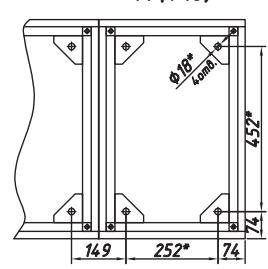
D (1:4) исполнение 2



C (1:2)



A (1:10)

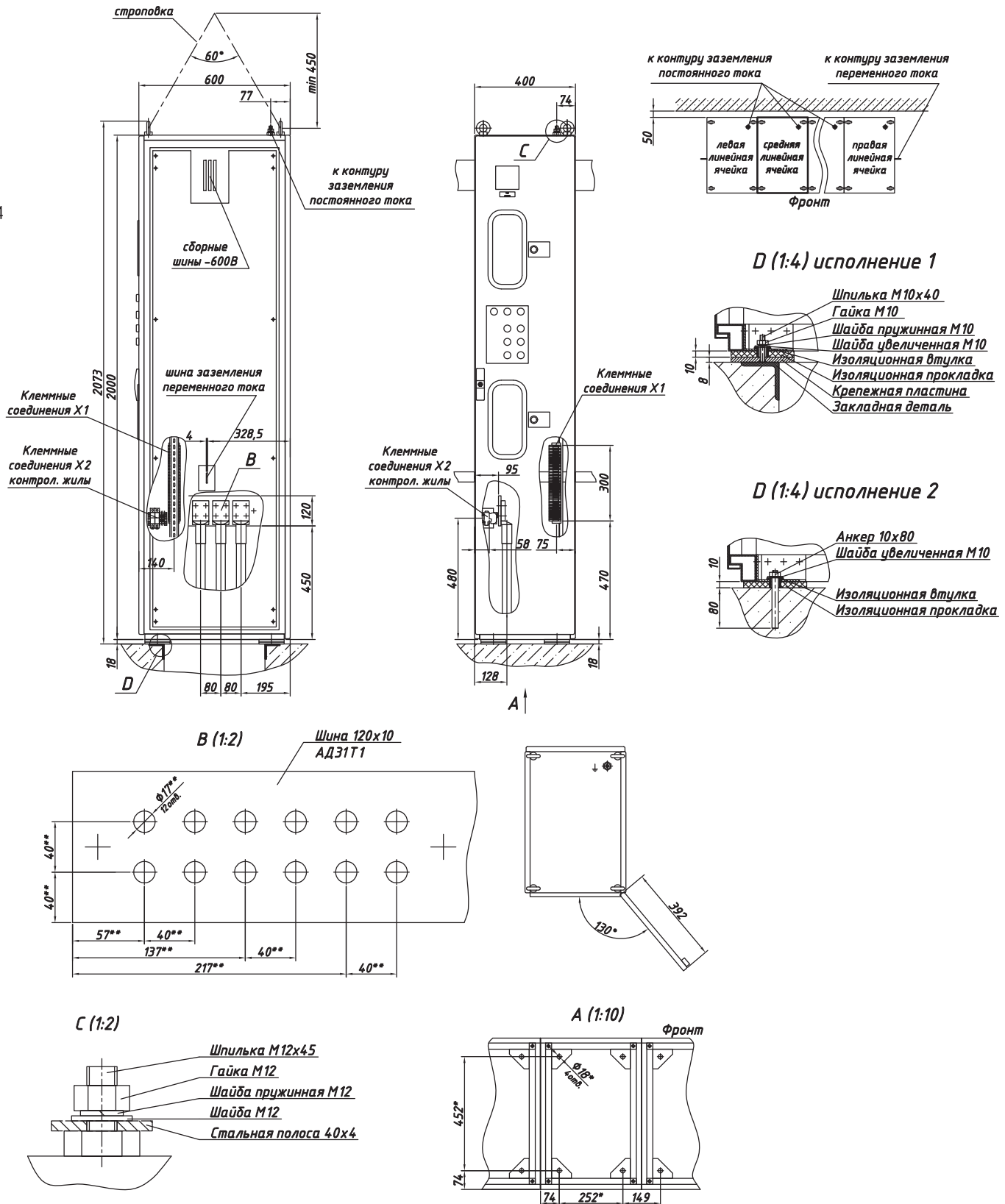


1. * Установочные размеры.
5. Шкаф представлен, как правая линейная ячейка.



