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## Transporting Radioactive Materials

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### Key Facts

■ Of almost 400 million packages of hazardous material shipped each year in the United States, radioactive materials account for less than 1 percent. Of these 3 million packages, the vast majority are shipments of radiopharmaceuticals and radioisotopes used in medical applications.

■ Other shipments include low- and high-level radioactive waste, uranium in various forms, and fuel for nuclear power plants. About 250,000 packages per year contain radioactive materials that are byproducts of electricity generation by nuclear power plants.

■ Transported radioactive materials include radiographic devices; radiopharmaceuticals; smoke detectors; luminous dials and indicators; waste from industrial, medical and electricity-generating facilities contaminated with low levels of radioactivity; and new and used nuclear fuel.

■ The U.S. Department of Transportation and the Nuclear Regulatory Commission strictly regulate the safety and security of radioactive material shipments. DOT and the NRC also are responsible for ensuring

that U.S. regulations are compatible with International Atomic Energy Agency (IAEA) protocols for international shipments of radioactive materials.

■ The nuclear industry has safely transported more than 45 million packages of radioactive materials. Strict packaging and handling requirements help ensure the industry will maintain its excellent safety record.

### Types of Radioactive Materials Vary

Most of the 3 million radioactive shipments made each year are for medical and industrial applications.

The radioactive waste that is transported—including plastic gloves and other protective clothing for workers, machine parts and tools, test tubes, syringes, filters and residues—comes from medical centers, manufacturing companies, universities, nuclear power plants and other licensed users of nuclear materials.

Nuclear power plants produce almost half of all low-level radioactive waste. This waste—making up only 0.25 percent of all shipped hazardous material—is transported to one of the nation's three licensed low-

level radioactive waste disposal sites.

Nuclear power plants produce about 2,000 tons of used reactor fuel each year. In comparison, industry produces 200 million tons of chemical waste annually. Of almost 400 million packages of hazardous material shipped in the United States, fewer than 100 contain high-level radioactive waste. Currently, almost all used nuclear fuel is stored on site at the nation's nuclear power plants.

### Strict, Comprehensive Regulation of Shipments

Two federal agencies—DOT and the NRC—have established strict requirements for packaging and shipping radioactive material. These requirements are based on the volume, nature and radioactivity of the material.

DOT regulates packaging, labeling, shipping papers, personnel training, loading and unloading, handling and storage. It also regulates transportation routing and vehicle requirements. The NRC regulates packaging safety to protect workers and the public. It also establishes regulations for protection against diversion of radioactive materials while in transport and regulates the use of radioactive materials,

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including the licensing and regulation of all shippers and carriers.

The three package categories are:

- Industrial packages for slightly radioactive materials. Transporters use such containers for most low-level radioactive waste.
- Type A packages for materials that are more radioactive. Generally designed to protect their radioactive contents under a variety of normal transportation conditions, these packages must meet testing requirements—including water spray, drop, compression, penetration and vibration tests.
- Type B packages for materials with the highest levels of radioactivity—such as used nuclear fuel. Designed under the assumption that accidents happen, these packages provide radioactive protection and nuclear safety under very severe accident conditions. These packages must survive simulated accident conditions—water immersion, a 30-foot drop onto an unyielding surface, severe penetration and extreme heat—and also must prevent a nuclear reaction during normal and accident conditions.

The design, testing, licensing and building of a Type B package takes three to five years to complete and costs more than \$1 million. Type B packages

must be recertified every five years to remain in use.

Materials used in Type A and B packages include steel and aluminum. For Type B packages, which require radiation shielding, shippers primarily use lead or depleted uranium, but they also may use other materials.

Shippers may transport low-level radioactive waste in industrial packages, or Type A or B packages, depending on the waste's radioactive concentration and other physical factors. Used nuclear fuel requires Type B packages.

Most radiopharmaceuticals travel in Type A packages; however, some higher-level medical products require a Type B package.

Companies ship the various forms of uranium used for the manufacturing of new fuel for nuclear power plants in Type A packages. They also ship new fuel in Type A packages.

Shippers must encase all materials so the radiation level does not exceed 10 millirems per hour at a distance of about 7 feet from the package. At this level, a person who stands that distance from a truck carrying radioactive materials for one hour would receive 10 millirems of radiation. By comparison, the average person receives about 300 millirems a year from natural background radiation from the sun, rocks, building materials and similar sources.

