FACT SHEET

Chernobyl Accident and Its Consequences

November 2008

Key Facts

■ The 1986 accident at the Chernobyl nuclear power plant in Ukraine, then part of the former Soviet Union, is the only accident in the history of commercial nuclear power to cause fatalities from radiation. It was the product of a severely flawed Soviet-era reactor design combined with human error.

■ Key differences in U.S. reactor design, regulation and emergency preparedness make it highly unlikely that a Chernobyl-type accident could occur in the United States.

■ Twenty-eight highly exposed reactor staff and emergency workers died from radiation and thermal burns within four months of the accident, and 19 more by the end of 2004. Officials believe the accident also was responsible for some 4,000 cases of thyroid cancer.

■ A landmark United Nations study published in September 2005 estimated that although 4,000 people theoretically could die from radiation-induced cancers, only 56 deaths could be attributed to radiation exposure from the accident. That total includes the 47 emergency workers mentioned above and nine people who died from thyroid cancer—most of whom were either children or adolescents at the time of the accident.

■ Most emergency workers and people living in contaminated areas received relatively low whole-body radiation doses, comparable to natural background levels, according to the study.

■ The study also found no evidence of increases in leukemia or other cancers, decreased fertility or congenital malformations.

■ Apart from radiation impacts, "the largest public health problem created by the accident" was its effect upon the mental health of the 600,000 people living in affected areas at the time of the accident, the report found.

What Happened

The accident, which occurred in the early morning of April 26, 1986, resulted when operators took actions in violation of the plant's technical specifications. Operators ran the plant at very low power, without adequate safety precautions and without properly coordinating or communicating the procedure with safety personnel.

The four Chernobyl reactors were pressurized water reactors of the Soviet RBMK design, or *Reactor Bolsho-Moshchnosty Kanalny*, meaning "high-power channel reactor." Designed to produce both plutonium and electric power, they were very different from standard commercial designs, employing a unique combination of a graphite moderator and water coolant.

The reactors also were highly unstable at low power, primarily owing to control rod design and "positive void coefficient," factors that accelerated nuclear chain reaction and power output if the reactors lost cooling water.

These factors all contributed to an uncontrollable power surge that led to the destruction of Chernobyl 4. The power surge caused a sudden increase in heat, which ruptured some of the pressure tubes containing fuel.

The hot fuel particles reacted with water and caused a steam explosion, which lifted the 1,000-metric-ton cover off the top of the reactor, rupturing the rest of the 1,660 pressure tubes, causing a second explosion and exposing the reactor core to the environment. The graphite moderator burned for 10 days, releasing a large amount of radiation into the atmosphere.

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The Chernobyl plant did not have the massive containment structure common to most nuclear power plants elsewhere in the world. Without this protection, radioactive material escaped into the environment.

The crippled Chernobyl 4 reactor now is enclosed in a concrete structure that is growing weaker over time. Ukraine and the Group of Eight industrialized nations have agreed on a plan to stabilize the existing structure by constructing an enormous new sarcophagus around it, which is expected to last more than 100 years.

Officials shut down reactor 2 after a building fire in 1991 and closed Chernobyl 1 and 3 in 1996 and 2000, respectively.

Exposures, Evacuations

Soviet scientists reported that the Chernobyl 4 reactor contained about 190 metric tons of uranium dioxide fuel and fission products. Estimates are that 13 percent to 30 percent of this escaped into the atmosphere.

Contamination from the accident did not spread evenly across the surrounding countryside but scattered irregularly, depending on weather conditions. Reports from Soviet and western scientists indicate that Belarus received about 60 percent of the contamination that fell on the former Soviet Union. A large area in the Russian Federation south of Bryansk also was contaminated, as were parts of northwestern Ukraine.

Short-Term Impact

Workers involved in the recovery and cleanup after the accident received high doses of radiation. In most cases, these workers were not equipped with individual dosimeters to measure the amount of radiation received. Further, dosimetric procedures varied, so experts could only estimate their doses.

According to Soviet estimates, between 300,000 and 600,000 people participated in the cleanup of the 30-kilometer evacuation zone around the reactor, but many entered the zone two years after the accident.

Soviet officials estimated that 211,000 workers participated in cleanup activities in the first year after the accident and received an average dose of 16.5 rem.

Some children in contaminated areas received high thyroid doses because of an intake of radioiodine, a relatively short-lived isotope, from contaminated local milk. Several studies have found that the incidence of thyroid cancer among children under the age of 15 in Belarus, Russia and Ukraine has risen sharply.

The childhood thyroid cancers that have appeared are treatable, if detected early, with surgery followed by iodine 131 therapy for any metastases and then thyroid hormone replacement.

Long-Term Impact

Immediately following the accident, the main health concern involved radioiodine, which has a half-life of eight days. For the longer term, there is concern about contamination of the soil with cesium-137, which has a half-life of about 30 years.

Soviet authorities started evacuating people from the area around Chernobyl within 36 hours of the accident. By May 1986, about a month later, authorities had relocated all those living within a 30-kilometer (18-mile) radius of the plant—about 116,000 people.

