The Dangers of Plutonium Transportation

Revised and Re-Released May 3, 2001

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The Current Situation

On January 4, 2000 the Department of Energy (DOE) issued its Record Of Decision to process up to 50 metric tons of surplus plutonium from the United States at Savannah River Site in South Carolina. This calls for the use of up to 33 metric tons as mixed oxide uranium and plutonium fuel. A new plant would take plutonium "pits" from warheads and convert them into fuel for commercial nuclear power reactors. In March 1999 the U.S. Dept. of Energy chose a consortium of private firms, Duke, Cogema, and Stone & Webster (DCS), to begin the design and construction work. Subcontractors to DCS include Duke Power Company which would provide four reactors where mixed oxide fuel would be used. Duke plans to modify existing commercial light water reactors to use mixed oxide fuel at two sites: Catawba in York, SC and McGuire in Huntersville, NC.

United States Weapons Plutonium Inventories

DOE Processing plant	Tons of Plutonium
Rocky Flats	12.9
Hanford	11
INEEL Idaho	4.5
Los Alamos	2.6
Savannah River	2.1
Pantex	21.3
Total	54.4

Data from WISE Plutonium Investigation No.17-18 Feb. 2000

In August 1999 DOE contracted with Raytheon to design a plutonium Pit Disassembly and Conversion Plant with an annual capacity of 3.5 metric tonnes. The January 2000 ROD would have up to 33 metric tonnes plutonium fabricated into fuel.

Plutonium Transport Problems

If even a small amount of plutonium were to be dispersed into the environment there could be serious consequences. International Physicians for the Prevention of Nuclear War estimates that 27 micrograms of insoluble plutonium-239 in the lungs would be sufficient to cause cancer in an adult human being.

The security measures necessary to safeguard the importation of plutonium would affect civil liberties. Because the proposed plan necessitates shipping nuclear weapons-usable plutonium over enormous distances, it might well increase the likelihood that such material could fall into the hands of terrorists. The U.S. National Academy of Sciences stated that shipments of plutonium fuel will require security measures equivalent to those needed for transport of nuclear weapons. Harvard Law School and the United Kingdom Royal Commission on Environmental Pollution have also raised concerns about the security measures needed for plutonium as an article of commerce and the effects on civil liberties.

A report prepared by a special commission of International Physicians for the Prevention of Nuclear War and the Institute for Energy and Environmental Research states:

> ***"Using plutonium as fuel on a large scale would be difficult to safeguard and would involve a high risk of diversion. In the case of plutonium from weapons, there would be a regular traffic of plutonium oxide from dismantlement and storage sites to fabrication facilities and reactors, with the risk of attack along transportation routes."*** [International Physicians for the Prevention of Nuclear War and The Institute for Energy and Environmental Research, Plutonium: Deadly Gold of the Nuclear Age, International Physicians Press, Cambridge Massachusetts, 1992, p.133-134]

MOX fuel has a greater quantities of plutonium and other hazardous radioactive isotopes such as Americium 241 and Curium 242--actinide elements which would cause additional harmful radiation exposure to the public during a failure of the reactor containment structure.

> ***"Public attention has been drawn to the higher actinide inventories available for release from MOX than from conventional fuels. <u>Significant releases of actinides during reactor accidents would dominate the accident consequences</u>. Models of actinide release now available to the NRC staff indicate very small releases of actinides from conventional fuels under severe accident conditions."*** *(emphasis added)* [Letter from Advisory Committee on Reactor Safeguards to Nuclear Regulatory Commission Chairman, May 17, 1999]

Irradiated Fuel Storage at McGuire and Catawba

Original capacity of the fuel pools at Catawba Nuclear Station was 2,840 assemblies. Catawba's two reactors opened in 1985 and 1986. McGuire Nuclear Station's original design had storage for 2,926 fuel assemblies. McGuire has two reactors which opened in 1981 and 1984. In addition to irradiated fuel assemblies generated at McGuire 1 and 2, hundreds of assemblies were trans-shipped from Oconee Nuclear Station to McGuire in the 1980's. The original irradiated fuel capacity at Oconee was just 2,137 assemblies for three reactors which opened in 1973 and 1974.

> ***"Trains will carry 14pwr and 36bwr assemblies assemblies respectively. McGuire-rail-6 shipments, Catawba-rail-5 shipments....These numbers reflect annual shipments. McGuire-3800 total assem. Catawba-4300 total assem."***
> October 28, 1987 memo from Paul Viggiano to Mary Cartwright, Duke Power General Manager for public relations regarding irradiated fuel shipments to an MRS in Tennessee .

