Troubled Disposition: Next Steps in Dealing With Excess Plutonium

- Arms Control Today

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What should the United States and Russia do with the tons of plutonium they no longer need for nuclear weapons? The two countries have been struggling to answer this question since the end of the Cold War. Unfortunately, however, despite the signature in 2000 of the U.S.-Russian Plutonium Management and Disposition Agreement (PMDA), projected schedules for getting rid of these dangerous stockpiles have slipped by more than seven years, and the estimated costs of the effort have increased dramatically. A pitched battle over the future of plutonium disposition is now being waged in Congress.

Disposition of excess plutonium can still offer security benefits worth its mounting costs, but only if disposition is ultimately applied to far larger stocks of plutonium than committed so far, as part of a broader pursuit of deep and irreversible nuclear arms reductions, and if stringent standards of security are maintained throughout. Whether it will make more sense to use the bulk of the excess plutonium as reactor fuel or immobilize it for disposal with high-level wastes depends in part on the answers to questions of cost, practicality, and Russian attitudes that should be answered as quickly as possible.

Massive Stockpiles

The United States and Russia still possess massive stockpiles of plutonium and highly enriched uranium (HEU) built up over decades of Cold War arms racing. Today, the United States has a stockpile of about 92 metric tons of plutonium separated from spent fuel. The United States has declared that 45 tons of that material is excess to its military needs, leaving 47 tons in reserve, enough to support a stockpile of some 10,000 warheads.

Russia is thought to have a stockpile of some 145 tons of separated weapons-grade plutonium, although the uncertainty in that estimate is about 25 tons, along with some 40 tons of civilian separated plutonium, which also is weapons usable. Russia has declared that “up to” 50 tons of its weapons-grade plutonium is excess to its military needs, but the only plutonium it has definitely committed to get rid of is the 34 tons covered by the PMDA. This represents one-quarter of Russia 's estimated stock of weapons-grade plutonium and one-fifth of its total stock of separated plutonium, leaving enough remaining for tens of thousands of nuclear weapons. The U.S. and Russian stockpiles of HEU are even larger.[1]

Why Disposition?

Because these huge stockpiles could readily be turned back into nuclear weapons, eliminating them would mark a key step toward deeper and less-reversible nuclear arms reductions. Such reductions, in turn, could strengthen international political support for measures to repair the global nonproliferation regime.

But plutonium disposition will not achieve this security objective unless the United States and Russia are pursuing deeper and irreversible arms reductions. Disposition must also be applied to most of the total stockpiles on each side so that the remainder is only enough to support low, agree-on numbers of nuclear weapons. If Russia and the United States agreed to reduce their nuclear weapon stockpiles to 1,000 total warheads, for example, they would only require four to five tons each of military plutonium. That would almost triple the amount of weapons-grade plutonium viewed as excess in Russia and nearly double the amount of excess material in the United States .

In principle, disposition of these large stocks—physically transforming them into forms that would be difficult and costly to recover for use in nuclear weapons—could also decrease the risk that some portion of them could be stolen and fall into the hands of terrorists or proliferating states. The British Royal Society warned in 1998 that even in an advanced industrial state such as the United Kingdom , the possibility that plutonium stocks might be "accessed for illicit weapons production is of extreme concern."[2] This risk, however, is not closely related to the total size of the nuclear material stockpiles, as a building containing one ton of weapons-usable nuclear material poses effectively the same theft risk as a building containing ten tons of such material. If the goal is to reduce the risk of nuclear theft, the first priority should be to remove the nuclear material entirely from as many small, vulnerable facilities as possible and then to beef up security at the remainder.

A disposition program that removed the material from a substantial number of potentially vulnerable buildings could reduce the risk of nuclear theft, but a program that only removed one-quarter of Russia 's excess plutonium stock and only removed some of the plutonium at each location would do little to reduce the risk of nuclear theft and terrorism.

Indeed, unless very high standards of security and accounting are maintained throughout the disposition process, removing this material from secure stores, processing it, and transporting it from place to place could increase rather than decrease theft risks. For this reason, and because getting plutonium or HEU is the most difficult part of making a nuclear bomb, a 1994 study from a committee of the U.S. National Academy of Sciences (NAS) recommended that, to the extent practicable, HEU and separated plutonium should be as well secured and accounted for as nuclear weapons themselves, the so-called "stored weapons standard."[3]

Fissile material disposition may also serve a "good housekeeping" purpose, avoiding the costs and hazards of storing this material indefinitely. If that is the principal purpose, however, it is important to focus the effort on those stocks that are in fact expensive and dangerous to store. Ironically, these tend to be the heavily contaminated stockpiles that are less likely to be used for nuclear weapons.

