

Year 2000 rolls smoothly by Soviet-designed reactors

Highlight

After nearly two years of cooperative efforts, the year 2000 arrived, testing the extensive preparations by Soviet-designed nuclear power plants in Armenia, Bulgaria, Czech Republic, Hungary, Kazakhstan, Lithuania, Russia, Slovakia, and Ukraine to overcome the year 2000 (Y2K) computer bug. Things went smoothly, first at Bilibino nuclear power plant (NPP) in far-eastern Russia and hours later at the other plants.

The U.S. Department of Energy (DOE) supported the preparations, focusing most of its efforts in Russia, Ukraine, Armenia, and Kazakhstan. Plant staff carried out the actual reviews, remediation, and contingency planning, with DOE providing training, consultation, and equipment. Power transmission and distribution specialists also were heavily involved in the extensive preparations in these countries.

During the date rollover, DOE provided technical experts at the Minatom and Rosenergoatom crisis centers in Moscow, Russia, and at the State Nuclear Regulatory Administration emergency control center in Kyiv, Ukraine. Using dedicated satellite communications systems, the U.S. specialists were in contact with the DOE Crisis Center in Washington, D.C., to keep the Department informed of the status of the Soviet-designed plants as the New Year moved westward across the globe.

U.S. and local specialists were confident that serious bugs in computer equipment had been fixed. Many of the nuclear power plants in these countries were less reliant on computers than similar plants in the United States. In particular, the critical safety systems are analog and immune to the Y2K bug.

Through its own program and often in coordination with other international organizations, DOE provided workshops, guidance, and replacement equipment to counteract the expected problems in computer systems important to safety. Specifically, plant sites had the opportunity to participate in technical exchanges for sharing Y2K information that

- supported their inventories of noncompliant digital systems
- assisted in their conduct of Y2K assessments



***Reactor module safety
improvement work
begins***

- provided hardware and software for their efforts to fix high-priority items
- provided assistance in developing contingency plans.

In addition, DOE provided some of the plants with a software-scanning tool to analyze and fix date-related problems in computer system source codes.

Work continued into December 1999 and, in some cases, projects were completed just before the date rollover. DOE tracked the progress at the plants on a biweekly basis during the past six months. A few items that were not critical to safety continue to be fixed at the plants. However, the absence of any major incident stands as a testament to the success of the overall Y2K cooperative effort. (Richard Reister, DOE, 301-903-0234; Tye Blackburn, PNNL, 509-372-4092) v

Russia

The Russian nuclear regulatory agency Gosatomnadzor (GAN) requires that electronic systems be tested and their performance verified before being placed into operation at Russian nuclear power plants. The All-Russian Institute for Nuclear Power Plant Operations (VNIIAES) proposes to use an analytical simulator to test such systems. To support this concept, DOE initiated a project to improve the safety of the electronic modules used in the control systems of Russian reactors by transferring U.S. digital control technology to Russia's nuclear industry.

During the week of December 13, five Russian specialists toured various facilities in the United States to gather information on digital control technology and equipment applicable to nuclear power plants. The specialists represented VNIIAES, Atomenergoproekt (the architect/engineer firm for non-nuclear portions of nuclear power plants with RBMK and VVER reactors), and Kursk NPP. U.S. facilities visited included

- the Foxboro Company in Foxboro, Massachusetts, to obtain information regarding Foxboro's Intelligent Automation series of control systems
- the Westinghouse Nuclear Power Division, for a presentation on a Westinghouse-developed process control and information technology
- Oconee NPP, where plant representatives presented design and testing details of the plant's new integrated control system and the simulator used for operational testing before placing the system into actual operation
- the U.S. Nuclear Regulatory Commission, for discussions of how the commission reviews digital instrumentation control systems for use in nuclear power plants.



Third safety parameter display system planned for Novovoronezh

Participants review safety parameter display system projects for Ukraine's VVER-1000 reactors



U.S. team members from Oak Ridge and Pacific Northwest national laboratories accompanied the Russian specialists during their visit. (Richard Reister, DOE, 301-903-0234; Ronald Wright, PNNL, 509-372-4076) v

U.S. and Russian specialists met in December to define the requirements for the safety parameter display system planned for Novovoronezh Unit 5. Participating in the discussions were representatives of Rosenergoatom, Novovoronezh NPP, the Russian design organization ConSyst, and U.S. contractor Burns & Roe Enterprises, Inc. Specialists from Pacific Northwest National Laboratory also were present.

