For Lack of a Database:
Uranium truck rollover in North Carolina
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On the evening of December 21, 2006, a tractor trailer hauling 3159 kg of low-enriched (fuel-grade) uranium dioxide overturned on the I-95 exit to eastbound I-40 at Benson, North Carolina. A blip of press interest followed the accident, but by Christmas it was gone. We might have hoped the Nuclear Regulatory Commission (NRC) and federal hazardous materials bureaucracies filed the incident in long-term memory for future reference. That doesn't appear to be the case. So, for lack of a more appropriate venue, this is the report that should have been.

The Accident
A Tri-States Motor Transport tractor trailer rig picked up the 20-foot long overseas shipping container loaded with uranium at Virginia's Portsmouth Marine Terminal. It was bound for the Global Nuclear Fuels (GNF) fuel rod fabricating plant in Wilmington, NC. The container, which was bolted to the flatbed trailer, remained attached when the rig rolled off the curving exit ramp and came to rest on its side in a grassy area. Tri-States executive vice president David Bennett told me the driver, Ken Brotsche, may have tried to reduce speed by setting a brake that doesn't work when the transmission is between gears. Brotsche overcorrected the steering and rolled the load. He and his wife, who was sleeping in the berth, were slightly injured. Nancee Brotsche was taken to a local hospital and released soon after.

The North Carolina Highway Patrol, led by hazardous materials coordinator Lt. Mark Dalton, responded. Dalton says he had no prior knowledge of the shipment, nor did regulations require it. As far as he was concerned this was regular commercial cargo. The four-digit hazardous materials number posted on the trailer was UN 3327. This translates to "Radioactive Material Type A Package, Fissile." Dalton determined that the material on board was uranium dioxide powder enriched to approximately 5% U-235. (U-235 is the uranium isotope responsible for starting fission, the nuclear chain reaction, inside a reactor.) He consulted the DOT's Emergency Response Guidebook http://environmentalchemistry.com/yogi/hazmat/erg/ and established a perimeter around the accident site. Dalton vigorously denies an Internet allegation that he kept reporters and others back farther than about 75 yards.

Other state officials including Lee Cox, radioactive materials manager for the NC Division of Environmental Health, also responded to the scene. Cox and the others visually inspected the shipping container and found no breach. The shipment was classified as "exclusive use," meaning that only specially trained staff are permitted to open the shipping container. So no attempt was made to inspect the twelve loaded 4 x 4 foot Type A uranium containers bolted to racks inside.

Cox says radiation at the shipping container's surface was 0.6 millirem (0.006 mSv) per hour. (A chest X-ray delivers a radiation dose about ten times higher and all at once.) He told me the low reading surprised him because the shipping papers listed a Transport

Index or TI of 7.2. (A TI of that magnitude is substantial, usually associated with radiation levels at least a hundred times higher than he observed. It turns out that radiation measurements used to determine TI are taken at the surface of the individual uranium containers, not the surface of the shipping container.)

With the integrity of the containment established, the load was righted and driven on to GNF Wilmington where an inspection of the contents took place. Doug Collins, NRC director of fuel facility inspections, told me the uranium containers were intact.

The Context

Warning—Contains Extreme Geek Factoids.

The big picture here is the internationalization of the nuclear power industry. Global Nuclear Fuels is a partnership between General Electric, Hitachi, and Toshiba. GNF spokesman Tom Rumsy says GNF Wilmington's decision to import fuel-ready uranium dioxide from GNF's Kurihama facility in Japan rather than make its own from uranium hexafluoride (much of which comes from Paducah, KY) was purely economic.

Rumsy dismissed Internet speculations that the cargo involved in the accident contained spent nuclear fuel. Reprocessing is a complex and highly specialized activity. Although President Bush wants to reprocess spent fuel in the US, it hasn't been commercially attempted here since 1976. Bush's Global Nuclear Energy Partnership proposal would require the construction of a multi-billion dollar reprocessing plant. Japan does have an operational fuel reprocessing facility, but GNF derives its uranium dioxide the old-fashioned way from ore, says Rumsy.

Radioactive cargoes deemed most dangerous on the road are designated HRCQ or Highway Route Controlled Quantity. These must travel approved routes and require prior notification of the affected states. NRC spokesman Roger Hannah told me uranium dioxide wouldn't be HRCQ unless it exceeds 20% U-235 or the shipment has more than 27,000 Curies of radioactivity. (A Curie is a measure of the number of atoms that decay—fall apart—per second. The shipment in question had 20.5 Curies.) He says NRC is only notified about a specific load like this if it gets into trouble. Lt. Dalton says some slightly less dangerous radioactive cargoes also requires state notification. But the GNF shipment wasn't classed RAMQC, Radioactive Material Quantity of Concern, either.

The idea that over three tons of enriched uranium could travel our highways with the same governmental awareness as a load of Cheerios may strike some as odd. This was not "yellow cake" uranium oxide, raw uranium extracted from ore. It was uranium dioxide, the refined stuff. When turned from powder to pellet, it powers nuclear reactors. If any significant quantity of enriched uranium dioxide were dumped in a pile it would undergo uncontrolled fission—go critical. On the scale of a nuclear power plant this is called a meltdown. (Conditions enabling the chain reaction depend on the concentration of U-235.)