Plans, Delays, Costs, and Obstacles

When the PMDA was drafted, both sides laid out tentative plans for their disposition efforts. Russia planned to use all of the 34 tons of weapons-grade plutonium covered by the agreement as uranium-plutonium mixed oxide (MOX) fuel in operating nuclear reactors—a few tons in the BN-600 fast-neutron reactor at Beloyarsk and the rest in Russia's VVER-1000 light-water reactors (LWRs).[4]

The United States planned to use 25.6 tons of uncontaminated plutonium as MOX fuel in LWRs and immobilize the other 8.4 tons covered by the agreement, along with nearly eight tons of other material not covered by the agreement. The immobilization approach on which the Department of Energy has focused, known as "can-in-canister," involves making small cans of either glass or ceramic mixed with plutonium. These cans are then arranged inside huge metal canisters. Molten glass containing intensely radioactive high-level waste from ongoing waste disposal programs would then be poured into these canisters. (The process of mixing plutonium or high-level waste with glass is known as "vitrification.") Hence, as with plutonium in spent fuel (the result of the MOX approach), the plutonium ends up as a small percentage of the total weight of a large, intensely radioactive object slated for storage and eventual disposal in a geologic repository.

Both sides projected that they would have full-scale MOX plants operational in 2007; the U.S. immobilization plant was to be built and operating a year later. Cost estimates around the time of the agreement suggested that disposition of the Russian material covered by the agreement would cost $1.8 billion ($2.1 billion in 2007 dollars), after subtracting $350 million for the expected value of the fuel produced.[5] The U.S. disposition program, which covered more material than just the 34 tons covered by the agreement, was expected to cost $4.1 billion ($4.8 billion in 2007 dollars), after similarly subtracting $565 million for the expected value of the MOX fuel to be produced.[6]

Today, the projected costs of these efforts are far higher and the expected schedules are much slower. The latest estimates suggest that a full-scale MOX plant will not start operations in Russia until 2018 and that the Russian program will have a total cost of $4.1 billion, from which the value of the MOX fuel produced might subtract $500 million or so, although this was not estimated in the most recent study.[7]

Although the original agreement called for each side to start off at a rate of two tons of plutonium a year and seek to move to four tons a year, the four-ton objective appears to have been largely abandoned, and the planned Russian program now stretches to 2040. Similarly, the Energy Department does not expect its MOX plant to open until 2016, although it hopes that an immobilization plant might open as soon as 2012. The capital and operating costs for disposition of U.S. excess plutonium using these facilities are now estimated at more than $10 billion in 2006 dollars, more than twice the earlier estimate.[8]

The Energy Department argues that the earlier cost estimates were unrealistic and did not adequately include contingencies to hedge against cost overruns; payment for the costs of providing site services such as water, electricity, and fire protection; and the like. Nevertheless, the capital and operating costs projected for both the U.S. and Russian MOX plants are far higher than the costs for comparable European plants that have already been built and operated, and the reasons for that difference have not been publicly explained. One part of the answer is that the Office of Management and Budget has constrained the effort to flat annual funding, stretching out construction and driving up costs.

A wide range of other obstacles have contributed to these slowing schedules and escalating costs. After delays resulting from a year-long Bush administration policy review, the Bush team delayed matters further by demanding that Russia accept liability provisions that would make Russia liable even for damage caused by intentional sabotage by U.S. personnel, a provision Russian negotiators predictably rejected. Because construction of the U.S. and Russian MOX plants had been linked, this dispute resulted in years of delay in both countries. A liability protocol for plutonium disposition, in which the Bush administration effectively abandoned its earlier demands, was finally signed in September 2006, ironically not long after the linkage between U.S. and Russian construction was dropped.

