

NUCLEAR ENERGY IN LITHUANIA

Since Lithuania gained its independence from the Soviet Union, it has relied increasingly on nuclear energy as the cost of imported fossil fuels has risen. At the time of the Soviet collapse, the Ignalina nuclear power plant alone provided about 60 percent of Lithuania's electricity. Thermal (coal, oil, gas) power plants generated about 39 percent, followed by hydroelectric plants at slightly more than 1 percent. In 1995, the Ignalina plant provided 87.5 percent of the country's electricity, and in 1996, 85.8 percent.

The two 1,500-megawatt RBMK units at Ignalina produce about 2,370 megawatts (net) of electricity. As designed by the Soviets, the plant has the capacity to produce even more power, but safety concerns and public reaction to the Chernobyl accident prompted authorities to operate the plant below its full capacity.

Lithuania assumed ownership of the plant Aug. 27, 1991, and set up its own inspectorate, the Lithuanian Nuclear Power Safety Inspectorate—VATESI—to oversee the plant. Today, even though most of the plant's operators are ethnic Russians, they have agreed to stay and become Lithuanian citizens.

Energy Program and Plans

Historically, Lithuania's neighbors—Latvia, Belarus and the Kaliningrad region of Russia—depended heavily on its power, which exceeded the country's demands. Since Lithuania gained its independence, the growing cost of imported fossil fuels, mainly from Russia, has made Ignalina almost 50 percent cheaper than other power sources. By 1993, Lithuania had set a world record for the proportion of nuclear-generated electricity produced in a single nation, with nuclear energy providing 88 percent of Lithuania's power, up from 60 percent in 1991. That figure slid to 79 percent in 1994, but rose again to 87 percent in 1995.

Electricity Exports. Since the breakup of the Soviet Union, Lithuania's economy has declined, as has the demand for power in general in the Baltic countries. Countries such as Belarus have had difficulty paying for Lithuanian power. In addition, Lithuania now must compete for certain sectors of its traditional export market with Russia's Smolensk plant.

In 1989, Lithuania was exporting 42 percent of its electricity, but by 1993, exports had fallen to 20 percent. In 1994, Lithuania imported about 11 percent of its electricity from Russia as payment for past Russian debts. Exports resumed in 1995, reaching 20 percent, and rose to 32 percent in 1996.

In February 1995, Lithuania's ambassador to Ukraine told a Ukrainian parliamentary leader that Lithuania was prepared to sell electricity from Ignalina to his country. The ambassador said that the electricity could be paid for in part with hard currency and in part with agricultural produce. During official Lithuanian-Belarusian talks that same month, Belarus reportedly expressed an interest in buying electricity from Lithuania because it was cheaper than the power available from other countries. Lithuania began exporting electricity to Belarus in the spring. Estimated sales to Belarus for 1995 totaled 2 billion kilowatt-hours. In 1996, Ignalina sold 16 percent of its output to Belarus, 12 percent to Latvia and 4 percent to Russia.

Lithuania warned Russia, Belarus and Latvia that electricity exports might be substantially curtailed or temporarily halted because of planned maintenance on Ignalina Unit 1, which was shut down in March 1997 for 108 days.

Lithuania-Poland Link. In summer 1995, a Lithuanian delegation to Sweden headed by the energy minister discussed the construction of a high-voltage transmission line between Lithuania and Poland that could be used to export electricity generated at the country's hydroelectric plants. In mid-July, Lithuanian Prime Minister Slezevicius said he hoped that Sweden would provide assistance for the \$150 million project.

Several utilities—Sweden's Vattenfall AB, the Polish Power Grid Co., Finland's Imatran Voima Oy, Germany's PreussenElektra and Denmark's SK Power—have joined with electricity generators and suppliers based in Latvia, Estonia, Lithuania and Belarus to form a consortium. The consortium members seek to establish a so-called Baltic Ring electricity market.

According to the Lithuanian energy ministry in January 1996, Electricité de France will study the feasibility of building a transmission line from Lithuania through Poland to permit the sale of Lithuanian electricity to Western Europe.

In May 1996, the Lithuanian State Power System signed an agreement with a U.S. company, The Stanton Group, which included the construction of power lines through Poland that would allow Lithuania to sell electricity to Western Europe.

