Disposition of Excess Plutonium:
Rethinking Security Objectives and Technological Approaches

Matthew Bunn

Project on Managing the Atom
Belfer Center for Science and International Affairs
John F. Kennedy School of Government
Harvard University

Testimony before the Subcommittee on Strategic Forces,
Committee on Armed Services, U.S. House of Representatives
July 26, 2006

Washington, DC

Mr Chairman, members of the committee, it is an honor to be here to discuss a subject that has important implications for U.S. national security – what the United States and Russia should do with the tens of tons of plutonium no longer needed for their nuclear weapons programs. I will briefly summarize my full statement, which, with your permission, I would like to submit for the record.

I was the study director for the National Academy of Sciences study *Management and Disposition of Excess Weapons Plutonium*, issued in two volumes in 1994 and 1995, which provided the foundation for many of the policies that have been pursued since then.[1] I then spent several years at the Office of Science and Technology Policy, where I was the principal staffer for the interagency plutonium disposition working group and for the U.S. delegation in the U.S.-Russian discussions of plutonium disposition. I was the U.S. staff director for the U.S.-Russia Independent Scientific Commission on Disposition of Excess Weapons Plutonium, which delivered its unanimous report to President Clinton and President Yeltsin in 1997.[2] After leaving the government, I have continued to pay close attention to this program and its many trials and tribulations. While in the past my program at Harvard had a small grant from the disposition office, and at one time I

---

[1] U.S. National Academy of Sciences, Committee on International Security and Arms Control, *Management and Disposition of Excess Weapons Plutonium* (Washington, D.C.: National Academy Press, 1994; available at http://books.nap.edu/html/plutonium/0309050421.pdf as of 20 March 2005); U.S. National Academy of Sciences, Panel on Reactor-Related Options, *Management and Disposition of Excess Weapons Plutonium: Reactor-Related Options* (Washington, D.C.: National Academy Press, 1995; available at http://books.nap.edu/html/plutonium/0309051452.pdf as of 20 March 2005).

[2] John P. Holdren and Evgeniy P. Velikhov, co-chairs, *Final Report of the US-Russia Independent Scientific Commission on Disposition of Excess Weapons Plutonium* (Washington, D.C.: Office of Science and Technology Policy, 1997; available at http://bcsia.ksg.harvard.edu/BCSIA_content/documents/fnlrpt.pdf as of 23 July 2006).

consulted for Bechtel National on its efforts in this area, at present I have no financial interest in any side of this debate.

As you know, the plutonium disposition program has suffered years of delays, shifting approaches, and skyrocketing costs, raising questions about whether and how to move forward from here. In this testimony, I will make four basic points:

(1) Plutonium disposition is not among the top priorities for reducing the risk of nuclear theft and terrorism, and can actually *increase* that risk unless very high standards of security are maintained throughout the process.

(2) Disposition of U.S. and Russian excess plutonium can nevertheless offer security benefits that are worth the effort *if and only if* the 34 tons of weapons plutonium on each side covered by the U.S.-Russian Plutonium Management and Disposition Agreement (PMDA) is the first step toward disposition of much larger quantities of plutonium.

(3) Congress should support moving forward with disposition of excess weapons plutonium, under appropriate conditions.

(4) But before providing the billions of dollars necessary to build and operate major facilities for producing uranium-plutonium mixed-oxide (MOX) fuels in the United States, or to help build new reactors and plutonium fuel facilities in Russia, Congress should ensure that (a) a policy context is put in place that will make it possible for plutonium disposition to offer benefits worth its costs; and (b) important technological alternatives to current approaches are fully considered.

In short, we should move forward, but only if there is agreement on a set of policies that will make doing so worthwhile.

Objectives of Plutonium Disposition

It is important to be clear about what investing in plutonium disposition can and cannot buy us, and under what circumstances. Disposition of excess weapons plutonium – by which I mean physically transforming the plutonium into forms that would be difficult and costly to recover for use in nuclear weapons – can, under the right circumstances, make an important contribution to two national security objectives: (1) reducing the risk of nuclear theft and terrorism, and (2) ensuring that nuclear arms reductions will be difficult and costly to reverse and thereby strengthening political support for international nonproliferation efforts. In addition, disposition of U.S. excess plutonium can serve what I would call a "good housekeeping" function, reducing the number of sites in the U.S. complex where directly weapons-usable plutonium is stored and the costs, risks, and political liabilities of storing it.

I have deliberately not included supporting the U.S. nuclear industry on this list of objectives. As desirable as that objective may be, plutonium disposition will do little to achieve it. The U.S. nuclear industry is doing very well with low-enriched uranium fuel and has no need for MOX fuel. While the use of such fuel made from weapons plutonium might be seen as a step in the direction of reprocessing and recycling, I believe that making a transition to reprocessing U.S. nuclear fuel any time in the next few decades would do more to undermine than to support the future of nuclear energy in the

United States.[3] That, however, is a subject for another hearing on another day. In any case, as the NAS studies pointed out, the plutonium that has been declared excess, while a large amount in terms of the number of nuclear weapons that could be made from it, is small in terms of global energy needs: even if it were all used as nuclear fuel, it would provide only a few months of the fuel for the existing global reactor fleet.

The key question, then, is under what circumstances can plutonium disposition provide benefits in these areas that are worth the substantial costs of moving forward – not only in money, but in high-level political attention and diplomatic capital expended? Let me consider each of these benefits in turn.

Plutonium Disposition and the Risk of Nuclear Theft

As currently planned, disposition of excess plutonium will have only minor benefits for reducing the risk of nuclear theft. The 34 tons of Russian weapons plutonium slated for disposition under the 2000 U.S.-Russian Plutonium Management and Disposition Agreement (PMDA)[4] will be some of the most secure plutonium in all of Russia: Russia plans to load some 25 tons of it into the Mayak Fissile Material Storage Facility – a highly secure fortress built with U.S. funds – and the remainder will come from plutonium oxide stored in secure vaults at Seversk and Zheleznogorsk, the latter of which is deep underground. Similarly, the risk that any of the 34 tons of U.S. weapon-grade plutonium covered by the PMDA will be stolen is quite far down the list of potential nuclear security vulnerabilities around the world.

