Reducing Fissile Material Stockpiles

With the end of the Cold War and the consequent dismantlement of thousands of nuclear weapons, both the United States and Russia have enormous stockpiles of plutonium and HEU they no longer need. These huge stockpiles will pose serious proliferation and arms-reduction-reversal risks as long as they remain in readily weapons-usable form. As former Russian Minister of Atomic Energy Victor Mikhailov once said, "Real disarmament is possible only if the accumulated huge stocks of weapons-grade uranium and plutonium are destroyed." [58]

[58] Address to the International Atomic Energy Agency, quoted by TASS, September 22, 1992.

Russian Perspectives on Disposition of Excess Weapons Plutonium

The dominant perspectives on disposition of excess weapons plutonium among Russian policymakers are strikingly different from those of U.S. policymakers—a fact that continues to require delicate negotiation to build agreements that both sides see as serving their interests.

The U.S. approach to disposition of excess weapons plutonium can be summed up in five basic principles:

- Excess weapons plutonium is primarily a security issue; because of the urgency of the security threats it poses, this material should be transformed into forms that are no more attractive for recovery and use in weapons than plutonium in spent fuel as rapidly as this can be safely and securely accomplished.
- Disposition of Russian and U.S. excess weapons plutonium should proceed in a balanced way, ending ultimately with roughly equal levels of material remaining in military stockpiles—meaning that at some point Russia, which begins with a larger military stockpile of plutonium, will have to carry out greater reductions in that stockpile.
- Excess weapons plutonium has no economic value, since the cost of using it to produce nuclear energy is more than the energy is worth. Indeed, it is a substantial economic liability, since all options for its disposition will cost billions of dollars—but it is worth paying those costs for the resulting decrease in security threats.
- Because of the security dangers posed by separated plutonium, and the high costs of separating and managing it, civilian plutonium should not be reprocessed and recycled, even if some portion of excess weapons plutonium is used as reactor fuel as the most effective way to meet the security objectives of disposition. The United States should not provide material support to recycling of civilian plutonium, in Russia or elsewhere.
- Decisions on disposition of excess weapons plutonium and on the future of nuclear energy should be made separately, since the stockpiles of excess weapons plutonium are tiny in the overall global energy resources picture, and decisions on nuclear energy can be made over a period of decades, while disposition of excess weapons plutonium is comparatively urgent.

The U.S. decision to undertake a multi-billion-dollar program in which some of its excess weapons plutonium would be used as reactor fuel (once-through, with no reprocessing, and with the plutonium fuel facilities to be shut and torn down after the excess weapons plutonium mission is accomplished), and some would be immobilized with high-level wastes, was based on these basic principles.

While the U.S.-Russian Independent Scientific Commission on Disposition of Excess Weapons Plutonium, which included experts from both Russia and the United States, reached a consensus on similar principles,[1] the majority opinion among Russian policymakers, particularly within the Ministry of Atomic Energy, is strikingly different. This dominant Russian view is aptly summed up in an interagency "concept" for disposition of excess weapons plutonium drawn up under MINATOM's chairmanship in 1998.[2] The view expressed in this official concept can be summed up in the following five principles:

- Excess weapons plutonium is primarily an energy issue: this plutonium has "significant energy potential" and its production "required great investments in material, labor, and financial resources." It should be seen as an energy resource, along with civilian plutonium, and it is therefore acceptable to keep storing the material for now, with disposition taking place over "several decades," a timescale "comparable with the timetables for the development and assimilation of new technologies in nuclear energy."

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[1] *Final Report of the U.S.-Russian Independent Scientific Commission on Disposition of Excess Weapons Plutonium,* op. cit.

[2] *Concept of the Russian Federation: Disposition of Plutonium Withdrawn During the Course of Nuclear Disarmament*, 1998. The working group that prepared the document was chaired by First Deputy Minister of Atomic Energy Lev Ryabev, and included representatives from most of the main departments of MINATOM and a variety of MINATOM enterprises, as well as the Ministry of Defense and the Kurchatov Institute.