Most U.S. officials believe that the U.S. excess plutonium stockpile poses few security issues and see getting rid of Russia 's excess plutonium stockpile as the main reason to bother with getting rid of the U.S. excess stockpile. The other major driver for the U.S. disposition effort is South Carolina , which would only allow the Energy Department to consolidate many of its plutonium stockpiles at Savannah River if there was a clear plan to do something with these stocks that would provide jobs and ultimately take them back out of the state. Congress has passed legislation that requires the Energy Department to pay substantial fines to the state if it does not meet plutonium disposition deadlines.

Disposition of Russia 's excess plutonium has been problematic, as the Russian government does not see excess plutonium stockpiles as a major security problem. Russia 's view has long been that its plutonium stockpiles should be used to produce energy as part of its long-term plan for a closed nuclear fuel cycle, and if the international community wants Russia to begin using this plutonium as fuel sooner than would otherwise be economic, the international community should pay the costs of doing so. In response, rather than agreeing to pay the full cost of Russian plutonium disposition itself, the United States has sought to put together a multilateral financing plan. So far, the total pledges only come to about $850 million, including $400 million from the United States , far less than needed to finance Russia 's plutonium disposition.

Some U.S. officials hope that, with earlier disputes resolved, further pledges will be forthcoming and that Russia may ultimately agree to pay to run the disposition facilities if the international community pays to build them, cutting the needed pledges roughly in half. Indeed, U.S. negotiators report that Russian negotiators in recent months have begun to acknowledge that Russia might pay a significant part of the costs of options that support Russia 's plans for nuclear energy growth. Nevertheless, for now, it appears more likely than not that Russian plutonium disposition will only move forward if the United States is prepared to make major additional investments in the effort.

With Russia 's newfound oil wealth and huge planned expenditures on new reactor construction, it may be difficult to convince Congress to put in more U.S. funds.

In addition to the financing problem, the low priority Russia assigns to this problem has meant that each bureaucratic issue has taken longer to resolve. Moreover, different factions in the Russian and U.S. nuclear establishments have had very different ideas about what technical options for plutonium disposition should be pursued, leading to prolonged uncertainties over which projects would finally move forward.

Congress, observing these delays and mounting costs, has become increasingly skeptical, and congressional constraints have themselves added to delays. During 2006, these concerns came to a head when House appropriators, led by Rep. David Hobson (R-Ohio), then chairman of the energy and water appropriations subcommittee, attempted to terminate funding for the U.S. MOX plant, shifting the United States toward an all-immobilization strategy. Earlier this year, Hobson and other MOX opponents sought to get the MOX plant zeroed out in the continuing resolution that is funding most U.S. government operations for the remainder of fiscal year 2007, which ends September 30. Senate appropriators, by contrast, sought to keep the U.S. MOX plant going. The final resolution provided a substantial budget for the MOX effort but prohibited the secretary of energy from beginning construction until August 1. That gives opponents an opportunity to try again to kill the funding before construction begins. Rep. Peter Visclosky (D-Ind.), the new chairman of the subcommittee, joined with Hobson in a February 2007 letter to the Energy Department questioning the MOX plant and demanding a wide range of data about MOX and possible alternatives, clearly signaling a bipartisan challenge to the Energy Department's current plans.

Alternatives

All of this raises the question of what the best disposition options would be. The NAS study recommended options that would convert the excess weapons plutonium into forms “roughly as inaccessible for weapons use as the much larger and growing quantity of plutonium in spent fuel from commercial nuclear-power reactors,” known as the “spent fuel standard.” After examining approaches ranging from shooting the plutonium into space to dissolving it in the oceans, the committee concluded that the two least problematic options were the use of plutonium as fuel in existing reactors and immobilization of the plutonium with high-level wastes. Later Energy Department studies reached the same conclusions, and I believe they remain valid today.

U.S. Plutonium Disposition

In the United States , the biggest immediate fight is between advocates of an all-immobilization approach and the Energy Department's mixed MOX-plus-immobilization plan in which 34 tons of the excess are currently slated for MOX and the rest, which is too contaminated to use as MOX, for immobilization.

Advocates of the Energy Department's MOX-focused approach make several points:

- An all-immobilization approach in the United States might lead to no disposition in Russia . Russian negotiators have long argued that immobilization is just another form of storage because the plutonium could in principle be recovered in weapons-grade form, albeit at great cost, and have objected to the idea of the United States immobilizing its plutonium while Russia uses its plutonium in reactor fuel, transforming it to reactor-grade material.

