

of 533 spent-fuel assemblies and one containing parts of the reactor that was shut down in 1992. A national nuclear waste dump, planned for Yucca Mountain in Nevada, is supposed to be ready in 2010 to accept waste from 19 decommissioned nuclear plants, plus 104 active plants.

# Vermont Yankee has a spent-fuel problem: Is the answer a dry-cask nuclear graveyard?

By ERIKA COHEN  
Sentinel Staff

**V**ERNON, Vt. — For most people, taking out the trash is a weekly chore of putting the cans by the curb or driving to the dump.

But what if there was no dump and all of your trash bags — dozens of years' worth — had to be stored in your house, without you knowing when they could be removed or where they could go?

That's the situation at Vermont Yankee nuclear power plant in Vernon, Vt. Its trash can is a 48,000-cubic-foot spent-fuel pool filled with all the highly radioactive fuel rods the plant has used since it opened 32 years ago.

## Fast facts

- ▶ Nuclear waste in the spent-fuel pool: 906 tons.
- ▶ Remaining pool capacity: 184 tons.
- ▶ Percent full: 83.
- ▶ Date pool will be full: 2007 if the plant boosts power by 20 percent; 2008 if the plant does not boost power.

The pool is holding 906 tons of trash and it's running out of space. Already the pool is holding more waste than it was designed to hold.

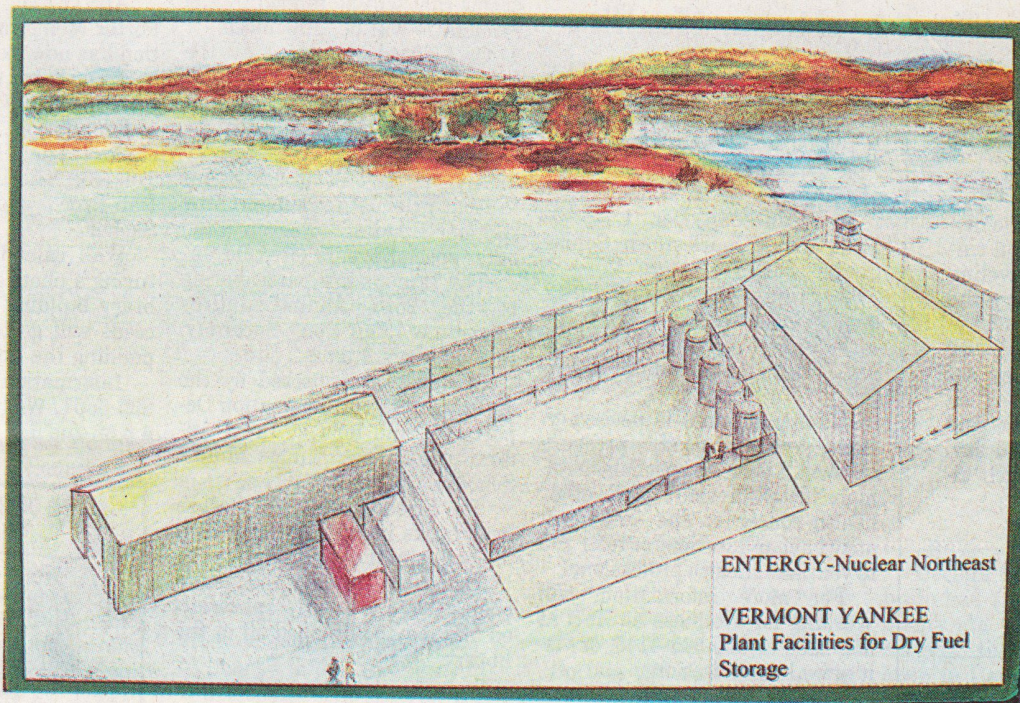
Meanwhile, the future federal nuclear waste dump at Yucca Mountain in Nevada, where the fuel would go, won't be open until after the pool is full.

That means Vermont Yankee must find a temporary dump for its nuclear waste, and plant officials are eyeing their own back yard.

If you can imagine trash cans on steroids — huge containers made of concrete and steel — you have a fair description of dry-cask storage. That's Vermont Yankee's temporary answer to its waste problem.

Plant officials hope to get Vermont's permission by the end of the year to build the system, said Rob Williams, spokesman for Vermont Yankee's owner, Entergy Nuclear.

