

Transportation of Spent Nuclear Fuel and High-Level Radioactive Waste to Yucca Mountain

Frequently Asked Questions



This publication was produced by the U.S. Department
of Energy's Office of Civilian Radioactive Waste
Management (OCRWM)

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Table of Contents

Overview	3
Safe transportation of spent nuclear fuel and high-level radioactive waste	4
Radioactive Waste Shipments	
What are spent nuclear fuel and high-level radioactive waste?	6
What is the safety record for transporting spent nuclear fuel and high-level radioactive waste?	8
How many shipments will there be to the repository?	9
Transportation Safety	
How are transportation safety and security standards established?	10
What precautions does the government take in the transportation of spent nuclear fuel and high-level radioactive waste?	11
What types of packages will be used to ship spent nuclear fuel and high-level radioactive waste to a repository?	13
Have actual casks been tested under real-life conditions?	14
Could a transportation package protect its contents and prevent the release of radiation in case of fire?	15
Transportation System	
How will transportation routes to a repository be chosen?	16
How will spent nuclear fuel and high-level radioactive waste be transported within Nevada to the repository?	18
How will DOE interact with interested parties as transportation decisions are made?	19
What are the specific plans for interactions with states and tribes?	20
Will communities know when to expect shipments of spent nuclear fuel and high-level radioactive waste?	22

Transportation Security

How will shipments of spent nuclear fuel and high-level radioactive waste be protected from sabotage?	23
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Emergency Planning and Response

How will public safety officials be prepared for an emergency involving a shipment of spent nuclear fuel or high-level radioactive waste?	24
---	----

Who will help state, local, and tribal safety officials respond to an accident involving spent nuclear fuel or high-level radioactive waste?	25
--	----

Who would pay for damages in the event of an accident resulting from the transportation of spent nuclear fuel or high-level radioactive waste?	26
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Transportation Information

Where can I find more information about spent nuclear fuel, high-level radioactive waste, and the transportation of these materials?	27
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Overview

Today, 20 percent of the United States' electricity is generated by nuclear power, and about 40 percent of the U.S. Navy's fleet is nuclear powered. Many universities also perform advanced research in nuclear reactors. These activities all require nuclear fuel, which produces enormous amounts of energy but eventually loses its efficiency. At that point, the fuel is considered "spent" and must be replaced with fresh fuel. In addition, continuing efforts to clean up Cold War era nuclear weapons plants and to reduce the nation's nuclear arsenal have produced large amounts of radioactive waste, including high-level radioactive waste.

Spent nuclear fuel and high-level radioactive waste are stored in temporary facilities at more than 100 sites throughout the United States. Some 160 million Americans live within 75 miles of one or more of these sites. To protect public health and safety and the environment from these highly radioactive materials, spent nuclear fuel and high-level radioactive waste must be securely contained and isolated while their radioactivity decreases over time.

Congress passed the Nuclear Waste Policy Act (NWPA) of 1982 to provide for the disposal of spent nuclear fuel and high-level radioactive waste in a deep geologic repository. The NWPA also established a federal office to implement the policy: the Office of Civilian Radioactive Waste Management (OCRWM) within the U.S. Department of Energy (DOE).

Congress amended the NWPA in 1987 and directed DOE to study only Yucca Mountain, Nevada, for its potential to become the nation's first permanent geologic repository. In 2002, the President and Congress approved Yucca Mountain as a suitable site for which DOE should prepare a license application to be submitted to the U.S. Nuclear Regulatory Commission (NRC).

If NRC grants DOE a license to construct a repository at Yucca Mountain, the secure and remote facility would

- Protect public health and safety
- Preserve the quality of the environment
- Provide secure disposal for utility spent nuclear fuel
- Provide for the environmental cleanup of DOE weapons facilities
- Provide the nation with additional protection from acts of terrorism
- Promote a sound and balanced national energy policy

To transport the spent nuclear fuel and high-level radioactive waste to the repository for disposal, DOE is planning and developing a safe and secure transportation program that will follow all applicable laws and regulations while drawing on a decades-long record of safely transporting such materials.

Safe transportation of spent nuclear fuel and high-level radioactive waste

Government and industry have a proven safety record in transporting highly radioactive materials in the United States. Since the early 1960s, the U.S. has safely conducted more than 3,000 shipments of spent nuclear fuel without any harmful release of radioactive material.

In addition, other shipping campaigns of radioactive materials have occurred within the last 10 years with equally safe records. Since 1999, DOE's Waste Isolation Pilot Plant (WIPP) in New Mexico has received shipments of "transuranic" radioactive waste that safely traveled several million miles and DOE's Foreign Research Reactor Spent Nuclear Fuel Acceptance Program has safely transported spent nuclear fuel from some 25 foreign countries.

