CURTISS-WRIGHT

Rivne NPP Implements RadICS Digital Safety System

DIGITAL CONTROL SYSTEM SOLUTIONS

Organization
Rivne, a nuclear power plant operating in the Ukraine.

Challenge
Plant-wide upgrades sought to achieve a higher level of accuracy and greater control over the technical parameters governing the plant's safety systems.

Solution
Upgrade existing systems using the RadICS platform to increase safety, availability, and long-term operational stability of the plant.

Results
The plant now has a more modern, efficient, and cost-effective digital safety platform.

radICS

Curtiss-Wright has partnered with Radics, LLC—an international nuclear engineering company specializing in advanced, customized I&C solutions— to bring the RadICS digital instrumentation platform to the U.S. nuclear power market.

Operated by the Ukraine National Nuclear Energy Generating Company—also known as Energoatom—Rivne Nuclear Power Plant (NPP) maintains four nuclear operating units with a total electrical capacity of 2,835 MW. Two VVER-440 power units, a type of pressurized water reactor common in Eastern Europe, were put into operation in 1980 and 1981, while one VVER-1000 reactor was put into operation in 1986 and a second was put into operation in 2004.

Since 2017, Radiy has supplied several I&C systems at Rivne Nuclear Power Plant in Varash, Ukraine based on the RadICS digital safety platform. Rivne NPP selected the RadICS platform for the flexibility of its digital architecture, logical design, near-100 percent diagnostic coverage, channel redundancy, and compliance with the latest nuclear regulatory requirements.

ADOPTING MODERN DIGITAL CONTROLS

Previously, Rivne NPP depended on a unified set of Kaskad-2 I&C systems (also called UKTS). While these units did the job, Aleksandr Puzyrnikov, Deputy Head of Rivne NPP's I&C division, and his team wanted to achieve a higher level of accuracy and greater control over the technical parameters governing the plant's safety systems. Furthermore, as the Kaskad-2 system reached the end of its useful life, the team found it progressively more difficult to obtain diagnostic information for internal and external communication. They were also frustrated by a lack of diagnostics information for internal and external communication.

Under the direction of Aleksandr Puzyrnikov, Rivne NPP developed the requirement specifications for new I&C equipment based on the latest Ukrainian nuclear and radiation safety requirements. Mr. Puzyrnikov is charged with operating and maintaining the plant's I&C systems in conjunction with its safety systems, plant processing systems, in-core monitoring systems, reactor protection systems, interlocks, and alarm systems.

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Digital Safety Systems Require Fewer Equipment Racks, Reducing the Total Data Center Footprint

The team adhered to established procedures specified by Energoatom, and new equipment was procured according to all current Ukraine legislation. Radiy specialists were involved at all stages of generating these requirements specifications for the I&C systems; they determined that replacing the old analog safety system was necessary based on deviations from the nuclear and radiation safety requirements associated with the old Kaskad-2 systems. They wanted to comply with today's stronger Ukrainian and international nuclear and radiation safety requirements, and specifically address aging UKTS hardware and the absence of UKTS hardware diagnostics.

"Radiy personnel actively participated in the I&C system modernization project and provided recommendations at each stage of the implementation through electronic communications, onsite visits, and discussions by Rivne NPP specialists at Radiy and Rivne NPP sites," Puzyrnikov says.

A ROBUST AND FLEXIBLE ARCHITECTURE

The RadICS platform is designed to be functionally and physically similar to currently installed I&C systems, which allowed Rivne NPP to streamline the installation, reengineering, and upgrade process. The user-friendly platform includes Field Programmable Gate Array (FPGA) chips as computational engines, which are highly regarded for their ability to support both digital and analog input/output (I/O) modules and deliver responses as fast as 10 milliseconds. These general-purpose building blocks can be configured according to the needs of each project and system. Rivne NPP now relies on RadICS as the basis for several new digital safety systems, including the Conventional Island (CI) I&C System, the Nuclear Island (NI) I&C System, and two new Engineered Safety Factors Actuation Systems (ESFAS).

The Unit 3 CI I&C System, operational since February 2017, includes a new turbine control system that provides conditioning and initiation of protection, interlocks and alarm signals, as well as conditioning and initiation of automatic regulation signals when process values deviate from setpoints. It also generates operator initiated remote control signals, and indicates the operator of actuators and control room statuses.

The Unit 3 NI I&C System, which has been operational since July 2018, also provides conditioning and initiation of protection, interlocks, and alarm signals, as well as conditioning and initiation of automatic regulation signals when process values deviate from setpoints. This system generates operator initiated remote control signals, and indicates the operator of actuators and control room statuses.

Rivne NPP's two new Unit 3 ESFAS – one of which has been operational since May 2018 and the other since August 2019

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— Aleksandr Puzyrnikov, I&C Manager

– offer even more benefits. These systems provide protection, blocking, and monitoring of the automated operation of actuators; automatic process control; and manual remote control of actuators.

