MOSELECTROSHIELD

Air Isolated
0.4-35 kV Busducts

MOSELECTRO

"MOSELECTRO" Group of Companies

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CATALOGUE

CONTENTS

Busducts

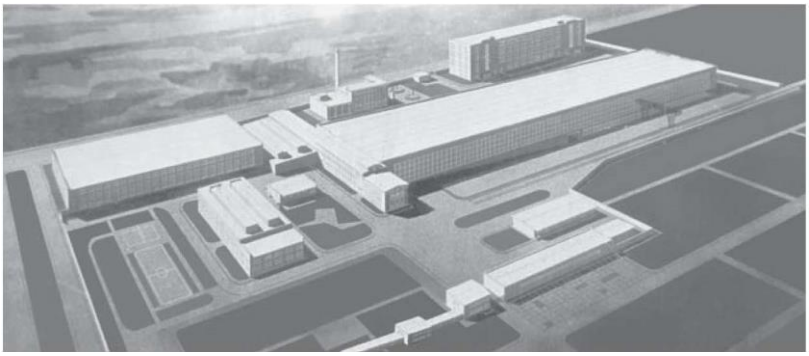


Fig. 1. "Electoshield" Moscow Plant (a panoramic view of the plant during the formation phase, 1960s)

INTRODUCTION

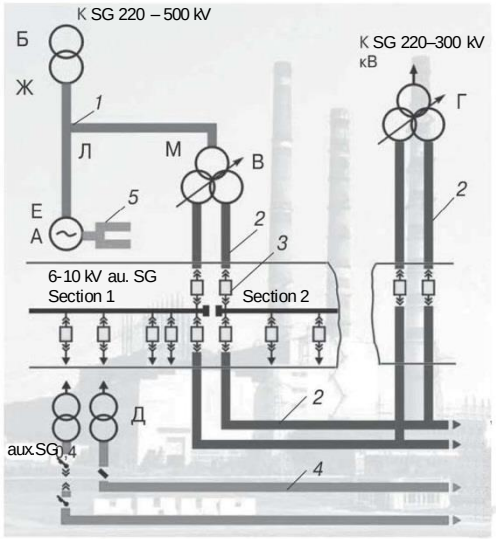
Our production has developed from switchboard equipment during early post-war years to complete 6 and 10 kV switchgears, generator voltage complete screened busducts and the extensive range of closed 0.4-10 kV busducts produced nowadays for different types of power plants (including nuclear plants), substations, industry, transport electrification, agriculture and other energy facilities.

Nowadays over 285,000 linear meters of our busducts are successfully operated in all Russian regions, CIS and several other countries.
Our products are certified, maintainable and intended for operation in different climatic conditions.

Busducts are delivered from the plant in operation ready assembly units (mounting blocks or sections), that allows faster installation and less effort.

The significant operational experience in the energy sector, application of advanced manufacturing equipment and qualified personnel provide potential to develop and produce high quality busducts of different purposes conforming modern technical requirements.

Our plant is currently ready to resolve the most complicated tasks to develop busducts (at customer's request).



- *1* - generator voltage busduct;
- *2* - 6 or 10 kV busducts;
- *3* - 6 or 10 kV switchgear and control gears (SCG);
- *4* - 0.4 kV busducts;
- *5* - 1.2 kV DC busducts (generator excitation circuit)

"Е" - "Ж" area – main busduct

"Л" - "М" area – branch busduct

Electrical equipment of power units

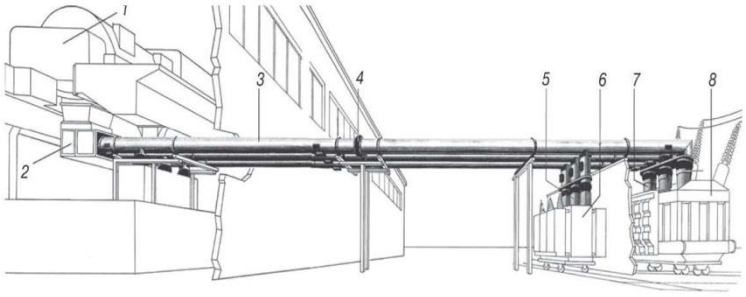
А – turbogenerator;
Б – step-up transformer;
В – auxiliary transformer (aux.);
Г – aux. standby transformer;
Д –10/0,4 kV voltage transformer.

Fig. 2. Heat and atomic power plants' 200-1500 MW power units' electrical connections diagrams

GENERATOR VOLTAGE COMPLETE PHASE-SCREENED 10, 20, 24, 35 kV BUSDUCTS OF ТЭНЕ AND ТЭНП TYPES

1.1. PURPOSE AND FIELD OF APPLICATION

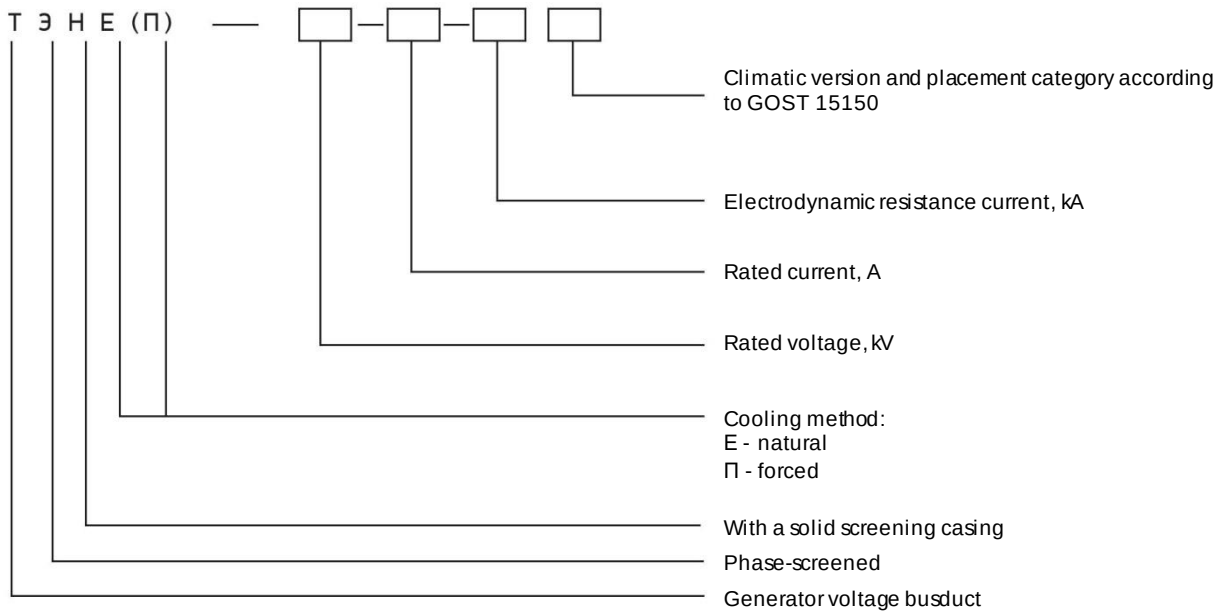
Generator voltage complete phase-screened 10, 20, 24, 35 kV busducts with the compensated external electromagnetic field of ТЭНЕ and ТЭНП series for rated currents varying from 1600 to 33000 A are intended for electrical connections at electric power stations, in 3-phase AC circuits with the frequency varying from 50 to 60 Hz of turbine generators with the power of up to 1500 MW with power step-up transformers, auxiliary power transformers, rectifier transformers and generator thyristor excitation transformers.



Generator voltage busducts may also be used for other power engineering, industrial, transport, agricultural facilities, etc.

Fig. 3. Afundamental version of the voltage generator busducts line at a power plant.
1 - turbogenerator; 2 – busduct connection unit to the generator, including generator's neutral unit; 3 – main busduct; 4 – thermal expansion absorber; 5 – branch busduct to aux. transformer; 6 – aux. transformer; 7 – busduct connection unit to the power step-up transformer; 8 – step-up transformer.

