Get the Facts on High-Level Atomic Waste Storage Casks!

The Dangers

"Spent" nuclear fuel is a misleading term. Irradiated nuclear fuel rods discharged from commercial nuclear power plants are highly radioactive, a million times more so than when they were first loaded into a reactor core as fresh fuel. If unshielded, irradiated nuclear fuel just removed from a reactor core could deliver a lethal dose of beta, gamma and neutron radiation to a person standing three feet away in just seconds. Even after decades of radioactive decay, a few minutes unshielded exposure time would be enough to deliver a lethal dose. Certain radioactive elements (alpha emitters such as plutonium-239) in "spent" fuel will remain hazardous to humans and other living beings for hundreds of thousands of years. Military high-level radioactive wastes – the highly radioactive liquid and sludge "leftovers" from reprocessing irradiated fuel rods to extract the uranium and plutonium for making nuclear bombs – has the same hazardous characteristics as "spent" commercial fuel. Irradiated fuel rods and high-level nuclear wastes are perhaps the most hazardous poisons ever created. There is the added danger that fissile materials still present in highly radioactive wastes will form a "critical mass," causing an inadvertent nuclear chain reaction that could radiate a deadly beam of neutrons and possibly even generate enough heat to melt through the container within which it is held. Thus, these wastes must be shielded for centuries, prevented from going critical, and isolated from the living environment for hundreds of millenia.

Past and Present Storage Techniques

With every operational cycle of 18 to 24 months at a U.S. nuclear power plant, the reactor is shut down and approximately one-quarter to one-third of its now extremely radioactive fuel assemblies are removed. These thermally hot and highly radioactive fuel assemblies are then transferred into the plant's irradiated fuel storage pool. These large, indoor water-filled storage ponds shield much of the high radiation underwater, and allow the assemblies to thermally cool down from the reactor's high operational temperatures.

These pools were originally designed for temporary storage only. Nuclear utilities assumed their high-level wastes would be shipped off for reprocessing to extract fissionable uranium and plutonium for making new fuel rods, or else transported for dumping at a "permanent geologic disposal site" -- an underground national sacrifice area. However, reprocessing of commercial wastes was abandoned in the 1970's as economically unfeasible and a threat of nuclear weapons proliferation (not to mention a source of serious radioactive pollution into water and air), and geologic disposal remains mired in technical and political controversy. Consequently, high-level waste inventories at commercial U.S. nuclear reactors have dramatically mounted in storage pools. After decades of "re-racking" to cram pools as full as possible, growing numbers have filled to capacity. This has complicated continued operations and waste generation at certain reactors, while at the growing number of closed down reactors, irradiated fuel assemblies sit in their storage pools even while the plant sites are dismantled and "decommissioned" around them.

Dry Storage Casks

As pools have filled, the nuclear industry and the U.S. Nuclear Regulatory Commission (NRC) have developed dry cask storage systems, or Independent Spent Fuel Storage Installations

(ISFSI's), to expand "interim" storage of wastes both on-site at plants and away from reactors. As of March, 2003 there were 28 operating licensed ISFSI's located in 22 different States. Numerous additional potential ISFSI sites in many more States may open in the near future (see U.S. Nuclear Regulatory Commission Spent Fuel Project Office's March, 2003 map of ISFSI locations at www.nrc.gov/waste/spent-fuel-storage/locations.html, as well as its "Nuclear Fuel Pool Capacity" graph at www.nrc.gov/waste/spent-fuel-storage/nuc-fuel-pool.html, showing the growing number of pools filling to capacity, an indication of impending moves to opening ISFSI's at those reactors).

After a minimum of five years of thermal cooling in "wet" storage pools, irradiated fuel assemblies can be transferred to NRC certified "dry" storage casks made of concrete, steel alloy, and neutron shielding materials.

