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Status Report of the U.S. Department of Energy's International Nuclear Safety Program

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Executive Summary

The U.S. Department of Energy (DOE) implements the U.S. Government's International Nuclear Safety Program to improve the level of safety at Soviet-designed nuclear power plants in Central and Eastern Europe, Russia, and Ukraine. The program is conducted consistent with guidance and policies established by the U.S. Department of State (DOS) and the Agency for International Development and in close collaboration with the Nuclear Regulatory Commission. Some of the program elements were initiated in 1990 under a bilateral agreement with the former Soviet Union; however, most activities began after the Lisbon Nuclear Safety Initiative was announced by the DOS in 1992.

Within DOE, the program is managed by the International Division of the Office of Nuclear Energy. The overall objective of the International Nuclear Safety Program is to make comprehensive improvements in the physical conditions of the power plants, plant operations, infrastructures, and safety cultures of countries operating Soviet-designed reactors.

This status report summarizes the International Nuclear Safety Program's activities that have been completed as of September 1994 and discusses those activities currently in progress.

Acronyms

A/E	architect/engineer
ACE	advanced containment experiment
BNL	Brookhaven National Laboratory
B&R	Burns and Roe Company
CEEC	Central and Eastern European countries
DOE	U.S. Department of Energy
DOS	U.S. Department of State
EOI	emergency operating instructions
EWG	expert working groups
GAN	Gosatomnadzor
GOSCOMATOM	Ukrainian State Committee on Nuclear Power Utilization
I&C	instrument and control
JCCCNRS	Joint Coordinating Committee for Civilian Nuclear Reactor Safety
LNSI	Lisbon Nuclear Safety Initiative
MINATOM	Ministry of Atomic Energy of the Russian Federation
NMAC	Nuclear Maintenance Activities Center
NPP	nuclear power plant
NRC	U.S. Nuclear Regulatory Commission
PNL	Pacific Northwest Laboratory

RBMK	Soviet-designed, graphite-moderated, boiling water-cooled, channel reactor
SAT	systematic approach to training
SCNRS	State Committee for Nuclear and Radiation Safety
USAID	U.S. Agency for International Development
VNIIAES	All Union Research Institute for Nuclear Power Plant
VVER	Soviet-designed pressurized water reactor
WANO	World Association of Nuclear Operators

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1.0 Introduction

In 1992 the U.S. Department of Energy (DOE) implemented the International Nuclear Safety Program to assist Russia, Ukraine, and the Central and Eastern European Countries (CEECs) in making safety-related improvements at nuclear power plants (NPPs) that were designed by the former Soviet Union. Some of the program elements were initiated in 1990 under a bilateral agreement with the former Soviet Union; however, most elements have resulted from the Lisbon Nuclear Safety Initiative (LNSI) of 1992. The overall objective of the program is to make comprehensive improvements in the safety culture, power plant operations and physical conditions, and infrastructure of countries operating Soviet-designed reactors.

This report summarizes the International Nuclear Safety Program's activities that have been completed as of September 1994 and discusses those activities currently in progress. Sections 2.1 and 2.2 briefly describe the funding levels, scope of activities, general approach, and organizational structure used for the International Nuclear Safety Program's activities in the CEEC and Russia/Ukraine, respectively. Section 3.0 reviews the status of all the activities that are currently part of the International Nuclear Safety Program. Appendix A provides a detailed listing, by country, of the Soviet-designed NPP in Russia, Ukraine, and the CEECs. Note that potential new activities are not discussed in this report.

2.0 Program Background and General Approach

DOE's nuclear safety efforts in the former Soviet Union can be traced back to its involvement in the Joint Coordinating Committee for Civilian Nuclear Reactor Safety (JCCCNRS), a cooperative program initiated in 1988 between the United States and the former Soviet Union. Although the JCCCNRS activity continues, the current U.S. International Nuclear Safety Program is based primarily on the LNSI, commitments made in support of the 1992 G-7 conference, and a January 1993 G-7 agreement to provide immediate assistance for short-term improvements at older Soviet-designed reactors (graphite-moderated, boiling water-cooled reactors [RBMKs] and pressurized water reactors [VVER-440/230s]).

DOE receives funding for the International Nuclear Safety Program from the U.S. Agency for International Development (USAID). These funds are used to provide safety assistance to countries with Soviet-designed NPPs in the CEECs, Russia, and Ukraine. USAID also provides funds to the U.S. Nuclear Regulatory Commission (NRC) for its work with the regulatory agencies of these countries. DOE develops the work scope for the International Nuclear Safety Program consistent with guidance and policies established by USAID and the U.S. Department of State (DOS). Interagency agreements have been established for transferring funds from USAID to DOE for specific activities managed by DOE.

The funding levels and the scope of activities have been significantly different for CEEC and Russia and Ukraine. Because of these differences, and the fact that the funds cannot be transferred between CEEC and Russia and Ukraine accounts, the International Nuclear Safety Program is being managed as two separate program elements: one for the CEEC (Bulgaria, Czech Republic, Hungary, Lithuania, and Slovak Republic) and one for Russia and Ukraine. Each program element is described below.

2.1 Central and Eastern European Countries

Nuclear safety activities for the CEEC were initiated in 1991. The five countries that participate in this assistance program are Bulgaria, Czech Republic, Hungary, Lithuania, and Slovak Republic. The total funding to date for the CEEC safety programs is $10.7M ($650K FY91, $2.8M FY92, $3.6M FY93, and $3.65M FY94); this relatively limited funding has restricted the number and scope of projects.

Specific projects are based primarily on the identified safety needs and priorities of cognizant representatives of each individual country. The general approach is for the recipient country to provide USAID and DOE with a prioritized list of projects and activities for which financial or technical assistance is sought. This list is then reviewed against USAID and DOE objectives, and an agreement is reached for funding specific safety enhancement activities based on those objectives and the country's priorities. Each country makes a concerted effort to obtain consensus among a range of stakeholders, including the regulator, for prioritizing their needs.

There are relatively few cognizant organizations involved in each country, permitting a simple administrative structure. A small project support office at Brookhaven National Laboratory (BNL) provided technical support and administrative assistance to DOE for this program. In the past, decision making has generally been limited to a small group consisting of individuals from USAID, DOE, and BNL. Although the DOS involvement has been limited, it has participated in the decision making process for the program as a whole. Because each country is able to provide prioritized lists of needs, based on a consensus of cognizant stakeholders, the need for U.S. technical experts also has been minimal.

