Unit 5: Transportation of Radioactive Materials

Objectives

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

At the conclusion of this unit the student should be able to --

Discuss the issues associated with the transportation of radioactive materials.
Identify the different type of packages used in transporting radioactive materials.
Explain the United Nations classification system for radioactive materials.
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:

Transportation of Radioactive Materials "Nuclear Reactor Concepts" Workshop Manual, U.S. NRC.
Backgrounder on Transportation of Spent Fuel and Radioactive Materials.
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 were started in 1935 by the U.S. Postal Service. Over the years, the Interstate Commerce Commission (ICC), now the Surface Transportation Board, became involved. There are at least five groups developing rules governing the transport of radioactive materials. These include the Nuclear Regulatory Commission, the Department of Transportation, the Postal Service, the Department of Energy, and the States. Of these agencies, the DOT and NRC are the primary ones issuing regulations based on standards set by the International Atomic Energy Agency (IAEA).

Questions

What is the problem with nuclear power plant waste?
What three things are involved in transportation of spent fuel assemblies?
Does the largest percentage of low-level radioactive waste in the U.S. come from nuclear power plants? Where does it come from?
In a test, the contents of a spent fuel cask must remain intact when hit by a train engine traveling at what speed?
What international organization assigns classifications to all hazardous materials?
Name five organizations which develop rules governing transport of radioactive materials.
How is radioactive material defined for transportation purposes?
What are the three basic types of packages used to transport radioactive materials?
Why are labels and markings used on packages containing radioactive materials?
What is a carrier? How many classes of carriers are there? What are their names?

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 which regulate them.

Regulations to control the transport of radioactive material were initiated by the Postal Service in 1935. Over the years, the Interstate Commerce Commission (ICC), now the Surface Transportation Board, became involved. Today, there are at least five groups that make rules governing the transport of radioactive material.

These groups are the Department of Transportation (DOT), the Nuclear Regulatory Commission (NRC), the Postal Service, the Department of Energy (DOE), and the States. Of these agencies, the Department of Transportation and the Nuclear Regulatory Commission are the primary ones 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, however, are primarily concerned with special packaging requirements for higher level quantities.

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.]

Since transport accidents cannot be prevented, the regulations are primarily designed to insure safety in routine handling situations for minimally hazardous material and insure integrity under all circumstances for highly dangerous materials.

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 high-level waste, namely 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 carriers (truck, barge, train), but all must pass a series of severe tests, such as

- a collision with an immovable object (like being dropped from 30 feet onto reinforced concrete)
- being dropped from 40 inches onto a steel spike
- being burned in a hot (gasoline) fire for 30 minutes
- submersion in water for eight hours

These tests are carefully monitored and measured with high-speed cameras. This helps engineers and scientists study these containers under conditions that simulate an accident.

To make doubly sure that nothing can go wrong, 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 railroad cars. In both instances, the casks did not 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 or surveyed 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 carrying the cask takes is also given careful consideration to avoid large cities and undesirable road conditions.

Whether high- or low-level wastes are being shipped, how they are 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 provide an explanation of the contents of a package by using standard terms and codes. [Show "Markings"]

Markings are designed to provide an explanation of the contents of a package by using standard terms and codes.

