**Entergy Nuclear Issue Brief**
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# Health Effects

***What are the long-term consequences of radiation exposure?***

- As a result of fuel damage in at least four of the Fukushima reactors, significant releases of radioactive materials have been detected at the site. It will take time to evaluate whether there are in fact any public health effects from these releases.

- By comparison, studies from the Three Mile Island accident, including a 30-year study by the University of Pittsburgh, demonstrated that there were no long-term health effects from the 1979 accident.

- Radiation experts have stated that there are no health risks in the U.S. from this event. Monitoring stations in various parts of the United States have detected radiation at levels that do not pose a threat to public health, according to doctors and federal agencies, including the Centers for Disease Control and the Environmental Protection Agency.

- These detections of radiation above background levels are not unexpected given the sensitivity of equipment in monitoring and detecting extremely low levels of radiation in the environment. Iodine 131 is one byproduct of the fission process in commercial reactors and is also used in medicine to diagnose and treat disorders of the thyroid gland. If released to the environment, it forms a vapor that can be transported great distances in the air. Until the Japan nuclear plant is stabilized, trace amounts of I-131 have been trapped in cloud formations and moved across the US as part of weather patterns. These trace amounts may continue to be detected as it rains.

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Japanese authorities are implementing the most effective options for protecting the public. In the early stages of this event, authorities ordered evacuation from a 12.5 mile radius around the Fukushima Daiichi plant and about two miles around the Daini plant. Other precautionary measures taken to evacuate residents near the sites were intended to prevent or mitigate any radiation dose from radiation releases that might occur as the situation developed.

TEPCO took additional actions to protect workers at the plant by limiting access to the plant to only the most essential personnel.

A 2005 World Health Organization report demonstrated that nearly 50 deaths were a direct result of the Chernobyl accident. Comprehensive studies of potential cancer effects noted an increase in childhood thyroid cancer. There was no increase noted for leukemia or other cancers. At Chernobyl, potassium iodide was not used. Potassium iodide has been distributed around the Fukushima site, as it would be in the United States under similar circumstances.

**Radiation from a Nuclear Power Plant During Routine Operations**
As a part of routine electricity production operations, small amounts of radioactive material are released from nuclear power plants into the environment in accordance with requirements that are specified in the plant operating licenses issued by the NRC. Radiation dose to members of the public from these releases into the air and water are routinely monitored by the plants, the states and the NRC and are documented in public reports submitted to the NRC. The average radiation dose from nuclear operations to a person living near a nuclear power plant is much less than one millirem per year.

**Radiation Facts**

**Millirem**
The unit of measurement of the amount of radiation received by a person ("radiation dose") is a millirem (mrem). This is similar to the units of inch (for length), ounce (for weight), and degree Fahrenheit (for temperature).

**Natural Background Radiation**
The average American receives more than 600 mrems of radiation exposure annually—about half from naturally-occurring sources and the rest from medical applications, such as CT scans and x-rays. Although there is scientific evidence for health risks following high-dose radiation exposures, risks of health effects are either too small to be observed or are nonexistent at levels below 5,000–10,000 mrem.

- Radon in home and workplaces accounts for two-thirds of natural background radiation dose (about 200 mrem per year).
- Taking a round trip flight between New York and Los Angeles results in an 8-mrem dose from the higher cosmic radiation at altitude. Flight crews receive 200-400 mrem per year.
- Standing at the site boundary of a nuclear power plant for a solid year results in a dose of 1 mrem.
- All organic matter contains small amounts of radiation from radioactive potassium-40 and radium-226. Some examples are:
    - Bananas 3520 pCi/kg P-40
    - Carrots 3400 pCi/kg P-40
    - Lima beans (raw) 4640 pCi/kg P-40
    - Brazil nuts 5600 pCi/kg P-40

**Medical and Dental Radiation**
Americans also receive radiation dose from medical and dental procedures in the form of x-rays, CT scans and nuclear medicine. Although the average amount of radiation dose from such procedures is more than 300 mrem per year, much larger amounts of radiation dose are received by people undergoing diagnosis or treatment for specific medical conditions.

