

NUCLEAR ENERGY IN ARMENIA

Armenia has one nuclear power plant at Medzamor consisting of two VVER-440 Model V230s. The units have been modified with seismic upgrades and are sometimes referred to as Model V270s. Before the plant was shut down in early 1989 following a disastrous earthquake in December 1988, it supplied 40 percent of the country's electricity.

Following the collapse of the Soviet Union, a territorial dispute between Armenia and neighboring Azerbaijan led to an embargo on all energy supplies—fuel and electricity—to Armenia. Azerbaijan effectively blocked roads, rail lines and energy supplies, leading to severe energy shortages in Armenia. In 1993, the government decided to restart the plant, and in late 1995, Unit 2 came back on line. In 1996, the unit supplied 37 percent of the country's electricity.

Nuclear Program and Plans

Medzamor's Unit 2 was selected for restart because it is the newer of the two units. According to a Russian news agency report in November 1995, the Ministry of Atomic Energy had signed an agreement with Armenia's Energy Ministry on restarting Unit 1. Armenian officials have said, however, that the country's first priority is to ensure the safe operation of Unit 2 and bring it closer to Western safety standards. In March 1997, the head of the atomic energy department in Armenia's Ministry of Energy said that there were no plans to restart Unit 1.

In its energy program to the year 2005, issued in 1995, the Armenian government included a two-stage plan for nuclear energy development. The first stage entails operating the Medzamor plant until 2005, and the second stage calls for bringing a new nuclear plant on line between 2005 and 2010.

During a meeting between Armenian President Ter-Petrosyan and French President Chirac in June 1996, the Armenian president reportedly asked for

help in building a new nuclear power plant; according to an Armenian news agency, Chirac said France would do its best to assist. In September President Ter-Petrossian said that Armenia would have to build a new 1,000-megawatt nuclear power plant between 2005 and 2007 to replace the 400 megawatts generated by Medzamor Unit 2 and Armenia's 600 megawatt electricity deficit. He said talks were under way with France, Germany, the United States and Russia.

In May 1997, the manager of the Medzamor plant said that restart of Unit 1 would not be economical, and the country should instead plan to build a new nuclear plant.

That same month, a presidential decree established the Nuclear Energy Safety Council, an advisory body to Armenia's president. The council, which consists of 14 members from various countries, met in May to discuss the safety improvement measures planned for Unit 2. The council reportedly recommended that Armenia not wait for funding promised by the European Union for safety upgrades. It suggested drawing up a list of the most urgent safety measures, which should be funded by Armenia. President Ter-Petrossian reportedly said that money would be made available from the state budget to finance the work.

Formulating and Implementing Electricity Policy

During the winter of 1994-95, residents of Yerevan, Armenia's capital, often had only 1-2 hours of electricity daily. With the restart of Unit 2, they were expected to have electricity for 10-12 hours daily.

In March 1995, the Armenian minister of energy and fuel said that the country planned to increase its electricity generating capacity by building a thermal plant, adding a fifth unit to the Hrazdan gas-fired plant, and rehabilitating existing plants. The government's long-term energy program calls for nuclear energy to provide 38 percent of the country's electricity, hydropower to provide 15 percent, thermal energy, 45 percent and alternative energy, 2 percent.

In September 1995, power sector officials from Armenia and Iran met to discuss cooperative activities. The two sides agreed to create a coordinating company that would develop a program for joint construction of electric power lines and use of the Araks River's hydropower potential. In the spring of 1996, Armenia sought bids on the construction of about 40 kilometers of high-voltage lines as part of the project; construction began in August. The line was completed in January 1997, and Armenia is now importing an average of 1 million kilowatt-hours of electricity daily from Iran.

Nuclear Operations. In late March 1996, the government reportedly put a joint-stock company in charge of Medzamor. All of the stock, however, is reportedly held by the government, most of it by the Ministry of Power Engineering. Previously, Aratomenergo, a department within the Armenian Ministry of Energy and Fuel, was responsible for operation of Medzamor.

Nuclear Energy Oversight

Prior to its shutdown in 1989, the Medzamor plant was part of the Soviet nuclear energy system. Nuclear regulation was the responsibility of Gospromatomnadzor, a regulatory agency created by the Soviet government. After the collapse of the Soviet Union in 1991, nuclear regulation became the responsibility of the individual independent countries.

