FACT SHEET

Beneficial Uses of Radiation

November 2008

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Key Facts

■ Modern society uses ionizing radiation, a form of energy abundant in nature, to provide hundreds of beneficial uses. Radioisotopes are both naturally occurring and man-made. They are used safely for medical diagnosis and treatment, in common household products such as television sets and smoke alarms, to produce electricity, and in basic scientific research, manufacturing, minerals exploration, and agriculture.

■ America's digital economy and high standard of living would not be possible without radioactive materials. These materials make processes better, easier, quicker and cheaper. In some cases, no alternatives to radioactive materials exist.

■ The U.S. Nuclear Regulatory Commission, together with state regulatory agencies, controls the use and handling of man-made radiation.

■ Radioactive materials also provide substantial economic benefits. Worldwide, nuclear applications in industry alone —including measurement gauges, smoke detectors and sterilization of medical supplies—account for more than $40 billion each year.

Benefits of Man-Made Radiation

In the 20th century, mankind learned to use radiation to improve the quality of life. The development of nuclear technology is one of the most significant achievements of the 20th century, according to the National Academy of Engineering. Today, people use nuclear technology in nearly every field and aspect of life—from medicine to manufacturing and construction, to powering common household items, to producing electricity for one of every five U.S. homes and businesses.

Here are some of the many ways radiation benefits us all:

Medicine. According to the Society of Nuclear Medicine, 5,000 nuclear medicine centers in the United States perform nearly 18 million nuclear medicine procedures each year. These procedures prolong and improve the quality of people's lives. Radioisotopes also are used in 100 million laboratory tests on body fluid and tissue specimens. Today, approximately 500,000 cancer patients in the United States receive radiation treatment at some point in their therapy. Radioisotopes and X-rays aid physicians in diagnosing and treating scores of other diseases.

Nuclear medicine can evaluate the functional performance of various organs. It can do that because different organs use different specific elements more than others. For example, the thyroid uses iodine, bones take up phosphorus and muscles use a lot of potassium.

In nuclear medicine, tiny amounts of a radioactive form of these elements are introduced into a patient's body. The "radioisotopes" are picked up by specific organs, enabling a special camera to take a picture of how that organ is functioning in striking detail. For example:

- Myocardial perfusion imaging maps blood flow to the heart, allowing physicians to see whether a patient has heart disease and to determine the most effective course of treatment.
- Bone scans can detect the spread of cancer six to 18 months earlier than X-rays.
- Kidney scans are much more sensitive than X-rays or ultrasounds in fully evaluating kidney function.
- Imaging with radioactive technetium-99m can help diagnose bone infections at the earliest possible stage.

- Laboratory techniques using radioactivity can detect underactive thyroids in newborn babies, making prompt treatment possible and saving many children from mental retardation.

In higher doses, radioisotopes also help treat disease. When former President George H.W. Bush and Mrs. Bush suffered from Graves' disease, a thyroid condition, they were cured by drinking a form of radioactive iodine that concentrates naturally in the thyroid and destroys the diseased portion. This treatment is so successful that it virtually has replaced thyroid surgery.

Radioactive iodine's widespread use in therapy for thyroid cancer results in a lower recurrence rate than drug therapy and voids potentially fatal side effects, such as the destruction of bone marrow.

Sealed sources of radiation placed inside the body, or radiation directed from sources externally, are effective in treating various cancers, including prostate tumors.

Hospitals also use radiation to sterilize materials, thereby helping prevent the spread of diseases without making the materials radioactive. Because of its penetrating power, radiation is particularly suitable for sterilizing such supplies as sutures, syringes, catheters and hospital clothing, since these supplies are packed in hermetically sealed packages prior to sterilization. Heat cannot sterilize these materials because it would destroy them.

Energy. Nuclear power plants generate 20 percent of the United States' electricity and 17 percent of the world's electricity. In producing one-fifth of America's electricity, U.S. nuclear plants cut emissions of carbon dioxide, the principal greenhouse gas, by 692.7 million metric tons in 2007.

Scientific Research. Radioactive materials are integral to research in nearly all fields of modern science. The U.S. Food and Drug Administration requires all new drugs to be tested for safety and effectiveness. More than 80 percent of these drugs are tested with radioactive materials.

Radioactive materials also are essential to biomedical research that seeks causes and cures for diseases such as AIDS, cancer and Alzheimer's disease.

Radioisotopes are used extensively in metabolic studies, genetic engineering and environmental protection studies.

Carbon-14, a naturally occurring, long-lived radioactive substance, allows archaeologists to determine when artifacts containing plant or animal material were alive, created or used. For example, carbon-14 dating showed that the Shroud of Turin did not belong to the period when Jesus Christ was alive.

Museums rely on radioactive materials to verify the authenticity of paintings and art objects.

Criminology also makes use of radiation, where investigators use neutron activation analysis in chemical analyses. These investigators use radiation to examine physical evidence and to link suspects to crimes. For example, using radiation, they can detect the toxic element arsenic in a single strand of hair.

Agriculture and Food Products. More than 50 countries have approved the use of radiation to help preserve nearly 40 different varieties of food, though not all have yet approved the sale of irradiated food on the open market.

The process exposes food to high doses of radiation from cobalt-60. This process kills bacteria, insects and parasites, while the food itself remains safe without becoming radioactive. In the United States, the federal government has approved the use of irradiation for fruits, vegetables, pork, poultry, red meat and spices. The first major U.S. plant to use the process opened in 1992 near Tampa, Fla., to process fruits, vegetables and poultry.

