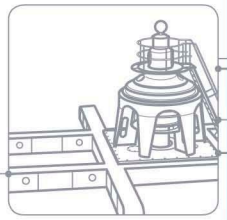
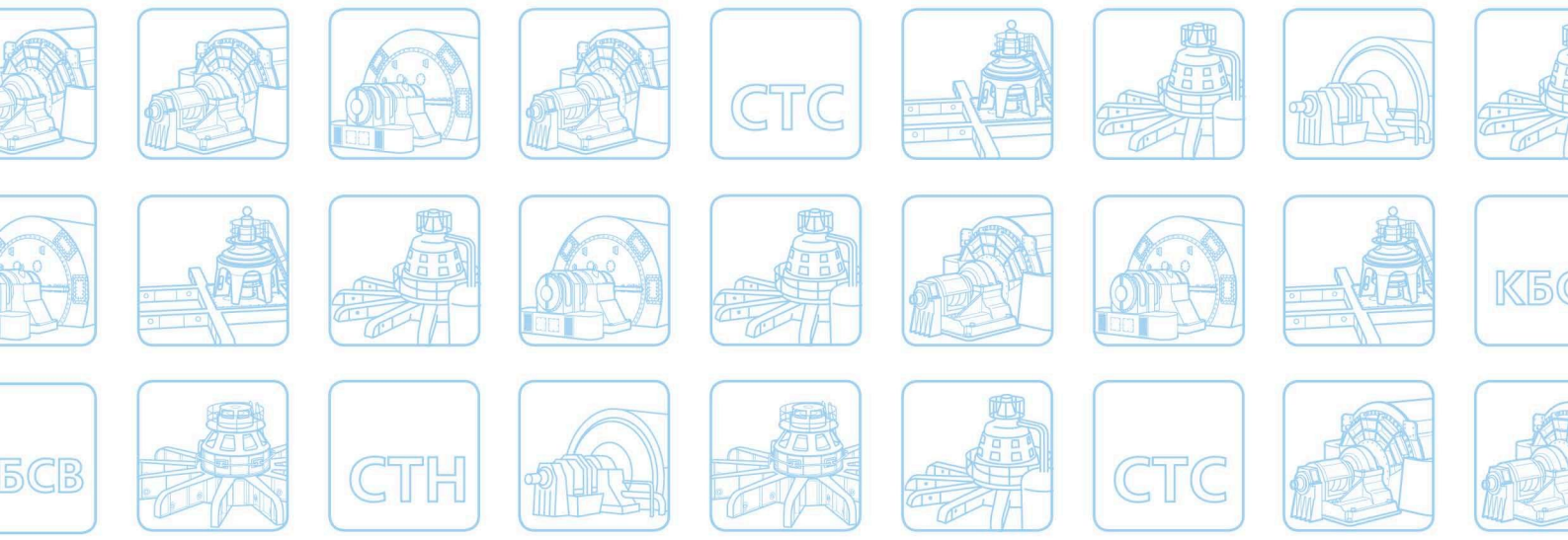
ELSIB

EXCITATION SYSTEMS

FOR TURBOGENERATORS AND HYDROGENERATORS




СТС
БСВ
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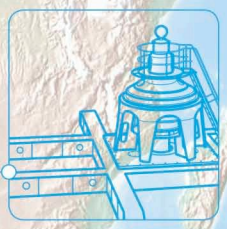
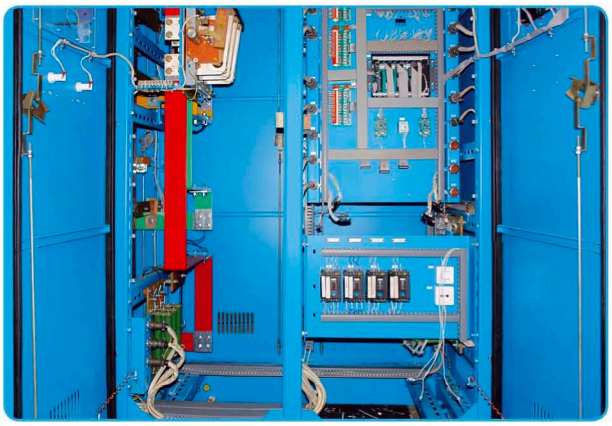


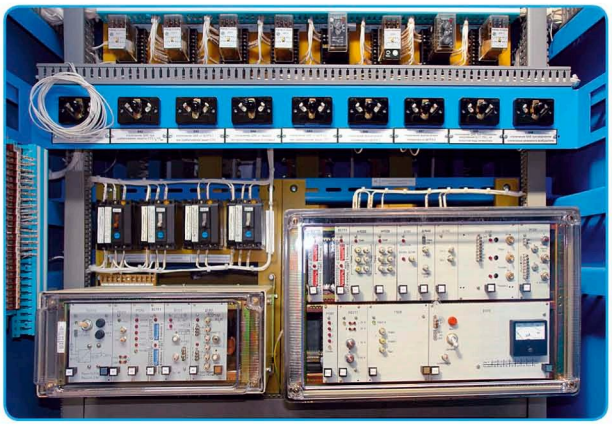
Content:

Excitation systems

"ELSIB" supplies the generators with the excitation systems of the following types:

- microprocessor static thyristor self-excitation systems (STS) for the turbogenerators and hydrogenerators;
- brushless excitation systems for the turbogenerators of capacity from 6 to 50 MW (КБСВ);
- thyristor autonomous excitation systems for powerful turbogenerators and hydrogenerators (СТН).