2.2 Russia and Ukraine

The nuclear safety assistance program for Russia and Ukraine was announced by the DOS at Lisbon, Portugal, in May 1992 and has become known as the LNSI--Lisbon Nuclear Safety Initiative. Activities under this program were initiated in late 1992. DOE and the NRC implement the program with guidance from DOS and USAID. The total amount of funding allocated to DOE as of September 30, 1994, was $65.9M ($21.9M FY92, $14M FY93, and $30M FY94). An additional $11M of FY93 Nunn-Lugar funds were released to DOE in November 1994.

The LNSI is a cooperative program between the United States and Russia and Ukraine, and it is coordinated by DOS, DOE, NRC, and USAID. The general organizational structure for this program has been based on the approach used under JCCCNRS. The Joint Coordinating Committee, co-chaired by representatives from operational and regulatory bodies in each country (DOE and NRC in the United States, Ministry of Atomic Energy of the Russian Federation [MINATOM] and Gosatomnadzor [GAN] in Russia, and the Ukrainian State Committee on Nuclear Power Utilization [GOSCOMATOM] and State Committee for Nuclear and Radiation Safety [SCNRS] in Ukraine) provides strategic planning, coordination, and guidance to project participants. A U.S. coordinating committee, chaired by DOS, provides interagency coordination, supports international coordination and cooperation, and develops policy. This committee includes representatives from DOS, DOE, NRC, and USAID.

In addition to the Joint Coordinating Committee, a joint Management Committee oversees the implementation of the various activities. This Management Committee is responsible for planning and managing activities, establishing expert working groups (EWGs), and approving the charters and work plans developed by the EWGs.

At the onset of the program, DOE established a Project Office at BNL to provide project management, technical, and contract management support for subcontractors performing specific tasks for DOE under this program. Project Office activities included procuring goods and services from U.S. and partner country sources, hiring and monitoring contractors, providing quality assurance and quality control, and coordinating technical projects. In addition, the Project Office worked with organizations in partner countries responsible for specific projects to ensure technical objectives were met.

In FY94 a concern was raised relative to the liability of U.S. firms or personnel working on reactor safety-related projects in Russia and Ukraine. To resolve this issue, the U.S. Government established bilateral agreements with Russia and Ukraine that include indemnification for safety-related work. Additionally, the Vice President of the United States provided written assurance that the U.S. Government will do all that is reasonable to ensure that these agreements will be upheld. At this time, most of the U.S. firms involved in this program have agreed to perform the reactor safety-related work.

Prior to the resolution of this liability issue, BNL's governing body, the Associated Universities Incorporated, withdrew BNL from the program management role because it felt that unresolved liability issues remained regarding the risk-related work in Russia and Ukraine. Even though the Pacific Northwest Laboratory (PNL) has some concerns about the liability issue, it has accepted the program management support role. PNL's position is to deal with the liability issue by either of the following methods: 1) risk-related work will be handled by direct DOE contracts with architect engineering or equipment supplier firms, or 2) PNL employees, for specific tasks, will be assigned to DOE through the Intergovernmental Personnel Act (IPA) Mobility Program for the duration of the task and will receive the same liability indemnification as a Federal employee.

The LNSI includes three general areas of assistance: 1) implementing operational safety activities (e.g., emergency operating instructions [EOIs], training, human factors); 2) instigating near-term risk reduction activities (which includes fire protection); and 3) strengthening the regulatory functions. The NRC has the lead in the regulatory support area; those activities are not included in this report.

EWGs were established to identify the specific safety enhancement projects to be performed. These EWGs are staffed jointly by U.S., Russian, and Ukrainian personnel. In establishing these EWGs, the support activities were broken into the following four areas:

- operational safety (EOIs and conduct of operations) - five EWGs
- training - two EWGs
- fire protection - two EWGs
- near-term risk reduction - two EWGs.

The EWGs are responsible for determining the specific scope of work for the various activities and then overseeing the managing and implementing of the activities. The first EWG meetings were held in late fall, 1992, and early winter, 1993. EWGs continue to meet as necessary to discuss issues related to project implementation, oversight, and planning. A brief discussion follows regarding the general approach and process that has been used for planning and performing work in the four general areas of activity.

2.2.1 Operational Safety

The operational safety activities were actually initiated in March of 1990 under the JCCCNRS, more than 2 years prior to the initiation of the LNSI. The current program continues and expands these activities.

Objectives

1. Assist Russia and Ukraine with developing symptom-based EOIs. These symptom-based procedures will improve the operator's response to plant emergencies, especially those where the particular fault is not immediately recognized or when multiple equipment problems exist.

2. Assist Russia and Ukraine in improving their management and operational control guides and procedures. Improving the management and operational controls of the day-to-day operation of the plant should help reduce incidents, particularly human-initiated (operator or maintenance) events, and, thus, reduce the risks associated with reactor operation.

Approach

The expertise and lessons learned in the United States over the last several years are used to sup port the development and use of symptom-based procedures, performance-based training materials, improved work control process, and improved log and record keeping activities. The Institute for Nuclear Power Operations and utility representatives are helping DOE transfer this expertise.

The EWGs for this activity were formed by reactor type rather than by country, so that an "owners group" relationship could be developed among the NPPs.

Currently, there are five EWGs for this activity:

- VVER-440/213

- VVER-440/230

- VVER-1000

- RBMK

- Management and Operational Controls.

2.2.2 Training

Training activities began in late 1992, shortly after DOE received funding for this program. The overall objective of this activity is to assist the Russians and Ukrainians in developing and implementing improved training programs for NPP personnel. The current program is outlined below.

Objectives

1. Transfer the technology needed for a systematic approach to the training of operating personnel at Russian and Ukrainian NPPs. Assist with the development of pilot training programs (with active recipient participation).

2. Provide the necessary equipment to support the development of pilot programs at the NPP sites.

3. Procure a full-scope simulator for Ukraine, and transfer simulator design and manufacturing technologies to Ukraine.

Approach

The EWG members assess programmatic needs and then create action plans in response to the needs identified by their assessments. This program allows for the review and approval of the recipient country.

