

## **Environmental Case Study**

### *Chernobyl:*

#### *Could It Happen Here?*

In the early morning hours of April 26, 1986, residents of the Ukrainian village of Pripyat saw a spectacular and terrifying sight. A glowing fountain of molten nuclear fuel and burning graphite was spewing into the dark sky through a gaping hole in the roof of the Chernobyl Nuclear Power Plant only a few kilometers away. Although officials assured them that there was nothing to worry about in this "rapid fuel relocation," the villagers knew that something was terribly wrong. They were witnessing the worst possible nuclear power accident, a "meltdown" of the nuclear fuel and rupture of the containment facilities, releasing enormous amounts of radioactivity into the environment.

The accident was a result of a risky experiment undertaken late at night by the plant engineers in violation of a number of safety rules and operational procedures. They were testing whether the residual energy of a spinning turbine could provide enough power to run the plant in an emergency shutdown if off-site power were lost. Reactor number four had been slowed down to only 6 percent of its normal operating level. To conserve the small amount of electricity being generated, they then disconnected the emergency core-cooling pumps and other safety devices, unaware that the reactor was dangerously unstable under these conditions.

The heat level in the core began to rise, slowly at first, and then faster and faster. The operators tried to push the control rods into the core to slow the reaction, but the graphite pile had been deformed by the heat so that the rods wouldn't go in. In 4.5 seconds, the power level rose 2000-fold, far above the rated capacity of the cooling system. Chemical explosions (probably hydrogen gas released from the expanding core) ripped open the fuel rods and cooling tubes. Cooling water flashed into steam and blew off the 1000-ton-concrete cap on top of the reactor. Molten uranium fuel puddled in the bottom of the reactor, creating a critical mass that accelerated the nuclear fission reactions. The metal superstructure of the containment building was ripped apart and a column of burning graphite, molten uranium, and radioactive ashes billowed 1000 m (3000 ft) into the air.

Panic and confusion ensued. Officials first denied that anything was wrong. The village of Pripyat was not evacuated for 36 hours. There was no public announcement for three days. The first international warning came, not from Soviet authorities, but from Swedish scientists 2,000 km away who detected unusually high levels of radioactive fallout and traced airflows back to the southern Soviet Union.

There were many acts of heroism during this emergency. Firefighters climbed to the roof of the burning reactor building to pour water into the blazing inferno. Engineers dived into the suppression pool beneath the burning core to open a drain to prevent another steam explosion. Helicopter pilots hovered over the gaping maw of the ruined building to drop lead shot, sand, clay, limestone, and boron carbide onto the burning nuclear core to smother the fire and suppress the nuclear fission reactions. More than 600,000 workers participated in putting out the fire and cleaning up contamination. Thousands who were exposed to high radiation doses already have died and many more have dim prospects for the future.

The amount of radioactive fallout varied from area to area, depending on wind patterns and rainfall. Some places had heavy doses while neighboring regions had very little. One band of fallout spread across Yugoslavia, France, and Italy. Another crossed Germany and Scandinavia. Small amounts of radiation even reached North America. Altogether, about 7 tons of fuel containing 50 to 100 million curies were released, roughly 5 percent of the reactor fuel.

For several years after the accident, the Soviet government tried to suppress information and deny the consequences. The dissolution of the USSR has allowed many of these secrets to come to light. It's difficult to separate the effects of Chernobyl from other causes of ill-health, but at least a half million people live in areas where radiation levels were high enough to be of concern. One clear effect is seen in

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children in Belarus, where thyroid cancers have increased a hundred-fold since 1986. Childhood leukemias and some autoimmune diseases also appear to be more prevalent in highly contaminated areas.

For the present, the damaged reactor has been entombed in a giant, steel-reinforced concrete "sarcophagus." Unfortunately, this containment structure was hastily built of inferior materials, and already has begun to deteriorate. Reconstruction started in 1999, but the Ukraine is demanding billions of dollars from other countries to finance this operation.

So far, more than 250,000 people have been relocated from the contaminated area. More than 70 villages have been destroyed and millions of hectares of the richest farmland in the Commonwealth of Independent States has been abandoned. The immediate direct costs were roughly \$3 billion; total costs might be one hundred times that much.

Only one of the four Chernobyl reactors is still in operation. Many people would like to see all of them shut down but fuel shortages and a crippled economy make building replacement power plants prohibitively expensive. The United States, Canada, and the European Community are currently negotiating with Ukraine and Russia to close down all remaining Chernobyl-type reactors. What do you think the United States should contribute to help bring this about? How important is it to prevent further catastrophies?

(Note: Since this article was written, the last reactor at Chernobyl has been shut down. Many officials still deny that the plant was unsafe, but international pressure forced the shutdown.)