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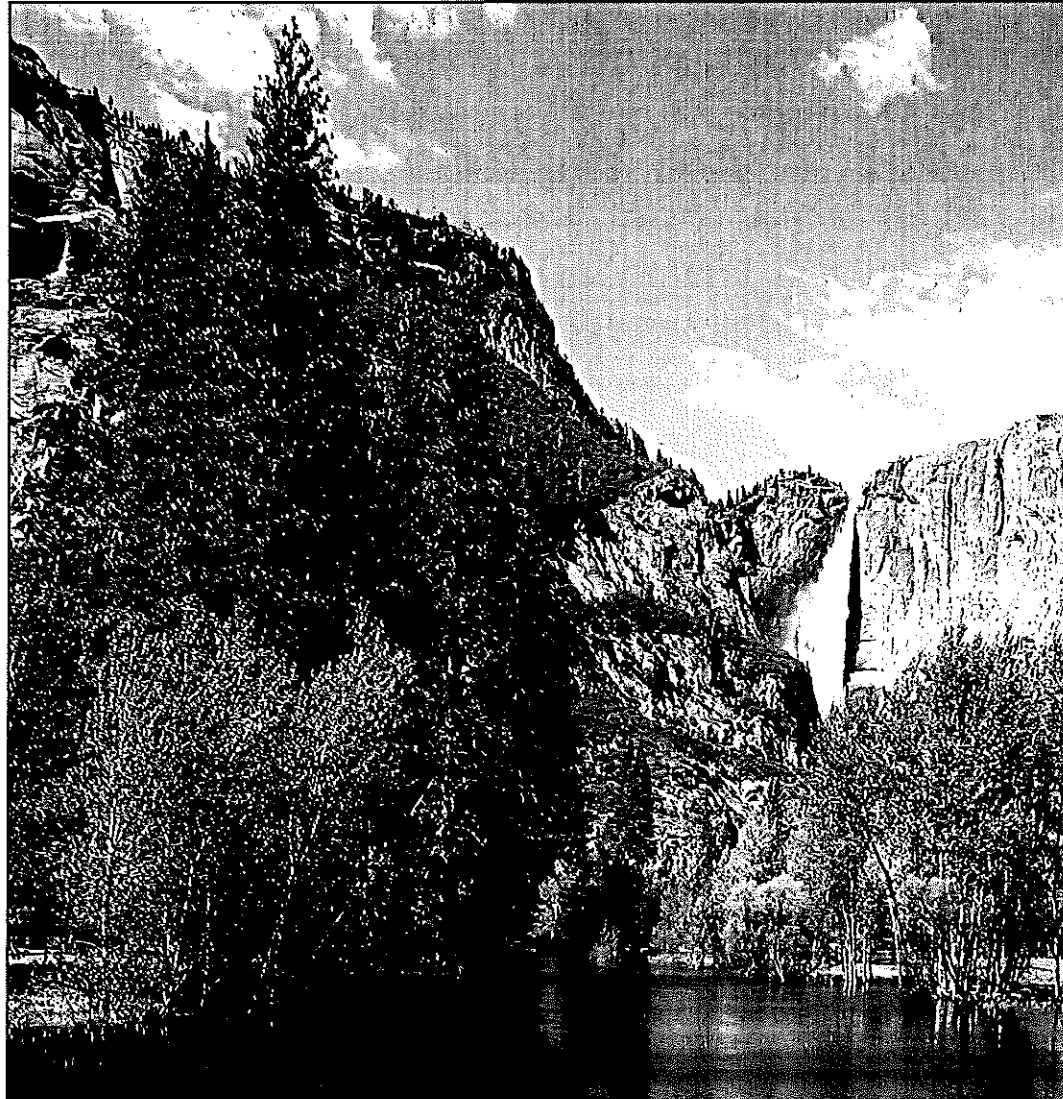
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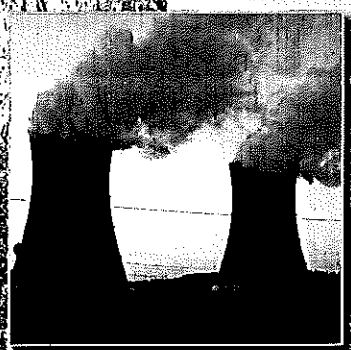
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All our Concord waters have two colors at least; one when viewed at a distance, and another, more proper, close at hand. The first depends more on the light, and follows the sky. In clear weather, in summer, they appear blue at a little distance, especially if agitated, and at a great distance all appear alike. In stormy weather they are sometimes of a dark slate-color. The sea, however, is said to be blue one day and green another without any perceptible change in the atmosphere. I have seen our river, when, the landscape being covered with snow, both water and ice were almost as green as grass. Some consider blue "to be the color of pure water, whether liquid or solid." But, looking directly down into our waters from a boat, they are seen to be of very different colors. Walden is blue at one time and green at another, even from the same point of view. Lying between the earth and the heavens, it partakes of the color of both. Viewed from a hilltop it reflects the color of the sky; but near at hand it is of a yellowish tint next the shore where you can see the sand, then a light green, which gradually deepens to a uniform dark green in the body of the pond.



