

**RISKY TRANSIT - THE FEDERAL GOVERNMENT'S
RISKY AND UNNECESSARY PLAN TO SHIP SPENT NUCLEAR FUEL
AND HIGHLY RADIOACTIVE WASTE ON THE NATION'S
HIGHWAYS AND RAIL ROADS**

A Report By The Nevada Agency for Nuclear Projects

Nuclear waste. The name alone invokes images of horror, death, sickness. For the most part, however, nuclear waste in the form of spent nuclear fuel that is the end product of nuclear-generated electricity and high-level radioactive detritus left over from nuclear weapons production has always been viewed by most Americans as someone else's problem. Few of us live in close proximity to nuclear power plants or nuclear weapons plants.

If the U.S. Department of Energy (DOE) has its way, however, millions of Americans from Main to California will find themselves face-to-face with tens of thousands of shipments of dangerous radioactive materials day after day, month after month, for over three decades.

The transport of deadly spent nuclear fuel and high-level radioactive waste to a proposed disposal site at Yucca Mountain, Nevada has the potential to dramatically and significantly impact communities across the nation. Depending on assumptions about the mix of shipping modes (rail vs. truck), handling and shipping capabilities at points of origin (e.g., at the various reactor sites), the size of the shipping canister or cask, and other factors, a Yucca Mountain repository, if constructed and opened, would result in up to 96,300 shipments¹ of spent nuclear fuel (SNF) from civilian nuclear power plants and high-level radioactive waste (HLW) from DOE weapons facilities. The repository would also receive an unknown but likely very large number of shipments of so-called "miscellaneous wastes requiring geologic disposal," adding to the overall number of radioactive materials shipments that would be required.

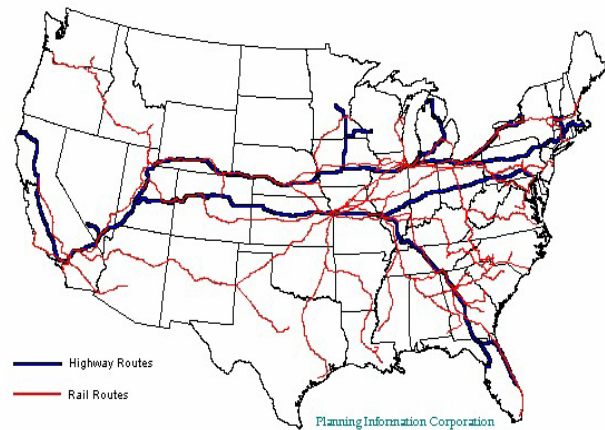
Studies by the State of Nevada and DOE indicate that [43 states](#) would be directly impacted by SNF and HLW shipments to the proposed Yucca Mountain repository. A study by DOE identified 109 cities with populations over 100,000 that would be affected by such shipments.² The DOE report parallels an analysis done by State researchers in 1995 and updated in 1996. The Nevada report examined shipping routes, both rail and highway, in relation to the impacts various alternatives would have on communities nationwide. The State's analysis shows that many of the reactors that would ship waste during the first 10 years of repository operations will likely use truck transport regardless of the availability of rail access to Yucca Mountain, thereby impacting a larger number of cities and communities than reflected in the DOE report.

¹ Under a scenario where most of the waste is shipped using legal weight trucks, there would be 96,000 truck shipments plus 300 Naval spent fuel shipments that would have to come by rail from Idaho National Engineering and Environmental Laboratory, due to the size and configuration of the Navy packaging.

² The report titled, "Nevada Potential Repository Preliminary Transportation Strategy Study 2," was released in February 1996 by TRW Environmental Safety Systems, Inc., DOE's management and operations contractor for the Yucca Mountain project.

Nuclear waste transportation will be the most visible and dramatic "driver" of potential impacts for communities throughout the country. Despite this fact, DOE has done almost nothing to evaluate such impacts. The few feeble attempts that DOE has made to address the transportation issue have been wholly inadequate and designed to obfuscate risks and impacts rather than deal with them forthrightly.