Outline, installation and overall dimensions of RUOSh-600L cabinet

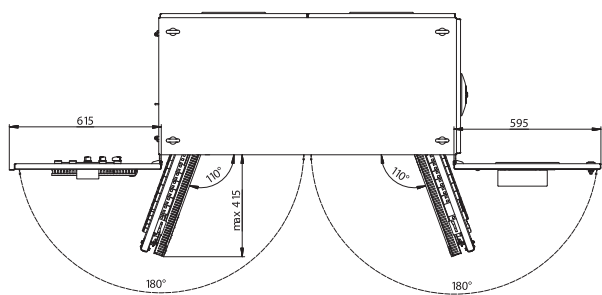
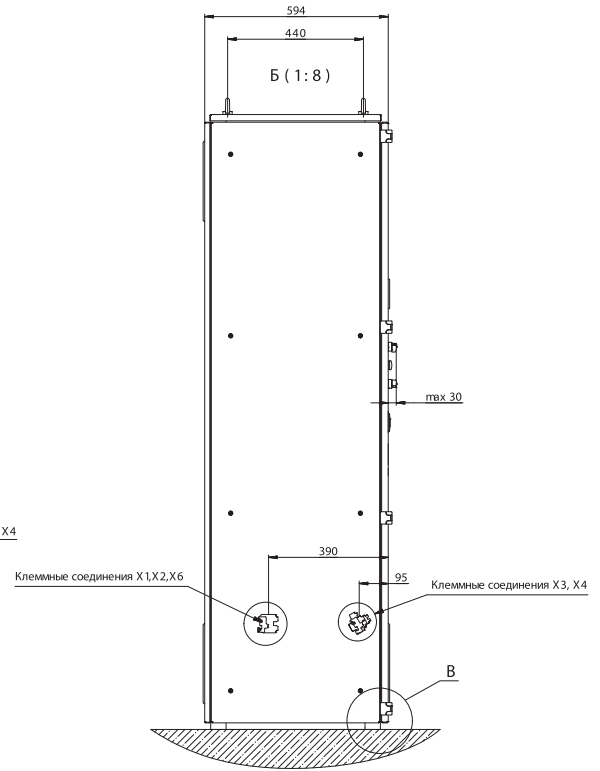
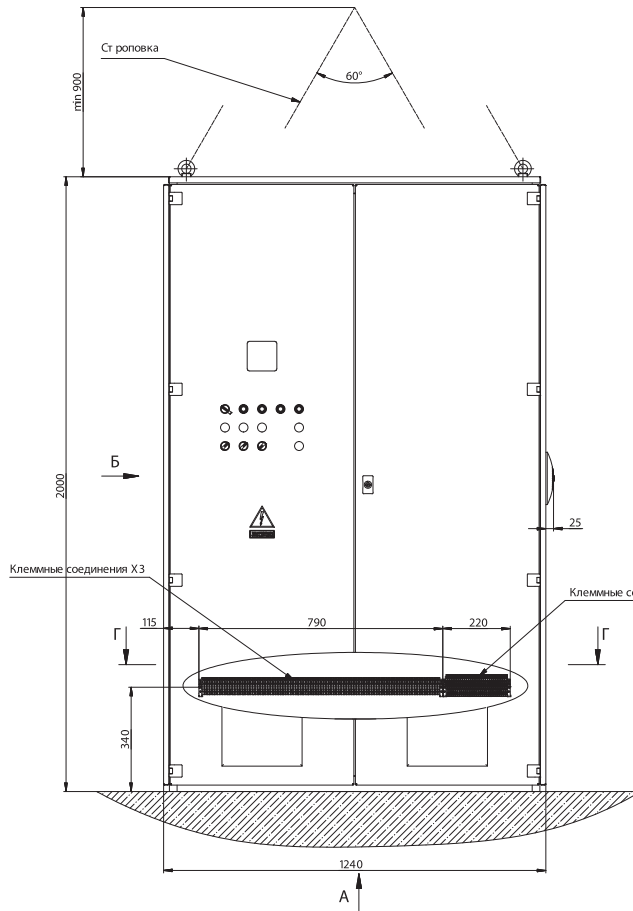
84



