

***Vacuum leak test  
technique shows  
promise in improving  
plant output***

### ***Highlight***



*A vacuum leak test and related repairs have improved the capacity factor of Rivne Unit 3. The improvement is beneficial to both safe steady-state operation of the plant and increased electricity production.*

Results of experimental tests conducted at Rivne nuclear power plant (NPP) indicate that a leak test technique may be an effective means of increasing the output, or capacity factor, of Ukraine's nuclear power plants. Increased output will enable the plants to run at steady-state power levels, well above the low vacuum turbine trip setting. During steady-state operation, conditions such as temperature, reaction rate, and neutron flux do not change appreciably with time. This operational state tends to be the safest for a nuclear power plant. Improved capacity factors also hold potential for increased electricity to sell, with attendant increase in revenues to a plant, raising the capability to pay for critical equipment maintenance and personnel salaries.

The tests were an outgrowth of a U.S.-supported project completed in June 1999, in which potential methods were identified for improving nuclear power plant capacity factor. A key recommendation emerging from that project was to reduce vacuum leaks in a plant's main condenser. Because those leaks reduce



***Meeting focuses on  
emergency operating  
instructions for Russian  
nuclear power plants***



efficiency, their elimination can increase the amount of electricity a plant produces.

Air leakage into a vacuum is difficult to detect. In Ukraine, the primary technique used to discover these leaks is called a **smoke test**. The smoke test involves holding a candle near potential vacuum leaks and tracing the path of the smoke.

A more advanced technique involves mixing a phosphorescent dye with water. The mixture is sprayed with an atomizer bottle in the area surrounding equipment that is under vacuum. An ultraviolet light is used to locate the paths followed by the mixture. Dye is drawn toward the leakage point and concentrates there, making the leak visible under ultraviolet light. After the leaks are located, minor repairs are made immediately and major repairs occur during the subsequent outage.

Ukrainian nuclear specialists conducted three vacuum leak tests at Rivne Unit 3 over the past few months (September, December, and January) under various conditions (demonstration, cold equipment during start-up, and hot equipment during operation). After each test, major leaks were repaired, including leaks with an equivalent air in-leakage of 40 kilograms/hour. The method was especially valuable in detecting small leaks and leaks in areas difficult to inspect with older methods like the smoke test.

Test results were made available at the end of February following Rivne's annual outage. Although the results are preliminary, the capacity factor for the Rivne Unit 3 VVER-1000 reactor increased by approximately 5 megawatts electricity, a significant improvement. The excellent results suggest the value of applying this technique at all nuclear power plants in Ukraine with VVER-1000 reactors. (Rich Reister, DOE, 301-903-0234; Bob Talbert, PNNL, 509-372-4061) v

## ***Russia***

In February, representatives from Balakovo, Kola, and Novovoronezh NPPs, as well as Rosenergoatom, VNIIAES, Gidropress, and the Kurchatov Institute, met in Moscow to discuss the development, implementation, and analytical validation of symptom-based emergency operating instructions for the Russian pilot nuclear power plants.

Participants discussed the status of emergency operating instructions being developed for Balakovo, Kola, and Novovoronezh Units 3 and 4. Rosenergoatom representatives presented the priorities and needs for current development, and VNIIAES representatives presented Gosatomnadzor requirements for implementing emergency operating instructions. Members of Gidropress presented their approach to thermal-hydraulic

***Request for proposal  
issued for Novovoronezh  
Unit 5 safety parameter  
display system***

***Paging and radio  
communication system  
installed at Smolensk***



validation of the instructions, and Pacific Northwest National Laboratory specialists described the current status of emergency operating instruction analysis in Ukraine and Bulgaria.

Participants discussed areas of possible U.S. assistance, which include analytical validation, operational verification and validation, training, and final implementation. The question of whether RELAP or Russian computer codes would be used for analytical validation still is under consideration.

Balakovo NPP and Kola Units 1 and 2 are going through the relicensing process, and each is required to implement symptom-based emergency operating instructions before a new license is issued. Symptom-based emergency operating procedures equip the plant operators to respond to a wider range of emergency situations than do event-based procedures. (Dennis Meyers, DOE, 301-903-1418; Larry Sherfey, PNNL, 509-372-4080) v

On February 25, Burns & Roe Enterprises, Inc., of New Jersey issued a request for proposal for two experienced U.S. vendors to supply Novovoronezh NPP with a safety parameter display system to be installed in 2001. Burns & Roe prepared the request for proposal with assistance from the Russian firm ConSyst and Novovoronezh NPP.