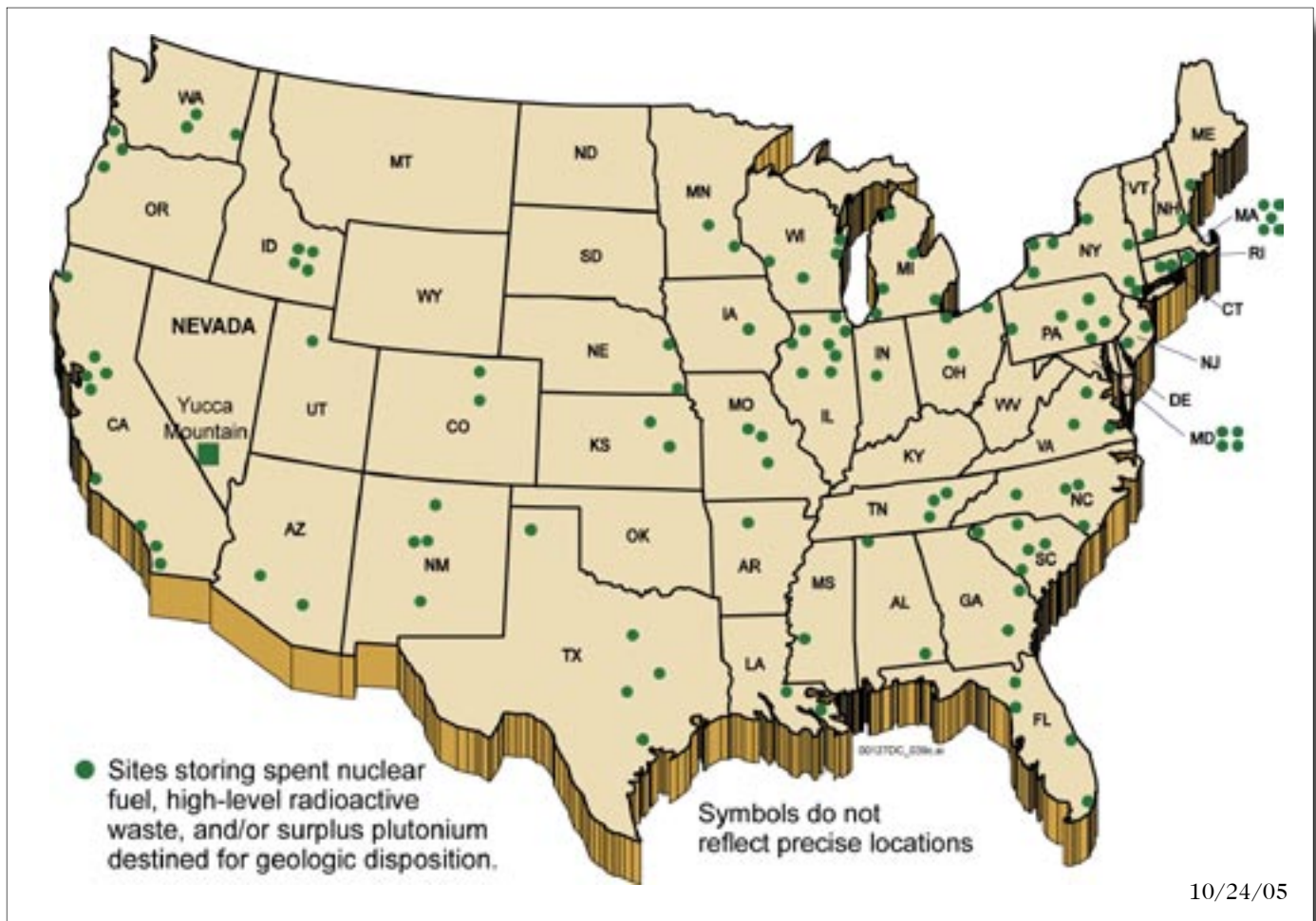


Worldwide, more than 70,000 metric tons of spent nuclear fuel have been safely shipped since 1970 — an amount approximately equal to the total amount of spent nuclear fuel that would be shipped to Yucca Mountain. DOE is committed to developing a safe and secure transportation system for Yucca Mountain and will continue its current practices:

- Meeting or exceeding all applicable transportation standards set by Congress, the U.S. Department of Transportation (DOT), NRC, other agencies like the U.S. Department of Homeland Security (DHS), and industry organizations like the Association of American Railroads and the American National Standards Institute
- Involving states, tribes, industry, utilities, and other interested parties in transportation planning

- Providing funding and technical assistance to states and tribes to train local officials along shipping routes in procedures for safe, routine transportation and emergency response
- Building on the lessons learned from prior shipments
- Striving for continuous improvement in the program

The purpose of this booklet is to provide information about transportation of spent nuclear fuel and high-level radioactive waste to a geologic repository at Yucca Mountain, for permanent disposal. Topics covered in this document reflect the primary issues and concerns raised by the general public regarding transportation of spent nuclear fuel and high-level radioactive waste to Yucca Mountain.



Radioactive Waste Shipments

Q: What are spent nuclear fuel and high-level radioactive waste?