Long-Term Energy Plan. Lithuania released a long-term energy plan in early 1994, developed with the assistance of two Scandinavian firms,

Sweden's Vattenfall AB and Finland's Imatran Voima Oy. The plan projected that:

- Ignalina's units can operate safely until about 2005 or 2010, provided upgrade programs continue.
- By completing Ignalina's safety upgrades, Lithuania's electricity supply will be stable for 10 to 15 years.
- Ignalina's premature closure would result in an increase of \$500 million in costs to the Lithuanian power supply system.
- Lithuania cannot expect a new nuclear unit to be as cost-competitive as gas-fired plants.

The plan suggested that:

- The establishment of an electricity supply system over the Baltic region would allow for the trading of power; such an arrangement would help balance the supply system better at peak periods
- Firm long-range import/export agreements would help finance Ignalina's improvement program.

EBRD Nuclear Safety Account Grant. In February 1994, Lithuanian authorities agreed to accept 33 million ECU (\$34.9 million)—later increased to 34.8 million ECU (\$36.8 million)—from the European Bank for Reconstruction and Development's Nuclear Safety Account (NSA) to support an Ignalina safety improvement program that VATESI first approved in September 1993. The EBRD, however, placed conditions on the grant. Those conditions, which Lithuania must meet if it is to receive the full amount, could affect Lithuania's long-range energy plans.

The EBRD stipulated that:

- Lithuania must complete an in-depth safety assessment by the end of 1995. The assessment, funded in part by 7 million ECU (\$7.4 million) from the Nuclear Safety Account, would help VATESI decide whether Ignalina's Unit 1 will operate beyond 1998.
- The operation of Ignalina Unit 1 beyond 1998 must depend on the results of the nuclear safety assessment, the cost of continued safety upgrades and the energy situation in Lithuania. To operate beyond 1998, Unit 1 will have to be relicensed by VATESI.
- Lithuania must close the two units when it is time to replace their pressure tubes. All RBMKs require such replacement after they have operated for about 15 years. The EBRD estimates that the deadline for Unit 1 will fall between 1999 and 2002, and the deadline for Unit 2 is 2010.

The objective of the safety improvement program is to keep Ignalina operating safely until its permanent closure. When the plant originally developed the program in 1993, it called for a full range of near-term

upgrades, including new equipment such as a refueling machine, non-destructive testing equipment, TV monitors and other equipment to inspect the plant while it is operating. The plan also recognized the need for better fire-protection systems, procedures to properly document plant equipment and an improved reactor protection system.

Lithuania's original intent was to direct about \$5 million of its own money toward plant improvements. Authorities expected that other bilateral agreements would help finance about \$7 million in hardware and software improvements, with Sweden as the leading benefactor.

As part of the overall improvement program, the EBRD funds were to support 18 projects in three areas: operational safety, technical improvements, and services. Operational safety improvements include non-destructive examinations, seals for pressure tubes, routine maintenance equipment, radiation monitors and a simulator. Near-term technical improvements include seismic, fire and explosion prevention. Services include project management and design and engineering work. By the end of 1996, 11 of 21 contracted projects were completed, and six more were completed in spring 1997. Three projects, however, may not be completed until the end of 1997. Short-term improvements will include: an emergency scram system, a neutron flux monitoring system, data processing upgrades, better fire protection and emergency core cooling system backfits.

The EBRD also earmarked 100,000 ECU (\$106,000) for consultancy services to prepare and carry out a public information program. The program will tell the population about the safety improvement effort, the EBRD's involvement in Lithuania's power sector, and the future of the Ignalina plant.

Program Implementation. Two British companies, National Nuclear Corporation Ltd. and Scottish Nuclear, won a contract in April 1994 to organize a project management unit that would oversee the implementation of the improvement program. Funds from the Nuclear Safety Account grant had been earmarked for the 1.9 million ECU (\$2 million) contract. The British team is working alongside Ignalina staff with the goal of turning all management responsibilities over to Lithuanian management when the project is complete.

By mid-1996, the project management unit (PMU) had awarded 18 contracts valued at 29.18 million ECU (\$30.9 million) for safety-related engineering projects.

Among the contractors is Westinghouse, which is supplying systems to protect against low reactor coolant flow and against a low operational reactivity margin. Westinghouse is working with the U.K.'s AEA Technology and the Lithuanian Institute of Information Technology on the project.

Problems developed in 1996 with one of the engineering projects—the provision of sealing rings for the reactors' fuel channels. The rings, made by a U.S. company, did not work properly, forcing the plant to buy ring replacements from Russia, according to Ignalina's manager. The U.S. company resolved the problems, which necessitated a design change, and carried out a trial installation in late 1996.