Resembling a giant metallic thermos (solid on one end, open on the other), inner canisters are loaded underwater (to shield workers from the high radiation). The pool water is then pumped out, multiple shield lids are welded or bolted on to seal shut the open end, and the interior of the canister is filled with inert gas (such as helium) intended to prevent deterioration of the fuel rods from oxidation with air, as well as to conduct heat away from the waste. These canisters are then transported to concrete storage pads either immediately nearby the reactor (an on-site ISFSI), or else away from the reactor at an off-site ISFSI. They are loaded into either horizontal "bunkers" or vertical silos (depending on the dry cask system design) made of concrete, which provide shielding against the gamma and neutron rays that emanate out from within the surprisingly thin metallic inner canister. Natural convection through vents in the concrete silo or "bunker" provides passive air cooling, but the inner metal canister can still reach temperatures of 400 degrees Fahrenheit or higher due to the waste's on-going radioactive decay. NRC approved ISFSI sites can accept irradiated fuel from more than one reactor.

Problems with Dry Cask Storage Surfaced Immediately: A Meltdown of Democracy, a Retreat from Regulation

Under a provision in the Nuclear Waste Policy Act of 1982, the NRC can approve ISFSI's under a nuclear plant's general operating license. This means even the nominal safeguards for protecting the environment and involving the public -- normally required for licensing a nuclear facility -- are done away with: no site-specific study is required, no environmental impact statement (EIS) is made, and no adjudicatory public hearing process is allowed. The original EIS for the reactor itself – prepared decades earlier, long before ISFSI's were even envisioned – is relied upon for licensing the dry cask storage site. An environmental assessment is issued by the NRC which automatically finds no adverse impacts on the environment based upon the earlier EIS.

Concerned citizens and community groups regard this "generic licensing process" as a meltdown of democracy. Michigan's Palisades nuclear plant was the first in the U.S. to receive the go-ahead from NRC to set up an ISFSI under the reactor's general operating license. In May, 1993 NRC allowed Consumers Energy Company to install a dry cask storage site on a sand dune identified by the Michigan Department of Natural Resources, the Army Corps of Engineers, and the University of Michigan as a "high risk erosion zone" just 150 yards uphill from the waters of Lake Michigan, the source of drinking water for tens of millions of people. Whereas the Palisades reactor itself is anchored to bedrock, its two dozen dry storage casks fully loaded with irradiated nuclear fuel (each one weighing 120 tons) sit on a three foot thick concrete storage pad, anchored to nothing but shifting sand.

In early 1994, an NRC inspector stated "it's the consequences that might occur from an earthquake that I'm concerned about. The casks can either fall into Lake Michigan or be buried in the loose sand because of liquefaction." He concluded "It is apparent to me that NMSS [NRC's office of Nuclear Materials Safety and Safeguards] doesn't realize the catastrophic consequences of their continued reliance on their current ideology," the generic licensing process. Over a decade later, these concerns have not been addressed. NRC continues to generically license IFSFI's, rubberstamping nuclear utility applications at an accelerating rate.

Cask Fabrication Before Certification: Build 'Em First, Ask Questions Later

Manufacturers of dry cask systems must go through the NRC's "certificate of compliance" (CoC) process. This covers a host of issues, including the development of the cask design technical specifications, operational limits, maximum radiation dose limits and the condition of irradiated fuel that can be stored inside. As of Feb. 5, 2003, NRC had approved 16 different dry cask storage systems for general use at or away from reactors (see www.nrc.gov/waste/spent-fuel-storage/designs.html). NRC cask certification is valid for 20 year intervals, with reviewed extensions available. NRC has stated that dry cask storage is safe and reliable for up to 100 years.

However, problems with dry casks have surfaced not after decades or a century, but almost immediately in the first few years, raising serious questions about the NRC cask certification process itself. Evidence documents that the NRC's CoC process has been taken over by cask manufacturers' and nuclear utilities' profit-driven pressure for expediency. The consequent lack of rigorous regulatory oversight has resulted in a complete lack of field testing of cask designs, NRC approval for exemptions allowing manufacturers to build casks before receiving the certificate of compliance, and mounting evidence of poor quality assurance and quality control of cask manufacturing.