- Excess weapons plutonium does also have a "political aspect" relating to the irreversibility of nuclear arms reductions (the issue of the risk of theft of such material is not mentioned as a reason to pursue disposition, except in statements that it must be adequately protected from theft). In accordance with this irreversibility objective, a "basic condition" is that "disposition of withdrawn weapons plutonium in Russia and in the USA must proceed in parallel"—and there should be equal reductions in U.S. and Russian plutonium stockpiles, not reductions to equal levels. "The quantities of plutonium that will remain necessary for purposes of national security in Russia and in the USA may not coincide."
- Excess weapons plutonium has enormous energy value, but at present its use as fuel would involve substantial additional costs (estimated in the paper to be roughly $1.5 billion, although different reactor options are presented that would have somewhat different costs). Therefore, if for political reasons other countries want Russia to carry out disposition sooner than it would make economic sense to do so, they should pay the cost: "*a condition for the implementation of the comprehensive use of withdrawn weapons plutonium in the Russian nuclear power industry is that Russia's added expenditures be covered by the United States and other countries interested in the fastest and guaranteed conversion of Russian weapons plutonium into forms unsuitable for use in nuclear weapons."* (emphasis in original)
- Plutonium recycling, ultimately in fast-neutron breeder reactors, is a desirable and essential part of the future of nuclear energy.
- Given the substantial energy content of the plutonium, decisions on disposition of excess weapons plutonium must be an integral part of decisions about the future of nuclear energy. "[T]he problem of disposition of these fissile materials must be resolved within the framework of a national strategy for the development of nuclear energy. This strategy is aimed at the gradual transition to a closed fuel cycle with the use of fast neutron reactors powered by plutonium."

Given these principles, the concept concludes that "the aim of disposition of withdrawn weapons plutonium is its use in the nuclear power industry," and approaches such as immobilization that do *not* make use of the energy value of the plutonium "will not be implemented." Disposition should include "the development of production processes and technologies of a closed fuel cycle with fast reactors, all the while observing international standards of safety and nonproliferation."

The draft agreement now nearing completion is designed to accommodate most of both sides' basic principles. It commits Russia to move quickly on plutonium disposition, as the United States would prefer—but only if funds to cover the extra costs become available from the United States and other parties. A MOX plant built with international assistance in Russia is to be used only for disposition of excess weapons plutonium as long as that mission lasts—postponing the argument about what happens then for decades into the future. The United States will not help Russia finance and build new fast-neutron reactors, but there is no prohibition on Russia doing so, if it can find the money somewhere. For this first step, there will be equal reductions in plutonium stockpiles, but that does not resolve whether ultimately there should be reductions to equal levels. Russia will use all of its plutonium covered by the agreement, but the United States will use some as fuel and immobilize the rest (though Russian opposition to immobilization extended to seeking limits on the amount of U.S. plutonium that would be immobilized, on the argument that immobilized material could more readily be recovered for use in weapons than material that had been used as MOX[3]). With flexibility, persistence, and a bit of luck, it may be possible to continue to bridge these basic disagreements for the decades that will be required to complete disposition of the U.S. and Russian excess weapons plutonium.

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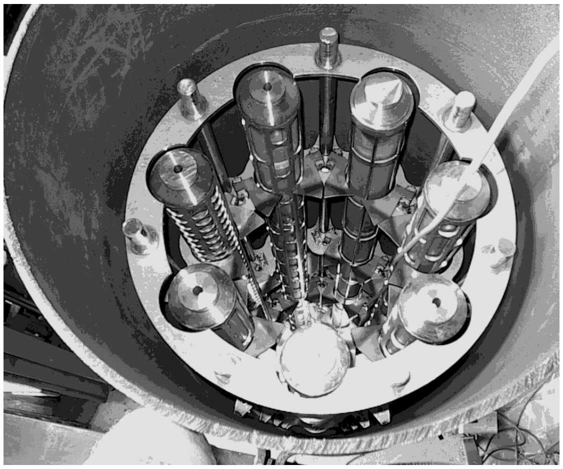
[3] This is more a talking point than a serious strategic concern, since the United States is holding far larger quantities of material in reserve in the form of assembled warheads and plutonium pits ready to be assembled into such warheads. Moreover, as a variety of studies have concluded, it will cost more than a billion dollars for the United States to immobilize its plutonium, and would probably cost nearly as much to get it back out, should a decision be taken to do so, offering a substantial degree of "irreversibility" for the process. Indeed, plutonium that had been irradiated as MOX could also be recovered in similar fashion; while its isotopics would have been degraded by reactor irradiation, nuclear weapons can be made from such reactor-grade plutonium with yield, weight, and reliability comparable to weapons made from weapon-grade plutonium.