1.2. REFERENCE DESIGNATION STRUCTURE FOR GENERATOR VOLTAGE BUSDUCTS



Busducts

ТЭНЕ and ТЭНП busducts are produced according to the ТУ 3414-013-00110496-01 standard.
An example of the way generator voltage phase-screened busducts are written in orders and technical documents is given below:

Phase-screened generator voltage 20 kV busduct with natural cooling, 12500 A rated current, 400 kA electrodynamic resistance current, climatic version УХЛ, placement category 1:
"ТЭНЕ-20-12500-400 УХЛ1
ТУ 3414-013-00110496-01"

Phase-screened generator voltage 24 kV busduct with forced cooling, 23500 A rated current, 560 kA electrodynamic resistance current, climatic version Т, placement category 1:
"ТЭНП-24-23500-560 Т1
ТУ 3414-013-00110496-01"

1.3. MAIN TECHNICAL CHARACTERISTICS

Main technical characteristics of generator voltage busducts are given in the Table 1:

Table 1

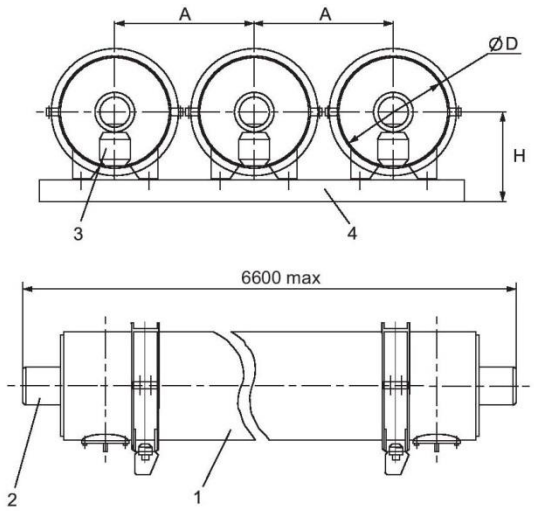
Parameter name / Busduct type	Rated voltage, kV	Rated current, A	Electrodynamic resistance current, kA	Thermal resistance current, kA, 3 sec	Rate phase loss at rated current, W/lm
ТЭНЕ-10-3150-128 УХЛ1	10	3150	128	51	219
ТЭНЕ-10-3150-250 УХЛ1	10	3150	250	100	155
ТЭНЕ-10-4000-250 УХЛ1 ТЭНЕ-10-4000-250 Т1	10	4000	250	100	259 232
ТЭНЕ-10-5000-250 УХЛ1 ТЭНЕ-10-5000-250 Т1	10	5000	250	100	355 302
ТЭНЕ-10-5500-250 УХЛ1	10	5500	250	100	378
ТЭНЕ-10-6000-250 УХЛ1	10	6000	250	100	408
ТЭНЕ-10-6300-250 УХЛ1	10	6300	250	100	448
ТЭНЕ-20-1600-560 УХЛ1, Т1	20	1600	560	220	39
ТЭНЕ-20-1800-560 УХЛ1	20	1800	560	220	49
ТЭНЕ-20-2000-560 УХЛ1	20	2000	560	220	61
ТЭНЕ-20-2500-560 УХЛ1	20	2500	560	220	96
ТЭНЕ-20-2500-900 УХЛ1 ТЭНЕ-20-2500-900 Т1	20	2500	900	360	96
ТЭНЕ-20-5000-300 УХЛ1	20	5000	300	120	331
ТЭНЕ-20-5500-300 УХЛ1	20	5500	300	120	372
ТЭНЕ-20-6300-300 УХЛ1 ТЭНЕ-20-6300-300 Т1	20	6300	300	120	397 355
ТЭНЕ-20-7200-300 УХЛ1	20	7200	300	120	524
ТЭНЕ-20-8000-300 УХЛ1 ТЭНЕ-20-8000-300 Т1	20	8000	300	120	547 404
ТЭНЕ-20-9000-300 УХЛ1	20	9000	300	120	519
ТЭНЕ-20-10000-300 УХЛ1	20	10000	300	120	644
ТЭНЕ-20-11250-400 УХЛ1 ТЭНЕ-20-11250-400 Т1	20	11250	400	160	709 638
ТЭНЕ-20-12500-400 УХЛ1 ТЭНЕ-20-12500-400 Т1	20	12500	400	160	883 671
ТЭНЕ-20-15000-560 УХЛ1 ТЭНЕ-20-15000-560 Т1	20	15000	560	220	792
ТЭНЕ-24-2000-750 УХЛ1	24	2000	750	300	47
ТЭНЕ-24-3150-750 УХЛ1 ТЭНЕ-24-3150-750 Т1	24	3150	750	300	98 106
ТЭНЕ-24-3150-900 УХЛ1 ТЭНЕ-24-3150-900 Т1	24	3150	900	300	98 106
ТЭНЕ-24-10000-560 УХЛ1	24	10000	560	220	645
ТЭНЕ-24-15000-560 УХЛ1	24	15000	560	220	792
ТЭНЕ-24-16000-560 УХЛ1	24	16000	560	220	911

Table 1 continued

Parameter name / Busduct type	Rated voltage, kV	Rated current, A	Electrodynamic resistance current, kA	Thermal resistance current, kA, 3 sec	Rate phase loss at rated current, W/lm
ТЭНЕ-24-18000-560 УХЛ1	24	18000	560	220	1160
ТЭНЕ-24-18700-560 Т1	24	18700	560	220	860
ТЭНЕ-24-20000-560 УХЛ1	24	20000	560	220	1230
ТЭНЕ-24-22000-560 УХЛ1	24	22000	560	220	1460
ТЭНЕ-24-24000-560 УХЛ1	24	24000	560	220	1480
ТЭНП-24-18700-560Т1	24	18700	560	220	1075
ТЭНП-24-23500-560Т1	24	23500	560	220	1698
ТЭНП-24-24000-560УХЛ1	24	24000	560	220	1854
ТЭНП-24-29500-560Т1	24	29500	560	220	2676
ТЭНП-24-31500-560УХЛ1	24	31500	560	220	3194
ТЭНП-24-33000-600УХЛ1	24	33000	600	240	3505
ТЭНП-27-30000-560Т1	27	30000	560	220	2312
ТЭНЕ-35-1000-560УХЛ1	35	1600	560	220	15,2
ТЭНЕ-35-1650-81 УХЛ1	35	1650	81	31,5	41,9
ТЭНЕ-35-5000-560УХЛ1	35	5000	560	220	307
ТЭНЕ-35-5000-300Т1	35	5000	300	120	247

NOTE. ТЭНЕ-10 busducts may be applied at power plants from supply voltage transformers to entries of SCG cabinets at rated current up to 3150 A.

1.4. BUSDUCT DESIGN



ТЭНЕ-10 busducts are of a phase-screened version. Each busduct phase consists of a current-carrying busbar 2 of relevant section, screening casing 1 and insulators 3 (Fig. 4).

The busbar is fixed on an insulator by a special busbar-holder. Isolators are fixed to covers, which are in their turn bolted to the screening casing. The spacing between isolators should be 3 m at most.

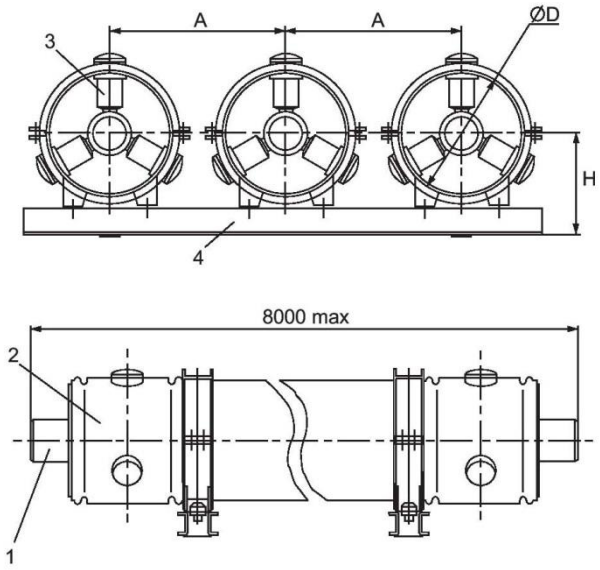
Fig. 4. ТЭНЕ 10 kV voltage busducts.
Rectilinear block.
1 – screening casing; 2 – current-carrying busbar; 3 - insulator;
4 – block bar.

a) 10 kV ТЭНЕ-10

Table 2 (to Fig.4)

Busduct type	Screen diameter (outer), D, mm	Phase axes distance, A, mm	Axis – busbar bottom distance, H, mm	Weight (single phase), kg/ lm
ТЭНЕ-10-3150-128УХЛ1	408	500	330	32
ТЭНЕ-10-3150-250УХЛ1	408	500	330	39
ТЭНЕ-10-4000-250УХЛ1 ТЭНЕ-10-4000-250Т1	408	500	330	39 41
ТЭНЕ-10-5000-250УХЛ1 ТЭНЕ-10-5000-250Т1	408 550	500 1000	330 483	46 65
ТЭНЕ-10-5500-250УХЛ1	550	1000	483	65
ТЭНЕ-10-6000-250УХЛ1	550	1000	483	69
ТЭНЕ-10-6300-250УХЛ1	550	900	475	69

b) 20, 24, 35 kV ТЭНЕ and ТЭНП



Each busduct phase consists of an aluminum busbar 1 and an aluminum cylindrical screening casing 2. The busbar is aligned and fixed on the casing screen by three insulators 3 arranged at 120° (Fig. 5).

Busbars in screens are aligned by turning insulators in threaded bushes of screens.

