THE TMI-2 CHRONICLE

THE HISTORY AND LESSONS OF
THREE MILE ISLAND UNIT TWO

ON THE COVER:

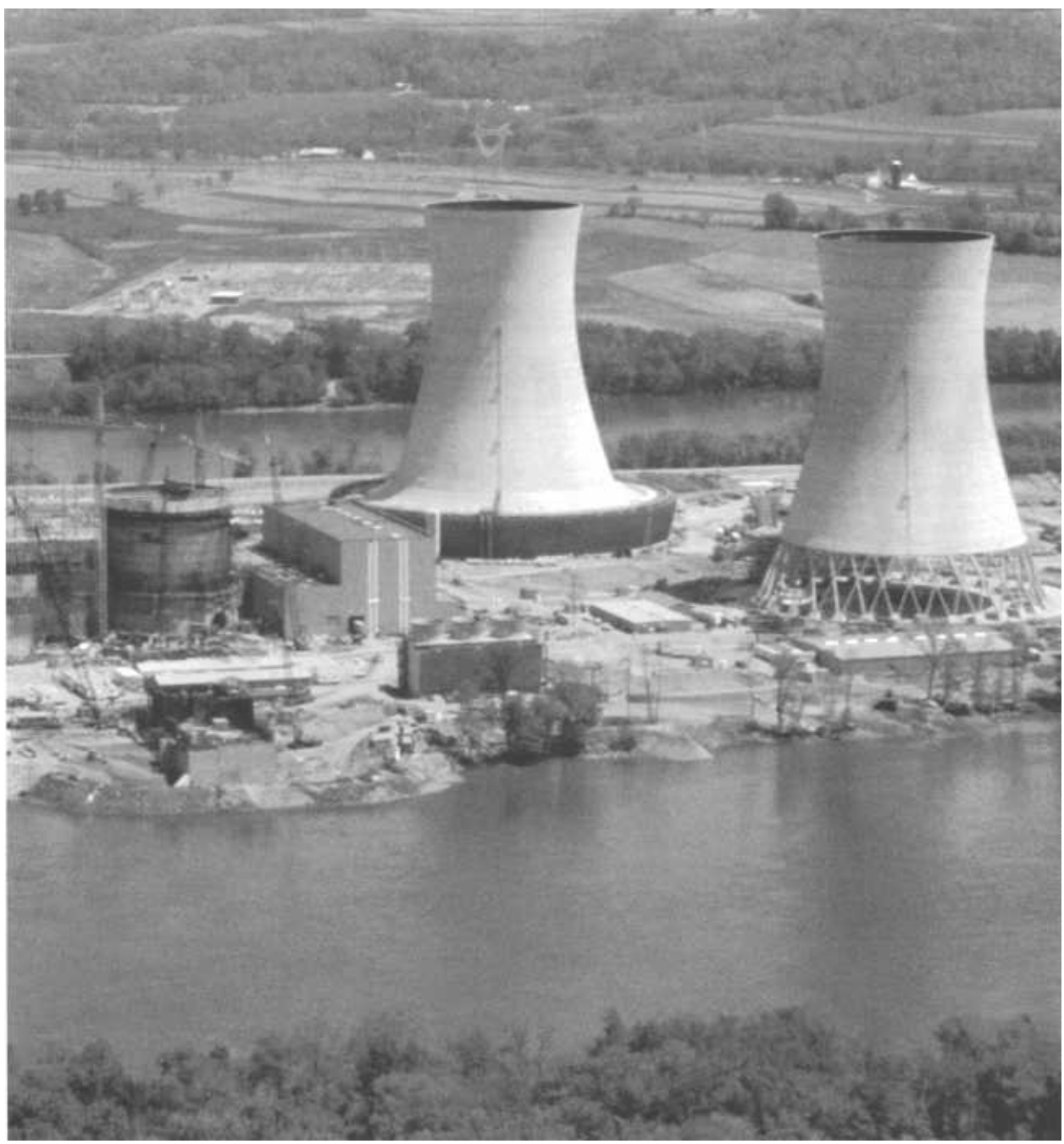
Seen from the east side of the Susquehanna River, Three Mile Island Unit 2 is in a safe state of monitored storage. The plant has been cleaned up from, the 1979 accident and awaits decommissioning. The health and safety of the public, the workers and the environment are ensured.