A portion of the U.S. excess weapons plutonium is to be immobilized with high-level radioactive wastes in the so-called "can-in-canister" immobilization form, shown here. Cans of weapons plutonium immobilized in ceramic are arrayed within a large canister, into which molten glass mixed with high-level waste is poured, making a massive, highly radioactive glass "log," protecting the plutonium from theft or recovery for use in weapons. Source: DOE

Yet progress in accomplishing that objective has been modest, to date.

Recognizing the reality that their fissile material stockpiles vastly exceed their current military requirements, both the United States and Russia have designated hundreds of tonnes of their fissile material stockpiles as being "excess" to their military needs, and pledged that this material will never again be used in nuclear weapons. The United States has designated 52.5 tonnes of plutonium as excess, along with 174.3 tonnes of HEU, for a total of just over 225 tonnes of excess fissile material.[59] Russia has designated "up to" 50 tonnes of plutonium and 500 tonnes of HEU as excess.[60] The United Kingdom has also declared more than 4 tonnes of plutonium excess.[61] Unfortunately, both the United States and Russia are still retaining even larger amounts of material in stockpiles reserved for military use—easily enough to support a rapid return to Cold War levels of armament, and to pose enormous risks of theft. (See "Enormous Excess Stockpiles—And Still Larger Remaining Military Stocks," p. 54.) Current programs designed to ensure that excess material is never again used in weapons can make a major contribution to both countries' stated goals of ensuring the irreversibility of nuclear disarmament and preventing nuclear proliferation—but only if

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[59] *Feed Materials Planning Basis for Surplus Weapons-Usable Plutonium Disposition,* Washington DC: Department of Energy, Office of Fissile Material Disposition, April 1997.

[60] Boris Yeltsin, *Message from the President of the Russian Federation to the Forty-First Session of the General Conference of the International Atomic Energy Agency,* September 26, 1997. The actual Russian language was that "up to" these figures had "become available through the nuclear disarmament process" and would be "remove[d] gradually from military nuclear programs," with the pace of this "dependent both on progress with the dismantling of nuclear weapons pursuant to existing agreements on nuclear disarmament, and on the creation of the necessary storage facilities for the material released from military use."

[61]The United Kingdom has declared 0.3 tonnes of weapons-grade plutonium, and 4.1 tonnes of non-weapons-grade plutonium excess to its military needs, along with 9,000 tonnes of natural or low-enriched uranium that had been held in military stocks for fueling military production reactors, and is placing these materials under EURATOM safeguards; they are is available for IAEA safeguarding, but the IAEA has not chosen to safeguard it because no funding is available to do so. These are from declared total stockpiles outside of safeguards of 7.6 tonnes of plutonium, 21.9 tonnes of HEU, and 15,000 tonnes of natural and low-enriched uranium. All of the HEU is to be held in military stockpiles for use either as weapons or as naval fuel. See "Communication Received from the United Kingdom of Great Britain and Northern Ireland: United Kingdom Fissile Material Transparency, Safeguards, and Irreversibility Initiatives," INFCIRC/570, Vienna, Austria: IAEA, September 21, 1998 (available at http://www.iaea.org/worldatom /infcircs/infcirc570.html), and discussion in Schriefer and Shea, "IAEA Perspectives on Excess Materials," op. cit.

they represent a first step toward dealing with much larger portions of the U.S. and Russian fissile material stockpiles in the future. As arms reductions proceed, these stockpiles should be reduced in parallel to roughly equivalent levels in the United States and Russia, suitable to support whatever agreed warhead levels remain, but not large enough to permit a rapid return to Cold War levels of armament.

Disposition of U.S. Fissile Material

The United States has publicly committed to place its excess material under IAEA verification, to confirm that it will never be returned to weapons. But as of the end of 1999, only a very small fraction of the material had actually been made available for verification.[62]

The excess HEU is being blended to LEU at U.S. facilities, for sale on the commercial reactor fuel market (or disposal, in the case of material that is too contaminated to have commercial value). Blending of the first 14.3 tonnes of this material (enriched to 75% U-235) was completed at USEC's Portsmouth enrichment plant in July 1998. An additional 50 tonnes (enriched to 40 percent U-235) has been transferred from DOE to USEC and is now being blended, with that process expected to be completed in 2005. Finally, DOE and the Tennessee Valley Authority (TVA) have agreed that 38 tonnes of off-specification material (enriched to 65% U-235) will be blended and burned in TVA plants over several years, with full-scale loading of the blended material now expected to begin in 2003-2004.[63] DOE is still making plans for disposition of the remaining excess HEU.