The safety parameter display system will be similar to those used in U.S. commercial nuclear power plants and will assist plant operators during abnormal conditions.

Proposals are due April 3, and the contract is expected to be awarded by May 1. (Rich Reister, DOE, 301-903-0234; Rich Denning, PNNL, 614-424-7412; Frank Panisko, PNNL 509-372-4472) v

During the week of February 21, U.S. specialists from ProCom completed setup, testing, and training in the use of a new communication system for the Smolensk NPP fire brigade. Under subcontract to Bechtel National, ProCom designed the system for the Smolensk plant. From the top of a sixteen-story apartment building in the neighboring town, the paging system can alert staff to a radius of approximately 25 kilometers. The U.S. team provided 60 paging units for use by the fire brigade. The radio system allows communication among fire fighters external to the plant. A radio base station transmits to up to 16 hand-held radio units. Bechtel staff provided oversight of system testing at the plant. (Grigory Trosman, DOE, 301-903-3581; Rich Denning, PNNL, 614-424-7412) v

***Expanded training  
course unveiled for  
simulator instructors***

***Scenarios for emergency  
operating instructions  
near completion***

***Energoatom managers  
participate in quality  
assurance seminar***



## ***Ukraine***

U.S. and Ukrainian training specialists jointly presented a newly revamped training course during the last half of January. Personnel from Khmelnytsky NPP served as students for the simulator instructor training course, which has undergone major modification since October 1999. In response to requests from Ukrainian instructors, the course length was extended from one week to two weeks and the content expanded to include more depth.

The U.S.-Ukrainian joint implementation served as a dry run before Ukrainian trainers present the course on their own in March 2000 for Zaporizhzhya NPP simulator instructors (see **Planned Activities**).

Specialists participating in the January dry run included trainers from Khmelnytsky and Zaporizhzhya NPPs, the Engineering and Technical Center for the Training of Nuclear Power Plant Personnel, Sonalysts, Inc., and Human Performance Analysis Corporation. The latter served as independent reviewer of the modified instructional program. (John Yoder DOE, 301-903-5650; Don Draper, PNNL, 509-372-4079) v

In January, representatives from Energorisk and Rivne, Zaporizhzhya, and South Ukraine NPPs participated in a two-week workshop in Richland, Washington, to develop scenarios for validating symptom-based emergency operating instructions. To date, specialists from Rivne NPP have completed scenarios for their plant. Pacific Northwest National Laboratory specialists are reviewing them for completeness. Zaporizhzhya NPP has submitted approximately one-third of its scenarios, which also are being reviewed. (Dennis Meyers, DOE, 301-903-1418; Larry Sherfey, PNNL, 509-372-4080) v

Approximately 25 department and division managers from Energoatom participated in a quality assurance seminar on February 23 in Kyiv. Seminar presenters included representatives of the Energoatom Quality and Surveillance Directorate and the Nuclear Power Plant Operations Support Institute, INIT, British Energy, and Pacific Northwest National Laboratory. The seminar, a follow-on to ones presented to nuclear power plant managers in 1999, focused on the benefits of and requirements for quality assurance application in work related to Ukraine's nuclear power plants. (Dennis Meyers, DOE, 301-903-1418; Lief Erickson, PNNL, 509-372-4097) v

***Energorisk analysts  
modify data input deck  
for Rivne safety  
assessment***

***South Ukraine and  
Energorisk complete  
models for safety assess-  
ment and screening  
analysis of fire hazards  
for Unit 1***

During January, Ukrainian analysts completed modifications to the principal data input deck, or analytical model, developed for U.S.-supported safety assessments under way at Rivne NPP. Analysts from Energorisk, the Ukrainian subcontractor to Rivne NPP, performed the tasks in conjunction with Rivne plant specialists. They completed their work on January 7.

The modifications, including verification and validation of input data, will enable specialists to apply the RELAP5 computer code to the Level 1 probabilistic risk assessment analyses of Rivne Unit 1, a VVER-440 Model 312 reactor. A probabilistic risk assessment is an essential component of modern technology for analyzing nuclear power plant safety. It assesses risks not addressed by the prescriptive methodology for design-basis accident assessment, providing information from which to identify areas on which to focus plant safety upgrades. (Walter Pasedag, DOE, 301-903-3628; Charles Dickerman, ANL, 630-252-4622) v

South Ukraine NPP staff and specialists from Energorisk collaborated in January to complete work on all analytical models to be used in the in-depth safety assessment of South Ukraine Unit 1. The models, or input decks, will facilitate calculations that must be performed as part of the overall deterministic safety assessment for South Ukraine NPP.

