

# FUKUSHIMA

## JUST THE FACTS

Four incidents at nuclear power reactors dominate society's perception of the technology: SL-1 in Idaho (1961), Three Mile Island in Pennsylvania (1979), Chernobyl in Ukraine (1986) and Fukushima in Japan (2011). Few events in human history have generated such disproportionate reactions.



### Earthquake effects at some places

≤ 130 feet  
high waves

6 miles  
distance some waves reached inland

8 minutes  
until first waves reached coast

The Fukushima Daiichi nuclear power station at Ōkuma, Japan, is 150 miles north of Tokyo. The fourth-most powerful earthquake on global record (9.0 on the Richter Scale) occurred 43 miles off the coast.

### What happened?

On March 11, 2011, three of the six Fukushima Daiichi reactors were operating when the Tōhoku quake and tsunami struck, destroying the station's connection to the electrical grid. All three automatically shut down and began the cooling process using emergency power. Yet, the diesel generators that provided backup electricity for the cooling equipment were built too close to sea level and were swamped by the tsunami's waves.

Even though Tokyo Electric Power Company (TEPCO), the electric utility, used fire trucks and seawater for emergency cooling, three units experienced core meltdowns. Hydrogen gas was produced as the fuel's protective cladding oxidized at high temperatures. That explosive gas blew apart the outer buildings of three units, and Japanese officials ordered the evacuation of 160,000 residents. The government enforced a prolonged evacuation due to widespread fears of radiation.

### How many people died?

0 people died as a direct result of the hydrogen explosions or radiation exposure.

The Tōhoku earthquake and tsunami killed **15,897** people, and **2,582** were still missing as of June 2019.

(Sources: International Atomic Energy Agency, Japanese government and National Police Agency of Japan)

## How many were exposed to radiation?



**Four** employees got sick from the radiation, according to the Japanese government.



Of **23,000** people who worked at the site during and after the meltdowns, **174** received doses of **10 rem** or higher, with **six** of them receiving doses of **25 rem** or higher.



Experts generally agree that doses higher than **50 rem** may increase the lifetime risk of cancer for **1 in 250** people.



Residents were assessed after the meltdowns, and experts estimated that adults got an average lifetime effective dose around **1 rem** or less. One-year-old infants would have received about **2 rem**.



A resident in the Fukushima prefecture (i.e., state) would naturally receive **0.2 to 0.3 rem per year** (about the same as a single mammogram).

(Sources: World Nuclear Association; World Health Organization, United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR))

## Other Impacts

The Japanese government took immediate steps to test the food and water supply, and doing so protected children from thyroid cancer. The government also worked to establish a baseline against which to measure. As a result, experts expect to see better outcomes at Fukushima than at Chernobyl due to the proactive response.

The prolonged evacuation is believed to have caused more than 1,000 premature deaths from emotional stress and disruption of medical and social welfare facilities.

**A study of more than 1,200 people in local care homes found that those who were evacuated were three times more likely to have died in the next two years than those who had not been evacuated. It wasn't the radiation that was killing them, it was the stress of evacuation, says Claire Leppold, a doctor in Minamisoma, a town near the evacuation zone.**

— The Guardian, in "What was the fallout of Fukushima?"

## Status Today

The three unharmed reactors have not been restarted. A massive cleanup and decommissioning program continues, including treating large amounts of contaminated water. While much of the radioactive material from the Fukushima reactors went into the ocean, its effect on fish was minuscule.

On Oct. 25, 2017, the environmental group Oceana's online magazine interviewed Nicholas S. Fischer, an expert on oceanic radiation at Stony Brook University. "The disaster added just a fraction of a percent to the radiation that's already in the ocean, 99 percent of which is naturally occurring," it concluded. "At those levels, you could eat piles of Pacific fish and have nothing to worry about from radiation, Fisher said. The dose of Fukushima-derived radiation from the average tuna fillet, he explained, 'would be far less than the total radiation you'd get from eating a banana or flying in an airplane.'"

In 2019, the local government decided that in 2020 it would stop conducting its annual health survey of expectant and nursing mothers in the area

(approximately 15,000 mothers, with a typical participation rate around 50%). The decision was based primarily on the fact that the survey detected no difference from the national average.

## Key Lesson

In simple terms, the reactors at the Fukushima Daiichi plant — and specifically emergency diesel generators needed to power cooling water pumps — were too close to sea level. The Fukushima plant is located on a bluff that, prior to construction of the reactors, was 35 meters (115 feet) above the normal sea level. However, TEPCO lowered the elevation of the bluff to about 10 meters (33 feet), to ease the lift of heavy components during construction, and to have the plant closer to bedrock. Had the reactors been 25 meters higher, the tsunami still would have created problems, but to a much lesser degree. In fact, reactors at sister plant Fukushima Daini, 10 km to the south, survived the tsunami.

## Societal Reactions

Within a week of the tsunami, the U.S. Nuclear Regulatory Commission, the independent federal agency that regulates American nuclear power plant safety, ordered broad reviews of safety equipment and procedures.

The NRC later issued regulatory changes addressing nuclear facilities' abilities to withstand earthquakes and massive flooding. These additions consider details such as the possibility that debris may limit access to a reactor, and require hardened cooling vents at the U.S. reactors that have containment designs similar to those at Fukushima.

By the end of 2019, all U.S. reactors completed the additional seismic safety reviews and flood protection required by the NRC or the U.S. Department of Energy.

## Sources

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