There is, and rightfully should be, great concern that shipments of spent fuel and other highly-radioactive waste to a Yucca Mountain repository will not be as safe and uneventful as the limited number of historical shipments often cited by DOE and the nuclear industry. State of Nevada transportation impact assessment efforts over the past 14 years have resulted in numerous disturbing findings with respect to spent fuel and high-level waste transportation and its impacts on the nation.



Likely highway and rail routes to a Yucca Mountain repository.

The Historical Record - Cause for Concern About Safety

The spent fuel shipping campaign to a Yucca Mountain repository would be by far the largest, most ambitious, and longest duration spent fuel or nuclear waste shipping campaign in history. Past performance on the part of the nuclear industry is no assurance that future Yucca Mountain shipments will be safe.

DOE and the nuclear power industry are quick to point to the record of safely shipping limited quantities of spent fuel during the past 30 years. What DOE and the industry do not publicize is that, prior to 1971, there were, in fact, transportation accidents and incidents that resulted in radiation releases. Between 1957 and 1964, there were 11 transportation incidents and accidents involving spent fuel shipments by the US Atomic Energy Commission and its contractors. Several of these incidents resulted in radioactive releases requiring cleanup, including leakage from a rail cask in 1960 and leakage from a truck cask in 1962. There is no comparable data for the period from 1964 to 1970, when utility shipments to reprocessing facilities began. Between 1971 and 1990, there were six accidents and 47 incidents involving spent fuel cask shipments. Three accidents (two truck, one rail) involved casks loaded with spent fuel. Fortunately, no radioactivity was released in these accidents. However, the record clearly indicates that accidents do happen and that the potential for accidents involving radiation releases exists.

In the past, limited numbers of spent fuel shipments have been made between and among utilities and to and from storage and research facilities. Shipping campaigns rarely involved more than a few shipments at a time. The average distance of past shipments has been less than 600 miles. For Yucca Mountain shipments, the average distance traveled will be almost four times that.

Depending on assumptions about the mix of shipping modes (rail vs. highway), handling and shipping capabilities at points of origin (e.g., reactor sites), size of the shipping canister or cask, and other factors, a Yucca Mountain repository, if constructed and opened, could receive more than 96,000 shipments of spent nuclear fuel from civilian nuclear power plants and high-level radioactive waste from DOE weapons facilities. The repository would also receive an unknown but potentially large number of shipments of so-called "miscellaneous wastes requiring geologic disposal," adding to the overall number of radioactive materials shipments that would be required.

Research by DOE as well as by the State of Nevada and independent scientists has demonstrated, for example, that shipments of spent nuclear fuel, especially shipments through urban areas, have the potential to negatively affect property values along transport routes, even without the occurrence of an accident or incident. An accident involving the release of radioactive material would have major consequences. DOE's own studies show that a worse case transportation accident would cause between 4 and 31 latent cancer fatalities. A 1985 DOE contractor report estimated that cleanup after a severe rail accident could cost \$620 million in a rural area and more than \$2 billion in an urban environment. State of Nevada evaluations of the same accidents, using DOE's computer models, found that the consequences could be hundreds of cancer deaths and tens of billions of dollars in clean up costs (not including decreased property values and business losses due to stigmatizing effects of a nuclear accident).

The precautions taken for historical shipments have often been extreme and beyond what is minimally required by regulation. This was possible because the shipments were usually one-time events. In the case of Yucca Mountain, there will be tens of thousands of spent fuel and high-level waste shipments continuously for over 30 years.

DOE is proposing to use a privatized market-driven system for shipping spent fuel to a Yucca Mountain repository, where cost will constantly be competing with safety when decisions such as routing, mode selection, etc. are being made. In the case of rail shipments, DOE's plans actually call for spent fuel casks to be shipped in mixed general freight instead of in secure and specially regulated dedicated trains. It will simply be impossible to afford the same level of care and attention to each Yucca Mountain shipment that was afforded to one-time utility shipments of the past.