- Immobilization is not as technically mature. A variety of reactors in Europe have been using MOX fuel commercially for years, but immobilization of plutonium has never been accomplished on a large scale.

- There may not be enough high-level wastes at Savannah River with which to immobilize the plutonium. Energy Department officials have argued that the Savannah River plant could finish the high-level waste vitrification process before immobilization of all the excess plutonium could be completed. That could potentially leave the plutonium cans with no high-level waste canisters to be put into and therefore no radiation barrier to increase the difficulty of using the plutonium in weapons.

• Immobilization may not save much if the costs of disposition and of storage until disposition could be completed are taken into account. An Energy Department study prepared last year concluded that its preferred mixture of MOX and immobilization would cost $15 billion and an all-immobilization approach would cost only slightly less.[9]

• MOX fuel poses few additional security risks. The risks from transporting MOX fuel to reactors and storing it at reactors can be reduced to a low level by sufficient investment in security for this material.

Immobilization advocates, by contrast, argue that the MOX option raises serious risks that plutonium in MOX form might be stolen, because it is more difficult to protect MOX fuel in transit or in storage at civilian reactors than plutonium secured in vaults or immobilized at a major nuclear weapons complex site. They also warn that MOX fuel carries additional safety risks; since the core of a plutonium-fueled reactor contains more long-lived actinides, there might be more deaths in the event of a catastrophic radiation release. They also argue that immobilization would be cheaper and faster than MOX fuel.[10]

Although the Energy Department considered an all-immobilization option based on building a new greenfield facility, which would be expensive and time-consuming, it does not appear to have given detailed consideration to the idea of making the immobilization plant it plans to build in existing facilities at Savannah River slightly bigger and running it longer in order to handle all of the excess plutonium and not just the contaminated material. The Energy Department projects that this facility could be operational in 2012, well before the planned MOX plant, and would process roughly two tons of plutonium a year. If it could be expanded to three tons per year, which is not certain given the space constraints in the facility where it is to be built, the 45 tons of separated plutonium currently considered excess could be processed by 2027, a year before the high-level waste vitrification plant is now scheduled to shut down.[11] The cost of operating this plant for a longer period and making it slightly larger would likely be substantially less than the costs of building and operating the MOX plant, currently estimated at more than $6 billion.

Congress should direct the Energy Department to provide an immediate assessment of the feasibility, costs, and safety and security risks of this all-immobilization option compared to the MOX-plus-immobilization option and should require an independent review of this assessment, perhaps by the NAS. The administration and Congress should also explore an all-immobilization option with Russia . Given the Russian focus on its own plutonium as an energy asset rather than a security issue, I believe there is at least a reasonable chance that a high-level U.S. approach to the Russian government combining a willingness to cooperate in developing nuclear energy (already being pursued) with a desire for Russia to accept an all-immobilization U.S. approach could be successful. It is in any case worth trying. On the other hand, Russia may be more reluctant to accept an all-immobilization U.S. approach if the two sides really were going to apply disposition to all but a small remaining stockpile of plutonium.

Disposition of Russian Excess Weapons Plutonium

In Russia , the entire nuclear establishment rejects the immobilization idea, so the main argument over technical options is over which reactors would use excess weapons plutonium as their fuel. This argument has seesawed back and forth between two camps. One group argues for using the plutonium in fast-neutron breeder reactors that create more plutonium than they consume, which can then be recycled as additional fuel—Russia's long-term nuclear-energy vision. The other group contends that fast-neutron reactors will not be commercialized for some time and it would make sense to use MOX fuel in the near term in LWRs, as has been done in Europe . The early 2006 announcement of the U.S. Global Nuclear Energy Partnership, with its focus on fast-neutron reactors, which is designed to consume plutonium and other actinides rather than breeding more, briefly brought the fast-neutron advocates in Russia to the fore again. Russia has restarted major construction on the BN-800 fast-neutron reactor, using its own funds.

