



SUITE 400  
1776 I STREET, NW  
WASHINGTON, DC  
20006-3708  
202.739.8000  
www.nei.org

## The TMI 2 Accident: Its Impact, Its Lessons

March 2009

### Key Facts

■ The accident at Three Mile Island 2 (TMI 2) in 1979 was caused by a combination of equipment failure and the inability of plant operators to understand the reactor's condition at certain times during the event. A gradual loss of cooling water to the reactor's heat-producing core led to partial melting of the fuel rod cladding and the uranium fuel, and the release of a small amount of radioactive material.

■ The TMI 2 accident caused no injuries or deaths. In addition, experts concluded that the amount of radiation released into the atmosphere was too small to result in discernible direct health effects to the population in the vicinity of the plant. At least a dozen epidemiological studies conducted since 1981 have borne this out.

■ Both the industry and the government responded swiftly and decisively to the TMI 2 accident. Among other actions, the industry established the Institute of Nuclear Power Operations (INPO) to promote excellence in operator training, and plant management and operation.

■ In the final chapter in a series of legal challenges, a federal appeals court in December 2003 dismissed

the consolidated cases of 2,000 plaintiffs seeking damages against the plant's former owners. The court said the plaintiffs failed to present evidence they had received a radiation dose large enough to possibly cause health effects.

### The Accident: What Happened

On March 28, 1979, TMI 2 near Harrisburg, Pa., was operating at about 100 percent power when it automatically shut down after a pump that provided cooling water stopped operating. Pressure and temperature increased in the reactor, causing a pressure relief valve to open. The valve opened as designed, and water and steam began flowing out of the reactor to a tank in the basement of the reactor building.

As pressure returned to normal, the valve should have closed. But, unknown to the operators, the valve stuck open. It remained open for more than two hours, allowing water that covered and cooled the fuel core to escape from the reactor system. This caused the fuel to begin to overheat.

However, instrumentation in the TMI control room indicated to the operators that the relief valve was closed and that too much water was being injected into the reactor vessel. Consequently, operators did not

replace the water that was lost as a result of the open relief valve.

As pressure continued to drop, more and more coolant turned to steam, causing excessive vibration in the main coolant pumps. The vibration prompted operators, who did not realize the reactor was experiencing a loss of coolant, to shut down the pumps.

The loss of pressure and water caused a large steam bubble to form in the top of the reactor vessel, further preventing the flow of cooling water through the core. Without coolant, core temperatures rose above the melting point of the fuel cladding and the uranium fuel.

About half of the fuel melted before coolant flow was restored. The colder cooling water also shattered some of the hot fuel rods. All the fuel was damaged.

As a result of the TMI 2 accident, 700,000 gallons of radioactive cooling water ended up in the basement of the reactor building and in tanks in the auxiliary building, contaminating them.

In addition, a small amount of radioactive material was released into the atmosphere from the ventilation stack of an auxiliary building to relieve pressure inside the reactor building.

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## No Measurable Health Effects

The TMI 2 accident caused no injuries, and at least a dozen epidemiological studies conducted since 1981 have found no discernible direct health effects to the population in the vicinity of the plant. (For details, see the appendix that follows this fact sheet.)

A federal appeals court in December 2003 dismissed the consolidated cases of 2,000 plaintiffs seeking damages against the plant's former owners for health problems they alleged the accident caused. The court said the plaintiffs had failed to present evidence they had received a radiation dose large enough to cause possible health effects.

Decades of research and scientific studies have shown no negative health effects on the population surrounding the plant.

People who suffered financial losses as a result of the precautionary evacuation following the incident were promptly paid, demonstrating the effectiveness of the industry's liability insurance protection under the Price-Anderson Act.<sup>1</sup> In addition, businesses were compensated for loss of revenue, and the state and local community were compensated for the expenses incurred during the response to the threat.

## TMI 2 Placed in Monitored Storage

After cleaning up the damaged TMI 2 reactor, GPU Nuclear placed the plant in monitored storage in December 1993. In December 1999, GPU sold TMI 1 to AmerGen Energy Co., a joint venture of Exelon and British Energy Co. British Energy subsequently sold its interest in TMI 1 to Exelon. In 2008, AmerGen Energy Co. was integrated into Exelon Generation, and the AmerGen legal entity was dissolved.

Under the terms of the sale, GPU retained ownership of TMI 2. GPU subsequently merged with FirstEnergy, making FirstEnergy financially responsible for the decommissioning of TMI 2. In-plant and off-site monitoring of TMI 2 will continue until it is fully decommissioned, with regular reports made to the U.S. Nuclear Regulatory Commission, the commonwealth of Pennsylvania and the public.

The two reactors will be decommissioned jointly when TMI 1 is taken out of service.

## Industry, Government Act to Improve Safety

Two weeks after the 1979 accident, President Jimmy Carter appointed a 12-member commission, headed by the late John Kemeny, then president of Dartmouth College, to investigate what had happened and the possible impact on the health and safety of the public and plant personnel.