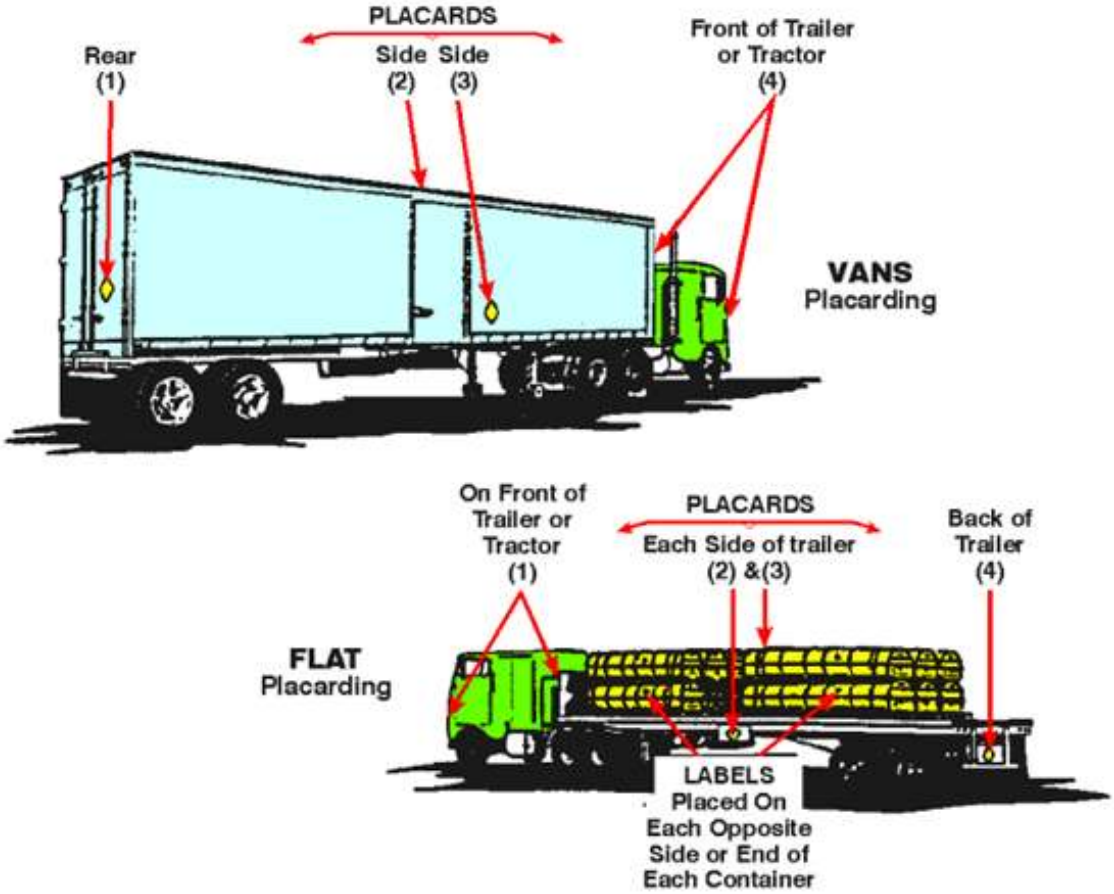
Labels are used to visually indicate the type of hazard and the level of hazard contained in a package. Labels rely principally on symbols to indicate the hazard. [Show "Labeling"]

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 which has three possible labels, depending on the relative radiation levels external to the package. Also, labels for radioactive material are the only ones which require the shipper to write some information on the label. The information is a number called the Transport Index (TI), which, in reality, is 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 are just bigger labels which are placed on the outside of the vehicle. Unlike labels, there is only one placard and no information need be written on it (i.e. no TI). In fact, a placard on a vehicle is only required if the vehicle is carrying a package bearing a Yellow 3 label or LSA material. If the amount of the material being transported constitutes a highway route controlled quantity, the diamond shaped placard has a black square border surrounding it.