One of the operational safety improvements under the Nuclear Safety Account grant—with partial financing from the Ignalina plant itself—is a full-scope simulator. The simulator, being supplied by Germany's STN Atlas with assistance from a Russian firm, is expected to be delivered in summer 1997.

Safety Analysis Report. The plant's safety assessment was carried out by plant personnel with the help of Sweden's Vattenfall, Canada's AECL, the U.S. company Stone & Webster and Russia's Research and Development Institute of Power Engineering. The safety analysis report (SAR) was completed in late 1996 and then reviewed by Eastern and Western technical safety organizations. The report and its review were then assessed by a panel of seven international experts, which made recommendations.

One improvement called for by the SAR was the installation of new secondary shutdown systems in both units. It would take 3-4 years to obtain bids on the systems, and to design and install them. According to the panel of experts, Lithuania must carry out an estimated \$120 million worth of safety improvements immediately, including a shutdown system for Unit 2. The panel did not recommend the installation of such a system at Unit 1 because it is expected either to be shut down or rechanneled between 1999 and 2002.

In their report, issued in March 1997, the experts recommended that neither unit be restarted after planned shutdowns for maintenance later in the year until important design and operational issues have been resolved. They criticized plant management for lack of direction and failure to promote a proper safety culture. Panel members were also critical of VATESI for not being more independent.

In April 1997, the panel members met with Lithuanian government officials to present their recommendations. The government gave its support to the recommended safety improvements and, according to one official, expects to pay for most of the work. Lithuania agreed that Unit 1 would not go back on line after planned maintenance until VATESI was satisfied that safety issues—including better plant management structure and the development of a safety case for the accident localization system—have been properly addressed.

In May, officials from the EBRD and the Lithuanian government met to discuss the implementation of the panel's recommendations. Among other issues, they considered options for alternative sources of electricity if Ignalina Unit 1 were to be closed. VATESI is to make a decision on licensing the unit by July 1, 1998. Bank officials said that one option was to use an EBRD grant of 40 million ECU (\$42.4 million) to modernize the Elektrenai thermal power plant, which runs at minimum capacity when Ignalina is operating normally. Another possibility was to modernize the Achema nitrogen fertilizer plant to reduce its power consumption.

In July 1997, however, the Licensing Assistance Project—a group of regulators from the United States, France, Germany, Finland, the United Kingdom and Sweden—said that Lithuania would be unable to meet the July 1998 deadline for licensing Unit 1. Because the English-language version of the SAR and its assessment by a panel of experts was delayed for a year, and

has not yet been translated into Russian—the language used by Lithuanian regulators and plant personnel for technical matters—VATESI has said it cannot license the unit until May 1999. The EBRD reportedly has insisted that the July 1998 deadline be met.

In late July, the panel of experts recommended that 21 accident initiating events be analyzed before Unit 1 is restarted. Lithuania had proposed that six events be analyzed before restart, with the remainder analyzed later. Unit 2 is scheduled to go off line for maintenance when Unit 1 restarts. If restart is delayed, Lithuania might need to import electricity or borrow money to ensure that demand is met during the winter.

New Safety Improvement Plan. Based on the results of the SAR and its review by independent experts, the Ignalina plant produced a new safety improvement plan, known as SIP-2. Lithuania and Western donors have agreed on funding of 100 million lita (\$24.9 million) for safety improvement work in 1997. Lithuania will finance 80 percent of the work through energy tariffs, with the remaining 20 percent coming from a combination of EBRD aid and bilateral assistance from Sweden, the United States and Japan.

Special Task Force. In April 1997, a special task force consisting of representatives of Ignalina's operators, the Lithuanian Economic Ministry and the Swedish International Project was set up to implement the recommendations of the international panel of experts. Lithuania's Nuclear and Radiation Safety Advisory Committee will monitor progress in implementing the recommendations. The committee, formed in 1993, is composed of safety advisors and environmental specialists from several European countries.

Power Sector Development Program. In light of the Nuclear Safety Account grant, Lithuania's Ministry of Energy (now the Ministry of Economy)—together with the Lithuanian State Power System and the Lithuanian Energy Institute—prepared a detailed least-cost program for the development of the country's energy sector. The first draft was submitted to the Lithuanian government and international lending institutions in November 1995. With the safety assessment of Ignalina now completed, the draft will be refined.

The program will cover:

- demand forecasts,
- Ignalina operation scenarios, based on the EBRD grant agreement,
- analysis of capacity requirements,
- options for meeting capacity requirements based on a least-cost analysis,
- cost estimates of each option, including environmental and safety costs, and
- estimated financing requirements for each option.

