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ABSTRACT

This brochure contains an engineering activity for upper elementary, middle school, and high school students that examines the transportation of radioactive waste. The activity is designed to inform students about the existence of radioactive waste and its transportation to disposal sites. Students experiment with methods to contain the waste and consider factors such as accidents, leaks, and ease of transport. They create and test a package designed to contain waste and withstand accidents. The outer layer of the "cask" is made from 2-liter soda bottles. An egg simulates the waste. Students design their own internal packaging system. Student and teacher instructions are included. (LZ)

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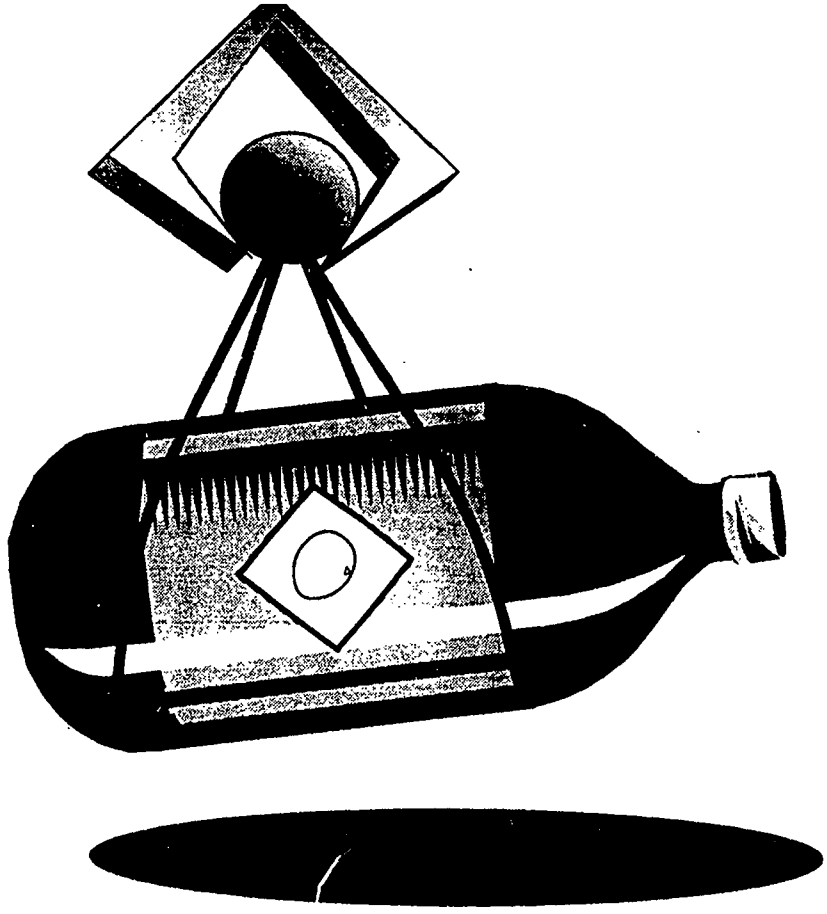
Transporting Radioactive Waste: An Engineering Activity



Grades 5-12

October 1994

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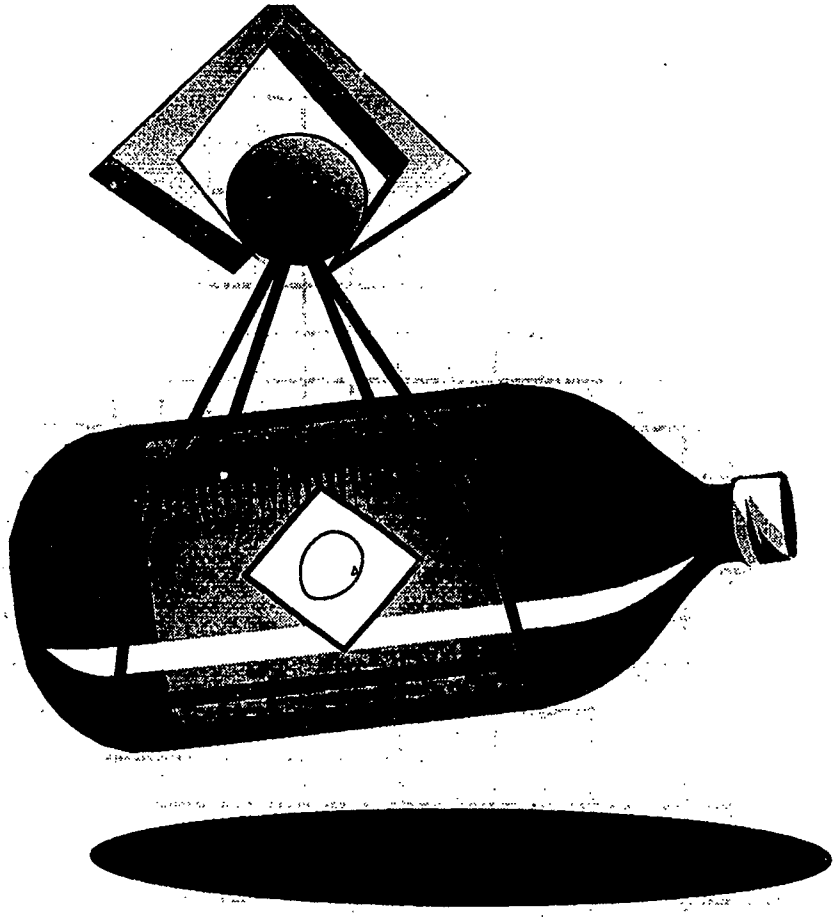