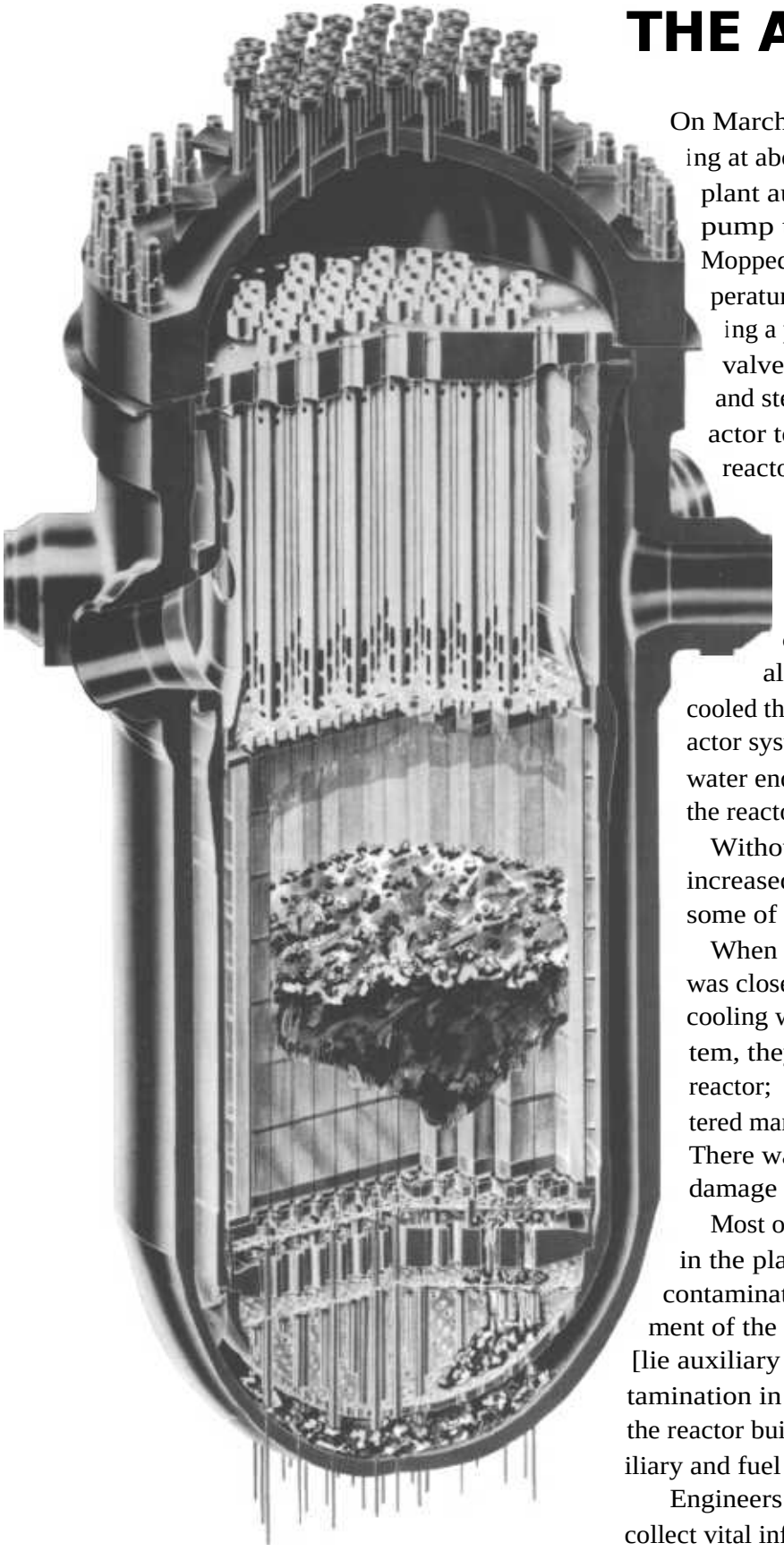
I NTRODUCTION

Construction on Unit 2 of Three Mile Island Nuclear Generating Station began in 1969. Construction was completed in 1978 and the plant began full-power operation in December of that year.

The 900 megawatt plant was built at a cost of 5700 million to supply electricity for General Public Utilities customers in Pennsylvania and New Jersey.

IJniL 2 operated for three months before it was permanently shut down as a result of an accident on Nlarch 28, 1979.





THE ACCIDENT

On March 28, 1979, Unit 2 was operating at about 100 percent power when the plant 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. Eventually, this radioactive water ended up on the basement floors of the reactor and auxiliary buildings.

Without cooling water, temperatures increased in the reactor to the point that some of the uranium fuel melted.

When the pressure relief valve finally was closed and operators discovered that cooling water had been lost from the system, they added water to help cool the reactor; however, the colder water shattered many of the extremely hot fuel rods. There was no other large-scale physical damage to the plant.

Most of the radioactivity was contained in the plant. Nearly a million gallons of contaminated water ended up in the basement of the reactor building and in tanks in [lie auxiliary building. The radioactive contamination in the water prohibited access to the reactor building and large areas of the auxiliary and fuel handling buildings.