2.2.3 Fire Protection

The initial activities in this area were coordinated directly by DOE. DOE used an existing contract with a U.S. architect/engineer to perform a limited fire hazard analysis at the Smolensk NPP in Russia and the Zaporozhye NPP in Ukraine. Due to the significant nature of the fire risks, it was later decided to establish the two EWGs (U.S.-Ukraine and U.S.-Russia) to address the fire protection issues.

Objectives

1. Improve fire protection capabilities at Russian and Ukrainian NPPs.

2. Increase the knowledge and awareness of NPP personnel regarding fire prevention and mitigation techniques.

Approach

The EWGs identify activities that would reduce the fire risks. A U.S. architect/engineer supports the engineers at the NPP who develop the specific design details for the fixes and assists the NPP engineers who implement the corrective actions (e.g., providing fire fighting equipment, improving fire suppression systems, and increasing fire detection capabilities). The EWGs oversee the designing, scheduling, and implementing of these activities.

2.2.4 Near-Term Risk Reduction

Activities in this area are focused on providing near-term assistance to help reduce the risks associated with the continued operation of the higher risk plants (the VVER 440/230's and RBMKs).

Note that the near-term risk reduction activities are only being performed on reactors in Russia. Ukraine has no VVER-440/230s, and the RBMK reactors at the Chernobyl site were originally scheduled to be shut down in December of 1993.

Objectives

1. Identify joint projects or measures where U.S. assistance or materials (equipment or components) can significantly reduce the risks associated with operating VVER-440/230s and RBMKs. These projects must meet the following criteria:

   - short-term (2 to 3 years to complete)

   - help prevent or mitigate consequences of an accident

   - not encourage, or promote, continued operation.

2. Implement selected risk reduction projects on a pilot-plant basis, using Kola NPP and Novovoronezh NPP for the VVER-440/230s and Kursk for the RBMKs. As appropriate, technology transfer will be used to assist the recipient country in developing the ability to manufacture the equipment or components for other NPPs.

Approach

The approach for the risk reduction activities is for the EWGs to identify potential risk reduction projects. A U.S. architect/engineer then evaluates the proposed projects to determine feasibility and estimates the cost and schedule. Using these engineering evaluations, the EWGs develop project specific work plans. The various projects are then implemented in accordance with these work plans.

2.3 Summary

Through September 1994, $20.4M has been spent in the general areas of assistance DOE is responsible for managing. The following summarizes the accomplishments in Russia and Ukraine:

- Sixty-five of the 189 EOIs and 20 of the 34 guidelines for conduct of operations have been drafted for the pilot plants.

- Two of the 24 pilot courses have been completed (the Systematic Approach to Training course and the Safety Culture courses).

- Limited fire hazards analysis reports have been completed for the pilot plants. Additionally, specific fire protection equipment was installed in the Smolensk NPP in Russia, and Phase I equipment was installed at the Zaporozhye NPP in Ukraine.

- Engineering evaluation reports have been completed for each of the proposed near-term risk reduction projects.

3.0 Country-by-Country Status of Activities

The following discussion provides a status of all the current International Nuclear Safety Program activities. The activities are listed by country in two general categories: accomplishments and work in progress. Included in the listing is the total funding allocated for the country, actual expenditures through September 1994, and outstanding commitments. The activities for Russia and Ukraine are first broken out according to the four topical areas of assistance (i.e., operational safety, training, fire protection, and near-term risk reduction). Then, within each of these four areas, the activities are listed in terms of accomplishments and work in progress.

Also included is a brief discussion of each country's nuclear power program and the major organizations involved with this program.

3.1 Bulgaria

Bulgaria has a total of six operating NPPs located at the Kozloduy site: four VVER-440/230s and two VVER-1000s. The primary organizations involved with this program are as follows:

- Bulgarian State Committee for Peaceful Uses of Nuclear Energy - Bulgarian nuclear regulatory authority

- Committee on Energy - responsible for all energy-related matters in Bulgaria

- National Electric Company - owner and operator of all Bulgarian electrical generation, transmission, and distribution equipment

- Kozloduy NPP - operator of the six Bulgarian nuclear power reactors.

Funding of $3,465K has been allocated to Bulgaria ($1,000K was made available in December 1994). Actual expenditures through September 1994 were $1,870K, and outstanding commitments are $62K.

3.1.1 Accomplishments

1. A VVER-440/230 plant analyzer was installed at the Kozloduy NPP. A workshop was also conducted to train the Kozloduy NPP engineers on the operation of the plant analyzer.

2. Pipe analysis software (Algor and Fracture Software) was purchased and is operable at the Kozloduy NPP.

3. Fire fighting equipment was delivered to the Kozloduy NPP and is now operable. Two fire trucks were purchased (crash and pumper trucks) in addition to the following support equipment: communications equipment, base stations and walkie-talkies), radiation monitoring equipment (dosimeters), and normal support equipment on the vehicles.

4. Protection suits for the fire fighters were delivered to Kozloduy NPP in July 1994.

5. The radiophone face masks for the fire fighters were delivered to Kozloduy NPP in July 1994.

6. NPP management and operations training was conducted at Kozloduy NPP in June 1994. The training addressed codes, regulations, and infrastructure.

7. The purchase of a 1000-Kw backup diesel generator for Kozloduy NPP was completed.

3.1.2 Work in Progress

1. Manufacturing of the 1000-Kw generator is proceeding, and delivery to Kozloduy NPP is expected in March 1995.

2. The Bulgarian representatives initially requested a seismic vulnerability assessment of the two VVER-1000s, Kozloduy V and VI. This study was superseded by an International Atomic Energy Agency generic seismic study, which used the Kozloduy site as the prototype plant. The project was then generally redefined to look at the spent fuel building. The Bulgarian representatives then requested that the funding be used to supply a 500-Kw diesel generator for Kozloduy NPP. However, the Committee for Peaceful Uses of Atomic Energy requested that the work be redirected back to the VVER-1000s to look specifically at the cable trays during seismic events. The issue remains unresolved. However, Dr. Yanev, Chairman of Bulgarian State Committee for Peaceful Uses of Nuclear Energy (the nuclear regulatory authority), has promised a letter to the U.S. side formalizing the desired scope of work.

