

Transportation of Spent Fuel and Radioactive Materials

The Nuclear Regulatory Commission and the Department of Transportation work together to oversee the transportation of radioactive materials.

DOT:

- Regulates shippers of hazardous materials, including radioactive material, and
- Oversees vehicle safety, routing, shipping papers, emergency response and shipper training requirements.

NRC:

- Regulates users of radioactive material in 13 states (37 states regulate radioactive material users within their borders),
- Approves the design, fabrication, use and maintenance of shipping containers for the most hazardous radioactive materials, including spent nuclear fuel, and
- Regulates the physical protection of commercial spent fuel in transit against malicious acts.

The NRC requires radioactive materials shipments to comply with DOT's safety regulations for transporting hazardous materials.

Millions of packages of radioactive material are shipped throughout the United States each year by rail, air, sea and road. They contain small amounts of radioactive material that are used in industry and medicine. Examples include smoke detectors, watch dials, radioactive materials used in medicine and slightly contaminated equipment such as syringes used to administer radioactive medicines. These packages provide a safe and economical means of transporting small quantities of radioactive material.

The greater the potential risk of the contents, the more stringent DOT's packaging requirements are. The DOT regulations limit how much radioactivity can be transported in each package. That way, the dose from any accident will not pose a serious health risk.

NRC regulations for the safety of transport packages for large quantities of radioactive materials, including spent nuclear fuel, can be found in [10 CFR Part 71](#).

Spent Nuclear Fuel Shipping Containers

Spent nuclear fuel has been used to power a nuclear reactor and is no longer useful for producing energy. It contains solid, highly radioactive uranium fuel pellets in metal cladding that is bundled into

fuel assemblies. After it is removed from the reactor, spent fuel is usually stored on site for several years. If it is transported, it must be placed in containers that shield and contain the radioactivity and dissipate the heat.

The NRC regulations require shipping packages, under both normal and accident conditions of transport, to:

- Prevent the loss of radioactive contents,
- Provide shielding and heat dissipation and
- Prevent nuclear criticality (a self-sustaining nuclear chain reaction).

Normal conditions that a spent fuel transport package must be able to withstand include hot and cold environments, changes in pressure, vibration, water spray, impact, puncture and compression.

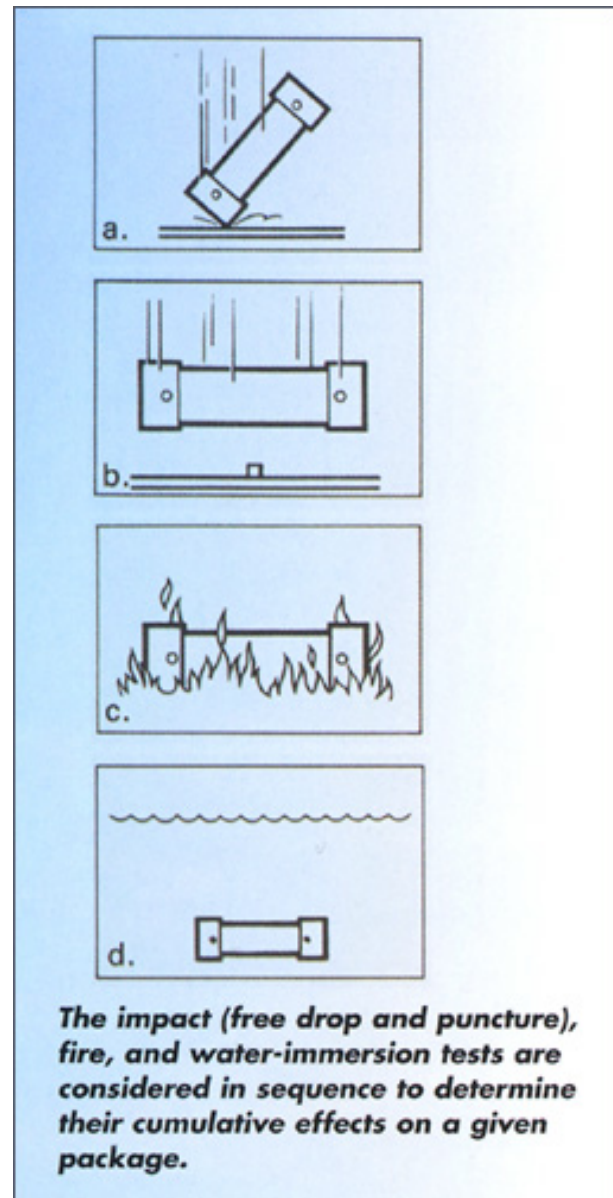
To show that it can withstand accident conditions, a package must pass impact, puncture, fire and water immersion tests. Transportation packages must survive these tests in sequence, including a 30-foot drop onto a rigid surface followed by a fully-engulfing fire of 1475 degrees Fahrenheit for 30 minutes. These very severe tests equate to the package hitting a concrete highway overpass at high speed, and being involved in a severe and long-lasting fire. The test sequence encompasses more than 99 percent of vehicle accidents.

The NRC reviews each package design to confirm that it meets the required conditions. Before a package can be used to transport spent fuel, the NRC must issue an approval certificate.

Multiple Layers of Safety

The NRC's regulatory controls apply to every U.S. shipment of spent nuclear fuel from commercial reactors, no matter how large or how frequent. For more than 40 years, this oversight has resulted in an outstanding record of safety and security. Thousands of domestic spent fuel shipments have been completed safely. After the Sept. 11, 2001, terrorist attacks, the NRC further expanded this robust system.