Epidemiological Studies

The International Chernobyl Project conducted the first major assessment of the radiological consequences of the Chernobyl accident. Led by an advisory group of international experts, the project included the Commission of the European Communities, United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), World Health Organization, Food and Agriculture Organization, International Labor Organization, and International Atomic Energy Agency (IAEA).

In a 1991 study, the project's scientists noted that, as expected, official Soviet data did not indicate a marked increase in the incidence of

leukemia or other cancers. However, several researchers pointed out that the project's sample size was too small, and the study's time frame too short, to identify an increase in the incidence of cancers with long latent periods. The project's scientists noted that "reported absorbed thyroid dose estimates in children are such that there may be a statistically detectable increase in the incidence of thyroid tumors in the future."

Institutions including WHO, the European Union, IAEA and UNSCEAR conducted exhaustive subsequent health studies. In general, these studies found that, apart from the "substantial increase" in thyroid cancer after childhood exposure observed in Belarus, Russia and Ukraine, there was very little evidence of "a major public health impact" related to ionizing radiation.

In addition, there was a consensus that the accident took a tremendous toll on the mental health of those living in affected areas, leading to an increase in anxiety, depression and stress-related disorders.

The Chernobyl Forum

A landmark study published in September 2005 by the Chernobyl Forum introduced new findings.

The report, "Chernobyl's Legacy: Health, Environment and Socio-Economic Impacts," incorporates the work of hundreds of scientists, economists and health experts. They studied the latest epidemiological data "to settle the outstanding questions about how much death, disease and economic fallout really resulted from the Chernobyl accident," said Burton Bennett, chairman of the forum, which is comprised of eight specialized U.N. agencies, as well as the governments of Belarus, Russia and Ukraine.

"The health effects of the accident were potentially horrific, but when you add them up using validated conclusions from good science, the public health effects were not nearly as substantial as had at first been feared," said Michael Repacholi, manager of WHO's radiation program.

Among the study's findings:

- Most emergency workers and people living in contaminated areas received relatively low whole-body radiation doses, comparable to natural background levels.

- About 4,000 individuals, most of whom were children or adolescents at the time of the accident, were stricken with thyroid cancer as a result of the contamination, and nine of them have died from the disease.

  However, the survival rate among such cancer victims has been almost 99 percent.

- The study theorizes that some 4,000 people eventually could die from cancer caused by radiation exposure. However, the international team of experts has found no evidence of any increases in the incidence of leukemia and other cancers among affected residents.

- The experts found no evidence or likelihood of decreased fertility or of increases in congenital malformations that could be attributed to radiation exposure.

- An estimated 5 million people live in areas that are contaminated with radionuclides, with about 100,000 in areas of "strict control," but these zoning definitions need to be relaxed in light of the new findings.

- Poverty, mental health problems and "lifestyle" diseases, such as alcoholism and tobacco dependency, pose a far greater threat to local communities than does radiation exposure. Relocation proved a "deeply traumatic experience" for some 350,000 people moved out of the affected areas, the study noted, while persistent myths and misperceptions about the threat of radiation have resulted in a "paralyzing fatalism" among residents of affected areas. Seeing themselves as "victims" rather than "survivors" has led to overcautious and exaggerated health concerns.

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A Safety Comparison With the United States

Could a Chernobyl-type accident occur in the United States? A 2004 report by the National Academy of Sciences identified four key differences between the forces at play in the Chernobyl disaster and the U.S. nuclear energy program.

Safer Nuclear Plant Designs

All U.S. power reactors have extensive safety features to prevent large-scale accidents and radioactive releases. The Chernobyl reactor had no such features and was unstable at low power levels.

Stringent Emergency Preparedness Plans

Even with the Chernobyl reactor's poor design, officials could have averted many radioactive exposures to the population with an effective emergency response. Key personnel at all U.S. power reactors work with surrounding populations on an ongoing basis to prepare for an orderly and speedy evacuation in the unlikely event of an accident.

Alert and Notification

Chernobyl plant operators concealed the accident from authorities and the local population and thus the government did not even begin limited evacuations until about 36 hours after the accident.

In the United States, nuclear power plant operators are required to alert local authorities and make recommendations for protecting the public within 15 minutes of identifying conditions that might lead to a significant release—even if such a release has not occurred.

The U.S. Nuclear Regulatory Commission posts resident inspectors at every nuclear power plant site to ensure the plants are following federal safety requirements.

Protecting the Food Chain

Since authorities did not promptly disclose details of the Chernobyl accident, many people unknowingly consumed contaminated milk and food. This would not be the case in the United States.

As it did following the Three Mile Island nuclear accident in 1979, the federal government would carefully monitor and test all food and water supplies that potentially could become contaminated. Under existing federal programs and regulations, the government would quarantine and remove from public consumption any unsafe food or water.

The accident at Three Mile Island caused the release of a small amount of radioactive material into the atmosphere, but it was too small to cause discernible health effects to the population living near the plant.

This fact sheet also is available at www.nei.org.