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Radioactive Roads And Rails

Hauling Nuclear Waste Through Our Neighborhoods

Florida PIRG Education Fund

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A Report of the U.S. PIRG Education Fund and the State Public Interest Research Groups

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U.S. PIRG Education Fund

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Executive Summary

The Bush administration has decided to press ahead with a plan to store much of the nation's nuclear waste in Yucca Mountain, Nevada. Yucca Mountain is located approximately 90 miles northwest of Las Vegas. The bulk of America's nuclear waste is generated and located east of the Mississippi - at the opposite end of the country from Nevada. This means that highly radioactive waste would be hauled across the country - through towns, communities and neighborhoods - on the way to Yucca Mountain.

The Senate will vote on whether to grant approval for proceeding with the Yucca Mountain project in late-June or July of 2002. However, the Department of Energy (DOE), which has oversight of the project, has not yet prepared a transportation plan for the shipment of nuclear waste.

This report examines DOE's proposed program of transporting highly radioactive nuclear waste to Yucca Mountain over the course of 38 years. The key finding of this report is that the transportation component of the Yucca Mountain project poses serious risks to the health and safety of a large cross-section of Americans, as well as to the environment.

Nuclear waste is recognized as the most dangerous substance known to humankind. The Yucca Mountain project is by far the largest proposal ever for the shipment of nuclear waste in America. More than 105,000 truckloads of nuclear waste could travel our roads and highways, throughout 44 states, over the course of four decades. Waste shipments would be so frequent that Atlanta, Cleveland and San Bernardino would see shipments traveling through their neighborhoods on a daily basis. Chicago would see one shipment every 15 hours; St. Louis, Kansas City and Denver, every 13 hours; Des Moines and Omaha, every 10 hours; Salt Lake City, one shipment every 7 hours.

DOE proposes to carry the thousands of shipments of nuclear waste in transportation casks. Some of the waste may be hauled by train, in high volume rail casks. Each rail cask will carry 240 times the long-lived radioactive material that was released at Hiroshima. As is the case with truck shipments, many of the rail line routes would take the nuclear waste through densely populated cities and towns on the way to Yucca Mountain. Other shipments, carrying the same amount of radioactive material as a large rail cask, may be shipped by barge over Lake Michigan, the Mississippi, the Atlantic and Pacific Oceans, and other waterways.

A wide cross-section of Americans will feel the impact of highly radioactive waste shipments, including those who commute from home to work or school on busy roadways. Because of size and weight limitations, it is not possible to build a transportation cask that does not "leak" some radiation. The DOE acknowledges that a truck carrying a nuclear waste cask will emit the equivalent of one chest x-ray per hour of radiation to those who are stuck in traffic nearby. In fact, emissions from passing casks will deliver small doses of radiation to people living within one-half mile of road and rail routes.

Estimates of the number of transportation accidents range from a DOE estimate of up to 310 accidents, to a state of Nevada estimate of up to 390 accidents over the full course of 38 years. The project could entail 2,789 waste shipments per year, a 30-fold increase over U.S. shipments in the past. Despite nuclear industry assertions to the contrary, even with a history of low shipment numbers there have been transportation accidents in the U.S. resulting in leaks of radioactive materials.

Emergency Medical Services officials have stated repeatedly that a severe accident - which could involve thousands of deaths and billions of dollars in property damage - is not something for which they have the training or equipment to properly respond. Because of the potential for accidents, several studies show that property values will decline for the millions of Americans who live near the transportation routes.

PIRG strongly opposes the Bush administration's decision to press ahead with the Yucca Mountain Nuclear Waste Repository in the face of all of the project's shortcomings, as cited in this report and elsewhere.

Background

Yucca Mountain – a volcano on an aquifer in an earthquake zone – is unsound as the designated site for the permanent storage of nuclear waste.

Congress passed the Nuclear Waste Policy Act of 1982 (NWPA) to address the issue of nuclear waste storage. The NWPA established a system for selecting a geologic repository for permanent storage of irradiated nuclear fuel and other highly radioactive nuclear waste. Under the NWPA, the Department of Energy was required to select three candidate sites that might be suitable for a national nuclear waste repository. The NWPA was modified by the Nuclear Waste Policy Amendments Act of 1987, which restricted DOE repository studies to Yucca Mountain only. DOE has proposed that that thousands of tons of nuclear waste be stored in tunnels beneath Yucca Mountain, isolated from the environment for at least 10,000 years.

The NWPA directed the DOE to study the appropriateness of the Yucca Mountain site on the basis of the natural geological characteristics of the mountain. After considerable study of the site, it became apparent that Yucca Mountain is unsound as the designated site for the permanent storage of nuclear waste. The geological characteristics of Yucca Mountain do not lend themselves to permanent storage. Problems include the fact that the area is intersected by 33 earthquake faults; water travels down through the mountain much faster than anticipated; and the proposed storage site is situated above an aquifer that provides the sole source of drinking water for a nearby community.