Fig. 5. 20, 24, 35 kV voltage ТЭНЕ and ТЭНП busducts. Rectilinear block*.
1 - current-carrying busbar; 2 - screening casing; 3 - insulator; 4 - block bar.
*** - according to transportation needs separate mounting blocks may be delivered in phases (in sections).**

Table 3 (to Fig. 5)

Busduct type	Screen diameter (outer), D, mm	Phase axes distance, A, mm	Axis – busbar bottom distance, H, mm	Weight (single phase), kg/ lm
ТЭНЕ-20-1600-560 УХЛ1, Т1	550	1000	483	60
ТЭНЕ-20-1800-560 УХЛ1	550	1000	483	60
ТЭНЕ-20-2000-560 УХЛ1	550	1000	483	60
ТЭНЕ-20-2500-560 УХЛ1	550	1000	483	60
ТЭНЕ-20-2500-900 УХЛ1 ТЭНЕ-20-2500-900 Т1	550	1000	483	70
ТЭНЕ-20-5000-300 УХЛ1	550	1000	483	65
ТЭНЕ-20-5500-300 УХЛ1	550	1000	483	68
ТЭНЕ-20-6300-300 УХЛ1 ТЭНЕ-20-6300-300 Т1	678	1000-1200	563	83 90
ТЭНЕ-20-7200-300 УХЛ1	678	1000-1200	563	83
ТЭНЕ-20-8000-300 УХЛ1 ТЭНЕ-20-8000-300 Т1	678 750	1000-1200	563 583	89 98
ТЭНЕ-20-9000-560 УХЛ1	750	1000-1200	583	98
ТЭНЕ-20-10000-300 УХЛ1	750	1000-1200	583	98
ТЭНЕ-20-11250-400 УХЛ1 ТЭНЕ-20-11250-400 Т1	890	1300-3000	668	100 107
ТЭНЕ-20-12500-400 УХЛ1 ТЭНЕ-20-12500-400 Т1	890	1300-3000	668	100 125
ТЭНЕ-20-15000-560 УХЛ1	1172	1500-3000	858	193
ТЭНЕ-24-3150-750 УХЛ1, Т1	678	1000-1200	563	80
ТЭНЕ-24-3150-900 УХЛ1 ТЭНЕ-24-3150-900 Т1	678	1000-1200	563	90
ТЭНЕ-24-10000-560 УХЛ1	750	1000-1200	583	98
ТЭНЕ-24-15000-560 УХЛ1	1172	1500-3000	858	193
ТЭНЕ-24-16000-560 УХЛ1	1172	1500-3000	858	193
ТЭНЕ-24-18000-560 УХЛ1	1172	1500-3000	858	193

Table 3 continued

Busduct type	Screen diameter (outer), D, mm	Phase axes distance, A, mm	Axis – busbar bottom distance, H, mm	Weight (single phase), kg/ lm
ТЭНЕ-24-18700-560 Т1	1362	1800	968	250
ТЭНЕ-24-20000-560 УХЛ1	1172	1500-3000	858	220
ТЭНЕ-24-22000-560 УХЛ1	1362	1800	968	217
ТЭНЕ-24-24000-560 УХЛ1	1362	1800	968	250
ТЭНП-24-18700-560 Т1	1172	1500-3000	858	220
ТЭНП-24-23500-560 Т1	1172	1500-3000	858	220
ТЭНП-24-24000-560 УХЛ1	1172	1500-3000	858	220
ТЭНП-24-29500-560 Т1	1172	1500-3000	858	220
ТЭНП-24-31500-560 УХЛ1	1172	1500-3000	858	220
ТЭНП-24-33000-600 УХЛ1	1172	1500-3000	858	220
ТЭНП-27-30000-560 Т1	1362	1800	968	250
ТЭНЕ-35-1000-560 УХЛ1	750	1000-1200	583	86
ТЭНЕ-35-1650-81 УХЛ1	750	1000-1200	583	76
ТЭНЕ-35-5000-560 УХЛ1	800	1000-1200	593	73
ТЭНЕ-35-5000-300 Т1	800	1000-1200	593	78

Fig. 6. A view of ТЭНЕ-20-10000-300УХЛ1 busduct's phase, busbar diameter – 280 mm, casing diameter - 750 mm.

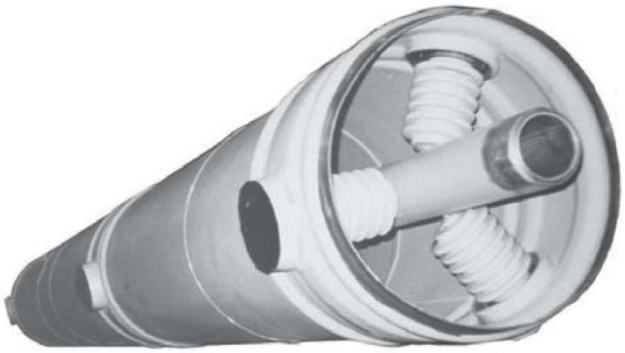


Fig.7. A view of a rectilinear section (phase) of branch busduct ТЭНЕ-20-1600-560 УХЛ 1.

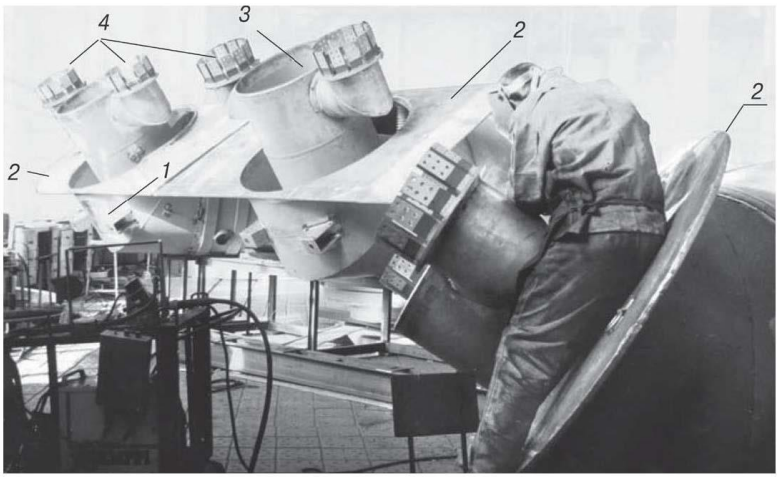
Fig.8. A view of a shaped section (phase) of branch busduct ТЭНЕ-20-1600-560 УХЛ 1.

1.5. COMPOSITION AND STRUCTURE OF BUSDUCTS. MAIN DESIGN FEATURES PROVIDING HIGH-RELIABILITY OPERATION

Depending on the line's configuration and built-in equipment a generator voltage busduct may consist of:

- Rectilinear blocks (sections) (Fig. 4, 5, 6, 7);
- Shaped sections (Fig. 8); with current transformers; with voltage transformers; with a groundwire; with a discharger; with excess-voltage suppressors; with a feedthrough insulator;
- Units for connection to line terminals of a turbogenerator;
- blocks for generator's neutral terminals (Fig. 9);
- blocks for connection to a power transformer (Fig. 10);
- units for end-to-end connection of sections; and connecting sections to a absorber; and
- blocks for mounting a switch (Fig.11) and other elements.

Fig.9. A view of a mounting block for generator's neutral terminals. A design option.



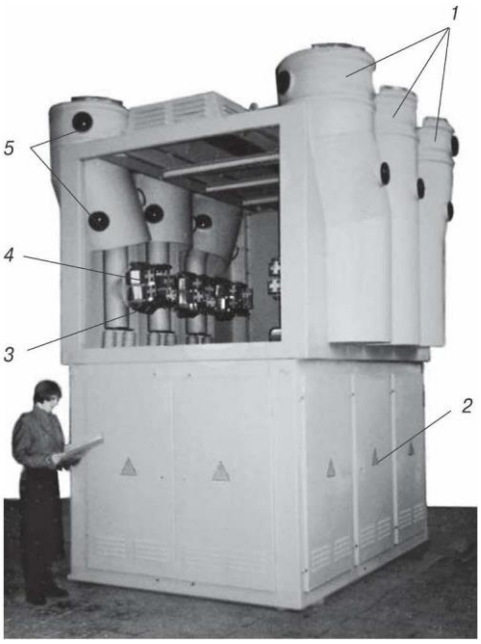


Fig.10. A busduct connection block to a power transformer. 1 – screening casing; 2 – bridge panel of screens; 3 – current-carrying busbar; 4 – contact junctions.
Fig.11. A view of the block for mounting a three-pole switch. 1 – busduct screening casing; 2 – panel for switch mounting; 3 – current-carrying busbar; 4 – flexible connection for bolting busbars to the switch; 5 – insulators for holdings of current-carrying busbars.