The key advantages:

Safety

- optimal selection of the power electronics components;
- set of necessary protections and blocks including against the incorrect actions of staff;
- design of the thyristor converters excludes a possibility of arising of the arc systems inside a cabinet.

Service comfortability

- submission of the technical documents in complete;
- monitoring for customer during a whole lifetime of equipment;
- capability of arrangement of the remote working places for a control of the parameters of the system;
- operation of the excitation systems at the autonomous mode.

Degree of factory readiness

- tests of a complete equipment before a delivery including the tests for the thyristor converters at rated load;
- mounting of the DC power circuits between the converting and controlling shields and the cabinet of excitation system is carried out by inner connections. The mounting of control circuits between the shields is carried out by the strands of "ELSIB" production.

The new technical decisions

- unique microprocessor automatic controller provides the realization of the algorithms of stable controlling of the generator voltage at all service modes with pre-set accuracy within a diagram of the generator capacity;
- software of own development;
- upgraded universal element base;
- different climatic versions;
- necessary rated parameters under any technical requirements.

Design

- unified unit and module design;
- devices and alarming are located in accordance with the ergonomic characteristics;
- simplicity of the design of the units and sections provides the easiness and convenience of their technical maintenance.

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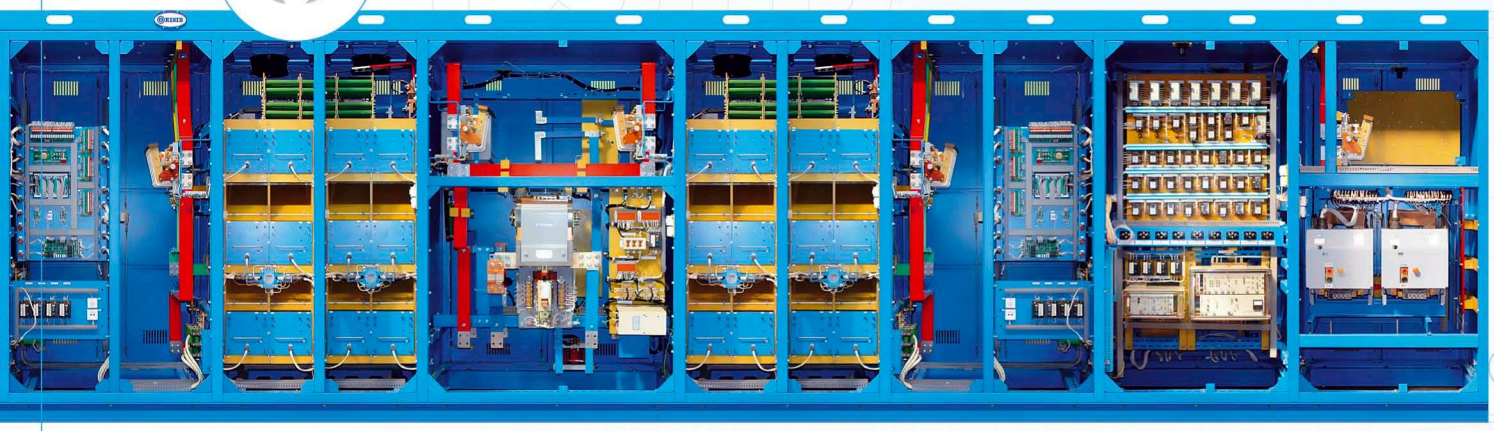
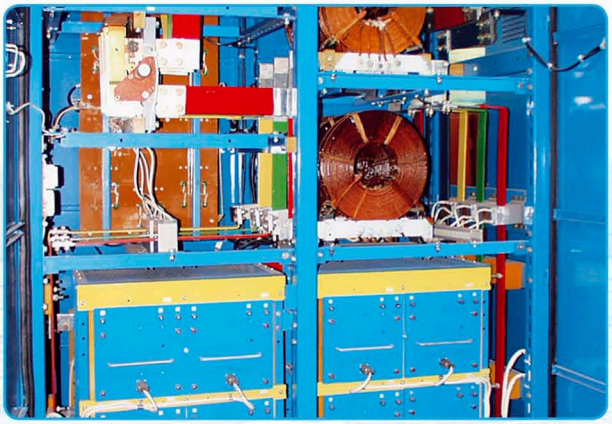


The excitation systems provide comprehensively the following modes of the generators operation:

- initial excitation;
- connection to the main supply network by the exact synchronization and self-synchronization ways;
- idle;
- operation of generator at power system with the loads and overloads admitted for the generator;
- remote change of generator voltage setting within 80-100 % of rated value;
- controlling of excitation using the apparatus of non-linear functions or by principle of PID-regulator;
- keeping of voltage with accuracy ±0.5 % at specified point of regulation in accordance with the preset setting and static ability at the normal modes of generator operation at a range of field current up to 110 % of rated one;
- forcing of excitation with specified multiplication factor;
- disexcitation at the failures at power system;
- limitation of double field current, and also, of the overloads on current of the stator and field windings according to the specified generator characteristics;



- limitation of minimum field current with the setting depending on the value of generator active capacity, at a mode of reactive capacity consumption from main supply network;
- extinction of the field at the emergency modes and normal stopping;
- generator operation at the group regulation system of reactive power.

