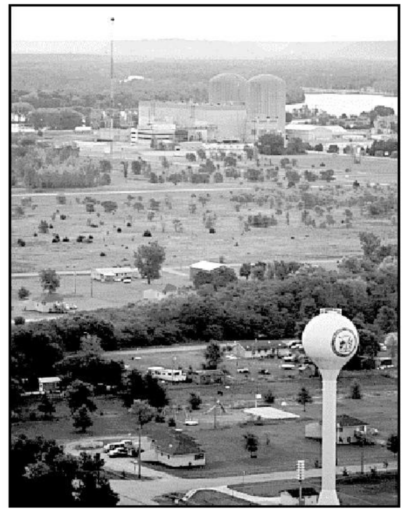
North American Water office

RADIATION & HEALTH IMPACTS

Xcel Energy aka Northern States Power Company (NSP) owns two pressurized water reactors at the Prairie Island Nuclear Power Plant (PI), and a single boiling water reactor at Monticello. All three reactors are operated for Xcel Energy by Nuclear Management Inc., headquartered in Hudson, Wisconsin. PI is located within the city limits of the City of Red Wing, Minnesota, on the Mississippi River about 45 miles southeast of the Twin Cities, and immediately adjacent to the Prairie Island Mdewakanton Dakota Community. The Monticello reactor is located about 45 miles northwest of the Twin Cities, also on the Mississippi River.

Radioactive contaminants from PI and Monticello are released to the air, ground, and the Mississippi River. This results in an elevated risk for radiation exposure and cancer in the surrounding communities. Radiation monitoring and analyses of public health records are not sufficient to accurately asses public health impacts of exposure to radiation routinely released by PI and Monticello.



Xcel Energy's Prairie Island Nuclear Reactors & Nuclear Dump are 700 meters away from the Prairie Island Mdewakanton Dakota Community Center and day care.

Inside features

What is radiation?

Atoms are a basic unit of all matter. They have a nucleus, or core, consisting of protons, which have a positive electrical charge, and neutrons, which have no electrical charge. Surrounding the nucleus is a "shell" of one or more electrons, which are negatively charged. The proton, neutron and electron components of the atoms of most elements are in a balanced (stable) relationship with one another. The components of radioactive elements are not. Nuclear and atomic radiation are waves of energy or tiny particles emitted by an unstable atom as it "seeks" a stable form. Even though we cannot see it, taste it, smell it or feel it, radiation is around us all the time.

Everything around us - including the cells of our bodies - has electric and magnetic fields that can produce radiation. Energy from the sun, radioactivity from the Earth and cosmic rays from outer space are three major sources of naturally occurring radiation in our environment. Various electrical devices in the home, workplace and community produce radiation and electromagnetic fields. Doctors use manmade radiation for diagnosis and to treat cancer. Radioactive drugs help diagnose and treat certain diseases. Light waves, radio waves, and microwaves are types of radiation that have much less energy than nuclear radiation, and don't affect matter the same way.

However, large exposures to radiation and exposure to slightly elevated radiation levels for extended periods of time are harmful or even fatal.

What are radioactive isotopes?

An atom of a particular element has a unique number of protons in its nucleus. The number of protons determines the kind of element. For each unique number of protons there can be different numbers of neutrons in the nucleus. Each combination of neutrons and an element's unique number of protons is called an "isotope" of that element.

Most isotopes found in nature are stable (not radioactive). When an atom has an unstable combination of neutrons and protons, the atom will decay in an effort to become stable. The unstable atoms are called "radioisotopes" and the atom is said to be radioactive.

Uranium, radium, and radon are some of the natural radioactive elements. They are found in rocks and soil and in many minerals. The level of natural radioactivity in the ground differs from place to place.

Different Sources of Radiation

The sun is a great nuclear furnace. It makes most of the cosmic radiation that strikes the earth's atmosphere. The atmosphere stops most cosmic rays. People who live at high elevations or crews of jet airplanes have less atmosphere above them, so they get more cosmic-ray radiation than other people. But everyone is exposed to "background radiation" from cosmic rays and from natural radioactive elements in the soil.

People are also exposed to man-made radiation. There are routine exposures from medical and dental use of x-rays and gamma rays. These are equal on average to about one-fourth of the natural background.

We can make uranium atoms split apart (fission) to generate large amounts of energy. Fission produces huge numbers of radioactive isotopes ("fission products") and neutrons. Stable atoms and neutrons can combine to produce radioactive isotopes.

Most fission products give off beta particles and gamma rays. Beta particles are high energy electrons. Gamma rays are waves of high energy. Some radioactive atoms give off alpha particles. Alpha particles are high energy particles made up of two protons and two neutrons. They are thousands of times heavier than beta particles.