Unit 5, a VVER-1000 reactor, will be the third unit at Novovoronezh to be outfitted with this safety-enhancing system. In 1999, Science Applications International Corporation and ConSyst completed work on safety parameter display systems installed in Novovoronezh Units 3 and 4 (VVER-440 reactors). Now in the pilot operation mode, those systems are functioning exactly as intended. On the Unit 5 project, ConSyst again will be the primary Russian contractor, working in collaboration with Burns & Roe. (Richard Reister, DOE, 301-903-0234; Rich Denning, PNNL, 614-424-7412; Frank Panisko, PNNL, 509-372-4472) v

Ukraine

To assess progress and develop plans for calendar year 2000, the steering committee for Ukraine's VVER-1000 safety parameter display system projects held a mid-December meeting. Committee members from Ukraine include representatives of Energoatom, the Nuclear Power Plant Operational Support Institute, Westron, and Khmelnytsky, Rivne, South Ukraine, and Zaporizhzhya NPPs. U.S. team members represented Westinghouse Electric Company, Pacific Northwest National Laboratory, and Burns & Roe Enterprises, Inc. Burns & Roe hosted the three-day meeting at its facilities in Oradell, New Jersey.

Highlights of progress to date include the full installation and current pilot operation of the safety parameter display systems at Khmelnytsky Unit 1, South Ukraine Unit 1, and Zaporizhzhya Unit 5. Ukraine's State Nuclear Regulatory Administration requires one full year of successful pilot operation before the systems can be declared fully operational.

In addition, the systems for Rivne Unit 3, Zaporizhzhya Unit 3, and South Ukraine Unit 2 have undergone successful factory acceptance testing at Westron facilities in Kharkiv. The Rivne Unit 3 system is completely installed at the plant and awaits

***Ukrainian specialists
participate in
Kyiv seminar***

plant permission/startup so final site acceptance testing can be performed. The system for Zaporizhzhya Unit 3 will undergo site acceptance testing and official turnover to the plant during January 2000. Pilot operation is scheduled to begin immediately afterward. The South Ukraine Unit 2 system is being installed at the plant. Installation initially was planned for completion in January, followed by site acceptance testing, turnover, and start of pilot operation. However, those activities are being delayed until March 2000 when South Ukraine Unit 2 is scheduled to restart after an extended shutdown.

In other action, committee members began work on the remaining system projects, ordering the long lead-time hardware for South Ukraine Unit 3 and Zaporizhzhya Units 2 and 4. These three systems are scheduled to be installed and turned over to those plants in mid- to late 2000. The current schedule also calls for installation of the final two systems during 2001 at Zaporizhzhya Units 1 and 6.

Based on the success of their efforts, steering committee members voted to rewrite their charter, transforming the committee into a working group, to meet only as needed until the remaining projects are completed. (Richard Reister, DOE, 301-903-0234; Rich Denning, PNNL, 614-424-7412; Frank Panisko, PNNL, 509-372-4472) v

In early December, U.S. specialists from Brookhaven National Laboratory presented a seminar in Kyiv on methodologies for quality assurance and peer review activities. Technical staff of Engineering Technologies and Developments (ET&D), the Ukrainian firm selected to provide those services for the in-depth safety assessment of South Ukraine NPP, hosted and conducted a majority of the seminar. Two specialists from the International Chernobyl Center in Slavutych also participated at the invitation of team members from DOE.

The U.S. presenters first described how to perform quality assurance audits of a probabilistic risk assessment project. Second, in the peer review portion of the seminar, they discussed the rationale and methods used to perform technical reviews of a probabilistic risk assessment project. The three days of presentations and accompanying discussions were held to support ET&D staff preparation of the peer review plan for reviewing the South Ukraine NPP probabilistic risk assessment. (Walter Pasedag, DOE, 301-903-3628; Ted Ginsberg, BNL, 516-344-2620) v



***Key analytical model
work completed for Rivne
safety assessment***

In collaboration with staff of Rivne NPP, specialists from Energorisk (Rivne's Ukrainian subcontractor) completed work on two principal analytical models for use in the in-depth safety assessment of Rivne Units 1 and 2. The analytical models—also referred to as ***input data decks***—are essential for completion of specific individual calculations that must be performed as part of the overall deterministic safety assessment for Rivne NPP.

In late November, Energorisk specialists finished modifying the RELAP5 basic thermal-hydraulic input data deck completed in October 1999. The modifications, including verification and validation of input data and models, will enable specialists to apply the RELAP5 model to the design-basis accident analyses of Rivne Unit 1.

In December, Energorisk specialists completed the MELCOR input data deck for Rivne Unit 1. The MELCOR deck provides the basic input data for analyses of the ability of Units 1 and 2 to mitigate consequences of accidents. This deck includes a detailed model of the bubbler condenser system, unique to the VVER-440 Model 312 reactor, for suppressing pressure and containing radioactive material in the event of an accident.

The design-basis accident analysis is an essential component of modern technology for assessing risks and identifying areas on which to focus resources for plant safety upgrades. The two models, completed in accordance with modern techniques for quality assurance and validation/verification, transfer the technology needed so Ukrainian team members can conduct the design-basis accident analyses for the Rivne in-depth safety assessment.