By December 2006, however, when the two sides completed a joint schedule and cost estimate for a Russian-proposed “base case” scenario, this Russian plan was back to the same one described in the PMDA, using a small amount of plutonium in the BN-600 and the bulk of it in the VVER-1000 LWRs. But the joint report explicitly held open the possibility that Russia might later switch to fast-neutron reactors or that the gas-turbine modular helium reactor (GT-MHR), being developed with funding from both sides might provide a supplement to other disposition approaches in the later phases of the project.[12]

Several key issues would have to be resolved before the United States gives its financial support to Russian fast-neutron reactors. First, as originally designed, the BN-800 is a plutonium breeder reactor, producing more weapon-grade plutonium than it consumes. Russian officials have expressed some willingness to remove some of the uranium “blankets” where the new plutonium production takes place, converting the reactor into a net plutonium burner. Moreover, under the PMDA, Russia is obligated not to reprocess irradiated fuel from plutonium disposition reactors until after disposition of the plutonium covered by the agreement is complete. What happens after the disposition program? Should the possibility that Russia might add breeder blankets preclude U.S. financing for construction of such reactors? Would Russia be willing to commit not to put on such blankets and not to process the fuel from this reactor in a way that would separate weapons-usable plutonium? In addition, the spent fuel from such a reactor would be in smaller fuel assemblies with lower radiation fields, higher plutonium concentrations, and better isotopics than if it had been used as MOX fuel in an LWR, making it potentially easier to recover for use in nuclear weapons.

By contrast, high-temperature gas reactors such as the GT-MHR, with their high-burn-up, difficult-to-reprocess fuel, do not pose similar policy issues. For them, the main issues are the cost of building such reactors and the time needed to do so. If Russia built such reactors for their nuclear energy value and they became available while there was still excess plutonium to burn, their use for that purpose should certainly be considered.

Reactors outside of Russia provide another option. Europe 's reactors licensed to burn plutonium fuel already have more civilian plutonium than they can handle. Nonetheless, there are at least a few possibilities that deserve exploration. Some German utilities, for example, might be willing to invest substantial sums in Russian plutonium disposition if, by contributing to disarmament, they could get a reprieve from government orders to shut their reactors down within a few years. In any international option, extremely stringent standards of security would have to be maintained during transportation, the point in nuclear material's life cycle when it is most vulnerable to forcible theft.

The only way Russia 's plutonium might be immobilized is if the United States (or some other donor) actually bought Russia 's plutonium and then paid for it to be immobilized. Although many Russian officials have rejected such ideas in the past, purchasing Russia's plutonium would allow Russia to realize the commercial value it sees in this plutonium immediately, and although this option would amount to paying for it twice, it might turn out to be cheaper than the surging costs of the MOX approach.[13] In any case, the United States should restart a joint plutonium-immobilization research and development program with Russia.

Plutonium Swaps

As a backup and complement to other approaches, the United States should also consider the possibility of swapping some portion of U.S. or Russian plutonium for European plutonium. Today, some 10 tons of reactor-grade civilian plutonium is already being burned as fuel for European power reactors each year. By far the fastest and cheapest approach to reducing stockpiles of excess weapons plutonium, if agreement could be reached on it, would be to substitute excess weapons plutonium for this civilian plutonium, thereby burning some 10 tons a year of excess weapons plutonium while using existing fuel fabrication facilities and contract arrangements.[14] Ten tons a year of civilian plutonium would be displaced and would build up in storage, effectively transforming a problem of excess weapon-grade plutonium in Russia and the United States under no international safeguards to a growth in the existing problem of excess reactor-grade plutonium stored in secure facilities in Europe under international safeguards.

The Way Forward

An immense amount of work and some major policy changes will be needed if this sad saga is to have a happy ending.

First, the United States and Russia should do everything in their power to ensure that all their stockpiles of nuclear weapons and weapons-usable materials and all other such stockpiles worldwide are secure and accounted for, to standards sufficient to defeat the threats that terrorists and thieves have shown they can pose. The Energy Department should move aggressively to consolidate its plutonium and HEU in a smaller number of highly secure locations, achieving higher security at lower cost, and should work with Russia to do the same.

Next, because all plutonium disposition options will take from years to decades to implement, the United States and Russia should move rapidly to commit their excess material never to be used in weapons and open this material to international monitoring. Years ago, both countries were pursuing such an approach in a trilateral initiative with the International Atomic Energy Agency, under which they were also developing special procedures for monitoring classified material without revealing sensitive information. Neither government was enthusiastic, however, and the initiative has effectively been abandoned. Rapid U.S. and Russian action to put all of their excess plutonium and HEU under international monitoring would be a substantial step toward convincing the international community that the two countries were serious about fulfilling their arms reduction obligations, which would strengthen international support for the measures that are now needed to strengthen the nonproliferation regime.

