

**Technical information of the equipment for which spare parts, gaskets and repair materials  
will be designed  
(TBB-1000-4Y3 turbine generators and ББД-4600-1500AY3 exciters)**

**1 Basic technical information for TBB-1000-4Y3 turbine generators.**

**1.1. General information.**

The turbine generator (which will be referred to hereafter as "generator"), is an implicitly pole synchronous electrical machine designed to produce electricity in continuous S1 operation according to IEC 60034-1 (2010) when directly coupled to a steam turbine and installed indoors in nuclear power plants. The generator is designed for operation at an altitude of not more than 1000 m and an ambient air temperature limit of +5 to +40°C. The construction of the machine is - hermetically closed and its degree of protection is IP54. The generator consists of:

- stationary part (stator) - comprising a core (active steel) and a stator coil which is connected to the mains;

- rotating part (rotor), on which are mounted 4 DC poles.

The mechanical energy transmitted from the shaft of the steam turbine to the shaft of the generator is converted into electrical energy by electromagnetic path, as in the rotor winding under the action of a constant electric current magnetic flux is excited, under the influence of which electromotive force is created in the stator winding and when connected under load, electric current with a frequency of 50Hz flows.

The main heat losses released in the stator winding are extracted by means of water flowing along the hollow wires of which the winding branches are located.

Heat losses released in the active steel, the rotor, the internal structural elements, mechanical losses from rotor friction with the gas and ventilation losses are extracted from the components by means of hydrogen gas. It circulates forcibly inside the generator and transfers the absorbed heat from the inside to the outside environment via 4 gas coolers (heat exchangers) in which technical cooling water flows. The heat thus removed from the stator interior (including the stator coil) is extracted by means of two circuits of cooling water: from the stator coil and from the heat exchangers - removing the heat from the hydrogen. The airtight housing of the generator is composed of three parts: one middle and two end parts.

In the middle part of the generator is located the active steel with the stator winding, and in the end parts are located the gas coolers, the end electrical leads and the hydraulic leads for cooling water inlet/outlet to the stator winding. External shields are mounted to the front parts of the end pieces to which the rotor shaft oil gasket assemblies are attached. The stator winding of the generator is three-phase with two parallel branches connected in a 'double star' connection. The temperature class of the insulation of the stator and rotor windings is "**Class F**", the highest permissible temperature of the active part of the generator is "**Class B**". The stator winding terminals are located on the end side of the excitation generator, as:

- 6 zero terminals are located on the upper side (forming the common star centre of the stator windings);

- 3 linear terminals are located in the bottom side (from which the produced electrical energy is discharged).

The gaskets to the rotor shaft are of the annular type, oil lubricated, single flow.

The excitation of the generator is carried out by a separate brushless excitation generator whose shaft is coupled rigidly to the shaft of the main rotor of the generator.

**1.2. Basic technical data.**

**1.2.1. The basic dimensional data of the generator are given in Table П3-1:**

Table II3-1

Name of parameter	Value
Mass of the middle part of the generator, kg	333600
End part weight (with mounting feet), kg	35650
Rotor mass, kg	155500
Stator gas volume (assembled), m <sup>3</sup>	120
Approximate length of generator with rotor mounted, mm	6300
Approximate height, mm	6700

1.2.2. 1.2.2 The basic nominal generator parameters are given in Table II3-2:

Table II3-2

Name of parameter	Value
Full power, kVA	1222000
Active power, kW	1100000
Voltage, V	24000
Stator current, A	29400
Rotor current, A (estimated)	7620
Rotor voltage, V (calculated at 75 °C)	480
Power factor	0.9
Efficiency factor, %	98.7
Connection diagram of the stator windings	double star
Number of terminals of stator windings	9
Operating current frequency, Hz	50
Rotor rotation speed, min <sup>-1</sup>	1500
Critical rotor rotation speed, min <sup>-1</sup>	1170/2330
Type of cooling gas in the housing	hydrogen
Rated operating pressure of the cooling gas in the housing, MPa	0.54
Maximum permissible pressure of the cooling gas in the housings, MPa	0.59