MAIN DESIGN FEATURES PROVIDING HIGH-RELIABILITY OPERATION OF BUSDUCTS

- Since busducts of the indicated series are mounted in lines of the generator voltage in "Е" - "Ж" и "Л" - "М" areas (Fig.2) and intended for transition and distribution of high voltage electric power, their execution conforms to the highest reliability requirements;
- Busducts are produced in a closed and isolated-phase arrangement. It allows avoiding inter-phase short circuits, ingress of foreign objects, and access of the personnel to current-carrying units of busducts;
- Busducts are all-welded along the whole line, except for dismountable connection units to turbogenerators, transformers, and switches;
- Busducts are electrodynamically resistant;
- The outer magnetic field of a busduct is compensated. It is due to connecting screening casings with bridges and grounding of corresponding line areas;
- Dismountable electric contacts of heavy-current cylindrical aluminum busbars with flat copper terminals of the electric equipment are connected by high-reliability contacts;
- A linear expansion absorber is mounted on busbars and busduct screening casings to compensate linear changes caused by temperature drops;
- Busduct include polymer bearing insulators resistant to dewfall and hoarfrost. If required fixing units provide easy replacement of insulators without dismounting screens;
- Capacitive discharges (sparking) are avoided in the busduct screen's cavity. The installation of special rod spring contacts (Fig. 6) is provided between busbars and upper insulators, and in case of vertical lining – on all insulators;
- Busducts are dust-protected, IP 54 (55) according to GOST 14254-96;
- The busduct design provides measures to remove hydrogen from screens' cavity in case of its leakage due to the looseness of generator's terminals' fixings;
- Screening casings are fixed to transversal beams in a dismountable and isolated way to avoid circulation of induced current;
- Measuring of the resistance in busduct bearing blocks (between screens and transversal beams) is provided without dismounting of fixing units;
- The block beams are fixed to construction structure by welding;
- The design of busduct screens' connections to generators and transformers allows avoiding overheating of screening casings from induced current through transformer covers and generator plates;
- The busduct screening significantly reduces heating of nearby metal and concrete structures. That is essential for operation of busducts in confined turbine rooms of power plants; and
- Other technical solutions of ТЭНЕ and ТЭНП busducts common for all series of busducts are indicated in Section 4.

1.6. ELECTRICAL EQUIPMENT OF GENERATOR VOLTAGE BUSDUCTS

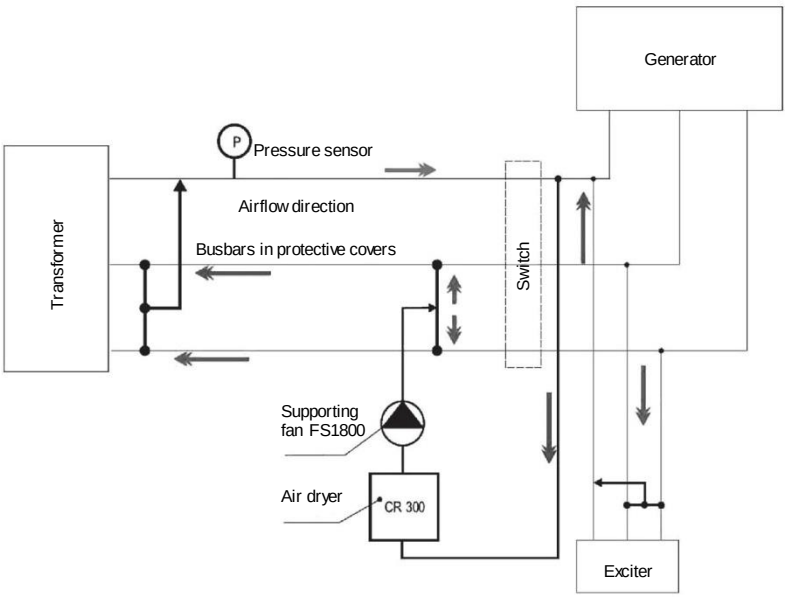
Depending on the customer's task busducts may consist of relevant electric devices and equipment*:
- ТШ, ТШВ, ТШЛ, ТШЛО, ТПОЛ, GSR, ТВЛ, ТЛШ toroidal current transformers;
- ЗНОЛ, ЗНОЛП, UGE voltage transformers;
- РВЭ, РВРД, РВМ, РВС, РВО dischargers;
- three-pole ЗР groundwires with П4 drive, ЗБ-1 blocking lock with КЭЗ-1 key of 220 V DC, and КСА auxiliary contact;
- ОПН-П, ОПН-КР/TEL, POLIM, ЗЕК (Siemens) excess-voltage supressors;
- РВПЗ-2, РВРЗ-2, РВРЗ-1б, РЗЧ, РРЧЗ-2 disconnectors with relevant drives;
- ИП, ИПУ, ИПП feedthrough insulators;
- generator busduct pressurization system (СНГТ); and
- bearing insulator control device (УКОИ), etc.
- — other types of electric equipment can be applied in busducts at the customer's request.

Busducts can be equipped with systems reducing the possibility of emergencies: pressurization system (maintaining excessive pressure) – СНГТ, bearing insulator control system – УКОИ, forced cooling system at currents of 24000 A – busducts of ТЭНП series.

УКОИ system allows:
- to provide diagnostics of busduct bearing insulator status during all the operation period under/without working voltage;
- to inspect bearing insulators for likely defects during initial period of current leakage; and
- to avoid possible emergencies on busducts.

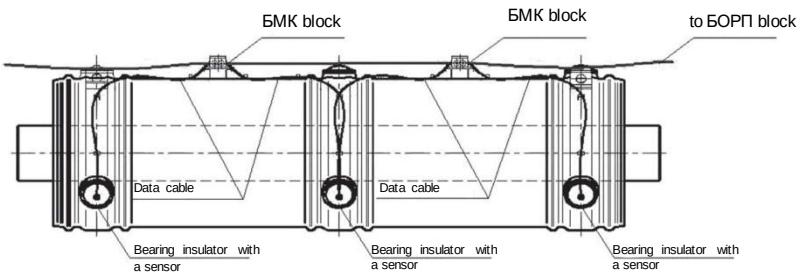
СНГТ system allows:
- to maintain relative humidity of air at 30-40% in busducts;
- to avoid premature destruction of bearing insulators;
- to abandon using feedthrough insulators built-in a busduct passing through a wall from inside to outside; and
- to maintain the level of pressure in a busduct at 500 Pa higher than atmospheric.

The insulation control system consists of the following units:



Pressurization system equipment:
- air dryer CR300;
- supporting fan
- pressure sensor;
- humidity sensor; and
- set of connecting pipes.

Fig.12. A diagram of connecting the pressuriszation system to generator busducts.



Insulation control system equipment:

- БМК blocks (bearing insulators status data collection block);
- БОРП block (interface cable data transfer block);
- БН1 block (dc voltage supply block); and
- software.

Fig.13. Insulation control system structure.

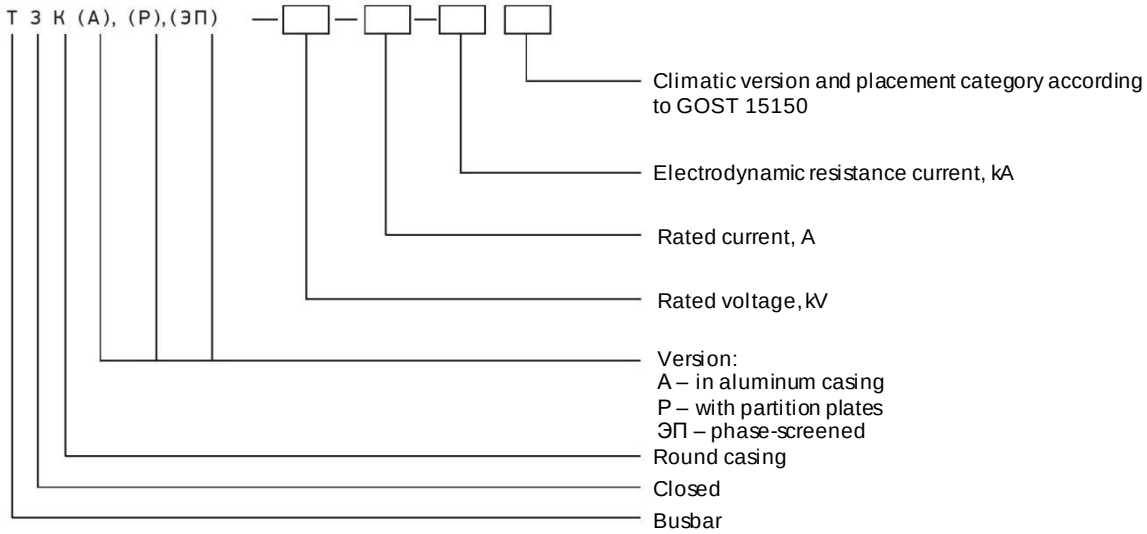
CLOSED COMPLETE 1, 3, 6, 10, 20 kV BUSDUCTS OF ТЗК, ТЗК(А), ТЗКР, ТЗКЭП SERIES

2.1. PURPOSE AND FIELD OF APPLICATION

Closed 1, 3, 6, 10 kV busducts with a three-phase joint metal casing for rated currents up to 6000 A are intended for electrical connections, auxiliary circuits at electric power stations, transformers with switchgear and control gear, and turbogenerators with power step-up transformers mounted in 3-phase AC circuits with the frequency varying from 50 to 60 Hz.

