

SALEM PRESS

Great Events from History

The 20th Century

1971-2000

www.SalemPress.com

April 26, 1986**SOVIET CHERNOBYL NUCLEAR PLANT UNDERGOES MELTDOWN**

The nuclear reactor disaster that took place at the Chernobyl power plant brought worldwide attention to the destructive potential of such facilities.

LOCALE: Chernobyl, Soviet Union (now in Ukraine)

CATEGORIES: Disasters; energy; environmental issues

KEY FIGURES

Viktor Bryukhanov (b. 1936), director of the Chernobyl plant

Nikolai Fomin (b. c. 1937), chief engineer at the Chernobyl plant

Anatoly Dyatlov (b. 1931), deputy chief engineer at the Chernobyl plant

SUMMARY OF EVENT

A Soviet power plant near the town of Chernobyl, situated about eighty miles north of Kiev, became the site of the worst nuclear reactor disaster to date on April 26, 1986, when the plant's number 4 reactor exploded. According to official accounts, thirty-one people were killed immediately, and about five hundred were hospitalized. Within days, everyone living within 18.5 miles of the site was evacuated.

The explosion and fire sent almost fifty tons of fuel, containing a large number of radionuclides with half-lives of between 80 and 24,000 years, into the atmosphere. The main radionuclides were cesium 137, strontium 90, iodine 131, and plutonium. The radioactivity in the immediate vicinity of the site ranged between 1,000 and 2,000 roentgens per hour. (The maximum safe dose of radiation for humans is 0.5 roentgens per year.) Exposure to radiation can result in immediate sickness or death and over time can cause cancer or genetic mutations. Large amounts of radiation initially induce vomiting, nausea, diarrhea, and other symptoms and can cause death within days or weeks.

In a controlled nuclear fission reaction, uranium 235 (U-235) neutrons are released that collide with other U-235 nuclei, producing more fission reactions. This "chain reaction" is self-sustaining if at least one neutron from each fission event causes another U-235 atom to split; when this occurs, a reactor is described as "critical." If too few neutrons are produced, the reactor is "subcritical," and the reaction stops. If more than one neutron becomes available, the reaction rate increases rapidly; the reactor is then "supercritical" because the heat liberated can cause a tremendous explosion.

In the core of a nuclear power plant reactor, uranium 238 (U-238), enriched with U-235, is enclosed in metal cylinders. A "moderator" such as heavy water or graphite surrounds the cylinders to slow the neutrons so that they can be absorbed more efficiently. Control rods, usually made of cadmium, absorb neutrons and regulate the power level of the reactor. If a malfunction occurs, the control rods are automatically inserted into the core to stop the reactions. Water circulates through the core and absorbs the heat produced, boils, and produces steam, which turns turbines that run electrical generators.

The amount of U-235 is limited, so some reactors (called "breeder reactors") use U-238 to produce plutonium 239 (Pu-239). Chernobyl's reactor number 4 employed a graphite-moderated cycle of boiling water without a pressure vessel. The fuel consisted of U-238 enriched with U-235. The graphite moderator operated at 700 degrees Celsius under anaerobic conditions. The entire core was encased in an airtight metal container with circulating inert gases. If a supercritical state occurred, the control rods could be dropped into the case immediately and cold water injected into any part of the core. The major faults of the reactor were the lack of an explosion-proof building and the fact that safety devices could be disconnected for tests.

On April 25, the Chernobyl engineers conducted an experiment to determine how long a spinning turbine could supply electrical power to parts of the power plant. The intent was to learn if the reactor could withstand an accident and a simultaneous loss of electrical power. About twenty-four hours before the explosion, the output of the number 4 reactor was reduced from 3,200 megawatts to between 700 and 1,000 megawatts. Twelve hours later, the reactor had reached half power. By 1:00 P.M. only the number 8 generator was providing the nation's electricity needs, as well as electricity for reactor number 4. The emergency water-cooling system was turned off at 2:00 P.M. so that the core would not be flooded, which would have shut down the reactor during the test. At that point, the national grid controller in Kiev ordered that reactor number 4 be used to help supply some needed electricity, and the test was postponed. The safety water-cooling system, however, remained off.