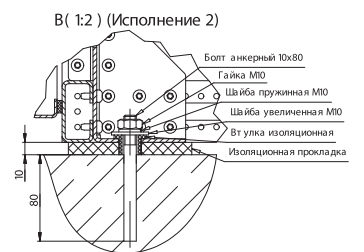
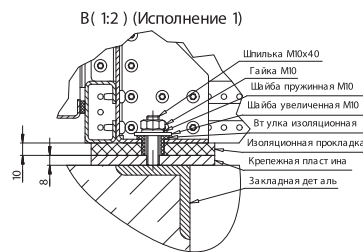
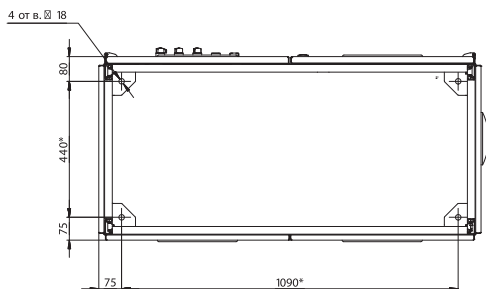
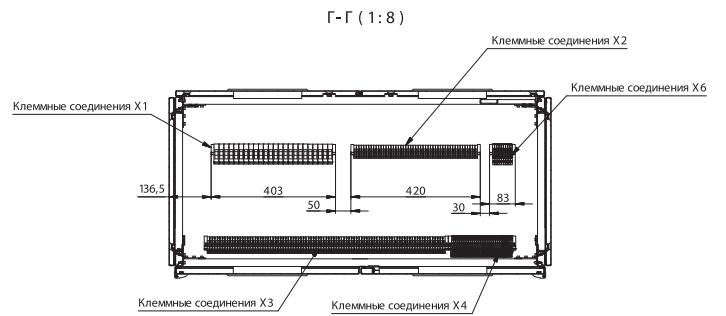
- 1 * Установочные размеры.
2. ** Размеры согласовываются с заказчиком. Отверстия подготовлены под установку наконечников НО-300-1, НО-400-1, НО-500-1 или НО-800.
3. Тип наконечника, количество и сечение кабелей согласовываются с заказчиком.
4. Глубина и ширина кабельного канала зависит от марки и сечения присоединяемого кабеля.
5. Шкаф представлен, как средняя линейная ячейка.