Spent nuclear fuel – or “used” nuclear fuel – results from producing electricity at nuclear power plants or from operating other reactors such as research reactors. Nuclear fuel is considered “spent” when it no longer gives off enough energy (in the form of heat) to produce electricity efficiently. The fuel is most commonly in the form of solid ceramic pellets, with each pellet approximately the size of a pencil eraser, secured inside an assembly of strong metal tubes. The tubes containing the pellets are bundled together to form assemblies. These pellets, tubes, and assemblies are specifically designed and manufactured to contain radioactive materials during use in a reactor and during long-term storage. In addition, as a ceramic material, spent nuclear fuel pellets are solid — not in a liquid or gaseous form — and therefore, spent nuclear fuel will not spill, evaporate, burn, or explode.

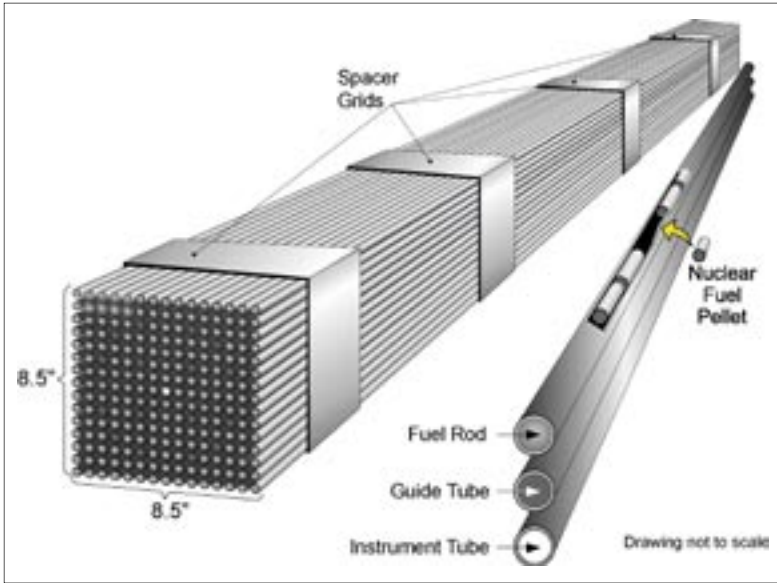
Commercial spent nuclear fuel is now being temporarily stored in pools of water, above-ground vaults, or concrete or steel casks at power plants. Government-owned spent fuel from test or research reactors is stored at various DOE sites. Spent nuclear fuel will be transported to a repository in specially designed packages called “casks.”

High-level radioactive waste that would be disposed of at the Yucca Mountain repository is radioactive waste containing byproducts from past processing of spent nuclear fuel for defense needs or other radioactive material that requires permanent isolation.

High-level radioactive waste resulting from defense programs is stored temporarily in underground tanks and vaults at government sites. High-level radioactive waste will be solidified in glass (some waste has already been solidified), packaged in stainless steel canisters, and placed in shielded casks for transport to the repository for disposal.



Spent nuclear fuel storage pool.



Spent nuclear fuel is most commonly in solid ceramic pellet form, about the size of a pencil eraser, secured inside an assembly of strong metal tubes.



Actual size of fuel pellet.

High-level radioactive waste is made solid by mixing it with glass-forming chemicals in stainless steel canisters and then subjecting it to heat. The result is a hard glass-like substance.

Radioactive Waste Shipments



Q: What is the safety record for transporting spent nuclear fuel and high-level radioactive waste?

Government and industry have a proven safety record in transporting highly radioactive materials in the United States. Since the early 1960s, the U.S. has safely conducted more than 3,000 shipments of spent nuclear fuel without any harmful release of radioactive material. This safety record is comparable to the worldwide experience where more than 70,000 metric tons of spent nuclear fuel have been transported since 1970.

Radioactive Waste Shipments

Q: How many shipments will there be to the repository?

Under the current plan, the repository would receive about 175 shipments per year for 24 years — about 130 by rail and 45 by truck each year.



There will be approximately 175 shipments per year for 24 years. 130 shipments will be delivered by rail (top), while 45 shipments will be sent by truck (bottom).

Transportation Safety

Q: **How are transportation safety and security standards established?**

DOT and NRC share primary responsibility for establishing standards for the safe transport of radioactive materials within the United States. These standards are based on international transport standards that are used to safely ship radioactive materials worldwide.

DOT standards cover packaging, transporting, and handling of radioactive materials, including labeling, shipping papers, placards, loading, and unloading. DOT standards also specify training needed for personnel who perform handling and transport of hazardous materials. The DOT, in cooperation with the DHS, sets standards for emergency preparedness for carriers.

NRC establishes design and performance standards for packages that carry materials with higher levels of radioactivity, like spent nuclear fuel and high-level radioactive waste. All shipments of spent nuclear fuel and high-level radioactive waste to Yucca Mountain must use containers whose designs meet NRC certification requirements.

When transporting radioactive materials, DOE meets or exceeds all applicable standards set by DOT and NRC.



Rail cask with impact limiters designed for the transportation of spent nuclear fuel and high-level radioactive waste.

Transportation Safety



What precautions does the government take in the transportation of spent nuclear fuel and high-level radioactive waste?



