'Black cells' engulf Hanford cleanup

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SUMMARY: With nuclear waste leaks adding new urgency, experts deal with a costly, problematic system

RICHLAND, Wash. --In the late 1990s the Hanford nuclear reservation's British contractor designed the world's largest nuclear waste treatment plant around a fateful feature: "black cells."

Fifteen years, a new set of contractors and $8 billion of construction later, the U.S. Department of Energy is still trying to figure out whether they'll work.

The cells, enormous concrete boxes lined with stainless steel, will hold mixing silos to process waste from 44 years of making plutonium for nuclear bombs.

They'll be highly radioactive and inaccessible to humans for the treatment plant's life. They're also central to Hanford's plans to treat 56 million gallons of nuclear waste stored in 177 underground tanks.

Recent disclosures of fresh leaks in six of those tanks, a half-dozen miles from the Columbia River, has brought renewed urgency to finishing the treatment plant, already delayed by two decades.

Yet concerns about black cell performance, raised by oversight groups and high-profile Hanford whistle-blowers, have stalled the most urgent construction.

The plant's latest startup deadline, 2019, is once again at risk. Its projected $13.4 billion cost, tripled since 2001, could go up by billions more.

The DOE has assembled five teams of nuclear experts to solve black cell threats.

But trust is low. Critics, the U.S. Government Accountability Office and an impatient Congress among them, note that the DOE and its contractors have declared many of the same issues fixed in the past.

In January the GAO questioned whether the plant, already more than half built, could succeed. Significant black cell failures could render it "unusable and unrepairable," the GAO said, "wasting the billions of dollars invested."

A witches' brew

Hanford covers 586 square miles of southeast Washington desert, bordered by bone-dry Rattlesnake Mountain and a U-shaped stretch of the Columbia.

The remote spot fit the bill for the World War II Manhattan Project.

Clean river water could cool nuclear reactors. And there was space for the enormous processing plants, called Queen Marys by workers, that extracted plutonium-239 from the reactors' uranium rods.

Hanford plutonium fueled the Fat Man bomb that flattened Nagasaki on Aug. 9, 1945, helping compel Japanese surrender and killing an estimated 80,000 people. Nine reactors produced Cold War plutonium through 1987.

It all left a monumental mess.

Workers dumped 450 billion gallons of waste on land, contaminating groundwater that connects to the Columbia; extensive cleanup is proceeding. An additional 56 million gallons, the worst of the worst, went into underground tanks expected to last just a few decades.

That tank waste is a witches' brew, loaded with uranium, plutonium, strontium, cesium, heavy metals and acids. It ranges from liquid to a peanut-butter sludge. The waste inventory, based on haphazard records, is often sketchy.

Those complications make the treatment plant "the riskiest, most complex project in the nation," with worst-case projections comparable to nuclear plant accidents, said Robert Alvarez, a former investigator for a committee headed by U.S. Sen. John Glenn and adviser to Clinton-era secretaries of energy.

"This project can't be treated as some sort of sideshow," Alvarez said. "We're talking about protecting one of the largest freshwater streams in America."

Black cells

The treatment plant may be rocket science, but the overall concept isn't.

Tank waste gets piped to a "pre-treatment" building, where it's sorted into high-level waste (really awful) and low-activity waste (merely awful).

Sorting allows the much smaller volume of high-level waste, destined for the highest-cost storage, to go through separate processing.

The two streams feed to two vitrification plants. Gigantic, 2,100-degree smelters will convert the waste to molten glass. Then it'll be poured into steel canisters for long-term storage.

Spinning nuclear waste into glass is fairly well tested around the globe.

Hanford's trouble mainly comes in the pre-treatment building, 12 stories high, lined with 15 black cells, full of pipes and mixing vessels with capacities up to 473,000 gallons.

The black cells will be so radioactive that human beings won't be allowed in, and remote access is limited. They'll have to operate with "perfect reliability" for 40 years for the plant to work as designed, the GAO says.

"One of the huge design failures is black cells," said Tom Carpenter, executive director of the watchdog group Hanford Challenge. "Everything bad that's flowed out of the waste treatment plant really started with that decision."

Instead of the black cells, designers could have chosen the "canyon" approach used in the past at Hanford and at other U.S. nuclear waste sites. Picture a huge, high-walled warehouse with some worker access and ceiling-mounted cranes to lift removable tank tops and fix problems.

But Hanford's late-1990s contractor, British Nuclear Fuels Ltd., opted for black cells used in Britain's Sellafield nuclear waste reprocessing plant, with sealed vessels and no access.

Off-limit cells would keep workers safer by containing leaks and reducing radiation exposure, the thinking went. The cells also took less room and were expected to cost less.

In retrospect, the decision opened a Pandora's box of stubborn safety challenges, all closely related.

Lingering problems

The black cells couldn't have moving parts, which might break and need to be replaced. Designers abandoned propeller-style mechanical mixers long used to keep waste safely mixed.