In fact, a whisteblower fired by the largest nuclear utility in the U.S. alleges major quality assurance (QA) violations involving Holtec storage/transport containers. Oscar Shirani served as a lead QA inspector for Commonwealth Edison/Exelon of Chicago for many years, earning impeccable credentials. A consortium of nuclear utilities invited Shirani to lead a QA inspection of Holtec cask design and manufacturing in 2000. Shirani identified 9 major QA violations (such as unauthorized welding, large numbers of departures from design specifications, and use of potentially shoddy materials), leading him to question the structural integrity of the containers, especially under severe transportation accident conditions. Shirani's discovery followed an NRC-led QA inspection just months earlier that had identified no problems with the Holtec casks, casting huge doubt upon the competence and credibility of NRC's QA regulatory oversight. Shirani sought a "stop work order" against the manufacture of the Holtec casks until the QA violations were rectified. Instead, Exelon harassed and ultimately fired him. Shirani has been blacklisted from the nuclear industry ever since, and his allegations have never been addressed. Frighteningly, Holtec casks are already in use at 33 U.S. nuclear reactors (see locations under "Spent Fuel Systems Division" at www.holtecinternational.com/).

Numerous technical problems with fully loaded dry casks are popping up around the country at an alarming rate, leading to charges from concerned citizens living nearby that ISFSI's (pronounced "is-IF-sees") are very "iffy," and represent "nuclear experiments" in their backyard.

Bubble, Bubble, Toil and Trouble: Cracks, Corrosion, and Explosion

A May 28, 1996 explosion at the Point Beach reactor in Wisconsin jolted public confidence in the dry cask storage program. While sealing shut a VSC-24 (a Ventilated Storage Cask built by Sierra Nuclear Corporation (SNC) holding 24 irradiated fuel assemblies; this cask design has now been taken over by British Nuclear Fuels, Ltd.), a welding torch ignited pent up hydrogen gas with enough force to dislodge the cask's 4,000 pound shield lid several inches in the air and tilt it ajar on top of the cask.

After allowing SNC to manufacture several VSC-24 units even before its CoC, NRC certified the cask design in May, 1993. The explosion was later determined to result from an electro-chemical reaction between an anti-corrosion zinc liner within the cask and the borated "spent" fuel pool water. The chemical reaction between zinc and boric acid to generate explosive hydrogen gas -- familiar to many high school chemistry students – somehow escaped the notice of all the "experts" at NRC, the cask manufacturer, and the nuclear utility company. Over a dozen VSC-24 casks had already been loaded around the country before the explosion. Utility employees had observed bubbles in the "spent" fuel pools during these loadings, yet had failed to understand that they were flammable hydrogen gas and did not report them to the NRC. In fact, a blue flame was observed burning within another VSC-24 loaded at Point Beach previous to the explosion, but had been shrugged off by employees as resulting from excess cleaning solvents and went unreported.

The explosion led to NRC inspecting SNC's cask manufacturing facility, revealing confusion, inadequate testing, and poor quality control. It also led to a three year halt on the loading of VSC-24's in the U.S. so that the NRC, nuclear utilities, and the cask manufacturer could get a grip on the situation. However, the next VSC-24 to be loaded, at Palisades in June, 1999 again experienced two separate "hydrogen ignition incidents." Again there was a breakdown in administrative controls. The NRC inspectors, thinking all was in order, had already gone home for the day before the "burns" occurred. A welder ignited a "burn" but did not report it, which led inevitably to a welder on the next shift igniting a second "burn". Days passed before NRC was notified. Just the next week later, a suspicious fire in the dry cask storage administrative office trailer at Palisades destroyed many documents, including those about the recent "burns". Concerned citizens cried foul, but NRC did not cite Palisades for any violations of regulations. In 2001, Palisades officials admitted to the NRC that the very same irradiated fuel that was involved in the hydrogen "burns" had actually cooled for less than five years in the storage pool. Loading it in dry casks had been in violation of the casks' technical design specifications, and thus federal regulations. Suspiciously, the less-than-five-years-cooled fuel had been evenly distributed between a number of casks, leading critics to charge that the "mistake" had in fact been intentional. However, records pertaining to the suspect loading procedure had been destroyed in the earlier suspicious office fire (for which fire inspectors never ruled out the possibility of arson).

Shortly thereafter, a VSC-24 cask loading at the Trojan nuclear plant in Oregon had to be suspended when so many hydrogen bubbles were generated in the fuel pool that workers could not see well enough to complete the job. In June, 2000 NRC cited the VSC-24's new owner, British Nuclear Fuels, for poor quality control and assurance in cask manufacturing and maintenance. Obviously, four years since the Point Beach explosion (1996-2000) was not long enough for NRC and industry to resolve problems with the VSC-24.