Routing — DOT has established a process for selecting highway routes. DOE will work with states through regional organizations, and with tribes on a government-to-government basis, to identify suites of routes, including alternatives to preferred shipping routes. All states and tribes can — and some states already have — designated “preferred” highway routes.

The process for identifying rail routes that DOE expects to use begins with the routes identified in the *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain*. These routes are based on established railroad practices and reflect operational input from potential railroads. Although commercial rail lines are privately owned, DOE will work with rail carriers, states, and tribes to identify and evaluate rail routes through a collaborative process.

Inspections — Specially trained federal, state, or carrier inspectors perform equipment and radiological inspections before every shipment. Inspectors also ensure compliance with applicable safety standards. States may require inspections en route, and inspections are required at final destination points for truck shipments of spent nuclear fuel.

Security — To implement an effective security program for transportation, DOE is actively collaborating with DOT, NRC, DHS, and other agencies. DOE is also collaborating with international agencies and working groups; state, tribal, and local government representatives; industry associations; and technical advisory and oversight organizations. DOE’s security program includes physical security systems like alarms, sensors, armed escorts, and tracking devices; information and cyber security; materials control and accounting; personnel security, training, and management; and emergency response capabilities.

Tracking — DOE will coordinate in-transit operations, including tracking, security escorts, and communications. DOE will use

a satellite tracking system similar to the TRANSCOM system currently used in other DOE transportation programs.

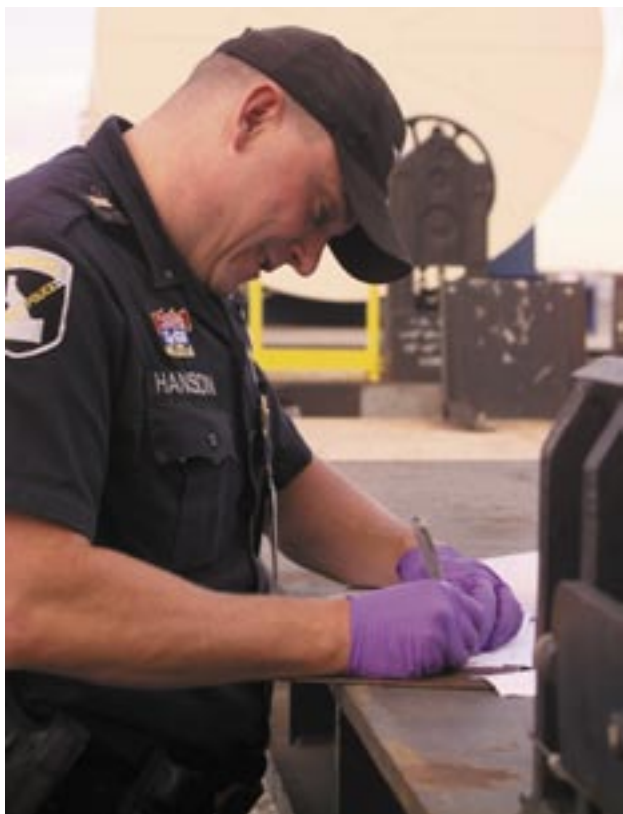
Notification of state and tribal officials

— As required under DOE policy and the NWPA, state governors and tribal leaders, or their designees, will be notified in advance of spent nuclear fuel and high-level radioactive waste shipments through their jurisdictions. Specific dates, times, and actual routes of shipments are safeguarded for security reasons. However, those with a need-to-know (such as state or tribal representatives, law enforcement and emergency response officials, and inspectors) will be informed of shipments before they enter a state or tribal land. All shipments will be closely

coordinated with state, tribal, and federal law enforcement agencies.

Emergency preparedness — The federal government has its own experienced teams of emergency responders, and currently funds a number of emergency preparedness activities for state, tribal, and local responders. DOE has highly trained special response teams from eight regional offices available to assist state, tribal, and local safety officials.

Training — States and tribes have and will continue to receive federal support specifically for training in preparation for DOE nuclear materials shipments. DOE will provide technical and financial assistance to states and tribes for training public safety officials in procedures for safe, routine transportation and emergency response situations.



A Commercial Vehicle Safety Alliance certified inspector completes his inspection of a high-level radioactive waste shipment to a DOE-controlled site.



DOE transportation standard practices manual used in planning and implementing shipments of spent nuclear fuel and high-level radioactive waste.

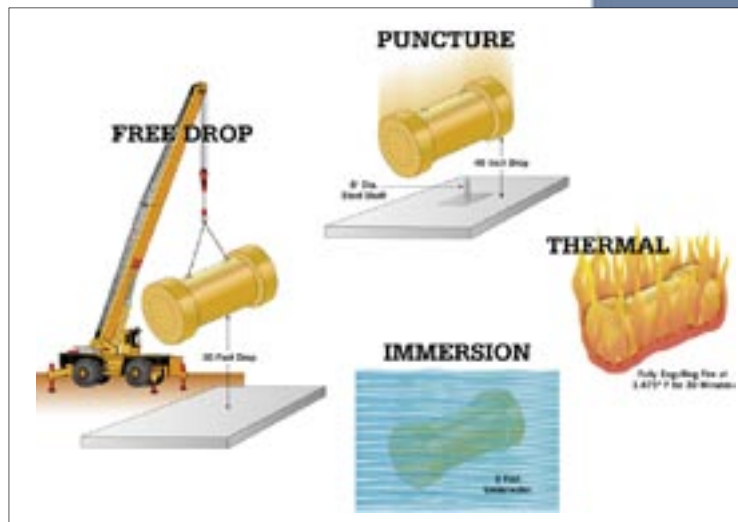
Q: What types of packages will be used to ship spent nuclear fuel and high-level radioactive waste to a repository?