Why did Duke not build larger storage facilities at Oconee? The company had pinned its hopes on a federal program for reprocessing.

> ***"In the early 1970's when Oconee was constructed, the national policy was for spent fuel reprocessing. Reprocessing is the processing of spent reactor fuel to recover the reusable fissionable material. On-site storage in the early 1970's was considered to be temporary and storage pools were sized to provide only a few years of storage. However, a 1977 federal moratorium on reprocessing was instituted requiring utilities to keep spent fuel at the reactor site. At that time, after evaluating the options, Duke requested to ship 300 fuel assemblies from Oconee to McGuire for storage."*** [October 28, 1987 memo from Paul Viggiano to Mary Cartwright, Duke Power General Manager for public relations regarding irradiated fuel shipments to an MRS in Tennessee.]

Duke's view of the plutonium fuel business was made clear in October 1998 when Senior Vice President Tuckerman told a reporter, "If MOX fuel is successful in the United states, it could ultimately lead to full scale reprocessing of spent nuclear fuel." [Nashville Tennessean]

Risk of Terrorism and Sabotage From Plutonium Fuel Transportation

The plutonium oxide fuel would be valuable target. The secrecy and defense measures which the military uses to transport plutonium weapons would have to be duplicated by every domestic utility company using plutonium fuel. The transport of the plutonium from present DOE facilities to the Savannah River Site and then to reactor sites would add to the risk of accidental release of radiation. The US Department of Energy's program would transport plutonium from Defense Department sites to South Carolina for immobilization and fuel fabrication. From Savannah River 33 tons of plutonium in mixed oxide fuel would be transported across hundreds of miles of isolated countryside to utility reactors in North Carolina and South Carolina. This overland transport link presents a unique opportunity to those who might intercept and divert the fuel for weapons use. The freshly fabricated fuel rod assemblies would be the most desirable form for groups who would go after the plutonium for unlawful use in their own explosive devices. DOE admits this vulnerability:

> ***"...the unirradiated fuel contains large quantities of plutoniumand is not sufficiently radioactive to create a self-protecting barrier to deter the material from theft...."***
>
> Revised Conceptual Designs for the FMDP Fresh MOX Fuel Transport Package, Ludwig et al, ORNL/TM-13574, March 1998

The risks of deliberate diversion and/or destruction of a fresh nuclear fuel or irradiated waste transport cask are increased by plutonium fuel. Higher actinide inventories increase the public health risks. The strategic value of plutonium oxide for new weapons increases the threat of diversion. Safety depends on adequate personnel and procedures.