The microprocessor static thyristor self-excitation systems (STS)

The main type of the excitation systems used with the power plants for the turbogenerators and hydrogenerators is the static thyristor self-excitation systems (STS).

The STS are intended for a supply of the field windings of the generators by the automatic controlled direct (rectified) current.

The main technical data of the excitation systems for the generators issued by "ELSIB" are shown at the following table:

Description	For turbogenerators	For hydrogenerators
Control system	microprocessor	microprocessor
Rated voltage, V	220...350	120...400
Peak voltage, V	488...750	245...865
Rated current, A	1200...2100	1100...2000
Maximum current, A	2060...3680	1878...3406
Rated power, kW	264...700	132...800
Maximum power, kW	1005...2550	460...2946
Multiplication factor of forcing on voltage	2,5	2,5
Rated voltage of generator stator, kV	10,5(6,3)	10,5/13,8/15,75
Version of converting units	Single module Double module	Double module
Field transformer	+	+

By the request and agreement with the customer, the excitation systems with other necessary rated parameters can be developed and produced.

The structure of specific designation of the microprocessor control excitation systems:

СТС (СТСГ) -	КНФР (КНФ) -	ХХХ -	ХХХХ -	2,5 -	ХХХ -	Х -	РВ -	УХЛ4

- climatic version, category of placing.
- Operation with reserve electric machine exciter
- Version of converting units
- Rated voltage of generator stator, kV
- Multiplication factor of forcing on voltage, r.u.
- Rated current, A
- Rated voltage, V

К - The excitation system control on a base of the industrial computer.

НФ - The automatic regulation of excitation on a base of a theory of non-linear functions.

Р - The one hundred per cent reservation of the converting and control channels

СТС - Thyristor self-excitation system

СТСГ - Thyristor self-excitation system (for turbogenerators driven from gas turbines)

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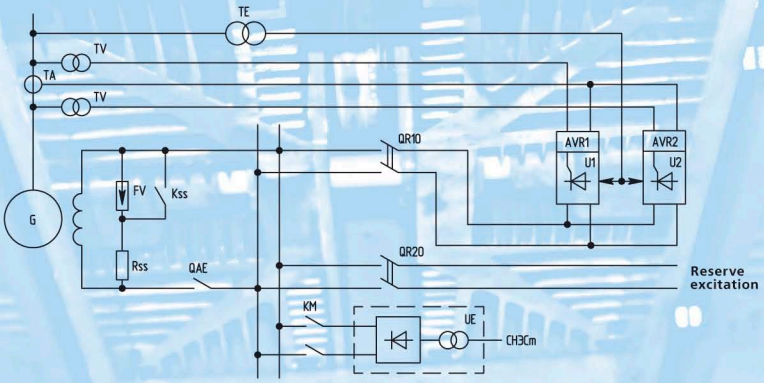
The design features of STS

The excitation system is designed with single group circuit. The excitation of generator at its starting is fulfilled by the device of initial excitation from the AC network of the own power plant or from the battery. The supply of the thyristor converters is fulfilled through a transformer (TE) connected to the main outputs of generator. The thyristor converters are designed with the three phase bridge rectifying circuit, with forced or natural cooling of the thyristors. The outputs of the thyristor converters are united at the power cabinet of the excitation system, and through the field extinction automaton, the excitation is supplied to the slip rings of generator rotor.



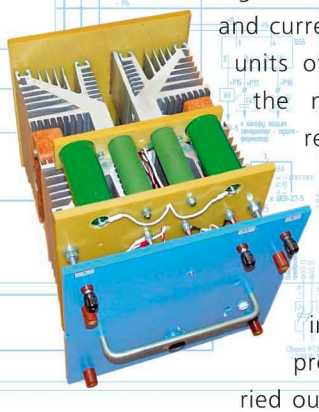
Thyristor self-excitation system

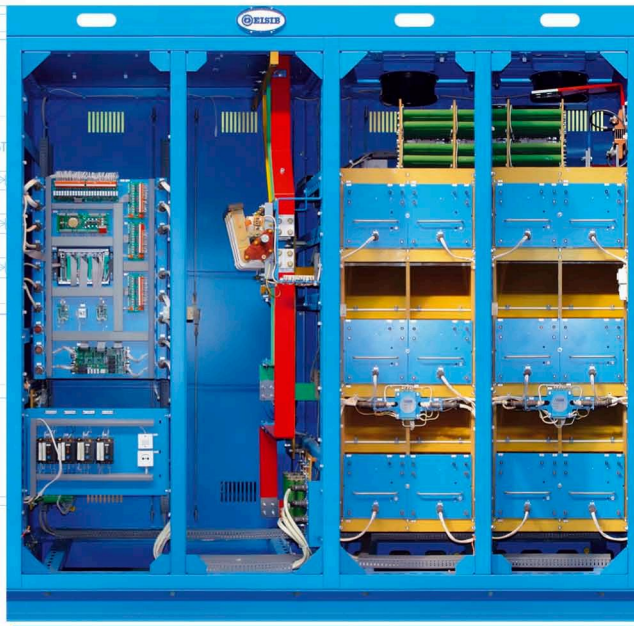
One-way one without a resistor connection – only U1, AVR1 excepting QR10 and QR20
Two-way one – U1, AVR1 and U2, AVR2 excepting QR10 and QR20
The systems with a connection of reserve excitation – the same with QR10 and QR20.