3. Work to provide the Kozloduy NPP with thermal imaging capability is continuing. This capability uses thermographic heat sensors coupled with special software to help detect hot spots in electrical systems that are caused by poor electrical connections or other causes. Thermal imaging will allow timely maintenance and corrective actions and should reduce the potential for electrical fires. The strategy for delivering this capability includes enrolling the National Electric Company in the Nuclear Maintenance Activities Center (NMAC). National Electric Company is expected to be enrolled in January 1995. The NMAC is a subsidiary of the Electric Power Research Institute, which fosters improved maintenance training in the United States.

4. Operational safety improvement activities continue with efforts to improve management and operational controls and with the development of EOIs.

3.2 Czech Republic

The Czech Republic has four operating nuclear power reactors, all VVER-440/213s, that are located at the Dukovany site. In addition, there are two VVER-1000s currently under construction at the Temelin site. The primary organizations involved with this assistance program are as follows:

- State Office for Nuclear Safety - Czech nuclear regulatory authority
- Ministry of Industry and Trade, Section for Nuclear Area Administration - responsible for NPPs and fuel cycle
- Nuclear Research Institute - nuclear research and development and operator of research reactor
- Dukovany NPP - operator of the four nuclear power reactors at the Dukovany site
- Temelin NPP - operator of the two nuclear power reactors under construction at the Temelin site.

Funding of $1,180K has been allocated to the Czech Republic ($400K was made available in December 1994). Actual expenditures through September 1994 were $230K, and outstanding commitments are $402K.

3.2.1 Accomplishments

1. Training related to nuclear safety culture and conduct of operations was provided.

2. Czech engineers participated in the Advanced Containment Experiment (ACE) program.

3.2.2 Work in Progress

1. Work is nearing completion with the development of the Dukovany NPP Equipment Reliability Database. This personal-computer-based, database of plant specific equipment failure rates is being developed for future use in probabilistic safety assessments (PSAs).

2. Operational safety improvement activities continue with efforts to improve management and operational controls and with the development of EOIs.

3.3 Hungary

Hungary has four operating nuclear power reactors, all VVER-440/213s located at the Paks site. The primary organizations involved in this assistance program are listed below:

- National Committee for Technological Development - ministerial-level organization with responsibility for nuclear power development and policy

- Hungary Atomic Energy Commission - Hungarian nuclear regulatory authority

- Institute for Electric Power Research - nuclear power research and development

- Hungarian Power Company - Hungarian national utility, owner and operator of Paks NPP

- Paks NPP - operator of the four nuclear power reactors at the Paks site.

Funding of $1,130K has been allocated to Hungary ($400K was made available on December 1994). Actual expenditures through September 1994 were $212K, and outstanding commitments are $356K.

Liability concerns impacted one project that involved calculating loads for the Paks NPP in the accident localization system during nuclear accidents. The project was changed to a generic calculation for VVER-440/213 reactors.

3.3.1 Accomplishments

1. Training was provided that related to the nuclear safety culture and conduct of operations.

2. Hungarian engineers participated, and are continuing to participate, in the ACE program.

3.3.2 Work in Progress

1. Hungarian engineers are learning to improve their analytic capabilities relative to the VVER-440/213 Accident Localization System. The scope of work includes a blowdown analysis of the facility and impacts on the facility structure.

2. Operational safety improvement activities continue with efforts to improve management and operational controls and with the development of EOIs.

3.4 Lithuania

Lithuania has two operating NPPs, both RBMK 1500s, that are located at the Ignalina site. These reactors are the two largest in the world and the only operating RBMK 1500s. The primary organizations involved in this assistance program are as follows:

- Lithuanian Nuclear Power Safety Inspectorate - Lithuanian nuclear regulatory authority

- Ministry of Energy - responsible for nuclear power

- Ignalina NPP - operator of the two nuclear power reactors at the Ignalina site

- Lithuania Energy Institute / Ignalina Safety Analysis Group - responsible for safety analyses for Ignalina NPP.

Funding of $2,373K has been allocated to Lithuania ($900K was made available on December 1994). Actual expenditures through September 1994 were $674K, and outstanding commitments are $411K.

3.4.1 Accomplishments

1. Expert assistance on positive void coefficients was provided.

2. Plant parameters for the Ignalina Plant Parameter Source Book were prepared both in English and Lithuanian.

3. A peer review on the initial phase of the Barselina PSA was performed.

4. The data collection phase for developing a RELAP5 model for the RBMK 1500 was completed. This activity supports the plant analyzer project and involves three phases of development. Phase 1, which included training for Lithuanian engineers, is now complete.

5. An initial Ignalina NPP Plant Analyzer and workstation were delivered to Ignalina Safety Analysis Group. Training workshops for the NPP staff on the use and modification of plant analyzers have been conducted.

3.4.2 Work in Progress

1. A peer review of the second phase of the Barselina PSA is being performed.

2. Support for the IRRAS computer code (a PRA analytical code) will be provided. The NRC has already delivered the code. In addition, procurement for the equipment and training is under way.

3. Work continues on the RBMK 1500 Plant Analyzer. Additional equipment has been procured and will be delivered by January 1995.

4. Operational safety improvement activities continue with efforts to improve management and operational controls and with the development of EOIs.

3.5 Slovak Republic

Slovak Republic has a total of four operating nuclear power reactors: two VVER-440/230s and two VVER-440/213s, all located at the Bohunice site. In addition, there are four VVER-440/213s under construction at the Mochovce site. The following primary organizations are involved with this assistance program:

- Nuclear Regulatory Authority - Slovak Republic

- Nuclear Power Plants Research Institute, Trnava - nuclear research and development, analysis, and training

- Bohunice NPP - operator of the four nuclear power reactors at the Bohunice site

- Mochovce NPP - operator of the four nuclear power reactors under construction at the Mochovce site.

Funding of $2,420K has been allocated to the Slovak Republic ($900K was made available in December 1994). Actual expenditures through September 1994 were $272K, and outstanding commitments are $919K.

Liability concerns impacted one project at the Bohunice NPP that involved calculating loads in the accident localization system during nuclear accidents. The project was modified to provide the Neptune and PACER computer codes and training to the Slovaks. In addition, the Slovaks requested some quality assurance checks on previous accident localization systems work.