Radiological Health Effects of Routine Shipments

Spent nuclear fuel is extremely radioactive and very deadly. It requires extraordinary precautions and shielding in order to safeguard the public and others from its lethal effects. A

person standing one yard away from an unshielded, 10 year old fuel assembly, for example, would receive a lethal dose of radiation (500 rem) in less than three minutes and would incur significant damage within seconds.

The surface dose rate of spent fuel is so great (10,000 rem/hour or more) that shipping containers with enough shielding to completely contain all emissions are too heavy to transport economically. Consequently, NRC regulations allow a certain amount of neutron and gamma radiation to be emitted from shipping casks during routine operations and transport (1,000 mrem/hr at the cask surface and 10 mrem/hr 2 meters from the cask surface). While the significance of human exposure to low levels of radiation, which may cause health effects less obvious than cancer or birth defects, is not fully understood and is the subject of much controversy in the medical and health physics communities, there is a risk of serious adverse health effects from routine emissions (i.e., without accidents occurring or radioactive materials being released from the shipping casks) to train crews due to emissions from rail casks, especially on dedicated trains; to truck drivers and others involved in truck transport of the waste; to inspectors dealing with large numbers of shipments over long periods of time; and to members of the public from truck casks during gridlock incidents. Another aspect of this issue is the excessive level of surface contamination (the so-called "weeping" phenomenon) on casks loaded in wet storage pools.

State of Nevada researchers, using DOE's shipment number figures and computer models, have estimated that the Yucca Mountain shipping campaign, even without a radiological accident occurring, would result in the following exposures:

- Truck safety inspectors would receive 2,500 millirems per year (mrem/yr);
- Occupants of a vehicle next to a spent fuel truck in a traffic situation lasting one to four hours would receive 10 - 40 mrem per person per incident;
- Members of the public along potential legal weight truck routes in Nevada could receive between 150 - 260 mrem/yr.

Such exposures could add up to substantial amounts of radiation when multiplied over the 28 - 35 year duration of a Yucca Mountain shipping campaign. People exposed repeatedly, over long periods of time, to such spent fuel and high-level waste shipments could experience serious and even life threatening radiation-induced health effects.

Terrorism Risks in High-Level Waste Transportation

State of Nevada research into the potential risks associated with terrorism or sabotage against repository shipments indicates that such risks are substantial and grossly underestimated by DOE, NRC, and the nuclear industry. Years of relative quiet on the national scene with respect to nuclear facilities and nuclear shipments have fostered complacency and what one researcher called an "atrophy of vigilance." Research conducted by the State indicates that past NRC and DOE evaluations of the terrorist threat are deficient with respect to the terrorist threat

in the 21st century.³ The type of terrorism (domestic as well as international), the methods that might be employed, and the weapons that are available to terrorist groups have changed markedly over the past 20 years. As a result, the risks of terrorist action and the consequences of such action against spent fuel or HLW shipments may be much greater than current estimates indicate.

The outcome of a terrorist attack on a SNF or HLW shipment will vary according to the type of attack, the weaponry used, the location, and other variables. The armor penetration capability of currently available weapons that could be used to attack a shipping cask is considerably greater and more effective than the capability that was assumed in the DOE and NRC assessments of the 1970s and 1980s. Guerrilla armies around the world are known to be equipped with older anti-armor missiles such as the Soviet RPG-7 and the American M72. With the ability to penetrate up to 10 - 14 inches of armor plate, these weapons pose a considerable threat to a nuclear waste shipping cask. Terrorists could conceivably obtain one of the dozen or more antitank weapons currently capable of penetrating 12 - 30 inches of tank armor.⁴

DOE's draft Yucca Mountain EIS includes an analysis of acts of sabotage against spent fuel shipping casks. DOE acknowledges that high-energy explosive devices available to terrorists are "capable of penetrating a cask's shield wall, leading to the dispersal of radioactive contaminants to the environment." [page 6-33]. DOE estimated that a successful attack on a truck cask in an urban area could release enough material to cause 15 latent cancer fatalities.

