Overview of the Cooperative Safety Work

The U.S. Department of Energy conducts a comprehensive, cooperative effort to reduce risks at Soviet-designed nuclear power plants. In the host countries—Armenia, Ukraine, Russia, Bulgaria, the Czech Republic, Hungary, Lithuania, Slovakia, and Kazakhstan—joint projects are correcting major safety deficiencies and establishing nuclear safety infrastructures that will be self-sustaining.

The joint efforts originated from U.S. commitments made at the G-7 conference in 1992. Amid heightened international concern about Soviet-designed reactors, world leaders agreed to collaborate with host countries to reduce risks at the older reactors. Since that time, U.S. efforts have expanded to include urgently needed safety work at 21 nuclear power plants with 65 operating reactors. U.S. work is conducted in cooperation with similar programs initiated by the other G-7 countries—Canada, France, Germany, Italy, Japan, and the United Kingdom, as well as international organizations.

The Nuclear Power Plants Participating in the Cooperative Effort to Improve Nuclear Safety

Timeline

1986

April

A nuclear accident destroys Ukraine's Chornobyl Unit 4 reactor, focusing worldwide attention on the dozens of Soviet-designed reactors that continue to operate.

1992

July

At a conference of G-7 nations in Munich, the United States agrees to support cooperative work to reduce risks at Soviet-designed nuclear power plants in Ukraine, Russia, Bulgaria, the Czech Republic, Hungary, Lithuania, and Slovakia.

September

A multinational working group convenes to begin planning safety training for nuclear power plant personnel.

1993

May

The first U.S. training course for nuclear power plant personnel is taught at training centers in Ukraine and Russia.

August

Using U.S. technology and materials, workers begin sealing leaks in the radiation confinement system at Russia's Kola plant.

1994

March

Bulgaria's Kozloduy plant receives U.S.-manufactured firefighting equipment.

Timeline

1994 *(cont'd)*

December

Czech specialists complete a probabilistic risk analysis at the Dukovany plant, identifying conditions that could damage the reactor fuel core. Dukovany staff begin modifying the plant's operating requirements to reduce the risk.

1995

January

Personnel from Soviet-designed reactors begin visiting nuclear power plants in the United States to observe reactor safety practices in action.

Spring

A control room operator at a Soviet-designed reactor uses skills developed in U.S. training to prevent a nuclear accident.

1996

After observing U.S. reactor personnel being trained to handle emergencies, managers at Russia's Balakovo and Ukraine's Zaporizhzhya plants each add an additional reactor operator per shift to monitor critical safety functions.

January

Russia's Leningrad plant receives U.S.-manufactured fire detection equipment.

Fire detection equipment like that delivered to the Leningrad plant.

Benefits

The cooperative effort to improve safety at Soviet-designed nuclear power plants carries significant benefits:

- It reduces the likelihood of a nuclear accident that could destabilize new democratic governments, require a massive influx of international aid, and threaten the viability of nuclear power worldwide.
- It promotes a stable business climate for international investments in countries with Soviet-designed reactors.
- It provides protection for Europe's public, economic, and environmental health and for U.S. citizens in Europe. As was clear after the 1986 Chornobyl accident, the effects of a nuclear disaster extend beyond international borders. More than 60,000 square miles of land were heavily contaminated in Ukraine, Belarus, and Russia. Neighboring European countries were contaminated, and fallout was detected in the United States.