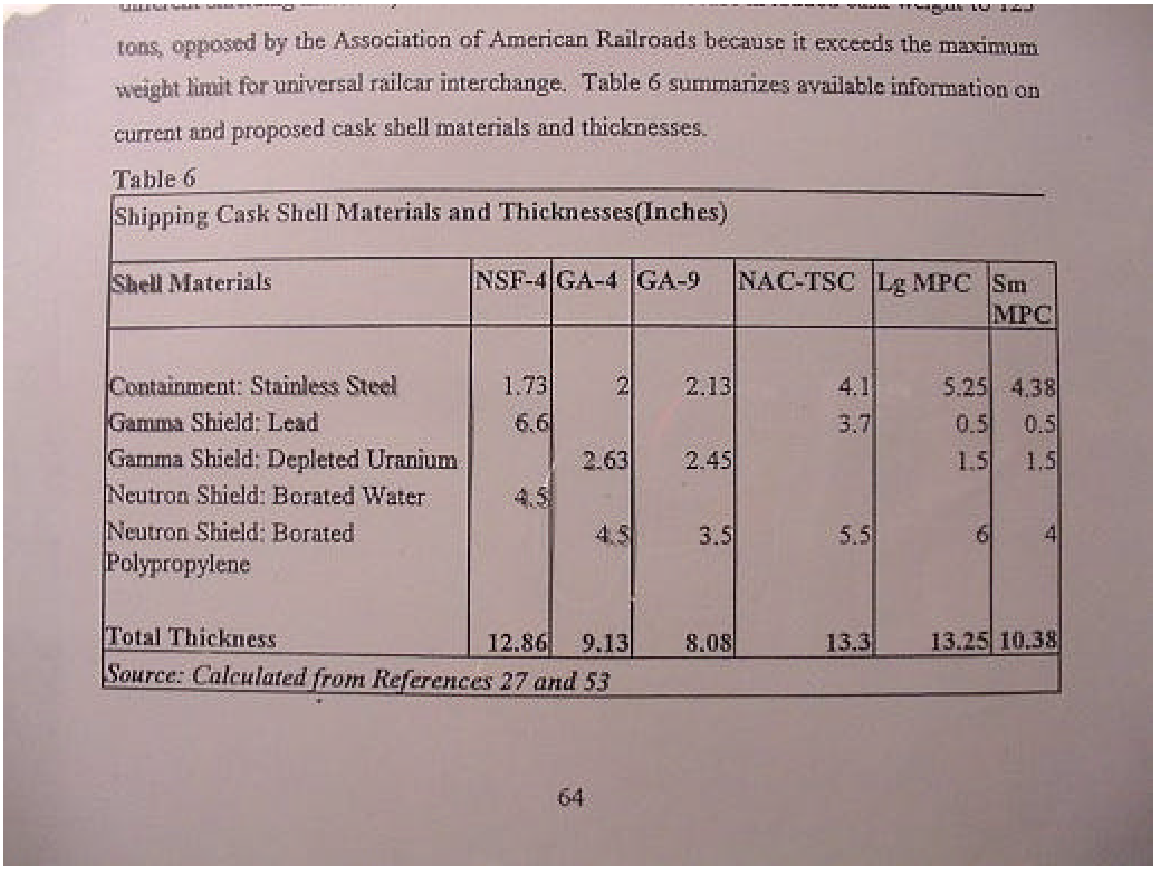
On October 9, 1995, a ten car Amtrak train with 248 passengers and twenty crew was derailed near Hyder, Arizona. Spikes had been removed from the rail bed, a metal bar connecting the rails had been removed, and the missing section wired to circumvent the electronic warning system. A terrorist group, Sons of the Gestapo, left a note at the scene claiming credit and criticizing law enforcement agencies, citing the Waco and Ruby Ridge incidents.

On October 1, 1995 a jury convicted Sheik Omar Abdel Rahman of conspiracy to use diesel-fertilizer bombs which would have been used to blow up United Nations headquarters, the Lincoln and Holland tunnels, the George Washington Bridge, and the New York federal building. The George Washington Bridge has been used for shipments of irradiated fuel and plutonium from Brookhaven National Laboratory to the Savannah River Site.

Incidents of rail and highway sabotage reveal that: 1) terrorist attacks would likely be designed to inflict maximum human injury, 2) electronic warning systems designed to alert officials and prevent accidents can be defeated by technical countermeasures, 3) effective attacks using home made explosives are possible, avoiding the need for exotic military weapons to breach transport containers, and 4) saboteurs have the ability to create damage which exceeds the containment standards of NRC certified shipping containers.

> ***"The willingness of terrorists to kill or injure large numbers of Americans, demonstrated in the World Trade Center and Oklahoma City bombings, compels any current assessment to focus on incidents that are clearly intended to cause, or could cause, radiological sabotage." The FBI's <u>Terrorism in the United States: 1995</u> reported: "In the past year, the country witnessed the re-emergence of spectacular terrorism with the Oklahoma City bombing. Large-scale attacks designed to inflict mass casualties appear to be a new terrorist method in the United States."***
>
> [Nuclear Waste Transportation Security and Safety Issues: The Risk of Terrorism and Sabotage Against Repositort Shipments, Halstead and Ballard, December 1998]

Halstead and Ballard state that risk assessments must consider direct attacks on transport casks using high energy explosive devices with or without capture of the shipments. Capture and control of the cask by terrorist agents would allow the cask to be breached with a variety of devices including commercially available conical shaped charges and cutting charges, or a massive diesel fuel-fertilizer truck bomb. Attackers may use transport personnel as hostages to retain control of the cask for hours. With the timed gained, attackers could increase the effect of explosives by removing barriers and applying them to the most vulnerable part of the cask. A GA 4 truck cask with four PWR conventional fuel assemblies would contain 850,000 curies. The NAS-TSC rail cask with 26 assembles would hold 5.5 million curies.



tons, opposed by the Association of American Railroads because it exceeds the maximum weight limit for universal railcar interchange. Table 6 summarizes available information on current and proposed cask shell materials and thicknesses.