DOE will use robust transportation packages called casks. Casks are typically made of stainless steel and metal shielding more than six inches thick to protect the contents and confine radiation in both routine transport operations and under severe accident conditions. All shipments to Yucca Mountain must be transported in casks certified by NRC. The NRC certification process requires that each transportation cask design must be analyzed or tested to meet the conditions of all of the following tests, in the given sequence:

- A drop from 30 feet onto a hard, unyielding surface that is equivalent to a high-speed crash into a bridge abutment
- A drop from 40 inches onto a shaft six inches in diameter
- A fully engulfing fire at 1,475 degrees Fahrenheit for 30 minutes
- Immersion under three feet of water

An undamaged version of the cask must also be able to survive immersion in the equivalent of 50 feet of water. Furthermore, casks designed for shipping spent nuclear fuel must be able to survive water pressure greater than 600 feet for 1 hour without collapse, buckling, or leaking.

The NRC utilizes state of the art computerized models, as well as scale-model and full-scale model tests, to determine whether cask designs meet NRC requirements for certification.



Transportation Safety

Q: **Have actual casks been tested under real-life conditions?**

DOE's National Laboratories have conducted a variety of cask tests simulating real-life conditions.

Sandia National Laboratories in New Mexico performed the following tests:

- A flatbed truck loaded with a full-scale cask driven into a 700-ton concrete wall at 80 miles per hour
- A rail car loaded with a full-scale cask driven into a 700-ton concrete wall at 80 miles per hour
- A cask broad-sided by a 120-ton locomotive traveling 80 miles per hour
- A transportation cask dropped 2,000 feet onto soil as hard as concrete — traveling 235 miles per hour at impact

In all of the Sandia National Laboratories crash tests, the casks survived intact and would have safely protected their contents with no release of radiation.

In Great Britain, an independent test by the Central Electricity Generating Board consisted of ramming a spent fuel cask with an unmanned locomotive at 100 miles per hour. The cask – which met international design standards that are essentially the same as U.S. standards – survived the test with only superficial damage.



Could a transportation package protect its contents and prevent the release of radiation in case of fire?

Transportation packages are designed to protect their contents and prevent radioactive releases. To be certified by the NRC, a transportation cask must be proven, by analysis or test, to protect its contents if placed in a fully engulfing fire that burns for 30 minutes at 1,475 degrees Fahrenheit.

Additional full-scale tests, scale-model tests, and computer analyses are used to evaluate the ability of transportation casks to prevent the release of radiation in case of fire. NRC has used data collected from large-scale, real-life fires to evaluate the impact such a fire could have if a nuclear waste shipment were involved. As a result, NRC has concluded that casks designed to meet its requirements would not release their contents.

Top photo — In a test conducted in the burn facility at Sandia National Laboratories, a transportation canister was positioned about three feet above the burning fuel for 30 minutes at 800 degrees Celsius or 1,475 degrees Fahrenheit.

Bottom photo — In a test conducted by Sandia National Laboratories in New Mexico, a full-scale transportation cask on a rail car was set on fire to evaluate the impact such a fire could have if a nuclear waste shipment were involved.