Other food processors have been slow to adopt the technique because of concerns about consumer acceptance, even though astronauts regularly eat irradiated foods on space missions. In May 2003, the U.S. Department of Agriculture cleared the way for irradiated ground beef to be available to schools through the National

School Lunch program. More recently, in August 2008, the U.S. Food and Drug Administration authorized the use of irradiation for fresh spinach and iceberg lettuce.

In agriculture, radiation helps breed new seed varieties with higher yields, such as the "miracle" rice that has greatly expanded rice production in Asia. By the end of the 1980s, radiation had eradicated approximately 10 species of pest insects in wide areas, preventing agricultural catastrophes. These include the Mediterranean fruit fly in Japan and Mexico, the tsetse fly in Africa and the screwworm fly in North Africa, the United States and Mexico.

In this process, which is known as the sterile insect technique, gamma radiation sterilizes millions of male insects so they are unable to mate productively. Once they are released into fields to mate with female insects, they produce no offspring, thereby breaking the cycle of infestation.

Radiation also has been used to:

- develop hundreds of varieties of hardier, more disease-resistant crops—including peanuts, tomatoes, onions, rice, soybeans and barley—in agricultural research laboratories
- improve the nutritional value of some crops, as well as improve their baking or melting qualities or reduce their cooking time
- pinpoint where illnesses strike animals, allowing the breeding of disease-resistant livestock
- show how plants absorb fertilizer, helping researchers learn when to apply fertilizer and how much to use. This prevents overuse, thus reducing a major source of soil and water pollution.

Space Exploration. Radioisotope thermoelectric generators (RTG) provide power for unmanned spacecrafts. RTGs use the natural decay of plutonium to produce heat. The RTGs convert that heat into electrical power through thermoelectric devices. A typical modern RTG produces about 300 watts and will operate unattended for many years. RTGs have powered 24 U.S. space missions, with an outstanding safety record. These include the Apollo Lunar Surface Experimental Packages, the Pioneer 10 and 11 spacecrafts launched in 1972 and 1973, two Viking Mars spacecrafts (1978), two Voyager spacecrafts (1977), and the Galileo (1989), Ulysses (1990), Cassini (1997), and New Horizons (2006) spacecrafts.

Powering the U.S. Navy Fleet. Nuclear reactors power both surface ships and submarines. The U.S. Navy has built more than 200 nuclear-powered ships and has steamed more than 100 million miles on nuclear energy. The Navy currently operates 72 nuclear-powered submarines and 11 nuclear-powered aircraft carriers. Speed, endurance, mobility, stealth and payload are afforded by nuclear power. The modern U.S. submarine, for example, can cruise more than 1 million miles, or more than 30 years, without refueling. Modern nuclear-powered aircraft carriers can operate continuously at high speeds for extended periods without the need for support ships.

Industry, Manufacturing, Engineering. Today, practically every industry uses radioactive materials. Manufacturers use radioisotopes to improve the quality of goods in thousands of industrial plants throughout the world. Because radiation loses intensity as it passes through substances, industry has been able to develop highly sensitive gauges to measure the thickness and density of many materials, as well as imaging devices to inspect finished goods for weaknesses and flaws.

Small amounts of radioactive substances commonly are used as tracers in process materials. They make it possible to track leakage from piping systems, monitor the rate of engine wear and corrosion of processing equipment, observe the velocity of materials through pipes, and gauge the efficiency of filtration systems.

Manufacturers also use radiation to "cold sterilize" plastics, pharmaceuticals, cosmetics and other products that are too heat-sensitive to be sterilized in other ways.

Radiation detection instruments make it possible to take measurements without direct physical contact with the substance being measured. For example, level gauges containing radioactive sources work well as measuring devices where heat, pressure or corrosive substances, such as molten glass or metal, make it difficult or impossible to use direct contact gauges.

Other industries and processes that use radioactive materials include:

- the automobile industry, to test the quality of steel in vehicles
- aircraft manufacturers, to check for flaws in jet engines
- mining and petroleum companies, to locate and quantify oil, natural gas and mineral deposits
- manufacturers, to obtain the proper thickness of tin and aluminum
- pipeline companies, to look for defects in welds
- oil, gas and mining companies, to map geological contours using test wells and mine bores, and to determine the presence of hydrocarbons
- construction crews, to gauge the density of road surfaces and subsurfaces.

Consumer Products and Services. Radioactive materials supply necessities and conveniences that virtually everyone depends on, including:

- Many smoke detectors—installed in nearly 90 percent of U.S. homes—rely on a tiny radioactive source to sound an alarm when smoke is present.
- Computer disks “remember” data better when treated with radioactive materials.
- Nonstick pans treated with radiation ensures that the coating will stick to the surface.
- Photocopiers use small amounts of radiation to eliminate static and prevent paper from sticking together and jamming the machine.
- Cosmetics, hair products and contact lens solutions are sterilized with radiation to remove irritants and allergens.
- Medical bandages and a variety of personal health and hygiene products are sterilized with radiation.

Economic Benefits. According to the International Atomic Energy Agency (IAEA), in 2003, nuclear applications in industry accounted for more than $40 billion worldwide. In food and agriculture, the economic benefit surpassed $22 billion.

In the United States, the market for medical radioisotopes and radiopharmaceuticals exceeded $1 billion. IAEA estimates the annual costs of all nuclear medical procedures to be between $8 billion and $10 billion.

This fact sheet also is available at www.nei.org.