Energorisk specialists completed the MELCOR model for South Ukraine Unit 1. The MELCOR model can be used to analyze accident progression and to mitigate accident consequences. It will be used to supplement the design-basis accident analyses performed using the RELAP5 and CONTAIN codes.

The South Ukraine team also completed a screening analysis of the internal fire hazards at Unit 1. This information will be used to define the approach and scope to further analyze the fire risk. The screening analysis provides a preliminary assessment of Unit 1's vulnerability to fire hazards and, where feasible, screens fire hazards of low risk (compared to the risk from initiators of internal events). The screening analysis also identifies scenarios that need a detailed assessment and the data needed to perform the risk assessment. Plans for completing the fire hazard risk assessment will be outlined from this information. (Walter Pasedag, DOE, 301-903-3628; Christian Kot, ANL, 630-252-6151) v



***RELAP5  
thermal-hydraulic  
model completed for  
Zaporizhzhya's Unit 5***

***Physical security  
upgrades begin at  
Khmelnyskyy***

***Instructor training  
program under  
development at  
Kozloduy***



Specialists from Joint Stock Enterprise EIS, the lead technical contractor for Zaporizhzhya NPP, collaborated with Zaporizhzhya technical staff in February to complete the RELAP5 thermal-hydraulic model for the reactor systems of Zaporizhzhya's Unit 5. This model now is being used to perform success criteria calculations for the Level 1 internal events probabilistic risk assessment, an integral element of the overall safety assessment for Unit 5. The RELAP5 model will be adapted later to perform further deterministic safety assessments for Unit 5. (Walter Pasedag, DOE, 301-903-3628; Christian Kot, ANL, 630-252-6151) v

A contract was negotiated and established in February to allow Transexpo Corporation of Ukraine to install physical security upgrades at Khmelnytskyy Unit 1. Planned upgrades include improvements to access control in the vital and limited access areas; detection, assessment, and alarm equipment; interior physical barriers; and related training programs and procedures. Energoatom and the State Nuclear Regulatory Administration have approved the project. Khmelnytskyy NPP will provide some materials and labor resources to manufacture metal doors and do some of the installation. The schedule calls for the project to be completed in July. (Grigory Trosman, DOE, 301-903-3501; Andrei Glukhov, PNNL, 509-375-3961) v

## ***Bulgaria***

January 17 through 28, U.S. and Russian training specialists collaborated with training and technical specialists from Kozloduy NPP to develop a training program for Kozloduy instructors. Work began in October 1999 and will culminate in training of Kozloduy instructors responsible for training plant operators on how to implement emergency operating instructions. Specialists from U.S.-based Sonalysts, Inc., and Russia's All-Russian Institute for Nuclear Power Plant Operations (VNIIAES) are providing technical support in designing training materials and analyzing the emergency operating instructions. (John Yoder DOE, 301-903-5650; Don Draper, PNNL, 509-372-4079) v

***Czech Emergency  
Response Center and  
Dukovany NPP provide  
Y2K-related update***

***Ignalina trainers  
implement new  
instructional program***

***Installation of control-  
and-protection system  
modules begins at  
Ignalina Unit 2***



## ***Czech Republic***

The U.S. Department of Energy provided Y2K assistance to the Czech Republic's State Office for Nuclear Safety by funding purchase of a computer system for its Emergency Response Center. The previous system was not Y2K-compliant and was sufficiently outdated that it could not be upgraded. Effective support from the United States on customs documentation allowed the rapid delivery of the system, which was installed in December, in time for the date rollover.

During a February tour, U.S. representatives observed how data collection, analysis, and display of the information with the new system takes less than 5 minutes. With the old system, the process took 30 minutes. U.S. representatives also were provided a tour of Dukovany NPP's Emergency Preparedness Center. Plant staff noted that a U.S.-supported workshop had helped them with their Y2K preparations. The plant identified 9 items that had to be remediated, 60 that were very important, and 80 that were important. (Rich Reister, DOE, 301-903-0234; Tye Blackburn, PNNL, 509-372-4092) v

## ***Lithuania***

During the last two weeks of January, training specialists from Ignalina NPP completed work and implemented a new instructional program aimed at plant reactor turbine technicians. Three technicians served as students in the mechanical maintenance course developed specifically for Ignalina NPP. Training specialists from Sonalysts, Inc., and Balakovo NPP in Russia collaborated with the Ignalina trainers to develop the course and course-specific materials. In addition, a training specialist from Human Performance Analysis Corporation attended the implementation session as an independent evaluator. Ignalina NPP training and maintenance management personnel also attended segments of the implementation. (John Yoder DOE, 301-903-5650; Don Draper, PNNL, 509-372-4079) v