Since the nation's first dry-cask facility was built in 1986, no one has broken into the fenced areas holding any of the casks and none have been damaged, said John D. Monninger of the Nuclear Regulatory Commission, the agency that



MICHAEL MOORE / Sentinel Staff

**PLANNING STAGE** — Officials at the Vermont Yankee nuclear plant in Vernon, Vt., are asking the state of Vermont for permission to build a dry-cask complex next to the reactor building. This artist's drawing shows the first five dry casks on a raised concrete pad surrounded by a high fence.

## 16 casks with nowhere to go

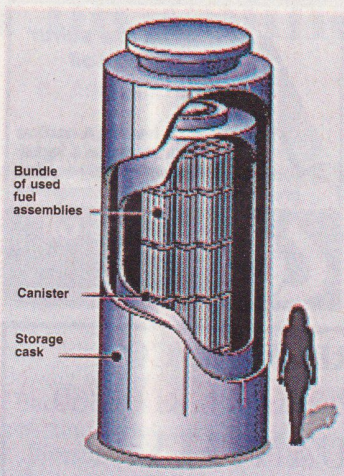
In Rowe, Mass., nuclear waste waits for a permanent home

### Inside

▶ Facts about spent fuel at Vermont Yankee. **Page 8**

▶ N.H. was once eyed for nuclear waste dump. **Page 8**

At right: Drawing of a dry-cask, showing the fuel rods, interior steel canister and the exterior concrete shell.



By ERIKA COHEN  
Sentinel Staff

**R**OWE, Mass. — Like graves in a New Orleans cemetery, the spent-fuel casks at Yankee Rowe Nuclear Power Station are lined up in rows and stored aboveground.

But unlike New Orleans, the nuclear graveyard just over the border in rural Rowe, Mass., is monitored 24 hours a day by cameras and security guards, and ringed by a chain-link fence topped

with razor wire.

The graveyard is home to 16 steel-and-concrete casks, each 11 feet tall. Fifteen hold 533 radioactive spent-fuel assemblies and one holds other bits and pieces from the now-dismantled nuclear reactor.

The casks will stay in Rowe until a national nuclear waste dump is opened, possibly in 2010 at Nevada's Yucca Mountain. When a federal dump is ready, the waste

See **YANKEE** on Page A-8

See **IS DRY-CASK** on Page A-8

## Index

CLASSIFIEDS E SECTION  
DEAR ABBY C-2  
HOROSCOPE D-5  
IDEAS & EDUCATION D-1

LETTERS D-3  
LIFE & FAMILY C-1,C-2  
LOTTERIES A-2  
NEW HAMPSHIRE A-2

OBITUARIES A-4  
OPINION D-2  
REGION A-3  
SPORTS B SECTION

SUNDAY DIVERSIONS D  
TRAVEL D  
WEATHER E  
Today: 64 pages, 7 section





# Is dry-cask

(Continued from Page A-1)

regulates commercial nuclear power and nuclear waste.

More than 30 of the nation's 104 nuclear power plants are already storing spent-fuel rods in casks outside their reactors. The steel-and-concrete containers are 11- to 15-feet tall and 8- to 10-foot wide. They're lined up on concrete pads outside the reactors.

Clean record or not, dry-cask storage raises many questions: How long would the casks remain in Vernon? How many would there be? How would they be guarded? What if a plane flew into them? What about radioactivity? Who would pay for them?

There is even a question of when they will be needed.

The 540-megawatt power plant is waiting for an answer from the NRC on whether it will be allowed to boost power by 20 percent. If it boosts power, the plant will run out of space in its spent-fuel pool in 2007; if it doesn't boost power, it will run out of space in 2008.

## Building a safe bunker; the nesting approach

Williams calls dry-cask storage a "common sense" option because the casks can be shipped from Vermont Yankee directly to a permanent storage site.

A dry-cask storage system is like a set of nested Russian dolls that fit inside one another. The spent fuel is stored in a welded-shut 1/2-inch-thick stainless steel cannister.

The cannister then sits in a concrete- and steel-reinforced cask 12- to 21-inches thick. The stainless steel and concrete provide radiation shielding and protection to the spent fuel stored inside.