The United States should adopt a policy of seeking deep, transparent, and irreversible nuclear arms reductions. Among other things, this should include reducing stockpiles of separated plutonium and HEU to the minimum required to support whatever reduced warhead stockpiles are agreed on.

In that context, the United States should maintain both a domestic plutonium-disposition program and a program to support disposition of Russian excess plutonium and should seek to begin disposition under the PMDA. Once talks on deep nuclear arms reductions are underway, the United States should begin discussions with Russia about disposition of material far in excess of the 34 tons on each side covered in the PMDA and designed to make those reductions more difficult to reverse. Facilities and programs for disposition should be designed to be expandable to handle much more material when more is declared excess. The goal should not be getting rid of only one-quarter of Russia 's weapons-grade plutonium by 33 years from now.

There need not be an ironclad commitment to go beyond 34 tons to justify moving forward with construction of disposition facilities, but there should at least be a policy that clearly identifies going well beyond 34 tons as a goal, and discussions of going further should not be left for the indefinite future. Otherwise, there is too great a risk that political leaders in the United States , Russia , and elsewhere will put in place measures to address the 34 tons covered in the PMDA and then walk away, wrongly thinking that they have solved the plutonium problem.

The Energy Department should quickly provide Congress with an in-depth assessment of the relative merits of all-immobilization and MOX-plus-immobilization options, which should be subject to independent review. The U.S. government should then pick an option and stick with it. Whether Russia implements the same option is not important, but it is important that Russia also pick an option and move forward to implement it.
In short, the United States should adopt policies that will make it possible for plutonium disposition to make a substantial contribution to U.S. national security and then move forward with disposition of a substantial fraction of the U.S. and Russian plutonium stockpiles.

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ENDNOTES

1. For updated estimates of the total stockpiles and the amounts declared excess, see David Albright and Kimberly Kramer, eds., Global Fissile Material Inventories (Washington, D.C.: Institute for Science and International Security, 2004); and International Panel on Fissile Materials (IPFM), “Global Fissile Material 2006: Report of the International Panel on Fissile Materials,” Program on Science and Global Security, 2006. The total U.S. declared stockpile is 99.5 tons, and the amount declared excess is 52.5 tons, but 7.5 tons of this amount is plutonium in spent fuel slated for disposal. Unclassified estimates suggest that modern nuclear weapons might contain an average of roughly four kilograms of plutonium. See David Albright, Frans Berkhout, and William B. Walker, Plutonium and Highly Enriched Uranium, 1996: World Inventories, Capabilities, and Policies (Solna, Sweden, Oxford, and New York: Stockholm International Peace Research Institute and Oxford University Press, 1996), pp. 34, 49; and IPFM, “Global Fissile Material 2006,” p. 16. Supporting a stockpile would require some additional material that was in various stages of the warhead and material life-cycle outside of operational warheads.

2. Royal Society, Management of Separated Plutonium (London: Royal Society, 1998).

3. Committee on International Security and Arms Control , U.S. National Academy of Sciences, Management and Disposition of Excess Weapons Plutonium (Washington, DC: National Academy Press, 1994).

4. “Agreement Between the Government of the United States of America and the Government of the Russian Federation Concerning the Management and Disposition of Plutonium Designated as No Longer Required for Defense Purposes and Related Cooperation,” 2000. Actually, on the Russian side, the agreement will likely end up covering some 38 tons of total plutonium because it permits Russia to blend the 34 tons of weapons-grade plutonium with up to four tons of reactor-grade material, in order to keep the isotopics of its weapons-grade stockpiles secret.

5. Joint U.S.-Russian Working Group on Cost Analysis and Economics in Plutonium Disposition, “Cost Estimates for the Disposition of Weapon-Grade Plutonium Withdrawn from Russia's Nuclear Military Programs,” 2001.

6. Office of Fissile Materials Disposition, U.S. Department of Energy, “Plutonium Disposition Life Cycle Costs and Cost-Related Comment Resolution Document,” DOE/MD-0013, 1999. This was already a dramatic increase from the $2.2 billion estimate (in 1996 dollars) that formed part of the basis for the Energy Department's Record of Decision on plutonium disposition in 1997.