For the excess U.S. plutonium, a substantial program is in place to demonstrate and implement two complementary disposition paths: a portion of it is to be burned as

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[62] The United States had officially stated that 38 tonnes of material would be made available for IAEA safeguards by the end of 1999 (see *Fact Sheet: U.S. Commitment to the Treaty on the Non-Proliferation of Nuclear Weapons*, op. cit.), but it appears that the actual amount made available by that time was roughly half that figure. The 38 tonne figure included 12 tonnes already under IAEA safeguards (2 tonnes of plutonium at Hanford and Rocky Flats, and 10 tonnes of HEU at Oak Ridge), 13 tonnes blended at the Portsmouth enrichment plant by 1998, and 13 additional tonnes of the 50 tonnes transferred to USEC from DOE when USEC was privatized in 1998. But of the 13 tonnes downblended at Portsmouth (ultimately 14.3 tonnes rather than the originally planned 13), the amount downblended during the verification "experiment" the IAEA was permitted to perform (for technical reasons, the United States and the IAEA determined that no genuine "safeguards" approach was feasible for that process at that facility) was only 3.7 tonnes, bringing the total verified by the IAEA to 15.7 tonnes as of the end of 1998. While it is planned to make the 50 tonnes transferred to USEC available for IAEA verification as it is downblended, under current plans it would not be made available for verification while in storage awaiting downblending, and only a small (undisclosed) amount had been downblended as of the end of 1999. For discussions of these amounts, see Schriefer and Shea, "IAEA Perspectives on Excess Materials," op. cit.; Amy B. Whitworth, "Implementation of International Inspections in the United States," in *Proceedings of the Institute of Nuclear Materials Management, 40th Annual Meeting,* Phoenix, AZ, July 25-29, 1999, and Nevile E. Whiting and Will Theis, "Portsmouth: The Conclusion," in the same volume.

[63] See John Longenecker and Ron Witzel, "Enrichment in a World of Privatization," *Nuclear Engineering International*, September 1999; "Megatons to Megawatts Program Status as of August 1998," press release, U.S. Enrichment Corporation (http://www.usec.com/Structure/Navigation/ThirdTier/newsreleases/09-22-98.htm); and Wayne Barber, "Plans for HEU Reloads Moving Slowly Through DOE, TVA," *Nuclear Fuel*, December 27, 1999.

The Expanded Threat Reduction Initiative

In his January 19, 1999 State of the Union address, President Clinton announced an Expanded Threat Reduction Initiative (ETRI), saying "we must expand our work with Russia, Ukraine, and the other former Soviet nations to safeguard nuclear materials and technology so they never fall into the wrong hands. Our balanced budget will increase funding for these critical efforts by almost two-thirds over the next five years."

Unfortunately, it soon became clear that the claimed two-thirds increase in spending for these programs to "safeguard nuclear materials and technology" was illusory. This was a peculiarly Washington kind of "increase"—judged not by comparing proposed spending to current spending, but by comparing proposed spending to previously planned deep cuts in spending. In reality, under the proposal, funding for most programs related to safeguarding nuclear materials and technology was to remain roughly flat, not increase. Much of what "increase" there was went to worthy efforts unrelated to safeguarding nuclear material, from providing civilian jobs for biological weapons experts to dealing with left over conventional ammunition in the Trans-Dniestr area of Moldova.[1]

The budget for the MPC&A program—the main program most directly dealing with safeguarding nuclear materials—tells the story. In FY1999, when the scope of the nuclear material emergency following the August 1998 financial meltdown became clear, rather than reprogramming additional funds for nuclear material security, DOE took funds away, redirecting $12 million of the $152 million Congress had appropriated for work on other projects. The much-vaunted "increase" for MPC&A in the Expanded Threat Reduction Initiative was a request for FY2000 of $145 million—$7 million *less* than Congress had appropriated the year before (though more, to be sure, than DOE had once planned to request, when the program had been slated to decline rapidly toward zero). A substantial amount of bureaucratic infighting was required even to bring the budget to that "not quite flat" level. The gap between the Administration's rhetoric and its budgeting could hardly be more stark.

