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Newsday

August 3, 1997, Sunday, ALL EDITIONS

SECTION: NEWS; Page A04

LENGTH: 3518 words

SERIES: THE LEFTOVERS OF THE NUCLEAR AGE. First in a series

HEADLINE: THE LEFTOVERS OF THE NUCLEAR AGE / THE ERA AFTER / AT NUCLEAR PLANTS
NATIONWIDE, TONS OF WASTE PILE UP AMID A POLITICAL, SCIENTIFIC DEBATE

BYLINE: By Earl Lane. WASHINGTON BUREAU

DATELINE: Limerick, Pa.

BODY:

Limerick, Pa. - Nestled in racks at the bottom of a 39-foot-deep pool of water, the used fuel from the Limerick nuclear reactor betrays only the slightest hint that it will remain deadly for 10,000 years or more.

The radioactive fuel gives off a faint blue glow as high-energy particles it emits speed through the water.

The effect is eerily alluring - amplified by water so clean that it tricks the eye. Although 22 feet below the surface, the cross-like tops of the fuel bundles seem within reach.

Such bundles - nasty leftovers of the nuclear era - have been accumulating in storage pools at 109 commercial power reactors across the country and at 10 closed reactors. More than 34,000 tons await disposal, an amount that grows by about 2,000 tons a year.

The fuel is called "spent," but that is a misnomer. It will retain its ominous residual activity for millennia. The final disposal of spent reactor fuel - an afterthought during the "Atoms for Peace" optimism at the birth of nuclear power - has become one of the great technical and political challenges of the modern era. It is the ultimate not-in-my-backyard dilemma.

The Environmental Protection Agency is charged with developing radiation protection standards for the ages - from identifying the population that might be at-risk from any radiation leaking from a waste repository to setting dose limits. Planners also must consider what could happen if someone were to inadvertently intrude into the dump centuries from now.

It is as if the ancient Egyptians had to do a risk assessment before burying King Tut, trying to determine the chances that his pyramid would ever be disturbed.



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Such forecasting aside, the nation's spent-fuel disposal program has been stymied, critics say, by false starts, escalating costs, management ineptitude, missed deadlines and nagging doubts about how quickly to put the deadly waste out of sight and out of mind.

The effort has been complicated recently by an all-out industry campaign to persuade Congress to approve a temporary holding facility for the waste adjacent to Nevada's Yucca Mountain, a step critics say is ill-timed and could jeopardize the effort to determine whether that barren ridge 100 miles northwest of Las Vegas is suitable as a permanent burial site for the commercial spent fuel as well as some wastes from military nuclear programs.

The temporary storage site would compete with the Yucca Mountain project for tight funds, they say, and - if built - would ease the pressure to build the permanent repository, now projected to open in 2010 at the earliest and cost at least \$33 billion (in 1994 dollars) through 2071. Under provisions of a House bill, the temporary storage facility would have an initial license period of 20 years, a second phase of up to 100 years - and renewable beyond that.

"I don't think they industry officials care about" a permanent repository, says Robert Loux of the state of Nevada's Nuclear Waste Projects Office. "They believe their only opportunity to get waste away from reactor sites is through interim storage."

Loux questions whether the temporary facility - essentially a parking lot for huge casks filled with reactor fuel assemblies - could be built, licensed and operating as quickly as the congressional legislation envisions. By a 65-34 vote in April, the Senate approved a plan to open the temporary storage site by 2003. On Thursday, a House subcommittee passed a similar bill with a 2002 opening for the storage site. The full House is expected to follow suit. But the White House promises a veto. The Clinton administration opposes any attempt to establish an interim storage site in Nevada until the viability of Yucca Mountain as a permanent burial site is established.

Backers of the interim facility say it will provide a measure of relief for utilities that have started to build expensive on-site storage facilities at nuclear reactors because the government has been unable to deliver on its legal obligation - affirmed last year by a U.S. appeals court - to start taking the waste off their hands by next January.

Utilities, state regulators and federal officials are due in court next month to discuss compensation or other legal remedies for the Energy Department's inability to take the waste. The department already has broached the possibility of reimbursing utilities - at taxpayer expense - for some of the cost of building new on-site storage facilities for used reactor fuel.

The battle over an interim storage facility in Nevada is but the latest chapter in the tangled and vexing history of nuclear waste policy in the United States.

Many experts remain confident that the nuclear waste dilemma - with its attendant questions about the safety of moving the spent fuel - can be solved. "Most people in the field don't see any problems," said Peter Soo, a nuclear



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engineer at Brookhaven National Laboratory. "The solutions are at hand. We know how to do it."