The biggest risks of nuclear theft are at small, vulnerable facilities with plutonium or highly enriched uranium (HEU), and disposition of 34 tons of excess plutonium in Russia and 34 more in the United States is not likely to reduce the vulnerabilities at these sites. Even the modest nuclear theft risks posed by the large, heavily secured sites where the plutonium slated for disposition is stored will not be much reduced by disposition of 34 tons of this material, as disposition will apply to only a portion of the plutonium at these sites, leaving substantial amounts still at these sites and still vulnerable to whatever modest risks of theft may exist there. As the Department of Energy has pointed out, "a building with 1 ton of nuclear material in storage is as great a threat as a building with 10 tons."[5]

---

[3] Matthew Bunn, "Assessing the Benefits, Costs, and Risks of near-Term Reprocessing and Alternatives," in *Proceedings of the 47th Annual Meeting of the Institute for Nuclear Materials Management, Nashville, Tenn., 16-20 July* (Northbrook, Ill.: INMM, 2006; available at http://bcsia.ksg.harvard.edu/BCSIA_content/documents/INMM_Assessing_the_Benefits_Costs_Risks_NearTerm_Reprocessing_Alternatives_2006.pdf as of 22 July 2006).

[4] U.S. Department of Energy, *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* (Washington, D.C.: DOE, 2000; available at http://www.nnsa.doe.gov/na-20/docs/2000_Agreement.pdf as of 30 March 2005).

[5] U.S. Department of Energy, *FY 2007 Congressional Budget Request: National Nuclear Security Administration--Defense Nuclear Nonproliferation*, vol. 1, DOE/CF-002 (Washington, D.C.: DOE, 2006; available at http://www.cfo.doe.gov/budget/07budget/Content/Volumes/Vol_1_NNSA.pdf as of 24 February 2006), p. 514.

The 34 tons of weapons plutonium covered under the PMDA represents less than a quarter of the roughly 145 tons of weapon-grade plutonium in Russia's stockpile.[6] Russia's more than 40 tons of separated reactor-grade plutonium are also weapons-usable and pose a risk of nuclear theft and terrorism; the total stockpile of potentially dangerous separated plutonium in Russia is in the range of 185 tons.[7] The 34 tons of weapons plutonium covered by the PMDA, mixed with up to four tons of reactor-grade plutonium as Russia is permitted to do under the agreement, represents only one-fifth of this total stockpile.

As the NAS studies pointed out, unless stringent security measures are taken throughout the process, removing plutonium from storage in secure vaults, processing it in bulk forms, and shipping it from place to place can *increase* rather than decrease the risk of nuclear theft. To avoid this risk, and because acquiring the needed nuclear material is by far the most difficult part of making a nuclear bomb, the NAS committee recommended that "an agreed and stringent standard of security and accounting must be maintained throughout the disposition process, approximating as closely as practicable the security and accounting applied to intact nuclear weapons."[8] We called that the "stored weapon standard."

With respect to nuclear theft and terrorism, HEU poses a somewhat greater threat than plutonium, as only HEU can be used to achieve substantial nuclear yields in the very simplest gun-type devices. Nevertheless, the possibility that terrorists could make a crude nuclear bomb from stolen plutonium cannot be ruled out.

In short, in a comprehensive, prioritized plan to reduce the risks of nuclear theft and terrorism, focused on addressing the greatest risks first, disposition of excess plutonium would be on the list of actions to take, but it would be far from the top – and it would only be on the action plan at all if stringent security measures were to be taken throughout the process, and if 34 tons were only a first step toward disposition of much larger quantities of material.

---

[6] Russia has never declared how much weapon-grade plutonium it has. Both unclassified estimates and U.S. intelligence estimates of the total amount of plutonium in Russia's stockpiles are subject to uncertainties of tens of tons. The 145-ton estimate, as of the end of 2003, is from David Albright and Kimberly Kramer, *Global Stocks of Nuclear Explosive Materials* (Washington, D.C.: Institute for Science and International Security, 2005; available at http://www.isis-online.org/global_stocks/end2003/tableofcontents.html as of 22 February 2006).

[7] Russia has officially declared that as of the end of 2005, it possessed 41.2 tons of separated civilian plutonium. See International Atomic Energy Agency, *Communication Received from the Russian Federation Concerning Its Policies Regarding the Management of Plutonium*, INFCIRC/549/Add.9/8 (Vienna: IAEA, 2006; available at http://www.iaea.org/Publications/Documents/Infcircs/2006/infcirc549a9-8.pdf as of 9 June 2006). The most detailed unclassified U.S. government statement on the weapon-usability of reactor-grade plutonium is in U.S. Department of Energy, Office of Arms Control and Nonproliferation, *Nonproliferation and Arms Control Assessment of Weapons-Usable Fissile Material Storage and Excess Plutonium Disposition Alternatives*, DOE/NN-0007 (Washington, D.C.: DOE, 1997; available at http://www.osti.gov/bridge/servlets/purl/425259-CXr7Qn/webviewable/425259.pdf as of 12 December 2005), pp. 37-39.

[8] U.S. National Academy of Sciences, *Management and Disposition of Excess Weapons Plutonium*, p. 12.

Plutonium Disposition and the Irreversibility of Nuclear Arms Reductions

A world in which Russia had far smaller stockpiles of nuclear weapons and weapons-usable nuclear materials – and in which those reductions would be difficult and costly to reverse – would be very much in the U.S. national security interest, reducing the danger that Russia would ever return to a Cold War-scale nuclear arsenal. Moreover, similar difficult-to-reverse reductions in the U.S. stockpiles of nuclear warheads and materials would make it clear to the world that we were committed to our Nonproliferation Treaty (NPT) obligation to negotiate in good faith toward nuclear disarmament. That would strengthen worldwide political support for the NPT and help win the votes needed to shore up the global nonproliferation with stronger export controls, more stringent inspections, and tougher enforcement. All of those measures will mean additional constraints on other states, and we are unlikely to get the support we need for them if we are unwilling to accept constraints on our own nuclear posture. Disposition of excess plutonium could make a substantial contribution to the irreversibility of nuclear arms reductions. Indeed, the "13 Steps" toward disarmament agreed to by the United States and the other nuclear weapon states at the 2000 NPT review conference included placing excess nuclear material under IAEA monitoring and then carrying out disposition, "to ensure that such material remains permanently outside of military programmes."[9]

Today, however, the U.S. government is not pursuing irreversible nuclear arms reductions. The Moscow Treaty was designed to be readily reversible should circumstances change. The current administration plan is to maintain large numbers of warheads beyond those that will be actively deployed and large numbers of additional primaries and secondaries so that more warheads could be assembled. That plan also includes a "responsive infrastructure" designed to have the capability to build significant numbers of new weapons should world circumstances require. There would be little point spending billions of dollars on a program whose primary benefit is to increase the irreversibility of nuclear arms reductions as long as it remains the policy of the U.S. government to ensure that nuclear arms reductions *are* reversible.