Overall, the Expanded Threat Reduction Initiative package called for $4.2 billion dollars in spending on a wide range of programs over 5 years, compared to $2.5 billion that had been previously planned for that period, or somewhat over the $3 billion that would have been spent had FY1999 expenditures (except for one-time initiatives such as the Domenici HEU and plutonium funding) been kept constant for five years.[2] Roughly two-thirds of the planned spending is for programs related, in one way or another, to warhead and fissile material control—but few of these are substantially increased compared to the FY1999 funding that existed before the initiative was launched. The table below compares: (a) appropriated funding for these programs for FY1999, before the initiative, (b) the Administration's request for FY2000, the first and largest year of the new initiative;

[1] See *Expanded Threat Reduction Initiative*, op. cit.

[2] Alternatively, the $4.2 billion can be compared to over $3 billion, which would have been the result of keeping previous spending levels constant for the five-year period, making the result closer to a one-third increase than a two-thirds increase.

uranium-plutonium mixed oxide (MOX) fuel in existing U.S. reactors, and the remainder is to be immobilized with high-level wastes.[64] Recovering plutonium for use in weapons

[64] For a detailed discussion of the options for plutonium disposition and the status as of 1997, see Bunn and Holdren, "Managing Military Uranium and Plutonium," op. cit., and sources cited therein; see also *Final Report of the U.S.-Russian Independent Scientific Commission on Disposition of Excess Weapons Plutonium*, Washington DC: Office of Science and Technology Policy, June 1997 (available at http://ksgnotes1.harvard.edu/BCSIA/Library.nsf/atom). A variety of current official program documents and briefings are available at the program website, at http://twilight.saic.com/md/; a particularly useful short official overview can be found in Laura S.H. Holgate, "Plutonium Disposition: A Case Study of Nuclear Materials Management," in *Proceedings of the Institute of Nuclear Materials Management, 40th Annual Meeting,* Phoenix, AZ, July 25-29, 1999.

(c) Congressional appropriations for that year; and (d) the Administration's request for FY2001, when it proposed some new efforts focused on security and monitoring of nuclear materials (see "DOE's Proposed Long-Term Nonproliferation Initiative for Russia," p. 70). As can be seen, the ETRI request held most of the programs roughly constant; the most substantial increases were for science cooperation programs that provide grants to former weapons scientists (including the International Science and Technology Centers, the Initiatives for Proliferation Prevention, and the Civilian Research and Development Foundation), many of which go to biological, chemical, or aerospace experts rather than nuclear experts. When these efforts are excluded, the Administration's request for programs related to safeguarding warheads and fissile materials for FY2000 was only 5 percent more than Congress appropriated in FY1999.

After fights over a variety of specific issues, Congress in the end approved a large fraction of the first year's funding for ETRI.[3] For programs related specifically to warhead and fissile material security, Congressional action increased funding.

As the following year's budgets were being prepared, with a presidential election underway, senior White House officials paid only modest attention to any organized attempt to set nuclear security priorities. In January, 2000, ETRI went unmentioned in President Clinton's longest State of the Union speech yet, and safeguarding nuclear material rated only a few-word phrase—though the actual budget, released two weeks later, included a $100 million new initiative devoted to that objective (see "DOE's Proposed Long-Term Nonproliferation Initiative for Russia," p. 70). At the same time, however, the Administration requested less than it had projected the year before for various other parts of ETRI, so the overall size of the ETRI effort did not increase significantly with this new proposal.[4]

In short, the Expanded Threat Reduction Initiative provided a modest amount of additional funding for warhead and fissile material control efforts, as well as for other worthy endeavors, and it deserves continuing support. But it fell far short of what is needed to address the urgent proliferation threats posed by nuclear materials in the former Soviet Union, and far short of what the President announced to the nation. Even the new initiative unveiled in February, 2000, while a useful step in the right direction, is only a fraction of what needs to be done to address the urgent security risks the United States now faces.

[3] For a detailed accounting of Congressional authorization and appropriation actions in FY2000 for programs in the Expanded Threat Reduction Initiative, see *Russian Nuclear Security and the Expanded Threat Reduction Initiative: A Summary of Congressional Reaction*, Washington DC: Russian-American Nuclear Security Advisory Council, forthcoming (2000).