This new equipment consumes a smaller equipment footprint than the analog equipment it has replaced, while also adding significantly more diagnostic and monitoring capabilities. The total number of cabinets has also been significantly reduced.

In addition, the new RadICS system is much simpler – there are only 10 module types (based on the use of FPGA chips), as opposed to 34 module types with the old UTKS safety system. "The convenience has increased, human errors have been virtually eliminated, the labor force spends less time on technical maintenance, and modern software has allowed for greater automation of key processes and procedures," Puzyrnikov reports.

RAPID IMPLEMENTATION CYCLE GIVES QUICK SUCCESS

Radiy spearheaded the implementation in conjunction with the Rivne NPP team and various local contractors and trade professionals, many of which were recommended by plant management. A certain amount of reverse engineering and innovative thinking was required to fully establish the original functionality, but Radiy was able to help the team identify issues and formulate solutions based on cumulative experience gained from other digital safety system projects. As issues arose, Rivne NPP received prompt assistance from Radiy personnel.

"All work by Radiy and its subcontractors was performed effectively and competently," Puzyrnikov notes. "They met the terms we established under the approved schedule and exhibited a high level of professionalism."

Radiy's expertise was critical to accomplishing this mission with the plant staff. The team was well organized, which allowed them to make quick progress with the installation of the new digital safety systems.

The new digital safety system meets the following important safety standards from the IEC/IAEA, including: reliability; single failure; redundancy; independence; common cause failure protection; technical diagnostics and monitoring availability; functions quality; functions stability; resistance to power parameter variations; electromagnetic compatibility and emission restriction; personnel error prevention; unauthorized access protection; and cybersecurity.

FLAWLESS OPERATION, OUTSTANDING RESULTS

Today, Rivne NPP depends on the RadICS platform to continuously monitor system status through signals that are received from field sensors. It performs logic computations to create control commands, and converts control commands to output signals that are applied to field actuators.

According to Puzyrnikov, the RadICS platform is highly reliable. "The RadICS platform has an easy-to-use human-machine interface that gives us full coverage of all on-line diagnostic functions and that optimizes surveillance testing for the plant's safety systems," he says.

The extensive programming/coding flexibility within the FPGA chips allows the team to operate the plant more easily and efficiently. The chips make it easy to tune and adjust setpoints as well as to collect and transfer plant and diagnostic data to a monitoring station via the redundant communications interface. Because of expanded monitoring and diagnostic information now available, routine work, such as testing and preventive maintenance, is easier, faster, and more informative, reducing overall labor.

"RadICS-based systems are advanced, highly reliable, and comply with the latest national rules and requirements for nuclear radiation and safety, as well as with pertinent international nuclear standards," Puzyrnikov says.

This new digital safety system delivers safety improvements that were not available with the old analog system, such as continuous diagnostics, more robust monitoring capabilities, and detailed performance indicators for operations and

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Rivne Nuclear Power Plant, Ukraine

maintenance staff. These automated capabilities eliminate the need for scheduled online surveillance activities and facilitate condition-based maintenance, boosting the efficiency of the maintenance staff. Defects or faults of any component are immediately detected and rectified by Rivne NPP personnel. None of the Rivne NPP units have experienced a shut down due to systems failure, experienced a spurious actuations, or had any unwanted shutdowns since the installation of the system.

As part of the upgrade, the team replaced old copper cable runs with fiber optic communication links, reducing the cabling footprint ten-fold. This has also served to improve the plant's overall safety posture, since less copper reduces the fire load in the power unit cable structures. Furthermore, the fiber optic links improve performance, are immune to signal noise, and are more reliable.

Rivne NPP now has a more modern, efficient, and cost-effective digital safety platform. The RadICS platform has minimized the footprint in the data center, since fewer equipment racks are needed for the digital gear, and has also reduced the number of modules, which means fewer spare parts have to be stocked in the warehouse. Rivne NPP has improved its diagnostic capabilities, which streamlines routine maintenance and troubleshooting; fewer staff hours are required to operate, maintain, and troubleshoot the system. This improved system reliability means less frequent corrective maintenance.

INTEGRATED DIGITAL SAFETY SOLUTIONS FROM CURTISS-WRIGHT

Based in part on Radiy's successful implementations at Rivne NPP and other sites around the world, RadICS has become an essential component in a new set of digital safety systems that Curtiss-Wright offers to the U.S. market. As a systems integrator, Curtiss-Wright brings together the best available hardware and software components for each project. The RadICS platform forms the basis of Curtiss-Wright's NRC-approved Digital Safety System, a functionally and technologically diverse replacement for analog and digital safety-related systems at nuclear power plants throughout the United States. The July 31, 2019 U.S. Nuclear Regulatory Commission approval of the RadICS I&C platform for use in safety-related systems in nuclear power plants paves the way for this technology at U.S. nuclear power plants.