1.2.3. The basic generator cooling medium data are given in Table II3-3:

Table II3-3

Name of parameter	Value
Type of working cooling gas in the housing	hydrogen
Rated operating pressure of the cooling gas in the housing, MPa	0.54
Maximum permissible pressure of the cooling gas in the housings, MPa	0.59
Rated cool gas temperature, °C	32
Minimum cool gas temperature °C	20
Hydrogen purity, %	≥98
Permissible oxygen content in hydrogen, %	≤1,2
Relative humidity of hydrogen at nominal cool gas temperature, %	≤25
Dew point, °C	≤15

1.2.4. The basic data of stator winding cooling water are given in Table II3-4:

Table II3-4

Name of parameter	Value
Nominal flow, m <sup>3</sup> /h	225
Nominal operating water pressure at stator winding inlet, MPa	0.49
Maximum permissible water pressure at stator winding inlet, MPa	0.52
Nominal incoming water temperature, °C	40
Nominal specific electrical resistance, kΩ cm	200
Specific electrical conductivity at 25 °C, μS/cm	5
Permissible minimum specific electrical resistance, kΩ cm	100
Maximum permissible copper content, μg/kg	100
Maximum permissible oxygen content, μg/kg	400

## 2. Basic technical information for ББД-4600-15004Y3 excitation generators.

### 2.1. General information.

The excitation generator (which will be referred to as the "exciter" for short) is used to provide a constant excitation current to the rotor winding of the main generator. The exciter is an inverter type synchronous generator with an operating frequency of 150Hz. The machine is generally composed of:

- magnetic system;
- cooling;
- rotor with a rotating rectifier;
- conductive node;
- rotor and rotary rectifier current control system;
- current carrying knot.

The rotor shaft of the exciter is connected to the shaft of the main generator by a rigid flange connection. A current carrying assembly with positive and negative poles shaped like rod bus bars is located in the cavities of the two shafts and serves to carry the excitation current from the exciter to the rotor poles of the main generator. At the boundary of the rigid flange connection between the two rotors (exciter rotor and generator rotor), the electrical connection to their current carrying assemblies is also made.

The magnetic system of the exciter is made of 12 poles, which are symmetrically arranged around the cage of the rotor coil by means of a metal structure.

In the rotor grooves, a double-layer contour winding is arranged, connected in a double star, each phase having 6 parallel branches. The terminal ends of the parallel branches are electrically isolated from the rotor shaft and are connected to the rotary rectifier via externally located bus bars.

The rectification of the alternating current generated in the rotor is done by a rotary rectifier system (located on the rotor of the exciter), which is connected by a bridge circuit. The rotary rectifier system is made up of a set of semiconductor rectifier blocks (filled with diodes, fuses and filter groups /RC groups - for protection against switching overvoltage), which are arranged symmetrically in 36 pieces in two independent ventilation rings forming the anode and cathode of the current carrying circuit through which the excitation current flows.

### 2.2. Basic technical data.

The basic exciter rating parameters at rated cooling medium temperature are given in Table II3-5 (below):

Table II3-5

Parameter name /at direct current/	Value
Rated power, kW	3660
Continuous operation power, kW	4425
Power at boost for 15s, kW	14630

<b>Parameter name /at direct current/</b>	<b>Value</b>
Rated voltage, V	480
Voltage at continuous operation, V	528
Voltage at boost for 15 s, V	960
Rated current, A	7620
Current at continuous operation, A	8380
Current at boost for 15 s, A	15240
Rotational speed, min <sup>-1</sup>	1500

Each of the rectifier blocks of the rotary rectifier is made of:

- base, which at the same time is used as a cooler, made of aluminium alloy; - power /rotor/ diodes: Д105-630-24 YXJ2 and Д105-630X-24 YXJ2 - respectively anode and cathode type, manufactured in Republic of Mordovia, Russia;

- fusible power fuses, type: № C1GAB10C500, cat. №C1GAB10C500, drawing D1012417 (1000V, 500A) "Ferraz Shawmut", manufactured by "MERSEN SB SAS" France.

Additionally, to each rectifier block is installed a RC filter unit, which protects the semiconductor elements of the rectifier blocks from damage due to switching overvoltage.