In February 1995, Lithuania's parliament ruled that the Ignalina plant should be not privatized before 2000. In June, an official of the Lithuanian State Power System (LSPS)—the country's utility—said that 15 percent of LSPS would be privatized.

Nuclear Energy Oversight

Lithuania's nuclear inspectorate, VATESI, faces three major tasks:

- Decide on a set of rules and standards to use for current regulation.
- Develop its own rules and standards, based on a survey and analysis of regulations from various countries, which will be codified in national legislation.
- Exercise regulatory control over Ignalina's operational safety.

To aid VATESI in these activities, the Lithuanian government issued a decree in May 1993 establishing the Nuclear and Radiation Safety Advisory Committee. The committee, which met for the first time in October 1993, is composed of safety advisors and environmental specialists from the United Kingdom, Germany, Sweden, Finland, Ukraine, Russia and Lithuania.

The committee proposed rules for the employment of Western companies at Ignalina and helped the government resolve the nuclear issue. The committee's expenses are covered by committee members and Lithuania's Ministry of Economy. The committee's agenda: to seek out regulatory information from the European community, to draw on Ukraine's expertise and to establish an independent safety group that will examine individual problems. The committee is advising Ignalina, VATESI and the Ministry of Economy on an integrated approach to safety upgrading and the development of a strong regulatory and technical infrastructure.

The committee has made recommendations to the Lithuanian government on prices for Ignalina electricity, and it appointed an independent group in October 1993 to review three key safety-related issues: 1) whether Ignalina Unit 2 should have operated through 1992 despite leaks, 2) the failure of some valves owing to poor configuration documentation and 3) the possibility that a fuel assembly could have been missing in February 1993. Specialists with the review group found that Ignalina would benefit from a special safety committee that has the authority to examine management decisions.

In April 1997, former Energy Minister Saulius Kutas was appointed director of VATESI, succeeding Povilas Vaishnis.

Electricity Policy and Plant Operations

In an April 1994 letter to the Lithuanian prime minister, the Nuclear and Radiation Safety Advisory Committee asked that the price of electricity from Ignalina be doubled—to about 10 Lithuanian cents per kilowatt-hour—to ensure the safe, long-term operation of the plant. The price increase was to take into account a new budget that includes upgrades, repairs, waste management and decommissioning.

The Lithuanian government officially authorized a price increase for electricity July 1, 1994, raising it to an average of 8 to 12 Lithuanian cents per kilowatt-hour. In October 1994, the price rose further to an average of 12

to 16 Lithuanian cents per kilowatt-hour, and in May 1995 it rose to an average of 20 cents per kilowatt-hour.

In September 1995, the Ignalina plant sued the Lithuanian State Power System (LSPS), the national utility, for failing to pay for the electricity supplied by the plant. According to Ignalina's director, LSPS owed the plant between 230 million and 240 million litas (\$57.4-59.9 million). The plant took LSPS to court in an attempt to recover 189 million litas (\$47.2 million). The same month, the government granted Ignalina a credit of \$5.6 million. In December 1995, the two sides settled their dispute, with LSPS agreeing to repay the debt in installments up to the end of 1996. However, LSPS was unable to repay its debt, and a debt forgiveness plan has been worked out between the power system, the Ignalina plant and the government.

In November 1996, the Ministry of Economy directed the Lithuanian Energy Institute to develop a waste management strategy, including options for decommissioning. VATESI and its technical support organizations have been charged with drawing up a detailed decommissioning plan by 2000. VATESI is using a grant from the European Union's PHARE program to develop decommissioning options.

Status of Liability Coverage

In January 1994, Lithuania became the first country of the former Soviet Union to ratify the Vienna Convention, which ensures that the responsibility for damage caused by a nuclear accident is channeled to the plant operator. Lithuania is also a party to the 1988 Joint Protocol on Civil Law Liability and Compensation for Cross-Boundary Damage from Nuclear Accident, which resolves potential conflicts between the Paris Convention—which covers 14 countries—and the Vienna Convention—which has worldwide coverage.

Lithuania passed a nuclear liability law in 1993 consisting essentially of the Vienna Convention's liability provisions. It has now developed nuclear legislation that includes a more comprehensive set of regulations. The draft law has been reviewed by Finnish, Swedish and German legal advisers, and approved by the Lithuanian government. The government sent it to parliament in mid-1996, and late in the year, parliament adopted the legislation.

Because of Lithuania's small size, Swedish vendors want Lithuania's neighbors—Estonia, Latvia and Belarus—to adopt nuclear liability provisions. Estonia and Latvia have done so, but Belarus—afraid it would be held retroactively liable for the Chernobyl accident—has not yet acted.