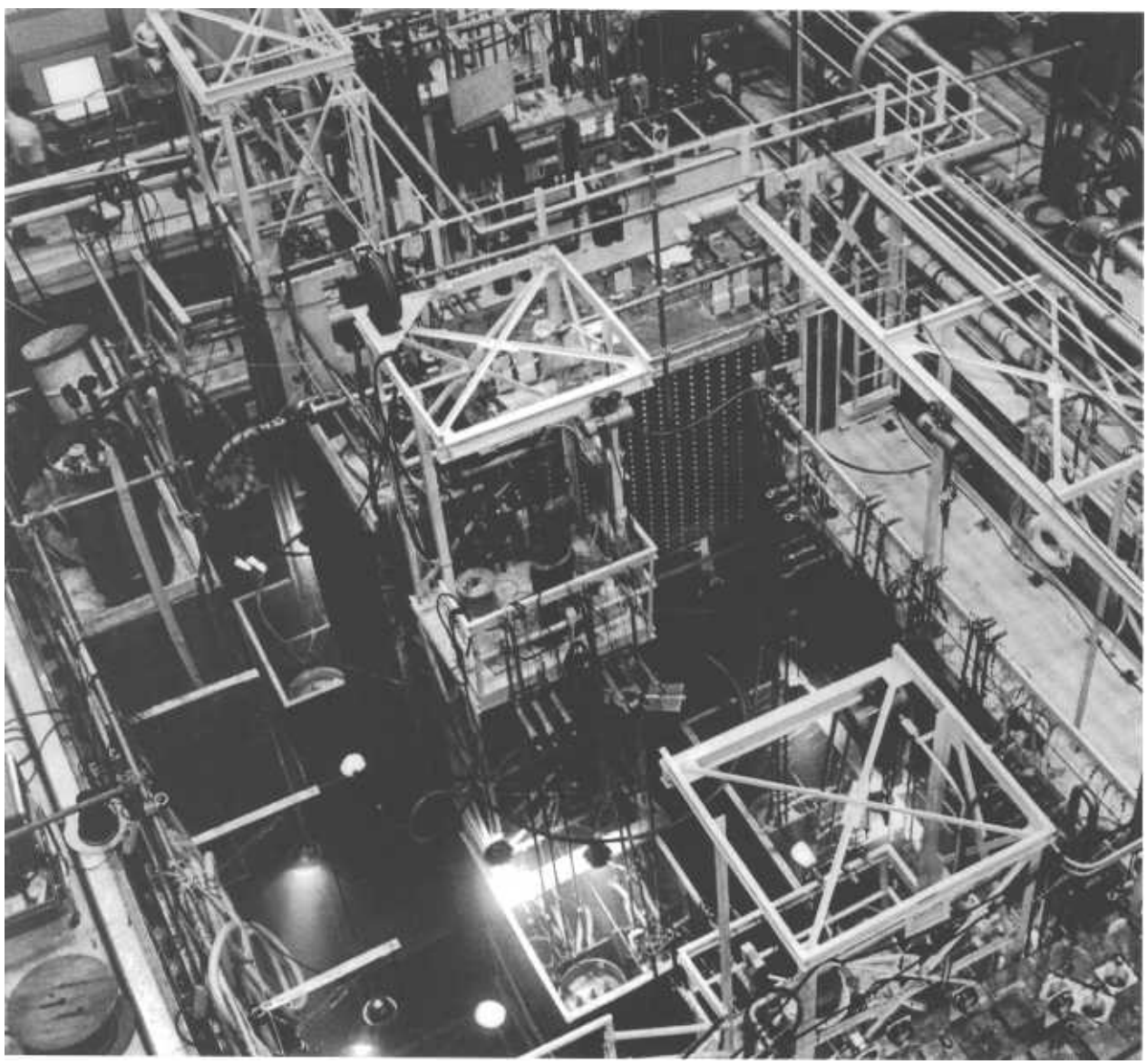
Engineers needed access to these areas to collect vital information for cleanup programs.

The company assembled a cleanup organization, drawing on the expertise of its own people, contractors and nuclear experts from around the world.

Removal of the contaminated water from the buildings was the first major decontamination task. Removing the water allowed access to the plant's auxiliary building and vital support systems. By the end of 1980, 500,000 gallons of the water had been pumped from the basements of the auxiliary and reactor buildings and processed to remove the contamination.

GPU Nuclear engineers directed the design and construction of a new water processing system called the Submerged Demineralizer System (SDS). It worked much like a home water softener and removed most of the radioactive material from the accident water.

Two specially designed tanks were built to store the processed water pending Nuclear Regulatory Commission approval to dispose of the water.