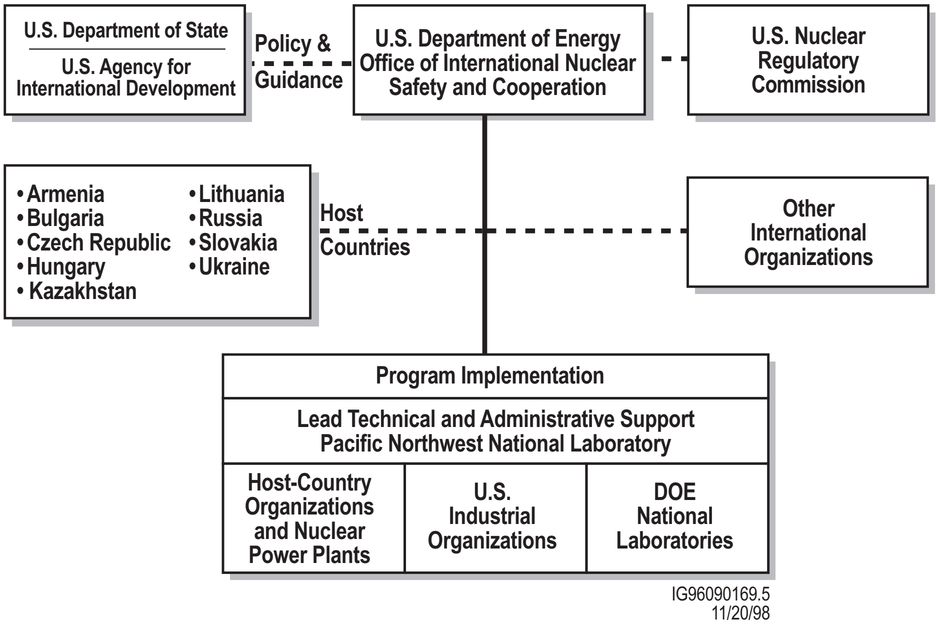
Safety Objectives

The United States supports host countries in their efforts to reduce the most serious risks at Soviet-designed nuclear power plants. The primary objectives include improving the plants' physical operating conditions, installing safety equipment, developing improved safety procedures, establishing regional centers for training reactor personnel, installing simulators for training control room operators, conducting in-depth safety assessments, and addressing the extraordinary problems at Chornobyl. A further priority is developing an institutional and regulatory framework for plant design, construction, regulation, and operation that is in keeping with international practices.

Participants

The U.S. Department of Energy's Office of International Nuclear Safety and Cooperation manages U.S. involvement in the cooperative work. The U.S. Department of Energy's Pacific Northwest National Laboratory in Richland, Washington, provides technical leadership, with project assistance from other U.S. national laboratories, U.S. businesses, host-country nuclear power plants, and host-country scientific organizations.

U.S. specialists work in accordance with the guidance and policies of the U.S. Department of State and the U.S. Agency for International Development and in close collaboration with the U.S. Nuclear Regulatory Commission.



U.S. specialists have established working agreements with organizations in the nine host countries, including key government agencies, scientific institutions, engineering and design organizations, and the nuclear power plants.

> *The term **technology transfer** refers not just to the delivery of hardware but to passing on knowledge, processes, and methodologies. The goal is to establish an infrastructure in each country that supports the safe operation and maintenance of nuclear power plants.*

Many other international organizations assist with improving the safety of Soviet-designed reactors, such as the Nuclear Energy Agency of the Organization for Economic Cooperation and Development, the International Atomic Energy Agency, the European Bank for Reconstruction and Development, the Institute of Nuclear Power Operations, the World Association of Nuclear Operators, and TACIS, a European Union assistance program.

More than 90 U.S. commercial firms have provided equipment, training, expert services, and technology transfer.

Historical Issues

The safety problems at Soviet-designed reactors have several underlying causes. The most significant is the historical isolation of the plants' operators, designers, and regulators. In the closed society of the Soviet Union, these personnel could not exchange information or technology with the

Timeline

1996 *(cont'd)*

March

The first symptom-based emergency operating instructions developed by U.S. and Russian experts are implemented at the Novovoronezh plant.

Russian regulatory personnel begin extensive training with U.S. experts to improve their oversight of nuclear power plants.

April

In partnership with the United States, Ukraine's President Kuchma signs a declaration establishing a scientific center to focus on nuclear safety and environmental issues at Chornobyl and throughout Ukraine.

May

Workers install a reliable, seismic-resistant emergency power system at Russia's Kola plant.

After restarting one of its two nuclear power reactors in 1995, the Armenia government begins working with the United States and the international community on cooperative safety projects.

August

The United States completes the delivery of pipe lathes to the five plants with RBMK reactors. The lathes are used for precision repair of reactor coolant piping.

1997

March

Ukraine's nuclear power plants receive ultrasonic inspection equipment for locating flaws in pipes before they cause problems.

Ultrasonic inspection equipment in use in Ukraine.

