

1. Solutions for the secondary part

1.1. I&C NO (I&C Normal Operation)

We offer the supply of a new or modernized I&C Normal Operation system (I&C NO). The system complies with the current legislative requirements in terms of providing nuclear safety, operation reliability and staff comfort while complying with strict qualification requirements.

The system performs control and information functions, enables collection of operational and diagnostic data from connected measuring circuits, actuators and other equipment. The system is based on the SandRA platform using the Z100 and Z200 technical means. The system executes safety functions of category A, B and C according to ČSN EN 61226 and communicates with the unit control and information system (UCIS).

The system processes and verifies data, enables online diagnostics and periodic testing of equipment functions. The data is subsequently transmitted to the unit diagnostic and information system. Individual parts of the system belong to the third, second and first level protection line.

The I&C Normal Operation system supplied by ZAT a.s. currently provides reliable and safe control of primary circuit technological equipment at VVER440 type reactors. We are however **ready to apply the system to VVER reactors of different power output as well as to other types of larger and small nuclear reactors.**

1.2. TPS (Turbine Protection System)

The Turbine Protection System is a top-quality and highly reliable system that ensures safe operation of the turbine set.

The system is of a three-channel design, with triple inputs and outputs. Simple actuators are connected via modules enabling 2-out-of-3 selection. In the case of triple actuators, a single actuator is always controlled from one channel.

For controlling and communicating, the panels at operator stations are used. The system performs safety functions of category B according to ČSN EN 61226 and it is based on the SandRA platform using HMI and Z100 technical means. It also communicates with the unit control and information system (UCIS). The system is also certified at the SIL3 (Safety Integrity Level) according to ČSN EN 61508.

Within the secondary part technological equipment, the Turbine Protection System supplied by ZAT a.s. **ensures safe and reliable operation of turbines of various types and power output.**

1.3. TCS (Turbine Control System)

The Turbine Control System serves for controlling and regulating the turbine and it is a top-quality and highly reliable system comprising two subsystems.

The first, regulation, subsystem is of a two-channel design with Y-branched inputs and it operates in a Master–Slave mode. Both channels are equipped with own input/output transducers. The valve control outputs are connected from each channel to a particular actuator (transducer) and the outputs from both channels are permanently active. For rotation speed measurement, three-channel HW inputs are used.

The other, control, subsystem is of a two-channel design, with Y-branched inputs and double inputs for actuator control. The control system operates in the 1-out-of-2 mode with a HW sum of signals per an actuator.

For controlling and communicating, the panels of operator stations are used. The system performs safety functions of category C according to ČSN EN 61226 and it is based on the SandRA platform using HMI and Z200 technical means. It also communicates with the unit control and information system (UCIS).

Within the secondary part technological equipment, the Turbine Control System supplied by ZAT a.s. **ensures safe and reliable operation of turbines of various types and power output.**



1.4. ES TG (Turbine Generator Excitation System)

The ES TG system is based on the use of the compact AVR Safety excitation regulator. The regulator is designed as a single-board module and it includes phase thyristor control, programmable gate array, two single-chip microcomputers of the ARM architecture as well as CAN, USB, RS232 and Ethernet communication adapters. The regulator control panel and the keyboard are embedded in the cabinet front door. There are several screens at the panel that display all the information on the state of the excitation system and values measured at the generator. There are command buttons at the panel serving for local control of excitation. A similar control panel is also offered for the unit control room.

The voltage regulator functions include:

- Regulation of voltage and idle power (voltage precision regulation at the generator terminals at a steady state being better than 0.5 %)
- Voltage aligning before the generator is synchronized to the grid
- Setting the zero idle power before the generator is switched off from the grid
- Regulation of excitation current during test implementation and upon the outage of stator voltage measurement
- Inverted operation of the thyristor rectified for the purpose of operational de-excitation of the generator
- Stator and rotor current limiters with a variable delay depending on the overcurrent value
- Voltage limiter and U/f limiter
- Under-excitation limit monitoring
- System stabilizer
- Generator phaser
- Sequential control of the excitation system, failure diagnostics and automatic transitions between the channels

The system performs safety functions of category C according to ČSN EN 61226 and it is based on the SandRA platform using the Z110 technical mean. It also communicates with the unit control and information system (UCIS).

The Turbine Generator Excitation System can be extended by the generator synchronizing equipment using the DSD Z110 technical mean. The generator synchronizing equipment is also of a single-board design and it includes analogous measuring inputs, programable gate array, two single-chip microcomputers of the ARM architecture as well as USB, RS485/422 and Ethernet communication adapter.

The synchronizing equipment functions include:

- Automatic switching of the generator power switch
- Monitoring and checking of switching

To ensure full control and maximum security of switching, a two-channel arrangement is used (there are two ZAT DSD 110 devices whereas one of these performs automatic switching and the other one performs checking and monitoring)

Where the ZAT AVR 110 excitation regulator is used, automatic switching is performed by the excitation regulator, while checking and monitoring is performed by a single ZAT DSD 110 device.

The Turbine Generator Excitation System supplied by ZAT a.s. **ensures safe a reliable voltage regulation and possibly phasing of the turbine generator at a nuclear power unit.**

The excitation system may be designed and implemented in accordance with the requirements of a particular customer and that is either as a replacement of the entire system or by means of modernizing the excitation control part only.



1.5. ES DG (Diesel Generator Excitation System)

The Diesel Generator Excitation System used within the excitation assembly is based on the use of the compact AVR Safety excitation regulator. The system is designed for emergency power supply of the nuclear power plant primary circuit and by means of its output (excitation current value) it ensures precise regulation of generator stator voltage and other quantities relating to electrical energy production.

The system performs safety functions of category A according to ČSN EN 61226 and it is based on the SandRA platform using the Z110 technical mean. It also communicates with the unit control and information system (UCIS).

The Diesel Generator Excitation System supplied by ZAT a.s. **ensures safe a reliable emergency power supply of the nuclear power unit primary circuit.** The excitation system may be designed and implemented in accordance with the requirements of a particular customer and that is either as a replacement of the entire system or by means of modernizing the excitation control part only.