Grades 5-12

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TRANSPORTING RADIOACTIVE WASTE
An Engineering Activity

Grade Level: Upper elementary, middle school, high school

Objective: Students will become informed about the existence of radioactive waste and its transportation to disposal sites.

Students will experiment with methods to contain the waste and consider factors such as accidents, leaks, and ease of transport. Students will test the performance of their container designs.

Materials:

- Student instructions
- Two 2-liter soda bottles per student/group
- Scissors
- Rulers
- Markers
- Variety of stuffing/packing materials
- Strong tape
- Raw eggs to represent radioactive waste
- Roof, ladder, or high place from which an adult can drop the containers

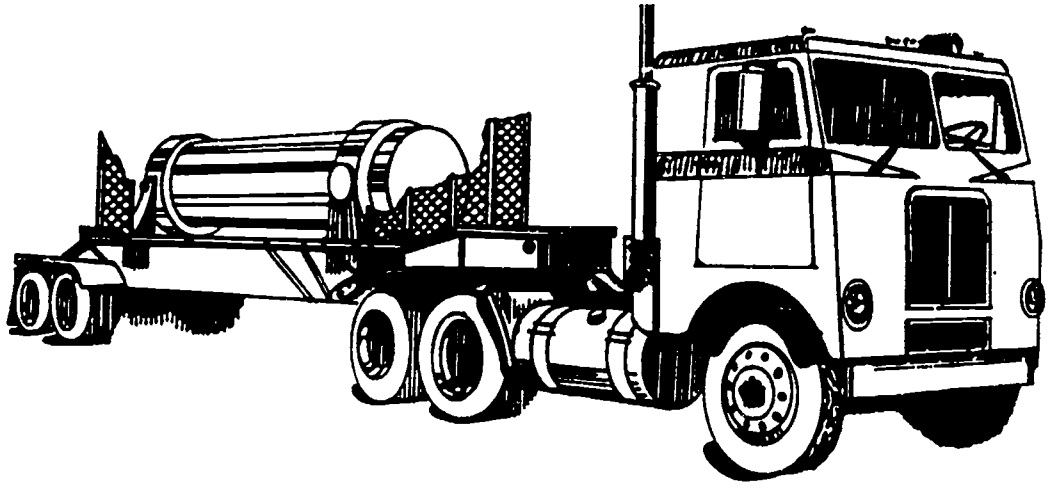
Optional: Gamma radiation source and Geiger counter

Additional Resource:

"Committed to Results: DOE's Environmental Management Program"
Center for Environmental Management Information. PO Box 23769.
Washington, DC 20026 (800) 736-3282 DOE/EM-0152P

Class sets are available from U.S. DOE Office of Scientific and Technical Information, PO Box 62, Oak Ridge, TN 37831 (615) 576-1301

"Transporting Radioactive Material...Answers to Your Questions" (DOE/EP-0064)
"What Radiation Material Package Testing is all About" (DOE/DP-0074)
"Shipment of Radioactive Materials by U.S. DOE" (DOE/DP-0065)
"Engineered For Safety" videotape from DOE Office of Civilian Radioactive Waste Management (800) 225-NWPA.



Methods for Testing

1. Drop Test:

Casks should be dropped by an adult from a roof, ladder, window, or other high place so that the egg cask lands on a hard or solid surface (e.g. concrete, plywood).

2. Shaft Test:

Attach a shaft of the listed dimensions to a piece of wood that will support the shaft upright (with strong glue or screws) and drop the bottle onto the shaft so that the bottle will fall three feet before hitting the shaft.

3. Side Impact Test:

Fill a 12-oz plastic drink bottle with sand so that it weighs one pound. Attach a string to the bottle and the other end of the string to the top center of a doorframe (use strong tape or other similar material). Place the egg cask bottle directly underneath the string so that the hanging bottle touches the side of the egg cask. Pull the hanging bottle so that it is suspended at an angle of approximately 45°, then release the hanging bottle and have it collide with the cask.

After testing, open each cask to determine whether it protected its contents.

Optional Radiation Test: Place the gamma radiation source inside the cask and use the Geiger counter to measure the counts of radiation released per minute before and after testing. Make sure to keep the Geiger counter the same distance from the cask and in the same position during both tests. Judge the effectiveness of the cask by determining whether the radiation increased after subjecting the cask to the stress of testing.