7. Joint U.S.-Russian Working Group on Cost Analysis and Economics in Plutonium Disposition, “Analysis of Russian-Proposed Unified Scenario for Disposition of 34 Metric Tons of Weapon-Grade Plutonium,” 2006 (hereinafter “Analysis of Russian-Proposed Unified Scenario.”)

8. For the MOX schedule, see U.S. Department of Energy, “FY 2008 Congressional Budget Request: National Nuclear Security Administration,” 2007, p. 501. For the immobilization schedule, see U.S. Department of Energy, “FY 2008 Congressional Budget Request: Environmental Management,” 2007, p. 333. Officially, the start of operations is not yet determined, but all construction costs are projected as being completed in 2011. The planned 2012 start date is also confirmed in internal Energy Department documents. For the total cost estimate, see U.S. Department of Energy, “Disposition of Surplus U.S. Fissile Materials: Comparative Analysis of Alternative Approaches,” November 2006. This study estimates the costs, including storage pending disposition, for an alternative including both MOX and immobilization as $15 billion (in constant 2006 dollars) through 2050. Without storage, the costs for MOX and immobilization were just under $10 billion. These are going-forward costs, however, neglecting the hundreds of millions of dollars already spent. The total costs for these efforts, including funds already spent, would be well more than $10 billion.

9. U.S. Department of Energy, “Disposition of Surplus U.S. Fissile Materials.” An earlier version of this study indicated that the all-immobilization option would be more expensive than the MOX option. Why this changed has not been publicly explained.

10. These arguments are summed up, with a large number of references, at the Nuclear Control Institute's “Plutonium Disposal” page, available at http://www.nci.org/nci-wpu.htm. See also Edwin S. Lyman, “The Future of Immobilization Under the U.S.-Russian Plutonium Disposition Agreement,” in Proceedings of the 42nd Annual Meeting of the Institute for Nuclear Materials Management (Indian Wells, California, July 15-19, 2001); and Allison Macfarlane and Adam Bernstein, “Canning Plutonium: Cheaper and Faster,” Bulletin of the Atomic Scientists, May/June 1999, pp. 66-69.

11. The several-year delay in vitrifying high-level waste at Savannah River , now not scheduled to be completed until 2028, leaves more time and more waste canisters available for immobilizing plutonium once an immobilization facility comes on-line. Moreover, the canisters produced so far at Savannah River contain only a small fraction of the radioactivity per canister that would be necessary to vitrify all the waste in the Savannah River tanks in the planned number of canisters, suggesting that more canisters will have to be made over a longer time, again offering more opportunities for plutonium immobilization. If the U.S. government declared more plutonium excess in the future, as it should, it is at least possible that canisters containing immobilized plutonium but without high-level waste could be shipped from Savannah River to Hanford , where vitrification of the high-level waste has not yet begun and will last longer. Whether sufficient waste canisters would likely be available for this option is one key factor that Congress should ask the Energy Department to address in detail and which should be reviewed independently.

12. “Analysis of Russian-Proposed Unified Scenario.”

13. In the ongoing HEU Purchase agreement, for example, in which Russia is taking HEU from dismantled nuclear warheads and blending it to low-enriched uranium, which the United States purchases for use in commercial reactors, the total price the United States would pay was originally set at about $12 billion for 500 tons of HEU. If the United States or another purchaser offered the same price per ton for excess weapons plutonium, which would be exceedingly generous because plutonium is so expensive to make into fuel that it actually is a net liability at present, 50 tons of excess plutonium would cost $1.2 billion.
14. For an outline of this approach, see Thomas L. Neff, “Perspectives on Actions Necessary to Move the Plutonium Disposition Program Forward,” paper presented at “International Policy Forum: Management and Disposition of Nuclear Weapons Materials,” Bethesda, Maryland, March 23-26, 1998. If appropriately presented and packaged with reasonable incentives for all concerned, this approach could be designed so that it would not interfere with European fuel-cycle choices, but indeed would effectively lock in use of plutonium fuel for a decade or more as part of a nuclear arms reduction initiative.

Posted: April 2, 2007

Source URL: http://www.armscontrol.org/act/2007_04/Bunn