AVR1, AVR2 – automatic regulators of excitation
FV – thyristor discharger
G – generator
KM – contactor of initial excitation
Kss – self-synchronization contactor
QAE – automaton of field extinction
QR10 – switcher of main excitation
QR20 – switcher of reserve excitation
Rss – self-synchronization resistor
TA – current transformer
TE – field transformer
TV – voltage transformer
UE – device of initial excitation
U1, U2 – thyristor converters

The control system consists of two autonomous identical channels, each of which includes the automatic excitation regulator (APB) and a system of pulse and phase control (СИФУ) of converter. Each channel is equipped with the own DC electric supply system. At the STS system, the digital microprocessor control is used.

The automatic excitation regulator (APB) fulfils the regulation of the field current to provide the required operation mode of the generator at the network. The control and regulation system fulfils the preliminary and current diagnose operation for the units of field shield, the storage of the main monitoring parameters, record and storage of information about an action of inner protections at the events diary with many page menu. At an emergency, the recording and storage of information preceding an emergency are carried out. The means allowing to read all the saved information on a display of current information are provided, for that, the terminal of operative control of excitation shield is provided.





1st channel

Control, regulation and protection system	Thyristor converters

The excitation system is equipped with the following kinds of the protections against the different types of damages or failures in a normal mode of its operation:

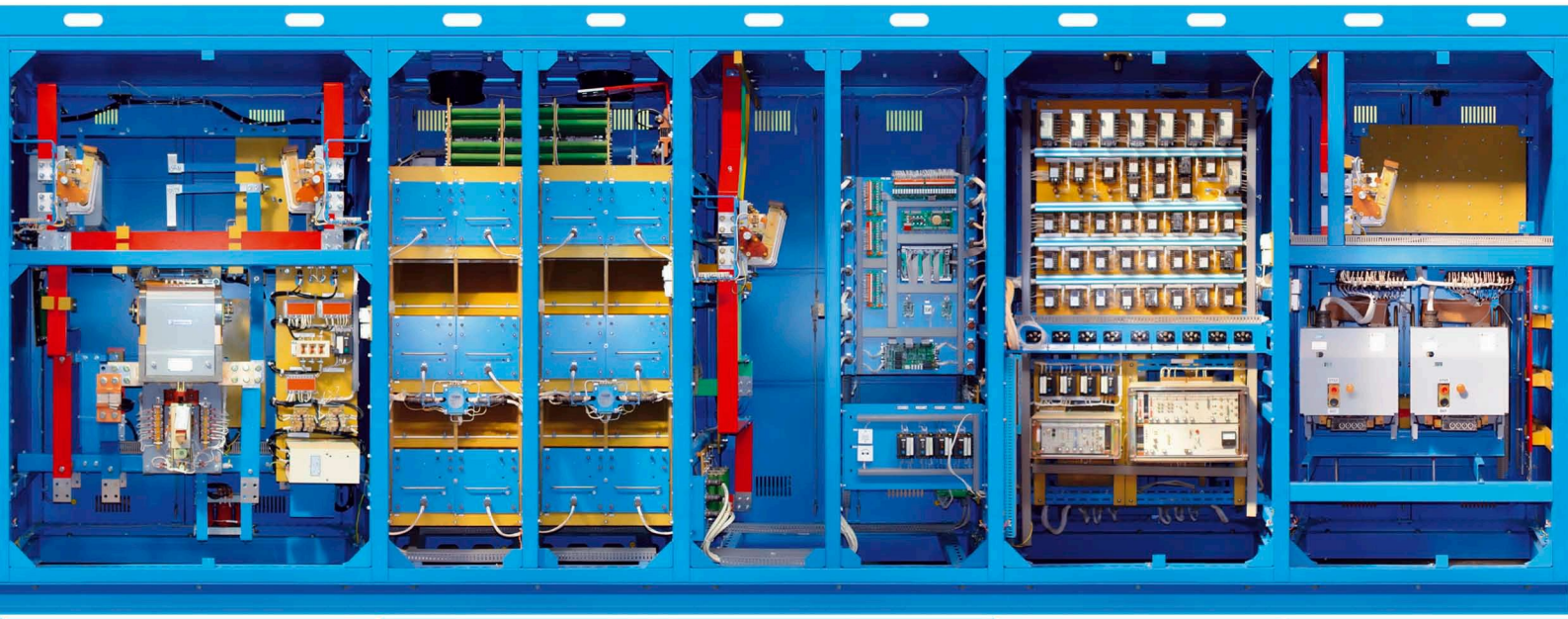
- protection of rotor winding and thyristor converter against overvoltages (thyristor discharger);
- technological protections of thyristor converter (including the protection of thyristor converter against overheating);
- protection of generator rotor winding against overload;
- protection against rotor current exceeding the double meaning, at a failure of limiting devices;
- protection against the ground short-circuits at a circuit of generator excitation;
- protection against the short-circuit on a side of rectified voltage of the thyristor converters;
- protection against a reduction of frequency of generator disconnected from the main supply (the first step of protection is provided with a cabinet of control, regulation and protection, the second step of protection is included at a complex of the digital protections of unit);
- protection against excitation loss (included at a complex of the digital protections of unit).