REACTOR BUILDING DECONTAMINATION

The reactor building presented a difficult challenge. During the TMI-2 accident the building proved to he a very effective barrier against the release of radioactivity to the outside world, but the building's interior was extremely contaminated.

Radioactive Krypton 85 gas had accumulated in the reactor building and had to be removed before technicians could enter the building safely. In the summer of 1980, with approvals from die Nuclear Regulatory Commission, Pennsylvania Governor Dick Thornburgh and the scientific community, the gas was safely vented Lo the atmosphere. This cleared the way for manned entries into the reactor building in July 1980.

Contamination inside the plant was washed from the floors, walls, pipes and other areas using high-pressure water sprays. Contamination was also removed from concrete using air-operated chisels and hydraulic pounding machines to break up the top layer of concrete.

Specially designed robots were sent into high radiation areas to do decontamination work and obtain information on physical and radiological conditions.

DEFUELING: AN ENGINEERING ACHIEVEMENT

All the decontamination work was in preparation for the biggest task of all removal of the damaged fuel core from the TMI-2 reactor vessel.

In the summer of 1982, camera inspections established that there was an empty space where the top five feet of the fuel core should have been. During the accident the top section of the fuel had collapsed into a bed of rubble.

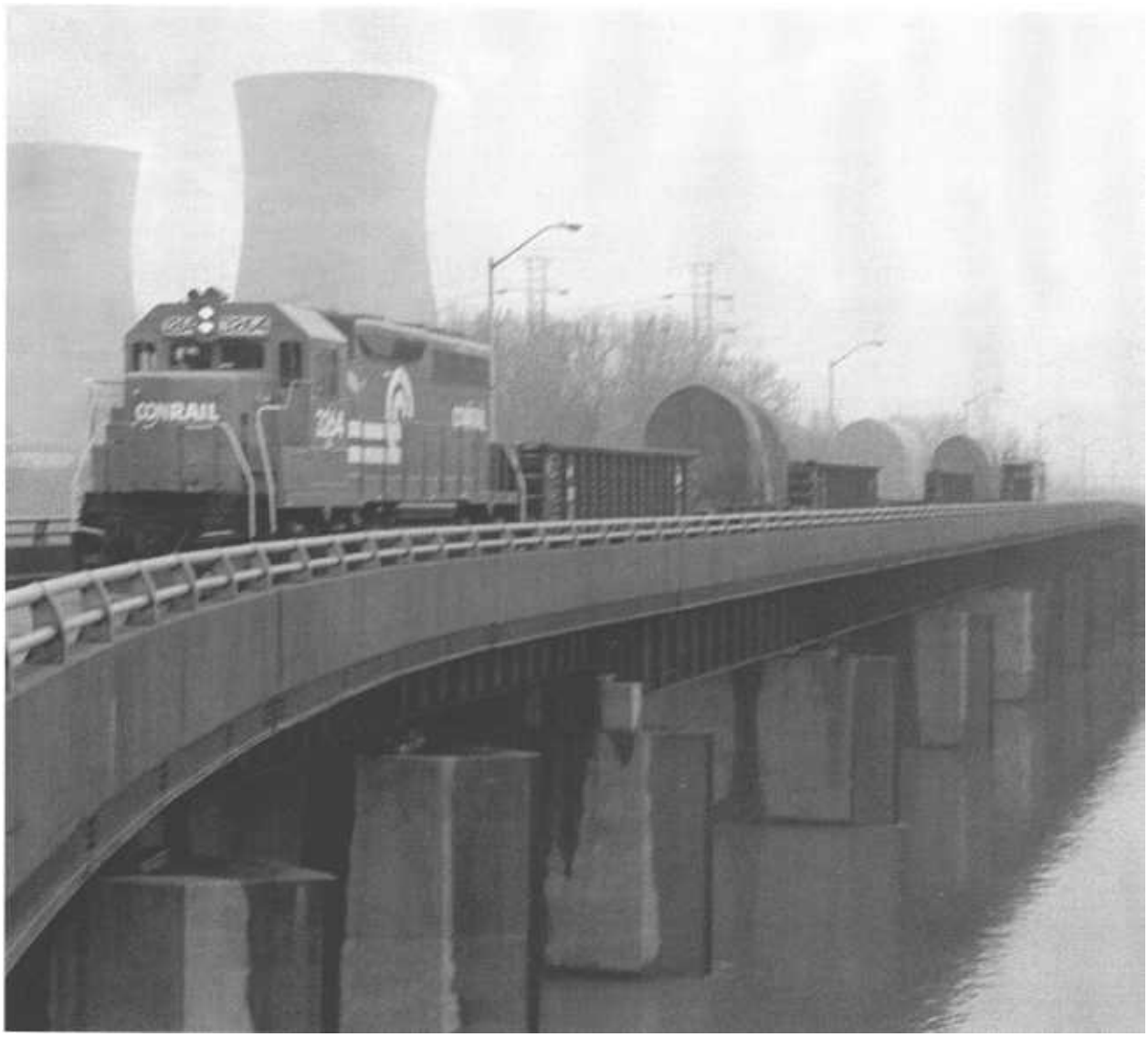
Later, camera inspections inside the reac-

for vessel confirmed the existence of another bed of rubble at the bottom of [lie reactor.