Closed busducts may also be used for other power engineering, industrial, transport, agricultural facilities, etc.

2.2. REFERENCE DESIGNATION STRUCTURE FOR 1, 3, 6, 10 AND 20 kV VOLTAGE BUSDUCTS



ТЗК, ТЗК(А), ТЗКР, and ТЗКЭП busducts are produced according to the ТУ 3414-010-00110496-01 standard. An example of the way closed 6 and 10 kV busducts are written in orders and technical documents is given below:

Closed 6 kV busduct with a round three-phase joint metal casing and partition plates between phases, 1600 A rated current, 81 kA electrodynamic resistance current, climatic version УХЛ, placement category 1:
"ТЗКР-6-1600-81 УХЛ1
ТУ 3414-010-00110496-01"

Closed phase-screened 6 kV busduct with round casing, 3150 A rated current, 128 kA electrodynamic resistance current, climatic versTion, placement category 1:
"ТЗКЭП-6-3150-128 Т1
ТУ 3414-010-00110496-01"

2.3. MAIN TECHNICAL CHARACTERISTICS

Main technical characteristics of closed 6 and 10 kV ТЗК* and ТЗКР* busducts for rated currents of 1600, 1800, 2000 A are given in Table 4:

Table 4

Busduct type	Parameter name				Casing material	Rate loss at rated current, W/lm
	Rated voltage, kV	Rated current, A	Electrodynamic resistance current, kA	Thermal resistance current, kA, 3 sec		
ТЗК-6-1600-81 УХЛ1 ТЗКР-6-1600-81 УХЛ1 ТЗК-10-1600-81 УХЛ1	6 6 10	1600	81	31.5	steel	396
ТЗКР-10-1600-81 УХЛ1 ТЗКР-10-1600-81 Т1	10	1600	81	31.5	aluminum	285 208
ТЗК-6-1800-81 Т1 ТЗКР-6-1800-81 Т1	6	1800	81	31.5	aluminum	347
ТЗК-6-2000-81 УХЛ1 ТЗКР-6-2000-81 УХЛ1	6	2000	81	31.5	aluminum	429

* — production with other rated parameters and sizes is available

Main technical characteristics of closed 6 and 10 kV ТЗК* and ТЗКР* busducts for rated currents of 2000, 3150, 4000, 6000 A are given in Table 5:

Table 5

Busduct type	Parameter name				Rate loss at rated current, W/lm	Casing material	Weight, kg/lm
	Rated voltage, kV	Rated current, A	Electrodynamic resistance current, kA	Thermal resistance current, kA, 3 sec			
ТЗК-10-2000-128 УХЛ1 ТЗК-10-2000-128 Т1 ТЗКР-10-2000-128 УХЛ1	10	2000	128	50	264	aluminum	50 50 78
ТЗК-10-3150-128 УХЛ1 ТЗК-10-3150-128 Т1 ТЗКР-10-3150-128 УХЛ1	10	3150	128	50	430	aluminum	67 70 87
ТЗК-10-4000-170 УХЛ1 ТЗКР-10-4000-170 УХЛ1	10	4000	170	67	677	aluminum	70 90
ТЗК-6-6000-220 УХЛ1	6	6000	220	86	706	aluminum	90

* — production with other rated parameters and sizes is available

Main technical characteristics of closed 6 kV ТЗКЭП* busducts for rated currents of 2000, 3150, 4000 A are given in Table 6:

Table 6

Busduct type	Parameter name				Rate loss at rated current, W/lm	Casing material	Weight, kg/lm
	Rated voltage, kV	Rated current, A	Electrodynamic resistance current, kA	Thermal resistance current, kA, 3 sec			
ТЗКЭП-6-2000-128 УХЛ1 ТЗКЭП-6-2000-128 Т1	6	2000	128	50	354	aluminum	55
ТЗКЭП-6-3150-128 УХЛ1 ТЗКЭП-6-3150-128 Т1	6	3150	128	50	693 615	aluminum	61 70
ТЗКЭП-6-4000-180 УХЛ1 ТЗКЭП-6-4000-180 Т1	6	4000	180	70	924 840	aluminum	75 82

* — production with other rated parameters and sizes is available
NOTE. In case 10 kV ТЗКЭП busduct is required, ТЭНЕ-10 busduct is applied.

Main technical characteristics of closed 6 kV ТЗК(А) busducts for rated currents of 1600, 2000, 3150 A are given in Table 7:

Table 7

Busduct type	Parameter name				Rate loss at rated current, W/lm	Casing material	Weight, kg/lm
	Rated voltage, kV	Rated current, A	Electrodynamic resistance current, kA	Thermal resistance current, kA, 3 sec			
ТЗК(А)-6-1600-81 УХЛ1	6	1600	81	31.5	284	aluminum	44
ТЗК(А)-6-2000-81 УХЛ1	6	2000	81	31.5	348	aluminum	47
ТЗК(А)-6-3150-81 УХЛ1	6	3150	81	31.5	446	aluminum	61

Main technical characteristics of closed 1 kV ТЗК(Р) busducts for rated currents of 1600, 2000, 3150 A are given in Table 8:

Table 8

Busduct type	Parameter name				Rate loss at rated current, W/lm	Casing material	Weight, kg/lm
	Rated voltage, kV	Rated current, A	Electrodynamic resistance current, kA	Thermal resistance current, kA, 3 sec			
ТЗК(Р)-1-1600-81УХЛ1	1	1600	81	31.5	284	aluminum	75.3
ТЗК(Р)-1-2000-128 УХЛ1	1	2000	128	50	348	aluminum	77
ТЗК(Р)-1-3150-128 УХЛ1	1	3150	128	50	446	aluminum	83.9
ТЗК-1-5600-220 УХЛ1	1	5600	220	86	329	aluminum	85

Main technical characteristics of closed 3 kV ТЗК(Р) busducts for rated currents of 1600, 2000, 3150 A are given in Table 9:

Table 9

Busduct type	Parameter name				Rate loss at rated current, W/lm	Casing material	Weight, kg/lm
	Rated voltage, kV	Rated current, A	Electrodynamic resistance current, kA	Thermal resistance current, kA, 3 sec			
ТЗК(Р)-3-1600-81УХЛ1	3	1600	81	31.5	284	aluminum	75.3
ТЗК(Р)-3-2000-128 УХЛ1	3	2000	128	50	348	aluminum	77
ТЗК(Р)-3-3150-128 УХЛ1	3	3150	128	50	446	aluminum	83.9
ТЗК-3-5600-220 УХЛ1	3	5600	220	86	329	aluminum	85

Main technical characteristics of closed 20 kV ТЗК busducts for rated currents of 2000, 2500, 3150 A are given in Table 10:

Table 10

Busduct type	Parameter name				Rate loss at rated current, W/lm	Casing material	Weight, kg/lm
	Rated voltage, kV	Rated current, A	Electrodynamic resistance current, kA	Thermal resistance current, kA, 3 sec			
ТЗК-20-2000-81УХЛ1	20	2000	81	31.5	297	aluminum	100
ТЗК-20-2500-81 УХЛ1	20	2500	81	31.5	348	aluminum	
ТЗК-20-3150-81 УХЛ1	20	3150	81	31.5	583	aluminum	

2.4 BUSDUCTS DESIGN

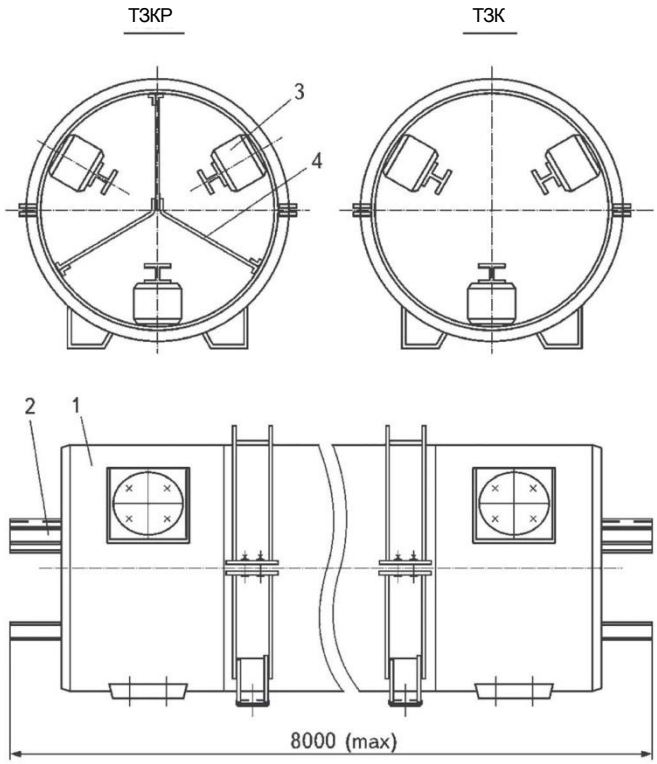


Fig.14. 6 and 10 kV Т3К and Т3КР busducts for rated currents of 1600, 1800, 2000 A.
1 - casing; 2 – current-carrying busbar; 3 - insulator; 4 – partition plate.

a) 6 and 10 kV Т3К and Т3КР busducts

Busducts (see Fig. 14) consist of a casing 1, joint for all three phases, current-carrying busbars 2 of relevant shape and section. Busbars are fixed to insulators 3 inside casing at apexes of an equilateral triangle by special busbar-holders. Т3КР busducts are produced with inter-phase partition plates 4.