- Single x-ray of pelvis 70 mrem
- Single x-ray of abdomen 60 mrem
- Single x-ray of chest 10 mrem
- CT full body scan 1000 mrem
- CT chest scan 700 mrem

**Risks from High Radiation Exposure**
Individuals can respond to radiation exposure differently but these are the typical physical responses for high levels of exposure:

- 50,000 mrem - some changes to white blood cell counts and temporary sterility in men
- 100,000 mrem - individual can experience nausea and reddening of the skin
- 500,000 mrem - will likely die without medical treatment

Populations within the 10-mile emergency planning zone of a nuclear plant are at greatest risk of exposure to radiation and radioactive materials including radioactive iodine. Beyond 10 miles, the major risk of radioiodine exposure is from ingestion of contaminated foodstuffs, particularly milk products. Both the EPA and the FDA have published guidance to protect consumers from contaminated foods within a 50-mile radius.

**Federal Radiation Safety Limits**
The Nuclear Regulatory Commission establishes radiation dose limits to protect public health and nuclear facility workers. The limits are based on the current scientific understanding of potential risks from radiation exposure.

The NRC's public radiation dose limit is 100 mrem annually. The average U.S. public exposure from the commercial nuclear fuel cycle, including nuclear power plant operations, is less than 1 mrem per year.

The NRC's annual limit for worker exposure to radiation is 5,000 mrem. Entergy takes an additional step on the behalf of worker safety, limiting annual exposure to 2,000 mrem annually. The average U.S. nuclear power plant worker receives 120 mrem annually.

**Radiation from a Nuclear Power Plant – Accident Conditions**
Under accident conditions at a nuclear power plant involving fuel damage or melting, radioactive fission products could be released from the fuel elements into water and steam surrounding the fuel within the reactor vessel. Primary fission products include radioactive noble gases (krypton and xenon), iodine and cesium, and to a lesser extent, strontium.

In the boiling water reactor design used at Japan's Fukushima Daiichi plants, as insufficient fuel cooling leads to a buildup of temperature and pressure in the reactor, safety relief valves release the steam into a "suppression pool"—a round shaped torus around the bottom of the reactor. Among other functions, the suppression pool helps to cool and trap the majority of cesium, iodine and strontium. At Fukushima Daiichi, periodic venting from the suppression pool was conducted to further manage temperature and pressure and protect the integrity of the primary containment.

Releases to the environment associated with venting consist primarily of radioactive noble gases, which by their chemical and physical nature, disperse in the atmosphere and provide a source of radiation exposure in a passing plume or vapor cloud.

**Potassium Iodide**
The thyroid gland preferentially absorbs iodine. In doing so it does not differentiate between radioactive and nonradioactive forms of iodine. The ingestion of nonradioactive potassium iodide (KI), if taken within several hours of likely exposure to radioactive iodine, can protect the thyroid gland by blocking further uptake of radioactive forms of iodine. KI does not protect any other part of the body, nor does it protect against any other radioactive element.

The NRC has supplied KI tablets to states that have requested it for the population within the 10-mile emergency planning zone of a nuclear reactor. Of the 33 states with nuclear power facilities, 22 participate in the NRC's KI tablet distribution program for the protection of their affected communities. Nine states – Arkansas, Georgia, Iowa, Kansas, Louisiana, Missouri, Nebraska, Texas and Washington – do not participate. Illinois has not joined the federal effort but organized its own distribution of iodine.

If necessary, KI is to be used to supplement other measures, such as evacuation, sheltering in place and control of the food supply, not to take the place of these actions. The Environmental Protection Agency and the Food and Drug Administration have published guidance for state emergency responders on the dosage and effectiveness of KI on different segments of the population. According to the EPA guidance, "KI provides optimal protection when administered immediately prior to or in conjunction with passage of a radioactive cloud." If state emergency agencies determine that KI distribution is recommended, members of the public would receive KI from the state. Note that policy on stockpiling and distribution varies from state to state.

**Radiation Risk to U.S. Public from Japan Incident**

Reports as of March 18 that trace levels of radiation (iodine) had been detected in California raised speculation that the radiation is from the Fukushima nuclear power plant in Japan.

President Obama and other federal agencies, including the Centers for Disease Control, have said that there is no threat to U.S. public health at this time due to radiation from the Fukushima nuclear plant. The levels detected in various U.S. states are exceptionally low and would have no impact on human health.

The ability to detect radiation levels is extremely sophisticated. Monitoring equipment used each day at nuclear energy and medical facilities and by health officials, for example, helps protect professionals and members of the public from exposure to radiation. Equipment also detects radiation that migrates into the local environment from other parts of the globe.

The NRC bases its radiation safety regulations on the best science available. Regulatory standards are informed by eminent scientific organizations, such as the United Nations Scientific Council on the Effects of Atomic Radiation, the National Academy of Sciences, the International Commission on Radiological Protection and the National Council on Radiation Protection and Measurements.