State of Nevada staff and contractors have replicated DOE's accident and sabotage consequence analyses, using the RADTRAN and RISKIND models, and have evaluated DOE's accident and sabotage scenarios using credible alternative assumptions. Nevada believes that the Draft EIS underestimates the impacts of a successful terrorist attack on a truck cask by at least a factor of 10. The population dose from the postulated attack could be at least 310,000 person-rem, resulting in at least 150 fatal cancers. Adverse economic impacts, including business losses and cleanup costs, could be as high as \$20 billion.

Nevada's Attorney General filed a petition for rulemaking with the NRC in June 1999. The petition requests amendments to the current transportation safeguards regulations and a comprehensive reexamination of the consequences of radiological sabotage against SNF/HLW shipments. In September 1999, the NRC accepted and published for public comment Nevada's Petition for Rulemaking. The Western Governors' Association endorsed Nevada's petition, as did nine individual states. As of December 2000, NRC staff are still reviewing the petition and public comments.

³ Ref. "A Preliminary Study of Sabotage and Terrorism as Transportation Risk Factors Associated with the Proposed Yucca Mountain High-Level Nuclear Waste Facility," by James David Ballard (September, 1996).

⁴ In fact, one such weapon, a U.S. Army "Super Dragon" anti-tank missile launcher, was recently found in a cave in Churchill County, Nevada by hikers. Neither the Army nor the Nevada National Guard could account for the weapon.

Meanwhile, in September 2000, the National Council on Radiation Protection and Measurements (NCRP) published a draft report on radiation protection issues related to terrorist activities intended to disperse radioactive material. (Radiation Protection Issues Related To Terrorist Activities That Result in the Dispersal of Radioactive Materials, NCRP Draft Report No. SC 46-14, September, 2000) The NCRP report states: “Nuclear reactors, adjacent spent fuel storage depots, nuclear fuel reprocessing facilities, transport vehicles, or any high level waste site are potential targets for the use of high explosives to disperse into the atmosphere the very high levels of radioactivity associated with materials at these facilities.” [page 15].

Nevada’s petition states that three major changes have occurred in the nature of the terrorist threat that argue for a strengthening of the safeguards regulations: (1) the increasing lethality of terrorist attacks in the United States; (2) an increase in serious terrorist attacks and threats against transportation systems; and (3) renewed concerns about nuclear terrorism generally, and specifically, terrorist actions involving potential radioactive contamination.

Developments in two related areas have increased the vulnerability of spent fuel shipping casks to terrorist attacks involving high-energy explosive devices. First, the capabilities and availability of explosive devices, especially antitank weapons, have increased significantly. Second, new spent fuel shipping cask designs, developed to increase payloads without exceeding specified weight limits, appear to be more vulnerable to attacks involving past, current, and future weapons systems and commercial explosives.

Spent nuclear fuel shipments to a geologic repository and/or centralized interim storage facility will be dramatically different from past shipments in the United States. The following differences will create greater opportunities for terrorist attacks and/or sabotage against SNF/HLW shipments and may also increase the consequences of any incidents that occur:

- (a) long duration, highly visible, nationwide shipping campaign;
- (b) regular and predictable shipments to a single destination;
- (c) large increase in amount of spent fuel shipped and increased numbers of truck and rail shipments annually, averaging several cask shipments per day, every day, for 30 years;
- (d) substantial increase in number of active routes and average shipment distances, with potential implications for selection of targets and attack locations;
- (e) significant concentration of shipments along certain highway and rail routes west of the Mississippi River, with implications for shipments through heavily populated areas and through locations that place shipments in significantly disadvantageous tactical positions;

- (f) potential use of routes within Nevada with marginal safety design features, limited rest and refueling locations, and low likelihood of swift local law enforcement agency response; and
- (g) DOE's planned use of a "market driven" transport system (i.e., a system of regional contractors and subcontractors selected on the basis of lowest cost), thereby complicating security for shipments and potentially increasing risks.