Partition plates are intended to avoid transition of a one-phase short circuit to an inter-phase short circuit.

Table 11 (to Fig.14)

Busduct type	Screen diameter (outer), D, mm	Axis – busbar bottom distance, H, mm	Weight (single phase), kg/ lm
Т3К-6-1600-81 УХЛ1	623	355	50
Т3КР-6-1600-81 УХЛ1	623	355	60
Т3К-6-1800-81 Т1	640	355	50
Т3КР-6-1800-81 Т1	640	355	60
Т3К-6-2000-81 УХЛ1	640	355	50
Т3КР-6-2000-81 УХЛ1	640	355	60
Т3К-10-1600-81 УХЛ1	623	355	50
Т3КР-10-1600-81 УХЛ1	700	400	70
Т3КР-10-1600-81 Т1	700	400	75
Т3К-6-6000-220 УХЛ 1	706	400	90

Fig. 15. A view of a rectilinear section of Т3КР-6-2000-81 УХЛ 1 busducts.

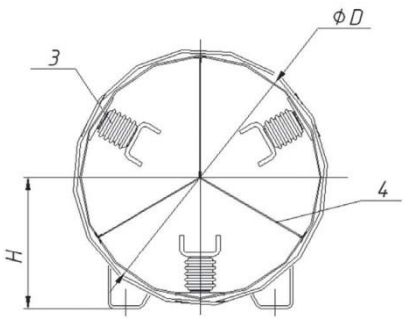


Fig. 16. 10 kV Т3КР busducts for rated currents of 2000, 3150 и 4000 А.
1 - casing; 2 – current-carrying busbar; 3 - insulator; 4 – partition plate.

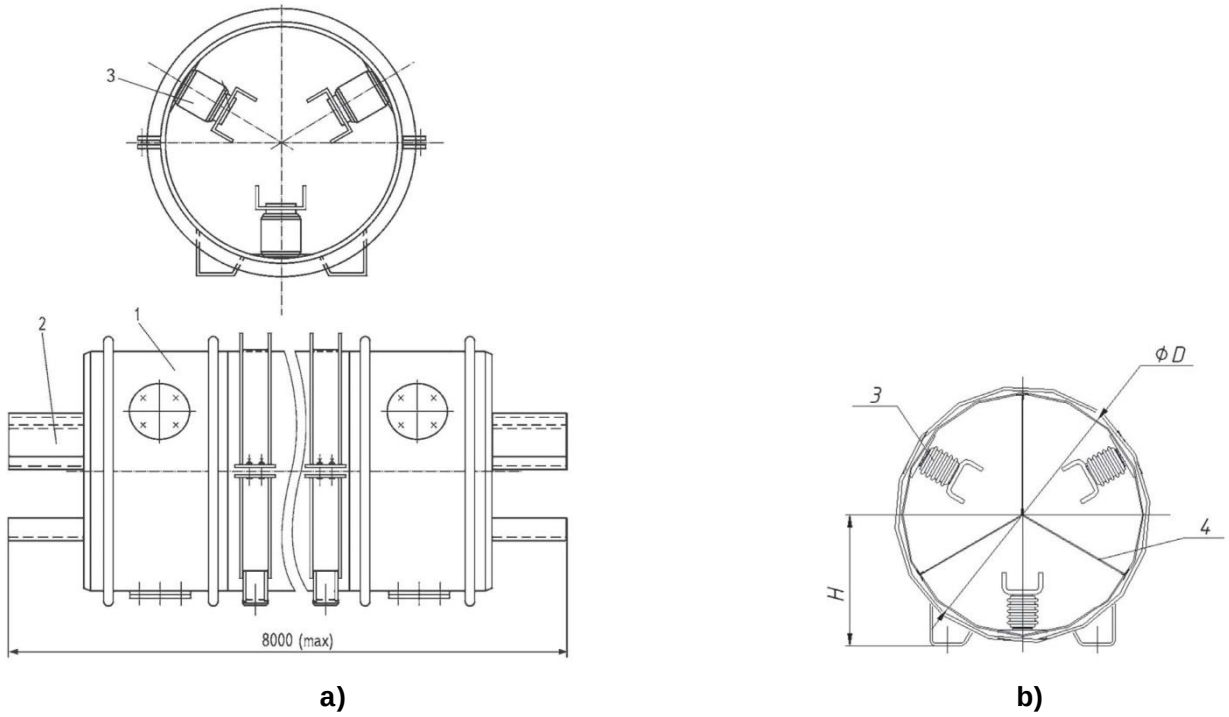


Fig. 17. 10 kV busducts for rated currents of 2000, 3150 и 4000 A of:
a) ТЗК series, b) ТЗК(R) series
1 - casing; 2 – current-carrying busbar; 3 - insulator; 4 – partition plate

Table 12 (to Fig. 16)

Busduct type	Screen diameter (outer), D, mm	Axis – busbar bottom distance, H, mm	Weight (single phase), kg/ lm
ТЗК(Р)-1-1600-81УХЛ1	678	415	75.3
ТЗК(Р)-1-2000-128 УХЛ1	678	415	77
ТЗК(Р)-1-3150-128 УХЛ1	678	415	83.9
ТЗК(Р)-3-1600-81УХЛ1	678	415	75.3
ТЗК(Р)-3-2000-128 УХЛ1	678	415	77
ТЗК(Р)-3-3150-128 УХЛ1	678	415	83.9
ТЗК-1-5600-220 УХЛ 1	706	400	85
ТЗК-3-5600-220 УХЛ 1	706	400	85

Table 13 (to Fig.17)

Busduct type	Screen diameter (outer), D, mm	Axis – busbar bottom distance, H, mm	Weight (single phase), kg/ lm
ТЗК-10-2000-128 УХЛ1 ТЗК-10-2000-128 Т1	706	400	50
ТЗК(Р)-10-2000-128 УХЛ1	890	480	78
ТЗК-10-3150-128 УХЛ1 ТЗК-10-3150-128 Т1	706	400	67
ТЗК(Р)-10-3150-128 УХЛ1	890	480	87
ТЗК-10-4000-170 УХЛ1 ТЗК-10-4000-170 Т1	706	400	70
ТЗК(Р)-10-4000-170УХЛ1	890	480	90

Busducts

Fig. 18. A view of ТЗК-10-3150-128 УХЛ 1 busduct. Rectilinear sections during packaging.

Fig. 19. A view of a bend section of ТЗК-10-4000-170. УХЛ 1 busduct

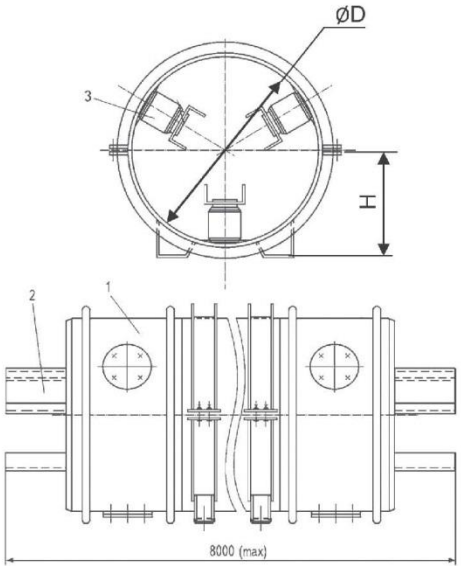


Fig. 20. 20 kV ТЗК busducts for rated currents of 2000, 2500 и 3150 A.
1 - casing; 2 – current-carrying busbar; 3 – bearing insulator

Table 14 (to Fig.20)

Busduct type	Screen diameter (outer), D, mm	Axis – busbar bottom distance, H, mm	Weight, kg/lm
ТЗК-20-2000-81УХЛ1	890	480	64.9
ТЗК-20-2500-81 УХЛ1	890	480	85.6
ТЗК-20-3150-81 УХЛ1	890	480	85.6