Moreover, plutonium disposition can only make a serious contribution to the irreversibility of nuclear arms reductions if it is applied to far more than 34 tons of plutonium on each side. Following disposition of 34 tons of excess weapons plutonium, Russia would still have well over 100 tons of weapon-grade plutonium remaining, enough to support a stockpile of over 20,000 nuclear weapons. The United States would still have over 50 tons of weapon-grade plutonium remaining, enough to support a stockpile of over 10,000 nuclear weapons. If irreversible nuclear arms reductions are the goal, then the United States and Russia should reduce their stockpiles of nuclear weapons to low, agreed levels, and reduce their stockpiles of plutonium and HEU to the minimum levels needed to support those agreed warhead stockpiles, as the NAS committee recommended.

---

[9] "2000 Non-Proliferation Treaty Review Conference Final Document" (New York, NY: United Nations, 2000; available at http://www.armscontrol.org/act/2000_06/docjun.asp as of 22 July 2006).

Plutonium Disposition and "Good Housekeeping" in the U.S. Complex

The current situation, in which plutonium that is no longer needed is stored in a wide variety of stable and unstable forms at several sites scattered throughout the Department of Energy (DOE) complex, is needlessly expensive and dangerous. The Defense Nuclear Facilities Safety Board has recommended that DOE move aggressively to consolidate all of its excess plutonium at a single site, and DOE ultimately hopes to consolidate all operations involving plutonium still in use for weapons at a single site.[10]

Disposition of some excess plutonium could help overcome the political obstacles to consolidating plutonium storage. South Carolina, in particular, has strongly objected to moving all of the excess plutonium there unless there is a clear path forward for what will be done with it, which ends with it being removed from the state. Disposition can also reduce the ongoing costs of storage. Indeed, in recent analyses, DOE has argued that simply storing all the excess plutonium at its current locations would cost even more than its proposed disposition program.[11]

If "good housekeeping" becomes the primary motivation for plutonium disposition, however, clear distinctions should be made between plutonium whose storage is costly and plutonium whose storage is cheap. The cost of storing various impure forms of plutonium ultimately slated for immobilization, at a large number of sites, is substantial. By contrast, the net additional cost of storing the excess plutonium that is in pits at Pantex , which represents the majority of the material slated for MOX disposition, is very modest, since large numbers of reserve pits will remain in storage there in any case.

Other Rationales for Proceeding with Plutonium Disposition

For better or for worse, the United States has been negotiating with other governments to move plutonium disposition forward for more than a decade now. As far back as the Group of Eight (G8) Nuclear Safety and Security Summit in Moscow in 1996, the G8 have endorsed moving forward with plutonium disposition as an important common nonproliferation and arms reduction objective. The centerpiece of the resulting efforts is the 2000 PMDA. For years, the United States has been in discussions with Russia and a variety of other states to pull together a multilateral agreement to finance and manage disposition of excess plutonium in Russia, and that accord is nearly complete. U.S.-Russian negotiations on liability measures for plutonium disposition have dragged on for years, but are now essentially resolved.

A U.S. decision now to abandon plutonium disposition, leaving all or most of the U.S. excess plutonium in indefinite storage, would require walking away from these agreements and negotiations. This could affect the credibility of U.S. pledges and

---

[10] Defense Nuclear Facilities Safety Board, *Plutonium Storage at the Department of Energy's Savannah River Site: Third Annual Report to Congress* (Washington, D.C.: DNFSB, 2006; available at http://www.deprep.org/2006/fb06l12b.pdf as of 23 July 2006). For a review of DOE's complex-wide problems with plutonium consolidation, see U.S. Congress, General Accounting Office, *Securing U.S. Nuclear Materials: DOE Needs to Take Action to Safely Consolidate Plutonium*, GAO-05-665 (Washington, D.C.: GAO, 2005; available at http://www.gao.gov/new.items/d05665.pdf as of 23 July 2006).

[11] Data provided by DOE, July 2006.

agreements across a broad spectrum of threat reduction cooperation stretching well beyond the specific subject of disposition of excess plutonium. Moreover, in a context in which the United States has already rejected many of the steps toward arms reductions it agreed to at the 2000 NPT review conference, rejecting yet another of these steps could give at least a modest amount of additional ammunition to those in non-nuclear-weapon states who argue that the United States is not fulfilling its legal obligation to move toward disarmament. These potential risks should be factored into decision-making about whether to move forward with plutonium disposition.

At the same time, it is not necessary to be constrained to the specific approaches identified in the PMDA six years ago. It is clear the PMDA will have to be modified: its schedules can no longer be achieved, and Russia appears to be leaning heavily toward reactor approaches other than those agreed to in the PMDA.

Similarly, the fact that the United States has already made substantial investments in one option or another should *not* be a major factor in how to proceed from here. Those costs are sunk already, and no decision we make now can bring them back. Rather, decision-making should be based on considering the costs, risks, and benefits of different options as we go forward from where we are today.

Technologies for Meeting the Objectives

The NAS studies recommended that, as a first priority, urgent steps be taken to ensure that all stocks of separated plutonium and HEU worldwide were effectively secured and accounted for. It is clear that secure storage is an essential first step for all disposition options for excess plutonium. For long-term disposition, the NAS studies recommended that options be chosen which:

(1) Would make the plutonium "roughly as inaccessible for weapons use as the much larger and growing quantity of plutonium in spent fuel from commercial nuclear-power reactors" – which we called "the spent fuel standard";

(2) Would maintain security approximating the "stored weapon standard" for the plutonium until it met the spent fuel standard;

(3) Would meet all applicable environment, safety, and health (ES&H) rules and agreements, and would not add significantly to the ES&H risks that would exist if plutonium disposition were not moving forward; and

(4) Within those constraints, would get the plutonium disposition job done rapidly and cost-effectively.