The commission's report on its investigation, issued in October 1979, recommended

that the industry develop its own standards of excellence. The commission also cited a need for agency-accredited training institutions for nuclear plant operators and immediate supervisors of operations.

The NRC also moved quickly, setting up a group to study the accident. The group, headed by attorney Mitchell Rogovin, reached many of the same conclusions as the Kemeny Commission.

## Industry Changes Increase Safety

Within nine months of the accident, the industry had formed INPO, whose mission is to promote the highest levels of safety and reliability in the operation of nuclear power plants.

To improve training, INPO in 1985 formed the National Academy for Nuclear Training. The academy reviews and accredits nuclear utilities' training programs for all key positions at each plant.

INPO has had a profound impact on the way nuclear plants are managed and operated. The proof is the steady improvement in plant performance in the nearly 30 years since the accident at TMI.

Today, the nation's 104 operating reactors maintain high levels of safety and reliability, as evidenced by the NRC's reactor oversight program and performance indicators tracked by the World Association of Nuclear Operators.

*Appendix follows this page.*

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<sup>1</sup> For more information about the Price Anderson Act, visit [www.nei.org](http://www.nei.org).

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## Appendix: Scientists Find No Health Effects

### *State Public Health Department Studies TMI*

Several studies were conducted by the Pennsylvania Department of Health. The conclusions are summarized below:

- A 1981 study reported that if the accident had any effect on infant death rates, there would have been a significant increase in the six months after the accident. Instead, the infant death rate was lower than normal.
- A 1982 study found that the incidence of congenital hypothyroidism within a 10-mile radius of the plant was well within a normal range in the year after the accident.
- A 1982 study found no measurable impact on infant mortality within a 10-mile radius of the plant, compared with infant mortality rates for Pennsylvania for 1977-79.
- A 1985 study found no significant difference in cancer mortality within a 20-mile radius of the plant during the five years preceding the accident and the five years following it. In a more detailed analysis of four communities downwind of the plant, the study found no significant abnormalities in either cancer mortality or cancer incidence among residents considered to be at potentially higher risk.
- A 1988 study found no connection between radiation or

psychological stress and failed and complicated pregnancies, such as fetal and neonatal mortalities and other problems.

- A 1989 study found no significant abnormalities in cancer mortality or incidence among residents of selected communities near the plant.
- Two 1991 studies showed no increased cancer incidence among people who lived near the plant in 1979. One study involved the general population living within a 5-mile radius of the plant; the other involved women of child-bearing age who lived within a 10-mile radius.

Although the studies have found no increased incidence of cancer as a result of the accident, they did find evidence of psychological stress, lasting in some cases for five to six years. According to the Pennsylvania Department of Health's Three Mile Island Health Research Program, people suffering from stress believed their health was poorer than it actually was when the health department checked their medical records.

### *Other Studies*

In addition to the Pennsylvania Health Department studies, several other studies have examined the health impact of the TMI accident on the population:

- A study presented by K. Ramaswamy at the 1988 annual meeting of the American Public Health Association compared post-

accident cancer deaths over a six-year period for residents within a 5-mile radius of the plant with cancer deaths of a large control population. The study concluded that the normal death rate and life expectancy for people around TMI were not affected by the accident.

- A study presented by E. Digon at the 1988 annual meeting of the American Public Health Association, concluded that—based on a comprehensive analysis of statistical data by health researchers—fetal and infant mortality in the vicinity of the plant were neither significantly higher than expected nor significantly different from those in the years before the accident.
- Several prominent scientists from Columbia University and the National Audubon Society studied cancers among the nearly 160,000 residents within a 10-mile radius of the TMI plant. The principal cancers considered were leukemia and childhood malignancies. The study, issued in September 1990, concluded: "Overall, the pattern of results does not provide convincing evidence that radiation releases from the Three Mile Island nuclear facility influenced cancer risk during the limited period of follow-up."
- In 1990, the National Cancer Institute of the National Institutes of Health released the results of a two-year study of cancer data in 107 U.S. counties that contained,

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or were adjacent to, major nuclear facilities that had begun operations before 1982. Among the counties were York, Lancaster and Dauphin near the TMI plant in Pennsylvania.

The study, which compared cancer mortality rates in the 107 counties with rates in counties with no nuclear facilities, found no increased cancer mortality for people living near the nuclear installations. The study also found no evidence that leukemia for any age was linked to routine operations at the TMI reactors or to the accident at TMI 2.

- In 2002, researchers at the University of Pittsburgh's Graduate School of Public Health (GSPH) conducted a 20-year follow-up study of mortality data on residents living within a 5-mile radius of the plant. The study found no significant increase in overall deaths from cancer. "This survey, which covers the normal latency period for most cancers, confirms our earlier analysis that radioactivity released during the nuclear accident at TMI does not appear to have caused an overall increase in cancer deaths among residents of that area over the follow-up period, 1979 to 1998," said Evelyn Talbot, professor of epidemiology at GSPH and principal investigator on the study.

*This fact sheet also is available at [www.nei.org](http://www.nei.org).*