Source: Henry D. Thoreau. *Walden; or, Life in the Woods*. Boston: Ticknor and Fields, 1854, 462-464.

Three Mile Island

The most severe commercial nuclear accident in the history of the United States occurred on March 28, 1979, at the Three Mile Island Nuclear Generating Station Unit 2 on the Susquehanna River near Middletown, 11 miles south of Harrisburg, Pennsylvania. The accident could have allowed radioactive fuel to burn through the foundation of Unit 2 to the soil—a scenario that the nuclear physicist Ralph Lapp (1917-2004) had termed the *China syndrome*. The euphemistic phrase implied that a molten core could theoretically bore all the way through the Earth. Americans began to grasp the troubling ramifications of a nuclear meltdown, in 1979, with the eerily prophetic release of a movie titled *The China Syndrome* just two weeks prior to the accident at Three Mile Island. The movie and the accident combined to strengthen many Americans' resistance to the civilian use of NUCLEAR ENERGY.

THE ACCIDENT

The Three Mile Island Nuclear Generating Station possessed two separate generators built by Babcock & Wilcox. The first unit, or Unit 1, was a water-pressurized reactor that came online and began commercial operations, in 1974. On March

28, 1979, Unit 1 was offline for refueling. Unit 2 began commercial operations on December 30, 1978.

The accident began at 4 A.M. on March 28, 1979, when a water pump stopped operating during attempts to repair a clogged pipe in the Unit 2 pressurized water reactor. When the water pump seized, the steam generator and the nuclear reactor shut down, but the heat and pressure in the nuclear reactor continued to build. Operators at the plant tried to correct the rising pressure in the system by briefly opening other valves, but one of these valves was defective and did not close, unbeknownst to the people in the control room for several hours.

The defective valve and a cascade of mistakes caused the primary radioactive cooling water (used to cool the reactor) to leak out of the vessel. Without water to cool the nuclear reactor core, overheating caused the zirconium-coated fuel rods that contained uranium fuel pellets to rupture and melt. An estimated 55 percent of the reactor melted. Meanwhile, operators could not comprehend what was happening, as multiple alarms sounded, data were erased, and COMPUTERS responsible for relaying the core temperature began printing question marks. Radiation was so high inside the plant and on-site that the levels exceeded the ability of the radiation monitors to measure the level. These offscale readings led confused operators to think the monitors had malfunctioned. Miraculously, as the core melted, it formed a solid cup, which then contained the rest of the disintegrating core, a hair's breadth away from the "China syndrome."

Nonetheless, the zirconium from the core reacted with the water in the vessel to create hydrogen, which later burned within the containment around 2 P.M. on the first day of the accident. In addition, radioactive gases such as xenon 133 and krypton 85 and radioisotopes such as iodine 131 entered the containment vessel surrounding the reactor. Some 250,000 gallons of radioactive coolant water leaked to the floor of the containment building. Some of this radioactive water was discharged to the nearby Susquehanna River. Radioactive air leaked out of the containment building, and the contaminated air was purposely vented out to the atmosphere to relieve pressure in the reactor during the crisis.

THE UNKNOWN HARM

Three Mile Island (TMI) was jointly owned by General Public Utility Corporation (GPU) and Metropolitan Edison Company (Met Ed). In the first hours of the crisis, on March 28, Met Ed officials reassured the public that no radiation had been released off-site, despite the clear severity of the accident by 7 A.M. By 7:10 A.M. a TMI engineer calculated that the possible exposure to the people of the nearby town of Goldsboro, Pennsylvania, was 40,000 millirems of radiation per hour, an estimated dose that was 40 times higher than what was needed to order an evacuation according to the emergency plan of the Nuclear Regulatory Commission

(NRC), the federal agency that oversees radioactive materials and their impact on the environment. An evacuation of the town, however, was not ordered until the third day of the crisis, on March 30. By comparison, the current allowable legal dose for the public living near nuclear power plants set by the NRC is 100 millirems in a year. (These standards are based on a referent male, who is 5 feet 7 inches, weighs 154 pounds, and is between the ages of 20 and 30.)