With the help of the International Atomic Energy Agency (IAEA), Armenia established a nuclear regulatory body—the Armenian Nuclear Regulatory Authority (NRA)—in 1994. The IAEA also offered to help Armenia regulators resolve technical issues with safety implications for the plant. The Armenian NRA, which was responsible for licensing the plant's restart, developed a list of safety-related measures to be carried out either before Unit 2's restart or at a later date.

Although the G-7 (Group of Seven) countries were opposed to Unit 2's restart, the U.S. Nuclear Regulatory Commission began providing limited regulatory assistance, not related to restart, in November 1994. During 1995, the NRC used funding from the U.S. Agency for International Development to provide training for Armenian NRA staff in the development of fire protection regulations, site security and the management of spent fuel. In 1996, the NRC plans to provide training in the regulation of seismic issues and decommissioning. It is also discussing additional activities with Armenian authorities.

Status of Liability Coverage

Armenia is a party to the Vienna Convention, which ensures that the responsibility for damage caused by a nuclear accident is channeled to the plant operator. It 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 European countries—and the Vienna Convention—which has worldwide coverage.

Fuel Supply and Waste Disposal

Supply of Fuel. As part of its agreement with Armenia on the restart of Medzamor 2, Russia is supplying nuclear fuel for the plant. The two countries signed an agreement in August 1996 under which Russia would provide a credit of 98.3 billion rubles for the purchase of nuclear fuel. However, fuel deliveries were halted during the summer of 1997 because of lack of payment. According to Armenian media, a Russian offer of credit would ensure the availability of fuel before the end of the unit's two-month outage for repair and maintenance work in September.

Spent Fuel Storage and Disposal. Spent fuel from Unit 2, which was moved to the reactor cavity from the spent fuel pool after the plant was shut down in 1989, has been retransferred to the spent fuel pool. Russia has

Operating Soviet-Designed Nuclear Power Plants In Armenia



Key

VVER ■

agreed to accept spent fuel generated after Unit 2's restart, but this option requires a secure land route.

In January 1996, France's Framatome signed a FF 40 million (\$6.3 million) contract to design a dry spent fuel storage facility for Medzamor. The facility, to be supplied under a combined grant-loan agreement, will be operational by the end of 1998. It is based on a U.S. system adapted to meet the specifications of the Russian-made VVER fuel used at Medzamor.

Technical/Upgrading Activities

In December 1994, the Armenian Council of Ministers Presidium—the cabinet—held an extraordinary session at the plant. It decided to lift customs duties on imported equipment needed for the plant, and to create a state commission to handle the start-up of Unit 2.

Armenian authorities planned to complete some safety upgrades before Unit 2 was restarted, but many improvements—such as the replacement of many valves and control rod drives and the modernization of instrumentation and control systems—will occur over the next three to four years. For details, see the separate summary of the Medzamor plant.

International Cooperation/Assistance

IAEA Membership. Armenia joined the International Atomic Energy Agency in 1993, entitling it to the agency's services. In June 1994, an IAEA team visited the plant and reported that the reactor and its basic equipment were comparable to those of other VVER-440 Model V230s. Among the issues addressed by the team were seismicity, safety conditions, reactor pressure vessel integrity, fire safety, operating procedures, radiation protection, and emergency planning. The team concluded that there were no technical obstacles to the plant's restart. During 1996, 72 specialists from the IAEA visited the Armenian Nuclear Regulatory Authority.

WANO Membership. Armenia became a member of the World Association of Nuclear Operators (WANO) in August 1994. Under the auspices of WANO, personnel from the Medzamor plant will participate in international exchanges. A WANO mission visited the plant to address requalification testing of plant operators.

Utility Partnerships. U.S. AID jointly sponsors a utility partnership program with the U.S. Energy Association (an association of public and private energy-related organizations that represents the United States on the World Energy Council). Staff from the Armenian utility, Armenergo, have spent several weeks at various U.S. utilities to learn about the market economy from management's point of view.

U.S. Assistance. U.S. AID has earmarked \$26 million for a program of energy efficiency and development in Armenia.