Timeline

1997 (cont'd)

July

Experts at the International Chornobyl Center for Nuclear Safety, Radioactive Waste and Radioecology complete their first technical project—a risk analysis. Other collaborative projects are under way.

Ukraine and the G-7 nations approve the Shelter Implementation Plan, which details measures to prevent collapse of the shelter around Chornobyl Unit 4 and safely seal the ruined reactor. The United States provided the primary technical support for developing the plan.

Shelter around Chornobyl Unit 4.

Technicians at the South Ukraine plant replace defective turbine blades after their new ultrasonic inspection equipment reveals unacceptable cracks.

September

Control room operators at Kursk Unit 2 begin using a safety parameter display system that gives them crucial information for controlling the plant in the event of an accident.

October

Technicians at the five sites with RBMK reactors are maintaining crucial safety systems with valve-seat resurfacing equipment.

international nuclear community and had limited interaction even with their counterparts in Soviet countries.

Another significant cause was a lack of emphasis on safety. Goals for low-cost production of electricity often outweighed safety goals. Regulatory bodies responsible for enforcing safety standards were ineffective, especially when their safety directives ran counter to production goals.

The new governments of countries with Soviet-designed reactors have invested millions of dollars toward improving the safety of their nuclear power plants. However, their economic and technical resources are insufficient to address many of the risks.

Reactor Types

Two basic designs, called RBMK and VVER, were used to build 59 of the 65 operating reactors addressed in cooperative safety efforts.

An **RBMK** reactor uses graphite to moderate neutrons—or slow down the nuclear chain reaction. The nuclear fuel is contained in about 1,700 pressure tubes. Cooling water passes through the tubes, where it is boiled by the nuclear heat to produce steam. The steam is routed to a turbine generator, which produces electricity.

A number of problems are inherent in RBMKs. If several pressure tubes rupture simultaneously, the force can raise the reactor lid, releasing radioactive fission products. An RBMK reactor is susceptible to power instabilities. Increased boiling can boost power levels, creating an uncontrolled nuclear reaction. The RBMKs lack a containment system to prevent release of radioactive materials to the environment. The RBMK's emergency core cooling system, fire-protection system, and electronic control-and-protection system do not meet international standards. Fourteen RBMK reactors are in operation. Chornobyl Unit 4, which exploded in 1986, was an RBMK. The thermal-hydraulic instabilities inherent in an RBMK contributed to the accident at Chornobyl.

VVER reactors use pressurized light water for core cooling and to moderate the nuclear chain reaction. Forty-five VVER reactors are in operation. There are three principal models.

The earliest, the **VVER-440/230**, has a limited containment system and virtually no emergency core cooling system. Its backup safety systems, fire-protection systems, and electronic control-and-protection systems are inadequate.

The **VVER-440/213** reactor is an enhanced version of the 230 model. It has an emergency core cooling system and a "bubbler condenser tower" that provides some containment. Fire-protection and electronic control-and-protection systems are inadequate.

The **VVER-1000**, the largest and newest model, meets most modern safety standards. It has an emergency core cooling system and a containment building. However, its fire-protection and electronic control-and-protection systems have shortcomings.

In 1996, two Russian plants with uniquely designed reactors requested U.S. collaboration in safety improvements. The Bilibino plant has four LWGR-12 light-water-cooled, graphite-moderated reactors. The Beloyarsk plant operates a BN-600 breeder reactor, cooled by liquid sodium.

In 1997, the Asian nation of Kazakhstan requested U.S. collaboration in improving safety at its Soviet-designed BN-350 breeder reactor at Aktau.

Reducing Risks as Reactors Continue to Operate

Western safety specialists have encouraged the host-country governments to shut down the most unsafe reactors. However, most will continue to operate for the foreseeable future.

The reactors provide urgently needed electrical power, with averages ranging from 14 percent of Russia's power supply to 47 percent of Ukraine's and 82 percent of Lithuania's. The international community is encouraging the development of alternative power sources, but the transition would take significant time and money, which the host countries can ill afford.

Abrupt closure of nuclear power plants would carry a high cost in human terms—the loss of thousands of jobs and an increase in electricity prices. These socioeconomic changes could have drastic consequences in fragile democracies that already are struggling to stabilize their economies.