The NAS committee concluded that the most promising approaches to accomplishing these objectives were the use of plutonium as fuel in existing reactors or immobilization of the plutonium with high-level wastes. Advanced reactors and fuel cycles are not needed to accomplish these objectives, and hence the committee recommended that plutonium disposition programs should not wait for, or pay for, advanced reactors or fuel cycles to be developed and deployed. If, on the other hand, advanced reactors are built because of their benefit for the future of nuclear energy, their use should be considered for disposition of whatever excess plutonium remains when they become available.

While many things have changed in the intervening decade – including, in particular, much improved economic circumstances and nuclear security arrangements in Russia – I believe this fundamental framework remains valid. With the passage of more than a decade and with Russia's stabilization, however, the importance of getting the job done rapidly now seems somewhat less than it did when the NAS committee made its recommendations. In addition, as disposition will only have substantial security benefits if it is applied to far more than 34 tons of plutonium on each side, a disposition option that could address 34 tons of plutonium but was not expandable to cover more material would not be the right way to go. With the passage of time, and investments in particular options, important implementation specifics such as estimates of the cost and schedule of different technologies have changed, which may change the answers that result from applying this framework, but the framework itself has not changed.

As one analyst sitting at Harvard University, I obviously have not had the resources to perform complete analyses of the detailed costs, security risks, ES&H risks, and other factors that should be considered for all the possible options for U.S. and Russian weapons plutonium. The following discussions are therefore summary judgments, based on previous work by the NAS committees, by DOE, in joint U.S.-Russian analyses, and by independent experts.

Technologies for Disposition of Russian Excess Plutonium

Until recently, the plan for disposition of Russia's excess plutonium, as outlined in the PMDA, called for using a small portion of it as fuel in the existing BN-600 fast-neutron reactor, while using the rest of it as MOX fuel in existing light-water reactors (LWRs). As you know, Russia has recently re-emphasized that rather than implementing this plan, it would much prefer to use the excess plutonium as fuel in new reactors it plans to build, such as the BN-800 fast neutron reactor now under construction or high-temperature gas reactors it is considering building in the future. Russia has taken the view, in effect, that since MOX in LWRs does not otherwise fit into its vision of the future of nuclear energy, Russia would only proceed on that course if the international community paid every penny of the cost, whereas for options that do fit into its plans, Russia would be willing to pay a substantial portion of the cost itself. Some in Congress have seen this as a major reversal of the Russian position; in my judgment, however, it is more a reemphasis of Russia's long-standing preferences. Whatever U.S. officials may have told Congress about positive Russian hints they had received, Russia was never committed to paying any of the costs of the plan laid out in the PMDA. The recent Russian shifts may, in the long run, have some positive effect: if a plutonium disposition approach can be agreed that Russian officials are genuinely enthusiastic about, success will be more likely than it would be dragging along on a course that Russian officials saw as pointless or marginal.

The total cost of building and operating these new reactors and plutonium fuel facilities for them would be far higher than the total cost of using MOX in existing LWRs. Depending on the outcome of negotiations, however, the international community's share of that cost might be the same or less. The schedule for these advanced reactors is highly uncertain as well, particularly as Russia has yet to determine where the money to pay for its ambitious reactor construction plans will come from. In 2005, for instance, the Russian government reportedly requested some $200 million for

BN-800 construction, but the Duma provided just over $30 million.[12] At that level of funding, completing the roughly $1.5 billion in work remaining would take some 50 years.

Fast-neutron reactors. Before the United States agrees to support construction and operation of the BN-800 fast-neutron reactor for plutonium disposition, a range of policy issues would have to be addressed. First, as originally designed, the BN-800 is a plutonium breeder reactor, producing more weapon-grade plutonium than it consumes; under traditional plans, this plutonium would be reprocessed using PUREX, separating pure weapon-grade plutonium. Supporting Russia to use weapon-grade plutonium to make more weapon-grade plutonium would do more to undermine than to support U.S. nonproliferation objectives. Russia might be willing to remove some of the breeder blankets, converting the reactor into a net plutonium burner, and under the PMDA, it is obligated not to reprocess irradiated fuel from plutonium disposition reactors until after disposition of the plutonium covered by the agreement is complete. But what happens after the disposition program? Should the United States seek agreement that Russia would not add breeder blankets to the reactor the international community had helped build after the disposition program, and would not process the fuel from this reactor in a way that would separate weapons-usable plutonium? Would Russia be willing to make such commitments? How much does it matter that 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 in an LWR?

High-temperature gas reactors. Advocates of high-temperature gas reactors often point out that such systems offer high burnup, creating the potential to fission a large fraction of the plutonium loaded. As we pointed out in the NAS studies, however, once the excess weapons plutonium has reached a point where it poses no more security risk than the enormously larger quantity of plutonium in spent fuel around the world, further burnup has little security benefit. Nevertheless, high-temperature gas reactors, with their difficult-to-reprocess fuel, do not pose the same kinds of policy issues that the BN-800 poses.

MOX in LWRs. It remains possible that after U.S. and Russian experts have considered the various options available, they will return to the use of MOX in existing (or planned) LWRs as the best approach. For that approach, much of the relevant design, site preparation, and regulatory work is already well advanced. Russia's existing LWRs are not sufficient, without substantial modifications, to reach the four ton per year disposition rate envisioned in the PMDA – but Russia plans to bring a substantial number of additional LWRs on-line over the next decade. If Russia remained unenthusiastic, however, it is likely that this approach would continue to advance slowly and encounter one bureaucratic obstacle after another.