NRC regulations reflect the International Atomic Energy Agency transportation safety standards. They also supplement DOT regulations. The NRC looks at its transportation regulations every few years and proposes changes, if needed, to address new requirements, policies or technical improvements.

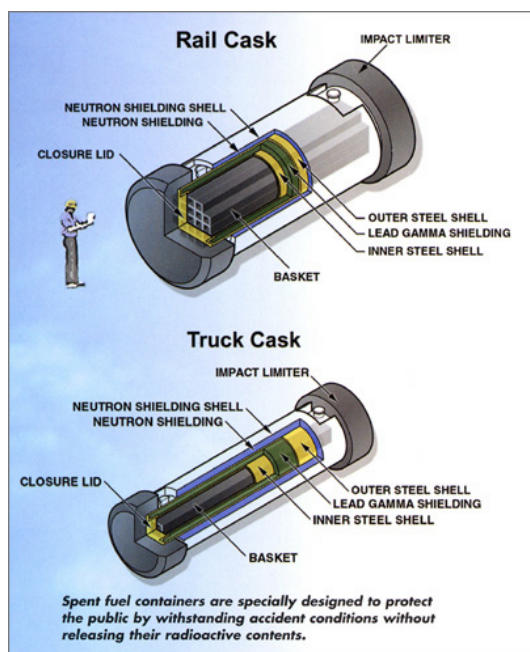


To ensure that large quantities of radioactive materials are transported safely, the NRC:

- Reviews and certifies transport package designs;
- Requires designers to follow strict quality assurance programs for package design, fabrication, use and maintenance;
- Inspects package designers and fabricators to ensure that packages conform to NRC-approved designs and quality assurance programs; and
- Inspects some shipments.

Many additional requirements help to ensure these shipments are safe:

- DOT regulations require shipper and carrier training;
- DOT and the Federal Emergency Management Agency oversee emergency response coordination, training, and communication; and
- DOT carries out its own transportation inspection and enforcement programs.



There is no way to completely eliminate risk. Still, the NRC has found both the likelihood of an accident that releases nuclear material and the risk to the public to be small. The NRC will continue to be vigilant about public safety as an essential part of its mission.

Regular NRC Safety Studies

The NRC periodically studies the risks from spent fuel shipments. Each study uses newer technology. As computer programs advance, simulations can address more and more data taken from actual spent fuel transport casks.

The [first study](#), completed in 1977, allowed the NRC to conclude that its transportation regulations adequately protect public health and safety. Studies in [1987](#) and [2000](#) found the risks were even smaller than the 1977 study predicted. The 2000 study used improved technology to

analyze the ability of containers to withstand an accident.

In 2014, the NRC published a [Spent Fuel Transportation Risk Assessment](#). This study modeled the radiation doses people might receive if spent fuel is shipped from reactors to a central facility. The study confirmed that NRC regulations for spent fuel transport are adequate to ensure safety of the public and the environment. It found:

- Doses from routine transport would be less than 1/1000 the amount of radiation people receive from background sources each year;

- There is less than a 1 in 1 billion chance that radioactive material would be released in an accident; and
- If an accident did release radioactive material, the dose to the most affected individual would not cause immediate harm.

The NRC also studies major transportation accidents across the country to understand the actual accident conditions. These studies allow the NRC to determine whether its regulations would protect the public if large quantities of radioactive materials were involved. These studies coupled with the risk assessments give the NRC added confidence in the safety of spent fuel shipments.

Transportation Security

The NRC and the Department of Energy jointly operate a system to track domestic and foreign nuclear materials shipments. In addition, the NRC requires that licensees and carriers involved in spent fuel shipments:

- Follow only approved routes;
- Provide armed escorts through heavily populated areas;
- Provide monitoring and redundant communications;
- Coordinate with law enforcement agencies before shipments; and
- Provide advance notice to the NRC, local tribes and states the shipments will pass through.

After the terrorist attacks on Sept. 11, 2001, the NRC enhanced security requirements for transporting spent fuel and large quantities of radioactive materials. Through advisories and orders to licensees, the NRC required:

- More pre-planning and coordination with affected states,
- Additional advance notification of shipments,
- Enhanced control and monitoring,
- Trustworthiness checks for people who have access to or information about the shipment, and
- Stronger security controls over shipment routes and schedules.

These newer requirements and other enhancements were formally added to the NRC's transport regulations through a [rulemaking](#), finalized in May 2013.

Accident Response Assistance

State and local governments have primary responsibility to oversee the response to any accident involving a nuclear materials shipment. They would ensure the carrier and others take the actions required to protect public health and safety.

The NRC has special procedures that are triggered by any event involving NRC-licensed material that could threaten public health and safety or the environment. During an event, the NRC may activate its Headquarters Operations Center. It also may activate one of its four Regional Incident Response Centers (Region I-King of Prussia, Pa.; Region II-Atlanta, Ga.; Region III-Lisle, Ill.; and Region IV-Arlington, Tex.).

The NRC's highest priority in any accident is to provide expert consultation, support, and assistance to state and local responders. Teams of NRC specialists evaluate information, assess the potential impact on the public and environment, and evaluate possible recovery strategies. Other experts consider the effectiveness of different protective actions, including sheltering in place or evacuation. More information is on our [website](#).

Additional information on the safety of spent fuel transportation can be found on our [website](#).

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