Standard scope of delivery for excitation system:

field transformer	1
converting and controlling shield consisting of thyristor converter and cabinet of control, regulation and protection	2
power cabinet of excitation system	1
protection cabinet of excitation system	1
units of self-synchronization resistors	2
group set of SPTA for excitation system	1

At the scope of the excitation system of the generators, the cabinet of excitation starting from the reserve electric machine exciter or reserve excitation system can be included.

The excitation systems for the generators have one hundred per cent reservation the technical parameters of which are determined by the kind of generator.



Circuit of field extinction and rotor protection	2nd channel		Circuit of relay protection and control	Starting of reserve and thyristor excitation
	Thyristor converters	Control, regulation and protection system		

Configuration of excitation system СТС-КНФР-330-1500-2,5-10,5-11ЕРВУХЛ4 for Vyborg TPP-17

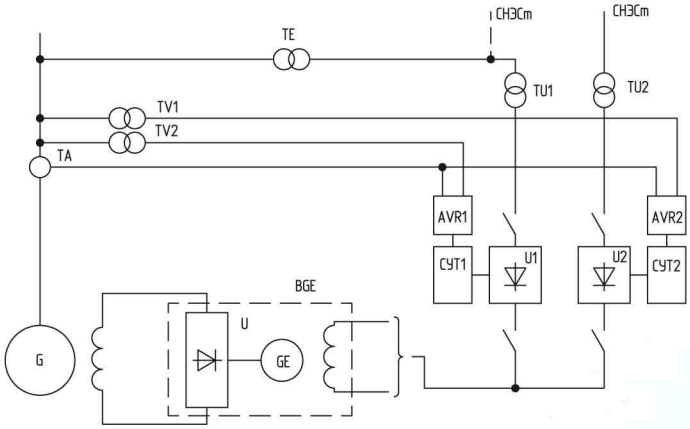
The brushless excitation systems of the turbogenerators of capacity from 6 to 50 MW (КБСВ)

The turbogenerators of capacity from 6 to 50 MW are equipped with the brushless excitation systems with microprocessor system of control, regulation and protection.

The brushless exciter is the reversible synchronous generator with three phase system of the windings and diode rectifier placed on a turbogenerator shaft. The magnet system with the poles and field winding occupies an anchor and it is placed on a foundation plate.

To protect from the overvoltages, the varistors and resistor and capacitor circuits are used.

The excitation system has one hundred per cent reservation – two identical converting and controlling channels each of which provides all the modes of generator excitation including the forcing. The system of control and protection is designed on a base of industrial computer.



Brushless excitation system

AVR1, AVR2 – automatic regulators of excitation
BGE – brushless exciter (БЩВ)
G – turbogenerator
GE – generator БЩВ
TA – current transformer
TE – field transformer
TU1, TU2 – converting transformers
TV1, TV2 – voltage transformers
U – rotating diode rectifier
U1, U2 – converting channels of excitation БЩВ

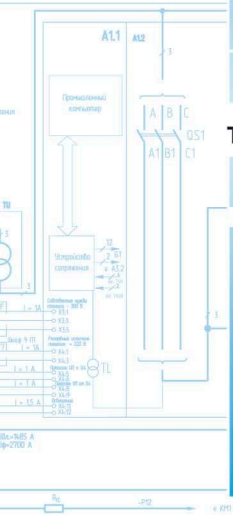
The parameters of the brushless excitation systems are determined by a kind and capacity of turbogenerator.

Parameter	
Rated voltage, V	135...155
Maximum voltage, V	240...272
Rated current, A	300...905
Maximum current, A	520...1700
Rated power, kW	45...136
Maximum power, kW	156...495
Multiplication factor of forcing on voltage, r.u.	2
Rated voltage of generator stator, kV	6,3/10,5

The structure of specific designation of excitation system:

КБСВ -	135 -	605 -	2 -	6,3 (10,5)	УХЛ4

climatic version, category of placing.
rated voltage of generator stator, kV
multiplication factor of forcing on voltage, r.u.
rated current, A
rated voltage, V
computer brushless excitation system



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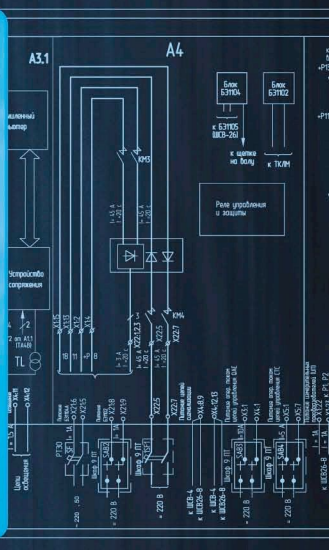
ТВФ–110, BACHAO, CHINA