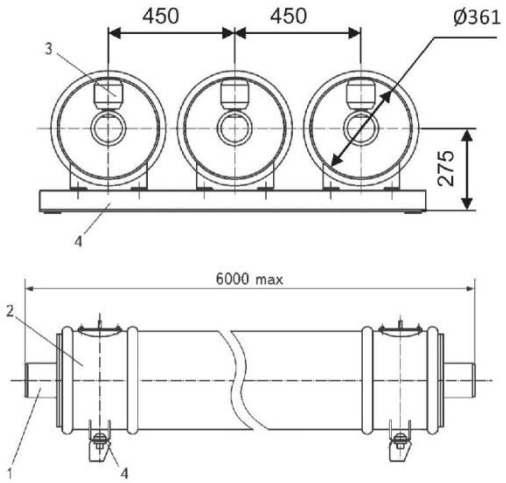


Fig. 21. ТЗКЭП-6 busducts for rated currents of 2000, 3150, 4000 A. Rectilinear block.

b) 6 kV ТЗКЭП busducts

ТЗКЭП busducts (see Fig. 21) are of a phase-screened execution. Each busduct phase consists of an aluminum current-carrying busbar 1 of relevant tube section, aluminum cylindrical screening casing 2 and insulators 3. Bearing insulators are mounted on covers, each of which is fixed to casings by six bolts. A busbar is fixed at its section to one insulator by a special busbar-holder.

The magnetic field compensation of ТЗКЭП-6 busduct is similar to the one applied in ТЭНЕ busducts.

Busduct casings serve as partition plates of screens at connection points of busducts to SCG cabinets.

Fig. 22. A view of three packaged rectilinear blocks of ТЗКЭП-6 busducts.

c) 6 kV ТЗК(А) busducts

ТЗК(А) busducts (see Fig. 23) consist of casing 1, joint for three phases, and current-carrying busbars 2 of relevant shape and section. Busbars are fixed to bearing insulators 3 inside casing at apexes of an equilateral triangle by special busbar-holders.

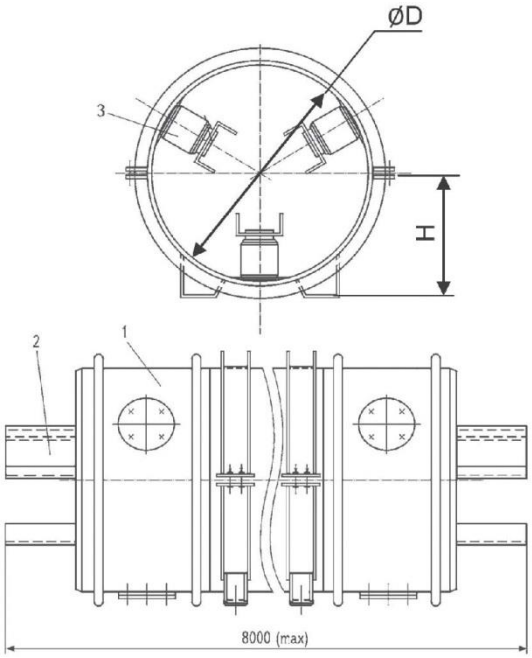


Fig. 23. 6 kV ТЗК (А) busducts for rated currents of 1600, 2000, 3150 A
1-casing, 2-current-carrying busbar, 3-insulator

Table 15 (to Fig.23)

Busduct type	Screen diameter (outer), D, mm	Axis – busbar bottom distance, H, mm	Weight, kg/lm
ТЗК(А)-6-1600-81УХЛ1	550	320	44
ТЗК(А)-6-2000-81 УХЛ1	550	320	47
ТЗК(А)-6-3150-81 УХЛ1	550	320	61

2.5. COMPOSITION AND STRUCTURE OF BUSDUCTS

Busducts are supplied factory-assembled in separate mounting units or sections not exceeding 8 m in length (not more than 6 m for ТЗКЭП-6).
All sections are joined and welded on site by gas shielded welding.

Depending on the configuration and purpose busduct elements are divided into units:

- rectilinear (Fig. 14 and 15, 16 and 17, 18);
- bend (Fig. 19);
- with current transformers; with excess-voltage supressors; with voltage transformers; with dischargers; with feedthrough insulators; with phase transposition; with phase slue; three-way; SCG cabinet's connections; transformers' connections; generators' connections; and
- blocks (Fig. 22), and units for end-to-end connection of sections to busbars, absorbers and other elements.

2.6. ELECTRICAL EQUIPMENT OF 6 AND 10 kV VOLTAGE CLOSED BUSDUCTS

Busducts can be equipped with relevant electric devices and equipment: voltage transformers, current transformers, dischargers, excess-voltage supressors, groundwires, feedthrough insulators, etc. requirements for optional equipment and its volume is defined in project documents during task issue.

CLOSED COMPLETE 1.2 AND 0.4 kV BUSDUCTS OF ШЗК SERIES

3.1. PURPOSE AND FIELD OF APPLICATION

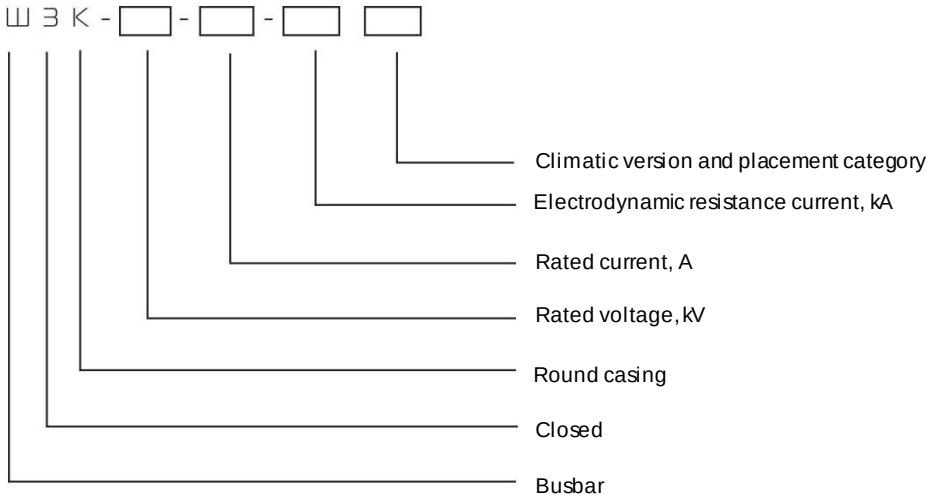
Closed ШЗК-1.2 busducts with DC up to 1.2 kV for rated currents of 2000, 4000, 5000, 6300 A are intended for electrical connections of exciters to cabinet panels of working and standby excitement of generators up to 1200 MW at electric power stations.

Closed ШЗК-0.4 busducts of 380 V AC with a three-phase joint metal casing for rated currents of 1600 A with the frequency varying from 50 to 60 Hz are intended for electrical connections of auxiliary transformers up to 1000 kVA to ПСН auxiliary panels and КТПСН-0.5 cabinets at electric power stations. Busducts of the indicated series may also be used for other power engineering, industrial, transport, agricultural facilities, etc.

3.2. REFERENCE DESIGNATION STRUCTURE FOR 1.2 AND 0.4 kV VOLTAGE BUSDUCTS:

Busducts are produced according to the ТУ standard:

- ШЗК-1.2 ТУ 3414-012-00110496-01; and
- ШЗК-0.4 ТУ 3414-011-00110496-01.



An example of the way closed 1.2 and 0.4 kV busducts are written in orders and technical documents is given below:

Closed 1.2 kV DC busduct with a round casing, 2000 A rated current, 51 kA electrodynamic resistance current, climatic version У, placement category 3:
ШЗК-1.2-2000-51 У3 ТУ 3414-012-00110496-01

Closed 0.4 kV AC busduct with a round three-phase joint casing, 1600 A rated current, 51 kA electrodynamic resistance current, climatic version Т, placement category 3:
ШЗК-0.4-1600-51 Т3 ТУ 3414-011-00110496-01

3.3. MAIN TECHNICAL CHARACTERISTICS

Main technical characteristics of closed 1.2 kV ШЗК* busducts are given in Table 16:

Table 16

Busduct type	Parameter name						Casing material	Weight, kg/lm
	Rated voltage, kV	Rated current, A	Electrodynamic resistance current, kA	Thermal resistance current, kA, 3 sec	Rate loss at rated current, W/lm	Forcing type, kA		
ШЗК-1,2-2000-51 У3	1.2	2000	51	20	169	4	steel	40
ШЗК-1,2-4000-81 У3	1.2	4000	81	31.5	306	8	steel	50
ШЗК-1,2-5000-128 У3	1.2	5000	128	50	287	10	steel	70
ШЗК-1,2-6300-128 У3	1.2	6300	128	50	469	12.6	steel	70
ШЗК-1,2-2000-51 Т3	1.2	2000	51	20	169	4	aluminum	38
ШЗК-1,2-4000-81 Т3	1.2	4000	81	31.5	306	8	aluminum	48
ШЗК-1,2-5000-128 Т3	1.2	5000	128	50	287	10	aluminum	68

* — production with other rated parameters and sizes is available

Main technical characteristics of closed 0.4 kV ШЗК* busducts are given in Table 17:

Table 17

Busduct type	Parameter name					Casing material	Weight, kg/lm
	Rated voltage, kV	Rated current, A	Electrodynamic resistance current, kA	Thermal resistance current, kA, 3 sec	Rate loss at rated current, W/lm		
ШЗК-0,4-1600-51 У3	0.4	1600	51	25	207	aluminum	35
ШЗК-0,4-1600-51 Т3	0.4	1600	51	25	174	aluminum	38
ШЗК-0,4-1600-81 У1	0.4	1600	81	25	207	aluminum	35

* - production with other rated parameters and sizes is available

3.4. BUSDUCTS DESIGN

ШЗК busducts of closed execution.
Two ШЗК-1.2 U-profile busbars of relevant section are located horizontally (Fig. 24), while three ШЗК-0.4 U-profile busbars of relevant section are inside the casing at apexes of an equilateral triangle (Fig. 25).