3.5.1 Accomplishments

1. Training was provided that related to the nuclear safety culture and conduct of operations.

2. Engineers from the NPPs participated in the ACE program.

3. Four workstations configured for use at the VVER 440/230 plant analyzer model were delivered. Additionally, two workshops were conducted on the use of the model.

3.5.2 Work in Progress

1. Work upgrading the PC simulator for the VVER-440/230 has started. Software for the upgrade and two RISC 6000 workstations for the simulator are being provided.

2. The VVER-440 Plant analyzer for the Bohunice NPPs is being developed further.

3. The work scope for upgrading the accident localizations system analysis capabilities had been completed when the Slovaks suggested revising the work scope. A revised proposal consistent with the revised work scope is being prepared.

4. Operational safety improvement activities continue with efforts to improve management and operational controls and with the development of EOIs.

3.6 Russia

Russia has a very large and active nuclear power program with 29 operating commercial nuclear power reactors located at 9 different sites. There is a wide variety of reactor types and models including: 11 RBMK 1000s, four VVER-440/230s, two VVER-440/213s, seven VVER-1000s, one BN-600 (breeder reactor), and four light-water-cooled, graphite-moderated reactors located at Bilibino. A number of organizations and institutes are involved in the design, construction, operation, and regulation of these facilities, including those listed below:

- MINATOM - responsible for developing nuclear reactor and fuel cycle enterprises

- NERGOATOM (REA) - a business concern of MINATOM responsible for NPPs (includes All Union Research Institute for Nuclear Power Plant (VNIIAES), RDIPE, ATOMENERGOPROJECT, etc.)

- VNIIAES - new name is "Russian Institute for Nuclear Power Plant Operations") - assists in NPP startup, operations, and training; manufactures full-scope and analytical simulators

- RDIPE (Research and Development Institute of Power Engineering) - also known as NIKIET or ENTEK; main designers of RBMK reactors

- ATOMENERGOPROJECT - VVER and RBMK nuclear facility architect/engineer

- GAN - Russian regulatory organization responsible for startup and safety of nuclear reactors and fuel cycle enterprises

- GIDROPRESS - Experimental Design Institute (OKB) - responsible for VVER steam generator design, manufacturing, VVER reactor, thermal hydraulic code development and testing

- Institute of Physics and Power Engineering (Obninsk) - responsible for researching, developing, testing, and designing liquid-metal-cooled reactors, including BN series, test reactors, lead-cooled reactors (also for developing fuel for them). Fuel cycle development, both U - Pu and Th - ^{233}U.

Funding of $45,998K has been allocated to Russia ($22,000K was made available on September 30, 1994). Actual expenditures through September 1994 were $12,841K, and outstanding commitments are $10,555K.

Severe economic conditions in Russia are impacting the availability of funds from the primary organizations to support program activities. Adequate funding is critical to meeting quality and schedule objectives. DOE is pursuing ways to assist in resolving the issue such as contracting directly with primary organizations. The liability concerns expressed by U.S. contractors also impacted program activities, causing some activities to be delayed and others to be initiated early to maintain the momentum of the program.

3.6.1 Operational Safety - Russia

As stated earlier in Section 2.2, the objective of this activity is to assist Russia in developing EOIs and improving its management and operational guidelines for day-to-day operations. The following describes accomplishments, as of September 1994, and ongoing work for the Russian operational safety activity.

Accomplishments

1. The 42 EOIs for Novovoronezh NPP (VVER-440/230) were drafted, verified, and validated. Operator training activities will be implemented upon obtaining final approval from the regulator (GAN).

2. Selected management controls and control room organizational changes were completed at Novovoronezh NPP.

3. EOIs for Kola units 3 and 4 (VVER-440/213) are in the initial draft stage. Additionally, six of 34 EOIs were drafted.

4. EOIs for the Balakovo NPP (VVER-1000) are in the initial draft stage. Four of 38 EOIs were also drafted.

5. Some EOI planning and strategy documents were drafted for the Smolensk NPP (RBMK 1000).

6. Ten out of 17 guidelines for conduct of operations were drafted for Balakovo NPP. One site-specific instruction was implemented at Balakovo NPP.

Work in Progress

The development of EOIs is proceeding at the three pilot plants (Smolensk [RBMK], Balakovo [VVER-1000], and Kola [VVER-440/213]). In addition, the operational controls group and management are implementing 17 identified guides and instructions at pilot plants.

3.6.2 Training - Russia

The objective of the training activity, as described in Section 2.2, is to determine what training issues need to be addressed and then to develop action plans based on the issues. Specific accomplishments and ongoing work activities for the Russian training activity are listed below.

Accomplishments

1. Balakovo NPP has been selected as the pilot training site.

2. Sonalyst was selected to assist with developing the training programs, and a Basic Ordering Agreement (contract) is in place. Sonalyst has accomplished the following:

   - completed the "training needs analysis" and identified program development requirements and priorities

   - completed the first of 12 pilot training courses for the instrument and control (I&C) technician program

   - delivered special training courses on the systematic approach to training (SAT) and safety culture including course materials (lesson plans, student materials) and software

   - delivered PACE electronic soldering equipment to support the I&C technician course

   - delivered the first shipment of training center equipment (e.g., personal computers, copy machines, overhead projectors)

   - delivered training courses on simulator software and hardware maintenance and provided simulator maintenance tools

   - transferred the pilot I&C technician training program to Ukraine

   - completed the reactor building operator course. Operations specialists from the Balakova site visited the United States in August 1994 to assist in developing the course.

Work in Progress

1. Work continues on developing the pilot training programs for key plant staffing positions. Specific programs are being developed for turbine building operators, shift supervisors, and mechanical maintenance technicians.

2. Work is continuing on the development of both the instructor training course and a general employee safety training course.

3. Procurement of additional training equipment is in progress.

3.6.3 Fire Protection - Russia

The objective of Russia's fire protection activity, as described earlier in Section 2.2, is to analyze and enhance the fire protection capabilities at its NPPs. This section lists the accomplishments of the Russian fire protection activities, as of September 1994, as well as the work in progress.

Accomplishments

1. Initial plant walk-throughs and fire hazard analysis at the Smolensk NPP were completed, and a limited Fire Hazards Analysis report was prepared.

2. EWGs were established, and general action plans were developed.

3. The U.S. architect/engineer to assist with this activity was selected. A Basic Ordering Agreement (contract) is in place.