A report issued in December 2001 by the General Accounting Office, the investigative arm of Congress, concluded that DOE lacks the research and data to substantiate its Yucca Mountain repository proposal and that 293 "significant unresolved technical" issues remain outstanding.[1] Subsequently, in a letter dated January 24, 2002, the Nuclear Waste Technical Review Board, which was created by Congress and appointed by the President, stated that "the technical basis for the DOE's repository performance estimates is weak to moderate." An April 2002 article in *Science Magazine* noted that "[i]n the face of the scientific uncertainties about the site, there is a surprising sense of urgency to move forward with a positive decision on Yucca Mountain as a nuclear waste repository."[2]

Transporting Nuclear Waste by Road, Rail and Barge

The bulk of the nation's nuclear waste is generated and stored east of the Mississippi River - at the opposite end of the country from Nevada.

Land Transportation Routes

The Yucca Mountain High Level Nuclear Waste Repository project is comprised of two principal components: nuclear waste transportation and nuclear waste storage. The transportation component involves shipping highly radioactive nuclear waste across the country to Yucca Mountain from 131 sites in 39 states.[3] The shipment of waste, through 44 states and the District of Columbia over the course of 38 years,[4] represents a formidable and complex logistical endeavor. DOE proposes to ship nuclear waste using a combination of two or more of the following modes of transportation: legal weight truck; heavy-haul truck; railway car; or barge.[5]

There are, of course, a number of options in selecting routes by which to haul the waste to Yucca Mountain. Routes for hauling waste, both highway and rail, could be selected so as to minimize traversing dense population centers and vulnerable or dangerous infrastructure such as bridges and tunnels. DOE, in preparing the Final Environmental Impact Statement (Final EIS),[6] has decided to reject such criteria and has instead opted to select transportation routes using commercial routing computer programs, which use expeditious shipping as the principal criteria for route selection. DOE national highway routes are selected using the "HIGHWAY" computer model,[7] and the national rail routes are selected using the "INTERLINE" computer model.[8] DOE's reliance on commercial shipping programs is likely influenced by the fact that DOE is proposing to use a private, market-driven system for transporting the nuclear waste.[9] Under DOE's approach, cost would constantly be competing with safety when contractors make decisions regarding mode and route selection, frequency of inspections, and other important operating protocols.

The bulk of the nation's nuclear waste is generated and stored east of the Mississippi River - at the opposite end of the country from Nevada. Consequently, the DOE proposed routes must span an enormous part of the country in order to bring the waste to Yucca Mountain. The average shipment will travel more than 2,000 miles.[10] Several states, including Delaware, Indiana, Kentucky, Nevada, New Mexico, Oklahoma, Utah, West Virginia, and Wyoming, would experience thousands of nuclear waste shipments, even though the states themselves have no stored high-level nuclear waste or nuclear power facilities within their borders. The proposed highway routes traverse 703 counties across the country with a total population of 123 million people.[11] The proposed rail routes traverse counties with a total population of 106 million people.[12] By the year 2035, when the Yucca Mountain project would be well under way, a projected 10.4 to 16.4 million Americans would be living within one half mile of the waste transportation routes.[13]

Shipping of the waste would involve transportation through 109 cities with a population exceeding 100,000.[14] State-by-state maps depicting likely road, rail, and barge transportation routes can be found at the back of this report.

- The primary truck routes out of **New England** and the **Middle Atlantic** states converge on I-80/90 near Cleveland, pick up shipments from Midwestern reactors, and follow I-80 west from Chicago through Des Moines, Omaha, Cheyenne, and Salt Lake City to I-15. The primary rail routes out of New England and the Middle Atlantic states are the former Conrail mainlines from Buffalo and Harrisburg to Cleveland and Chicago. These shipments switch to the Union Pacific near Chicago, are joined by shipments from Midwestern reactors in Illinois and Iowa, and continue west via Fremont, Gibbon, Cheyenne, and Salt Lake City to Nevada.

- The primary truck routes out of the **South** are I-75 from Florida, I-20 from Atlanta, and I-64 from Virginia. These routes converge on I-70 near St. Louis, follow I-70 west through Kansas City and Denver to I-25 then join I-80 near Cheyenne. The primary rail routes out of the South are the CSXT from Atlanta to East St. Louis and the Norfolk Southern from Atlanta to Kansas City via Birmingham and Cairo. These two streams merge on the Union Pacific in Kansas City and in turn merge with the northern Union Pacific shipments at Gibbon, Nebraska.[15]

- The primary truck route from the **Pacific Northwest** is I-84 to I-15 in Utah. One of the major rail routes includes the Union Pacific from Oregon via Boise.

- Other major truck routes are I-40 and I-10 from the **Mid-South** and I-5 in **California**. These routes converge on I-15 in Southern California. Other major rail routes are the Union Pacific and BNSF from California and the Southwest via San Bernardino and Daggett.[16]

Shipping Waste by Road and Rail Through Our Communities

The DOE proposes several shipment scenarios in the Final EIS, the principal two being a "mostly truck" scenario and a "mostly rail" scenario. Each scenario includes variations that are related to difficulties with employing a uniform shipping system at all 131 nuclear waste sites across the country.