Reactors outside of Russia. Technically, it would be straightforward to burn MOX from excess Russian weapons plutonium outside of Russia as well as inside Russia – but politically and institutionally, this might be difficult. Europe's reactors already licensed to burn plutonium fuel already have more civilian plutonium than they can handle. Nonetheless, for some years there have been quiet international discussions of

[12] Interview with DOE officials, April 2006.

possibilities for burning some of Russia's excess weapons plutonium in reactors in other countries, and there are at least a few reactors that could be possibilities – particularly if their incentive to use this fuel was increased by having the fresh fuel service packaged with the service of taking the spent fuel back to Russia, in a fuel "leasing" arrangement. In addition to Western Europe, there is Ukraine, where 11 VVER-1000s, the most modern Soviet reactor design, are already operating, and already receive their fuel from Russia. There is also Canada, whose CANDU reactors have also been explored as possibilities for burning excess weapons plutonium. The United States and Russia should continue discussions with these other countries, in pursuit of ways to accelerate the disposition of Russia's excess weapons plutonium.

Immobilization. Russia has always rejected immobilization for any substantial quantity of its own plutonium – though in the negotiation of the PMDA, Russia identified roughly a ton of plutonium in sludges appropriate for immobilization. Given the priority on production over safety in the Russian complex during the Cold War years, and the huge quantities of plutonium in the U.S. complex that is not suitable for use in MOX fuel, it would be quite surprising if Russia really has only one ton of plutonium in forms unsuitable for MOX. I believe the United States should re-start the joint U.S.-Russian research and development on immobilization approaches that was pursued in the past, while exploring with Russia whether massive plutonium facilities such as Mayak and Seversk may have additional stockpiles only suitable for immobilization and disposal as waste. Immobilization is unlikely, however, to gain Russian acceptance for the bulk of its excess plutonium.

Plutonium swaps. As a backup and complement to other approaches, the United States should consider the possibility of "plutonium swaps." Today, some 10 tons of reactor-grade civilian plutonium is already being burned as fuel for civilian 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.[13] The excess weapons plutonium would be converted to oxides suitable for fuel fabrication in Russia and the United States, and shipped to existing European fuel fabrication facilities under heavy guard. Modest license modifications for those facilities and for the reactors that use fuel from them would likely be needed in order for them to use weapon-grade rather than reactor-grade plutonium. The civilian plutonium that would have been burned at a rate of 10 tons per year would be displaced and would build up in storage, adding to the large quantities of civilian separated

[13] This approach was outlined in Thomas L. Neff, "Perspectives on Actions Necessary to Move the Plutonium Disposition Program Forward" (paper presented at the International Policy Forum: Management and Disposition of Nuclear Weapons Materials, Bethesda, Maryland, March 23–26, 1998). Senator Pete Domenici (R-NM) championed the idea briefly, but dropped it after finding little European interest (see, for example, Dave Airozo, "Finding Europeans Disinterested, Domenici Shelves `Global Burn'," *Nuclear Fuel*, July 27, 1998). If appropriately presented and packaged with reasonable incentives for all concerned, however, 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. A similar approach was also discussed in U.S. National Academy of Sciences, *Management and Disposition of Excess Weapons Plutonium*, op. cit., pp. 176–181.

plutonium that are already in storage. In effect, this would transform a problem of excess weapon-grade plutonium in Russia and the United States, under no international safeguards, to a problem of excess reactor-grade plutonium stored in secure facilities in Europe under international safeguards. While that transformation would not reduce the total amount of separated plutonium in the world, it would be a substantial benefit in reducing the risk of nuclear theft and improving the irreversibility of nuclear arms reductions. These stockpiles of displaced civilian plutonium could be "swapped" for the excess weapons plutonium, so that the United States and Russia would retain title to the same amount of fissile plutonium they each sent to Europe (potentially important for Russia, which focuses more on the potential future value of plutonium than on its present liabilities). Indeed, given the costs and difficulties for utilities in managing plutonium, the European and Japanese utilities that own the huge stocks of separated civilian plutonium now in storage would likely be happy to have Russia take title to two tons of civilian plutonium for every one ton of weapons plutonium sent to Europe.

Performance-based financing approaches. As the United States and Russia, with their other contributing partners, explore different technological approaches for disposition of Russia's excess weapons plutonium, they might also consider revised approaches to structuring the financing the international community might provide. Rather than agreeing, for example, to pay all of the capital cost for a particular fuel facility – which gives Russia little incentive to keep that cost low – the international community might agree with Russia on a particular amount to be paid per ton of plutonium whose disposition Russia completed, with a portion of those funds to be paid up-front (allowing Russia to finance some of the needed investments), and a portion to be paid when disposition was complete. This would give Russia an incentive to find ways to reduce total costs, and to find ways to get the job done expeditiously, so that it could receive the final payments. Since security measures are inevitably an extra cost that managers are tempted to cut, it would make sense for the international community to contribute to stringent security measures as a separate item.

Plutonium purchase options. The ultimate in performance-based financing approaches would be to actually buy Russia's excess weapons plutonium. If Russia were willing to sell (senior Russian officials have expressed contradictory views on this point at different times) the cost would likely not be astronomical. If the buyer – the United States or other countries participating in the G-8 Global Partnership – were willing to pay the same amount per ton as the United States is now paying for HEU, then 50 tons of plutonium (enough for over 10,000 nuclear weapons) would cost just over $1 billion.[14] This would be a generous offer, since in the current commercial market the plutonium's actual commercial value is negative (the costs of securing it and making fuel from it are much higher than the value of the fuel). Once the plutonium had been purchased, the buyer would presumably then have the right to remove the material from Russia for immobilization or use as fuel elsewhere, or to pay for it to be immobilized or used as fuel within Russia. In the case of a U.S. purchase, for example, it might be possible to build only one plutonium fuel fabrication plant, rather than one in the United States and one in Russia. There are a wide range of difficult political and legal questions that would have to be addressed – along with some technical and economic questions – before such a

[14] The original estimated price for 500 tons of HEU was $12 billion.

purchase could become a reality, but it remains something that should be considered. The option may be particularly valuable if the current plan to use plutonium as fuel runs into serious obstacles or cost overruns, while Russia continues to resist throwing its plutonium away through immobilization. In that case, the option of purchasing Russia's plutonium (thereby allowing Russia to monetize it immediately), and then paying for it to be immobilized, might provide a plausible back-up approach. As with the "swap" concept, however, considerable care must be used to explore these concepts without undermining the main thrust of the plutonium disposition program, which remains focused on using the material as fuel while it remains under the control of its original owners, Russia and the United States.