4. Specific modifications for enhancing fire safety at Smolensk NPP were identified.

5. Samples of equipment (smoke detectors, heat detectors, etc.) were shipped to Russia for testing and evaluation to determine what equipment will satisfy their requirements.

6. The Russians completed their evaluations and identified the specific equipment for use at Smolensk NPP.

Work in Progress

The equipment and materials have been identified for fire safety upgrades at Smolensk NPP. Some of the equipment has already been ordered and is in storage at various sites; the rest is in the process of being procured. All the equipment is expected to be delivered by the second quarter of FY95.

3.6.4 Near-Term Risk Reduction - Russia

As stated in Section 2.2, the objectives of the near-term risk reduction projects are to identify, evaluate, and resolve near-term safety issues at higher-risk Russian NPPs. The accomplishments, as of September 1994, and current activities for this activity are described below.

Accomplishments

1. Two EWGs, one for VVER-440/230s and one for RBMKs, were established. The EWGs proposed several near-term risk reduction projects for the review/concurrence of the Management Committee.

2. An engineering evaluation report for each of the proposed projects was performed to determine cost estimates, establish schedules, and determine potential problems/constraints.

3. EWGs developed project specific work plans which identified 1) specific project goals and objectives and 2) action items and responsibilities for the United States and Russian participants.

4. Basic Ordering Agreements (BOAs) with seven architect/engineer firms were established allowing specific task orders to be issued, as needed, to these architect/engineers to perform the work activities identified in the work plans.

5. BOAs with the Kola, Kursk, and Novovoronezh NPPs for performing the Russian portions of the "work plans" were established.

6. The first phase of improving the confinement leak-tightness at Kola NPP (test of sealant materials) was completed.

7. Two different prototype, high-temperature suits, were delivered to Kursk NPP in May 1994. After testing these two suits, Kursk NPP management determined that one of the suits would be acceptable with several minor modifications. These modifications are currently being incorporated into a final prototype suit for acceptance by Kursk NPP management.

8. The "N Reactor Lessons Learned Workshop" was completed. Twelve Russians travelled to Richland, Washington, for a workshop on the approaches used and lessons learned for the N Reactor safety upgrade program. A detailed guide that was written both in English and Russian was distributed to all participants.

Work in Progress

There are a variety of activities currently under way. Recently, task orders were issued for the reliable DC Power Supply and Confinement Isolation Valves Projects at Kola NPP, as well as the Safety Parameter Display System Panel Project at Novovoronezh. However, some projects experienced delays because of liability concerns that have now been resolved. During the delays, funds originally identified for those projects were used to continue ongoing activities and start other activities ahead or the original schedule. Table 3.1 provides a brief description of each project, and the current status, actual expenditures (through September 1994), and estimated cost at completion for the project.

Table 3.1. Near-Term Risk Reduction Activities

Project	Status	Expenditures Through 9/94	Total Project Est'd Cost
VVER - EWG	EWG is established and functioning.	$734K	$1,410K
Reliable DC Power Supply - Kola: Provide new DC power supply (batteries, racks, switch panel, and switchgear).	**Active** - Project Work Plan has been agreed to, and specifications are being prepared. Kola NPP is identifying the necessary design information. Work is continuing. No equipment has been ordered.	$349K	$2,300K
Safety Panel - Novovoronezh: Provide a centralized computer-based panel for monitoring critical safety functions and parameters necessary to execute the EOIs.	**Active** - Project Work Plan has been agreed to. Novovoronezh NPP is preparing specific design information. Work is continuing. No equipment has been ordered.	$37K	$2,500K
Emergency Water Supply - Novovoronezh: Provide an independent source of emergency feedwater.	**On hold** - Project Work Plan has been agreed to. Novovoronezh NPP is preparing specific design information. However, project activity is on hold because funds were reallocated to other activities during period of liability concerns.	$27K	$650K

Table 3.1. (contd)

Project	Status	Expenditures Through 9/94	Total Project Est'd Cost
Improve Confinement Leak Tightness - Kola: Improve leak tightness of Kola confinement using U.S. materials (e.g., sealants, surface coatings, gaskets).	**Active** - Project Work Plan has been agreed to, and test applications have been completed. Kola has prepared specific design information. Some sealant materials are onsite at Kola; the rest should arrive onsite in early September. A Russian specialist is applying the sealant with assistance from a U.S. specialist.	$499K	$650K
Confinement Leakrate Instrumentation - Kola: Provide instrumentation to determine leakrate of confinement rooms.	**Active** - Procurement is being prepared (part of Leak Tightness activity described above).		(Included in amount above)
Leak Locating Instrumentation - Kola: Provide instrumentation to locate leakage areas.	**Active** - Sample detectors will be shipped to Kola NPP (part of Leak Tightness activity described above).		(Included in amount above)
Confinement Isolation Valves - Kola: Provide fast acting, reliable confinement isolation valves.	**Active** - Project Work Plan has been agreed to. Kola NPP preparing specific design information. Kola NPP is the process of defining technical specifications for these valves.	$19K	$2,000K
Confinement Ventilation - Novovoronezh: Provide a post-accident ventilation system to help maintain slightly negative pressure in the confinement rooms.	**Active** - Project Work Plan has been agreed to. Conceptual design activities are under way, and a contract is in place.	$58K	approximately $5,000K (will firm up estimate after conceptual design)

Table 3.1. (contd)

Project	Status	Expenditures Through 9/94	Total Project Est'd Cost
Radiation Monitors (Post-Accident) - Kola: Provide reliable indication of radiation levels in the confinement following an accident.	**Active** - Kola NPP has prepared specific design information. Bids are being evaluated.	$34K	$350K
RBMK - EWG	**Active** - The EWG has been established and is functioning.	$725K	$1,410K
DC Switch Panels - Kursk: Provide seismically qualified DC switch panels and switchgear.	**On hold** - Project Work Plan has been agreed to. However, project activity is on hold because funds were reallocated to other activities during period of liability concerns. In addition, Kursk NPP recently expressed a desire to change scope of activity. It wants the United States to supply the batteries instead of the panels.	$2K	$1,500K
Safety Panel - Kursk: Provide a centralized, computer-based panel for monitoring critical safety functions and parameters necessary to execute EOIs.	**On hold** - Project Work Plan has been agreed to. However, project activity is on hold because funds were reallocated to other activities during period of liability concerns. However, Kursk NPP is preparing the specific design information.	$27K	$2,500K