The information gathered from these inspections was applied to the training of defueling operators and the development of new tools and equipment. Operators trained for several months on a full-scale defueling work platform constructed outside the reactor building.

In May 1985, while specially designed defueling equipment was being installed, operators were being trained to remove the fuel material using tools on 35-foot-long handles. The training and decontamination work reduced radiation exposure to levels that compared with levels in the refueling of a normal operating plant.

Removal of the fuel debris began in October 1985. Like many other aspects of the cleanup, the removal of the damaged fuel core was a first-of-a-kind challenge. Using the long-



handled tools, operators were guided by underwater television cameras as they remotely loaded canisters with fuel debris.

The defueling work was completed in January 1990 with the removal of 99 percent of the damaged fuel.

The canisters containing the fuel core debris were shipped in specially designed rail casks on a special train to a U.S. Department of Energy facility in Idaho for research and development and storage.

The removal of the damaged fuel and the cleanup at TMI-2 was named one of the top engineering achievements of 1990 by the National Society of Professional Engineers.

DISPOSAL OF THE PROCESSED TMI-2 WATER

Regulators approved a water evaporation process for the 2.3 million gallons of water collected from the accident and the cleanup. The evaporation was completed in August 1993.

The water filtering system had removed 99 percent of the radioactivity and boiling it twice in the evaporator before releasing it as steam removed most of the remaining traces of radioactive particles. However, radioactive tritium could not be removed and was released into the environment with the steam. Tritium is a radioactive isotope of hydrogen. There was about one teaspoonful of tritium in the 2.3 million gallons of water.

The maximum radiation exposure that a member of the public might have received from the entire evaporation process was less than one millirern, or the equivalent of about ll day's background radiation. The average Pennsylvania resident receives about 300 millirems of radiation annually from natural sources like the sun, soil and rocks.

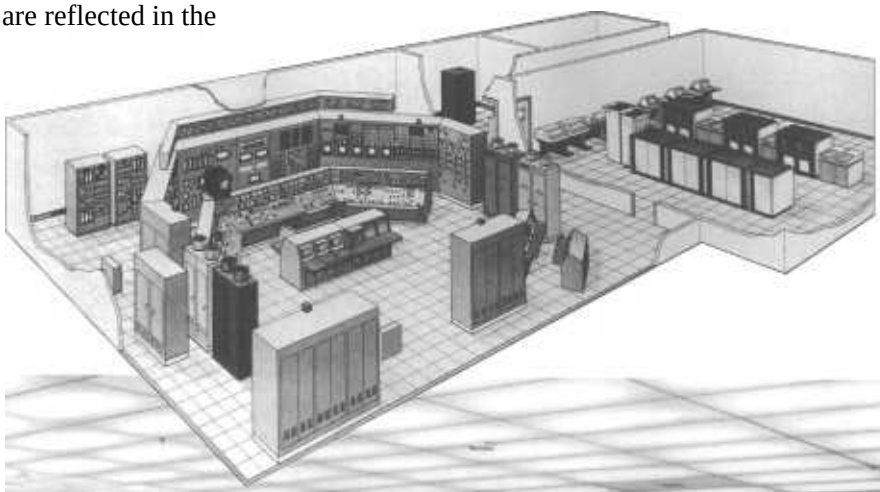
1~t.~5VN5 LEARNED FROM THE TMI-2 ACCIDENT

Much has been learned from the TMI-2 accident and applied throughout the industry. Most of the lessons have been related to people: training and procedures have been improved, equipment is designed for easier use and understanding by people, and staffing has been increased.

At TMI-1, the people lessons are reflected in the formation of the GPU Nuclear Corporation in 1982 and the three-fold increase in personnel dedicated to the operation of the plant.

The training program has been improved and expanded. Much of the training is clone on a computer-driven, full-scale simulator of the TMI Unit 1 control room.

The nuclear industry also made many plant modifications at operating .reactors to improve safety. At TMI Unit 1, more than 100 modifications were completed at the plant and over $95 million was spent in response to the accident.