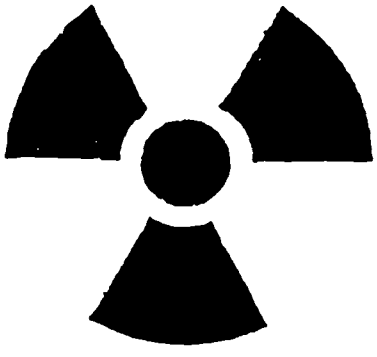
Questions and Extensions:

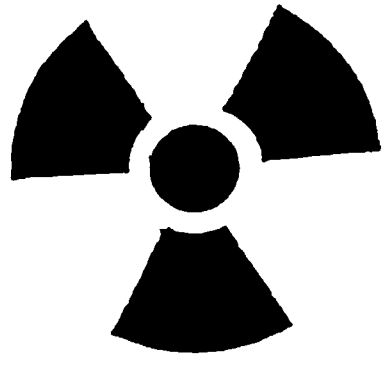
Have students report on the strengths and weaknesses of their designs. What could be improved in future attempts?

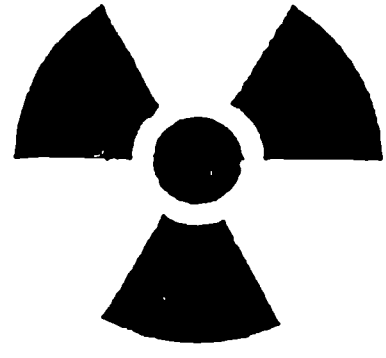
When a cask fails to contain its contents, must all waste and contaminated material be cleaned up? How? By whom? What safety measures should be considered?

What should ultimately be done with waste and contamination?

Discuss the concept of reducing hazardous waste at its source (producing less to start with). How would changes in manufacturing/industrial methods affect the consumer of goods? Would our lifestyles have to change?





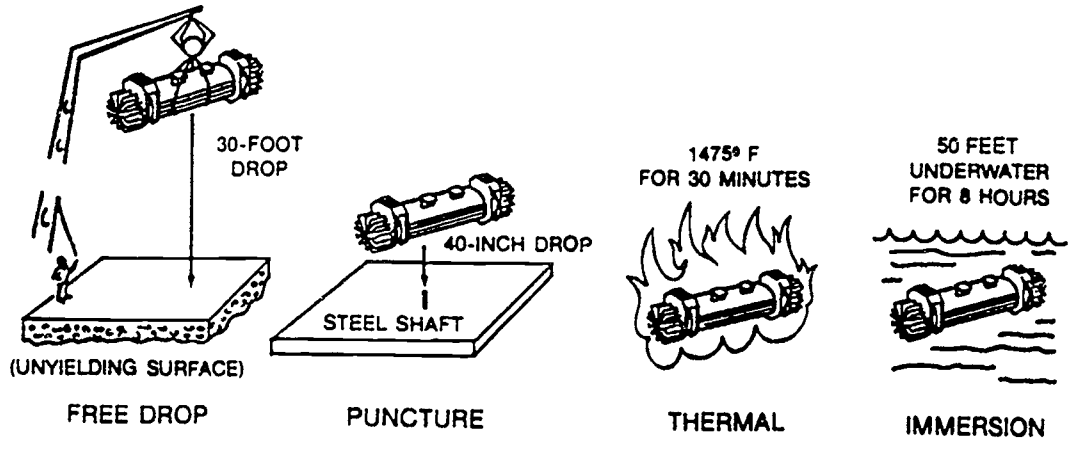


TRANSPORTING RADIOACTIVE WASTE
An Engineering Activity

Background:

The U.S. Department of Energy was established to oversee research and production of nuclear materials used in weapons. Today, with the need for nuclear weapons decreased, the primary role of DOE is environmental restoration and waste management. In other words, DOE must now clean up waste and contamination generated by past activities. Often the cleanup process involves moving waste to a processing or disposal site. DOE has designed packages which retain their contents and withstand severe transportation accidents, whether being moved by truck, train, or ship.

Casks of radioactive waste must survive extensive testing. Tests include being dropped from a 30 foot height onto an unyielding surface, then being dropped 40 inches onto a steel shaft. Casks are exposed to 1475°F flames for 30 minutes, then submerged 50 feet underwater for 8 hours.



Objective:

Your job as a DOE engineer is to create and test a package (a cask) designed to contain waste (an egg) and withstand accidents. The outer layer of the cask will be made from 2-liter soda bottles, and the interior packaging can be made from your choice of materials and design.

Requirements:

1. All of your packing and materials must fit in no more than two 2-liter plastic soda bottles that have a combined length of two feet or less.

2. The maximum allowable weight of the entire cask with egg must be equal to or less than 1 pound (454 grams).

3. Have the cask withstand a drop of 20–30 feet (7–10 meters) without the egg breaking.

4. Have the cask withstand the force of a swinging one-pound (454 grams) weight striking the side of the cask without the egg breaking.

5 Drop the cask from a height of 3 feet (1 meter) onto a post 2 inches (5 cm) tall and 1/2 inch (1.23 cm) in diameter without the egg breaking.

Scoring:

In the event that more than one cask survives all of the previous tests, the cask that weighs the least wins (reason: less weight means greater fuel efficiency during transportation).