Nevada believes that a national repository or interim storage facility may have a greater symbolic value to terrorists as a target for attack than current at-reactor storage facilities, and that the enhanced symbolic value of the facility as a target may extend to SNF shipments to such a facility. Nevada further believes that a storage or disposal facility operated by DOE, the U.S. government agency responsible for producing nuclear weapons, may have greater symbolic value to terrorists as a target for attack than commercial storage facilities and that the enhanced symbolic value may extend to DOE's shipments of SNF and HLW to such a facility.

Combine the attractiveness of repository shipments as targets and the prominence of Las Vegas (or Reno) as a major resort area and media market, and there exists a not insignificant potential for terrorism or sabotage within Nevada. In addition, many of the geographic and terrain features in the State, such as long expanses of unpopulated rural highways and railroads, rugged mountain areas that provide ideal cover and facilitate escape, etc., also combine to increase the risks of terrorism against spent fuel and high-level waste shipments.

Shipping Cask Performance in Severe Accidents and Sabotage or Terrorism Incidents

The assumption by DOE, NRC, and the nuclear power industry that shipping casks will survive the most severe accidents, sabotage, or terrorist incidents without loss of shielding or containment is not only unsubstantiated, but dangerously irresponsible. Nevada-sponsored research indicates that the NRC cask performance standards do not reflect credible worst-case accident or attack scenarios. None of the casks currently in use have been physically tested to determine if they comply with current standards because full-scale testing is not required by the NRC. DOE has no plans for full-scale testing of the new cask designs that would be used for repository shipments, even though they will differ significantly from current designs.⁵ Furthermore, DOE has not adequately considered human factors in all phases of cask development and deployment. Human error may affect cask performance in the design phase, in fabrication, in licensing, in operations, and in maintenance. DOE's consideration of human factors in cask design has been inadequate, as documented in the Agency's review of the preliminary design reports for the GA-4/9 and BR-100 casks. Human factors management will be especially important in DOE's transportation system because the large cask fleet will require mass production and large-scale maintenance operations.

In addition, none of the casks to be used to ship spent fuel and high-level radioactive

⁵ Casks to be used for repository shipments are being designed to hold much more spent fuel than current casks. The new casks will be less heavily shielded; manufactured with new, different, and lighter weight materials; and mass-produced in large quantities instead of being hand built like existing casks.

waste are required to be physically tested. NRC allows manufacturers to use computer simulations to demonstrate compliance with safety regulations. State researchers and others have strongly criticized not only the lack of physical testing for casks, but also the NRC cask safety regulations themselves as being too lenient and not representative of real world accident conditions.

Conclusion: Transportation Risks are Substantial and Unwarranted

State of Nevada research has documented that there are substantial risks to communities in located along potential shipping routes from the transport of spent nuclear fuel and high-level waste to a repository or interim storage facility in Nevada. These risks are significant “drivers” of many of the socioeconomic and related impacts associated with the federal program. DOE’s and the federal government’s activities in the area of transportation analysis, planning, and risk management have done little to attenuate these risks and, instead, have either obfuscated or actually exacerbate risks and their consequences.

Not only are the risks from spent fuel and high-level waste shipments potentially great, but they are also unnecessary. These materials have long been - and are currently being - stored in safe, secure fixed locations where risks are minimized. With currently available dry storage technology, spent fuel can continue to be safely and economically stored on site for the next 100 years or more. Exposing millions of people in 43 states and thousands of communities to needless risks from the transportation of these materials is more than unwarranted - it is irresponsible and foolhardy.

This paper was prepared by the State of Nevada’s nuclear waste watchdog agency from the findings of extensive research into the transportation of spent nuclear fuel and high-level radioactive waste that was undertaken over the past 15 years.