Replacement modules for Ignalina Unit 2's control-and-protection system were built in 1998 and delivered to Ignalina Unit 2. NUS Instruments built 100 modules; a Lithuanian company, the Center for Electromagnetic Compatibility, built 200 more. In February, the installation of the first 100 modules began in one complete channel of the three-channel control-and-protection system. Performance of the new modules will be observed until the next maintenance outage in the fall. If the performance is satisfactory, the remaining 200 modules will be installed, completing the update of the modules. The control-and-protection system monitors plant conditions and automatically shuts down

the reactor if conditions become abnormal. (Rich Reister, DOE, 301-903-0234; Ron Wright, PNNL, 509-372-4076) v

## *Planned Activities*

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

- **March 2 — Vilnius, Lithuania**

**Management and Operational Safety.** The Lithuanian Nuclear Safety Advisory Committee will meet to review activities and ongoing safety improvement work at Ignalina NPP. The U.S. representative on this committee, Future Resources Associates, will travel to Lithuania to participate in this regular meeting. This committee, comprising members from Lithuania, Russia, Ukraine, Japan, the United Kingdom, France, Germany, Sweden, and Finland, advises Ignalina management and Lithuania government officials on safety matters at the plant. (Dennis Meyers, DOE, 301-903-1418; Lief Erickson, PNNL, 509-372-4097)

- **March 13-16 — Kyiv, Ukraine**

**Plant Safety Assessment.** Drawing on their experience as the contractor for quality assurance and peer review for U.S.-supported safety assessments at Kola and Novovoronezh NPPs, specialists from the Russian Academy of Sciences (IBRAE) will present a one-day seminar on peer review and quality assurance for scientists from Engineering Technologies and Developments and Gesellschaft fur Anlagen und Reaktorsicherheit mbH. The seminar will transfer training and technology needed to perform independent peer reviews of the in-depth safety assessments under way at nuclear power plant sites in Ukraine. A specialist from Brookhaven National Laboratory also will participate in the seminar. (Walter Pasedag, DOE, 301-903-3628; Christian Kot, ANL, 630-252-6151; Ted Ginsberg, BNL, 516-344-2620)

- **March 17 — Zaporizhzhya NPP, Ukraine**

**Engineering and Technology.** The U.S.-provided safety parameter display system for Zaporizhzhya Unit 3 will undergo site acceptance tests at the plant. (Richard Reister, DOE, 301-903-0234; Rich Denning, PNNL, 614-424-7412; Frank Panisko, PNNL, 509-372-4472)

- **March 20-24 — Armenia NPP, Armenia**

**Engineering and Technology.** Representatives from the U.S. Department of Energy, Pacific Northwest National Laboratory, and Burns & Roe Enterprises, Inc., will hold discussions with plant staff on completion of major projects already under way. New activities also will be discussed. (Dennis Meyers, DOE, 301-903-1418; Rich Denning, PNNL, 614-424-7412)