Also in December, Energorisk specialists finalized the definitions and category grouping of initiating events to be addressed in the Level 1 probabilistic risk assessment for Unit 1. This deliverable also provides an essential basic step for subsequent risk assessment work by the Ukrainian team. (Walter Pasedag, DOE, 301-903-3628; Charles Dickerman, ANL, 630-252-4622) v

***Ukrainian plant safety
assessment projects
reviewed***

U.S. and Ukrainian participants reviewed progress and plans for two safety assessment projects under way at nuclear power plants in Ukraine. Meeting December 6 through 10 at Argonne National Laboratory, in Argonne, Illinois, participants reviewed deliverables submitted as part of work on the design-basis accident analyses and Level 1 probabilistic risk assessments being done at Rivne and South Ukraine NPPs. Team members also prepared and agreed upon detailed schedules for completing those assessment tasks at both plants.

Meeting participants included Ukrainian and U.S. specialists involved in the in-depth safety assessments for the two plants. Two additional U.S. specialists joined the meeting for two days to



***New training program
implemented***

***Safety parameter
display system
nearing completion***

***VUJE specialists
demonstrate
computerized system for
project data collection***



review Ukrainian bounding mode analysis scenarios for analyzing the Rivne Unit 1 emergency operating instructions. (Walter Pasedag, DOE, 301-903-3628; Charles Dickerman, ANL, 630-252-4622; Christian Kot, ANL, 630-252-6151) v

Armenia

In collaboration with specialists from Sonalysts, Inc., training staff of Armenia NPP implemented a new instructional program for plant staff during the week of December 13. Five plant workers—four technicians and one supervisor in radiation protection—served as trainees for the new Radiation Protection Technician program. Training specialists from the International Atomic Energy Agency and Human Performance Analysis Corporation also participated in the program implementation. Based on successful implementation of this pilot session, the radiation protection course now will be taught to all plant workers. (John Yoder, DOE, 301-903-5650; Don Draper, PNNL, 509-372-4079)

In December, specialists from Data Systems & Solutions (DS&S) successfully finished their work to implement a safety parameter display system at Armenia NPP. All that remains to complete the project is the site acceptance testing, which is expected to be conducted in January. DS&S, a joint venture between Science Applications International Corporation and Rolls Royce based in Delaware, Ohio, is a subcontractor to the U.S. firm of Burns & Roe Enterprises, Inc. (Richard Reister, DOE, 301-903-0234; Rich Denning, PNNL, 614-424-7412; Frank Panisko, PNNL, 509-372-4472) v

Czech Republic

Progress on the human reliability analysis project under way at Bohunice NPP was the topic of a mid-December meeting in Trnava, Czech Republic. Project participants from Bohunice NPP and the Nuclear Power Plants Research Institute Trnava, Inc. (VUJE) held discussions at VUJE facilities with their U.S. technology integrator on the data collection effort for the project.

To open the meeting, VUJE representatives demonstrated the computerized data collection system that VUJE developed for the project. The system consists of a Microsoft Access program that incorporates all current revised emergency operating instructions, the scenarios to be evaluated, and an instructor interface. The program is capable of generating a unique file for each data collection session. The results then can be exported to a Microsoft Excel file for comparison of crew performance and

***Ignalina staff observe
U.S. training methods***

identification of common faults across all evaluated crews. This information subsequently can be used to identify common causes for the faults; the system includes a mechanism to notify the responsible group. Plant operations, training, and procedures managers all have been provided feedback from the initial session. Perhaps the most impressive feature of this program is the synchronization of parameters in the plant computer with the program, which provides real-time plant response showing the impact of improper or delayed operator action. This information is available to the crews immediately following the evaluation session.

The VUJE representatives then reviewed the results of the initial data collection session and discussed the need to perform one additional session to ensure that enough data are available for analysis. That data will be collected during the next crew re-training period, which commences January 10. In addition, the host-country representatives indicated willingness to support secondary technology transfer efforts to other countries operating Soviet-designed reactors, including Russia and Ukraine. The U.S. team is exploring that possibility. (Walter Pasedag, DOE, 301-903-3628; Thomas Vehec, PNNL, 509-372-4072) v

Lithuania

Four staff members from Ignalina NPP spent December 8 through 22 in the United States gathering first-hand observations of training programs for American nuclear power plant maintenance personnel. The Ignalina staffers, all maintenance specialists, were participating in a fellowship program sponsored jointly by the International Atomic Energy Agency and DOE. The program was designed to demonstrate effective methods for training maintenance personnel.