But as Brookhaven's own public relations fiasco with a small tritium leak from its main research reactor has shown, the public anxiety about all things radioactive can make calm discussion about technical solutions for nuclear waste problems difficult.

Brookhaven also became an early lightning rod for opposition to spent-fuel transport in the mid-1970s when New York City objected to truck shipments of the lab's spent fuel on city streets. Although a court ruled in its favor, Brookhaven decided to ship the fuel off Long Island by barge instead.

The history of nuclear waste policy is littered with aggrieved parties, heated rhetoric and often shaky data on both sides. The industry lately has been pressing a sense of urgency, labeled dubious by critics, about reactors running out of storage space and facing shutdown (a contention that surfaced in Senate debates in the early 1980s as well). Anti-nuclear activists have warned that transport of spent fuel will create "mobile Chernobyls," potential catastrophes on wheels in ill-prepared communities, although there has never been a serious accident involving spent-fuel transport here or abroad. For years, the Energy Department promised that it would meet the congressionally mandated Jan. 31, 1998, deadline for accepting spent fuel from commercial reactors - even as it made little substantive progress toward that goal while spending nearly \$3 billion at Yucca Mountain alone.

The debate has been marked by what seems at times an unbridgeable gap between engineers who feel comfortable with the risks and benefits of nuclear power and a public that fears the specter of any radiation release, mistrusts the assurances of engineers and scientists and has felt misled in the past by inept management of government nuclear weapons plants and some commercial power reactors.

"On the whole, the industry has done a poor job of educating the public and establishing confidence with the public in their ability to deal with nuclear materials and nuclear waste," said Vincent Franceschi, president of Vectra Technologies, a vendor of storage casks for spent nuclear fuel. "The technologists have rebutted back with factual, technical arguments that don't carry much weight in an emotional discussion. It's a pretty steep uphill battle."

Rather than an impending crisis in fuel storage space, some social scientists say, the real crisis is the continuing lack of public confidence in nuclear technology.

"The civilian nuclear power program has grown out of the weapons program and the bomb," said Paul Slovic, president of Decision Research Inc. of Eugene, Ore. "The image of the bomb is in the back of virtually everyone's mind . . . If you ask people what a typical accident might entail at a nuclear plant, you get images that look like the aftermath of a nuclear bomb." Slovic's firm has done opinion research on nuclear issues for Nevada.

Given the adamant opposition of that state - and the likelihood of wider public concern once transportation of spent fuel begins nationally - Slovic and others say it makes more sense to leave the stuff where it is until attitudes



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change.

Marvin Resnikoff of Radioactive Waste Management Associates, a Manhattan-based consultant who has done contract work for Nevada, argues that storage at reactors is safer for now than mounting a large-scale movement of spent fuel to a single location.

"The longer the fuel sits and cools down, the safer it is to transport it," Resnikoff said. For now, he said, the spent fuel should be stored at reactors. "You make it, you take it," Resnikoff said.

There is little sympathy for that view in the U.S. nuclear industry, which sees few hopes of ever building another reactor - the last order in this country came in 1978 - unless the waste disposal dilemma is resolved.

Industry officials contend the Energy Department is dragging its feet. "We haven't got back anything but excuses," said Michael Morris, president of Consumers Energy Co., a nuclear utility in Jackson, Mich.

By getting spent fuel - at more than 70 reactor sites in 34 states - to Nevada as soon as possible, analysts say, the industry avoids having to store it indefinitely at reactors at a time when proposed utility restructuring already threatens to leave operators of unprofitable nuclear power plants with as much as \$70 billion in unrecoverable costs.

Nuclear industry officials counter that it is the taxpayers who might have to pay billions if Uncle Sam is required to reimburse for on-site storage costs and other economic impacts on utilities after failing to take title to the commercial spent fuel.

Moreover, they argue that reactors were never meant to become de facto fuel storage sites. Many are situated on waterways or in other environmentally sensitive locations. With increasing local opposition to on-site fuel storage, the industry says it could be caught in an untenable position: unable to ship the fuel to a central storage or disposal site and unable to keep piling it up at the reactors.

But is the situation as desperate as portrayed in some of the congressional debates?

Proponents of the interim storage facility - citing industry figures - have warned that 27 reactors will run out of space to house their spent fuel by next year, with dozens of others to follow during the next decade.

But those 27 reactors already has alternative arrangements for on-site storage of the fuel, according to reports the utilities filed with the federal government. Even industry officials acknowledge that no reactor is seriously threatened with shutdown in the near-term.

"You don't need to shut down reactors," said Morris of Consumers Energy Co. "This isn't a threat."