MONITORED STORAGE

GPU Nuclear placed TM 1-2 in monitored storage in December 1993 after completing the requirements established by the U.S. Nuclear Regulatory Commission.

IN MONITORED STORAGE:

- The health and safety of the public, the workers and the environment are ensured.
- There is no potential for a nuclear chain reaction or for a hazardous release of radioactivity to the environment. About 100 metric tons of damaged fuel and 50 metric tons of damaged reactor components have been collected and shipped offsite for research and disposal.
- Radioactive waste has been packaged and shipped offsite for disposal at a licensed, low-level waste facility.
- Radioactivity has been reduced to levels that permit safe access by plant workers for maintenance and monitoring activities in all parts of the plant except the reactor building basemcnt.

PUBLIC HEALTH AND SAFETY ARE PROTECTED

1. The plant is maintained in a safe, stable condition with:
   - no possibility of a nuclear chain reaction
   - few combustible materials
   - virtually no water in plant systems and equipment
2. Residual fuel and radioactivity are isolated from the public and the environment inside rugged seismic and tornado-proof structures.
3. GPU Nuclear conducts radiological and environmental monitoring in the plant and in the environment.

HEALTH STUDIES

At least 16 major studies have assessed the health effects from radiation released during the accident. The studies, conducted by such organizations as the National Cancer Institute, Columbia University and the Pennsylvania Department of Health, concluded that the releases were too small to significantly affect the people and the environment around the plant.

MAJOR CONCLUSION OF STUDIES:

Radiation exposures from the T141-2 accident were a small fraction of the annual radiation exposure most people receive each year of their lives from natural background radiation and medical treatment. People living in the Harrisburg, Pa., area each year receive about 300 nilirems of radiation from natural background radiation in rocks and soil and from cosmic radiation.

- The average radiation dose from the accident to people within 10 miles of TMI was about 8 millirems. (A chest x-ray is about 10 millirems.)
- The average radiation dose to people within 50 miles of TMI was less than 1.5 millirems.
- The highest possible radiation dose from the TMI-2 accident was about 100 millirems. To receive that a person would have had to stand naked at the plant gate during the entire accident.
- There exists the potential that two cases of cancer could result from the TMI-2 accident. Those two possible cases would be undetectable among the 541,000 cancers that will occur naturally in the 2.2 million people who live in the TMI area.

DECOMMISSIONING TMI-2

TMI-2 will not operate again. GPU Nuclear expects to decommission TMI-2 when TMI-1 is decommissioned. Decommissioning means returning the site of a nuclear power plant to its original radiological condition. It does not necessarily mean removing all the buildings and structures, but it does mean removing radioactivity.

TMI-1's operating license currently expires in 2014. The Nuclear Regulatory Commission permits the extension of operating licenses for nuclear plants beyond their 40-year license if they are maintained in good condition.

GPU Nuclear is saving money for the decommissioning of both TMI plants. As of June 1994, more than $109 million had been placed in the trust fund for TMI-2.

KEEPING YOU INFORMED

GPU Nuclear is committed to keeping the public informed. Speakers are available for clubs and organizations; there are TMI tours for the public and briefing programs are available at the Visitors Center.

If you would like more information about Three Mile Island call (717) 948-8829

or write:

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Communications Department
Route 441 S.
P.O. Box 480
Middletown, Pa., 17057-0191

FURTHER READING

PUBLICATIONS ON THE TMI-2 ACCIDENT ARE AVAILABLE FROM THE PENNSYLVANIA STATE LIBRARY IN HARRISBURG AND OTHER PUBLIC AND COLLEGE LIBRARIES:

Kemeny, John, "Final Report of the President's Commission on the Accident at Three Mile Island," 1979.

Rogovin, Mitchell, "Three Mile Island - A Report to the Commissioners and to the Public," Nureg/CR-1250, 1980.

"Report of the Governor's Commission on Three Mile Island," 1980.

Hart, Gary, "Nuclear Accident and Recovery at Three Mile Island," a report prepared by the Sub-Committee on Nuclear Regulation for the Committee on Environmental and Public Works, 1980.

PUBLICATIONS AVAILABLE FROM THE GPU NUCLEAR COMMUNICATIONS LIBRARY:

"Nuclear Safety after TMI," EPRI Journal, 1980.