Technologies for Disposition of U.S. Excess Plutonium

The establishment of the Nuclear Materials Disposition and Consolidation Coordination Committee last year has the potential to be a major step forward in organizing DOE's thinking about storage and disposition of nuclear material throughout the DOE complex. In particular, it is important to think about all the plutonium at the same time, whether it happens to belong to the Office of Materials Disposition, to Environmental Management, or to other entities; one way or another, the taxpayer is going to end up paying for managing it, and therefore whatever opportunities there are for synergies in managing these different plutonium stocks should be aggressively pursued.

Several options can be considered for long-term disposition of DOE's excess plutonium stockpiles.

Indefinite storage: the no-action alternative. DOE believes that simply continuing to store all the different forms of excess plutonium that now exist in the U.S. complex would be the most costly option (though the annual storage could be greatly reduced if all of the excess plutonium could be stabilized and consolidated at one or two sites).[15] Moreover, this option would not accomplish any of the security objectives of plutonium disposition, and would require walking away from the 2000 PMDA and related negotiations. This option appears to be the least desirable of the available choices.

Partial immobilization: the least-cost alternative. While no complete and recent study has been done, it seems likely that that the lowest-cost alternative would be to immobilize that portion of the excess plutonium that would otherwise be costly to store for the long term, and store the rest, consolidated at one or two sites.[16] The life-cycle savings compared to a mixed MOX-and-immobilization plan for all 50 tons of excess plutonium might be several billion dollars, though this requires detailed examination. The excess plutonium most relevant to possible reversal of nuclear arms reductions – the pits at Pantex and other clean metal and oxide – would likely remain in storage

[15] Data provided by DOE, July 2006.

[16] While DOE's 2002 disposition study was looking only at 34 tons of plutonium, not the full stock of excess material, for the stock they examined, this partial immobilization approach clearly involved the lowest costs (at least over the period they examined). See U.S. Department of Energy, *Report to Congress: Disposition of Surplus Defense Plutonium at the Savannah River Site* (Washington, D.C.: DOE, 2002; available at http://www.nci.org/pdf/doe-pu-2152002.pdf as of 23 July 2006).

indefinitely, and thus in this case, too, few of the security objectives of plutonium disposition would be accomplished. This option would also require abandoning the 2000 PMDA. This option would only be the best choice if the United States was not interested in going beyond the 34 tons of plutonium covered in the PMDA, or was absolutely convinced that Russia would never agree to go further; in that case, the benefits of disposition of 34 tons of weapon-grade plutonium under the PMDA might well be smaller than the additional costs of moving forward beyond this least-cost approach.

The all-MOX option. An all-MOX option is not realistic, as the MOX approaches cannot handle the large quantities of highly impure plutonium in the DOE complex, unless this impure plutonium were reprocessed to purify it; some of this material may even be difficult to reprocess without large investments in specialized processes.

The all-immobilization option. An all-immobilization option is a real possibility that should be seriously considered. In a "ceramic can-in-canister" approach, the plutonium would be immobilized in ceramic pucks, which would be loaded into metal cans that would be placed inside the large canisters into which molten high-level-waste glass is poured. This would put the plutonium into a massive, intensely radioactive waste form that roughly meets the spent fuel standard. While immobilization is less technologically mature than use of plutonium as MOX, it would involve fewer difficult-to-safeguard steps, handling of plutonium at fewer sites that would have to be guarded, and less potentially vulnerable transportation. Unfortunately, the immobilization research and development program was terminated in 2001 and only recently restarted in Environmental Management (now with a focus on immobilizing only a fraction of the total amount of excess plutonium); as a result, if this option is chosen, there will inevitably be some additional difficulties and costs in getting the effort going again.

In the past, DOE has rejected all-immobilization approaches on the grounds that Russia might not move forward with disposition of its own plutonium if the United States relied only on immobilization, which Russia considers simply another form of storage. This Russian view of immobilization is clearly wrong: immobilization would drastically increase the cost and difficulty of recovering plutonium for weapons use, and if the United States had any intention whatever of ever recovering this material for use in weapons, it would surely not spend billions of dollars to put it into forms from which it cost additional billions to recover it. It is becoming increasingly clear that the specific technologies of the U.S. and Russian programs will be delinked, and Russia is now re-opening the agreed approaches in the PMDA for its own disposition effort. I believe that there is at least a reasonable chance that if the United States agrees to support a disposition approach in Russia that fits with Russia's long-term energy plans, Russia might accept an all-immobilization approach for U.S. excess plutonium – though that might be more genuinely problematic from the Russian perspective if the two sides really were agreeing to apply disposition to all but a small portion of their plutonium stockpiles. If, based on other criteria, an all-immobilization approach was considered attractive, this possibility should at least be explored.

DOE has recently raised a number of concerns about the all-immobilization option, arguing that (1) it would cost just as much as options combining MOX and immobilization, and (2) if immobilization of high-level wastes at the Savannah River Site

(SRS) proceeds at the pace currently planned, and a large-scale plutonium immobilization facility takes until 2019 to get operating, there may no longer be enough waste canisters still to be produced to contain all the excess plutonium.[17] Both of these issues require further examination. Previous DOE analyses, by contrast, concluded that all-immobilization approaches would be significantly cheaper than hybrid MOX and immobilization approaches, even before the recent dramatic escalation of the estimated cost of MOX options.[18] Congress should require DOE to provide a detailed analysis of the factors that have reversed its previous conclusion, and then submit these cost analyses to independent review, perhaps by the National Academy of Sciences.

Similarly, with respect to the availability of waste canisters, Congress should require DOE to provide an in-depth (and independently reviewed) examination of approaches for providing sufficient waste canisters for plutonium immobilization, including, but not necessarily limited to: (1) modest delays in high-level waste immobilization at SRS (as might occur in any case, given the past delays in high-level waste processing and the need to bring the high-activity salt waste processing facility on line);[19] (2) a faster schedule for bringing the plutonium immobilization facility into operation (as projected in previous DOE reports);[20] (3) possible additional wastes whose processing may lead to additional canisters being produced (such as the return of U.S.-origin research reactor fuel, now extended until 2019, whose processing will require the management of millions of curies of radioactive waste beyond what is currently in the SRS tanks);[21] or (4) immobilizing some or all of the plutonium at Hanford, whose waste

---

[17] Data provided by DOE, July 2006. DOE expects that it can put 28 kilograms of plutonium in each canister, so 50 tons of plutonium would require over 17,000 canisters; if the DWPF immobilization of high-level waste and the high-activity salt waste processing facility both move forward with no further delays, and it takes until 2019 to bring plutonium immobilization on-line, as DOE now expects, then by the time plutonium was being immobilized there might only be two-thirds as many canisters remaining as required for immobilization of 50 tons of plutonium.