A March, 1997 NRC inspection report revealed another defect with VSC-24's: delayed cracking in welds supposed to seal shut the multiple shield lids on casks at Palisades, Point Beach, and Arkansas One nuclear plants. Such cracks can allow the inert helium gas within the cask to escape, making the irradiated fuel assemblies vulnerable to contact with air, oxidation, and deterioration. Such degradation could lead to serious irradiated fuel handling and transportation problems in the future. Again, weld failure in shield lids was unanticipated and unanalyzed by industry and the NRC.

Over the past several years, NRC has identified serious problems in other dry cask systems. Three NUHOMS casks, manufactured by VECTRA Technologies (now owned by Transnuclear, Inc., a subsidiary of the French nuclear giant COGEMA) and fully loaded at the Davis-Besse nuclear plant in Ohio, were discovered to have been built below technical specifications: the aggregate used to fabricate the casks' outer concrete shells was poor quality, and the shells themselves were ground too thin. In January, 2000 NRC reported that a TN-32 cask (manufactured by Transnuclear, containing 32 irradiated fuel assemblies) at the Surry nuclear plant in Virginia had developed six inch long cracks in its outer concrete shield, loose bolts, and a helium leak.

In late May, 2000 NRC discovered an unreported flaw with the neutron shielding material supplied to New Jersey-based cask manufacturer Holtec International by Nuclear Assurance Corporation. Holtec hopes to deploy no less than 4,000 HI-STORM dry casks for use at the proposed Private Fuel Storage, LLC high-level nuclear waste dump targeted at the tiny, impoverished Skull Valley Goshutes Indian Reservation in Utah. Transportation of irradiated fuel rods to Utah in Holtec HI-STAR containers – the first dual purpose storage/transport cask to be certified by NRC -- from Eastern, Southeastern, and Midwestern reactors would traverse dozens of States, past the homes of millions of Americans, raising unprecedented safety concerns.

In April, 2001 the Sacramento Municipal Utility District halted loading its first Transnuclear West Nuhoms dry storage cask at the Rancho Seco reactor in California due to an unexpected mishap. A faulty O-ring leaked air underwater in the irradiated fuel storage pool during loading operations, threatening to contaminate the fuel-holding inner canister with radioactive pool water.

In Sept., 2001 an Exelon Corporation spokesman at the Dresden nuclear reactors in Illinois admitted to a visiting group of nuclear power officials touring the plant's new dry cask storage facility that the NRC had granted Dresden an exemption when its recently, poorly poured dry cask storage concrete pad did not meet specifications.

Atomic Brinksmanship

The explosion within the VSC-24 took place immediately above 24 irradiated fuel assemblies already loaded into the cask, containing the equivalent amount of long-lasting radioactivity released by 240 Hiroshima-sized atomic bombs; the nearby "spent" fuel pool held the full inventory of high-level radioactive waste generated at that plant over the course of decades. Although the NRC and utility reported that no radiation was released, no damage was done to the irradiated fuel assemblies in the cask, and no one was injured by the blast, the forceful explosion occurred near the plant's "spent" fuel pool , not a place to "play with fire" or make mistakes with objects weighing many tons.

Loaded dry storage casks, weighing more than 100 tons, are among the heaviest loads moved within a reactor during power operation. Human error and equipment failure raise issues of worker and public safety during cask handling and moving activities. Dropping either a loaded or unloaded cask inside the fuel pool building can severely damage plant safety equipment, jeopardizing reactor operation and the cooling of irradiated fuel in the storage pond.

On May 13, 1995 a loaded TN-40 cask became stuck in the hoisted position above the Prairie Island, Minnesota plant's irradiated fuel storage pool for 16 hours. This incident occurred just after NRC had granted Northern States Power (now Xcel Energy) an exemption from regulatory requirements for reviewing cask loading procedures. Over 120 tons of metal storage cask and irradiated fuel assemblies dangled precariously over 22 years' worth of the reactor's accumulated irradiated fuel assemblies in the pool below – many hundreds of tons of deadly nuclear waste. This dangling "sword of Damocles" risked dropping back into the pool, damaging irradiated fuel stored there, or punching a hole in the pool leading to a loss of coolant accident and potentially catastrophic consequences. Luckily, nothing happened – that time.