Morris said the industry has a legitimate gripe, however, about the lack of results 15 years after Congress ordered utilities to start collecting fees from



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ratepayers - now running about \$630 million a year - for a federally run disposal program that seems no closer than it did a decade ago.

"There needs to be some certainty in the planning process," said Theodore Garrish, vice president for nuclear waste at the industry's Nuclear Energy Institute.

That was what Congress had tried to do when it passed the 1982 Nuclear Waste Policy Act. It ordered the Department of Energy to start a rigorous, nationwide search for spent-fuel repository sites and to begin accepting spent fuel from utilities on Jan. 31, 1998, a target which some scientists say was unrealistic from the outset.

The act ordered the Energy Department to develop two high-level waste repositories, one in the West and one in the East, where most of the commercial reactors are situated. But the agency proposed some sites - such as the government's polluted Hanford reservation in Washington state - that even its own scientists warned were likely unacceptable. Plagued by unrealistic deadlines and local opposition to proposed sites, the selection process was in disarray by 1986.

Frustrated, Congress called off the search in 1987 and passed legislation designating Yucca Mountain - in politically weak Nevada - as the sole repository candidate.

A decade later, the suitability of Yucca Mountain as a permanent waste repository remains to be determined, with gaps in information about such basic questions as the water infiltration rates. A five-mile tunnel through the mountain was completed recently and will allow more extensive studies.

Recent discoveries suggest that rainwater may percolate into the mountain at least four times faster than previously estimated. Scientists also have found evidence suggesting that some water has been able to reach the repository horizon - about 1,000 feet underground - in 50 years or less.

Given time, moisture can attack even the sturdiest waste containers.

A viability assessment of the Yucca Mountain repository - essentially a decision on whether there are any showstoppers so far - is due late next year, with a final decision on its suitability due by 2001.

For backers of Yucca Mountain, the biggest nightmare is that it would prove unsuitable after billions spent and no other site jumps to the fore. "We don't have a contingency plan if we decide we are not going to make a commitment to a geologic repository," said Daniel Dreyfus, who formerly headed the Energy Department's Office of Civilian Radioactive Waste Management. Accordingly, he said, a barely hidden agenda on Capitol Hill is to approve the temporary storage facility, get the spent fuel to Nevada at all costs "and the hell with it."

Even if shipments of spent fuel to Nevada were to begin in a few years - whether to an interim storage site or a permanent repository - they would not necessarily bring quick relief to some locations where critics of on-site storage of reactor fuel have been vocal.



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The existing contracts between the Energy Department and the nuclear utilities call for the oldest fuel to be shipped first. Reactors that have been shut down recently for political or economic reasons - such as the Trojan reactor near Portland, Ore. - do not have the oldest fuel and could be stuck with on-site storage for up to 20 years in any event.

In fact, much of the spent fuel slated for initial transport lies not in storage pools at active reactor sites but at an existing storage facility at a commercial fuel-reprocessing facility in Morris, Ill., that never operated. Also slated for early removal is fuel still on-site at the defunct reprocessing facility at West Valley, near Buffalo.

The Nuclear Waste Technical Review Board, an independent panel of experts reporting to Congress and the Department of Energy, said last year that "developing a centralized storage facility at Yucca Mountain now would only reduce, but not eliminate, the need to continue adding spent fuel storage capacity at reactor sites." The board also concluded that there is "no compelling technical or safety reasons for moving spent fuel to a centralized storage facility for the next few years." It said "the methods now used to store spent fuel at reactor sites are safe and are likely to remain safe for decades to come."

The industry developed ways to squeeze more spent fuel into the existing storage ponds and built large storage casks that can be lowered into the cooling pools and filled remotely with used fuel assemblies. The casks are then raised, drained of water, sealed and placed on reinforced, fenced concrete storage pads near the reactor for indefinite storage.

The federal Nuclear Regulatory Commission, which licenses the storage casks, has concluded that they can be safely used for as long as a century. There now are 10 on-site storage facilities in the United States, and another dozen being planned. The first such at-reactor facility, at the Surry Power Station in southeast Virginia, now has 31 filled casks and slots for as many as 84 - enough to store all of the spent fuel from the two Surry reactors when their operating licenses expire in 2012 and 2013.

While industry officials agree such dry cask storage facilities are safe, they argue it would be more efficient - and cheaper - to manage and secure the spent fuel at one central location rather than dozens of reactor sites, especially with some communities now starting to object to construction of new on-site storage facilities.