When a permanent nuclear waste dump is ready, the inner steel canister will be removed and shipped to its final resting place.

Just over the border in Rowe, Mass., plant officials at Yankee Rowe Nuclear Power Station laud dry cask storage, which has been used there since 2002.

Yankee Rowe closed in 1992. The spent nuclear fuel still sits inside 15 dry casks on a concrete pad up the hill from the mostly dismantled reactor building. A

16th cask holds parts from the reactor.

"It's definitely a safe place for storage of fuel," said Frank J. Helin, the director of decommissioning at Yankee Rowe and project manager for the fuel transfer and storage. "You never have to handle the individual fuel bundles again."

Helin said the biggest advantage of dry-cask storage is that it's a passive system, meaning it requires monitoring but no regular maintenance. The casks are monitored 24 hours a day by cameras and security guards, and ringed by a chain-link fence topped with razor wire.

With only 16 casks, Rowe is one of the smaller dry-cask facilities. Many plants have about 20 casks and some have as many as 100, each holding up to 68 spent-fuel assemblies, Monninger said.

Williams said Vermont Yankee officials are planning to build about five dry casks at first. The casks would sit to the north of the reactor building inside the fenced-in area that houses the building, said Laurence M. Smith of Vermont Yankee. A separate fence would surround the raised platform where the casks sit.

Vermont Yankee will pay for the casks and the guards to watch them. Williams said plant officials don't have a cost estimate yet.

According to Helin, radiation associated with the casks is "very small" — a couple of millirems on the platform within the enclosed area.

Millirems are a measure of radiation, which is a part of daily life. For example, medical X-rays expose people to 40 millirems of radiation.

Outside the fenced-in area, radiation levels associated with dry-cask storage can't exceed 25 millirems a year, according to NRC regulations, Monninger said.

## Out in the open, a terrorist target?

When it comes to dry-cask storage, people are more concerned about the threat from above than a threat on the ground.

At Vermont Yankee hearings last spring, local residents said they were already worried the power plant might become a ter-



# Hot Stuff

## Vt. Yankee's answer?

### Some facts about nuclear waste

**N**uclear power plants use uranium stored in fuel rods to produce electricity. In the reactor, the uranium atoms split, releasing energy in the form of heat. This heat boils the water in the reactor and turns it into steam.

At Vermont Yankee, the reactor is filled with fuel rods containing pellets of enriched uranium dioxide. The reactor also contains control rods, which are made of a material that regulates the speed of the nuclear reaction, and thus how much energy is produced.

Every 18 months, the plant shuts down and replaces a third of the fuel in the reactor, or about 122 spent fuel assemblies. Spent-fuel assemblies remain in use in the reactor for about 4½ years.

The used fuel rods are placed in the spent-fuel pool, located inside the reactor building and next to the reactor itself. The rods are stored underwater to protect workers from radiation. The water temperature in the spent-fuel pool reaches about 100 degrees Fahrenheit.

When the spent-fuel pool fills up, fuel that has been out of the reactor for at least one year (but usually closer to five years) can be stored in huge, above-ground dry casks.

To transfer the fuel, a huge drum is lowered into the spent-fuel pool and filled with fuel assemblies. Water is drained from the drum and helium is pumped in before putting the drum into the outdoor cask.

During the transfer process, the spent-fuel rods are never exposed to the air. The helium helps prevent corrosion and removes heat from the very hot radioactive fuel rods.

The temperature of the spent-fuel assemblies measure about 200 degrees Fahrenheit when they are first moved into casks. Over time, the uranium breaks down and the fuel rods cool.

*Sources: Nuclear Regulatory Agency, Entergy Nuclear Vermont Yankee, U.S. Department of Energy.*

▶ How it's currently stored: 12-foot-long, pencil-thick fuel rods filled with uranium are gathered in bundles of 64 to 100 rods each and stored under at least 20 feet of water in the plant's spent-fuel pool. The bundled rods are called assemblies.

▶ Number of fuel assemblies in the nuclear reactor: 368.

▶ Temperature in the reactor: about 550 degrees Fahrenheit.

▶ Number of fuel assemblies in the spent-fuel pool: 2,787.

▶ Capacity of the spent-fuel pool: 3,353.