Table 3.1. (contd)

Project	Status	Expenditures Through 9/94	Total Project Est'd Cost
Reactor Trip (Press Decrease) - Kursk: Provide a new reactor trip based on the rate of pressure decrease.	**On hold** - Project Work Plan has been agreed to. However, project activity is on hold because funds were reallocated to other activities during period of liability concerns. However, Kursk NPP is preparing specific design information.	$27K	$800K
Reactor Trip (Low Flow) - Kursk: Provide a new trip based on low flow rate in the group distribution header (GDH).	**Cancelled** - Project Work Plan was agreed to. However, the project was cancelled by Kursk NPP.	$26K	
Ultrasonic (UT) Test Equipment - Kursk: Provide UT inspection equipment to improve the inspection capability and reliability.	**Active** - Project Work Plan has been agreed to. The procurement of manual equipment is under way. Kursk NPP is preparing the necessary information relative to the automatic equipment.	$25K	$500K
High Temperature Suits - Kursk: Provide special high-temperature suits for entry into confinement rooms.	**Active** - Two prototype suit designs were sent to Kursk NPP for testing. One design was selected; however, several minor modifications are necessary. The modifications are being incorporated into a final prototype suit for approval by Kursk NPP management.	$67K	$500K

Table 3.1. (contd)

Project	Status	Expenditures Through 9/94	Total Project Est'd Cost
Fast Acting Valves - Kursk: Provide highly reliable opening valves for use in the "Upgraded ECCS."	**On hold** - Project Work Plan agreed to. However, project activity is on hold because funds were reallocated to other activities during period of liability concerns. However, Kursk NPP is preparing specific design information.	$22K	$2,500K
Improve Confinement Leak Tightness - Kursk: Improve leak tightness of Kursk confinement using U.S. materials (e.g., sealants, surface coatings, gaskets).	**Active** - Preparations are underway to procure leak detection and leak rate monitoring equipment. In addition, Kursk NPP is preparing necessary information to determine specific material requirements.	$11K	$1,000K
Confinement Isolation Valves - Kursk: Provide fast-acting, reliable confinement isolation valves.	**Cancelled** - Project Work Plan was agreed to. However, the project was cancelled by Kursk NPP.	$4K	
Mobile Pumping Unit - Kursk: Provide an independent source of emergency feedwater.	**On hold** - Project Work Plan has been agreed to. However, project activity is on hold because funds were reallocated to other activities during period of liability concerns. Kursk NPP is preparing specific design information.	$14K	$1,200K

3.7 Ukraine

Ukraine has 14 operating NPPs, including 2 RBMK 1000s, 2 VVER-440/213s, and 10 VVER-1000s located at five different sites. The primary organizations that have been involved with this program for Ukraine include those listed:

- Ukrainian SCNRS - Ukrainian nuclear regulatory authority
- GOSCOMATOM - responsible for the operation of all NPPs in Ukraine
- Kiev Energo Project - Ukrainian architect/engineer.

Funding of $21,588K has been allocated to Ukraine ($8,000K was made available September 30, 1994). Actual expenditures through September 1994 were $7,537K, and outstanding commitments are $3,735K.

Severe economic conditions in the Ukraine are impacting the availability of sufficient resources from the primary organizations to support program activities. Resource availability is critical to meeting quality and schedule objectives. DOE is pursuing ways to help resolve the issue, e.g., contracting directly with the primary organization.

Again, as noted in Section 2.2, there are no near-term risk reduction activities discussed here because Ukraine has no VVER 440/230s and the RBMK reactors at the Chernobyl site were originally scheduled to be shut down in December of 1993.

3.7.1 Operational Safety - Ukraine

The objective of this activity is to assist Ukraine in increasing the operational safety of its NPPs. Listed below are the accomplishments, as of September 1994, and ongoing work for the Ukraine operational safety activity.

Accomplishments

1. EOIs for the Rovno NPP (VVER-440/213) are in the initial draft stage. Only 1 of 34 EOIs has been drafted.

2. EOIs for the Zaporozhye NPP (VVER-1000) are in the initial draft stage. Twelve of 41 EOIs have been drafted.

3. Ten out of 17 guidelines for conduct of operations have been drafted for the Zaporozhye NPP.

Work in Progress

The development of EOIs is proceeding at pilot plants. In addition, implementation of 17 identified management and operational guides and instructions will be pursued at Zaporozhye NPP. Work is proceeding on EOIs for the following NPPs:

- Zaporozhye (VVER-1000)

- Rovno (VVER-440/213).

3.7.2 Training - Ukraine

With regard to Ukraine' training activity, the EWGS determine which training issues need to be addressed. Action plans are then developed based on these issues. Specific accomplishments and ongoing work activities for the Ukraine training activity are listed below.

Accomplishments

1. Khmelnitsky NPP has been selected as the pilot training site.

2. The contractor has been selected to assist with developing the training programs, and a Basic Ordering Agreement (contract) is in place. The following has been accomplished: completed the "training needs analysis" and identified course requirements,

   - completed the first of 12 pilot training program courses for the mechanical maintenance technicians program,

   - delivered special training courses on the "systematic approach to training and safety culture" including course materials (lesson plans, student materials) and software,

   - provided 8 weeks of training in the United States on SAT methodology to eight Ukraine representatives from all five Ukraine NPP sites and GOSCOMATOM,

   - developed the training course on simulator hardware maintenance at Zaporozhye and provided simulator maintenance tools,

   - transferred the mechanical maintenance training pilot program to Russia, and

   - procured PACE electronic soldering stations for the I&C technicians' course transferred from Russia (Balakova NPP).

Work in Progress

1. Development work is continuing with the pilot training programs for key plant staffing positions and special training courses. Specific programs are being developed for the following positions: control room reactor operator, control room turbine operator, refueling operator, and reactor vessel technician.

2. The development of both an instructor training course and a general employee safety training course is underway.

3. Procurement of additional training equipment is in progress.

4. Bid reviews for the Khmelnitsky simulator have been completed and a contract was awarded in November 1994.

3.7.3 Fire Protection - Ukraine

The objective of the Ukraine fire protection activity is to analyze and enhance the fire protection capabilities at its NPPs. This section lists the accomplishments of the Ukraine fire protection activities, as of September 1994, as well as the work in progress.

