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Is the solution to the U.S. nuclear waste problem in France?

By KATHERINE LING, [ClimateWire](#)

LA HAGUE, France -- Visiting the spent nuclear fuel reprocessing facility here is a bit like stepping into the script from a 1960s Star Trek show. When visitors peer through a 40-inch-thick, radiation-shielding plate of glass, they can see a ballet of industrial-strength robots.

Old nuclear fuel assemblies -- highly radioactive, elongated packages of metal rods that once energized some of France's 58 nuclear power plants -- are gripped by large mechanical arms. They are hoisted by cranes and placed on belts that move them along in the dim orange light. The machinery works to prepare the assemblies to be lowered into four giant pools.

There they will sit, with about 13 feet of demineralized water above them, a bath to shield and cool them, for about three years. Then more machines will lift them out, chop them up and put the pieces to be dissolved in vats of nitric acid. The fissioning of the fuel in the power plant, or the splitting of uranium atoms to release energy, has created a large family of elements, called fission products. The goal of this process is to find and recycle the ones that still contain more energy -- the plutonium and the uranium.

Spent fuel rods also contain elements that have relatively little energy, but plenty of long-lasting radiation. These include americium, curium, cesium and iodine. They are sent off to be immobilized -- hopefully for thousands of years -- by imbedding them in glass logs. Employees here monitor and operate their robotic helpers from a bank of computers housed in lime-green metal coverings.

Many advocates of a "nuclear renaissance" to help curb climate-changing emissions know about this facility, perched near the edge of a craggy cliff that offers spectacular views of the English Channel. It is part of France's answer to the question pressing nuclear power plant owners in nearly every part of the world: What do you do with spent nuclear fuel?

Spokesmen for Areva -- the name of France's majority state-owned complex of nuclear

companies -- regard this plant as the "crown jewel" of its technology. "Old fuel in, new fuel out. A pretty elegant solution," said Mike McMahon, one of a number of Americans being trained at French facilities to learn the ropes so that they can bring the knowledge back to similar Areva facilities planned for the United States. The United States has the biggest nuclear power market on the planet, and Areva has laid ambitious plans to participate in its "nuclear renaissance."

McMahon works at the Melox facility in southeastern France, where the separated plutonium from La Hague is mixed with enriched uranium to make mixed oxide (MOX), which partially fuels 20 of France's reactors and accounts for about 10 percent of the country's electricity per year. Areva and the Shaw Group Inc. are building a similar plant for the U.S. Energy Department at the Savannah River Site near Aiken, S.C., to make use of excess plutonium from the U.S. nuclear weapons program.

U.S. policy: a state of perpetual indecision

The French are making their move at a time when U.S. nuclear policy for what engineers call managing the "back end" of the nuclear fuel cycle has been locked in a state of perpetual indecision. Since President Carter shut down the U.S. reprocessing program in the 1970s, U.S. policy has been to take used power plant fuel and bury it. In 1987, Congress designated Nevada's Yucca Mountain as the final resting place for the country's nuclear waste, but the facility there has never opened. Now President Obama has proposed to stop federal funding for Yucca -- which is strenuously opposed by Nevada politicians -- while a new federal commission reviews Congress' old policy.

To be sure, the problems raised in dealing with the "back end" are not tidy or small, but they are being sorted out here. Areva and French government officials say the reprocessing solution reduces the volume of the highly radioactive nuclear waste by a factor of four to five by taking uranium and plutonium out of the storage equation. The wastes isolated in the glass logs will remain here until France constructs a deep geological repository -- currently targeted for completion in 2025, although there are some Nevada-like protests over the chosen site.

Japan, Germany, Switzerland, the Netherlands, Belgium and Italy have shipped their wastes for reprocessing here in the past or are currently doing so. Eventually, after the residue from their wastes cools down, they will get it back for disposal.

One result for the French is jobs. La Hague and Melox provide about 11,000 jobs and €479 million (about \$624 million) for the local economy. According to Areva, the process costs

consumers about 6 percent of the fuel costs per kilowatt-hour. Areva's back-end unit -- including cleanup of nuclear facilities -- had revenues of €1.74 billion (about \$2.3 billion) in 2007.

Areva officials admit that their solution is not perfect. It includes trucking plutonium and waste 700 miles between the reprocessing and recycling facilities. Plutonium is one of the explosive metals used for nuclear weapons and must be carefully guarded en route. If terrorists were somehow able to acquire and handle the highly radioactive wastes, they could be made into a so-called "dirty bomb" using conventional explosives.