▶ Available area: 566 spaces. This includes 180 slots for spent-fuel assemblies and 386 slots to empty all the reactor assemblies into the pool, in case of an emergency.

▶ Date pool will be full: 2007 if the plant boosts power by 20 percent; 2008 if the plant doesn't boost power.

▶ Date the spent fuel will be transported to a permanent storage facility: Unknown. The earliest possible opening date for a permanent storage facility at Yucca Mountain in Nevada is 2010.

▶ Future storage options: Dry casks, huge drums holding up to 68 spent fuel assemblies each, and first used in 1986 at the Surry Nuclear Power Plant in Virginia.

spent-fuel pool, but he fears the casks will be terrorist targets.

"The question is how much explosion can these things stand?" Shadis asked. Putting the fuel in dry casks "does not reduce the threat from terrorists."

### Choosing a system for storing future waste

Dry-cask storage is not Vermont Yankee's only option. The plant could shut down, or it could ask permission again for more fuel to be stored in the spent-fuel pool, an option called "reracking."

While Vermont Yankee doesn't need permission from the NRC to build dry-cask storage, it does need permission from the state of Vermont, and Williams said the plant won't build dry-cask storage if Vermont says no.

Williams "can't speculate" on what happens to the spent fuel if Vermont gives the plant a thumbs down.

One of the options, reracking, is like a California closet system. By changing the layout of the spent-fuel assemblies, more fuel can be stored in the same space.

Vermont Yankee has reracked three times.

The spent-fuel pool at the plant was originally licensed to store 600 spent-fuel assemblies, said Rick B. Ennis, the Vermont Yankee project manager for the NRC.

But in nearly three decades, thousands more have been allowed. In 1977, the plant's license was amended to hold 2,000 assemblies; in 1991, the number was upped to 2,870, and in 1999, it rose to 3,355, its current capacity.

Williams would not say whether plant officials might consider reracking, but Ennis said the NRC would consider such an application. The NRC has set no maximum for the amount of spent-fuel assemblies that can be stored in a spent-fuel pool, Ennis said.

In any case, Vermont Yankee will likely be producing spent nuclear fuel until its license expires in 2012, as long as there's someplace to put it.

The question is, where will it go, how safe are the different options and how long will the waste remain in Vermont.

terrorist target. And they feared that producing more power would only increase the risk of attack and larger radiation releases.

Dry-cask storage, which is located outside the reinforced reactor building, raises new questions about missiles or planes flying into the casks.

Monninger said that all dry-cask systems aren't explicitly designed to remain intact if hit by an airplane, but "quite a bit of analysis has been done in regards to the (casks') ability to withstand different types of

events. The results of the analysis show they are significantly strong structures."

The casks at Yankee Rowe, designed by NAC International of Atlanta, are built to withstand the impact of a plane, Helin said.

Monninger said all casks are designed to survive hurricanes, tornados, lightning strikes, earthquakes, floods and explosions from nearby propane tanks.

And it's possible the strength of the casks may one day be tested.

According to a Federal Aviation Administration advisory, pilots are currently allowed to fly over nuclear power plants, but "are strongly advised to avoid the airspace above or in proximity to such sites" and "should not circle as to loiter in the vicinity over these types of facilities."

This potential frightens Raymond G. Shadis, the technical adviser with the New England Coalition, a Brattleboro-based anti-nuclear group.

He said segregating the fuel into separate casks is safer than storing it all together in the



# Yankee Rowe waste awaits final resting place

(Continued from Page A-1)

will be shipped there for permanent burial. Yankee Rowe was shut down Feb. 26, 1992, after more than 31 years of producing electricity. It was the third nuclear power plant built in the United States and the first in New England.

No one has ever tried to break into the fenced-in area or to damage the casks, but if they did, Frank J. Helin of Yankee Rowe is confident the 110-ton containers would not break or leak radiation.

Helin, director of decommissioning at Yankee Rowe and project manager for the year-long transfer of spent fuel to the casks, has a number of reasons for that confidence:

- ▶ Once moved into the casks, the spent-fuel rods are entombed in a steel drum surrounded by 21 inches of concrete.
- ▶ The casks sit on a raised concrete platform about the size of a basketball court.
- ▶ The casks were built and designed to with-

stand the impact of an airplane without suffering any structural damage.