[4] For a description of the latest initiative, see "Fact Sheet: Long-Term Nonproliferation Program for Russia," U.S. Department of Energy, February 7, 2000. Reductions in other areas include, for example, a budget for DOD's Cooperative Threat Reduction Program roughly $50 million less than had been projected in the 1999 Expanded Threat Reduction Initiative proposal, a Nuclear Cities Initiative budget that is more than $12 million less than projected, an Initiatives for Proliferation Prevention budget that is over $7 million less than projected, and so on (FY2001 budget documents).

from the massive, highly radioactive waste forms from either of these processes would be roughly as difficult and unattractive as recovering it from the vastly larger quantities of ordinary commercial spent nuclear fuel that already exist—the so-called "spent fuel standard." A final record of decision outlining DOE's plans to implement both of these approaches was issued in January, 2000.[65] For either of these approaches, plutonium will have to be converted from weapons components or other forms to oxide; a prototype

[65] See *Record of Decision for the Surplus Plutonium Disposition Final Environmental Impact Statement*, Washington DC: U.S. Department of Energy, January 4, 2000; and *Surplus Plutonium Disposition Final Environmental Impact Statement* (3 vols. and summary), DOE/EIS-0283, Washington DC: U.S. Department of Energy, Office of Fissile Materials Disposition, November 1999.

facility for that purpose was dedicated at the Los Alamos National Laboratory in September, 1998, and a full-scale facility at Savannah River is expected to begin operations in fiscal 2006. A commercial contract for the initial design stages of the MOX portion of the program—with options for later stages—was signed in March 1999, with a full-scale MOX fuel fabrication facility at Savannah River also expected to begin operations in 2006 (after initial MOX test assemblies are fabricated at Los Alamos). Full-scale "hot" (radioactive) tests of the immobilization approach are expected in a few years, with operation of a full-scale plant to follow in 2008. While the disposition of the HEU will return funds to the U.S. Treasury from the material's commercial value, plutonium has no value in the current market, as noted above, and hence the U.S. plutonium disposition program is expected to cost in the range of $4 billion (roughly twice earlier estimates).[66]

The immobilization track has faced technical difficulties that have delayed its progress and increased its cost, including the failure of the previously planned process for vitrifying high-level waste at the Savannah River Site. (The vitrified high-level waste is to provide the radiation barrier to deter theft in the planned "can-in-canister" disposition concept, in which the plutonium would be immobilized in ceramic, and small cans of this ceramic would be arrayed in the large canisters into which intensely radioactive high-level waste glass is poured.[67]) The MOX track, meanwhile, has been criticized by a broad range of non-governmental organizations on grounds of undermining the U.S. opposition to civilian plutonium recycling. Defenders have countered that what the U.S. has long opposed is making *more* separated, weapons-usable plutonium, and that using all the available means to *reduce* stockpiles of separated plutonium is completely consistent with this policy.[68] The politics of the use of plutonium in U.S. reactors remains deeply problematic, however, and it remains to be seen whether DOE will succeed in carrying out this part of the program. It was precisely because of the likelihood of technical

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[66] These planned dates and cost estimates are from *Plutonium Disposition Life Cycle Costs and Cost-Related Comment Resolution Document*, DOE/MD-0013 Rev. 0, Washington DC: U.S. Department of Energy, Office of Fissile Materials Disposition, November 1999. The $4 billion figure is an undiscounted total life cycle cost in 2000 dollars. For earlier official estimates, see *Cost Analysis in Support of Site Selection for Surplus Weapons-Usable Plutonium Disposition*, Rev. 0, Washington DC: Department of Energy, Office of Fissile Materials Disposition, July 22, 1998; and *Technical Summary Report for Surplus Weapons-Usable Plutonium Disposition*, Rev. 1., Washington DC: U.S. Department of Energy, Office of Fissile Materials Disposition, November 1996 (which provided an estimate of roughly $2 billion for a similar hybrid option). All of these reports are available at the Office of Fissile Materials Disposition web page, at http://twilight.saic.com/md/.

[67] For discussions of the can-in-canister concept and how difficult it would be retrieve plutonium immobilized in this way, see *Nonproliferation and Arms Control Assessment*, op. cit.; and John P. Holdren (chair) et. al., *Interim Report,* Panel to Review the Spent-Fuel Standard for Disposition of Excess Weapons Plutonium, Committee on International Security and Arms Control, National Academy of Sciences July 1999.