The "Mostly Truck" Scenario

Under the "mostly truck" scenario, DOE plans to haul nuclear waste to Yucca Mountain using casks loaded on a standard tractor-trailer truck. Legal weight trucks would be able to access all 131 nuclear waste sites; travel on all roads and highways that are open to trucks; and carry the nuclear waste casks to the final unloading point in Nevada.[17] If the Yucca project goes forward, there could be 105,985 cross-country truck shipments of nuclear waste over 38 years.[18] That represents 2,789 truckloads per year, a 30-fold increase over U.S. shipments in the past. Over the past three decades, there have been fewer than 90 shipments per year in the U.S.[19]

As shown in Table 1, several major cities, including Atlanta, Nashville and Cleveland, would see waste truck shipments traveling through their neighborhoods on a daily basis. Chicago neighborhoods would experience a truck shipment every 15 hours; St. Louis, Kansas City and Denver, every 13 hours; Des Moines and Omaha, every 10 hours; and Salt Lake City, a waste shipment every 7 hours.[20]

Table 1. Potential Truck Shipments Through Major Metropolitan Areas, 2010-2048[21]

Metropolitan Area	Total Shipments	Avg. Annual Shipments	Avg. Daily Shipments
Las Vegas	95,957	2,525	6.9
Salt Lake City	52,392	1,379	3.8
Cheyenne	33,685	886	2.4
Omaha	33,685	886	2.4
Des Moines	32,869	865	2.4
Chicago	22,541	593	1.6
Cleveland	18,394	484	1.3
Denver	27,612	727	2.0
Kansas City	26,570	699	1.9
St. Louis	25,835	680	1.9
Nashville	16,329	430	1.2
Atlanta	15,150	399	1.1

The "Mostly Rail" Scenario

DOE's "mostly rail" scenario would haul nuclear waste to Yucca Mountain on rail cars traveling in "mixed freight" trains.[22] Mixed freight trains carry general freight, including flammable gases and liquid, and other hazardous materials. DOE has not endorsed the option of shipping nuclear waste via "dedicated trains" – trains which carry only one commodity.[23] The Association of American Railroads maintains that spent nuclear fuel should only be shipped in dedicated trains.[24] Such trains would handle only nuclear waste, have track priority in relation to other trains, and operate at restricted speeds. Existing U.S. Department of Transportation regulations allow the shipment of nuclear waste in mixed fright trains. The July 2001 Baltimore rail tunnel fire, which involved a mixed freight train, occurred on a rail line considered for use in the shipment of nuclear waste from the Calvert Cliffs, Maryland nuclear plant to Yucca Mountain.

One impediment faced by DOE's "mostly rail" scenario is that up to 32 of the nation's 72 nuclear power plant sites cannot ship directly by rail[25] (the rail facilities do not exist). All five DOE reactor sites have the capacity to ship by rail. DOE acknowledges that the solution lies in shipping the waste using a combination of truck and rail.[26] The combined total of truck and rail shipments from 72 nuclear plant sites and the five DOE sites under the "mostly rail" scenario would be up to 21,365 shipments over 38 years.[27]

None of these figures include shipments from the 54 nuclear waste sites across the country that were inexplicably not included in the Department of Energy's Final Environmental Impact Statement.

Transporting Nuclear Waste by Barge

Casks are only certified for immersion in deep water for one hour.

According to the DOE Final EIS, the possibility exists that barges could be used in part to ship nuclear waste to Yucca Mountain.[28] Many of the nation's 72 nuclear power plants do not have facilities to ship by rail; those that are situated near water could use barges to bring the waste to a rail line (Table 2). DOE does not propose the use of casks designed exclusively for marine transportation. It intends, instead, to simply employ rail casks that are certified by the Nuclear Regulatory Commission for immersion in 200 meters of water for one hour.[29]

Table 2. Potential Barge Shipment Routes and Ports[30]

Nuclear Plant	Waterway	Port
Browns Ferry, AL	Tennessee River	Wilson Loading Dock, MS
Diablo Canyon, CA	Pacific Ocean	Port Hueneme, CA
Haddam Neck, CT	Atlantic Ocean	Port of New Haven, CT
St. Lucie, FL	Atlantic Ocean	Port Everglades, FL
Turkey Point, FL	Atlantic Ocean	Port of Miami, FL
Calvert Cliffs, MD	Chesapeake Bay	Port of Baltimore, MD
Pilgrim, MA	Massachusetts Bay	Port of Boston, MA
Palisades, MI	Lake Michigan	Port of Muskegon, MI
Grand Gulf, MS	Mississippi River	Port of Vicksburg, MS
Cooper Station, NE	Missouri River	Port of Omaha, NE
Hope Creek, NJ	Delaware River	Port of Wilmington, DE
Oyster Creek, NJ	Atlantic Ocean	Port of Newark, NJ
Salem, NJ	Delaware River	Port of Wilmington, DE
Indian Point, NY	Hudson River	Port of Jersey City, NJ
Surry, VA	James River	Port of Norfolk, VA
Kewaunee, WI	Lake Michigan	Port of Milwaukee, WI
Point Beach, WI	Lake Michigan	Port of Milwaukee, WI

Transportation Casks: Are They Failsafe?

The Nuclear Regulatory Commission does not require the full-scale testing of nuclear waste transportation casks.