Transportation System

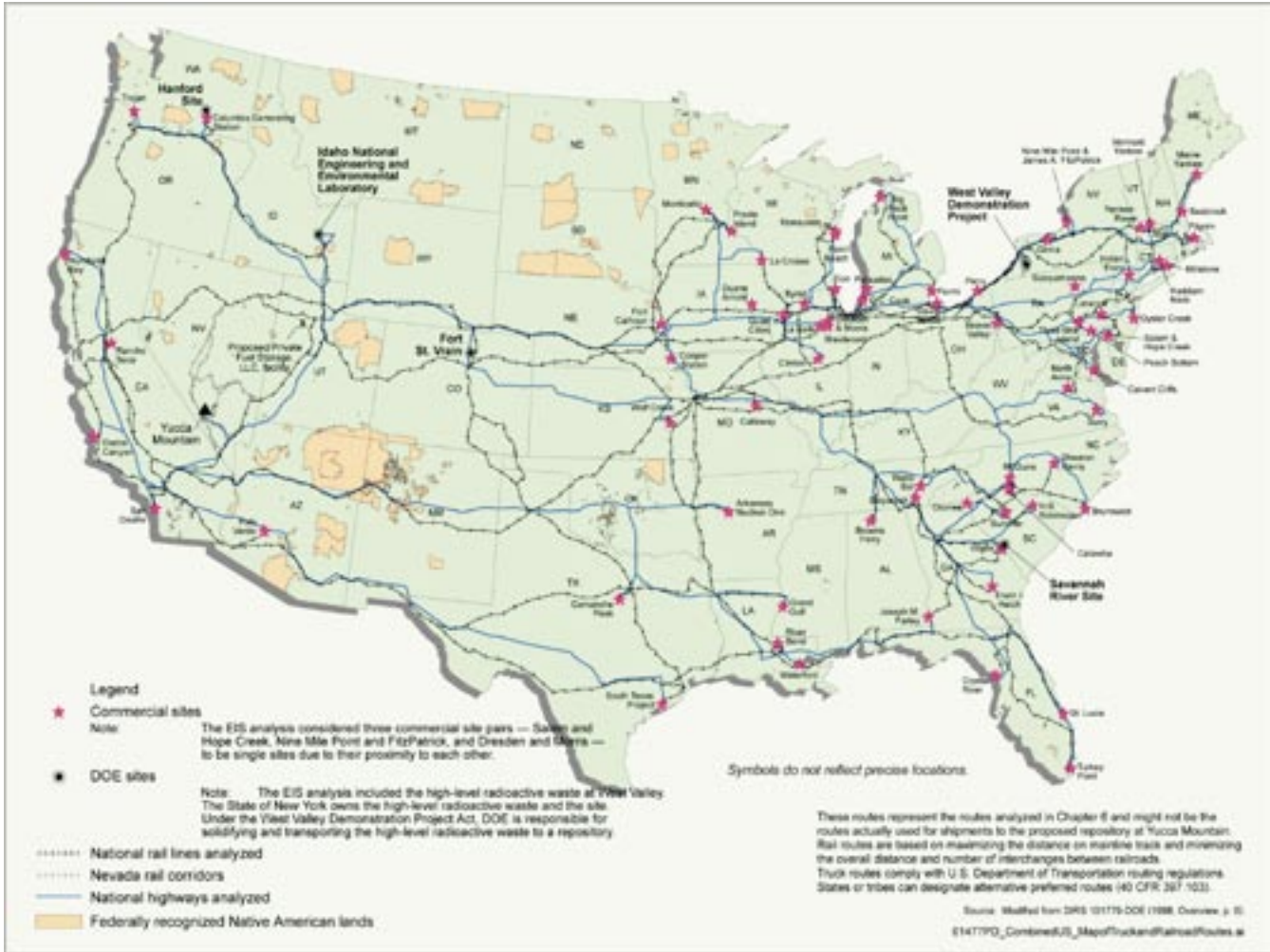
Q: How will transportation routes to the repository be chosen?

DOE is working with states through four state regional groups to identify suites of transportation routes in each region for highway, rail, and waterways. DOE will also interact with federally recognized tribal nations on routing issues. The process includes identifying highway routes and identifying rail and waterways using industry and federal standards. DOE will continue its practice, to the extent appropriate, of coordinating the details of shipment routes and specific modes with states, tribes, utilities, and carriers.

After considering a range of alternatives, DOE has decided that the transportation system will be mostly rail. Rail transportation was determined to have significant support from stakeholder organizations and to offer operational and security efficiencies. In addition, DOE has decided to use dedicated train service for shipments to the repository. Dedicated trains would transport only spent fuel or high-level radioactive waste and would provide better operational control as well as cost savings for DOE shipments to Yucca Mountain. Barge and highway routing will be used where rail is not available (barges may be used to ship spent nuclear fuel from some reactor sites to nearby railheads).

Some shipments will require transport over the national highway system. Under the DOT highway routing process, these shipments would travel on interstate highways, designated beltways, and urban bypasses to limit time in transit. For highway shipments, spent nuclear fuel and high-level radioactive waste is classified as “Highway Route Controlled Quantity” for purposes of the DOT highway routing process. Carriers of these materials must use “preferred routes” that would reduce transit time.

State and tribal agencies, following the DOT process, may designate alternative highway routes through their jurisdictions. The key consideration for states and tribes in determining alternative preferred routes is minimizing radiological risk to the public. This is done by considering factors including population density, time of day, and day of week. DOE is working with the states and tribes to consider criteria for rail transport.



Transportation routes analyzed in the Yucca Mountain Repository Environmental Impact Statement.

Transportation System

Q: How will spent nuclear fuel and high-level radioactive waste be transported within Nevada to the repository?

Within Nevada, the majority of spent nuclear fuel and high-level radioactive waste shipments will be by rail. DOE plans to construct a rail line to connect the Yucca Mountain repository site with an existing rail line in Nevada.

DOE identified and selected the remote, 318 to 344-mile long Caliente corridor within Nevada for the study of alignment options for the potential construction of a rail line. An Environmental Impact Statement is being prepared in accordance with the National Environmental Policy Act (NEPA) to consider alternative route alignments within the Caliente corridor. The final route alignment will define the path of the actual rail line. No construction of a rail line can begin until the NEPA process is complete.