EBRD Study. In July 1995, the European Bank for Reconstruction and Development (EBRD) asked a group of experts to assess the main safety-related issues at Unit 2. The group, which included nuclear experts from France, Germany, the United Kingdom, Russia and the EBRD, concluded that, if WANO and Russia continued to support the plant technically and if Armenia's nuclear regulatory body received support from within Armenia and from foreign advisers, Armenia should be eligible for the same nuclear safety assistance as other countries with VVER-440 Model V230s. The group suggested that rather than isolate Armenia, the international community should sponsor its participation in safety-related training and help the nuclear regulatory body maintain contact with its counterparts in other countries.

EBRD Nuclear Safety Account. Armenia reportedly has applied to the EBRD for a grant from the Nuclear Safety Account.

Plant Inspections

In July 1994, a team of experts from the IAEA visited the plant. They reviewed technical, seismic and staff-related issues at the plant, and recommended that:

- safety modifications approved by the Armenian regulator be made,
- comprehensive tests of safety systems be done before plant restart,
- steps be taken to ensure a sufficient number of qualified, licensed staff,
- issues relating to the integrity of the unannealed reactor pressure vessel be resolved,
- continuous efforts be made to assess and upgrade the seismic safety of the plant, and
- steps be taken for emergency planning.

In May 1995, a team of IAEA experts visited Medzamor to assess the seismic characteristics of the plant and site. The team concluded that the seismic protection measures were satisfactory.

July 1997

MEDZAMOR NUCLEAR POWER PLANT

Type: VVER-440 Model V270 (a variant of the V230)

Units: Two

Total megawatts (net): 752

Location: Medzamor, Armenia

Dates of initial operation: Unit 1 - December 1976
Unit 2 - December 1979

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

On Oct. 15, 1982, a short circuit in a power cable of a large boron make-up pump in Unit 1 caused electrical protection failure and overheating of cable and motor. Fire started simultaneously in several places along the cable way and smoke spread through open shafts to the main control room. Fire spread rapidly to four parallel cable tunnels serving both units. The destruction of many power and control cables caused several malfunctions.

The automatic fire alarm in the cable tunnels worked, but the fixed foam extinguishing system failed to discharge. The fire led to a total station blackout. The power supply from diesel generators was lost because of fires in the cable tunnels, and the external grid connections were also lost. Control of the plant was endangered because of smoke in the main control room and the total lack of emergency control provisions.

After the fire, a separate shutdown train was installed in the boron pump room. In addition, cables were given a fire-resistant coating, cable penetrations were tightened and fire-fighting arrangements were improved.

In 1988, Unit 1 was annealed.

Unit 1 was shut down in February 1989 and Unit 2, in March 1989—following the devastating earthquake of December 1988—because of public

concern about the plant's safety. The plant itself was undamaged by the earthquake. Unit 2 was restarted in October 1995 and connected to the grid in November; Unit 1 remains closed.

Training. Prior to the restart of Unit 2, plant operating staff were trained on simulators at Russia's Novovoronezh plant, Finland's Loviisa plant (a VVER-440 V213), and Germany's Greifswald plant (now closed). In addition, selected plant staff were sent for training, under the auspices of the IAEA, to various countries, including Finland, Bulgaria, the Czech Republic and the Slovak Republic. The training covered licensing, accident management and fire protection. Operating personnel were examined by a panel of five inspectors from the country's regulatory body to qualify for a reactor operator's license. At the regulators' request, the IAEA sent observers from Hungary and the Slovak Republic with experience in training VVER personnel.

The operating staff of Unit 2 includes one trained Russian operator on each shift.

According to Armenian radio, the country's unstable power network prevented Unit 2 from reaching its desired capacity in December 1995. The unit was operating at 310 megawatts, not the target 376 megawatts.

Technical/Upgrading Activities

Both units are variants of the VVER-440 Model V230—sometimes referred to as the Model V270. They have been seismically upgraded for Armenian conditions, with reinforcements made to the reactor building and structures, electrical cabinets and cooling towers. In addition, because the plant site has a remote cooling water source, the Model V270s have primary coolant pumps with longer coast-down time, an additional emergency feedwater system and an additional residual heat removal system.

After the fire in 1982, several modifications were made, including installation of an additional control panel, fitting of an additional independent emergency power cable network, improved separation of safety-related cabling and the implementation of numerous fire protection measures.