Fuel Supply and Waste Disposal

Supply of Fuel. After investigating other sources of fuel for Ignalina, Lithuanian authorities reported they intend to keep purchasing it from Russia, which has a limited market for RBMK fuel.

In September 1995, Russia agreed to supply nuclear fuel in exchange for electricity from Ignalina. The fuel-for-electricity swap, which involved the export of up to 4 billion kilowatt-hours of power to Russia, began in November and extended to May 1, 1996.

In March 1996, however, the Lithuanian government bought fuel for Ignalina after fuel deliveries from Russia were delayed because the Lithuanian State Power System—which is responsible for buying fuel—could not pay for it. As a result of the delay, power at the two reactors was reduced.

In April, Lithuanian media reported that Russia might revoke the fuel-for-electricity agreement. A Russian official reportedly said that if Lithuania wanted to buy fuel in April, it would have to repay a \$12 million debt as well as pay nearly \$20 million in advance.

New Fuel. The Russian fuel manufacturer, Mashinostroitelny Zavod Elektrostal, has modified the fuel for RBMK reactors to reduce the void coefficient and thus improve safe operation. A pilot batch of the new fuel was loaded in Ignalina's reactors in July 1995. As of April 1996, the new fuel accounted for about 10 percent of Unit 2's fuel. According to the plant's manager, Ignalina would switch to the new fuel over the next three years.

Spent Fuel Storage and Disposal. Because reprocessing of RBMK spent fuel is too costly and storage space is limited, Lithuania has entered agreements with Sweden and Germany to deal with its waste management problem.

In October 1992, the Swedish firm Svensk Kärnbränslehantering AB (SKB) was awarded a contract by Lithuania's Ministry of Energy to help evaluate and select a suitable solution for interim spent fuel storage at Ignalina. Given the short time before the plant would run out of storage space, SKB considered dry storage in casks or vaults to be the only feasible option.

In December 1993, Lithuania signed a contract with the German company Gesellschaft für Nuklear Behälter (GNB) for 60 CASTOR casks to be used for dry storage. At the time, the Lithuanian Ministry of Energy asked GNB to carry out research on producing a cheaper cask.

Seeking to lower the cost of the project, the Energy Ministry called for new tenders that included both the storage vessels and the storage facility. In April 1996, an official of VATESI—the Lithuanian regulator—said the ministry had received bids from three companies to supply a complete dry storage facility—Ontario Hydro, Atomic Energy of Canada Ltd. and GNB. A year later, two finalists remained: AECL and GNB.

By mid-1997, GNB had delivered 20 CASTOR casks to Ignalina. In July, GNB signed a contract with Ignalina for the delivery of 40 casks of the new CONSTOR type. The company expects to begin delivering the casks in March 1999, with all casks delivered before 2001. But Lithuania has reportedly awarded a letter of intent to AECL to supply a system for storing Ignalina's spent fuel over the lifetime of the plant's two units.

International Cooperation/Assistance

Barselina Project. By mid-1994, Swedish, Lithuanian and Russian experts had completed three phases of the Barselina project in 1994—the first probabilistic safety assessment (PSA) of an RBMK reactor (see the **International Assistance** section). The project involved a safety comparison between the Ignalina plant and the Barsebäck plant in Sweden.

During the fourth phase—which ran from July 1994 to September 1996, the Ignalina PSA was refined, taking into account plant changes, improved modeling methods and greater plant information on events and dynamic effects. The project will continue under the name Barselina 2000 as a cooperative Lithuanian-Swedish effort aimed at improving safety management and plant performance at Ignalina.

RBMK Safety Review Consortium. In 1993, the European Union (formerly the European Communities) launched an RBMK safety review aimed at developing a better understanding of the RBMK design and operation. The review used Ignalina 2 and Russia's Smolensk 3 as reference plants. For details, see the **International Assistance** section.

Swedish Aid. The Swedish government increased its contribution to the Ignalina safety project by \$2.1 million in early 1994 and doubled its share in the EBRD account. Sweden's EBRD contribution now totals \$6 million. In addition, Sweden spent about \$10 million in 1991-92, \$6 million for Ignalina and \$4 million for VATESI. It planned to spend \$7.5 million in 1993-94. In June 1993, Sweden's Vattenfall and ABB Atom AB decided to delay safety improvements for Ignalina scheduled for the summer because the Lithuanian government had enacted no liability laws. When Vattenfall began supplying fire protection and emergency equipment, it accepted government indemnity in the absence of an official law. After Lithuania adopted comprehensive nuclear legislation in 1996, ABB Atom supplied a pressure relief valve. For details of assistance, see the separate summary of the Ignalina plant.