DOE is working closely with local and tribal government officials and private citizens along the Caliente corridor to determine where the final railroad route alignment should be located.



Q: How will DOE interact with interested parties as transportation decisions are made?

The NWPA established a stepwise approach for making decisions related to the approval, licensing, operation, and eventual closure of the repository. DOE is committed to a similar stepwise approach to transportation planning, as outlined in DOE's *Strategic Plan for the Safe Transportation of Spent Nuclear Fuel and High-Level Radioactive Waste to Yucca Mountain: A Guide to Stakeholder Interactions* (available online at <http://www.ocrwm.doe.gov/wat/pdf/tsp.pdf>).

DOE's experience with transportation programs related to WIPP, foreign spent nuclear fuel, U.S. naval reactor fuel, and others has proven that interaction and collaborative planning with interested parties is critical to mission success.

Through a collaborative planning process, DOE is working with states, tribes, and other interested parties to develop specific policies and procedures and to make transportation decisions. The collaborative process will incorporate successful elements from transportation systems developed for other DOE programs.

Interactions with interested parties on the national level take place primarily through the Transportation External Coordination Working Group, whose membership includes representatives from

- State, local, and tribal organizations
- Police, fire, and medical professional and technical associations and unions
- Industry
- Federal agencies and oversight groups

DOE also interacts with individual parties, as appropriate, when specific issues of mutual concern arise.



Transportation System

Q: What are the specific plans for interactions with states and tribes?

DOE emphasizes cooperation with states and tribes in developing its transportation system, because states and tribes have the primary responsibility for the health and welfare of their citizens.

Four state regional groups anchor the collaborative process with the states:

- Southern States Energy Board
- Western Interstate Energy Board
- Council of State Governments, Midwestern Office
- Eastern Regional Conference of the Council of State Governments

DOE interacts frequently with these groups and others on other DOE shipping programs and relies on them to provide consolidated state input on various topics and to assist with transportation plans. Where appropriate, DOE will interact with individual states, or their designated state agencies, as specific issues of mutual concern arise.

DOE interacts with federally recognized tribes on a government-to-government basis. DOE will consider successful consultation and collaborative processes used by other federal agencies and will continue to work with tribal organizations along potential transportation routes throughout the planning, operational testing, and operations phases of the transportation program.



DOE engineer uses a truck and rail cask model to explain transportation information to the public.



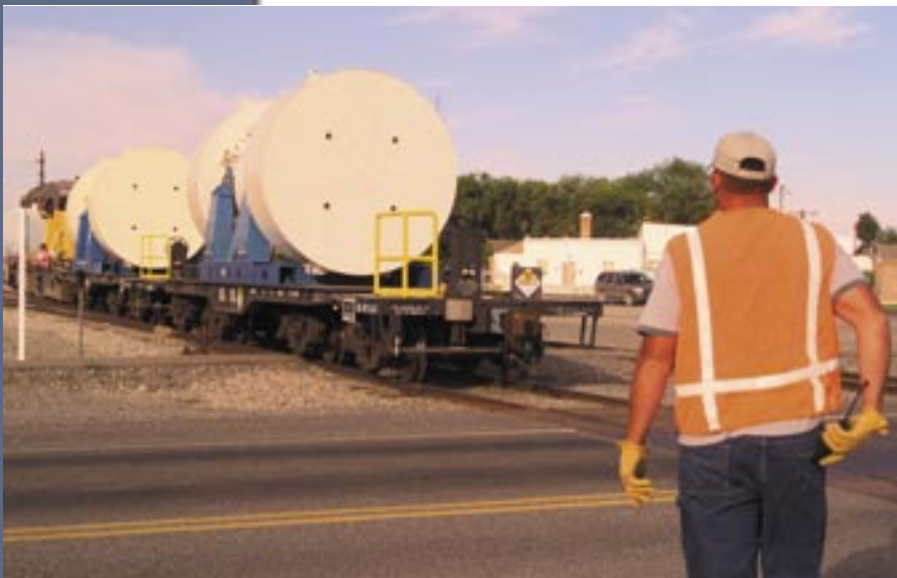
During an open house tour of Yucca Mountain, the public participants look at the heavy-duty construction of a NAC-LWT legal weight truck transportation cask.

Transportation System

Q:

Will communities know when to expect shipments of spent nuclear fuel and high-level radioactive waste?

As required under DOE policy and the NWPA, state governors and tribal leaders, or their designees, are notified in advance of spent nuclear fuel and high-level radioactive waste shipments through their jurisdiction. Specific dates, times, and actual routes of shipments are safeguarded for security reasons. However, those with a need-to-know (such as state or tribal representatives, law enforcement, emergency response officials, and inspectors) are informed of shipments before they enter a state or tribal land. All shipments are closely coordinated with state, tribal, and federal law enforcement agencies for security purposes.



Transportation Security



How will shipments of spent nuclear fuel and high-level radioactive waste be protected from sabotage?



The same robust design and construction features that make transportation casks safe also limit their vulnerability to sabotage. DOE will coordinate all shipments with state, tribal, and federal law enforcement agencies, and shipments will be monitored around the clock through a satellite-based tracking system (see illustration below).