The main backfits approved by Armenian regulators include hardware modifications of: primary circuit, protection and control systems; emergency cooling systems; thermal insulation; and fire and explosion protection.

Specific upgrades carried out or under way include new seismic-resistant storage batteries from Germany, an additional DC panel to provide backup power, a new diesel generator hookup that provides twice the redundancy of the original configuration, and rerouting of power lines to separate trains. In addition, all monitoring equipment has been replaced, and additional reactor protection system shutdown logic installed for water levels in the steam generators and for water and steam levels in the pressurizer. Sealing gaskets and other components providing isolation in the system's confinement were upgraded using materials and technology from a U.S. company, and the reactor hall sprinkler system was modernized. Following

an inspection of the unit's steam generators, about 5 percent of the tubes were plugged.

According to the plant manager, over 500 tons of equipment needed to refurbish and upgrade the unit—most of it from Russia—was airlifted to the site because of the land-route blockade by neighboring Azerbaijan.

A system of five large basins is under construction at the plant site to upgrade the essential service water supply. It is expected to begin operating in 1997.

An additional \$90 million in upgrades, including a new computer system, reportedly are planned before the year 2000.

International Exchange/Assistance

French Study. In October 1992, the French architect-engineer Framatome was awarded a \$400,000 contract by the European Communities (now the European Union) to study conditions for start-up of Medzamor. Framatome experts estimated that it would take at least two years to get the newer Unit 2 on line and longer still for the older Unit 1. The Framatome study called for a complete inspection of the primary circuitry, the annealing of Unit 2's pressure vessel and a detailed seismic assessment of the site.

In addition, France has agreed to provide FF 40 million (\$6.3 million) for safety improvement work, with FF 15.5 million (\$2.4 million) of that amount in grants and the remainder in 40-year loans. Some of the money will be used to build a spent fuel storage facility at the plant site.

German Aid. The German government has announced it will contribute DM 30 million (\$16 million) for safety improvement work at the plant.

Russian Assistance. In early 1994, Armenia asked Russia for help in bringing the Medzamor plant back on line. In March, Russia and Armenia agreed to cooperate in restarting the plant; proposed activities included a full site investigation, improvements in safety standards, and maintenance and repair.

The project was estimated to cost between \$70 million and \$100 million. Russia agreed to provide a credit of about 60 billion rubles, with Armenia providing the rest of the funding. The money was earmarked for Russian technical expertise and fuel as well as equipment. In January 1995, Russia's lower house of parliament—the Duma—approved a draft law ratifying the agreement to offer Armenia 110 billion rubles in credit, 60 billion of it for the restart of Medzamor.

Russia is also providing training at its VVER-440 Model V230 full-scope simulator, and has made available Russian operators, shift supervisors and inspectors to draft start-up and operating procedures and review test results. Experts from Russia's Institute for Nuclear Power Operations and Gidropress, the manufacturer of the plant's pressure vessels, inspected Unit 2's vessel to measure the extent of embrittlement.

EU Support. The European Union has allocated 10 million ECU under its TACIS program for safety-related upgrades at Unit 2, on the condition that Armenia not restart Unit 1 and close Unit 2 in the intermediate term. The United States is providing 4.5 million ECU (\$4.7 million). Much of the TACIS funding will be spent for on-site assistance provided by a consortium of European utilities led by Italy's Enel.

The consortium will carry out about 10 projects identified by the plant, including the replacement of pressurizer and steam generator safety valves and improvements to instrumentation and control systems and fire protection systems. Among other projects are in-service inspection, procurement of spare parts from the decommissioned Greifswald plant in eastern Germany, and the development of normal and emergency operating procedures. A separate 1.6 million ECU contract (\$1.7 million) will be awarded for the supply of a multipurpose simulator.

In addition, a consortium of Western European technical safety organizations, led by Riskaudit, will help the Armenian Nuclear Regulatory Authority to analyze the upgrades that have been proposed by the plant and its consultants.

Croatian Contract. Croatia's Inetek has a contract, running from 1994 to 1999, to carry out steam generator tube eddy current testing and tube plugging of Unit 2. The scope of the project depends on the tube inspection results.