Nuclear waste is typically shipped in metal casks lined with material that restricts the emission of radiation. DOE and other federal agencies have used casks of various designs in the past and have experienced performance problems at certain points in time.

Nuclear Regulatory Commission (NRC) regulations do not require full-scale testing of nuclear waste transportation casks. Moreover, DOE reportedly opposes mandatory full-scale testing of the casks that would be used in shipping waste to Yucca Mountain.[31] Instead, DOE intends to rely on truck and rail casks that undergo scale model testing and computer simulation testing.

There are certain inherent limitations to scale model testing, as well as to computer simulation, which cannot be overcome short of running actual full-scale tests.[32] For example, testing for the effect that fire will have on a given cask design is inadequate when performed only in relation to a scale model. Likewise, testing for the effectiveness of critical components, such as bolts and seals, falls short on a scale model. There are other instances where scale model testing will be inadequate. For example, the fact that the proposed transportation casks will be significantly larger than those previously used also is a significant factor. Existing truck casks hold approximately 0.5 metric ton of nuclear waste; the proposed casks will hold two tons. Existing rail casks hold approximately 3.5 metric tons of waste; the proposed rail casks will hold up to 12 tons of waste.[33] The significant increase in the weight and volume of the nuclear cargo changes the role that the waste itself plays inside the cask in the event of an impact accident. It is impossible to accurately predict this role through scale model accident simulation.[34]

To be certified by the NRC, each type of transportation cask must be deemed able to withstand a series of four tests: (1) a 30 foot drop onto an unyielding surface, landing on the cask's weakest point; (2) a puncture test, during which the container must fall 40 inches onto a steel rod six inches in diameter; (3) a 30 minute exposure to fire at 1,475 degrees Fahrenheit that engulfs the entire container; (4) and submergence of the container under three (3) feet of water.[35]

It is easy to envision real-life circumstances under which a cask might fail one or more of these tests in an accident while en-route to Yucca Mountain. For example:

(1) Thirty foot drop: At that height, the cask strikes the surface at only 30 mph.[36] Many of the routes to Yucca Mountain include rail and highway bridges that span heights of well over 30 feet.

(2) Forty inch drop onto a six inch rod: At that height, the cask strikes the steel rod at 10 mph.[37] A highway or rail accident could foreseeably involve a steel rod striking a cask with greater force than occurs with a 40 inch drop.

(3) Thirty minute fire at 1,475 degrees: The July 2001 Baltimore rail tunnel fire burned for five days at temperatures exceeding 1,500 degrees Fahrenheit. Diesel, which fuels the trucks and locomotives that would haul nuclear waste to Yucca Mountain, burns at 1,800 degrees Fahrenheit.

(4) Submersion under three feet of water: The DOE proposal includes the shipment of casks by barge on the Atlantic and Pacific Oceans.

In a separate test, an undamaged cask must be deemed able to withstand water pressure equivalent to a depth of 200 meters for one hour, without leakage.[38] Once again, it is easy to envision real-life circumstances involving an accident in which an immersed cask cannot be retrieved within one hour, or where it is under more than 200 meters of water.

DOE acknowledges in the Final EIS that a severe highway or rail accident, or an attack involving high-energy explosives, could release radioactive material from a shipping cask.[39] Each rail cask will carry 240 times the amount of long-lived radioactive material that was released at Hiroshima.[40] The DOE Final EIS also acknowledges that the Baltimore rail tunnel fire was severe enough to release radioactive material had a nuclear waste shipment cask been involved.[41] As noted, the rail line in question in Baltimore has been identified as a potential nuclear waste transportation route.

Irradiated nuclear fuel from power reactors comprises about 90 percent of the radioactive waste that would be shipped to Yucca Mountain (the balance is comprised of other high-level radioactive waste).[42] Spent nuclear fuel is extremely dangerous; when initially removed from the nuclear reactor core, it delivers a lethal dose of gamma and neutron radiation within seconds. It must be cooled in special pools for five years before it can be loaded into a truck transportation cask and ten years before it can be loaded into a rail transportation cask. Even after ten years of cooling, spent nuclear fuel will deliver a lethal does of radiation in under four minutes of exposure.[43]

However, it is important to note that transportation casks do not eliminate human health risk even under normal circumstances. Due to size and weight limitations, it is not feasible to build a transportation cask that does not “leak” some radiation. In fact, emissions from passing casks will deliver small doses of radiation to people within one-half mile of highway and rail routes. DOE acknowledges that a truck cask will emit a 10 millirem/hour dose of radiation from a distance of six feet.[44] As a consequence, people stuck in traffic for one hour next to a shipment of nuclear waste will receive a dose of radiation equivalent to that of a chest x-ray. This dosage of radiation is not generally recommended, particularly for pregnant women and young children. In fact, transportation workers who inspect or deliver truck and train casks have their work hours strictly limited due to the emission of radiation from casks.[45]

Nuclear Waste: Accidents Do Happen

When it became apparent that [the bags of highly radioactive water] would not fit, he held his breath, turned his head and pushed the bags into the cavity while puncturing them with a screwdriver.