The Nuclear Energy Institute, the industry lobbying group, estimates that as many as 55 nuclear sites may require at-reactor storage facilities by 2010 - when the permanent repository is supposed to start accepting spent fuel. The cost of building and operating those facilities through 2010 is projected to be at least \$4.3 billion, according to Theodore J. Garrish, the institute's vice president for nuclear waste management.

Auke Piersma, an analyst for Public Citizen - a nonprofit group that has been critical of the nuclear industry - challenges those estimates. Using Department of Energy data and different criteria for the amount of reserve space required in the spent fuel pools, Piersma projects that 32 sites will need added storage by 2010. He puts the cost at \$665 million.



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The Congressional Budget Office has estimated the central storage facility being discussed in Congress would cost \$2.3 billion over five years, with \$1.4 billion of that devoted to transporting the spent fuel to Nevada from sites around the country.

Transportation is another sore point for opponents of the centralized facility. Some state and local officials worry about the potential for more frequent accidents if the number of spent-fuel shipments increases dramatically. There have been estimates that it would take as many as 17,000 rail and highway shipments over several decades to move the spent fuel to Nevada.

Specialists say there has never been a serious accident during the more than 2,400 shipments of spent nuclear fuel in the United States over the years. While commercial spent fuel has been piling up at reactors, used fuel from smaller research reactors is shipped regularly to a Department of Energy storage site near Aiken, S.C.

"Spent reactor fuel has moved around this country for years," said Susan Shankman, a specialist on nuclear fuel transportation and safety at the Nuclear Regulatory Commission. "Research reactor fuel moves almost weekly, and safely."

Critics also contend that certification of the shipping casks is done largely through computer simulation of accident scenarios and subscale tests of cask models. Whether those tests adequately predict the behavior of the casks under real world conditions such as a catastrophic highway tunnel fire remains a point of contention.

Daniel Dreyfus, who formerly headed the Energy Department's commercial radioactive waste program, sees the current argument over an interim storage site as a "sideshow" to the more pressing question of whether Yucca Mountain will be deemed suitable as a burial site for the waste. "We've bet the farm on one site geologically," Dreyfus said. "We're unlikely to ever look at another site if it doesn't work," he said.

Dreyfus, who also worked on Capitol Hill for many years, said "the politicians got suckered" in the early 1980s when they approved a nuclear waste disposal program that has proved to be far more costly, complex and difficult to sell than they had imagined. There was talk at the time of building a repository for a total of \$800 million, Dreyfus said.

D. Warner North, a senior vice president of Decision Focus Inc., a consulting firm in Mountain View, Calif., argues that social sciences are now proving as necessary as Earth sciences and engineering in setting policy on nuclear waste. "We should ask the social scientists for their help in communicating with the public about nuclear waste," North wrote recently in *Physics Today*.

Proponents of a centralized storage facility say their message is simple enough. "It's in the best interest of the communities locally that the spent fuel not be kept there indefinitely," said Eileen Supko of Energy Resources International, a consulting firm that has done work for the nuclear industry. "It makes no sense to store the fuel for 50 or 100 years. It's a waste of resources. We could be spending that money on renewables, clean coal technology, the next generation of nuclear plants, whatever."



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Dreyfus, now associate director for operations at the National Museum of Natural History, agrees that the spent fuel should not be left at reactor sites indefinitely.

"The basic truth is that someday it's got to move," Dreyfus said. But he adds, "I can't find any reason to leap forward and do it instantly." How Waste Occurs 1. Nuclear reactors are powered by enriched uranium-235 fuel. This fuel is in the form of bullet-sized pellets loaded into long rods. The fuel turns the coolant into steam, which turns the turbines that make electricity. 2. About 200 rods are packed into fuel assemblies. After about six years, the spent fuel assemblies are removed and placed in storage pools to cool. Here they remain unless they are removed to dry storage.

GRAPHIC: Newsday illustrated chart by Steve Madden - How Waste Is Created. Source: Department of Energy. Nuclear Regulatory Commission. (SEE END OF TEXT; ILLUSTRATIONS NOT IN TEXT DATABASE). 1) Color cover photo by Dan Z. Johnson - Engineer Matthew Eyre at spent-fuel cooling pool at Limerick, Pa., power plant. 2) Color photo by Ken Korotkin- View inside the Yucca Mountain project tunnel, where nuclear waste would be stored if the U.S. government approves the Nevada site as a permanent repository for radioactive materials. 3) Color photo by Dan Z. Johnson- A pool of water cools used radioactive fuel from a nuclear reactor in Limerick, Pa. 4) Photo by Dan Z. Johnson A sign in the spent-fuel pool area warns workers at the Limerick, Pa., nuclear reactor.

LANGUAGE: English

LOAD-DATE: August 3, 1997



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