During their stay, the four were hosted by Sonalysts, Inc., at the latter's facilities in Waterford, Connecticut. Specialists from Sonalysts arranged for a visit to Seabrook NPP in New Hampshire so the Ignalina specialists could observe and participate in technical discussions with on-site trainers. (John Yoder, DOE, 301-903-5650; Don Draper, PNNL, 509-372-4079) v



***Bubbler condenser
project undergoes final
review***

***Lithuanian and
Ukrainian specialists
extend working
knowledge of RELAP5
code capabilities***



Cross-Cutting Activities

A U.S. specialist from Idaho National Engineering and Environmental Laboratory traveled to Brussels, Belgium, in mid-December to participate in the final meeting of the Technical Advisory Committee (TAC) on the European Commission Bubbler Condenser Experimental Qualification (BCEQ) Phare project. The objective of this TAC meeting was to provide final review of the project. The BCEQ project consisted of thermal-hydraulic and fluid-structure interaction tests for the bubbler condenser.

The results of these tests indicated that the bubbler condenser can withstand large-break loss-of-coolant accident loads and that the system can maintain structural integrity under most loads. Further tests are needed to ensure the validity and extendibility of these results. A meeting of the Organization for Economic Cooperation and Development Bubbler Condenser Support Group is planned for early 2000 to discuss additional testing.

At the end of the meeting, the TAC and the project management representatives completed a meeting summary and formulated the general conclusions based on the project. (Walter Pasedag, DOE, 301-903-3628; Mike Modro, INEEL, 208-526-9402) v

During the first two weeks of December, specialists from Idaho National Engineering and Environmental Laboratory conducted a training workshop on the RELAP5 three-dimensional computer code. The training was held in the offices of the Lithuanian Energy Institute in Kaunas, Lithuania. Students included six specialists from the host organization and four from Ukraine (two from Kyiv University and two associated with Zaporizhzhya NPP). The purpose of the workshop was to introduce the participants to RELAP5-3D and, particularly, its multidimensional nodal kinetics capabilities.

The workshop was designed for experienced RELAP5 users and included both lectures and hands-on exercises. The exercises addressed input model development techniques, nodal kinetics input development and modification, cross-section subroutine development, and plant transient analysis. For the plant analysis exercises, the class was divided into groups to address separate RBMK and VVER events. The U.S. specialists also provided individual consulting on current problems the students had encountered in their own work. The U.S. team will continue to provide consulting support as the students start using the code in their own applications. (Walter Pasedag, DOE, 301-903-3628; Jeff Binder, ANL, 630-252-7265) v

Planned Activities

• *indicates the event is new or has changed in some way since the previous report was issued.*

• **January 17-28 — Kozloduy NPP, Bulgaria**

Training. Specialists from Kozloduy NPP and the U.S. contractor Sonalysts, Inc., will continue development work on a training program for emergency operating instruction trainers. (John Yoder, DOE, 301-903-5650; Don Draper, PNNL, 509-372-4079)

• **January 17-28 — Khmelntyskyy NPP, Ukraine**

Simulators/Training. Ukrainian and U.S. specialists will implement the newly modified training program for simulator instructors. Implementation participants will include representatives of Ukraine's Engineering and Technical Center for the Training of Nuclear Industry Personnel; Chornobyl, Khmelnytsky, Rivne, South Ukraine, and Zaporizhzhya NPPs; and Sonalysts, Inc. (John Yoder, DOE, 301-903-5650; Joe Cleary, PNNL, 509-372-4094)

• **January 17-28 — Ignalina NPP, Lithuania**

Training. Training specialists will complete and implement a new instructional program for reactor turbine technicians at Ignalina NPP. Organizations participating with Ignalina trainers in the effort will include specialists from the International Atomic Energy Agency, Sonalysts, Inc., and Human Performance Analysis Corporation. (John Yoder, DOE, 301-903-5650; Don Draper, PNNL, 509-372-4079)

• **January 23-February 5 — Richland, Washington, USA**

Emergency Operating Instructions. Pacific Northwest National Laboratory specialists will host a workshop for representatives of Rivne, Zaporizhzhya, and South Ukraine NPPs as well as their host-country analysis organizations. Participants will complete development of scenarios for the analytical validation of emergency operating instructions in Ukraine. Specialists from Science Applications International Corporation, Energoproekt (Sofia, Bulgaria), and Pacific Northwest National Laboratory will provide technical assistance. (Dennis Meyers, DOE, 301-903-1418; Larry Sherfey, PNNL, 509-372-4080)

• **January 29-February 5 — Idaho Falls, Idaho, USA**

Plant Safety Assessment. Nuclear specialists from Idaho National Engineering and Environmental Laboratory will provide a Russian counterpart with training and technical support related to the RELAP5 computer code. Together they will develop an input file of neutronics data for Kursk Unit 1 to be used in the in-depth safety assessment for that RBMK reactor site. (Walter Pasedag, DOE, 301-903-3628; James Fisher, INEEL, 208-526-0571)

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