No one maintains that the transportation of nuclear waste to Yucca Mountain will be without accident. The Department of Energy has commissioned accident rate assessment studies at various points in time and come up with different figures ranging from up to 66 accidents[46] in one study to up to 310 accidents[47] in another (during the first 24 years of waste transportation). The state of Nevada undertook an analysis applying the actual accident and incident rates from past shipments to the projected shipment numbers and distances that would result under the DOE Yucca Mountain proposal. The Nevada analysis concluded that 160-390 accidents would be expected over 38 years if future shipments were to proceed on the same basis as past shipments.[48]

DOE and the nuclear industry have tried to create the impression that past transportation of irradiated nuclear fuel has been entirely safe. The Nuclear Energy Institute (NEI) claims that the U.S. has an "outstanding safety record of no radioactive leakage in more than 3000 shipments covering more than 1.7 million miles."[49] This claim is false.

In a 1996 report based on Atomic Energy Commission and DOE data entitled *Reported Incidents Involving Spent Nuclear Fuel Shipments, 1949 to Present*, the Nevada Agency for Nuclear Projects documents 72 nuclear waste transportation accidents. Four involve accidental radioactive material contamination beyond the vehicle (Table 3); four involve contamination confined to the vehicle (Table 4); 13 involve traffic accidents with no release or contamination (Appendix A); 49 involve accidental container surface contamination (Appendix B); and two accidents include no description.

Table 3: Accidents Involving Radioactive Material Contamination Beyond the Transportation Vehicle[50]

Date	Mode	Accident Description
Jan. 27, 1984	Truck	Slow drip from bottom front end of empty cask while stored in transportation terminal
Nov. 11, 1964	Truck	Cask leakage, trailer, packages and terminal contaminated
Aug. 21, 1962	Truck	Cask leakage, trailer and small portion of road contaminated
June 2, 1960	Rail	Leak from cask, small area at three rail yards contaminated, no run-off or aerial dispersion.

Table 4: Accidents Involving Radioactive Material Contamination Confined to the Transportation Vehicle[51]

Date	Mode	Accident Description
July 4, 1976	Truck	Pinhole leak of, reported as, coolant/moderator on outside jacket of cask. Shipment continued without risk to public.
Dec. 10, 1963	Rail	Cask leakage, cask contaminated, contamination confined to trailer.
Sept. 22, 1961	Truck	Leak from cask onto trailer floor, result of shifting, contamination confined to vehicle.
Nov. 20, 1960	Truck	Small leak from cask onto trailer floor, result of shifting cask, contamination confined to vehicle.

One accident, a "slow drip from bottom front end of empty cask while stored in transportation terminal," occurred in 1984 in connection with a truck cask. The report lists incidents as late as the early 1990s, but notes the scant nature of available data: "Description of the events and equipment are insufficient to evaluate the failure mechanisms or sources of contamination." Such poor documentation will make it difficult to learn from past accidents. It also obfuscates the true extent of the risk and the shortfall in public safety.

Closer examination reveals that some of the accidents are actually quite significant. For example, an August 25, 1980 accident is reported as "surface contamination on cask," but there is much more to the events according to Dr. Marvin Resnikoff, author of *The Next Nuclear Gamble: Transportation and Storage of Nuclear Waste*.[52]

A truck transportation cask capable of shipping one irradiated fuel assembly was delivered to the San Onofre nuclear plant in California on

August 20, 1980. Unknown to the workers about to handle the cask at San Onofre, the cask had been used four months earlier to ship a leaking fuel assembly from the Oyster Creek, NJ nuclear plant. The cask had become so severely contaminated in the process that officials added external lead shielding in an effort to lower the exposure to workers and the public from the harmful emission of radiation.

When the empty cask arrived at San Onofre, the radiation level in the truck driver's cab was more than twice the maximum legal limit. Two cask technicians arrived to decontaminate the cask, which at certain points on the exterior of the cask emitted 11 to 40 times the legal limit of radiation. A San Onofre health physics technician was on the scene to safeguard the workers' health against radioactivity. However, NRC documents reveal that the health technician was not qualified for this particular task.

The technicians opened a capped pipe leading to the interior of the cask, prompting highly contaminated water to pour out. One technician caught it in a plastic bag and measured the radiation. The water emitted up to 100 rem/hour of radiation, a level high enough to deliver a lethal dose to an adult after five hours of whole-body exposure. The technicians used a paper towel to wipe up moisture in the pipe. The paper towel gave off an even higher 300 rem/hour reading. One technician attempted to place the plastic bags filled with contaminated water into a shielded container. When it became apparent that they would not fit, he held his breath, turned his head and pushed the bags into the cavity while puncturing them with a screwdriver. No standard air samples were taken, and no proper respiratory safety equipment was used. San Onofre was subsequently fined $125,000 for lax health physics supervision.[53]

U.S. experience in transporting spent nuclear fuel spans several decades. However, 2,700 shipments transported over 1.6 million miles in the course of the past 30 years[54] averages out to 90 shipments per year. Under the proposed Yucca Mountain program, there could be 105,985 truck shipments traveling more than 200 million miles, which averages out to more than seven shipments daily over the course of four decades.

When confronted with the scant transportation history in the U.S., DOE and the nuclear industry often rely upon the European experience. There has been a much greater volume of irradiated fuel shipments in Europe, because these countries send irradiated fuel to reprocessing facilities. However, Europe has experienced its own nuclear waste transportation accidents.