[18] See, for example, U.S. Department of Energy, *Disposition of Surplus Defense Plutonium*.

[19] DOE currently projects that a plutonium immobilization facility for 50 tons of excess plutonium would take more than a decade to bring on-line, and that if the Defense Waste Processing Facility at SRS worked well in the intervening time, there might not then be enough canisters of waste glass yet to be produced to hold 50 tons of plutonium. (Data provided by DOE, July 2006.) A delay of only a few years, however, would be sufficient to ensure that sufficient waste canisters were still available at SRS to immobilize 50 tons of plutonium. Such a delay might occur in any case, or Congress could consider instructing DOE to operate its facilities to achieve an appropriate balance among different objectives, rather than maintaining an inflexible schedule for high-level waste immobilization that was unable to accommodate plutonium immobilization.

[20] The 2002 report on cost analysis, for example, projected that an immobilization facility for 50 tons of plutonium would complete operations shortly after DOE now projects it could begin operations. See U.S. Department of Energy, *Disposition of Surplus Defense Plutonium*. Previously, DOE had projected it would take eight years to design, build, and begin to operate an immobilization facility, compared to the 13 years now projected.

[21] Reprocessing of this fuel, if that is the option chosen, would result in large quantities of liquid waste containing tens of millions of curies of radioactivity that would have to be immobilized. Use of a "melt and dilute" approach would result in large quantities of radioactivity being captured in the off-gas system, and the off-gas filters would then become high-level radioactive waste that would require immobilization as well. See, for example, 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, Calif., 15-19 July 2001* (Northbrook, Ill.: INMM, 2001; available at http://www.nci.org/new/el-inmm2001.htm as of 23 July 2006).

immobilization program is moving more slowly, rather than at Savannah River. Congress should direct to DOE to examine not only whether enough canisters can reasonably be made available to immobilize 50 tons of plutonium, but also whether enough could be made available to immobilize even larger quantities if additional material were declared excess. Potential impacts on how much canister storage will be required at the immobilization sites, pending the shipment of the canisters to Yucca Mountain, should also be examined.

Mixed MOX-and-immobilization options. DOE currently proposes to pursue a mixed strategy that involves using roughly 34 tons of its excess plutonium as MOX fuel in existing LWRs and immobilizing the remainder (in some cases after dissolution in the H-Canyon). Cost estimates for this approach are now much higher than they were six to seven years ago.[22] Unfortunately, while the investments over the intervening period have led to significant progress in designing, getting regulatory approval for, and preparing to build a MOX plant, the cost escalation for the MOX option has been more rapid than the progress, so that the estimates of remaining cost are bigger, rather than smaller, than they were years ago; and the plant is still not expected to be able to come on line until 2015 at best (whereas six years ago it was expected to be going into start-up operations about now). DOE believes that with only a portion of the plutonium being immobilized rather than all of it, immobilization can make greater use of existing facilities rather than green field construction and hence can come on-line sooner, be less expensive, and have plenty of waste canisters available for the job. Moreover, since the material to be used in reactors under the PMDA would still be used in reactors, this option would offer Russia no rationale for backing out of its disposition obligations. If additional plutonium were declared excess, it would largely be additional clean metal and could be used as MOX by extending the operations of the proposed MOX plant.

This hybrid approach may in fact be the most effective available strategy, but it is certainly costly. Congress should require DOE to consider a number of options for cost reduction, such as combining some of the four proposed major facilities into one or two buildings.

Advanced reactors and fuel cycles. Despite the large increases in the projected cost of MOX options and the extended delays in implementing them, it remains highly likely that developing and deploying any advanced reactor or fuel cycle approach would cost more and take longer, without delivering commensurate benefits. As in Russia's case, however, if advanced reactors are built for other purposes and some excess plutonium is still available when they come on-line, their use for plutonium disposition should also be considered.

Plutonium swaps and transfers. The "plutonium swap" approach described above could also be applied to U.S. excess plutonium. Indeed, it is highly unlikely that it would be acceptable to Russia unless pursued in parallel. More broadly, a variety of options for transferring plutonium to Europe for fabrication, irradiation, or both could be considered. I have long advocated, only partly in jest, that we should offer France and Britain 50 tons of plutonium (or however much we could provide in pure forms) and $100 million to take it off our hands: if they said "yes," this would be by far the lowest

[22] Data provided by DOE, July 2006.

cost of the available options, while if they said "no," that would firmly put the lie to the oft-repeated notion that plutonium has great value rather than being a dangerous liability.

Recommendations

(1) As a first priority, the United States should do everything in its power to ensure that all stockpiles of nuclear weapons and weapons-usable nuclear materials worldwide are secure and accounted for, to standards sufficient to defeat the threats that terrorists and thieves have shown they can pose. This effort should be prioritized, focusing on addressing the highest risks of nuclear theft first. A variety of U.S. programs are making significant progress toward this objective, but much more remains to be done.[23] The global initiative announced by President Bush and President Putin in St. Petersburg may turn out to be a dramatic step forward in this global effort.

(2) DOE 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 and other countries to encourage them to do the same.

(3) The United States should adopt a policy of seeking deep, transparent, and irreversible nuclear arms reductions. In that context, it should seek agreement with Russia to reduce each country's total stockpile of assembled nuclear weapons to 1,000-2,000, and to take a range of steps to make these reductions difficult to reverse. This should include, but not be limited to, reducing stockpiles of separated plutonium and HEU to the minimum required to support the reduced warhead stockpiles. While such a policy is not without some risks, those risks are more than outweighed by the nonproliferation and arms reduction benefits.[24]

(4) The United States should maintain both a domestic plutonium disposition program and a program to support disposition of Russian excess plutonium. Funding for the U.S. MOX program should not be cut to zero, as proposed in the House Energy and Water appropriation bill.

