INTRODUCTION

Since the accident at Chernobyl Unit 4 in 1986, Soviet-designed reactors—especially the RBMK design used at Chernobyl—have been the subject of considerable scrutiny. Experts in the West—from international organizations, independent groups and governments—as well as specialists in the former Soviet Union and Eastern Europe have examined the designs and performance of these nuclear plants. From the time it was first issued in 1992, the *Source Book on Soviet-Designed Nuclear Power Plants* has tracked much of this activity, from the plants' operation to efforts aimed at improving their safety. There has been forward movement on the issue of Soviet reactor safety. While neither smooth nor consistent, nor always enough to satisfy, it is progress all the same.

Focusing on Chernobyl's Shutdown

Eighteen months ago, those in the West who had been pressing for the closure of the Chernobyl nuclear power plant appeared to get what they wanted. After more than a year of negotiation, the Group of Seven industrialized nations and Ukraine signed a memorandum of understanding (MOU) in December 1995 that called for the plant's shutdown by the year 2000. The two sides also agreed to a restructuring of Ukraine's electric power sector and a program that included the completion of two VVER-1000 units—Khmelnitskiy 2 and Rovno 4, the rehabilitation of thermal and hydropower plants, pumped storage projects and energy efficiency.

To pay for all of this, the G-7 promised to provide $498 million in grants already committed, and $12.809 billion in international and Euratom loans. Ukraine's President Leonid Kuchma took the first step in April 1996, when he pledged to shut Chernobyl's Unit 1 before the end of the year. It closed Nov. 30, 1996.

The MOU moved closer to reality in the spring of 1997, when a project management team was chosen to guide the work at the Chernobyl plant. That work included short-term upgrades to Unit 3, the only operating reactor, as well as the construction of waste storage and treatment facilities and plans for the decommissioning of units 1, 2 and 3. It began to look as though the plant really would shut down by the turn of the century.

Assessing the Accident's Health Effects

For many in the West, Chernobyl has come to symbolize the dangers of all Soviet-designed reactors, not least because of the environmental and health effects of the accident at Unit 4 in 1986. Screening programs have revealed a sharp increase in the incidence of childhood thyroid cancer in areas of Ukraine, Belarus and Russia affected by the accident. Epidemiological studies to date have shown no increased incidence of other types of cancer or disease. The latency period for solid cancers—other than leukemia and thyroid cancer—is usually at least 10 years. Researchers and medical personnel have, however, observed an increase in psychological disorders, a likely result of the tremendous stress imposed on the population of the affected areas.

Growing Regional Cooperation

What happened at Chernobyl focused the world's attention on Soviet-designed reactors in general, and RBMKs in particular. In response to the accident, representatives of 144 electric utility organizations with operating nuclear power plants around the world gathered in Moscow in 1989. There, they chartered the World Association of Nuclear Operators. Through international exchange visits between nuclear professionals, WANO enabled the operators of Soviet-designed plants to share experience from Western plants and to learn from one another. By 1991, teams from every nuclear power plant in Eastern Europe and the former Soviet Union had visited a plant in the West.

In the early 1990s, the International Atomic Energy Agency evaluated several Soviet reactor designs—the VVER-440 Models 230 and 213 and the VVER-1000 as well as the RBMK. The aim was to help countries with these plants identify design and operational weaknesses and prioritize safety improvements. Each reactor type had its own set of challenges, but a country's political, economic and regulatory climate influenced a nuclear plant's safety culture and determined how safely its reactors ran. Today, the IAEA is reviewing the safety improvements that each country has proposed or carried out.

For the most part, experience has flowed from West to East. But increasingly, it is being exchanged within the universe of Soviet-designed nuclear plants.

Five years ago, Karel Wagner—then-chairman of the Czech Atomic Energy Commission—said to the West: "Help us to help ourselves."

Today, international funding is helping to support regional cooperation. The Slovak Republic, for example, has offered to help Armenia develop its own regulatory program. The Czech Republic has expressed an interest in assisting Ukraine to upgrade its nuclear power plants. Lithuanian and Ukrainian officials have shared their experience with safety-related improvements to RBMKs.