At 11:10 P.M. the experiment was resumed, but no one reset the automatic power control that kept the power above 700 megawatts. Neutron activity quickly decreased, and enough xenon gas accumulated to force the

technicians to discontinue the test. From 12:28 A.M. until the explosion, the operators tried to increase power manually. They managed to stabilize it at 200 megawatts by withdrawing control rods until there were fewer in the core than the thirty needed to prevent a supercritical state. More water was added, which cooled the reactor and caused more control rods to be withdrawn.

As the reactor cooled, less steam was generated, and the water level in the steam drums decreased. Because such a drop in water level would shut down the reactor, the emergency controls for the steam drums were disconnected. With less water available to absorb heat, the temperature rose, and control rods reentered the core, but not soon enough to stop a reaction. The switch that would have shut down the reactor when the number 8 turbine generator ceased turning had been deactivated. Instead, when the number 8 generator stopped, the flow of water into the reactor decreased, and the temperature in the core rose. In one second the power increased from 200 to 32,000 megawatts. The power continued to increase, and

the supervisor activated the emergency button to drop all control rods into the core; the rods, however, disintegrated in the heat, causing the core container to explode at 1:23 A.M. The explosion broke through the floor, walls, and roof and shot up into the sky. Once the core was exposed to air, a second explosion occurred, and the reactor began to burn.

The plant's firefighting crew responded by 1:30 A.M., and a second crew from the town of Pripyat arrived at 1:35 A.M. By 4:00 A.M., more fire crews arrived, but the fire on the roof and in the building was not extinguished until 6:35 A.M. The nuclear core continued to burn. The other reactors continued to operate for a time; number 3 did not stop until 5:00 A.M., and numbers 1 and 2 continued to run for another twenty-four hours.

Water was used to try to cool the burning reactor, but it vaporized. Eventually, lead, sand, clay, dolomite, and boron carbide were dumped into the core by helicopter crews, but the core was not filled and capped until May 2. On May 11, the Soviet government announced that the



critical period had passed. The reactor was ultimately entombed in a one-meter-thick concrete sarcophagus.

SIGNIFICANCE

Sweden was the first country outside the Soviet Union to learn about the nuclear accident. On April 28, 1986, workers at the Forsmark nuclear plant on the Baltic coast, eight hundred miles from the accident, detected abnormally high levels of radiation in the air. Atmospheric analyses revealed that a cloud of radionuclides from the Soviet Union had begun blowing over Scandinavia on April 27.

The three areas most seriously contaminated were Belorussia (now Belarus), the Ukraine, and the Russian Soviet Federated Socialist Republic (now Russia). The forests suffered the heaviest contamination because they acted as natural filters. Meadows and arable land remained generally less contaminated; there, the radionuclides were found in the top five centimeters of soil. Plants grown in these regions contained a high quantity of radionuclides that subsequently became concentrated in herbivores.

The radionuclide concentration in water was high in some places, such as the Pripyat and Aozh rivers, both of which had high concentrations of cesium 137. This contamination affected the lives of farmers who used river water to irrigate, fishermen, and those who used the rivers for transportation. All the aquifers within 30 kilometers became polluted with radiation, and the lakes around the Chernobyl plant showed high levels of contamination.

Because of the long half-life of the nuclides and their decay products, the amount of radioactivity in the soil did not decrease noticeably in the following years. In addition, the natural movement of the soil caused the amount of radioactivity in the air to be higher than normal.

The radiation remained high in many areas. Health effects in children included an increase in cataracts, thyroid cancer, nose and throat ailments, and diseases of the gastrointestinal tract, liver, and spleen. Adults suffered from increased gastrointestinal problems, cardiovascular diseases, goiters, tuberculosis, anemia, hypertension, cancers, and tumors. The mental health of both adults



The April 26, 1986, accident at the Chernobyl nuclear power plant in the Ukraine released 5 percent of the radioactive reactor core into the atmosphere, contaminating large areas of Belarus, Ukraine, and Russia. (AP/Wide World Photos)

and children declined, and birth defects became a significant problem in humans and animals.

The Chernobyl accident disrupted normal life and work in the areas around the power plant. The farmland taken out of cultivation amounted to 144,000 hectares, which resulted in the loss of jobs and income for many people. More than 100,000 people were evacuated from the area and relocated elsewhere. Some of the towns close to the power plant remained uninhabitable for many years. Decontamination of the radioactive areas was extremely expensive; by 1988, the cost to the Soviet Union was estimated at between \$13 billion and \$14 billion.

