Radiological Issues

Pathways to Exposure

Production of nuclear power in the United States is licensed, monitored, and regulated by the U.S. Nuclear Regulatory Commission (NRC). Provisions in the operating licenses of each nuclear power plant allow utilities to discharge very low levels of radioactive material to the environment. The kind and quantity of releases are strictly regulated and must fall within limits defined in federal law as protective of human health and the environment.

Pathways of potential human exposure to radioactive material in the environment are similar to those for other pollutants. When exposed to ionizing radiation, the tissues may absorb some of the energy; the transfer of energy to the tissues is called a dose. A human may potentially receive a dose of radiation by ingesting contaminated (i.e., irradiated) water, seafood, terrestrial animals, or vegetation; by coming into contact with contaminated sediments or water; or by inhaling radioactive gas or airborne particles.

Nuclear power plants are minor contributors to radiation exposure in the United States, as estimated by the National Council on Radiation Protection and Measurements (NCRP).[1] As Figure 1 illustrates, natural radiation sources (radon, thoron, and other background sources) account for 50 percent of the average annual radiation dose to humans, as estimated from data compiled in 2006. Of the remaining radiation dose to humans that arises from man-made sources, less than 0.05 percent is attributed to commercial nuclear power production as a component of the industrial category in the NCRP summary.

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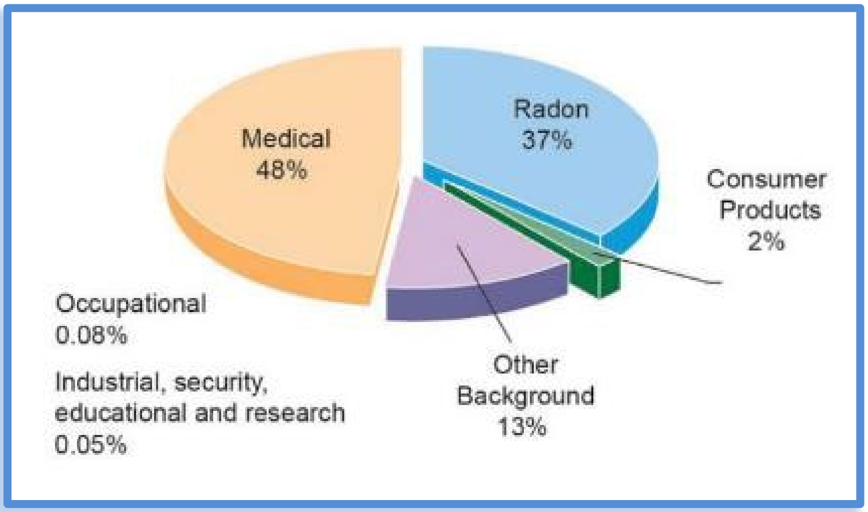
[1]Data source: National Council on Radiation Protection and Measurements, Ionizing Radiation Exposure of the Population of the United States, NCRP Report No. 160, 2009.

Figure 1 Percentages of Annual Estimated Radiation Exposure to the General Population from Natural Background and Man-made Sources

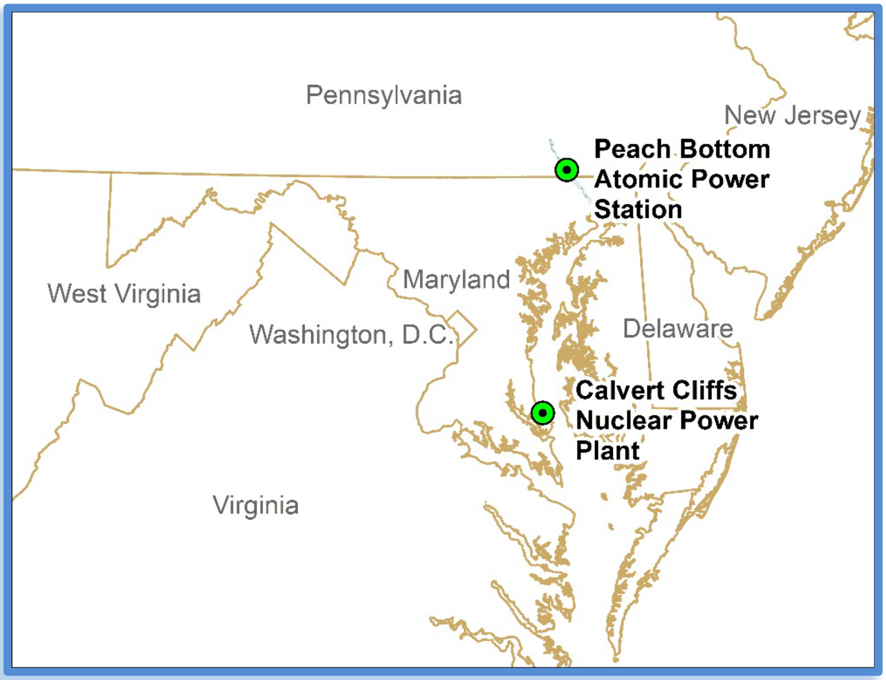


Nuclear power plants routinely release small quantities of gaseous, particulate, and liquid radioactive material into the atmosphere and adjacent waterways used for cooling water because of normal plant operations. The level of radioactivity in the effluent at any given time depends on many factors, including plant operating conditions and conditions of the nuclear fuel.