Some reactor designs, such as in G.E. boiling water reactors, have placed the irradiated fuel storage pools several stories up in the reactor building. Consequently, cask movement can place heavy loads up to ten stories high inside the reactor building. A cask drop would send the heavy load crashing down through several floors of the building which house vital safety systems, with untold consequences.

When in Doubt, Rush Full Speed Ahead Anyway

These widespread problems make clear that NRC's high-level waste storage and handling regulations are dangerously inadequate and in need of comprehensive review. Despite this, NRC continues to expedite ISFSI licenses: there are scores of nuclear power reactors in dozens of states planning to open ISFSI's in the next several years due to the fact that their indoor storage pools are completely filling up. In addition, NRC continues to allow vendors to manufacture casks before they have received their certificates of compliance. Once casks are already built, the pressure is on NRC to help "fix" any problems that surface via an "efficient and effective" (i.e., quick, cheap and easy) CoC amendment process, which again locks out involvement of concerned citizens, and leads to changes on the casks that leave NRC itself unsure that its "Safety Evaluation Report" still applies. The nuclear industry has even pushed for NRC permission to "fix" cask problems without even notifying the federal agency charged with protecting public health and safety and the environment!

As more and more utilities quickly run out of pool space and seek to store fuel in dry casks or even to transport fuel off-site, NRC certification of cask designs is accelerating: in February, 2000 alone, NRC was engaged in certifying five new cask designs, and beginning review of an additional three applications for cask certification. As Bill Brach, director of the NRC's Spent Fuel Project Office (which is in charge of cask certification) cheerfully reported to the NRC Commissioners in February, 2000, "We've been extremely busy." Given the history of past mistakes and the current rush job, future certification, manufacturing, and operational mistakes are inevitable.

The First Rule of Holes: When You're in One, Stop Digging

Incredibly, not a single dry storage cask, once loaded, has ever been unloaded in the U.S. This has led critics to charge that no safe unloading procedure exists.

In May, 1993 local environmental groups and the State of Michigan filed for an injunction in federal court against the loading of VSC-24's at Palisades, alleging that there was no proven safe method for unloading the casks. The NRC and Consumers Energy assured the court that in an emergency, casks could be safely unloaded simply by reversing the loading procedure. The court denied the injunction and allowed the casks to be loaded. Just over a year later, in August, 1994 Consumers Energy discovered that its fourth loaded VSC-24 dry cask had weld flaws. To demonstrate its commitment to public safety and the environment, as well as to live up to its promise to the court, Consumers announced it would unload the irradiated fuel in the cask back into the storage pool. Only then were the difficulties discovered.

Reintroducing the 400 degree Fahrenheit fuel assemblies back into the 100 degree fuel pool water would result in a radioactive steam flash hazardous to workers, and would thermally shock the fuel assemblies threatening to further degrade them. Also, the welded-shut inner canister would have to be cut open in a timeframe of less than 50 hours, for the cooling process could not be maintained during the unloading procedure and the fuel within would begin to overheat. In addition, there was no procedure yet developed to remove steel shims that were pressure fit inside the cask lid. Rather than leading to a pause for reflection, however, Consumers rushed to immediately load nine more VSC-24's, a move taken by local concerned citizens to be in very bad faith. Ten years after Consumers announced it would unload the defective cask #4, it still sits fully loaded on the Lake Michigan shoreline, alongside two dozen more fully loaded VSC-24's of questionable structural integrity.

The failure to safely unload dry casks has concerned other neighbors next to reactors. The Prairie Island Mdewakanton Dakota Tribe in Minnesota petitioned the NRC to prohibit Northern States Power from loading any more TN-40 casks until a safe unloading procedure had been demonstrated, but to no avail. 17 dry casks sit fully loaded just several hundred yards from the nearest homes and a tribal child care center on this tiny island on a flood plain in the middle of the Mississippi River. Recently, Xcel Energy pressured the Minnesota state legislature to permit it to load scores more casks at Prairie Island, violating an agreement made in 1994 to limit the number of casks to 17.