TMI-2 TIMELINE

December 1978
TMI-2 begins commercial operation

April 9, 1979
Federal officials declare end to accident crisis

July 1980
1st person enters TMI-2 reactor building

July 1981
Pa. Governor Richard Thornburgh proposes clean-up financing plan

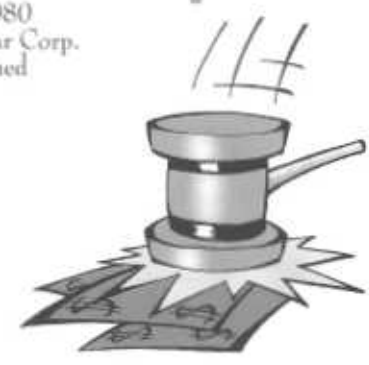
July 1982
mini underwater camera gets 1st look inside reactor vessel

Sept. 1985
Pa. Dept of Health reports no evidence of increased cancer in area

March 28, 1979
TMI-2 accident

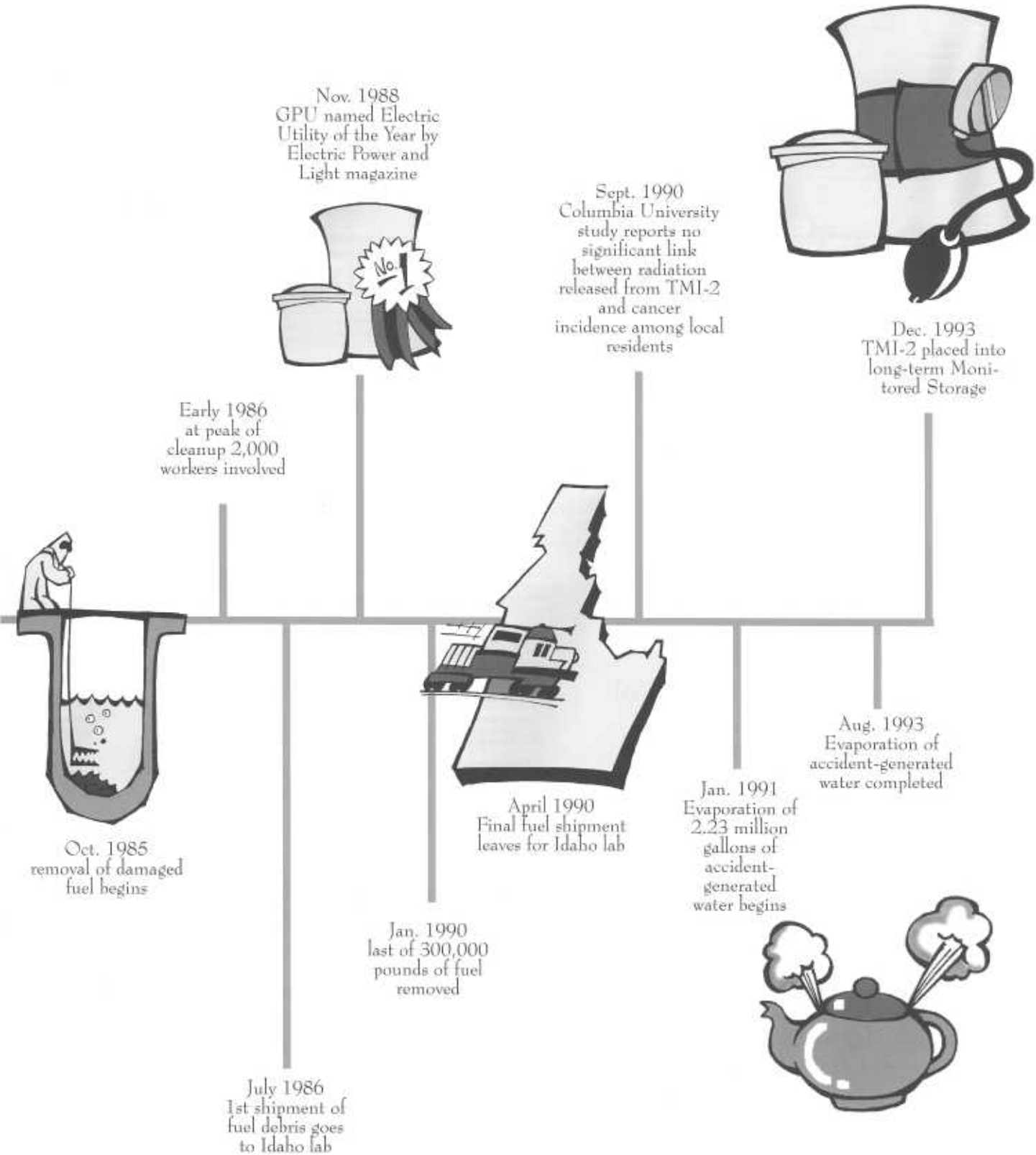
June/July 1979
krypton gas venting from reactor building