Table 6

Shipping Cask Shell Materials and Thicknesses(Inches)

Shell Materials	NSF-4	GA-4	GA-9	NAC-TSC	Lg MPC	Sm MPC
Containment: Stainless Steel	1.73	2	2.13	4.1	5.25	4.38
Gamma Shield: Lead	6.6			3.7	0.5	0.5
Gamma Shield: Depleted Uranium		2.63	2.45		1.5	1.5
Neutron Shield: Borated Water	4.5					
Neutron Shield: Borated Polypropylene		4.5	3.5	5.5	6	4
Total Thickness	**12.86**	**9.13**	**8.08**	**13.3**	**13.25**	**10.38**

Source: Calculated from References 27 and 53

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Table 6 from *Nuclear Waste Transportation Security and Safety Issues*, Halstead & Ballard, 1998, p.64

> ***"A terrorist incident resulting in a one percent release of cask contents would have radiological consequences far greater than those assumed in the outdated DOE and NRC consequence assessments."*** [Nuclear Waste Transportation Security and Safety Issues: The Risk of Terrorism and Sabotage Against Repositort Shipments, Halstead and Ballard, December 1998]

Full scale tests by Sandia National Laboratory published in 1983 utilized a military shaped charge (US Army M3A1) on a GE IF-200 truck cask containing unirradiated fuel. Even this outdated test demonstrated that the cask could be breached and that radioactive materials would be released. Based on these tests, NRC proposed relaxed rules for shipments in 1984, but public criticism caused the rulemaking to be "terminated."

Sandia Full-Scale Test Results

Hole diameter	6.0 inchs (15.2 cm)	
Fuel rods damaged	111 of 223	50%
Fuel mass fractured	45.8 pounds (20.82 kg)	10%
Fuel mass released	5.6 pounds (2.55 kg)	1%
Released as aerosol	1/10 ounce (2.94 grams)	

Current weapons, such as the Superdragon anti-tank missile, are more powerful and can penetrate 18 inches of armor plate. This weapon was used by the U.S. in Operation Desert Storm, and is used by at least ten other nations. The release of even more toxic radioactive elements would cause more fatalities immediately following an accident. Lindsay Audin's analysis of fuel rod behavior during incidents involving sabotage explains how much greater amounts of fine particles and vapors would be released from a conventional irradiated fuel cask.

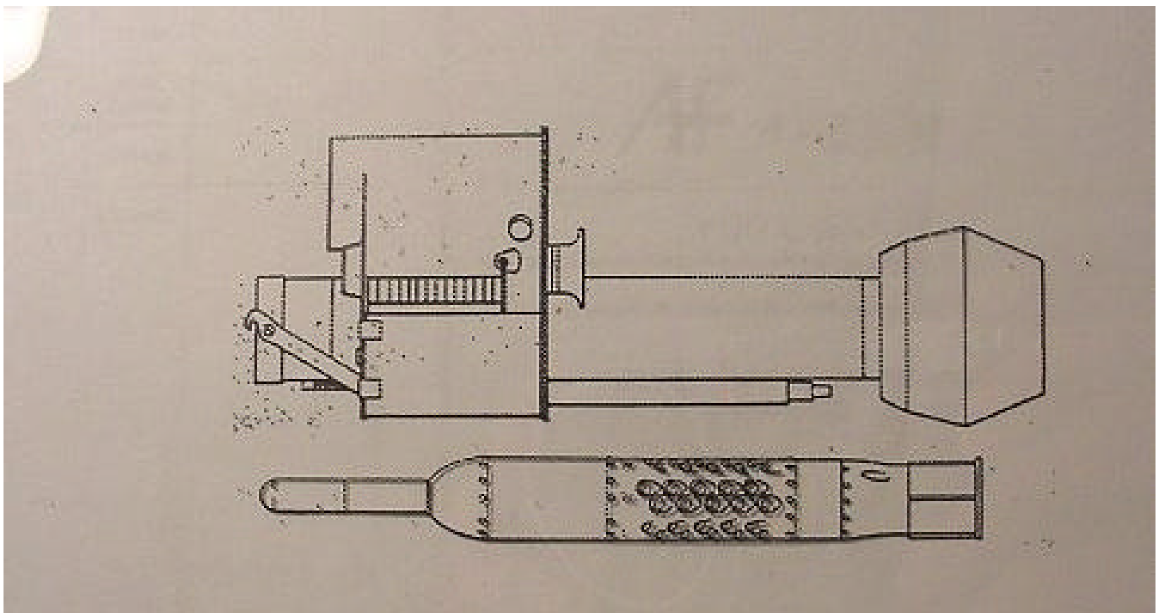

Figure 18a: Schematic of the Superdragon Anti-tank Missile

Figure 18a from *Nuclear Waste Transportation Security and Safety Issues*, Halstead & Ballard, 1998, p.57