- ▶ Even if a plane hit them and exploded — releasing jet fuel — the fuel would disperse over the basketball court-sized enclosure and would not “puddle” — preventing a hotter, more concentrated fire.

And that’s not all. According to John D. Moninger of the Nuclear Regulatory Commission, the casks are also built to withstand hurricanes, lightning strikes, explosions of any nearby propane tanks and other natural disasters.

The casks also are tended to daily. The 16 casks are lined up about 4 feet apart on the concrete pad. They’re inspected twice a day to ensure nothing gets caught in vents that allow air to flow between the interior steel drum and the concrete outer cask.

The radiation and temperature monitors mounted on the casks are also checked twice daily.

If someone bent on terrorism did try to break in,

Helin says there are systems in place to deter such attacks, both in the enclosed area and in the nearby woods.

- ▶ Lights and security cameras are mounted on poles at all four corners of the fenced area. The cameras point both inward and outward.
- ▶ A guard station is staffed 24 hours a day and additional guards walk the perimeter of the fence, patrolling with guns.
- ▶ Other “passive and active security” systems are in place around the plant and in the nearby woods. For security reasons, Helin would not give details.

Radiation and temperature sensors on top of the casks detect any potential problems or radiation leaks.

The dry-cask storage facility cost about \$15 million to build, including the casks and security equipment. That figure doesn’t include the fuel transfer and labor costs.

Since the fuel from the decommissioned reactor

was moved to the casks — beginning in 2002 — they haven’t been opened. A transfer cask, which looks like a rocket, sits next to them, waiting for the time when the interior steel canister containing the spent fuel will be shipped to a permanent storage facility.

Helin said the radiation released is minimal. Radiation exposure on the concrete platform, where the casks are stored, is about 2 millirems. During a recent check, readings at the vents were 6 millirems.

Outside the fenced-in area, the readings are even lower.

“There is some background radiation associated with spent fuel, but it’s very small,” he said.

In the United States, an average person is exposed to 360 millirems of radiation a year, according to the U.S. Environmental Protection Agency. The majority of this radiation comes from radon, a naturally occurring radioactive gas that is found in granite.

# N.H. was once ground zero for a federal nuclear dump

By ERIKA COHEN  
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THE U.S. DEPARTMENT OF ENERGY’S PLAN CALLED FOR A 400-ACRE SITE WITH A LARGE MINE SHAFT REACHING 1,000 FEET TO 4,000 FEET BELOW THE SURFACE. THE PRIMARY



# N.H. was once ground zero for a federal nuclear dump

By ERIKA COHEN  
Sentinel Staff

Southwestern New Hampshire is home to rolling hills dotted by white church steeples and farms, winding country roads, and numerous lakes and streams.

But for a five-month period in 1986, it looked like the region might also be home to something much less bucolic: a massive nuclear waste dump.

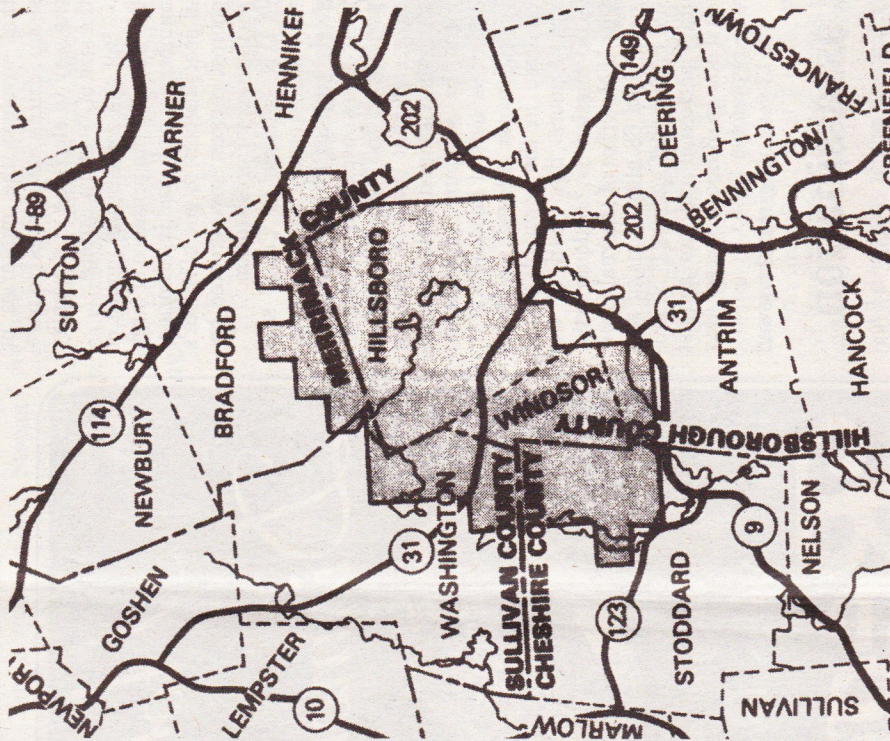
The U.S. Department of Energy was researching locations to permanently store high-level nuclear waste, and its short list tapped a 78-square-mile area covering much of Windsor and Hillsboro, and including portions of Antrim, Bradford, Stoddard, Henniker and Washington.