Jacques Bouchard, an adviser to the chairman of the French Atomic Energy Commission, believes that, in the long run, inaction in the face of the accumulating waste poses a more serious problem. "I would not like to be in the situation to have accumulated so much used fuel, and the next generation, my son, my grandson, says, 'OK, what have they done?'" he said.

"If you want to sustain the nuclear renaissance, you have to deal with the back end," said Remi Coulon, an Areva director of strategy and international projects. France has already started construction on a new advanced reactor at Flamanville, which can be seen from La Hague, and in January announced the construction of a second at Penly, also in northwestern France.

Supporters in the U.S.

Some U.S. nuclear experts, such as Bill Magwood IV, a physicist who directed nuclear programs in the Department of Energy for both the Clinton and Bush administrations, think there is much to learn from the French. In a recent paper, Magwood likened the U.S. process to "pulling a log out of the fireplace just because the bark has burned off." More than 90 percent of the energy in spent nuclear fuel remains available for reprocessing, while only 3 to 4 percent is "useless waste," he explained.

Mark Ribbing, policy director at the Progressive Policy Institute, a think tank for moderate Democrats, which published Magwood's paper, said the question of nuclear waste is "an issue you should confront with clear eyes."

The outgoing Bush administration tested the political reaction to reprocessing in 2006 and found 11 communities that showed interest in having a reprocessing facility. The approach promised high-paying jobs for hosting a regional intermediate highly radioactive nuclear waste site, a sort of "energy park."

South Carolina Sen. Lindsey Graham (R) earlier this month said he would like to bring such an "energy park" to the Savannah River Site -- where Areva is building the MOX facility -- and plans to speak to House leadership and President Obama on the matter. Reprocessing is moving elsewhere on the congressional front, including in draft legislation from Sen. Jeff Bingaman (D-N.M.), chairman of the Senate Energy and Natural Resources Committee, that would study the feasibility of a reprocessing facility as a part of comprehensive energy legislation. Sen. Lisa Murkowski (R-Alaska), the committee's ranking member, said she will propose an alternative nuclear provision to provide cost-sharing incentives for two reprocessing facilities and other new nuclear reactor incentives.

As for President Obama, it appears his policy is research, research, research. The proposed budget for next year includes \$192 million for fuel cycle research and development, but nothing for facilities. Energy Secretary Steven Chu says DOE will continue to research to develop reprocessing methods that are proliferation-resistant, but the technology is not ready yet to have any sort of "pilot" or demonstration facility.

Areva, General Electric Co. and another unnamed vendor have asked the NRC to develop licensing procedures for reprocessing plants by 2012. Areva officials say the earliest a reprocessing plant could be built in the United States would be in the 2020-25 time frame, and that such a plant would cost about \$20 billion to \$25 billion.

No shortage of vehement critics

Anti-nuclear environmental groups and experts worried about proliferation have tended to dominate the political stage in the United States. France's nuclear waste solution has some critics, such as Yves Marignac, head of WISE-Paris, an independent nuclear information organization based in Paris. He asserts that intermediate wastes liberated by reprocessing still have to be stored for some 500 years. "There is no sign that France made the [waste management] solution simpler or quicker," Marignac said.

The U.S. Energy Department came to a similar conclusion about the additional volume of intermediate-level waste from reprocessing in its environmental impact **statement** (pdf) on the Global Nuclear Energy Partnership -- President Bush's administration push for a domestic and international closed nuclear fuel cycle -- released last October.

Marignac and other critics have noted that once spent fuel components are recycled, they have a higher concentration of radioactive materials, making them "hotter" than once-through spent nuclear fuel when they first come out of the reactor. The reduction in the physical volume of the MOX waste is not helpful until the radioactivity of the recycled fuel is

reduced to at least the level of once-through spent fuel.

A 2001 report by the French Commission on Sustainable Development -- a former advisory committee to the prime minister -- found that spent MOX fuel would have to cool for 150 years, compared to 50 years for other spent fuel, saying such a long surface storage period was "not an equitable one for future generations."

But Jarrett Adams, an Areva spokesman, says an **Areva study** (pdf) concludes that reprocessing and recycling would reduce U.S. waste volume by a factor of four for the same cooling period as once-through spent fuel -- about 50 years. The study was done exclusively for the Yucca Mountain repository, as geology and repository design play an important role in dictating how much capacity savings can be achieved, he said.

