NUCLEAR CRISIS
JAPAN & THE FUTURE OF ENERGY POLICY

# 5. NUCLEAR CRISIS: Weighing fears of radiation doses in Japan

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For a moment last night -- early morning in Japan -- dire news emerged from the Fukushima Daiichi nuclear power plant. For the first time, measured radiation levels briefly spiked toward dose ranges known to cause radiation sickness and serious health problems.

But since that single detection event, which caused the evacuation of noncritical personnel around the plant, radiation levels at the plant have subsided, according to the International Atomic Energy Agency. The IAEA is closely collaborating with the Japanese government on monitoring the Fukushima plant.

The high-dose event detected at the plant hit 400 millisieverts (mSv) per hour, a rate that could cause radiation sickness within a few hours. Sieverts, typically measured in millisieverts or microsieverts -- an important rate difference -- are the international standard for measuring the effective health risks different radiation types will have on the human body.

Since that event, radiation levels at the plant dropped to 11.9 mSv per hour and then, six hours later, 0.6 mSv per hour, a level well below immediate health concerns but still equivalent to receiving six chest X-rays in one hour.

It is uncertain what caused the radiation spike. Japan's chief Cabinet secretary, Yukio Edano, today told the Japanese television network NHK TV that debris from the collapse yesterday of the external building around the plant's No. 3 reactor and containment structure may have been the cause, but that has not been confirmed.

When considering the dose levels circulated in the past 24 hours, it is important to keep a few things in perspective. First, radiation doses are cumulative, measured in terms of dose per hour, day or year. For example, an astronaut on a typical half-year mission on the International Space Station will record a dose of up to 150 mSv, in total, over that time -- well below the per-hour dose briefly detected at Fukushima.

While a dose of 400 mSv per hour is considered a high-risk event -- small increases in cancer risk can begin to be detected from that point -- acute exposure begins to take a severe health toll at one level higher of exposure. At 4,000 mSv of total exposure, a level that has not been reported, red blood cells begin to expire and the gut takes moderate damage, often leading to a patient's death, especially if untreated.

The radiation detected at the plant, however, is largely a health concern for local workers. (*For more on understanding radiation, click here.*) If the broader public receives any additional radiation exposure -- residents of the United States, for example, are exposed to about 5 mSv a year of radiation through natural and medical sources -- it will come through ingesting wind-borne, radioactive particles released by the plant.

U.S. regulators have said radiation from Japan's crippled Fukushima Daiichi nuclear plant is not expected to reach the United States.

The particles of most concern are iodine-131 and cesium-137. The iodine isotope emits electrons, subatomic particles that are unable to penetrate the skin. If the iodine is ingested and migrates to the thyroid in large enough quantities, however, these electrons -- called beta radiation -- can do serious long-term damage to the thyroid, causing cancer.

Cesium-137, meanwhile, emits charged light, massless particles that can stream through the body, known as gamma radiation. However, the ultimate concern with cesium also involves ingestion, as the element can concentrate in bones, continuing to emit gamma radiation as it does. Unlike iodine, which quickly falls in concentration, reduced by its own radioactivity, cesium-137 is persistent, lingering for decades before its decay drops its size in half.

It is uncertain, currently, how much cesium and iodine have escaped the plant.

Radiation doses can be difficult to understand. Sieverts are used to estimate doses to the entire body; directed exposure of organs sensitive to radiation can be problematic at lower doses, and vice versa. Radiation targeted directly at cancer tumors is measured in whole sieverts, but thanks to its targeting, the more direct health effects are avoided.

While any listing of health impacts from radiation is incomplete, here is a sample of dose ranges, taken from an **explanatory chart** prepared by the Energy Department's Office of Science:

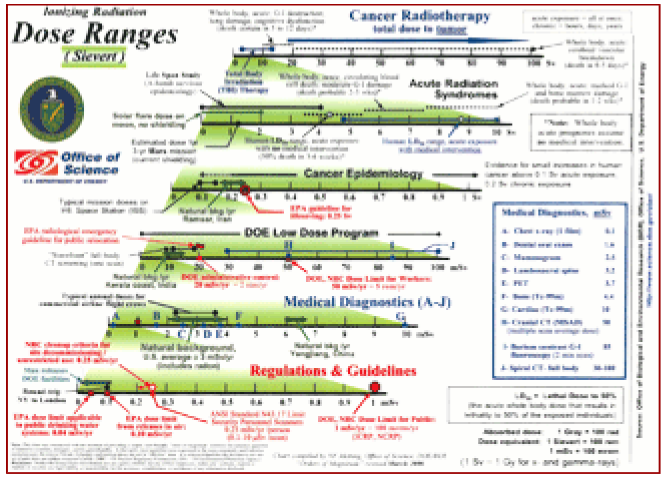


Chart prepared by DOE's Office of Science showing regulatory standards and health effects of low- and high-dose radiation. Click the image for a larger version. Photo courtesy DOE.

- 0.1 milliSievert (mSv), single exposure = one chest X-ray.
- 3 mSv per year = average U.S. exposure to natural background radiation.
- 3 mSv per year = average additional dose for commercial airline workers.
- 3.7 mSv, single exposure = one PET scan.
- 50 mSv per year = limit for DOE nuclear workers.
- 30-100 mSv, single exposure = one full-body CT scan.
- 100 mSv and above, single exposure = evidence for small increase in cancer incidence.
- 200 mSv per year = natural background radiation in Ramsar, Iran.
- 1,000 mSv (1 Sv) = estimated dose for a three-year mission to Mars.
- 4 Sv, single exposure = 50 percent risk of death in three to six weeks, without treatment.
- 8.5 Sv, single exposure = 50 percent risk of death in three to six weeks, with treatment.
- 11 Sv, single exposure = certain death in five to 12 days without medical intervention.
- 100 Sv, single exposure = certain death in zero to 5 days without medical intervention.