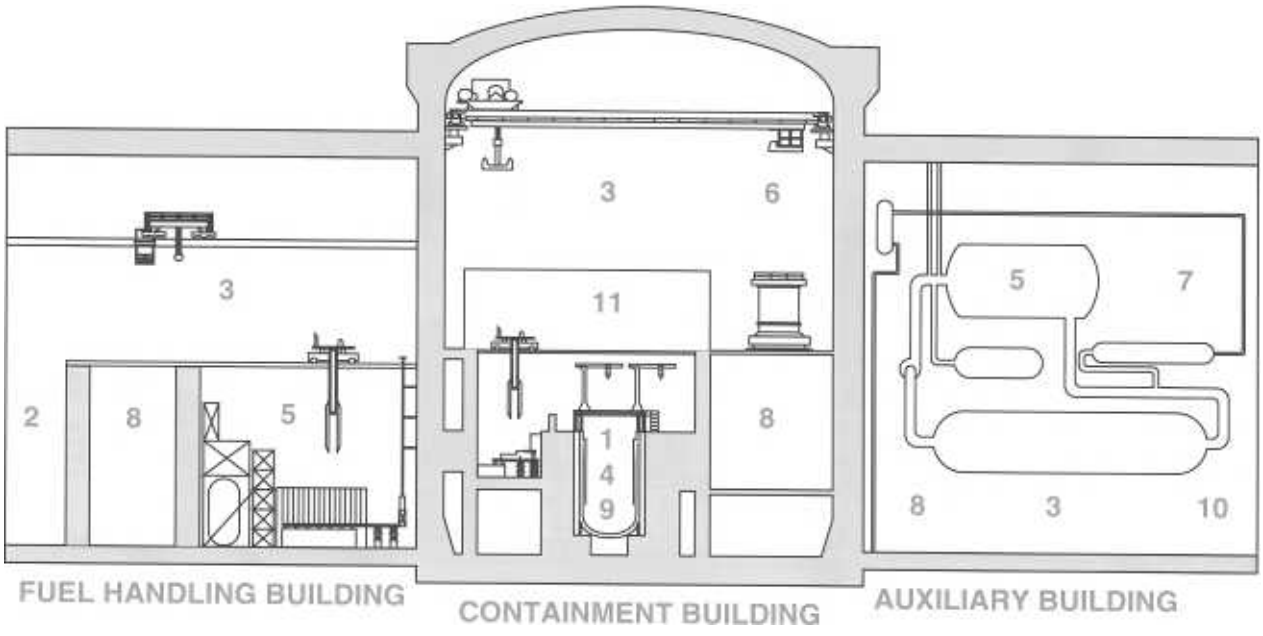
Sept. 1980
GPU Nuclear Corp. established



Sept. 1981
GPU pays $25 million in economic losses settlement to local businesses

July 1984
reactor vessel head removed


Nov. 1988
GPU named Electric Utility of the Year by Electric Power and Light magazine
No. 1
Sept. 1990
Columbia University study reports no significant link between radiation released from TMI-2 and cancer incidence among local residents
Dec. 1993
TMI-2 placed into long-term Monitored Storage
Early 1986
at peak of cleanup 2,000 workers involved
Oct. 1985
removal of damaged fuel begins
April 1990
Final fuel shipment leaves for Idaho lab
Aug. 1993
Evaporation of accident-generated water completed
Jan. 1991
Evaporation of 2.23 million gallons of accident-generated water begins
Jan. 1990
last of 300,000 pounds of fuel removed
July 1986
1st shipment of fuel debris goes to Idaho lab



MONITORED STORAGE

The following were the major steps taken to place TMI-2 in a safe, monitored storage phase. During monitored storage TMI-2 will be safe until it can be decommissioned:

1. More than 99% of the fuel and debris inside the TmI-2 reactor was removed. This provides no potential for a nuclear chain reaction known as criticality.

2. All fuel and debris removed from the TMI-2 accident was shipped off-site to federal testing and disposal sites.

3. The TMI-2 plant site was decontaminated so that no potential for the release of radiation to the environment can exist.

4. The water in the reactor systems was drained and processed as needed through EPICOR II and through the TMI-2 processed water evaporation system.

5. The water was removed from all other plant systems, such as the fuel storage pool, and processed as needed for evaporation.

6. Areas of the TMI-2 containment building where pipes and plant systems penetrate the containment building wall were closed and sealed.

7. Low-level radioactive wastes generated during the TMI-2 cleanup were packaged and shipped to licensed disposal facilities.

8. Radiation levels inside most areas of the plant were reduced to levels which allow safe entry for routine monitoring survey teams.

9. Special nuclear materials, such as small amounts of fuel that could not be removed from the TMI-2 reactor vessel, were measured and accounted for.

10. The EPICOR II water processing and processed water evaporation programs removed all water containing forms of radiation from TMI-2.

11. A regular monitoring program was established to ensure the continued safety of the plant.

GPU Nuclear Communications

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