The lack of coordination among city, state, and federal agencies and officials responsible for the safety of nearby residents and the lack of an evacuation plan compounded the terror of the incident for people in the area. Met Ed, GPU, and NRC officials were overwhelmed by the problems at Unit 2 and hesitant to increase panic or harm the reputation of the nuclear industry if an evacuation was unwarranted. However, helicopters measured 1,200 millirems of radiation per hour in a plume above the TMI vent stack on the morning of the third day of the crisis, March 30. At this time, people within a 10-mile radius were advised by the Pennsylvania governor, Richard Thornburgh (1932–), to remain indoors and close their windows.

By noon on March 30, the governor finally ordered an evacuation for a five-mile radius around the plant for children and pregnant women because of the rapid cell division that occurs in growing bodies, which makes fetuses and children more vulnerable to radiation's effects. Adding to the horror, a hydrogen bubble was discovered in the reactor vessel. This bubble caused fears of an explosion and led to the exodus and panic of many remaining residents from the area by March 31, the fourth day of the crisis. At least 147,000 people fled the region.

On April 1, President JIMMY CARTER and his wife, Rosalyn, visited the TMI control room wearing only protective booties over their shoes to reassure the public. Later that day, actions to mitigate the hydrogen bubble were successful, and the crisis diminished. By April 4, the severe threat was considered over, and within weeks, T-shirts such as "I survived Three Mile Island—I think" went on sale.

THE AFTERMATH

After the accident, antinuclear activists such as RALPH NADER and the actress Jane Fonda (1937–), who appeared in the movie *The China Syndrome*, continued with new fervor to lobby CONGRESS and other federal officials. The nuclear physicist Edward Teller (1908–2003), who had participated in the MANHATTAN PROJECT and was an advocate of nuclear energy, responded by lobbying vociferously in favor of the industry. He suffered and survived a heart attack during his campaign. On July 31, 1979, Teller was featured in the *Washington Post* in an advertisement paid for by the manufacturer of the faulty valve, Dresser Industries, with his picture and the words "I was the only victim of Three Mile Island" to dispel concerns over nuclear power safety.

Investigations into the accident by several commissions, including President Carter's 1979 Kemeny Commission (led by the mathematician and Dartmouth University president John Kemeny), determined that the accident was caused by a combination of factors, including the defective valve, human error, lack of proper regulatory oversight, and design deficiencies. The commission also concluded that the NRC, GPU, Met Ed, and federal and state officials had severely mismanaged the crisis, raising questions about the safety of nuclear power worldwide. The commission also concluded that radiation releases had been negligible and that no negative health impacts beyond emotional effects were expected.

Later investigations determined most of the radiation escaped Unit 2 before the evacuation was ordered. The amount of radioactivity released during the accident continues to be disputed, as well as the health effects. Several weeks after the accident, 2,000 regional residents joined in a class action lawsuit. GPU and Met Ed paid more than \$70 million for health studies and compensatory damages from lawsuits, but the 1957 Price Anderson Act protected GPU and Met Ed from punitive damages. This federal law limits the liability of the nuclear industry in the event of accidents.

According to the NRC, there has been no increase in adverse health effects beyond emotional trauma due to the accident. Numerous health studies by independent scientists dispute this conclusion, such as the peer-reviewed 1997 study by the public health scientist Stephen Wing that found increases in leukemia, lung cancer, and other cancers in the TMI area.

The 13-year effort to remedy the existing dangers in Unit 2 exceeded \$1 billion and resulted in additional releases of radioactive material to the environment, including the 1980 venting of 57,000 curies of krypton 85 despite vehement community opposition. The community also opposed the 1985 restart of Unit 1, and legal challenges were mounted to oppose the evaporation of the remaining water in the Unit 2 containment, in 1993. The 1979 accident inspired new attention to safety, training, and design in the nuclear industry and government agencies, and a new awareness of the need for evacuation planning. After the accident at Three Mile Island, however, no new nuclear power plants were built in the United States.

In 2007, the first application for a new nuclear reactor since the accident was approved by the NRC using new streamlined siting rules. It is currently unknown whether there will be actual construction of the new reactor, which would be a second unit to join the existing Exelon Nuclear-owned plant near Clinton, New Jersey. There are 104 operating commercial nuclear power reactors in the United States, and 23 new reactors have pending applications with the NRC for licenses with 14 new designs in the process of approval.