Nuclear Waste Transportation Accidents: The European Experience

The figure for internal rail car contamination, 8,000 Bq per centimeter squared, represents 2,000 times the limit permitted by law.

Several European nations, most notably France and Germany, have been shipping nuclear waste by truck and train for several decades. The European experience has included serious incidents involving the release of radiation.

In June 1998, the World Information Service on Energy of Paris (WISE-Paris) released the results of an investigation revealing that French and German authorities had experienced massive contamination of nuclear waste transportation casks and vehicles.[55]

The investigation disclosed that 26 percent of spent fuel casks and 36 percent of transport vehicles (trucks, trains or both) coming into the Valognes waste transfer facility from French power plants, between January and November of 1997, were contaminated with radioactive material. It also revealed that 13 of 17 power reactor sites had shipped contaminated casks and that 16 of the same reactor sites had experienced contaminated transportation vehicles. The investigation further revealed that of 192 casks and transportation vehicles surveyed, 50 were identified as being contaminated up to 200 Bq (per centimeter squared) of radioactive material - 50 times the legal limit (the legal limit is four Bq per centimeter squared).

On April 27, 1998, the French Environment Minister acknowledged in an official statement that the Ministry has "recently noted an abnormally high radioactive contamination, very clearly above the limits defined by law." On the same day the waste transportation company in question provided a document to the French nuclear safety authority admitting that in the course of 1997-1998 "the maximum contamination noted on the rail cars was 700 Bq for the external contamination and 8,000 Bq for the internal contamination." The figure for internal rail car contamination, 8,000 Bq, represents 2,000 times the limit permitted by law.

At the same time, German shipments of nuclear waste from France to Germany were halted by the German authorities in May of 1998. Shipments did not resume until the spring of 2001. This halt in shipments was ordered after it was found that casks and rail cars from several nuclear plants were contaminated well beyond the legal safety limit - including almost 2,000 times the legal limit in some instances.[56]

These examples show that, despite DOE and industry assertions to the contrary, there are inherent dangers in the transportation of nuclear waste that the Europeans have not been able to avoid.

Health Consequences of a Nuclear Waste Transportation Accident

The Radioactive Waste Management Associates study concluded that the number of expected latent cancer fatalities could be up to 1,370 individuals in the event of a rail accident.

Several transportation risk assessments have been conducted recently in connection with the transportation of nuclear waste to Yucca Mountain. Two have been conducted at the behest of DOE and one for the state of Nevada.

The first DOE transportation risk assessment was utilized in the preparation of the Draft EIS.[57] Following the accident severity categories designated by the NRC Modal Study, DOE estimated the consequences of the most severe truck accident using the RISKIND computer code. DOE used weather and demographic inputs based on national average data and assuming the maximum long-term exposure following the accident would be one year. This represents an artificially short duration for long-term exposure. DOE assumed that the truck cask would be loaded with spent nuclear fuel allowed to cool approximately 26 years prior to shipment. NRC regulations permit transportation of much more radioactive five-year-cooled spent nuclear fuel.

The second DOE transportation risk assessment was conducted by Sandia National Laboratories (NUREG/CR-6672) and utilized in the preparation of the Final EIS.[58] This controversial assessment was finalized without the solicitation of public comment. Nor is it apparent whether the revised risk analysis indicates lower risks than previously estimated, or whether the variation is simply a function of the different methodology used.

Radioactive Waste Management Associates (RWMA) prepared a transportation risk assessment for the state of Nevada in 2001.[59] In estimating the consequences of the most severe truck and rail accident, RWMA also used the RISKIND computer code. RWMA used weather conditions (weighted average of all stability categories) and dispersion models and assumed maximum long-term exposure following the accident of one year or 50 years (spanning the gamut of realistic long-term exposure durations, given that people typically continue to reside in contaminated areas). RWMA assumed that the truck and train casks would be loaded with spent nuclear fuel allowed to cool either 10 years or 25.9 years, a more realistic figure that reflects NRC regulations for spent fuel cooling before transportation. The RWMA study concluded that the number of expected latent cancer fatalities could be up to 1,370 individuals in the event of a rail accident (Table 5).

RWMA also estimated the economic impacts of a severe truck and rail accident in an urban setting using the RADTRAN models. For the most severe rail accident in an urban setting under weighted average weather conditions, the analysis estimated the economic costs to be up to $270 billion for 10-year-cooled spent fuel and $145 billion for 25.9-year-cooled fuel. For the most severe truck accident in an urban setting under the same conditions, the analysis estimated the economic costs to be $36.6 billion for 10-year-cooled irradiated fuel and $20.1 billion for 25.9-year-cooled fuel.[60]

Table 5. Latent Cancer Fatalities in the Event of a Nuclear Waste Transportation Accident[61]

Long-Term Exposure Time	Irradiated Fuel Age (years)	Expected Latent Cancer Fatalities: Truck Accident	Expected Latent Cancer Fatalities: Rail Accident
1 year	25.9	15.9	109
50 years	25.9	135	933
1 year	10	20.8	144
50 years	10	199	1,370

The Likelihood of Rail Accidents

The likelihood of transporting nuclear waste by rail without experiencing a number of severe accidents is remote. The U.S. rail system has historically been plagued with accidents, causing both loss of life and property. One need only examine the record of severe railway accidents in the first five months of 2002 to find an illustration of the rail industry's poor safety record (Table 6).