[68] For a summary of the critics' view, see Edwin S. Lyman and Paul Leventhal, "Bury the Stuff," *Bulletin of the Atomic Scientists*, March-April 1997; for a summary of the supporters' view, see John P. Holdren, John F. Ahearne, Richard L. Garwin, Wolfgang K.H. Panofsky, and Matthew Bunn, "Excess Weapons Plutonium: How to Reduce a Clear and Present Danger," *Arms Control Today*, November-December, 1996. For a direct response to the main criticisms, see Matthew Bunn, "The Case for a Dual-Track Approach—And How to Move Forward From Here," *Nuclear Materials Monitor*, Vol. 1, No. 5, July 14 1997 (available at http://ksgnotes1.harvard.edu/BCSIA/Library.nsf/atom).

obstacles for the immobilization track and political obstacles for the MOX track that a panel of the National Academy of Sciences originally recommended pursuing both in parallel, so that each could serve as a backup to the other.[69]

Disposition of Russia's Excess HEU: The HEU Purchase Agreement

Disposition of Russia's 500 tonnes of excess HEU from dismantled weapons is covered by the U.S.-Russian HEU Purchase Agreement, under which this material is being blended to LEU and sold to the United States for re-sale on the commercial reactor fuel market. This is perhaps the most important and creative single U.S.-Russian fissile material control program. At one stroke, the HEU purchase provides financial incentives to dismantle thousands of warheads, destroys hundreds of tonnes weapons-usable material that could otherwise pose risks of proliferation or arms-reduction reversal, provides employment to thousands of Russian nuclear workers, and provides hundreds of millions of dollars a year to the desperate Russian nuclear complex—all (until recently) at virtually no net cost to the U.S. taxpayer. By the end of 1999, almost 75 tonnes of HEU—enough for thousands of nuclear weapons—had been blended to LEU and delivered to the United States.[70]

This HEU deal has been plagued with a series of problems, however—serious enough to interrupt blending and deliveries for months at a time. Indeed, there has never yet been a year in which as much HEU was actually blended and delivered as had been agreed for that year. These problems were largely caused by placing the deal in the hands of the United States Enrichment Corporation (USEC), which has had no profit incentive to implement it efficiently, as the large-scale imports of Russian enriched material compete with its own production, preventing it from running its plants at the most cost-effective production level.[71] The Clinton administration then compounded the error by privatizing USEC in the summer of 1998, thereby placing a critical national security initiative at the whim of the commercial market—a step that was taken even after it had become clear that changes in the uranium and enrichment markets since the initial decision to privatize made it inevitable that a privatized USEC seeking to maximize profit would have to attempt to undermine the HEU deal, and even after the administration was warned in detail of the likely security impact of privatization.[72] This

[69] See NAS 1995, op. cit.

[70] For an overview of the HEU deal, and a discussion of the problems that beset it in its early years, see Richard Falkenrath, "The HEU Deal," Appendix C in Allison et. al., *Avoiding Nuclear Anarchy*, op. cit. For a more optimistic official view, see U.S. Enrichment Corporation, "Chronology of the Megatons to Megawatts Contract (as of January 1, 2000)" (available at http://www.usec.com/Structure/Navigation/ThirdTier/newsreleases/08-31-98.htm).

[71] The material brought in under the HEU deal represents a substantial fraction of the total U.S. market for enrichment services, greatly reducing the amount of its own production USEC requires to meet the market demand. Moreover, because of oversupply in the enrichment market, enrichment prices have fallen to the point that under the current contract, USEC is buying material from Russia at just above the price at which it can sell the material, wiping out any profit it was once making on the deal.

[72] For an overview of privatization and its early impact, see Thomas L. Neff, "Privatizing U.S. National Security: The U.S.-Russian HEU Deal at Risk," *Arms Control Today,* August/September, 1998 (available at http://www.armscontrol.org/ACT/augsep98/tnas98.htm); the earlier background can be found in depressing detail in Falkenrath, "The HEU Deal," op cit.

episode certainly ranks among the most egregious national security blunders of the Clinton team.