Ionizing and Non-Ionizing Radiation

Ionizing radiations are either waves or particles with sufficient energy to knock electrons out of atoms or molecules in matter. This disruption is termed "ionization". When ionizing radiation knocks an electron out of an atom, the atom is left with a positive charge, and the free electron is negatively charged. These two are referred to as an "ion pair". *Ion pairs* are chemically active and will react with neighboring atoms or molecules. The resulting chemical reactions are responsible for causing changes or damage to matter, including living tissue.

Infrared radiation, microwaves and radio waves emitted by electrical devices are examples of non-ionizing radiation. Because they are too low in frequency to cause ionization, these waves were widely believed to be harmless. Recently, however, some studies have suggested that magnetic fields from non-ionizing radiation (particularly extremely low frequencies from powerlines, for example) may interfere with the functioning of human cells.

Internal and External Exposure

Any activity involving nuclear radiation or radioactive materials creates a potential for innocent victims to be exposed, or become externally or internally contaminated with radioactive material.

External exposure is simply being exposed to radiation from a source outside the body. Gamma rays can penetrate into or through the body. Beta particles can penetrate through the skin. Alpha particles cannot penetrate even the skin's outer layer. Except for the eye, alpha particles are harmless from outside the body. Three factors are used to control external exposure of persons:

- Time: limit time in the exposure field as much as possible,
- Distance: Stay as far away from the source as practical, and
- Shielding: Keep as much mass as practicable between the person and the source.

A person with internal exposure has in some way introduced radioactive material into his/her body, through inhalation, ingestion, or entry through a cut or opening in the body. Internal alpha, beta or gamma exposure can be extremely harmful or fatal.

NORTH
AMERICAN
WATER
OFFICE
PO BOX 174
LAKE ELMO, MN
55042
651-770-3861
www.nawo.org
gwillc@nawo.org

Low and High Radiation Dose

"Dose" refers to the amount of radionuclides taken in by humans during the course of a real or hypothetical exposure. The effects of a radiation dose are either prompt or delayed. Prompt effects occur within the first several months after exposure. Delayed effects occur over many years. The delayed effects may include cancer or other diseases in exposed persons, and genetic illness in their descendants.

Some scientists believe that injury due to ionizing radiation begins at a threshold, that is, no radiation injury occurs with exposure below a certain threshold. More recently, scientists found evidence that any exposure to ionizing radiation may cause some degree of radiation injury that may or may not be expressed clinically, depending on several factors. There is now scientific evidence that low-dose radiation is more harmful per dose-unit (called rem) than high doses of radiation because low-dose ion pairs remain electrically charged and chemically active much longer than high-dose ion pairs. High-dose exposure causes electrically charged ion pairs to be packed more closely together, so opposite charges are more likely to find each other sooner, and get neutralized.

A Radiation Dose Perspective

To understand exposure, exposure rate, dose and dose rate, it is necessary to identify the units of radiation measurement. The units for measuring dose to ionizing radiation are the "rad" and the "rem". The rad is the absorbed dose of radiation, defined by the amount of energy deposited in tissue by radiation. The rem relates dose to biological effects of the dose, irrespective of the type of radiation. The rem makes it possible to compare radiation dosages even though the same amount of radiation will cause differing amounts of damage depending on the type of tissue being exposed. One millirem equals one-thousandth of a rem. A person on a one-way flight from New York to Los Angeles absorbs a 2.5 millirem dose from cosmic radiation; s/he also absorbs 10 millirem following one chest x ray using modern equipment. In general, an average yearly dose of 80 millirem is determined for people in the U.S. who have been exposed to artificial sources. Medical and dental uses make up the majority of this exposure. Some also comes from past bomb tests, airport security x-ray machines, and nuclear and coal fired power plants. Radiological health physicists and governmental health professionals determine the dose of ionizing radiation humans are allowed to receive.

The following doses are provided to illustrate some guiding levels of radiation exposure:

- **25 millirem**: Yearly exposure limit set by the U.S. Environmental Protection Agency (EPA) for people who live near nuclear plants. The real average yearly exposure from such plants is less than one millirem.

- **100 millirem**: Yearly limit from all sources of man-made radiation (except medical and dental).

The International Commission on Radiological Protection set this limit for a non- radiation worker.

- **1-5 rem**: Under the EPA's "Protective Action Guidelines", public officials should take emergency action when the dose to a member of the public from a nuclear accident is likely to reach this range.

- **5 rem**: Yearly limit for nuclear workers set by the U.S. Nuclear Regulatory Commission.

- **25 rem**: EPA guideline for voluntary maximum dose to emergency workers for nonlifesaving work during a reactor emergency. This exposure is assumed to be a once-in-a lifetime event.

- **75 rem**: EPA guideline for the maximum dose to emergency workers volunteering for lifesaving work.