Adding further to worries about cask unloading, corrosion between the metallic inner canister and the metallic lining of the outer shell of VSC-24's could cause a bonding together that would be very difficult to pry apart. Even if the casks were to malfunction, or the waste to leak, or a repository to open that could accept the wastes, it remains unclear whether dry casks could be safely unloaded back into fuel storage pools or into transport casks for shipment off-site.

So What's To Be Done?! Leave it in the pools? Ship it away to be buried? Stop making it!

High-level nuclear waste presents us with an unprecedented dilemma – poisons that remain deadly for hundreds of thousands of years. If dry cask storage is so problematic, why not keep the wastes in wet storage pools? Wastes are dangerous there too, for cooling pumps must operate 24 hours per day, 7 days per week, for decades. Without pumps circulating cooling water, the thermally hot waste could boil away the pool water in a matter of hours. A recent NRC report admitted that even decades-cooled irradiated fuel could spontaneously combust if overheated or put in contact with air. A pool fire could release disastrous amounts of radioactivity to the environment. A puncture of a pool and consequent loss of water could lead to similar catastrophic consequences. So could a simple loss of power, causing the cooling and water circulation pumps to stop working. A raccoon at the Fermi reactor in Michigan once caused such a loss of power to the cooling pumps. For these reasons, many see dry cask storage as safer than wet pool storage. Dry casks have no moving parts, and individually contain smaller amounts of high-level waste than cram-packed pools. The word "safer" is relative, for high-level nuclear waste is dangerous no matter how or where it is stored.

The terrorist threat to nuclear power reactors -- brought home so clearly by the attacks of Sept. 11, 2001 as well as the U.S. federal government's admission that nuclear reactors are high on al-Qaida's list of potentially catastrophic terrorist targets – also raises concern about waste stored on-site at reactors. Pool fires caused by terrorist attacks could release massive amounts of radioactivity into the environment for hundreds of miles downwind, risking death and injury to hundreds of thousands of people. But dry casks, stored in concentrated rows (not unlike bowling pins) in clearly visible outdoor locations, are also very vulnerable to terrorist attack. Some concerned citizens groups have advocated "hardening" at-reactor waste storage, fortifying it against terrorist attack, such as by emptying vulnerable pools and dispersing and bunkering dry storage casks behind thick concrete, steel, and earthen shields to defend against attacks by high explosives or missiles (see www.nukebusters.org/issues/hoss).

If irradiated fuel rods are dangerous in pools and dry casks, then why not ship them to the proposed Yucca Mountain site in Nevada for burial? For one thing, Yucca Mountain is not a scientifically suitable site. Yucca Mountain is an active earthquake zone, prone to volcanic activity. Yucca leaks water like a sieve into the aquifer below, the sole source of drinking water for nearby farming communities. If waste were buried there, it would eventually leak into that drinking water, harming people downstream. In addition, shipping many tens of thousands of irradiated fuel casks cross country through 45 states plus Washington, D.C. (according to the U.S. Energy Dept.'s 2002 Final EIS for Yucca Mountain), through major metropolitan areas and America's breadbasket, past the homes of 50 million Americans carries unprecedented risks. The transport containers have been inadequately safety tested, most emergency responders are poorly trained and equipped for dealing with a radiation accident, and the health and economic impacts of a radiation release would be immense. Going forward with Yucca Mountain and such cross country transportation is ill-conceived and would make the nuclear waste dilemma worse, not better.

An ounce of prevention is worth a pound of cure. The U.S. must stop generating radioactive waste. NRC estimates that 52,000 metric tons of irradiated nuclear fuel will be stored at commercial reactors in the U.S. by 2005. If currently operating reactors continue generating waste until the end of their 40 year licenses, the mountain of waste will more than double in size. If NRC continues to allow old reactors to extend their operating lifetimes from 40 to 60 years, the amount of waste will increase still more. If new nuclear reactors are built, yet more waste would be produced. Nuclear power must be phased out and replaced with safer, cheaper, cleaner ways to meet our electricity needs: conservation, efficiency, and renewable sources such as wind, solar, and fuel cells.

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