SAVANNAH RIVER SITE, South Carolina - A half-finished monolith of raw concrete and rebar rises suddenly from slash pine forests as the public tour bus crests a hill at this heavily-secured site south of rural Aiken.

Dozens of hard-hatted workers in bright green and orange vests slog through the damp clay and clamber over a half-finished roof five floors up. Others filter in and out of openings cut into the windowless, half-a-million square-foot box, where towering construction cranes are clustered.

Guide Laurie Posey uses the bus loudspeaker to describe the project’s 6,800 miles of cable, 80 miles of
radiation-resistant piping and double walls of reinforced concrete. Recently, she said the government factory would cost $4.86 billion, then coughed into her fist and shot a glance at the bus' driver.

"Do you think they picked up on that?" she asked, shaking her head. The estimate she cited -- $4.86 billion -- is a fiction the government used well after its lead contractor said the real number was likely to be $3 billion higher.

Dark clouds hover over this ambitious federal project, 17 years in the making and at least six more from completion--if, indeed, it is ever completed. It lies at the center of one of the United States' most troubled, technically complex, costly, and controversial efforts to secure nuclear explosive materials left stranded by the end of the Cold War.

This plant - and another just like it in Russia -- is meant to transform one of these materials, plutonium, into commercial reactor fuel that can be burned to provide electricity for homes, schools and factories, essentially turning nuclear "swords into ploughshares." The aim of the so-called Mixed Oxide, or MOX, plant is to ensure the material never winds up in the hands of terrorists.

In the right hands, only nine pounds of plutonium -- an amount about the size of a baseball -- could make a bomb as powerful as the one the U.S. dropped on Hiroshima. The world's military and civilian nuclear programs have produced about 500 metric tons of pure plutonium, an amount that could fuel tens of thousands of nuclear weapons yet fit into a backyard shed. Countries with nuclear programs continue to add roughly two tons to this inventory every year.

Washington has been spending hundreds of millions of dollars annually to help secure or remove plutonium and weapons-grade uranium in dozens of countries. But the U.S.-Russia plutonium disposition program, which includes the Savannah River plant, is the U.S. government's single most expensive nonproliferation project now, according to Michelle Cann, senior budget analyst with a nonprofit group called Partnership for Global Security.

Its aim is to eliminate 34 metric tons of U.S. plutonium -- or 40 percent of the U.S. stockpile of military plutonium -- in exchange for a similar
destruction of 34 tons of plutonium in Russia.

But that noble goal has slowly turned into a classic Washington disaster.

The plant here -- the core of the American half of the bargain -- is so grossly over its original budget and so unlikely to achieve its original ambitions that lawmakers and government officials in Washington are on the verge of killing it -- even though $3.7 billion has already been spent.

After four contentious, high-level recent government meetings - including several attended by the secretaries of State, Defense and Energy - the Obama administration has proposed to put the plant's construction on life support, at a cost of $320 million in the next year, while it examines a cheaper method of eliminating the plutonium.

Blown deadlines, lax oversight, and design and construction snafus have transformed the project into an embarrassing symbol of mismanagement by the DOE's National Nuclear Security Administration, which auditors have repeatedly placed on the government's "high risk" list of agencies vulnerable to fraud, waste and abuse.

And the original deal with the Russians that called for construction of the U.S. plant has been quietly altered and twisted to the point that Russia may actually emerge from the arrangement with more plutonium in its stocks, not less, experts say.
View Savannah River Site in a larger map

The huge new nuclear fuel plant at Savannah River reached this shaky stage via a convoluted path. The idea behind it grew out of a crisis. Arms control agreements in the 1980s had left both the U.S. and the Soviet Union with huge stockpiles of fissile materials from dismantled warheads. The collapse of the Soviet economy left workers at vast weapons production complexes without heat, power or paychecks, a circumstance that threatened security and raised the risk of nuclear smuggling.

At least four times between 1994 and 2000, small amounts of smuggled plutonium were recovered by law-enforcement officials in Europe, the Caucasus and Central Asia, according to the International Atomic Energy Agency -- all at the height of the Russian economic meltdown.