The idea is that after the plutonium is removed, the spent MOX fuel mainly has short-lived radioactive isotopes left, which makes the spent recycled fuel more radioactive than once-through spent fuel at first. but that over a longer period, the spent fuel becomes less radioactive because it does not have the long-lived isotopes of plutonium and americium -- a fission product from plutonium's decay, the study concludes.

French law deems some wastes not waste

Marignac asserted that there is also a problem with storing the most troublesome nuclear waste in glass, a process called vitrification. He said there is no evidence that mixing long-lived products like americium, curium, iodine and neptunium with glass and vitrifying them is safer than disposing of once-through spent fuel as would be done in Yucca Mountain.

Areva officials flatly stated that none of the elements escape the glass. An Areva employee said that although the glass logs cannot be tested once they are put in the stainless-steel containers (which erode in about 50 years) and are placed in intermediate storage underneath the floor of several buildings at La Hague, the French Atomic Energy Commission is monitoring the effects through simulations in the lab.

One of the elements of the French program that shields it from the politics that have stymied U.S. waste initiatives is the lack of public information. Mycle Schneider, an independent nuclear expert, said many nuclear decisions are still made in private discussions among industry, government and the French Nuclear Safety Authority.

A good example, he said, was French President Nicolas Sarkozy's January announcement that the nation was building a second EPR -- Areva's most advanced pressurized water

reactor -- at Penly in northern France. Schneider said it "was a bit like Obama suddenly announcing a reactor would be built somewhere in the United States" with no prior notice.

France's definition of waste also makes waste volumes difficult to pin down, Marignac said. Under French law, any product that industry says can be reused is no longer considered waste. Marignac said materials like "scrap" MOX -- recycled plutonium that cannot meet the specialized specifications -- are not considered waste by Areva, although they are unlikely to ever be used. Areva says all "scrap" MOX is sent back to La Hague and reprocessed for use.

Also piling up is the reprocessed uranium, Marignac said. There are only two reactors in France that currently use the recycled uranium -- a choice made by France's utility Électricité de France to save the depleted uranium until a time when the price of uranium rises and re-enriching the recycled uranium is cost competitive, Areva stresses.

Similar questions about what happens if there is a supply-demand imbalance have been raised in the United States regarding recycled fuel. Duke Energy Corp. was the only utility that had a contract to take recycled fuel from DOE's MOX plant in South Carolina, and it decided to let its contract lapse in December. So far, no other U.S. utilities have stepped forward -- even though they would actually be paid to take the fuel.

Technically, almost every nuclear reactor in the United States could accept MOX as one-third of its fuel, but they would require some investment in upgrades to monitoring equipment -- some more than others, according to the Nuclear Energy Institute.

A tension between jobs and doubts

Areva's Coulon said what makes reprocessing the "most controversial" is the idea that it makes nuclear power a long-term commitment.

When France built the La Hague facility in 1966, the United States had a fledgling reprocessing program under way, but President Ford froze the program in 1976, concluding that the proliferation risks from reprocessing were too great. The next year, President Carter announced that the United States would "defer indefinitely" the commercialization of reprocessing and recycling. President Reagan lifted the ban in 1981, but no company chose to pursue reprocessing on a completely private basis.

The United Kingdom, Germany, Russia and India also started programs. Germany closed its facilities in 2005, and the United Kingdom's facilities have run into serious management and financial difficulties. Japan is planning on opening its Rokkasho reprocessing facilities

later this year, which will be followed by a MOX plant in 2015.

Today, a vast majority of the region around La Hague depends on the facility for jobs, and France has put its faith and reputation behind the technology as the solution to nuclear waste. This makes officials biased toward the continuation of the program, WISE's Marignac asserts. "Once you start the process without proper consultation, it is biased forever. You will always get the local dependency as part of the equation," he said. But there remain doubters, even here.

Members of the Association pour le Contrôle de la Radioactivité dans l'Ouest (ACRO), an organization set up in Normandy to monitor the environment for radioactive discharge levels and bring information to the local community, have found that tritium and iodine levels are cumulatively much higher than they naturally would be. ACRO said community members are concerned about the environmental and health impacts of La Hague, but they are more concerned about their jobs.

"There is doubt in their heads," said ACRO's Pierre Barbey and André Guillemette through a translator. "They keep this fear at bay because the economics is favorable for the area."

French safety officials and Areva are constantly monitoring the facilities' discharge levels, and they are well within limits for health and safety, according to the French government.

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