The only economically viable solution is to work with the host countries to reduce the risk of accidents until they can shut down reactors or bring them into compliance with international practices.

Activities to Reduce Risk and Improve Safety

Since the inception of these efforts in 1992, U.S. specialists have initiated more than 150 joint projects. Many projects reduced risks immediately by decreasing the possibilities of equipment malfunction and operator error.

Projects are organized into six areas, which are referred to as work elements.

- *Management and operational safety projects* increase the safety of day-to-day operations by training operators, establishing safe operating procedures, and supplying up-to-date maintenance technology and training.

Timeline

1997 *(cont'd)*

October

The U.S. Department of Energy agrees to work with the nation of Kazakhstan to improve safety at its Soviet-designed nuclear power reactor.

Workers complete a project that began in 1993 at Russia's Kola plant—sealing leaks in the radiation confinement system and installing confinement isolation valves.

December

The first control room training simulator developed with U.S. support for Soviet-designed reactors begins operating at Ukraine's Khmelnytskyy plant.

Simulator at Khmelnytskyy plant.

1998

January

Russia's Novovoronezh Unit 3 becomes the first Soviet-designed reactor to implement a full set of symptom-based emergency operating instructions.

March

Zaporizhzhya workers inspect 1,500 steam generator tubes with remotely operated eddy-current equipment supplied by the United States.

Hungarians trained by U.S. experts to analyze the reliability of operator actions agree to support Czech specialists in a similar analysis.

Timeline

1998 *(cont'd)*

March

Ukrainian control room operators at Chornobyl's Unit 3 reactor implement symptom-based emergency operating instructions.

April

Ukrainian and international specialists begin carrying out the Shelter Implementation Plan at Chornobyl.

May

Workers at Chornobyl Unit 3 install a fire-resistant coating material on the turbine hall's structural steel. In the event of a major fire, the coating will help prevent a collapse of the roof.

June

Workers at Chornobyl stabilize a ventilation stack damaged by the 1986 accident. The accomplishment marks the first resolution of a significant safety issue stemming from the disaster.

Working to stabilize a ventilation stack at the Chornobyl plant.

July

Bulgaria's Kozloduy plant and Lithuania's Ignalina plant establish configuration management programs.

- *Engineering and technology projects* reduce operating risks by upgrading the safety equipment and systems of nuclear power plants. Projects are focused on improvements in fire safety, radiation confinement, and reactor safety systems.
- *Plant safety assessment projects* improve the abilities of designers, operators, and regulators to evaluate the safety of their plants through the use of internationally accepted methodologies and computer analysis codes.
- *Fuel cycle safety projects* improve the handling and storing of reactor fuel and the operation of nuclear-fuel-cycle facilities.
- *Nuclear safety institutional and regulatory framework projects* address the need for effective regulatory systems in countries with Soviet-designed reactors.
- *Chornobyl initiatives* involve three major efforts:
  - support of an international effort to prevent collapse of the shelter around Chornobyl's ruined reactor Unit 4, suppress the radioactive dust inside the shelter, and protect shelter workers from radioactive and industrial hazards
  - development of technical strategies for shutting down and deactivating the Chornobyl plant and constructing a new heating plant to maintain safety systems when deactivation begins
  - establishment of an international research laboratory center in the city of Slavutych, near the Chornobyl site, and a related center in Kyiv.

Key Accomplishments

Technology Transfer

U.S. and host-country organizations are conducting joint projects to manufacture safety equipment, perform safety assessments, and use advanced technology in staff training. After U.S. training, a Lithuanian company manufactured replacement modules for reactor control-and-protection systems. Through work with U.S. engineers, a company in Ukraine and another in Russia developed the capability to manufacture highly effective fire doors. The United States is transferring computer analysis codes and methodologies that enable host-country specialists to assess plant safety, identify risks, and set priorities for safety upgrades.

Training

With U.S. support, Russia and Ukraine each have established a successful nuclear training center to accelerate the transfer of skills and safety information. The instructors have developed and conducted job-specific maintenance and operations courses, along with courses in employee safety and supervisory skills.