NRC standards address the physical protection of spent nuclear fuel in transit. DOE will meet or exceed these standards that provide for the following:

- Notification to relevant governors and tribal leaders before transport begins
- Special safeguard procedures for the shipper to follow in emergencies
- Escort training on threat recognition, response, and management
- Advance arrangements with law enforcement agencies along the route
- Armed escorts to accompany the shipment
- Escorts to maintain visual surveillance of the shipment at all times
- Status reporting by the escorts every two hours
- The capability to immobilize the cab or cargo-carrying portion of the vehicle (for highway shipments)
- Protection of specific information about any shipment
- Satellite tracking of shipments, with access to tracking information by appropriate federal, state, and tribal officials



Emergency Planning and Response



Q:

How will public safety officials be prepared for an emergency involving a shipment of spent nuclear fuel or high-level radioactive waste?

In an emergency, state, tribal, and local governments are responsible for the safety of their residents and responding to accidents in their jurisdictions.

In accordance with Section 180(c) of the NWPA, DOE will provide technical and financial assistance to states and tribes for training public safety officials in procedures for safe, routine transportation and emergency response situations. DOE will apply the experience derived from existing emergency preparedness programs within the DOE and other federal agencies. DOE will also support exercise programs to test and validate state, tribal, and local officials' transportation emergency response plans.



Emergency responders across the country participate in realistic training and practice exercises to prepare themselves for an emergency involving a radioactive waste shipment.

Emergency Planning and Response

Q:


Who will help state, local, and tribal safety officials respond to an accident involving spent nuclear fuel or high-level radioactive waste?

In the event of an accident, state, tribal, and local emergency responders would have federal resources available, if requested, to help them with emergency response activities. In addition, carriers have response programs and plans in place to assist local officials with emergencies. Specialty contractors are maintained by carriers to assist with response and recovery efforts, and carrier insurance defrays the costs of a response by state and local officials.

The federal government has its own experienced teams of emergency responders. DOE special-response teams from eight regional coordinating offices are available to assist with any transportation accident involving radioactive materials. These special-response teams assess the emergency situation, advise decision-makers on actions that could be taken, and provide expertise in assessment, area monitoring, air sampling, and exposure and contamination control.



DOE's eight Radiological Regional Coordinating Offices.



Who would pay for damages in the event of an accident resulting from the transportation of spent nuclear fuel or high-level radioactive waste?

In the unlikely event of an accident that results in a release of radioactive materials, any resulting damages would be covered under the Price-Anderson Act, which establishes a system of financial protection for the public in a nuclear accident, regardless of who causes the damage.

The Price-Anderson Act provides for indemnification of liability up to \$10 billion to cover claims that might arise from an accident in which radioactive materials were released, or one in which an authorized precautionary evacuation occurred. If the damage from a nuclear incident appeared likely to exceed that amount, the Price-Anderson Act contains a congressional commitment to thoroughly review the particular incident and take whatever action is determined necessary to provide full and prompt compensation to the public.

In addition, motor carriers who transport nuclear materials will have a minimum of \$5 million in private insurance coverage. This insurance coverage will be available in the event of an accident that does not involve the release of nuclear material or a precautionary evacuation. Rail carriers are self-insuring for accidents other than nuclear incidents or precautionary evacuations.



Where can I find more information about spent nuclear fuel, high-level radioactive waste, and the transportation of these materials?

Many opportunities exist for people to learn more about spent nuclear fuel and high-level radioactive waste issues, and about the transportation of radioactive materials. Access to scientific and technical information is available online through the Office of Civilian Radioactive Waste Management website at www.ocrwm.doe.gov, and at public reading rooms located throughout the country.

DOE also operates three public information centers in Nevada (in Beatty, Las Vegas, and Pahrump) and provides a speakers bureau that arranges for project experts to speak at public events.

Citizens can discuss their concerns and receive answers to their questions about the Yucca Mountain Project by contacting:

U.S. Department of Energy
Office of Repository Development
1551 Hillshire Drive
Las Vegas, NV 89134
(800) 225-6972
www.ocrwm.doe.gov

For more information on DOE's transportation programs, contact:

Office of National Transportation
Office of Civilian Radioactive Waste Management
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585
(202) 586-9117
www.ocrwm.doe.gov

Transportation Resource Exchange Center
ATR Institute
University of New Mexico
Albuquerque, NM 87106-4342
(877) 287-TREX (8739)
www.trex-center.org

Other government agencies and facilities:

U.S. Nuclear Regulatory Commission
Office of Nuclear Materials Safety and
Safeguards
Washington, DC 20555
(301) 415-7800
www.nrc.gov

U.S. Department of Transportation
Pipeline and Hazardous Materials Safety
Administration
Hazardous Materials Information Center
400 Seventh Street, SW
Washington, DC 20590
(202) 366-4488
www.dot.gov

U.S. Department of Homeland Security
Federal Emergency Management Agency
Public Affairs
500 C Street, NW
Washington, DC 20472
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