> ***"An attempt to disperse the fuel would likely involve a high explosive device that must first penetrate a transport cask. Such a device would penetrate one or both sides of the cask, shatter the fuel rods and pellets in its path, and heat the area along that path. The shock and heat involved would...initiate several processes not normally experienced by uranium dioxide and zirconium alloy. At high temperatures in the presence of oxygen, both materials will change form. Uranium dioxide UO_2 will "reoxidize" and become U_3O_8...expanding and forming a very fine power in the process. Zirconium will literally ignite, vaporizing itself.... The fuel pellets may also shatter back to the consistency of the uranium power involved in their manufacture. Ruthenium will vaporize and combine with oxygen to form minute particles, while other elements, such as iodine, will be released as gases."*** [Analyses of Cask Sabotage Involving Portable Explosives: A Critique, Lindsay Audin, 1989]

Emergency Response Problems

Emergency response to rail or highway accidents must be well-prepared and rapid. Delays in response to accidents which involve the release of radioactive material would expose unknown numbers of people to negative health effects. In 1996, a DOE Transport and Safeguards Division Safe Secure Transport (SST) trailer carrying nuclear weapons slid off the road and rolled over in rural Nebraska. Four hours elapsed before DOE headquarters were notified, and it was 20 hours before a Radiological Assistance Program team determined there was no release. A similar delay in response to a MOX fuel accident could make effective emergency response dangerous and clean-up impossible. The following comment by the Georgia Environmental Protection Division cites vehicular tests of powdered materials deposited on roadways and takes issue with the DOE's approach to emergency response to accidental plutonium fuel releases.

> ***"After passage of about 100 cars only a small fraction of the original contamination remained on the road surface. Unless emergency officials promptly close the accident scene to vehicle traffic (an unlikely situation), emergency responders may face an incident scene that is, unknown to them, extremely hazardous due to respirable plutonium. Post emergency actions may also be complicated due to the enhanced spread of contamination by vehicle traffic."*** ~Georgia Environmental Protection Division comments on DOE SPD DEIS

Nuclear Regulatory Commission Plans to Weaken Safeguards

Federal regulations require that the dose rate 6 feet from the external surface of the transportation vehicle not exceed 10 millirem per hour. But, according to the State of Nevada, there is no operating experience with spent fuel shipments in actual GA 4/9 transport casks. Also, traffic gridlock incidents could result in individual exposures of 30-40 millirem per person. [Comments of April 1999 by Nevada Agency for Nuclear Projects on need for spent fuel transport impact assessment by nuclear plant operators, FR 2/26/99]

Incredibly, the Nuclear Regulatory Commission now proposes weakening the already inadequate requirements for Type B transport containers (used for irradiated fuel) without fully informing or involving all of the communities along the potential transport routes for irradiated fuel. The NRC also proposes to weaken the requirements for containment of plutonium at the very point in time that we face major increases in the amount of plutonium transport. In a letter to the Secretary of the Nuclear Regulatory Commission, Janet Marsh Zeller said,

> ***"NRC must not abandon the double-lined containment for plutonium shipments. If, as some industrial representatives submitted on August 10, other radionuclide shipments are as dangerous as plutonium shipments, then the use of double containment must be extended to those dangerous transports. Further, the people of New Mexico and those communities along the transport routes to the WIPP facility have been promised by Congress that these shipments will have double containment. If the ill-advised plutonium fuel program moves forward for the Duke reactors in the southeast, the people of our region will demand transport containment with no radiation exposure."*** September 29, 2000 BREDL letter to USNRC and USDOT

DOE predicts an accident rate of 11.9 rail accidents per million shipment miles, or an accident every 84,000 miles (trucks=0.7-3.0/million miles).

Conclusion

We oppose the transport and use of plutonium fuel for commercial nuclear power for environmental, public health, and national security reasons. The use of plutonium in utility reactors would 1) reverse a two decade prohibition on the use of plutonium in civilian power reactors, 2) put a strategically valuable and dangerous material which is now controlled by the armed forces in private hands, and 3) employ one of the most toxic substances on earth to generate electricity.

May 3, 2001
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