The instructors now are working with U.S. training specialists to expand the training programs to other Ukrainian and Russian plants. Plant instructors are developing and conducting site-specific training courses.

U.S. training specialists also are working with instructors in Armenia, Bulgaria, Lithuania, and Slovakia to improve their training programs.

Simulator Development

Two plants in Ukraine and one in Russia now have control room simulators for training reactor operators. U.S. and host-country specialists are developing simulators for three more reactors in Ukraine and four in Russia. Through the cooperative projects, host countries are acquiring the capabilities to develop and support additional simulators.

Emergency Operating Instructions

Two plants with Soviet-designed reactors have implemented symptom-based emergency operating instructions—Ukraine's Chornobyl plant and Russia's Novovoronezh plant. Symptom-based instructions enable control room operators to stabilize a reactor quickly during an abnormal event. The time saved can prevent disaster.

U.S. specialists have transferred the skills for developing symptom-based instructions to pilot plants in Ukraine, Russia, and Central and Eastern Europe. U.S. and host-country specialists now are validating the instructions for use at Soviet-designed reactors.

Control Room Operator Prevents a Disaster

In spring 1995, a control room operator stopped a train of events at a Soviet-designed reactor that could have led to disaster.

The operator had participated in an exchange visit to the United States, where he watched a crew respond to a hypothetical disaster on a plant simulator. The "accident" depicted loss of cooling water to the reactor core. The operator also had worked with U.S. specialists to develop symptom-based emergency operating instructions for controlling accidents at his own plant.

Then, during routine testing at his plant, a valve for the reactor cooling system stuck open. The system rapidly depressurized. Cooling water stopped flowing to the reactor core.

Operating crews tried to determine the cause of the crisis in order to restore the flow of cooling water. They were unsuccessful, and the nuclear fuel began to overheat.

The operator who had worked with U.S. specialists intervened. Based on his knowledge of emergency operating instructions and his experience watching a U.S. crew deal with a similar situation during simulator training, he decided to use reactor head vents to restore cooling. Water returned to the reactor core, and the plant was brought to cold shutdown. The abnormal event ended before fuel damage occurred.

Timeline

1998 (cont'd)

July

Ukrainian technicians begin installing a U.S.-built monitoring system inside the shelter to determine the number of fission reactions occurring in the nuclear fuel mass.

The governments of Ukraine and the United States agree to create the International Radioecology Laboratory as a new subsidiary of the International Chornobyl Center. The laboratory will research the effects of radiation on plants and animals.

September

Workers at Armenia replace a flammable plastic floor covering with a nonflammable coating.

Ukraine's Khmelnytskyy and Chornobyl plants and Russia's Novovoronezh plant now have simulators to train control room operators.

Maintenance technicians at Chornobyl are using insulation analysis equipment and infrared cameras to detect hazards in electrical systems.

After U.S. training, a Lithuanian company manufactures reliable replacement modules for the aging control-and-protection system at Ignalina. With U.S. support, a new backup control-and-protection system is installed at Ignalina Unit 1.

Control-and-protection system panel at Ignalina Unit 1.

Timeline

1998 *(cont'd)*

November

U.S. personnel begin training Kazakh specialists to conduct nuclear safety analyses.

December

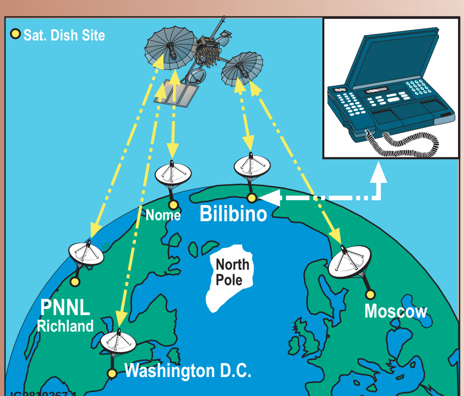
Control room operators at four plants in Ukraine and two plants in Russia now have safety parameter display systems.

Specialists at the South Ukraine plant and Russia's Leningrad plant complete preliminary probabilistic risk analyses, assessing events that could lead to damage of the reactor core.

The United States has delivered equipment and training to protect workers at the Chornobyl shelter from radiation and industrial hazards.