Outline and overall dimensions of ShSN auxiliaries cabinet



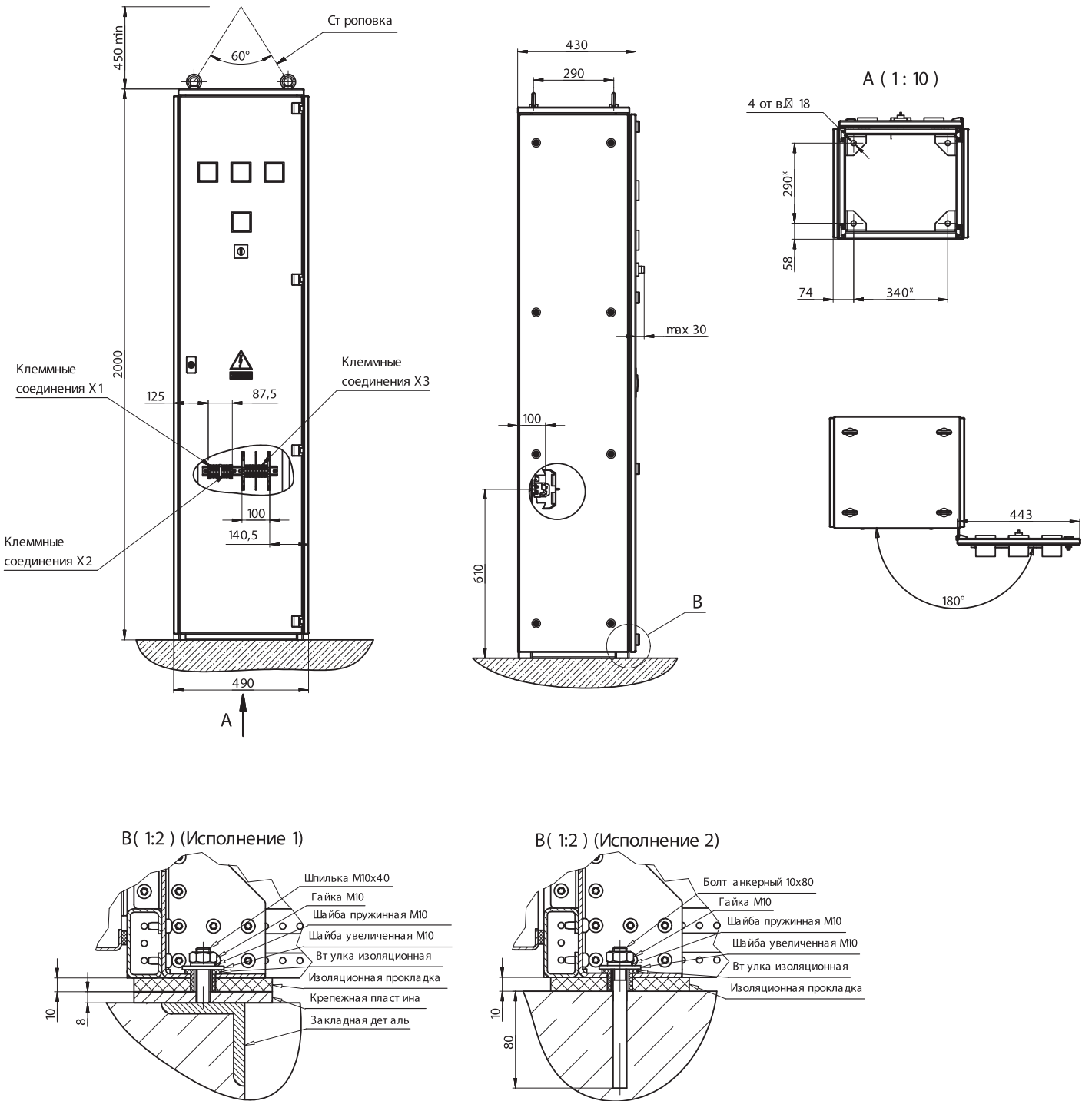
A (1:8)





