



Unit 5: Transportation of Radioactive Materials

Time: One hours

Objectives

A. Teacher:

1. To make students aware of nuclear waste shipments and the protections in place.
2. To help students become more familiar with the Federal agencies involved in waste transportation.
3. To fully educate youngsters on the nuclear waste transportation as a public policy issue.

B. At the conclusion of this unit the student should be able to —

1. Discuss the issues associated with the transportation of radioactive materials.
2. Identify the different type of packages used in transporting radioactive materials.
3. Explain the United Nations classification system for radioactive materials.
4. Explain the role of NRC, DOT, and other agencies involved in the transportation of radioactive materials.

Investigation and Building Background

1. Introduce term:

Students have little knowledge of the many issues and terminology associated with the transportation of radioactive materials.

2. Resources:

1. [Transportation of Radioactive Materials](#) "Nuclear Reactor Concepts" Workshop Manual, U.S. NRC.
2. [Backgrounder on Transportation of Spent Fuel and Radioactive Materials.](#)
3. [Safety of Spent Fuel Transportation \(NUREG/BR-0292\).](#)

3. Experiment:

No experiments or demonstrations are scheduled with this unit.

4. Generalizing:

Regulations to control the transport of radioactive materials have been in place since 1935.. Over the years, the agencies have changed. Today, the Nuclear Regulatory Commission and the Department of Transportation are the primary ones regulating radioactive waste transport in the United States, based on standards set by the International Atomic Energy Agency (IAEA).



Questions

1. What three things are involved in transportation of spent fuel assemblies?
2. What are the tests required for transport packages for the most hazardous radioactive materials?
3. Name the primary organizations that develop rules governing transport of radioactive materials.
4. How is radioactive material defined for transportation purposes?
5. What are the three basic types of packages used to transport radioactive materials?
6. Why are labels and markings used on packages containing radioactive materials?

References

The Harnessed Atom, Teacher's Edition, U.S. Department of Energy.

Lesson Plan

Greeting...

Every day, the lives of hundreds of millions of Americans are improved by the energy of the atom. Serious diseases are diagnosed and treated. Products from airplanes and bridges to soft drinks and aerosol cans are tested for safety and quality.

To provide these benefits, radioactive materials must be shipped from one location to another. Shipments of radioactive materials have been made with an excellent record of public safety — because of the care taken by the companies involved and the government agencies that regulate them.

The Department of Transportation and the Nuclear Regulatory Commission are the primary agencies issuing regulations based on the standards developed by the International Atomic Energy Agency.

The Nuclear Regulatory Commission and the Department of Transportation share responsibility for the control of radioactive material transport. Department of Transportation regulations are detailed and cover all aspects of transportation, including packaging, shipper and carrier responsibilities, documentation, and all levels of radioactive material from exempt quantities to very high levels.

NRC regulations are primarily concerned with special packaging requirements for larger concentrations of radioactivity.

For transportation purposes, radioactive material is defined as any material which has a specific activity greater than 0.002 [microcurie](#) per gram. This definition does not specify a quantity, only a concentration. **[Show [Radioactive Symbol](#).]**

Recognizing that transport accidents can happen even under the strictest safety requirements, the regulations are designed to insure safety in routine handling situations and to insure packages for the most hazardous radioactive materials will remain intact under severe accident conditions.

These goals are accomplished by focusing on the package and its ability to

- contain the material (prevent leaks)
- prevent unusual occurrences (such as [criticality](#))
- reduce external radiation to safe levels (provide shielding)



Today, we're going to talk about the shipment of used (spent) fuel. When shipping used fuel from nuclear power plants, special care is taken to prevent any release of radioactivity to the environment even under the worst imaginable accident conditions.

Spent fuel is shipped in heavy casks that weigh from 20 to 100 tons. Different casks are used for different modes of transport (truck, barge, train), but all must pass a series of severe tests in succession:

- being dropped from 30 feet onto reinforced concrete
- being dropped from 40 inches onto a steel spike
- being burned in a hot fire for 30 minutes
- submersion in water for eight hours

These tests are designed to mimic the forces a transport package would endure if it collided with an immovable object, then fell onto a spike, then burned in a gasoline fire, then fell into a body of water. They are carefully monitored and measured with high-speed cameras. The tests help engineers and scientists better understand how these containers would respond to conditions that simulate an accident. The results can help them revise their designs, if needed, and demonstrate to the NRC that their packages meet safety regulations.