During Lithuanian-Swedish talks in April 1995, Lithuanian Prime Minister Slezevicius said the two sides had discussed possible studies of Ignalina by Swedish nuclear experts, including decommissioning studies.

Canadian Agreement. In November 1994, Canada and Lithuania signed an agreement to cooperate in the peaceful use of nuclear energy. Under the agreement, Canada will help improve safety at the Ignalina plant by providing equipment and expertise.

U.S. Assistance. Under an assistance program funded by the U.S. government, a peer review of the Barselina project and expert assistance on the RBMK's positive void coefficient are being provided. Other program activities include the provision of a full set of computer codes for safety, transient, severe accident and operation analysis; the development of an RBMK-1500 plant analyzer; the development and implementation of a management system to maintain and update key design, maintenance and safety information; and the provision of non-destructive examination equipment and training support.

In August 1994, the U.S. Agency for Trade and Development awarded Lithuania a \$175,000 grant to prepare a technical specification and a plan for modernizing the country's electrical grid.

Russian Technical Support. In October 1994, Ignalina management requested assistance from Russia's RBMK institute, RDIPE, to review safety improvements planned under the EBRD's Nuclear Safety Account grant program. The objective of the review, according to Lithuanian authorities, is to examine whether safety improvements planned under the EBRD-sponsored program will have any negative effect on parts of the reactor that were not the direct focus of the program. About 21,000 ECU (\$22,260) from the Nuclear Safety Account grant will be used to support RDIPE's work in preparing technical specifications. In addition, 1 million ECU (\$1.06 million) from the grant will be used for accident analyses in the safety assessment.

Ukrainian-Lithuanian RBMK Experience. At an April 1997 meeting, Lithuania's president and the Ukrainian ambassador to Lithuania discussed the exchange of experience in enhancing the safety of RBMK reactors.

July 1997

IGNALINA NUCLEAR POWER PLANT

Type: RBMK

Units: Two

Total megawatts (net): 2,600

Location: Visaginas (formerly Snieckus), Lithuania

Dates of initial operation: Unit 1 - December 1983
Unit 2 - August 1987

Principal Strengths and Deficiencies

For an overview of the principal strengths and deficiencies of Soviet-designed plants, see **Soviet Nuclear Power Plant Designs**.

Operating History

Swedish sources speculated that a faulty weld led to the release of contaminated water at Ignalina in January 1994, an event that forced one unit to shut down.

Lithuanian authorities reported an energy shortage later in January 1994 after operators shut down Ignalina Unit 1 following the failure of control board instrumentation. The event was classified as Level 0 on the IAEA's International Nuclear Event Scale (INES).

Cold weather in February 1994 led to the freezing of fire protection equipment. Lithuania classified the incident as Level 1 on the INES.

In February 1994, Ignalina shut down so that engineers could locate and stop leaking in certain valve compartments. Plant workers determined the source of the leaks to be damaged sealing gaskets. The incident was classified as Level 1 on the INES.

Lithuania classified an incident that occurred on July 11, 1994, as an IAEA Level 1 event. Engineers had incorrectly installed a new switch used to move control rods in and out of the reactor. Operators discovered the error when testing the new switch, which they then successfully replaced.

In November 1994, authorities shut down both Ignalina units in response to a terrorist threat. Lithuania's prime minister asked Swedish authorities for help in searching the plant because they were well-acquainted with areas most vulnerable to attack.

Both units returned to service after searches revealed no bombs. Following the incident, Lithuanian authorities launched a crash program to improve plant security. Their first steps included the procurement of new equipment, such as infrared binoculars for guards. Other actions included the creation of three working groups to improve security measures. The groups include representatives from the Lithuanian police, the defense ministry, the energy ministry (now the economy ministry) and the environment ministry. The groups will write bid specifications and purchase relevant equipment, train personnel in security and physical protection, write complete instructions for how to search the plant in the event of further bomb threats, and train personnel to participate in such searches. In addition, Lithuanian regulators introduced a computerized accounting system for fuel at the plant and changed personnel routines. Sweden, Finland, Germany and other observers praised the Lithuanians for their actions in response to the terrorist threat.

In August 1995, the crane loading an emergency sealing plug into a refueling machine during a routine maintenance outage became entangled with the electric feed cable of another crane, causing a cut in the power supply. The incident was provisionally classified as Level 1 on the INES.