Busbars are fixed to bearing insulators 3 inside casings by special busbar-holders. Bearing insulators are fixed to covers 4, which are bolted to casings 2 through rubber sealing gaskets.

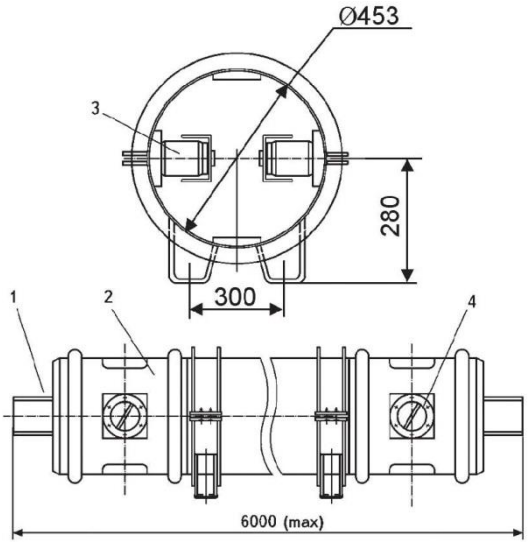


Fig. 24. ШЗК-1.2 busduct. Rectilinear section.
1 – current-carrying busbar; 2 - casing; 3 - insulator; 4 – insulator cover.

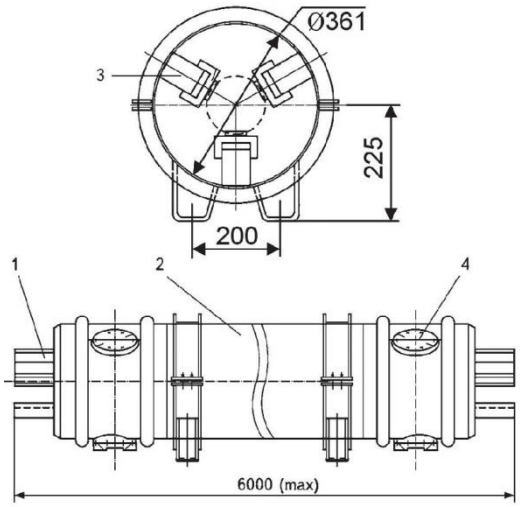


Fig. 25. ШЗК-0.4 busduct. Rectilinear section.
1 – current-carrying busbar; 2 - casing; 3 - insulator; 4 – insulator cover.

Fig.26. A view of rectilinear sections of 1.2 and 0.4 kV ШЗК busducts.

3.5. COMPOSITION AND STRUCTURE OF BUSDUCTS

Busducts are supplied factory-assembled in separate mounting units or sections of various configuration not exceeding 6 m in length.
All sections are joined and welded on site.

Depending on the configuration and purpose busduct elements are divided into units:

- rectilinear (Fig. 24, 25, 26);
- bend;
- branch; and
- blocks for connection to devices, etc.

Units with absorbers and other elements are supplied for connecting sections with each other.

3.6. ELECTRICAL EQUIPMENT OF 1.2 AND 0.4 kV VOLTAGE BUSDUCTS

Busducts can be equipped with necessary electric equipment according to the specifications.

GENERAL TECHNICAL DECISIONS AND STANDARDS

4.1. OPERATING CONDITIONS

In terms of effects from environment factors busducts conform to УХЛ and Т climatic versions, 1 and 3 placement categories, GOST 15150-69, GOST 15151-59, GOST 15543.1-89, and GOST 17412-72, II atmosphere type. In terms of effects from mechanical environment factors busducts conform to M6 group (M5 for generator voltage busducts) according to GOST 17516.1-90.

The protection class for busducts is IP54 and IP55 according to GOST 14254-96. Generator voltage busducts mounted indoors in the zone of connection to the generator's terminals can be executed with a holed casing (IP22 protection class according to GOST 14254-96).

Busducts provide operability at 9-point seismic load on the MSK-64 scale being mounted up to 10 m height according to GOST 17516.1-90, or at 8-point seismic load being mounted up to 25 m height.

Busducts are intended to mounting below 1000 m above sea level (mounting above 1000 m is available conforming requirements of GOST 15150-69).

4.2. RELIABILITY CONDITIONS

Table 18

Parameter name		Parameter value
Mean time between failures		$4x10^5$
Flaw rate, 1/4		$2,5x10^{-7}$
Service life (provided by changes of components), years	ТЭК ТЭНЕ ТЭНЕ (for NPP)	30 40 50
Life cycle before first medium repair, years		10

Protection class of busducts – IP54 for indoor installations and IP55 – for outdoor installations according to GOST 14254-96.

Busducts

All types of busducts' cooling are air natural, except for ТЭНП busducts with forced air cooling.

The maximum heat temperature of busduct elements under rated operating conditions are given in Table 19:

Table 19

Busducts elements	Maximum heat temperature, °C
Busbars, absorbers and sectional contact connections	120
Screening casings (casings)	80
Busbars at short-circuit current	not more than 200
Supporting and surrounding metalware	not more than 40

Each 5°C increase of ambient temperature above 55°C reduces the current load by 150 A.

4.4. MARKING

A nameplate with the following data is placed on one of the blocks (sections) at connection units to a transformer, SCG cabinet, or in other places:

- manufacturer's trademark;
- identification code of the item;
- specifications designation;
- rated voltage;
- rated current;
- protection class according to GOST 14254-96;
- order number; and
- year of manufacture.

Nameplates of busducts intended for use at nuclear power plants should bear "for NPP" sign, and those intended for export should bear "Made in Russia" sign.

4.5. COMPLETENESS OF DELIVERY

Each set of a busduct contains:

- components according to the assembly drawing or the package list of the order; and
- spare parts, tools and equipment according to spare parts list (upon request).

A set of accompanying documents, supplied in 2 copies, contains:

- package list;
- set of assembly drawings for busduct lines;
- Operation manual (User's manual);
- SPTA list (if any); and
- certificate (1 copy).

Accompanying documents are packed into water-proof material, and either put into Coli №1 or sent by mail.

Busducts intended for export are produced according the contract.

4.6. MANUFACTURER'S WARRANTY

The warranty period is 3 years after commissioning and 3.5 years since production.

The warranty period for the exported equipment is 1 year after production, but not more than 2 years after crossing the State border of Russia.

BUSDUCTS TARGET SPECIFICATIONS FORMAT REQUIREMENTS

The plant produces all types of busducts indicated in this information. The plant may produce busducts with other parameters upon customer's request.

The plant develops special sections (blocks) according to the specifications of an engineering company (customer) for busducts line areas, which do not consider applying standard elements.

The scope of the specification should contain:

- Drawing of the line (a simplified view is acceptable). The drawing should bear marks and ties to construction axes, dimensions of straight and vertical area of the line; rotation angles, necessary sections and other dimensions determining special position of the busduct;
- List of necessary electric equipment and devices under the scope of supply. Full designation of their types, amount and manufacturers; and
- Necessary information on electric equipment to be connected to the busduct (generator, transformer, switches, switchgears) and other devices (beyond the scope of supply of busducts). It should also indicate: flange connection sizes with ties to equipment's covers, terminal sizes with indication of their holes' positions, material, electrolyte coating type, etc.

The given data can be represented in the form of drawings or sketches on the line's drawing of the specification. The specification should be agreed with the manufacturer.

Since the plant is constantly developing its busducts' design, the actual execution may slightly differ from its description; and it has no effect on their technical characteristics, reliability and operational safety.

You can get advice on the equipment of your interest by phone +7 (495) 787-43-59 or by e-mail info@moselectro.ru

Send request