To provide confidence that meeting the regulatory requirements means a package will perform safely in a real accident, spent fuel casks have been tested under real and possibly extreme accident conditions. For example, in one test a truck carrying a cask crashed into an unyielding cement wall at 85 miles per hour and in another test a cask was broadsided at 100 miles per hour by a 140-ton locomotive pulling three railcars. In both instances, the casks were not damaged enough to leak any radioactive waste.

Let's take a close look at how the spent fuel is prepared for shipment. First, the spent fuel assembly from the reactor is placed inside its cask and the cask is sealed. Second, the outside of the cask is cleaned and then measured for radioactivity. Third, the cask is loaded onto the truck or train car that will carry it.

However, before shipping can begin the cask must be inspected a second time to make sure that it is properly installed on the vehicle. Finally, the spent fuel cask and the vehicle carrying it must both be labeled.

In addition to all the requirements that casks must meet to be shipped by truck, the truck driver must be trained in the hazards of radioactive materials, transportation regulations, and emergency procedures. The route the truck will take is also given careful consideration to avoid large cities and undesirable road conditions. And special security requirements ensure the cargo will be adequately protected along the entire route.

No matter what type of radioactive material is being shipped, how it is packaged is the most important consideration. The three basic types of packages are strong tight containers (STCs), Type A containers, and Type B containers. While the characteristics of STCs are not specified by regulation, types A and B have very specific requirements listed in the Department of Transportation regulations.

An STC is designed to survive normal transportation handling. In essence, if the contained material makes it from point A to point B without being released, the package is classified as being a strong tight container.

A Type A container, on the other hand, is designed to survive normal transportation handling and minor accidents. Type B containers must be able to survive severe accidents.

Fissile materials (spent fuel) that could be involved in a criticality accident also have additional packaging requirements.



Markings on packages, labeling, and placarding on transportation vehicles are also important aspects of the transport of radioactive materials. Markings are designed to describe the contents of a package by using standard terms and codes. **[Show "[Markings](#)"]**

Labels are used to visually indicate the type and level of hazard contained in a package. Labels rely principally on symbols to indicate the hazard. **[Show "[Labeling](#)"]** Although the package required for transporting radioactive material is based on the activity **INSIDE** the package, the label required on the package is based on the radiation hazard **OUTSIDE** the package.

Radioactive material is the only hazardous material that has three possible labels, depending on the relative radiation levels on the outside of the package. Also, labels for radioactive material are the only ones that require the shipper to write some information on the label. The information is a number called the Transport Index (TI), which is essentially the highest radiation level at one meter from the surface of the package.

The three labels are commonly called White I, Yellow II, and Yellow III, referring to the color of the label and the roman numeral prominently displayed. A specific label is required if the surface radiation limit and the limit at one meter satisfy the requirements shown on the "[Labeling](#)" transparency.

Placards are just bigger labels that are placed on the outside of the vehicle. Unlike labels, there is only one placard and no information need be written on it. **[Show "[Placarding](#)"]** Placards on a vehicle are only required if the vehicle is carrying a package bearing a Yellow III label or low specific radioactive material.

The outstanding safety record of storing and shipping used fuel is no accident. It is the result of a philosophy that places public safety and environmental protection first, and a practice of controlled handling and packaging of the used fuel so that it cannot harm the workers, the public or the environment.



Answers to Questions from Transportation of Radioactive Materials Unit Outline:

1. Q: What three things are involved in transportation of spent fuel assemblies?

- A: a. a series of tests to make sure the casks that will be used really work
b. careful loading and inspection for proper installation of the spent fuel cask
c. training of the truck driver on the hazards of radioactive materials, transportation regulations, and emergency procedures.

2. Q: What are the tests required for transport packages for the most hazardous radioactive materials?

- A: a. 30-meter drop onto an unyielding surface
b. 40-inch drop onto a steel spike
c. a 30-minute hot fire
d. submersion in water for eight hours

3. Q: Name the primary organizations that develop rules governing transport of radioactive materials.

- A: a. The International Atomic Energy Agency
b. Department of Transportation (DOT)
c. Nuclear Regulatory Commission (NRC)

4. Q: How is radioactive material defined for transportation purposes?

- A: It is defined as any material which has a specific activity greater than 0.002 microcuries per gram. This definition does not specify a quantity, only a concentration.

5. Q: What are the three basic types of packages used to transport radioactive materials?

- A: a. Strong tight containers (designed to survive normal transportation handling)
b. Type A containers (designed to survive normal transportation handling and minor accidents)
c. Type B containers (able to survive severe accidents)

6. Q: Why are labels and markings used on packages containing radioactive materials?

- A: Labels are used to visually indicate the type and the level of hazard contained in the package. Markings are designed to provide an explanation of the contents of a package by using standard terms and codes.