The United States and its allies worried these cases were the tip of an iceberg. Princeton physicist Frank von Hippel, a key player in the early push for a disposal agreement, recalls his surprise on visiting the huge Mayak nuclear complex in western Siberia in 1994. There, he found 30 metric tons of plutonium oxide from civilian reactors capable of being fashioned into bombs, stored in 12,000 teakettle-sized containers. A fence surrounded the reservation, but inside the gates all that stood between a thief and the plutonium was a padlock on the warehouse door and a nervous conscript guard.

A distinguished panel concluded in a special 2001 report for the Energy Secretary that the threat of diverted weapons materials from the former Soviet Union "is a clear and present danger, to the international community as well as to American lives and liberties."

Nor has the risk of nuclear terror diminished since then, U.S. officials say. "Two decades after the end of the Cold War, we face a cruel irony of history -- the risk of a nuclear confrontation between nations has gone down, but the risk of nuclear attack has gone up," President Obama warned on the eve of an April 2010 global summit on nuclear security in Washington. Former vice president Dick Cheney told the American Enterprise Institute the following year that a terrorist with nuclear materials and know-how was "the most dangerous threat" the U.S. faced.

But even though the United States and Russia worked together to stem nuclear security problems in the 1990s, the two countries disagreed from the start about controlling plutonium. The U.S. view, initially, was that the best way to prevent the explosive from being used in new bombs was to lock it away in ceramic and glass.

Russia, though, was eager to tap the vast riches locked in its Cold War detritus. The country pressed to use its plutonium as fuel for a type of nuclear reactor that can actually produce more plutonium than it burns, in a form that is more easily used in nuclear explosives - a reactor known as a "breeder" that many Western experts say can promote a dangerous international trade in the nuclear explosive.

In a long struggle to resolve this disagreement, the Russians got the better of Washington, according to some experts who followed it closely. As a result, the South Carolina plant's troubles partly reflect the fact that soaring U.S. national security ambitions were brought to earth by unsuccessful diplomacy. Officials in Washington thought they had clinched a deal with Moscow to ensure that the Russian plutonium stockpile would shrink, only to discover after years of delay that Russia had other plans.
How did the agreement wander so far off course, and disappoint many of its earliest advocates? First, some background is needed.

Breeder reactors, in a kind of Atomic Age alchemy, can manufacture more plutonium than they consume, inspiring dreams of almost limitless energy. By generating fast-moving neutrons that transform the uranium mixed into their fuel into additional plutonium, they hold the promise of a significant energy reward: One gram of plutonium can produce more energy than a ton of oil. At one time or another, breeders have been pursued by every major nuclear nation.

Until 1983, the federal government’s biggest civilian nuclear program was the promotion of plutonium breeder reactors, according to von Hippel. But breeder reactors are costly to build and operate, have special safety and reliability problems, and have long raised proliferation concerns. President Jimmy Carter decided not to pursue them, principally out of worry that making a lot more plutonium would eventually promote the spread of nuclear weapons worldwide.

His decision, which was opposed by the U.S. nuclear industry, led to a fundamental disagreement with Russia. "The U.S. has always looked at plutonium as a proliferation risk," said Kenneth Bromberg, who helped set up the Energy agency’s Office of Fissile Materials Disposition in the early 1990s and served as its chief from 2004 until his retirement in 2011. "The Russians have always looked at it as an energy source," ideal for use in breeders.

In early discussions, Nikolai Yegorov, the deputy minister at Russia’s Ministry of Atomic Energy, described the American plan to immobilize the plutonium in ceramic and glass as foolhardy. Yegerov told Matt Bunn, an MIT-trained policy expert who helped craft the deal, that "If the United States wants to throw gold down the toilet, let them."

Ernest Moniz, an MIT physicist who became Energy Secretary last month, played a key role in resolving the early impasse, while serving as a special negotiator for the Clinton administration. His June 2000 deal, approved by the two country’s presidents, called for both sides to use the plutonium mostly as a reactor fuel, as Moscow sought.

But the deal also demanded that almost all of the fuel be burned in standard reactors, from which Russia could not extract any residual plutonium in spent fuel for several decades, a significant nonproliferation achievement.