Despite the improvements, obstacles remain. One is a cash flow crisis. In those countries where a market economy is developing more slowly, consumers often don't pay for the electricity they use. As a result, nuclear plants have little money to buy fuel and spare parts, pay their employees, or carry out safety upgrades.

Complicating the upgrades is the liability issue. Russia, Ukraine, Lithuania, Armenia and the four Eastern European countries with Soviet-designed nuclear plants—the Czech Republic, the Slovak Republic, Hungary and Bulgaria—are signatories to the Vienna Convention, which is intended to ensure that the responsibility for damage caused by a nuclear accident is covered and channeled to the plant operator. However, some of these countries—Russia and Ukraine, for example—have yet to put in place full legal and financial protection in the event of an accident. The lack of such protection has hindered the installation by Western contractors and suppliers of safety-related equipment that directly affects reactor operation.

Politics or *Realpolitik*?

For a time, some Western governments seemed prepared to fund improvements that could prolong the operating life of Soviet-designed nuclear plants. But now there are signs of a return to the strategy of the early '90s—shut down the unsafe plants. It is a strategy with a poor track record.

The Slovak Republic, for example, turned down a loan from the European Bank for Reconstruction and Development because the price tag was too high. The bank wanted Slovakia to raise electricity prices by one-third and close the two older units of the Bohunice plant in exchange for funding to help complete two new nuclear units. Instead, the Czech Republic offered to complete the units, with financial assistance from Russia and safety-related upgrades provided by France and Germany.

Bulgaria accepted a Nuclear Safety Account grant on the condition that it close units 1-4 of its Kozloduy plant at the earliest possible date—possibly before the year 2000. But a Bulgarian energy official has said that the country plans to operate units 1 and 2 until 2004, and units 3 and 4 until 2010 to 2012.

Many in the West understand the factors driving continued operation of Soviet-designed reactors: the fact that nuclear energy plays a significant role in electricity supply, the desperate state of fossil-fuel plants—many of them old, inefficient and short of fuel, the lack of money to build replacement plants and, in some cases, the need to sell fossil fuels or electricity abroad for hard currency. In Russia, there is also the intangible factor of national pride in a long-established nuclear industry. Finally, as their economies begin to improve, these countries will need safe and reliable sources of electricity as an engine of growth.

Few countries with Soviet-designed nuclear power plants are likely to turn their backs on nuclear energy any time soon. The transition to safer nuclear technology—and a more stable economy—won't happen without Western help. And much remains to be done. The U.S. nuclear industry understands this, and is actively participating in projects—through the World Association of Nuclear Operators and bilateral efforts—to help these countries improve the safety of their plants.

A Brief Word on Terminology and Transliteration

As the activity surrounding Soviet-designed reactors has increased, the *Source Book* has grown in size. This edition includes a new section—an index—to make the information more accessible to the reader.

Most spellings of Ukrainian nuclear plants and place names are transliterations from the Russian, reflecting the legacy of Russian linguistic domination of the nuclear industry in the former Soviet Union. These spellings also tend to be the versions most recognizable to readers in the West. Where transliteration from the Ukrainian is used, it appears in parentheses after the Russian transliteration. Also, throughout the *Source Book*, the terms probabilistic safety analysis, probabilistic safety assessment and probabilistic risk analysis are used. They all mean the same thing; the terminology varies to reflect the usage of specific organizations and countries.

About the Nuclear Energy Institute

The *Source Book* is produced by the Nuclear Energy Institute. NEI, the nuclear energy industry's Washington-based policy organization, represents almost 300 companies and organizations worldwide. It focuses the collective strength of the industry to shape policy that ensures the beneficial uses of nuclear energy and related technologies in the United States and around the world.

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Every effort has been made to ensure the accuracy of the information presented here. However, the *Source Book*'s information has been drawn from a wide variety of sources, with sometimes differing views on highly technical subjects, and from information available directly from newly independent countries with rapidly evolving governments and power-production systems.

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