Emergency Medical Services Preparedness

None of the public safety agencies were able to state that they are adequately prepared or equipped to respond to the [nuclear waste] transportation accident scenario used in the study.

There is little actual experience involving emergency response for a severe transportation accident in which radioactive material is released. The technical literature regarding decontamination following a major radioactive release in a transportation accident is virtually non-existent.

The state of Nevada commissioned a study[62] whereby it put the following scenario of an accident, involving a truck carrying spent nuclear fuel and a gasoline tanker near an urban center, to public safety officials in Clark County, Nevada:

> *The [truck] accident triggers a chain reaction collision. Twenty-seven civilians, four sheriff's deputies, and seven firefighters are hospitalized after exposure to radiation at the site of the accident. Another 1,000 or more persons are exposed to radiation from the fire's radioactive plume. Experts indicate that 5 to 200 latent cancer fatalities may result from the accident. The affected highway and several access ramps are closed for four days. The two drivers of the spent fuel hauler and the gasoline tanker, and one driver escort, died from head injuries and burns. Six months later, the cleanup effort is still underway, and thousands of lawsuits have been filed. Preliminary reports estimate cleanup costs and economic losses in excess of $1 billion.*

Public safety officials consisting of firefighters, police officers, and emergency management personnel participated in the study. None of the public safety agencies were able to state that they are adequately prepared or equipped to respond to the transportation accident scenario used in the study. However, the Department of Energy characterizes the role of first responders in an emergency situation involving radioactive materials as follows:

> *The first responders would investigate the potential presence of radioactive material, treat injuries, protect themselves and the public, and secure the area. As noted above, first responders would determine further appropriate emergency response actions, because they would be in charge of the accident scene.*[63]

Table 6. Severe U.S. Railway Accidents, January 1, 2002 – June 1, 2002[64]

DATE	LOCATION	DESCRIPTION
May 30, 2002	Hall County, GA	12 cars were derailed when a truck drove into the side of a Norfolk Southern train. 250 Oakwood residents were forced to evacuate because of possible chemical spills.
May 28, 2002	Clarendon, TX	22 coal cars and three freight cars derailed when two trains collided in a head-on, fiery collision.
May 27, 2002	Potterville, MI	35 cars derailed outside Potterville carrying explosive liquid propane and sulfuric acid. The town's 2,200 residents were forced to evacuate. The accident occurred within yards of a subdivision, where it is estimated that 30 freight trains pass everyday.
May 15, 2002	Coosawatchie, SC	A train collided with a logging truck in South Carolina, derailing all ten cars and injuring 14 people. The driver claimed not to have seen the train. At the crossing there were no warning devices, lights or railroad gates.
May 13, 2002	Wright, WY	One freight car collided with another stationary freight car. The accident resulted in nine cars being derailed and several injuries among crewmembers.
May 07, 2002	North Lake, WI	A train carrying liquid fertilizer derailed, left an estimated three miles of debris, and finally stopped, one car dangling from a partially collapsed bridge over Highway 83.
April 24, 2002	35 mi. south of downtown L.A.	A mile long freight train ignored railway traffic signals and collided head-on with a stopped commuter train, killing two and injuring more than 160 others.
April 19, 2002	12 mi. north of Independence, NV	Thirteen cars derailed early in the morning. They were empty, but they contained some residue from hazardous materials.
April 18, 2002	Crescent City, FL	An Amtrak Auto train derailed in Crescent City about 60 miles north of Orlando. The accident killed four and seriously injured almost 100 others.
April 7, 2002	Gainesville, VA	Two propane cars, carrying a total of 70,000 gallons of propane, derailed forcing the evacuation of the area. This was the seventh railroad accident in Prince William County since 1997.
March 29, 2002	Newark, NJ	A freight train derailed for the second time in five days in the same place. Officials suspect vandalism to be the cause of both accidents.
March 16, 2002	Atlanta, GA	Eight cars derailed on their way to North Carolina, leaking hexamethylenediamine – a corrosive chemical that burns the respiratory tract, eyes, and skin.
March 14, 2002	Neal, WV	Several cars derailed at an accident at a Sunoco Chemicals plant. On car hit one of the plant's silos, allowing polypropylene plastic pellets to leak everywhere. 40 homes were forced to evacuate.
Feb. 24, 2002	Tucson, AZ	Five cars derailed in Tucson's south side, probably from a mechanical failure. There were hazardous chemicals on board.
Feb. 14, 2002	Richmond, TX	32 cars derailed in a Union Pacific accident that caused the cars to spill their cargo onto US Highway 90. The cars only contained gravel.
Jan 18, 2002	Minot, ND	One person died and hundreds more were injured in a 30 car derailment, leaking 240,000 gallons of anhydrous ammonia into the air and 100,000 to 150,000 gallons into the ground.