To encourage Moscow to proceed, Washington agreed to forego the burial option for all but 9 tons of its plutonium. Washington also promised to share technology and help fund the Russian effort, including construction of the Russian MOX fuel plant.

Some experts say that lurking behind that deal were not-so-hidden political and industry agendas to revive the development of breeder reactors. Breeder advocates were pleased because it would create, for the first time, an industrial-scale facility in America capable of turning plutonium into reactor fuel -- a key step on the path to a revived breeder program.

The MOX plant was "the plutonium nose under the tent," said Henry Sokolski, who served as a senior nonproliferation official under President Reagan.

The U.S. breeder revival got a more concerted push in 2001, when an industry-friendly energy task
force formed by Vice President Dick Cheney called for nuclear "fuel treatment technologies" that would lead to the recovery and reuse of plutonium for electricity production.

A year later, the Energy Department dropped the plan to encase some of the U.S. plutonium in glass or ceramic, citing the Russian insistence on burning plutonium as a fuel and asserting it was too costly to pursue both approaches.

The George W. Bush administration subsequently embraced a plan to promote breeder reactors and the recycling of plutonium, not just domestically, but by other nuclear states including Russia, in a controversial program known as the Global Nuclear Energy Partnership. Formal papers ordering the start of the MOX plant construction were signed in August 2007 by a former chief of the Bush-Cheney energy policy transition team, according to an internal Energy Department document.

Russia's construction of its own MOX fuel factory nonetheless stalled as the two countries squabbled about whether U.S. contractors working on it would have immunity from Russian lawsuits. A U.S. official involved in the discussions said the spat could have been resolved sooner but that Moscow wanted an excuse to delay producing the fuel to be burned in standard reactors, as its agreement required.

Moscow initially demanded that Washington pay for most of the plutonium disposal project's expenses. But by 2007, the United States had only managed to corral promises of $800 million in aid-- $400 million in U.S. funds, and $400 million from its allies - while Russia estimated the amount it needed was $4 billion.

The shortfall allowed the Russians some wiggle room. During this period, a former U.S. negotiator recalled, the Russians were saying "more and more, 'Look, we are willing to do it your way if we don't have to pay for it. But if we are going to have to pay for it, we want to do it our way.'" Jerald Paul, principal deputy administrator of the National Nuclear Security Administration from 2004 to 2006, said "the Russians were constantly moving the goalposts."

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With a shortfall of Western aid and a new pro-plutonium policy in Washington, Russia pressed to renegotiate the deal. At a meeting in Paris in February 2005, Russian atomic agency chief Alexander Rumyantsev told top Energy Department officials that "Russian plutonium disposition should be recast to focus on fast [breeder] reactors," according to a classified cable disclosed by Wikileaks.

His ambition was clear: Moscow wanted the Russian MOX plant, financed by Washington, to make fuel not for standard reactors, but for a full-scale breeder program, including a reactor the country is building 880 miles southeast of the Russian capital, an older reactor, and at least two other breeders in the development stage.

Negotiations reopened, and in mid-November 2007 -- 3.5 months after construction began at the Savannah River MOX plant -- Bush administration Energy Secretary Samuel Bodman and the director general of Russia's atomic ministry, Sergey Kiriyenko, announced the outlines of a revised deal.

The Bush administration agreed -- with little public notice -- to let Russia renge on its original promise and burn its plutonium in two breeders --breeders that could produce more plutonium.
Bodman also recommitted the U.S. to spending $400 million to help finance the deal and to "seek other donor funding." It was a strange outcome, in one respect: At that time, the U.S. was spending $926 million to replace three aging Chernobyl-style reactors in Siberia with two fossil fuel power plants, partly because of safety concerns but mostly because those plants were churning out weapons-grade plutonium.

Linton Brooks, who served from July 2002 to January 2007 as administrator of the National Nuclear Security Administration, defended the deal in an interview. He noted that the Russians promised not to make more plutonium than they burned in the breeders--at least for several decades--or to use it in weapons.

"If the alternative is having Russian and U.S. plutonium sit around for a long time, I'm fully happy with what the administration did," Brooks said. "I would not accept the view that we added to proliferation rather than reduced proliferation."

