

## 1. Solutions for the primary part

### 1.1. RRCS (Reactor Rod Control System)

We offer supply of a new or modernized Reactor Rod Control System (RRCS) compliant with current applicable legislative requirements in terms of providing nuclear safety, operation reliability as well as staff comfort while complying with strict qualification requirements.

The new modernized Reactor Rod Control System is essential for ensuring nuclear safety of new or modernized nuclear power units. Its design is based on the SandRA platform using the state-of-the art ZAT SandRA Z100 digital control and information system, ZAT Horus HMI system and it executes B and C category functions according to ČSN EN 61226. The system communicates with the unit control and information system (UCIS).

Its key properties and advantages comprise more precise evaluation of the control rod position in the case of rotary drives (in the case of stepper drives, higher accuracy depends on the position indicator used). Furthermore, RRCS has integrated testing modes that serve for the execution of tests during reactor commissioning and contribute to shortening the time of system maintenance during planned outages. The system design lifetime of up to 30 years supported by the SandRA control system lifecycle includes extensive diagnostics of the drive, cluster and fuel assembly mechanical condition.

The power output part is supplied with respect to the control mechanism type either for linear stepper drives of the LKP-M, LKP-M/3 to LKP-M/4, ШЭМ-3 type or for synchronous rotary drive of the RD42, РД42-4Р type.

The system ensures power supply and position evaluation from UP-1 to UP-3, UP-4, ДПШ type sensors for linear stepper drives and from LD-1, ИДП type sensors for synchronous rotary drives.

The Reactor Rod Control System supplied by ZAT a.s. currently ensures reliable and safe nuclear fission in VVER440/1000/1200 type reactors. At the same time, **we are ready to apply the system to other types of control mechanisms as well as to other types of larger and small nuclear reactors.**

### 1.2. RCS (Reactor Control System)

The Reactor Control System (RCS) is designed for automate control of the reactor neutron output and steam pressure in the main steam collector. The system is designed using the SandRA Z100 platform.

We execute supplies of both a new and modernized pressurized water reactor control system compliant with current applicable legislative requirements in terms of providing nuclear safety, operation reliability and staff comfort. The new pressurized water reactor control system is designed using the state-of-the art ZAT SandRA Z100 digital control and information system and it executes B category functions according to ČSN EN 61226. The system communicates with the unit control and information system (UCIS).

The system is designed to control the reactor power output according to the turbine generator output and to stabilize the desired reactor neutron output level. It provides base load operation as well as load monitoring not requiring reactor shutdown or pressure release.

The function of the equipment that is active under normal operating condition is permanently monitored by measuring respective parameters whereas exceeding of preset limit values is indicated. The equipment condition is checked during its operation by means of an automated operation diagnostic system. Data collection and its transmission to the company network for archiving and further evaluation is executed using state-of-the art computer technology.

The reactor control system supplied by ZAT a.s. currently ensures reliable and safe reactor output control in VVER440 type reactors. At the same time, **we are ready to apply the system to reactors of different output as well as to other types of larger and small nuclear reactors.**



### 1.3. RTB (Reactor Trip Breaker)

**The Reactor Trip Breaker (RTB) is designed to promptly disconnect the power supply to reactor control mechanisms.**

The RTB is divided in two identical sets that are serially connected to ensure higher reliability. These sets are located in separate rooms and cannot be disabled simultaneously.

When even one of the RTB sets is activated, power supply to control mechanisms is safely disconnected and then the reactor is promptly shut down.

The system operates based on commands from related protection systems and commands from the unit and emergency control room operator. The embedded user functions enable easy testing of power isolator switching on/off and diagnostic data collection. Information on the status of main functions, detection and indication of any failure occurred in the RTB system is also displayed. The system communicates with the unit control and information system (UCIS).

The RTB system performs the highest safety function of category A according to ČSN EN 61226 and has been designed using the ZAT-RA technical means.

The Reactor Trip Breaker system supplied by ZAT a.s. currently ensures reliable and safe reactor output control in VVER440 type reactors. At the same time, **we are ready to apply the system, based on a respective specification, to reactors of different output as well as to other types of nuclear reactors.**

### 1.4. RVLIS (Reactor Vessel Level Instrumentation System)

The system serves for monitoring the water level in the reactor vessel using water level monitoring assemblies compliant with all design safety measures and requirements for geometry and design. The system uses KNI-LM assemblies designed by ŠKODA JS a.s. based on so-far used in-core neutron flux monitoring (KNI). The measured water level values are transmitted to the post-accident monitoring system (PAMS).

The system uses redundant water monitoring assemblies and both heated and non-heated thermocouples are used as sensors. These are characterized by a good thermal contact with the inner surface of their common tube. Non-heated thermocouples serve as reference sensors which makes the system independent from the medium temperature.

The system performs safety functions of category A according to ČSN EN 61226 and it is based on the SandRA platform using the Z100 technical means. The system communicates with the unit control and information system (UCIS).

The reactor vessel level instrumentation system supplied by ZAT a.s. currently monitors the in-vessel water level at VVER440 type reactors. **we are ready to apply the system to reactors of different output as well as to other types of nuclear reactors.**

### 1.5. IN-CORE (Reactor Vessel Level Indication System)

The system is designed for automated and centralized data collection and processing according to fixed algorithms. The system ensures real-time processing of basic information on the condition of the reactor core, primary circuit and significant parameters of the secondary circuit.

The IN-CORE system includes collection of data from technological sensors (in-core neutron flux sensors, temperature sensors), collection of data from other APCS systems, input data processing (linearization, correction). Further it performs calculations, data preparation, its transmission to the superior system and its displaying at operator stations. The system executes safety functions of category C according to ČSN EN 61226 and it is based on the SandRA platform using the Z200 technical means. The system communicates with the unit control and information system (UCIS).

Besides standard diagnostics of input signals, the system also performs diagnostics of the insulation state of sensors (carried out once a year during a refueling outage) as well as sensor vibration diagnostics.



The IN-CORE system supplied by ZAT a.s. currently provides reliable and safe processing of information of the core, primary and secondary circuit state at VVER440 type reactors. We are however **ready to apply the system to other types of larger and small nuclear reactors as well as to reactors of different power output.**

## 1.6. 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 part 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.**

## 1.7. PAMS (Post Accident Monitoring System)

The system is a special, top-quality and reliable display system designed for processing and displaying nuclear power plant parameters essential for its safety that would have to be used by the plant operators under emergency conditions.

Its primary functions include displaying of parameters necessary for post-accident monitoring. It particularly monitors nuclear power plant critical safety functions as well as disruption of protections against fission product release. It confirms correct function of safety systems and enable the operators in the unit control room to make any necessary safety-related decisions. Furthermore, it confirms safe reactor shutdown.

Its secondary functions include providing information for accident cause determination and providing information enabling to instruct other staff to carry out specific and adequate activities to ensure plant safety.

The system performs safety functions of category B, C according to ČSN EN 61226 and it is based on the SandRA platform using the Z100 technical means.

The Post Accident Monitoring system supplied by ZAT a.s. currently provides processing and displaying of nuclear power plant parameters essential for its safety at VVER440 type reactors. **We are however ready to apply the system to reactors of different power outputs as well as to other types of larger and small nuclear reactors.**