Nuclear Waste Transportation: Post September 11th

The Department of Energy has not made plans to take into account the additional dangers of transporting nuclear waste through our communities post-September 11th.

As noted earlier in this report, the Department of Energy has not yet commenced preparation of a transportation plan for the shipment of nuclear waste to Yucca Mountain. Likewise, DOE has not made plans to take into account the additional dangers of transporting nuclear waste through our communities post-September 11th.

The Yucca Mountain project would entail the movement of nuclear waste from 131 more securable locations, over thousands of miles of roadway and rail line that cannot be secured. This creates an opportunity for sabotage throughout neighborhoods across America, in what experts refer to as a “target rich environment.”[65] Given the potential number and duration of shipments – more than 100,000 over the course of 38 years – would-be saboteurs will be able to determine the pattern of nuclear waste transportation routes, dates and times.

Reducing Americans’ Quality of Life

The Decline in Real Estate Values along Transportation Routes

Twenty percent of respondents thought that property values near rail lines used for hauling nuclear waste would decrease by 21 to 30 percent.

The risks and dangers associated with nuclear waste transportation have historically had a negative impact on residential property values. This pattern of depreciation is expected to continue with the proposed transportation of waste to Yucca Mountain. For reasons that are readily apparent, the majority of Americans do not want to live in close proximity to nuclear waste. Home owners are willing to pay a premium to live in area that is free of hazardous materials such as spent nuclear fuel. The obverse of this is that home owners expect a discount on the value of a property that is located in close proximity to a nuclear waste transportation route.

In a study conducted for the Utah Association of Realtors in September 2000, home owners were asked a series of questions in connection with nuclear waste transportation routes and property values. Seventy-three percent of respondents said it would definitely or probably have an impact on whether they purchased property within a half mile of railway tracks, if they knew that nuclear waste was to be transported on those tracks. Of those interviewed, 63 percent said that transporting nuclear waste by rail will definitely or probably result in a drop in property values. Three-fourths of respondents thought that transportation of nuclear waste along rail lines would definitely or probably have a negative impact on current homeowners who are trying to sell their homes. Finally, 20 percent of respondents thought that property values near rail lines used for hauling nuclear waste would decrease by 21 to 30 percent.

In a May 2000 study conducted for the Department of Energy, the University of New Mexico analyzed the impact of nuclear waste transportation on residential property values in South Carolina. According to the study, a home adjacent to a nuclear waste rail route would be valued three percent less than a similar home five miles from the rail route.

A case heard before the New Mexico Supreme Court in 1993 recognized that the public’s perception of fear associated with the transportation of nuclear waste may provide the basis for a damage award. The City of Santa Fe condemned 43 acres of private land for a highway bypass around the city to provide a route for nuclear waste shipments to the Waste Isolation Pilot Plant near Carlsbad, New Mexico. The New Mexico Supreme Court determined that the private landowners were entitled to receive compensation for the reduction in value of 630 acres of land adjacent to the condemned land because of public fear of the proposed nuclear waste shipments. The Court affirmed the jury's award of $337,000 for the loss - a 4.75 percent drop in market value of the land.

Limitations on Nuclear Accident Insurance

Nuclear waste transportation operators and all other Department of Energy contractors are relieved of all liability – even in the event of gross negligence or willful misconduct.

Under the Price-Anderson Act, the Department of Energy provides indemnification for any nuclear accident arising in the course of transportation of nuclear waste to Yucca Mountain. The level of indemnification is to a maximum of $9.43 billion. Damages for nuclear waste transportation accidents have been estimated at many times this figure by several experts. There is no liability to the victims of an accident above and beyond this amount, and waste transportation operators and all other DOE contractors are relieved of all liability – even in the event of gross negligence or willful misconduct. This type of broad exemption from liability reduces the incentive for safe operation and accountability. In addition, general home insurance policies explicitly exclude compensation for personal and/or property damage sustained as the result of an accident involving nuclear materials.

Recommendations

The Bush administration has decided to proceed with the Yucca Mountain project. At the same time, Energy Secretary Spencer Abraham has stated on the record that DOE is "just beginning to formulate its preliminary thoughts about a transportation plan" for the project.[66] This means the Bush administration has made a decision that could risk the health and safety of millions of Americans before it has adequately studied those risks.

Nuclear waste is recognized as the most dangerous substance known to humankind. The Yucca Mountain High-Level Nuclear Waste Repository is an ill-conceived industry driven project that is fraught with substantive technical problems. The proposal to transport thousands of tons of highly radioactive waste across the country is an integral part of the Yucca Mountain project and poses a serious threat to the health and safety of millions of Americans today and for generations to come. PIRG strongly opposes the Bush administration's decision to press ahead with the Yucca Mountain Waste Repository, because it poses an unacceptable threat to Americans living near Yucca Mountain and those living along the waste transportation routes.

Nuclear Waste Truck and Rail Shipments through the State of

FLORIDA

Number of shipments through the state – Mostly Truck scenario:	**5,223**
Number of shipments through the state - Mostly Rail scenario:	**348**
Number of Fatal Tractor-Trailer Wrecks (1994-2000):	**1,690**
Number of Train Wrecks (1990-2001):	**1,880**