In November 1995, fast-acting valves between the emergency core cooling pressurized tanks and the Unit 2 reactor spontaneously opened and roughly 12 tons of water were released. An operator noticed that the valves had opened, and shut them. The incident was classified as Level 1 on the INES.

Technical/Upgrading Activities

The plant has carried out numerous major upgrades since 1989, including:

- modification of reactor control and protection systems,
- replacement of fuel channel inlet flow control isolation valves,
- fire protection upgrading, and
- increasing the reliability of emergency core cooling system pumps.

International Exchange/Assistance

Plant Twinning. Ignalina is twinned with Germany's Krümmel plant.

Swedish Assistance. The Swedish utility Vattenfall AB began supplying Ignalina emergency gear and fire protection equipment after two divers died while working in Ignalina's inlet channels. As of November 1993, Vattenfall had supplied about \$125,000 worth of equipment, including protective fire-fighting clothing and fire extinguishers. Vattenfall has also recommended that authorities arrange for more firefighters to protect the plant in an emergency. By early 1994, Vattenfall AB had completed the installation of fire protection systems.

Under a Swedish-Lithuanian agreement, a project to examine Ignalina's fuel channels was launched in 1992. Using non-destructive examination equipment developed by Sweden's ABB Tekniska Röntgencentralen, welds were examined in Unit 2 as the basis for a comprehensive examination program at Unit 1. In addition to conducting the examinations, ABB TRC will supply non-destructive testing equipment and train Ignalina technicians in its use. ABB TRC is providing several new manipulators for RBMKs as well as modern ultrasonic and eddy current instruments.

In November 1995, Vattenfall signed a Kr 7.8 million (\$971,880) contract to supply fire protection equipment, including fire doors and new fire-retardant floor covering.

In December 1995, the Swedish government agreed to provide equipment to improve access control at the Ignalina plant. Among the Kr 4.5 million (\$560,700) in equipment to be supplied by ABB subsidiary Trax AB are: computerized magnetic-strip ID cards, surveillance cameras, metal detectors and other security devices. In addition, the U.S. government plans to provide some assistance for the security project.

A pressure relief pipe from the confinement at Ignalina Unit 1 was installed in 1996 after Belarus agreed to sign the Vienna Convention on third-party nuclear liability. Delivery of robotic installation equipment designed and made by ABB Atom had been delayed for two years because of liability concerns. A pressure relief pipe was installed at Unit 2 in late 1996, even though Belarus had not yet signed the convention. But in April 1997, an ABB Atom official said that the liability issue would have to be resolved before the company did any more safety improvement work at Ignalina.

Swedish International Project (SIP). SIP, an organization established by the Swedish regulator, has a large bilateral safety assistance program in place. Its activities in Lithuania include: supplying modern inspection equipment and training Ignalina personnel in its use; supplying non-destructive testing specialists to participate in inspections during Ignalina's outages; developing a proposal for a law that would transform Ignalina into an independent state-owned limited company; and supporting an upgrade of Ignalina's communications technology. SIP reported in early 1996 that Ignalina had made significant progress in monitoring its reactors. That analysis will be used in the plant's maintenance, according to SIP.

U.S. Loan. In April 1997, the United States and Lithuania finalized a \$9.5 million loan agreement. The loan will be used to upgrade the TITAN plant process computer at Ignalina's Unit 1. The system supports plant operations and maintenance activities by collecting data to monitor plant heat balances, thermal efficiency and equipment failures. The U.S. company Science Applications International Corp. will provide the new system, with financing coming from the Bank of New York and the loan guaranteed by the U.S. Export-Import Bank.

Finnish Help. IVO International has a contract, funded by the European Bank for Reconstruction and Development (EBRD) to carry out an engineering study and deliver a computerized technical documentation management system.

German Aid. GEC Alsthom Energie has received a contract, funded by the EBRD, to supply equipment for in-service inspection of Ignalina's reactor channels. The equipment will include mechanical hardware and ultrasonic inspection equipment to examine fuel channels, control rod channels and graphite channels.

Japanese Assistance. Under an agreement signed in July 1997, Japanese specialists will help the Ignalina plant to upgrade its computer control system. Japan reportedly also will supply equipment for the plant.

Ignalina Safety Analysis Group. The Ignalina Safety Analysis Group, a component of the country's nuclear safety structure, is devoted to analyzing Ignalina's scientific and technical aspects. The group, consisting of Lithuanian experts, seeks to:

- gain in-depth understanding of the RBMK-1500's physical processes,
- collect, systematize and verify design and operational data,
- quantify and prioritize Ignalina safety issues,
- simulate and analyze the consequences of potential accidents, and
- provide technical and scientific consultation to VATESI and governmental and international organizations.