Instead they chose "pulse-jet mixers," turkey-baster contraptions that blend waste through suction and air blasts. Sellafield uses them for less complex reactor waste, but the mixers haven't been used at Hanford's scale or for waste with so many solids.

Bechtel National took over the treatment plant contract in 2001, working with URS Corp., the fourth set since cleanup began. Soon after, oversight groups began questioning whether pulse jets could handle Hanford's unique waste.

Proper mixing, it turns out, is a very big deal. Without it, Hanford's gooiest waste could clog inaccessible pipes between tanks or the pulse jets themselves.

If the jets allowed heavy waste such as plutonium and uranium to settle in the vessels, hydrogen gas could build up and explode or the clustered radioactive material could reach "criticality," an uncontrolled nuclear reaction.

A seemingly simple solution --jacking up the pulse-jet power --proved troublesome. Too much force on Hanford's solids-heavy waste could grind holes in the inch-thick stainless steel vessels, spilling the radioactive mix.

Black cell problems aren't just theoretical. In 2005 a pipe feeding a black cell tank at Sellafield cracked open. It leaked uranium and plutonium in 22,000 gallons of nitric acid.

The cell contained the leak. But operators didn't discover it for three months, and the plant shut down for two years.

Hanford's black cell issues have lingered for more than a decade. In 2010, Bechtel and the Department of Energy declared many of the mixing problems resolved, allowing construction to proceed.

Then came the whistle-blowers.

Critics corner

Walter Tamosaitis, URS Corp.'s supervising engineer on the project for seven years, first sounded the alarm.

Tamosaitis, who has a whistle-blower lawsuit pending, said Bechtel and the DOE rebuffed his warnings in 2010. He was reassigned to a lesser job in a basement office.

Also going public: Don Alexander, a senior DOE scientist; Donna Busche, a URS manager for nuclear safety; and, most recently, Gary Brunson, the DOE's director of engineering for the plant, who is now retired. All questioned pre-treatment's safety and readiness.

The Defense Nuclear Facilities Safety Board agreed. The DOE, the board said in 2010, is "heavily reliant" on the engineering judgment of Bechtel, under pressure to meet deadlines and win contract bonuses. The agency granted conditional approval of designs "in areas involving significant technical uncertainty," the board said.

A year later, the board added another zinger: Technical dissent was "discouraged, if not opposed or rejected without review" by project managers, especially if it affected budgets or schedules.

Busche, who has filed her own whistle-blower lawsuit, is still working at URS --and talking about her concerns.

The DOE's "design-build" contract with Bechtel and URS was supposed to save time and money. In practice, construction has outpaced safety, Busche said.

Today the pre-treatment plant still looks skeletal. But 29 vessels have already been installed in its black cells, without full-scale testing of how they'll work.

The plant is scheduled to begin treating tank waste in 2019, completing the job by 2047. Given black cell challenges and tight federal budgets, Busche said, those dates are "incredibly optimistic."

DOE's plans

The DOE and Bechtel hope to clear the technical hurdles by as early as next year. They won't comment on the 2019 deadline or costs until the DOE-led review is done.

Installing wear plates where pulse jets blast the sides of vessels could help. So could larger black-cell openings to admit robots for repairs.

There will be full-scale testing of vessels before they go live, the DOE says, and more monitors in the cells to spot problems.

The DOE, Bechtel and URS have made errors, said Nils Diaz, former chairman of the U.S. Nuclear Regulatory Commission. But they've learned from them, he said, and nuclear experts can solve problems as they pop up.

"The biggest contribution to safety is to move forward and get the damn stuff out of the ground," said Diaz, who served on a waste plant safety review committee in 2011. "Every time something is delayed, the cost goes up."

The DOE is also considering ways to bypass the pre-treatment building in the short term, sending waste from the underground tanks directly to glass-making.

A bypass, perhaps targeting storage tanks with a simpler mix of waste, could speed up treatment and back up the pre-treatment plant if it falters.

But that would take new storage tanks and equipment, the GAO says, and could "add billions" to the plant's cost, not a happy prospect for Congress. Overall, Hanford receives about $2 billion a year.

So far, the DOE has kept its review largely secret, asking participants to sign nondisclosure agreements.

Without details, critics and watchdogs are wary. The bypass idea seems "like they drew it on a napkin," said Carpenter of Hanford Challenge.

Whistle-blower Tamosaitis considers the robot fixes far-fetched: "There's so much piping and so many vessels inside the cells, going in them would be an absolute nightmare."

Critics want a more independent on-the-ground watchdog than the DOE. They also don't like Bechtel having so much design control.

Sen. Ron Wyden, D-Ore., chairman of the Senate Energy and Natural Resources Committee, has pledged to boost scrutiny of the

Hanford cleanup and make it a top priority in Congress.

But safety concerns mean change won't come quickly, said Ken Niles, who heads the Oregon Department of Energy division that monitors Hanford.

Niles is "not very" confident the plant will fire up by 2019. He does contend the treatment plant can succeed, despite its checkered history.

"I certainly hope so," he said. "We're 10 years into construction. To start over would be disastrous."

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