(5) The United States, however, should only be prepared to invest billions in construction and operation of relevant facilities if:

    a. For disposition of U.S. plutonium:

---

[23] We provide a detailed assessment of progress to date and a far-reaching set of recommendations for next steps in Matthew Bunn and Anthony Wier, *Securing the Bomb 2006* (Cambridge, Mass.: Project on Managing the Atom, Harvard University, and Nuclear Threat Initiative, 2006; available at http://www.nti.org/securingthebomb as of 23 July 2006).

[24] For a discussion of the case for such reductions, see, for example, U.S. National Academy of Sciences, Committee on International Security and Arms Control, *The Future of U.S. Nuclear Weapons Policy* (Washington, D.C.: National Academy Press, 1997; available at http://newton.nap.edu/html/fun/ as of 24 July 2006). For discussions of the controls over nuclear materials that might be part of such a regime, see U.S. National Academy of Sciences, *Management and Disposition of Excess Weapons Plutonium*; U.S. National Academy of Sciences, Committee on International Security and Arms Control, *Monitoring Nuclear Weapons and Nuclear-Explosive Materials* (Washington, D.C.: National Academy Press, 2005; available at http://books.nap.edu/catalog/11265.html as of 8 August 2005).

i. The United States has adopted a policy of seeking irreversible nuclear arms reductions, in which which disposition of 34 tons is seen as only a first step toward disposition of enough plutonium so that the remainder would no longer be sufficient to construct a Cold War-scale nuclear arsenal; or

ii. The costs and risks of disposition are less than the costs and risks of continued storage, in the context of an overall assessment of the best approaches to managing *all* plutonium under U.S. government control. That assessment should include not only technical but political realities, including the feasibility of moving forward with a consolidation effort in the absence of a disposition path forward.

b. For disposition of Russian plutonium:

i. The United States has adopted a policy of seeking irreversible nuclear arms reductions, and is seeking to convince Russia to adopt a similar policy, in which disposition of 34 tons would be only a first step toward disposition of enough plutonium so that the remainder would no longer be sufficient to construct a Cold War scale nuclear arsenal.

There need not be an ironclad commitment to go far beyond 34 tons to justify moving forward major construction, 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 wipe their hands and walk away, thinking, wrongly, that they have solved the plutonium problem.

(6) The United States should re-examine the technical options for plutonium disposition, and choose options that achieve the spent fuel standard; maintain security as close as practicable to the stored weapon standard throughout the process; meet applicable ES&H standards, and do not create significant new ES&H risks that would not exist in the absence of plutonium disposition; are scalable to larger quantities of plutonium than 34 tons; and, within those constraints, provide the best balance of timing, security advantages, and reasonable costs.

(7) For disposition of U.S. excess plutonium, both a hybrid MOX-and-immobilization option and an all-immobilization option should be seriously considered. To help make the choice, Congress should direct that DOE provide detailed analyses of the costs, benefits, and risks of each option, and Congress should direct that in-depth independent peer reviews of these analyses be carried out. These analyses should include, but not be limited to:

a. Why DOE’s cost estimates for these options are now less favorable to immobilization than DOE’s earlier studies, despite the large escalation in projected costs of the MOX approach.

b. What options may exist for ensuring that sufficient high-level waste canisters would be available for immobilizing 50 tons of excess plutonium, and whether

these options could be scaled to provide sufficient canisters for immobilizing even larger quantities of U.S. excess plutonium.

(8) For Russian excess plutonium, the United States:

a. Should continue to seek a degree of linkage – that is, to ensure that Russia will carry out disposition of quantities of plutonium comparable to or larger than those slated for disposition in the United States, on a comparable time scale. This is important since, at least from the U.S. point of view, most of the national security benefit of disposition of U.S. excess plutonium comes from its effect of enabling disposition of Russia's excess plutonium. The specific technologies and the specific times at which facilities would begin construction and operation need not be the same in the United States and Russia, however.

b. Should begin discussions with Russia now on declaring additional material excess to their military needs, and should structure plans for the disposition program to ensure that the program, once underway, could handle much larger quantities of plutonium than are covered under the initial agreement.

c. Should seek an agreed decision with Russia concerning which long-term disposition options will be implemented as rapidly as practicable. The criteria for choice should be the same as those in point (6) above.

d. Should seek to complete an international financing and management agreement for disposition of Russia's excess plutonium as rapidly as practicable.

e. Should be willing to support reliance on new reactors for plutonium disposition only if options are developed that offer a better mix of costs to the United States, risks, and timing than does the use of existing reactors.

f. Should not support construction and operation of new fast-neutron reactors for disposition of excess plutonium until it is convinced that arrangements are in place that will ensure that doing so will contribute to, and not undermine, U.S. nonproliferation objectives.

g. Should restart joint immobilization research and development with Russia.

(9) As a complement and backup to other approaches, "plutonium swaps" and other options for transfers or purchases of plutonium should continue to be considered.

(10) For both U.S. and Russian excess plutonium, the United States should take steps to build in stringent standards of security and accounting, approximating the stored weapon standard as closely as possible, for the beginning; tacking on security measures as an afterthought later is likely to lead to higher cost and lower effectiveness. In the United States, the Nuclear Regulatory Commission decision that reactors using MOX fuel should not have to prove that they have security measures in place capable of defeating the Category I design basis threat for theft should be reversed. In Russia, detailed planning for security measures throughout the process – possibly going beyond the measures that Russian regulations currently require – should be integrated into the effort from the outset.

(11) Given the delays in disposition of excess plutonium, and the desirability of sending a message internationally that this material will never be returned to weapons, the United States and Russia should implement the PMDA commitment to placing their excess plutonium stocks under International Atomic Energy Agency monitoring as soon as practicable.

(12) The United States should support efforts to avoid accumulation of additional stockpiles of separated plutonium. In particular, the United States should continue to support the shut-down of Russia’s plutonium production reactors (if the quantity of plutonium whose production would be avoided is judged to justify the cost of the effort); should resume the negotiation of a 20-year U.S.-Russian moratorium on plutonium separation, which was almost complete at the end of the Clinton administration; and should support negotiation of a verifiable fissile cutoff treaty.

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.