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The pact was still not signed when President Obama entered office in 2009, eager to "reset" U.S. relations with Moscow. Top officials initially hoped to nail details down before Obama met Russian President Vladimir Putin in July that year.

Russian hesitation over the deal's high costs prevented that from happening, and the summit deadline was missed. But the Obama administration dangled a legal agreement Russia wanted--allowing the transfer of U.S. nuclear power-related technology--to help gain Moscow's approval of a new deal in time for the president's April 2010 summit in Washington on nuclear security.

The terms, signed by then-Secretary of State Hillary Clinton and Russian Foreign Minister Sergey Lavrov, were radically different from the 2000 Clinton-era deal, though little changed from the arrangement worked out by the Bush administration. They spelled out how the Russians could use $400 million in U.S. funding to design the core of a new breeder reactor, and to modify an older breeder to accommodate the MOX fuel.

In a significant concession by Washington, Russia would be allowed to extract some plutonium immediately from fuel burned in one of the reactors used in the program--rather than waiting for decades to undertake such a process as Clinton officials had insisted. With the technical assistance Washington reaffirmed it would provide, Russia could make even more plutonium in additional breeder reactors now on drawing books. Russia promised, however, to accumulate any new plutonium only for civilian power rather than nuclear weapons.

U.S. officials recall no big internal debate about the terms amid the scramble to "find things that would make [the Russians] happy" and promote warmer ties, as one former senior Obama administration official put it.

On signing the agreement, Clinton hailed a "historic time for U.S.-Russian relations," and said the accord would "irreversibly and transparently dispose" of weapons-grade plutonium in both countries. Obama separately hailed the accord as a way "to prevent terrorists from acquiring nuclear weapons."

Since then, work on the MOX plants in both countries has proceeded. But Congress so far has refused to
approve any U.S. funding for the Russian reactor and fuel plant. Japan and the other Western countries that pledged money to the original effort also have not ponied up funds for the revised deal.

Joan Rohlfing, president of the Nuclear Threat Initiative, a nonprofit group that promotes aggressive action to reduce nuclear explosive risks, said she believes the project is still worth completing. "I am both surprised and disappointed" that the administration is questioning its investment, she said.

Likewise, a Russian official who has followed the plutonium agreement closely denied that Russia's breeder program undermined nonproliferation goals and said the project was still worth pursuing to reduce the threat of the theft of nuclear materials.

But the deal has not been popular among arms control and nonproliferation groups, which argue that it enables Russia to use U.S. funding and technical assistance to help design and fuel its new fleet of breeders, allowing it to expand its plutonium production in the future, or to help other countries - that buy Russian breeders - expand theirs.

Russia's nuclear energy chief was quoted in the official government newspaper last year, for example, saying that Russia's breeder reactors "are the basis of our competitiveness" in the global contest for nuclear plant construction contracts. The country is already discussing the sale of two to China. Anatoli Diakov, a Russian physicist who founded and directed an arms control and energy study center in Moscow, said in an interview that no matter what the United States does, Russia "is going to use the plutonium fuel" in breeder reactors.

"Down the road, we could see the MOX program in Russia lead to the creation of more separated plutonium, not less," said Tom Z. Collina, a senior official with the Arms Control Association. "That's one of the dangers of the agreement. It could ultimately defeat the original purpose...which is to eliminate stocks of separated plutonium."

An administration official who has been critical of the cost overruns, says the effort does not deserve further funding because "it's not going to do what it was supposed to do." The official, who asked not to be named because he spoke without authorization, added that the deal "gives the Russians what they want and limits our options."

Von Hippel said the MOX plant has "become from my point of view a pretty meaningless program" that should now be killed. "The problem...is that Russia doesn't intend to dispose of its plutonium permanently, right?" he said. "In fact, it's setting itself up to produce and recycle its plutonium indefinitely." That creates risks "that this stuff will get stolen, so in fact the security situation gets worse."

Pavel Podvig, an independent Russian arms control specialist based in Vienna, agrees.

"The irony of this whole project is that it basically started with a good goal, of eliminating weapons grade material with the idea that it won't be available for weapons purposes," Podvig said. "But then it sort of evolved into this program that provides a fairly significant subsidy to the plutonium economy. So in the end, we will end up with more plutonium."

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