- **March 20-31 — Zaporizhzhya NPP, Ukraine**  
**Simulators/Training.** Training specialists from the Engineering and Technical Center for the Training of Nuclear Industry Personnel and Khmelnytsky and Zaporizhzhya NPPs will present the expanded simulator instructor training course. Nuclear power plant simulator instructors will be the students in this course. U.S. team members from Sonalysts and Human Performance Analysis Corporation will review and comment on the presentation. (John Yoder, DOE, 301-903-5650; Joe Cleary, PNNL, 509-372-4094)
- **March 23 — Slavutych, Ukraine**  
**Chornobyl Initiatives.** Ukrainian and U.S. representatives will participate in the official opening of the International Radioecology Laboratory. The Laboratory, a part of the International Chornobyl Center, was created to facilitate and expand international research on the environmental effects of the 1986 Chornobyl accident. Top-level managers from the U.S. Department of Energy, University of Georgia (USA), and the Savannah River Ecology Laboratory are expected to participate in the opening, as are Ukrainian officials from the Ministries of Energy and Emergency Situations, Chornobyl NPP, and the National Academy of Sciences of Ukraine. (Riaz Awan, DOE, 301-903-2687; Michele Dash, PNNL, 202-586-3550)
- **March 28 — Rivne NPP, Ukraine**  
**Engineering and Technology.** Site acceptance tests will be conducted for the Rivne Unit 3 safety parameter display system. (Richard Reister, DOE, 301-903-0234; Rich Denning, PNNL, 614-424-7412; Frank Panisko, PNNL, 509-372-4472)
- **March 30 — Slavutych, Ukraine**  
**Chornobyl Initiatives.** The Council of Members, International Chornobyl Center, will meet to discuss strategic planning and organizational and project development. Members, who comprise senior officials from Ukraine, the United States, the United Kingdom, Japan, France, and Germany, are anticipated participants. (Riaz Awan, DOE, 301-903-2687; Michele Dash, PNNL, 202-586-3550)
- **March 27-31 (tentative) — Rivne NPP, Ukraine**  
**Management and Operational Safety.** Ukrainian specialists will conduct an audit of nuclear fuel management and handling at Rivne NPP. The material collected for and during this audit will provide a framework and field data from which a functional area performance guide for fuel management can be developed for use at all nuclear power plants in Ukraine. (Dennis Meyers, DOE, 301-903-1418; Lief Erickson, PNNL, 509-372-4097)
- **Late March-early April — Armenia NPP, Armenia**  
**Engineering and Technology.** The U.S.-provided safety parameter display system will undergo site acceptance testing at Armenia NPP. Plant technical staff and representatives of U.S. contractors Science Applications International Corporation, Data



Systems & Solutions, and Burns & Roe Enterprises, Inc., will participate in the testing. (Richard Reister, DOE, 301-903-0234; Rich Denning, PNNL, 614-424-7412; Frank Panisko, PNNL, 509-372-4472)

• **April 3-7 — Zaporizhzhya NPP, Ukraine**

**Simulators and Training.** Zaporizhzhya NPP will host a training course on the validation and verification of simulators at nuclear power plants. Technical specialists from the Balakovo Training Center, VNIIAES, and Brookhaven National Laboratory will present the course. Three representatives each from the training centers at Rivne, South Ukraine, and Zaporizhzhya NPPs are expected to participate, as are staff of the Engineering and Technical Center for the Training of Nuclear Industry Personnel and the Ukraine State Nuclear Regulatory Administration. (John Yoder, DOE, 301-903-5650; Joe Cleary, PNNL, 509-372-4079, Peter Kohut, BNL, 631-344-4982)

• **April 10-13 — Boston, Massachusetts, USA**

**Engineering and Technology.** Specialists from Engineering Planning and Management Inc. (EPM) will host a progress meeting on the safe-shutdown analysis under way at Zaporizhzhya NPP. Participants will include analysts from Kyiv Energoprojekt as well as technical specialists from EPM and Brookhaven and Pacific Northwest national laboratories. Participants will review comments on two reports documenting specific analysis tasks. They also will discuss the start of the deterministic and probabilistic analysis tasks. (Grigory Trosman, DOE, 301-903-3581; Andrew Minister, PNNL, 509-376-4938)

• **May 22-27 (tentative) — Kyiv and South Ukraine NPP, Ukraine**

**Management and Operational Safety.** U.S. specialists will work with Ukrainian team members to prepare a plan for auditing radiation safety management at South Ukraine NPP. Representatives of South Ukraine NPP, Energoatom, the Nuclear Power Plant Operational Support Institute, SCIENTECH, Inc., and Pacific Northwest National Laboratory will participate. The South Ukraine audit plan and resulting audit are intended to provide a framework and field data from which a functional area performance guide can be developed for use at all nuclear power plants in Ukraine. (Dennis Meyers, DOE, 301-903-1418; Lief Erickson, PNNL, 509-372-4097)

• **April 25 — South Ukraine NPP, Ukraine**

**Engineering and Technology.** Site acceptance testing will be conducted for the Rivne Unit 2 safety parameter display system. (Richard Reister, DOE, 301-903-0234; Rich Denning, PNNL, 614-424-7412; Frank Panisko, PNNL, 509-372-4472)



- **May 27-June 4 — Scholkino, Ukraine Management and Operational Safety.** Specialists from Ukraine's Crimea Scientific and Engineering Center and Zaporizhzhya NPP will present a training seminar on the application of procedures for event analysis and reporting. Additional Zaporizhzhya NPP personnel will participate as trainees. The seminar seeks to provide a plant-wide understanding of procedures and improved practices for nuclear power plant event analysis and reporting to Energoatom. (Dennis Meyers, DOE, 301-903-1418; Lief Erickson, PNNL, 509-372-4079)



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