1999—Planned

At Russia's Bilibino plant, just 850 miles from Nome, Alaska, workers will install a satellite-based communications device. The device will enable plant personnel to communicate reliably with colleagues in Russia and the United States. In case of a nuclear accident, the device can serve as an early-warning system.



Communications system for Bilibino plant.

Safety Maintenance Technologies

The United States has supplied up-to-date tools and training for maintenance workers at the five plants with RBMK reactors. The workers now maintain crucial piping systems with pipe lathe/weld-preparation machines, valve-seat resurfacing equipment, and vibration monitoring and shaft alignment systems. They use ultrasonic and other nondestructive examination equipment to find flaws in pipes and other key reactor components.

Preventive maintenance workers at Bulgaria's Kozloduy plant and Ukraine's Chornobyl plant are using infrared thermography cameras to detect faulty components, "hot spots," and cold connections in electrical and instrumentation and controls systems. In addition, workers at the Chornobyl plant and Lithuania's Ignalina plant are using advanced equipment to detect the onset of insulation breakdown in the main generator and high-voltage wiring, preventing fires and potential system failures.

Engineered Safety Upgrades

The United States has supplied basic fire-protection equipment to plants in Armenia, Ukraine, Russia, and Bulgaria. Russia's Kola and Kursk plants and Bulgaria's Kozloduy plant received backup power systems to supply vital electricity during emergency shutdowns. Russia's Kursk and Novovoronezh plants received mobile pumping units for emergency water supplies. With U.S. support, workers at Armenia's nuclear power plant constructed a nuclear service-water system as an alternative to the plant's cooling tower, which is vulnerable to earthquake damage.

Control room operators at four plants in Ukraine and two in Russia now have safety parameter display systems, which enable them to assess abnormal conditions rapidly and take corrective actions. Development of systems for seven other Soviet-designed reactors is under way.

With U.S. support, Kola staff have substantially reduced leaks in the radiation confinement system. Lithuania's Ignalina plant has received reliable replacements for the aging modules in its electronic control-and-protection system. With U.S. support, a new backup control-and-protection system has been installed at Ignalina Unit 1. U.S. and host-country experts have defined methodologies for conducting safe-shutdown analyses at Soviet-designed reactors, and pilot analyses are under way at Ukraine's Zaporizhzhya plant and Russia's Smolensk plant.

Safety Projects at Bilibino

Russia's extremely isolated Bilibino plant has had difficulty retaining skilled workers, finding replacement parts, and communicating reliably with the outside world. Nome, Alaska, is just 850 miles and predominantly downwind from Bilibino. The North Slope of Alaska is directly downwind of the plant. With U.S. support, the plant will install a satellite-based communications device early in 1999. The device will serve as an early-warning system while giving plant personnel the ability to exchange maintenance and safety information regularly with U.S. and Russian personnel. U.S. training specialists are working with Bilibino instructors to improve training programs, and the United States is supplying high-priority maintenance equipment.

Spent-Fuel Storage

The United States has worked with Ukraine to develop a dry-cask system for storing spent fuel at the Zaporizhzhya plant. The plant's pools for storing spent-fuel rods are nearly full. The United States delivered equipment and trained Ukrainian personnel to build and regulate a safe, modern, dry-cask storage system.

Configuration Management

With support from U.S. specialists, Bulgaria's Kozloduy plant and Lithuania's Ignalina plant have established configuration management programs. Configuration management ensures proper documentation and control of a plant's safety design basis. It also ensures that plant operators can rely on the accuracy of drawings and documents they use in making operating decisions. U.S. specialists are supporting the development of configuration management systems at the Zaporizhzhya plant in Ukraine and the Novovoronezh plant in Russia.

Regulatory Capabilities

Regulatory experts from Ukraine and Russia have participated in extensive training with U.S. experts, developing capabilities for effective oversight of nuclear power plants.

Chornobyl Initiatives

Addressing an urgent safety concern, workers have stabilized a ventilation stack damaged by the 1986 accident at Chornobyl. The repairs marked the first resolution of a significant safety problem stemming from the disaster. The Ukrainian contractor completed the work on schedule, demonstrating Ukraine's ability to manage and perform high-quality work under an international contracting arrangement. U.S. specialists provided technical support that minimized worker exposure to the high radiation levels around the stack. The United States, Canada, and Ukraine funded the project.