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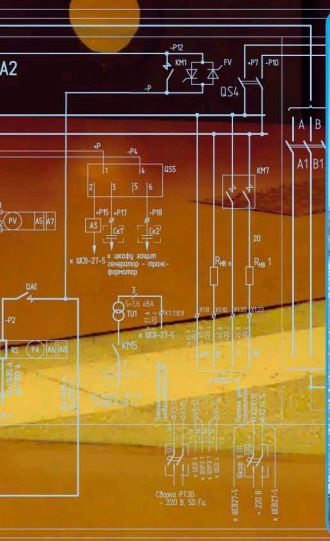
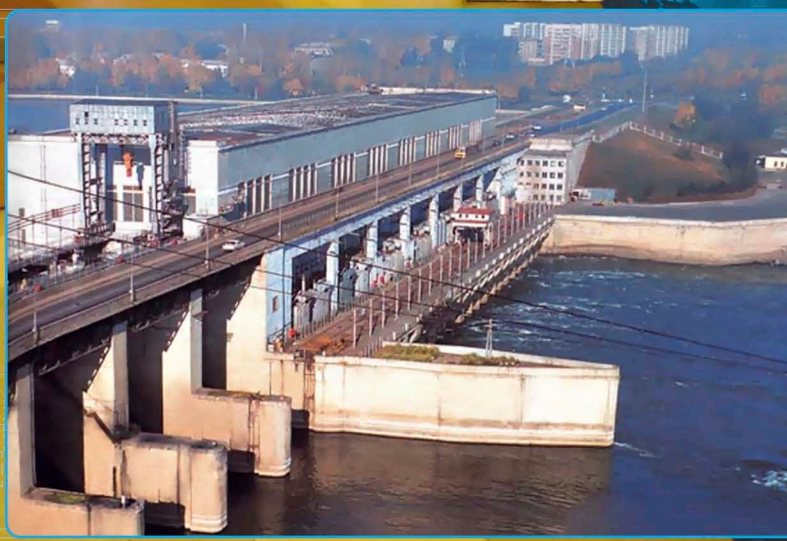
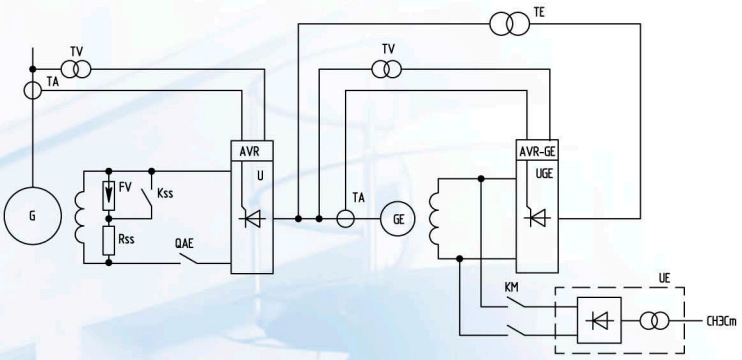




The thyristor autonomous excitation systems for large turbogenerators and hydrogenerators (CTH)

The thyristor autonomous excitation systems are intended for a supply of the field windings for large turbogenerators and hydrogenerators by rectified regulated current. Unlike the self-excitation systems, at the autonomous excitation systems, the thyristor rectifier of main generator is supplied from the auxiliary synchronous generator rotating on the same shaft that the main generator.

At that, the auxiliary generator is excited according to a circuit of self-excitation. The thyristor autonomous excitation systems possess one important advantage – their parameters do not depend on the processes running at power system.



Thyristor autonomous excitation system

AVR – automatic regulator of excitation
AVR-GE – automatic regulator of excitation of auxiliary generator
FV – thyristor discharger
G – generator
GE – auxiliary generator (ВГ)
KM – contactor of initial excitation
Kss – contactor of self-synchronization
QAE – automaton of field extinction
TA – current transformer
TE – field transformer ВГ
TV – voltage transformer
U – thyristor converter
UE – device of initial excitation
UGE – thyristor converter СВ ВГ

The thyristor autonomous excitation systems provide:

- independence of excitation from duration and distance of the short-circuits and other fluctuations at power system;
- high speed of field voltage rising.

The parameters of thyristor autonomous excitation systems:

Parameter	for turbogenerators	for hydrogenerators
Rated voltage, V	455	189...200
Rated current, A	6150	1300...2225
Rated power, kW	2800	260...423
Maximum forcing voltage, V	830	380...530
Forcing current, A	11200	2600...4150
Forcing duration, s	20	50
Multiplication factor of field forcing on voltage to rated field voltage, r.u.	2	2...3
Thyristor rectifier cooling system	water	natural air water

The structure of specific designation of thyristor autonomous excitation systems:

CTH -	XXX -	XXXX -	X	УХЛ4

- Climatic version, category of placing.
- Multiplication factor of forcing on voltage, r.u.
- Rated current, A
- Rated voltage, V
- Autonomous thyristor system

"ELSIB", besides the excitation systems, supplies the additional equipment for a providing with a technological cycle of the generators operation.

The electric braking systems for hydrogenerators

The electric braking system provides more effective and quick braking of hydro-unit in comparison with the mechanic way.

The electric braking of hydro-unit is fulfilled by the electromagnet moment creating at a mode of three phase short circuit of hydrogenerator.

At a content of the electric braking system, the following items are included:

- electric braking transformer;
- cabinet of electric braking system;
- thyristor converter.

As a thyristor converter, the complete converting and controlling shield of hydrogenerator excitation system is used.

The parameters of equipment of electric braking systems are defined by the parameters of hydro-generator.

By the orders of the hydraulic power plants, completely with the generators, the electric braking systems of hydro-unit can be supplied.