Nuclear Power Plants of Interest to Maryland

The study of radioactivity levels within Maryland focuses on the one nuclear power plant located in Maryland and the one closest to Maryland, near the northern state border (Figure 2). Calvert Cliffs Nuclear Power Plant (CCNPP) is located on the western shore of the Chesapeake Bay in Calvert County, and it is the only nuclear power plant in Maryland. Peach Bottom Atomic Power Station (PBAPS) is located on the western shore of Conowingo Pond in York County, Pennsylvania. The two power plants are owned and operated by Constellation Energy Generation LLC.

Figure 2 Nuclear Power Plants Nearest to Maryland



Monitoring Programs and Results

The releases to the environment (directly to air and water) from normal operations at CCNPP and PBAPS contain very small amounts of radioactive material. Aqueous discharges may contain varying concentrations of radionuclides that can be accumulated in the tissues of plants and animals, and the animals that consume them, or become trapped in bottom sediments. The components of the discharges are thus environmentally significant, and may include iodine or metals such as cobalt, cesium, zinc, nickel, and manganese. Over time, these radionuclides may potentially contribute to a radiation dose to humans by transport through the food chain.[2] Releases of environmentally significant radionuclides have declined over the past two decades due to improvements in coolant water filtration technology at the nuclear power plants.

Monitoring conducted by PPRP meets Maryland's requirements to research the environmental effects of electric power generation, maintain oversight of environmental monitoring, and satisfy NRC requirements to verify the extent to which any releases from normal plant operations might result in potential doses to humans. Biennial reports published by PPRP document results of monitoring of radionuclide levels in the environment. See CEIR-21, Chapter 5.5 for more details about this topic.

Estuarine (e.g., Chesapeake Bay) and riverine (e.g., Susquehanna River) sediments are useful indicators of environmental radionuclide concentrations because they serve as natural sinks for

[2] McLean, R.I., T.E. Magette, and S. G. Zobel. 1982. Environmental Radionuclide Concentrations in the Vicinity of the Calvert Cliffs Nuclear Power Plant: 1978-1980. PPSP-R-4. Maryland Power Plant Siting Program, Annapolis, MD.

radioactive metals. The environmentally significant radionuclide Cesium-137 (^{137}Cs) was detected in 86 percent of the sediment samples collected near CCNPP and 100 percent of the samples from the area near PBAPS. Very small amounts of ^{137}Cs are released by CCNPP and PBAPS annually; the vast majority of the ^{137}Cs in the environment derives from fallout from nuclear weapons tests conducted during the 1950s and 1960s. No other significant radionuclides released by the power plants were detected in any sediment sample collected during the most recent reporting period.

Chesapeake Bay oysters are also useful indicators of environmental radionuclide concentrations because, as adult oysters, they do not move from their point of attachment, and if they ingest radioactive metals, the material concentrates in their tissues. Test results indicated that oysters collected near CCNPP did not contain detectable levels of the environmentally significant radionuclides during the 2020–2021 reporting period.

Conowingo Pond supports a recreational fishery, and finfish are the primary pathway for PBAPS-related releases of environmentally significant radionuclides to contribute to a human radiation dose through ingestion. Fish can accumulate radioactive metals in their tissues and their guts through exposure to food and water in their environment. During the 2020–2021 monitoring period, one sample of finfish tissue contained a small amount of ^{137}Cs, and the likely source of the metal is fallout from weapons testing, due to its prevalence in the environment. Other environmentally significant radionuclides derived from man-made sources were not detected in the samples.

As part of its assessment program, PPRP uses models to estimate doses of radiation to individuals who consume seafood. Results indicate that estimated radiation doses are well below federally mandated limits. The annual total body dose that originates from industrial releases of radionuclides, and subsequent consumption of seafood and drinking water, is small relative to other modes of dose accumulation. See CEIR-21, Chapter 5.5 for more details about this topic.

Results of analyses of environmental samples collected in the vicinities of CCNPP and PBAPS can be found in the biennial environmental reports described above. Some overall trends are evident in the long-term data, as summarized in the following list:

- Plant-related radionuclides are rarely detected in seafood (i.e., oysters and finfish).
- Plant-related radionuclides are rarely detected in sediments collected near the facilities.
- Although radionuclide concentrations fluctuate seasonally and annually, no long-term accumulation of plant-related radioactivity in local aquatic life and sediments is evident.
- The radioactivity introduced into the environment by CCNPP and PBAPS, when detected, is very small compared with background radioactivity in the environment from natural sources and weapons test fallout.
- Estimated radiation doses to humans associated with atmospheric and aqueous releases of environmentally significant radionuclides are well within regulatory limits.