A new town, Slavutich, located about ninety-seven miles east of the power plant, was built for Chernobyl personnel. A railway connected the plant with the town, which was divided into eight sectors representing the major republics of the Soviet Union. The first contami-

nation map, published in 1989, showed that parts of the town and the land surrounding it were radioactive. All inhabitants were given regular medical examinations, and all food was brought in from outside the area.

The accident affected many countries outside the Soviet Union. Radionuclides from Chernobyl were detected in countries as far away as the United States, Canada, and Japan. The United Kingdom experienced high concentrations in highland sheep. Reindeer were contaminated in Scandinavia, and in many countries vegetables and dairy products were found to be unfit for human consumption. The countries with the highest amounts of cesium 137 and iodine 131—Sweden, Norway, Italy, Austria, Finland, and Switzerland—experienced economic hardship, increased medical costs, and environmental contamination.

The ultimate impacts of the Chernobyl accident may never be completely known. The extent of the harm to the environment and to future generations of humans and animals may not be fully understood for decades. Various reports published some twenty years after the incident estimated widely divergent impacts. The United Nations issued a report in 2005 in which the total human deaths to date caused by the Chernobyl accident were estimated at four thousand, with approximately five thousand more cancer-related deaths likely to occur in the future. In contrast, a report issued by European Greens in 2006 indicated that between thirty thousand and sixty thousand deaths related to Chernobyl could be expected in the future, depending on the risk factors evident in areas exposed to cancer-inducing substances.

—Lynn M. Mason

FURTHER READING

Alexievich, Svetlana. *Voices from Chernobyl: The Oral History of a Nuclear Disaster*. Translated by Keith Gessen. New York: Picador, 2006. A journalist presents the personal accounts of individuals who were directly affected by the events at Chernobyl.

Cheney, Glenn Alan. *Journey to Chernobyl: Encounters in a Radioactive Zone*. Chicago: Academy Chicago, 1995. Brief report by an American college writing teacher who went to Ukraine in 1991 and carried out his own informal investigation of the aftermath of the Chernobyl accident. Includes photographs.

Chernousenko, V. M. *Chernobyl: Insight from the Inside*. Berlin: Springer-Verlag, 1991. The author, scientific director of the task force of the Ukrainian Academy of Sciences in Chernobyl, wrote this book to dispel what he calls “myths” about the accident. Written on a technical level, but not difficult to read; a good source of information.

The International Chernobyl Project: Technical Report. Vienna: International Atomic Energy Agency, 1991. Summarizes the data collected about Chernobyl by an international committee. Easy to read and understand; an excellent source of information.

Marples, David R. *The Social Impact of the Chernobyl Disaster*. New York: St. Martin’s Press, 1988. Provides good descriptions of the design of the reactor, the accident, and the impacts of the disaster two years after the event. Includes many statistics and personal stories.

Medvedev, Grigori. *The Truth About Chernobyl*. New York: Basic Books, 1991. An attempted reconstruction of the accident by the deputy chief engineer of the Chernobyl nuclear power plant during the time of its construction. Accuses Soviet authorities of engaging in a massive cover-up to hide the extent of the disaster.

Nuclear Energy Agency. *Chernobyl and the Safety of Nuclear Reactors*. Paris: Organization for Economic Cooperation and Development, 1987. Very technical work includes a concise description of Chernobyl-type reactors and their safety characteristics as well as a summary of improvements made to the reactors and a thorough analysis of the accident.

_____. *The Radiological Impact of the Chernobyl Accident in OECD Countries*. Paris: Organization for Economic Cooperation and Development, 1987. Very technical work presents an excellent summary of the effects of the Chernobyl accident on countries involved in the Organization for Economic Cooperation and Development.

SEE ALSO: Nov. 13, 1974: Silkwood Becomes a Symbol for the Antinuclear Movement; Mar. 28, 1979: Three Mile Island Accident; Dec., 1985: European Nations Open Superphénix; Feb., 1992: Yankee Rowe Nuclear Plant Is Shut Down; Jan. 4, 1993: Trojan Nuclear Plant Is Retired.