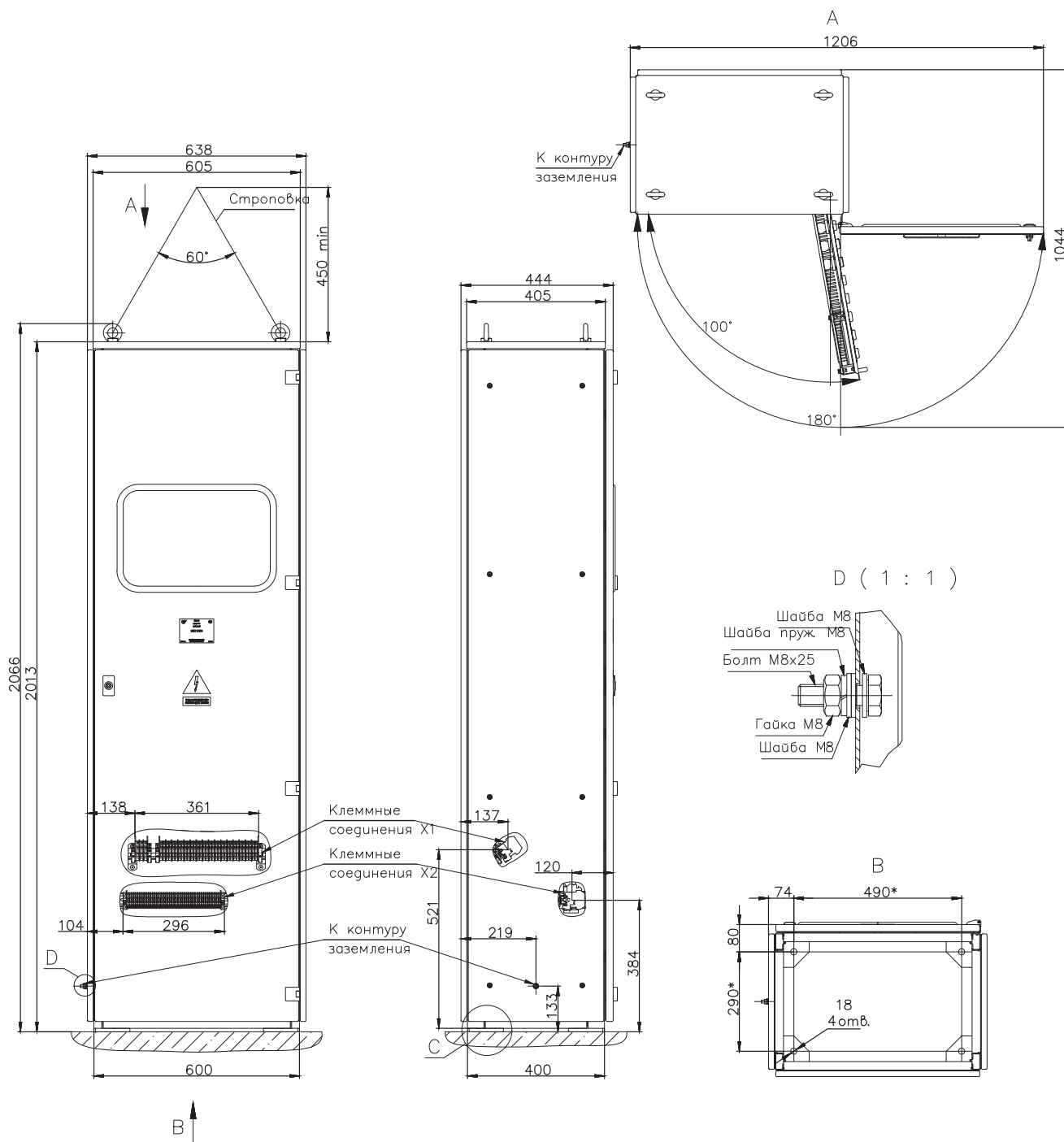
Outline, installation and overall dimensions of VRU 380/220 input switching device

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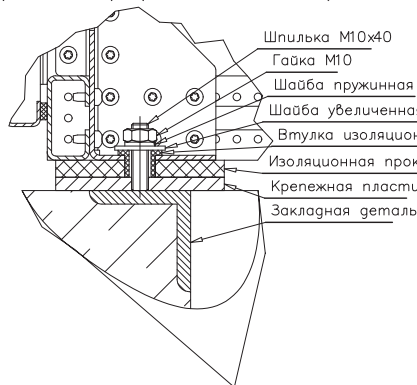




Outline, installation and overall dimensions of ShZK cable protection cabinet



C (1 : 2) (Исполнение 1)



C (1 : 2) (Исполнение 2)