See also ATOMIC ENERGY COMMISSION; NUCLEAR WEAPONS AND TESTING.

Linda Richards

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tick fever

Tick fever, or bovine babesiosis, is a parasitic disease that destroys red blood cells. It primarily affects CATTLE, although it also strikes humans, HORSES, mules, goats, and DEER. Babesiosis is caused by two organisms that can be transmitted by the bite of a tick: *Babesia bovis* and *Babesia bigemina*. Infected cattle typically die within days of being bit, and the disease nearly crippled the U.S. cattle industry, in the late 19th century.

Tick fever is transmitted by ticks, or small bloodsucking parasitic arachnids. Tick fever takes two different forms. The acute version, *B. bovis*, is generally contracted during the summer months; infected cattle stand still with lowered head and arched backs until death occurs three or four days after fever develops. In the chronic form of cattle fever, *B. bigemina*, which is contracted in autumn or winter, surviving animals may become weak, stunted, and anemic through continuous loss of blood. Chronically infected animals may have relapses and become susceptible to other diseases or secondary infections.

The Spanish introduced types of cattle fever ticks (*Boophilus annulatus* and *Boophilus microplue*) and cattle fever disease to the Americas when they transported infested cattle on their ships. The disease has since spread out from the original Spanish colonies to cover much of the United States. However, it is most common along the Texas border with Mexico and in California. The newly hatched seed ticks, or larvae, crawl up plants and wait for an animal to pass by. When an opportunity is presented, the ticks attach themselves to the soft skin inside the animal's thigh, flanks, or foreleg, or along the belly. Once attached, they suck blood.

Tick fever is so destructive that it became the focus of the first joint federal-state disease eradication effort. In 1892, the federal government established a national quarantine line in order to prevent the disease from infecting northern herds. Such a line proved expensive to maintain, and, once researchers discovered, in 1893, that the cattle tick spread the

parasite that caused the disease, federal authorities developed a cure as an alternative. Federal officials decided that dipping cattle every two weeks in an arsenic solution offered the best way to eradicate the pest.

The Cattle Fever Tick Eradication Program, begun in 1906 as part of the Animal and Plant Health Inspection Service, sent inspectors on horseback to patrol for ticks in a quarantine zone that extended more than 900 miles, from Del Rio, Texas, to the GULF OF MEXICO. The riders detected and captured any stray or smuggled Mexican livestock or any American livestock that entered Mexico and returned home. Inspectors also examined and dipped all native stock being moved away from the Mexican border in PESTICIDES that kill ticks. Treatment, however, did not prevent reinfestations. For this reason, inspectors redipped animals for at least one year after presumed contact with a cattle fever tick. Every animal in every infected and exposed herd had to be treated, and cattle movement limited within a state until federal inspectors declared an area to be clean. In 1938, the U.S. DEPARTMENT OF AGRICULTURE created a permanent, narrow quarantine area along a 500-mile stretch of the RIO GRANDE in southern Texas.

Cattle-tick eradication programs have remained controversial, as some ranchers vehemently oppose the eradication of the pest and, especially, the methods adopted by federal and state officials. Large landowners could spare the manpower to round up and dip their own animals, but smaller ranchers could not easily afford the time or expense. Ranchers also had to pay the increased county costs for eradication, a financial burden that small-scale ranchers could ill afford. These ranchers generally tried to express their opposition through legal means but occasionally resorted to dynamiting dipping vats and killing federal agents.

By the 1940s, tick fever was effectively controlled in most of the United States. The tick that transmits the disease is still found in Mexico. The United States continues to maintain strict inspection standards and treats all live cattle imported from Mexico with pesticides. Nonetheless, the number of fever tick introductions in the quarantine area and just north of this buffer zone has increased, in the 21st century. Some ticks have developed resistance to acaricides (pesticides designed specifically to kill ticks). In other cases, hoofed wildlife, such as indigenous elk and deer, or exotic wildlife imported into Texas for hunting are carriers of the tick.

See also DISEASES, ANIMAL; DISEASES, HUMAN; INSECTS; LYME DISEASE; MEXICO AND THE UNITED STATES; PEST CONTROLS; SPANISH EXPLORATION AND SETTLEMENT—MEXICO AND TEXAS; SPANISH EXPLORATION AND SETTLEMENT—NEW MEXICO AND CALIFORNIA; SPECIES, EXOTIC AND INVASIVE; UNITED STATES—CALIFORNIA; UNITED STATES—GULF COAST; UNITED STATES—SOUTHWEST.

Caryn E. Neumann