The thermal control systems of СТК–МП series for hydrogenerators

The thermal control systems of СТК-МП series are intended for continuous automatic control for a status of hydro-unit, for a comparison of measured values of temperatures with the settings and for a formation, on a ground of this comparison, of the signals and commands transmitted to the control system, the technological protections and alarming system.

The temperature measuring of the controlled points of hydro-unit is fulfilled by the reading of the copper resistance thermometers set in them.

The system consists of the measuring unit and displaying system.

The measuring unit of СТК–МП fulfils the following functions:

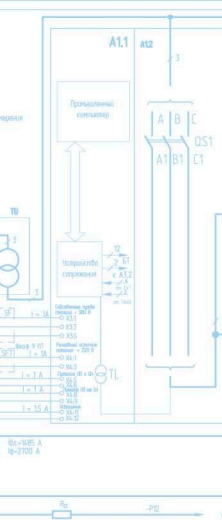
- revelation of temperature deviations for controlled points from specified value and a formation of the signals about these deviations for alarming system;
- revelation of non-admitted violations of temperature status and a formation of the commands of emergency stopping for a control system of hydro-unit;
- revelation of failures of the sensors and communication line;
- transmitting of information about the temperature status of unit and of other necessary information for a displaying system providing the information visible ability;
- self-diagnose operation of СТК, protection against failures and false operation, an indication of the failures and signalling about failures and supply failure of СТК.

The displaying system fulfils the following functions:

- continuous collection of information about the current temperature status of hydro-unit;
- collection of information about the violations of temperature mode of hydro-unit and the failures of СТК;
- preparation of statistic information about the temperature status of hydro-unit.

The information about the violations and failures is displayed by the operator's request, and also, documented as the tables.

The modifications of the СТК-МП system are defined by a quantity and type of the sensors mounted on a hydro-unit, and agreed with the Customer.



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VILYUI HPP

The automatized control systems of the technological parameters of turbogenerators and hydrogenerators

The generators issued by the enterprise can be completed not only with the excitation systems but the control systems of the technological parameters (CTK).

The control systems of the technological parameters (CTK) are intended for continuous control of the technological parameters of turbogenerators and hydrogenerators at a content of the automatized control complexes.

CTK is designed with the programmed controller consisting of processor, supply module and base panel on which the modules of discrete input and output are mounted.

The upgraded modification of the system provides:

- measuring of given set of the technological parameters (temperature of active parts, bearings, cooling media, electric parameters, air moisture, mechanic vibrations and vibrations of straight portions, moisture of insulation of inter-phase areas and others);
- checking of revelation of these parameters within the specified limits with a preparation of appropriate signals and messages, if any deviations from these limits, or at the failures of the measuring devices and control means of the system;
- monitoring of generator;
- a formation and preparation of shift report;
- a displaying of data requested by an operator and technologist as the tables, graphs or mnemonic diagrams;
- a formation of power diagram;
- a creation of files of the control results;
- a fulfillment of a number of service and maintenance functions.

The optional service capabilities which are not included at a base scope of delivery, can be fulfilled by the individual order.

The main capabilities:

- high accuracy and stability of the measurements;
- resistance to the interference;
- high reliability;
- flexibility in a connection and information exchange with other systems;
- rich service facilities;
- absence of strict requirements to the service conditions.

Service and engineering

By the orders from power plants, "ELSIB" fulfils the complex technical inspection of the equipment status after its durable service, it gives an appraisal of the current status and the recommendations on the further operation or modernization.

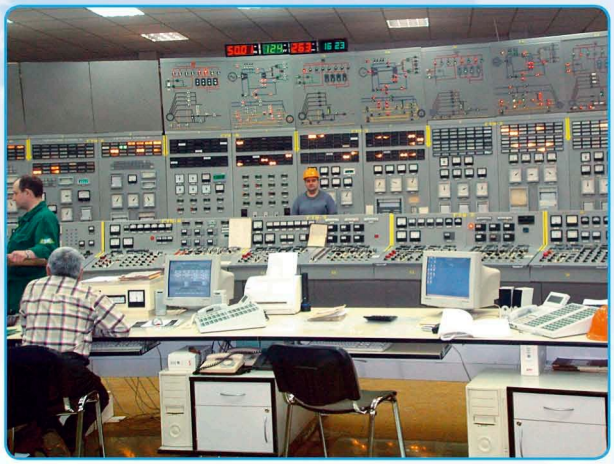
The enterprise presents:

- technical audit of the status of excitation systems serviced by the customer;
- preparation of the recommendations and proposals;
- commission and alignment, guaranty and service maintenance of the supplied excitation systems;
- supply of the spare parts, complete units and accessories for the schedule and restoration repairs;
- checking on a test stand before a delivery of equipment;
- training of staff of the power plants for an operation with our excitation systems;
- technical consulting and management at erection and alignment, liquidation of disrepairs, modernization.

"ELSIB" has an experience in a modernization of the equipment of the high frequency excitation systems of turbogenerators.

The modernization of high frequency excitation systems is done for an exclusion, from the system, of the additional exciters operating unreliably and for a replacement of the obsolescent panels of automatic excitation regulation.

Instead of the excluding elements, the microprocessor regulation system of turbogenerator excitation is used. The regulation system is designed as a cabinet MPCB-120 containing the microprocessor regulator of excitation and power output for a supply of the windings of autonomous excitation of high frequency exciter. The system has 100 % reservation of the excitation regulator and power thyristor converters. The technical characteristics are determined by the concrete parameters of the modernized excitation system.