Shipping packages for fissile, potentially chain-reacting, materials are designed to prevent criticality by a wide margin in normal driving conditions and a lesser margin in accidents, says Robert Lewis, NRC branch chief of the Division of Spent Fuel Storage and Transportation. The relative criticality risk is given by a number in the shipping papers called the Criticality Safety Index, CSI. CSI is derived from several factors. Suffice it to say that the maximum allowable CSI per vehicle is 100. The maximum CSI per package is 50. The Tri-State vehicle CSI was 8.4. For true geeks, a discussion of TI and CSI may be found in a document from the UN Secretariat at http://www.unece.org/trans/doc/2006/ac10c3/ST-SG-AC10-C3-58a2e.doc

Criticality isn't the only concern in packaging fissile materials. Radiation doses to workers and resistance to fire, water, and accident damage are also important A News & Observer story dated 12/22 quotes Jim McCauley, identified as an officer with the NC Emergency Management Operations Center, telling a reporter, "They can drop one of those containers 35 meters onto a pointed spear, and it won't breach the container." Not so, say Bennett, Dalton, Cox, and Lewis. That only applies to Type B casks.

Typical surface-transport packages for radioactive substances are designated Type A or Type B. Type B casks are supposed to perform as McCauley stated. They're used to store or transport spent fuel rods and other especially deadly things. (This may include uranium dioxide if enriched to 20% U-235 or more. Uranium dioxide powder traveling from Nuclear Fuel Services in Erwin, TN, to the Framatome plant in Washington State is shipped in Type B casks HTTP://WWW.EPA.GOV/FEDRGSTR/EPA-IMPACT/2001/NOVEMBER/DAY-19/I28844.HTM.)

The GNF shipment that rolled over was traveling in Type A packaging. While Type A containers are designed with accident resistance in mind, they are nowhere near as impervious to fire or physical damage as a Type B cask. They're also much lighter and cheaper to transport. Drop GNF's shipping container from a height of 35 meters onto a pointed spear and you'd get a mangle of steel with a spear through it and the likelihood of an ugly radiological mess.

The Official Assessment

In terms of threats to public safety posed by this accident, the bottom line is that no radiation leakage or exposure seems to have occurred. No other vehicles were involved. The driver and his wife escaped serious injury. Emergency responders on the scene apparently functioned appropriately. The uranium containers survived an accident that caused light damage to humans and equipment—for which we are all glad. Apart from whatever driving citations may be issued, the federal government pretty much considers the case closed. One is tempted to say, case forgotten.

Cox told me shipments of enriched uranium fall under NRC jurisdiction. I asked Collins about that. He said NRC didn't lead any investigation except the inspection of the shipping container in Wilmington. Because there was no loss of life, radiation leak, or extensive damage to property, NRC didn't post an event report for the mishap. He thought a note might find its way into the restricted access NMED, Nuclear Materials

Event Database but wasn't able to find one. Later, NRC spokeswoman Holly Harrington informed me that it wouldn't go on NMED because there'd been no event report.

The NRC participates in the International Atomic Energy Agency's incident reporting system. However, since the rollover didn't cause a "significant spread of contamination/overexposure of a worker" or demonstrate "significant failures in safety provisions," the threshold criteria for an IAEA report are not met. National accident databases maintained by other agencies, such as the National Response Center, also filter out accidents not meeting severity criteria peculiar to their agencies. Don't look for this accident to be recorded there either. The North Carolina highway patrol has a record. It will be archived and cease to be readily accessible after a year or two.

The Problem

Official hazardous materials recordkeeping, at least the parts of the system we're allowed to know about, relies on winnowed facts. It excludes data that don't meet criteria for severity or relevance to the mission of a specific bureaucracy. Database fiefdoms fragment information, but they're simpler to operate. The strategy makes sense but only to an inadequate point.

Fragmentation and narrow focus seriously impede the comprehensive analysis of system vulnerabilities. It becomes harder to proactively address risks for types of major accidents that have yet to occur. For example, is it possible that top-heaviness of the uranium cargo was a contributing factor in the Tri-States accident? A federal regulator or commercial cargo designer might be interested to learn how many such shipments tip over. Unfortunately, she could only expect to find reports of accidents with severe consequences. She'd have no way of determining whether the 12/21/06 accident was the first in history or the thirteenth that year.

If we were discussing Cheerio trucks, only hungry people might care. But radioactive heavy metals aren't Cheerios, ask any former Russian spy. These substances cause severe, widespread, and long-lasting damage to people and environments. A uranium dioxide truck rollover involving higher speed, fire, or another vehicle might have had a less benign aftermath. Is official amnesia for near-misses a responsible approach to ensuring public safety?

To be crude about it, the existing system is equivalent to ignoring the whizzing bullets until one hits you. It's a strategy that may serve the interests of industry, but the poor bugger to takes the first slug might feel differently.