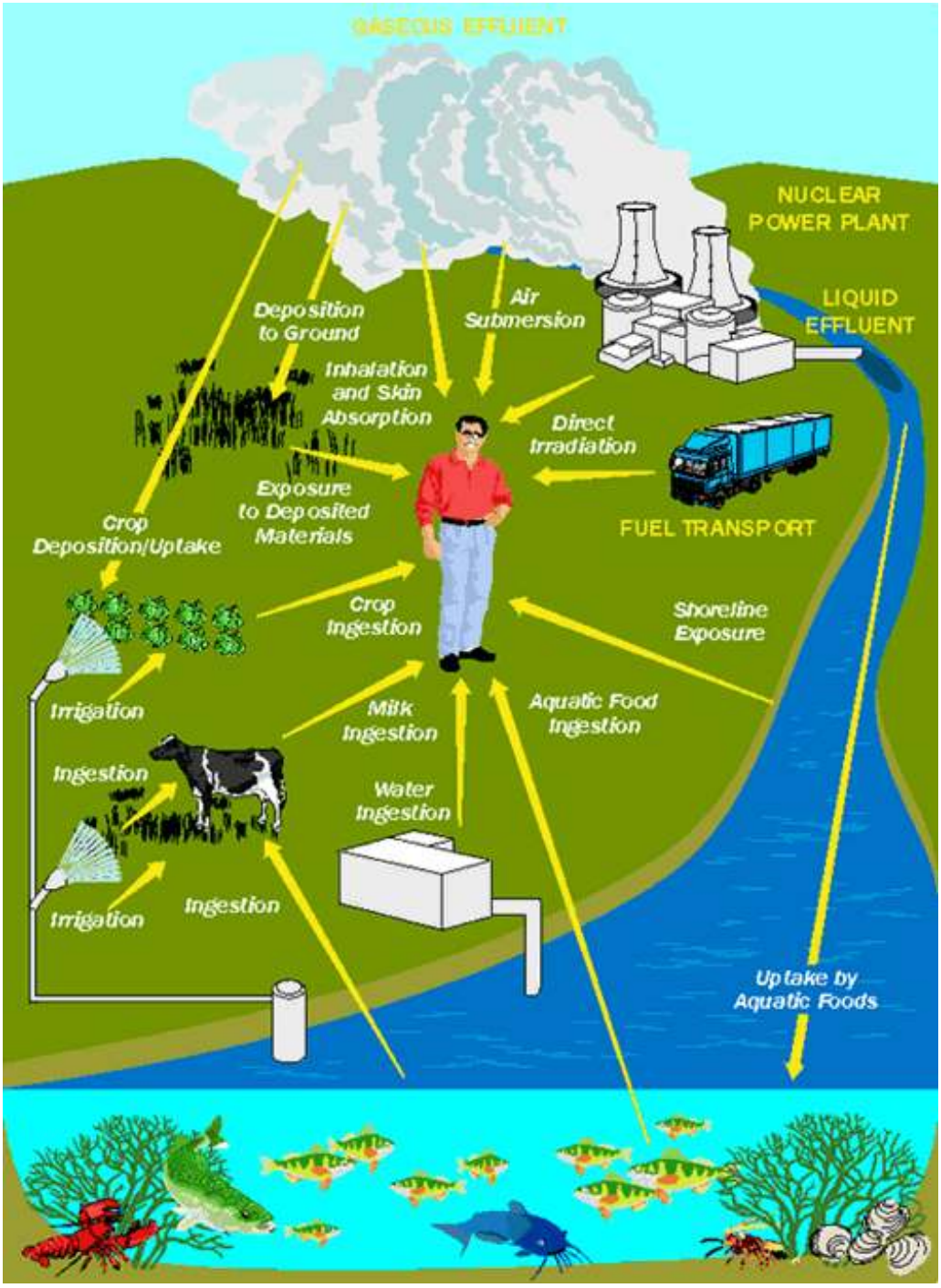
Placards on a vehicle are only required if the vehicle is carrying a package bearing a Yellow III label or is carrying low specific radioactive material.

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 is the problem with nuclear power plant waste?
A: Some of it is radioactive
2. 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.
3. Q: Does the largest percentage of low-level radioactive waste in the U.S. come from nuclear power plants? Where does it come from?
A: No. It comes from hospitals and industry
4. Q: In a test, the contents of a spent fuel cask must remain intact when hit by a train engine traveling at what speed?
A: 80 miles per hour
5. Q: What international organization assigns classifications to all hazardous materials?
A: The United Nations
6. Q: Name five organizations that develop rules governing transport of radioactive materials.
A: a. Department of Transportation (DOT)
b. Nuclear Regulatory Commission (NRC)
c. Postal Service
d. Department of Energy (DOE)
e. The States
7. 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.
8. 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)
9. Q: Why are labels and markings used on packages containing radioactive materials?
A: Labels are used to visually indicate the type of hazard 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.
10. Q: What is a carrier? How many classes of carriers are there? What are their names?
A: Vehicles used to transport radioactive materials. There are three classes: common, contract, and private.

Gaseous Effluent



Gaseous and liquid radioactive waste, after processing, may be released to the environment. This can result in the exposure of general members of the public. The diagram above shows some of the pathways that could result in the exposure of a member of the public.

Liquid releases could be taken in by the aquatic growth, which could then be consumed by an individual. The water could be used to irrigate crops or processed as drinking water. Also, the individual could receive direct exposure from the release if in the vicinity of the water, such as swimming or sunbathing.

Gaseous releases could result in exposures by being inhaled by the individual. Also, if the individual is the in the vicinity of the release, a direct exposure could be the result.

The transport of solid radioactive waste (radwaste) and fuel also contribute to the exposure of the average individual.

The amount of exposure received due to all of these processes is very small when compared to the average yearly dose received. Also, there are limits on the amount of exposure a member of the public can receive from a nuclear power plant.