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Reference – list

The supplies of the excitation systems of "ELSIB" since 1999.

Year	Plant	Country	Excitation system	Q-ty	Power, kW	Voltage, V	Current, A	Generator
1999	Barabinsk Tpp-2	Russia	СТС-220-1200-2,5-10,5-1-РВ УХЛ4	1	264	220	1200	ТФ-63-2У3
2000	TPP-11 Mosenergo	Russia	СТС-350-2000-2,5-10,5-1-РВ УХЛ4	1	700	350	2000	ТВФ-110-2ЕУ3
2000	TPP "Kostolac"	Serbia	СТС-350-2000-2,5-10,5-1 УХЛ 4	1	700	350	2000	ТВФ-110-2ЕУ3
2001	TPP-22 Mosenergo	Russia	СТС-350-2000-2,5-10,5-1-РВ УХЛ4	1	700	350	2000	ТВФ-110-2ЕУ3
2002	Yakutsk PP	Russia	СТСГ-250-2100-2,5-10,5-1-РВ УХЛ4	1	525	250	2100	ТВФ-63-2ЕУ3
2002	Gissarak HPP	Uzbekistan	СТС-КНФ-120-1100-2,5-10,5 УХЛ4	1	132	120	1100	СВ335/121-12 УХЛ4
2003	Yuzno-Kuzbass PP	Russia	СТС-330-1500-2,5-10,5-1Е-РВ УХЛ4	1	350	350	2000	ТФ-110-2У3
2003	TPP-22 Mosenergo	Russia	СТС-350-2000-2,5-10,5-1-РВ УХЛ4	1	700	350	2000	ТВФ-110-2ЕУ3
2004	Vilyui HPP-3	Russia	СТС-КНФ-300-1600-2,5-13,8-1Е УХЛ4	1	480	300	1600	СВ1280/145-68 УХЛ4
2004	TPP-28 Mosenergo	Russia	СТС-КНФ-220-1200-2,5-10,5-1 УХЛ4	1	132	220	1200	ТФ-63-2У3
2004	Novosibirsk TPP-3	Russia	СТС-КНФР-350-2000-2,5-10,5-1-РВ УХЛ4	1	700	350	2000	ТВФ-110-2ЕУ3
2004	HPP Naglu	Afghanistan	СТС-КНФ-200-1300-2,5-10,5-3Е Т4	1	260	200	1300	СВ525/110-24Т4
2005	TPP "OA Alyuminiy Kazalhstana", Pavlodar	Kazakhstan	СТС-КНФР-220-1200-2,5-10,5-1Е РВ УХЛ4	1	264	220	1200	ТФ-63-2У3
2005	TPP-2, Astana	Kazakhstan	СТС-КНФР-330-1500-2,5-10,5-1Е РВ УХЛ4	1	495	330	1500	ТФ-125-2У3
2005	TPP SKHK, Seversk	Russia	СТС-КНФР-330-1500-2,5-10,5-1Е РВ УХЛ4	1	495	330	1500	ТФ-110-2У3
2005	TPP-21 Mosenergo	Russia	СТС-КНФР-350-2000-2,5-10,5-1-РВД УХЛ4	1	700	350	2000	ТВФ-110-2ЕУ3
2005	Novosibirsk HPP	Russia	СТС-КНФР-400-2000-2,5-13,8-1 УХЛ4	1	800	400	2000	СВ1343/140-96
2005	TPP-2, Yaroslavl	Russia	СТС-КНФР-350-2000-2,5-10,5-11П-РВ УХЛ4	1	700	350	2000	ТВФ-110-2ЕУ3
2006	Novosibirsk HPP	Russia	СТС-КНФР-400-2000-2,5-13,8-1 УХЛ4	1	800	400	2000	СВ1343/140-96
2006	TPP AGK, Achinsk	Russia	СТС-КНФР-350-2000-2,5-10,5-11Е-РВ УХЛ4	1	700	350	2000	ТВФ-110-2ЕУ3
2006	TPP SKHK, Seversk	Russia	СТС-КНФР-220-1200-2,5-10,5-11П-РВ УХЛ4	2	264	220	1200	ТФ-63-2У3
2007	TPP-3 Minsk	Byelorussia	СТС-КНФР-200-1200-2,5-10,5-11П УХЛ4	1	240	200	1200	ТФ-80-2У3
2007	Geleznogorsk HPP	Russia	СТС-КНФР-330-1500-2,5-10,5-11Е РВ УХЛ4	1	495	330	1500	ТФ-125-2У3
2007	Tomsk PP-2	Russia	СТС-КНФР-220-1200-2,5-10,5-11Е-РВ УХЛ4	1	264	220	1200	ТФ-63-2У3
2008	Vyborg TPP17	Russia	СТС-КНФР-330-1500-2,5-10,5-11Е РВ УХЛ4	1	495	330	1500	ТФ-125-2У3

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Certificates

The excitation systems meet the requirements of GOST 21558-2000 and they are certified according to ISO 9001:2000. The microprocessor automatic excitation regulator has passed the complex inspection and tests with JSC "NII Postoyannogo toka" (St.-Petersburg) for a providing of the requirements on system reliability and stability of parallel operation of the power plant with power system.

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