As reported then in The Sentinel, the N.H. location was one of 12 in the East and upper Midwest being researched for one of two national nuclear waste dumps.

At the time, Yucca Mountain in Nevada was one of three finalists for the western location.

The U.S. Department of Energy's plan called for a 400-acre site with a large mine shaft, reaching 1,000 feet to 4,000 feet below the surface. The primary site would house the waste-handling facility, surrounding it would be a 5,000-acre control area where no one would be allowed to live.

In 1988, Congress directed the energy department to study only Yucca Mountain for a single national dump. The desert site, about 100 miles northwest of Las Vegas, was designated as the na-



**GROUND ZERO** — Site proposed by the U.S. Department of Energy for a nuclear waste dump in 1986.

tion's official and only choice in 2002.

## Quick and angry response

News that the Hillsboro-Antrim site was on the short list stunned local residents, who nev-

er thought the solid granite rock formations of the area would be eyed for such a use.

And they had plenty to say in the first five months of 1986.

"My own reaction is: There must be a better place, a less-pop-

ulated area," Gregory R. Lawn of Peterborough told The Sentinel in January 1986. "I would really say these guys should have their heads examined."

Lawn was far from alone in his feelings.

At Harrisville's town meeting in 1986, one person said a nuclear waste dump would make the land "condemned for eternity."

Residents in all seven N.H. towns affected by the federal dump plans quickly formed groups to battle the plan. Signs sprung up on Main Street in Hillsboro saying "Don't dump on me" and more than 1,000 people attended a public hearing in Henniker — many offering expert testimony on the problems of locating a nuclear dump in the region.

State legislators also spoke out against the plan, including then-governor John H. Sununu, father of current U.S. Sen. John E. Sununu, R-N.H., and Sen. Judd Gregg, R-N.H., who was then a congressman.

Even Marlow schoolchildren spoke up, suggesting other locations. Their ideas — illustrated and handed to Gregg — included the desert, underneath the White House, on the sun and in Libya.

**THE U.S. DEPARTMENT OF ENERGY'S PLAN CALLED FOR A 400-ACRE SITE WITH A LARGE MINE SHAFT REACHING 1,000 FEET TO 4,000 FEET BELOW THE SURFACE. THE PRIMARY SITE WOULD HOUSE THE WASTE-HANDLING FACILITY; SURROUNDING IT WOULD BE A 5,000-ACRE CONTROL AREA WHERE NO ONE WOULD BE ALLOWED TO LIVE.**

than the 10,000 years the energy department was planning for.

The department has said repeatedly this ruling will not alter its plans to begin accepting spent fuel at Yucca in 2010.

But some officials disagree. Robert R. Loux, director of the Nevada Agency for Nuclear Projects, thinks the energy department is living in a fantasy world. Loux said even the department's models show the spent-fuel containers breaking down in 15,000 to 20,000 years.

In addition, the Yucca Mountain site might prove to be corrosive because the underground tunnels where the canisters will be stored are not as dry as the energy department estimated in its reports, Loux said. They're actually about 90 percent saturated with water, he said.

In its 100-page decision, the federal court also faulted the U.S. Environmental Protection Agency for disregarding findings by the National Academy of Sciences to protect against radiation releases for more than 10,000 years.

"In our minds, the project is dead," Loux said. "I don't think Yucca Mountain can meet a new standard."