The group is working on cooperative projects with Germany, the United States and Sweden.

The group's activities cover the following areas:

- analysis of safety-related operational transients and loss-of-coolant accidents,
- thermal-hydraulic assessment of accident confinement system,
- structural analysis of accident confinement system and other plant buildings,
- strength analysis of piping and other elements of the main circulation system,
- evaluation of graphite and fuel channel safety concerns,
- development of RBMK-1500 neutron dynamic models,
- probabilistic safety assessment, and
- development of Ignalina plant analyzer.

The group took part in the Ignalina safety assessment funded by the EBRD's Nuclear Safety Account. In September 1996, the group—working with the University of Maryland—completed the thermal-hydraulic assessment, which was supported by the U.S. Nuclear Regulatory Commission. Also in 1996, the group initiated the structural analysis project.

Inspections

ASSET Mission. Ignalina was the focus of the first ASSET (Assessment of Safety Significant Events Team) review in the former Soviet Union by the IAEA. The IAEA team, which visited the plant Nov. 20-Dec. 1, 1989, studied plant operating history and incident-prevention programs.

The team reported that Ignalina was operated at internationally acceptable standards and that the plant was one of the world's lowest in unplanned automatic shutdowns. In both 1987 and 1988, there were 40 reported events at the plant; for the first 10 months of 1989, there were only four.

The team noted that while the plant's surveillance policy appeared to be sound, management needed to take additional measures to develop an effective plant surveillance program for prevention of incidents. Among the team's suggestions:

- Management should set up a department of surveillance with the same authority as the department of operations and department of maintenance.
- The department's responsibilities should include assessment of personnel proficiency, assessment of performance in areas of safety and reliability, and assessment of all operational events to ensure complete feedback.

Follow-Up ASSET Mission. A follow-up ASSET mission visited Ignalina Feb. 1-12, 1993, to review the implementation of recommendations made by the 1989 ASSET mission. The team found that most of the recommendations had been considered by plant management, which had taken steps to implement them.

The team identified a few areas where recommendations had not been implemented:

- involving the operating staff in the review of procedural revisions,
- evaluating the effectiveness of the surveillance program, and
- the frequency of control cable testing.

The team also found a number of good practices, many involving the creation of special groups with responsibility for specific areas, such as the maintenance and modification of cables, the collection of reliability data, and the measurement and analysis of vibration data on rotating equipment.

The team offered two suggestions:

- improve the revision of operating documentation by involving experienced operating staff, and
- further develop the surveillance program to ensure effective feedback and monitoring.

The team also suggested a structured walkdown of the plant to remove any combustible material, especially material near cable trays and other safety-related equipment.

In addition, the team reviewed a total of 173 reported events between January 1989 and October 1992. Of these, 140 were considered to be safety relevant; three events were classified as Level 2 on the International Nuclear Event Scale, 14 were classified as Level 1 and the rest as Level 0.

The team reviewed two events in detail, and from the review developed four main recommendations:

- improve the primary circuit in-service inspection program,
- enhance the operational procedure review program,
- further improve the plant's newly established surveillance program, and
- improve coordination and communication throughout the plant.

OSART Mission. An IAEA OSART (Operational Safety Review Team) mission visited the Ignalina plant Sept. 4-22, 1995. The team noted that the plant was carrying out many initiatives, with the help of the international community, to improve safety. Among the initiatives: buying a full-scope simulator and upgrading operating procedures.

The team identified several areas of good performance:

- The Ignalina staff is well educated, with most operating staff holding university degrees.
- The maintenance department uses several methods of self-assessment that effectively identify and correct maintenance problems.
- The plant's general material condition and housekeeping are improving.
- Senior management is present at the plant daily and is very involved in day-to-day operations.

The team also offered several proposals for improvement, including:

- Management should establish more challenging nuclear safety expectations and provide better guidance to staff in achieving safety performance.
- Plant funding needs to be improved.
- Plant personnel radiation-exposure levels should be reduced and radioactive-contamination practices should be improved.
- Organizational structure should be improved.
- Several aspects of emergency planning should be improved.
- Personnel training should be strengthened.
- Nuclear safety regulation should be strengthened.

Follow-Up OSART Mission. A follow-up OSART mission visited Ignalina June 2-6, 1997. To date, no information on the mission has been released.