Accomplishments

1. Initial plant walk-throughs and fire hazard analysis at the Zaporozhye NPP were performed, and a limited Fire Hazards Analysis report was prepared.

2. EWGs were established, and general action plans were developed.

3. The U.S. architect/engineer was chosen to assist with this activity. A basic ordering agreement is in place.

4. Specific modifications for enhancing fire safety at Zaporozhye NPP were identified.

5. Samples of equipment (e.g., smoke detectors, heat detectors) were shipped to Ukraine for testing and evaluation to determine what equipment will satisfy their requirements.

6. The Ukrainians completed their evaluations and identified the specific equipment for use at Zaporozhye NPP.

7. Phase 1 materials were installed at Zaporozhye NPP; a close-out report was produced.

Work in Progress

The equipment and materials have been specified for the identified fire safety upgrade at the Zaporozhye NPP. The current plan is to purchase U.S. manufactured equipment and materials, as well as buy the Ukranian manufactured equipment and materials, including the fire doors.

Appendix A

List of Soviet-Designed Nuclear Power Plants in Countries of Central and Eastern Europe and the Newly Independent States

Appendix A

List of Soviet-Designed Nuclear Power Plants in Countries of Central and Eastern Europe and the Newly Independent States

Reactor	Type	Startup
Armenia		
Metsamor-1	VVER-440 Model 230	1977 (Shutdown 1989)
Metsamor-2	VVER-440 Model 230	1980 (Shutdown 1989)
Bulgaria		
Kozloduy-1	VVER-440 Model 230	1974
Kozloduy-2	VVER-440 Model 230	1975
Kozloduy-3	VVER-440 Model 230	1980
Kozloduy-4	VVER-440 Model 230	1982
Kozloduy-5	VVER-1000	1987
Kozloduy-6	VVER-1000	1991
Czech Republic		
Dukovany-1	VVER-440 Model 213	1985
Dukovany-2	VVER-440 Model 213	1986
Dukovany-3	VVER-440 Model 213	1987
Dukovany-4	VVER-440 Model 213	1988
Germany		
Nord-1	VVER-440 Model 230	1974 (Shutdown 1990)
Nord-2	VVER-440 Model 230	1975 (Shutdown 1990)
Nord-3	VVER-440 Model 230	1978 (Shutdown 1990)
Nord-4	VVER-440 Model 230	1979 (Shutdown 1990)

Reactor	Type	Startup
Hungary		
Paks-1	VVER-440 Model 213	1982
Paks-2	VVER-440 Model 213	1984
Paks-3	VVER-440 Model 213	1986
Paks-4	VVER-440 Model 213	1987
Kazakhstan		
Shevchenko	BN-350	1973
Lithuania		
Ignalina-1	RBMK-1500 (G-2)	1983
Ignalina-2	RBMK-1500 (G-2)	1987
Russia		
Kola-1	VVER-440 Model 230	1973
Kola-2	VVER-440 Model 230	1974
Kola-3	VVER-440 Model 213	1981
Kola-4	VVER-440 Model 213	1984
Sosnovyy Bor-1	RBMK-1000 (G-1)	1973
Sosnovyy Bor-2	RBMK-1000 (G-1)	1975
Sosnovyy Bor-3	RBMK-1000 (G-2)	1979
Sosnovyy Bor-4	RBMK-1000 (G-2)	1980
Kalinin-1	VVER-1000	1984
Kalinin-2	VVER-1000	1986
Smolensk-1	RBMK-1000 (G-2)	1982
Smolensk-2	RBMK-1000 (G-2)	1985
Smolensk-3	RBMK-1000 (G-3)	1990
Kursk-1	RBMK-1000 (G-1)	1976
Kursk-2	RBMK-1000 (G-1)	1978
Kursk-3	RBMK-1000 (G-2)	1983
Kursk-4	RBMK-1000 (G-2)	1985

Reactor	Type	Startup
Russia (contd)		
Novovoronezh-1	VVER-210	1964 (Shutdown 1988)
Novovoronezh-2	VVER-365	1969 (Shutdown 1990)
Novovoronezh-3	VVER-440 Model 230	1971
Novovoronezh-4	VVER-440 Model 230	1972
Novovoronezh-5	VVER-1000	1980
Balakovo-1	VVER-1000	1985
Balakovo-2	VVER-1000	1987
Balakovo-3	VVER-1000	1988
Beloyarsk-1	LWGR	1964 (Shutdown 1981)
Beloyarsk-2	LWGR	1969 (Shutdown 1989)
Beloyarsk-3	BN-600	1980
Bilibino-1	LWGR-12	1974
Bilibino-2	LWGR-12	1975
Bilibino-3	LWGR-12	1976
Bilibino-4	LWGR-12	1977
Slovakia		
Bohunice-1	VVER-440 Model 230	1978
Bohunice-2	VVER-440 Model 230	1980
Bohunice-3	VVER-440 Model 213	1984
Bohunice-4	VVER-440 Model 213	1985
Ukraine		
Chernobyl-1	RBMK-1000 (G-1)	1977
Chernobyl-2	RBMK-1000 (G-1)	1978 (Shutdown 1991)
Chernobyl-3	RBMK-1000 (G-2)	1981
Chernobyl-4	RBMK-1000 (G-2)	1983 (Destroyed 1986)
Rovno-1	VVER-440 Model 213	1981
Rovno-2	VVER-440 Model 213	1982
Rovno-3	VVER-1000	1987
South Ukraine-1	VVER-1000	1983
South Ukraine-2	VVER-1000	1985
South Ukraine-3	VVER-1000	1989

Reactor	Type	Startup
Ukraine (contd)		
Zaporozhye-1	VVER-1000	1985
Zaporozhye-2	VVER-1000	1985
Zaporozhye-3	VVER-1000	1987
Zaporozhye-4	VVER-1000	1988
Zaporozhye-5	VVER-1000	1989
Khmel'nitskiy-1	VVER-1000	1988

Key:
VVER: Pressurized water reactor
RBMK: Light-water-cooled, graphite-moderated pressure-tube reactor
LWGR: Light-water-cooled, graphite-moderated reactor
BN: Breeder reactor
G-X: Generation X