Ukrainian and international specialists have begun carrying out the Shelter Implementation Plan, which aims to prevent collapse of the shelter around the ruined reactor Unit 4, construct a new shelter to cover the current one, and protect workers and the environment. U.S. specialists provided the

Timeline

1999 *(cont'd)*

To begin permanently shutting down and deactivating the Chornobyl plant, workers will defuel reactor Unit 1.

Chornobyl workers will complete the construction of a heating plant to maintain reactor safety systems during the deactivation process.

Replacement heat plant for Chornobyl.

A U.S.-built, radiation-hardened robot will enter a room in the Chornobyl shelter to survey its structural conditions and demonstrate whether this technology can be used in the shelter.

Three more plants in Russia and another in Ukraine will have simulators for training control room operators.

Russia's Bilibino plant will receive high-priority maintenance equipment.

Russian specialists will complete a safe-shutdown analysis at Smolensk, identifying ways to reduce the plant's most dangerous fire risks.

Specialists at the Kola Unit 4 reactor will complete a preliminary probabilistic risk analysis, assessing events that could lead to damage of the reactor core.

Control room operators at six more plants in Ukraine and Russia will have safety parameter display systems to give them crucial information for controlling the plants in the event of an accident.

U.S. and Kazakh specialists will develop technical strategies for shutting down the reactor at Aktau.

Timeline

1999 (cont'd)

The Armenia plant will have upgraded steam isolation valves, an emergency cooling water system, and a safety parameter display system.

Ukrainian specialists will define strategies for managing the nation's spent fuel.

Zaporizhzhya will begin using a dry-cask storage system developed through U.S.-Ukrainian cooperation.

primary technical support for developing the plan. The United States has provided shelter workers with equipment and training to reduce their radiation exposure, improve industrial safety, and suppress the radioactive dust inside the shelter.

U.S. personnel are working with Ukrainian specialists to develop technical strategies for shutting down and deactivating the Chornobyl plant. The United States also is working with Ukraine to complete the construction of a new heating plant. A new heat source must be available to maintain safety systems at Chornobyl when deactivation begins.

Joint projects in data analysis, spent-fuel management, and reactor closure are under way at the International Chornobyl Center for Nuclear Safety, Radioactive Waste and Radioecology, established in 1996 in Kyiv. Ukraine also established the center's Slavutych Laboratory in 1996 in the town of Slavutych, near Chornobyl. The United States has supported development of the center and has provided a satellite communications system, which gives the center reliable telephone access to the rest of the world, as well as videoconferencing capability and electronic access to the information databases of partnering organizations. U.S. personnel have provided training for center staff in management skills and the evaluation of nuclear-related technologies.

The United States and Ukraine have agreed to create the International Radioecology Laboratory as a new subsidiary of the International Chornobyl Center. The laboratory will facilitate Ukrainian and international research on the effects of radiation on plants and animals.

Performance Measurement

The U.S. team has established end points that define the successful completion of projects in each technical area. A project reaches its end point when the host country, its nuclear support organizations, and its nuclear power plants can sustain safety achievements and build upon them to meet internationally accepted nuclear safety practices. These end points are measurable, achievable targets.

The U.S. team defined the end points by weighing several factors for each project: its safety impact, its cost-effectiveness, the time needed to achieve results, and the ability of the host country to sustain the safety achievements over the long term. The end points are documented in the cooperative safety effort's Strategy Document.

Future Direction

Through their joint efforts, the United States and the host countries are reducing risks at Soviet-designed nuclear power plants.

U.S. personnel will continue working to meet the following goals:

- Transfer modern technologies and methods to enable each host country to establish and maintain a strong safety infrastructure.
- Engender a nuclear safety culture in which safety takes priority over power production.
- Provide opportunities for U.S. commercial companies to establish joint ventures and ongoing nuclear safety partnerships with the host countries.
- Promote safer plant operations over time.
- Accelerate efforts to reduce risks at Chornobyl and support the plant's shutdown and deactivation.