The company shipping the radioactive material must certify that each package presented for shipment meets DOT and NRC requirements. For Type B shipments, the shippers must use packages for which the NRC has issued a certificate of compliance. The NRC grants this certificate based on a demonstration by the package designer that the packaging could safely withstand the accident conditions discussed previously.

DOT regulates Type A packages and all shippers and carriers of radioactive material. The NRC regulates and approves Type B packages to ensure shippers, carriers and the public are protected from radiation.

## **An Unparalleled Safety Record**

Over the years, the nuclear energy industry has transported radioactive materials safely. When accidents have occurred, no one was harmed by the radioactive materials—neither members of the public nor transport workers.

Of the more than 45 million packages of radioactive materials shipped since 1971, about 3,500 were involved in accidents. Of these, only 197 packages containing low-level radioactive materials sustained damage or failed, and in some of these accidents, the packages released a small amount of radioactive material. But in every case, the levels of radioactivity were so low that they presented no hazard to the pub-

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lic or to the workers who cleared the accident scene. When higher levels of radioactivity are involved, this record is even more impressive—no accident has ever breached a used fuel container.

In 1971, a tractor-trailer carrying a 25-ton shipping container filled with used nuclear fuel swerved to avoid a head-on collision and overturned. The trailer, with the container still attached, broke away from the tractor and skidded into a rain-filled ditch. The container suffered minor damage but released no radioactive material.

This accident was the most severe of nine accidents involving the shipment of used fuel transportation containers. Four of the nine occurred during highway transport; the others happened during rail shipment. None caused any release of radioactivity.

Several factors contribute to the nuclear energy industry's excellent safety record, including:

- strict requirements for packaging and handling of radioactive materials
- extensive testing of the shipping package under normal and accident transport conditions
- careful control over the radioactive material being transported
- an established system for dealing with any accident

involving radioactive materials.

Emergency preparedness and planning requirements established by DOT and the NRC for radioactive material packaging ensure that—even in the event of a serious accident—the radioactive contents will cause no public health or environmental problems.

In the event of an accident, the carrier has responsibility for confining the spread of radioactive materials and for any cleanup. State and local government agencies, through their police and fire departments, normally are responsible for protecting people and property at the scene of an accident.

DOT has developed a comprehensive training program on handling emergencies involving radioactive materials shipments.

The Department of Energy operates a Radiological Assistance Program, with eight regional offices staffed by experts who are available for immediate assistance. If necessary, the police will summon these experts to handle the package and remove any radioactive material in the unlikely event that it may have released any.

In addition, the companies that operate nuclear power plants have entered into a voluntary mutual assistance agreement. Under this agreement, the company closest to the scene

of a transportation accident responds on behalf of the one that shipped the radioactive materials, until emergency response personnel from the carrier and the company that owns the radioactive material arrive on the scene.

Following the events of Sept. 11, 2001, the NRC took aggressive steps to strengthen the security of radioactive materials while in transit. The agency has established a graded approach to its security requirements for shipments of radioactive materials, beginning with industrial standards and increasing to the highest levels for any type of shipment.

## **International Protocols Ensure Safety Worldwide**

International transportation regulations are similar to those formulated by DOT and the NRC. The IAEA sets overall transportation directives for countries around the world. The International Maritime Organization and the International Air Transport Association also contribute to ensuring the safe transport of radioactive packages.

The IAEA, a United Nations organization, published its first regulations on the transport of radioactive materials in 1961 and has revised them periodically based on experience and technological advances.

The regulations establish safety standards for all modes of transportation—air, land and water. By 1998, more than 60 U.N. member states, including

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all major shipping and nuclear energy-generating nations, were using IAEA regulations.

The directives cover the design, manufacture, maintenance and repair of packaging; preparation and loading of radioactive materials; in-transit storage; and unloading and receipt of the contents at the final destination.

The objective of the IAEA regulations is to protect the general public and transport workers, as well as property and the environment, from direct or indirect effects of radiation during transport. The rules cover normal transportation and accidents.

*This fact sheet also is available at [www.nei.org](http://www.nei.org), where it is updated periodically.*

*For more information on transporting used nuclear fuel, see NEI's fact sheet: "Experience, Testing Confirm Transportation of Used Nuclear Fuel Is Safe, Reliable."*