As predicted, USEC privatization caused another rupture in the deal, stopping deliveries for months. This impasse was temporarily resolved only after Congress, with the leadership of Senator Pete Domenici (R-NM), provided a taxpayer subsidy of $325 million to save the agreement in the fall of 1998. Even then, a final agreement that allowed deliveries to restart was not reached until March 1999, after difficult negotiations.[73]

As expected, however, that “fix” was temporary: by the summer of 1999, USEC was actively seeking to get out of the five-year contract (running to the end of 2001) it had signed with its Russian partner while still government-owned, demanding either that Russia accept prices far below those that had been agreed in the contract, or that the U.S. government give USEC a subsidy of $200 million to compensate for its claimed lost profits in continuing to implement the contract. USEC threatened to pull out of its agreement with the U.S. government to serve as the “executive agent” for the HEU purchase agreement if its demands were not met. This dispute boiled over into disagreements over delivery schedules and canisters for shipping the uranium, and by early fall, the Russian Ministry of Atomic Energy indicated that with USEC unwilling to agree on delivery schedules, it had no choice but to cease blending HEU. After an intensive round of discussions between DOE, USEC, and the Russian partners in the deal, deliveries were resumed and USEC announced on December 1, 1999, that it would continue as executive agent even though neither Russia nor DOE had agreed to USEC’s demands.[74] Most analysts expect, however, that this resolution too will be temporary, and that continued U.S. government intervention will be needed as long as the deal remains solely in USEC’s hands, with no competition to ensure a fair market price.

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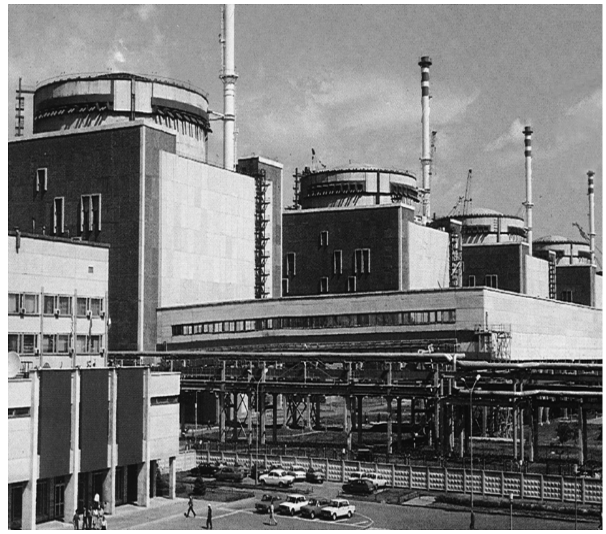
[73] As the HEU deal is currently structured, the uranium and enrichment work represented by the low-enriched uranium Russia delivers are handled separately, with different commercial arrangements. The March 1999 deal involved the United States government buying the uranium component of the material Russia had already delivered in 1997 and 1998—and agreeing to hold both that material and a substantial quantity of its own material off the market for a decade, to reduce the oversupply in the uranium market (which was caused in part by the U.S. decision to privatize USEC with a huge stockpile of uranium in its possession). Three Western companies—Cameco, Cogema, and Nukem—reached a simultaneous commercial contract with Russia giving them options to buy the uranium component from subsequent deliveries. Uranium the three companies did not choose to buy would be returned to Russia. In the end, the deal only addressed the uranium part of the HEU purchase agreement, not the enrichment part—which is more fundamental to USEC’s interests as an enrichment supplier—and since all the three companies were buying were options, which they would not take up if the price declined, the uranium part of the deal was not permanently stabilized either. For a useful explication of this rather complex agreement, see “The U.S.-Russia HEU Agreement,” *UI Trade Briefing*, Issue 1, London: Uranium Institute, August 1999.

[74] See “USEC to Continue as Executive Agent for Megatons to Megawatts Program,” USEC press release, December 1, 1999. Unfortunately, no comprehensive account of the maneuvering that led up to that point is yet available; much of this summary account is based on interviews with U.S. government officials. For discussions of portions of it, see, for example, Michael Knapik and Ray Silver, “USEC Looking to Administration, Congress For Help, Officials Weigh Comprehensive Fix,” *Nuclear Fuel*, October 18 1999, and Michael Knapik and Wayne Barber, “Glitches in HEU Deal Coloring Debate in Washington Over USEC Subsidy,” November 1, 1999. The author is grateful to Thomas L. Neff (author of the first published suggestion for the HEU deal) for extensive discussions of the HEU deal and access to a number of unpublished analyses.



These four VVER-1000 reactors at Balakovo are the most modern nuclear reactors in Russia, and could be modified to burn plutonium fuel in perhaps a third of their reactor cores. Existing Russian reactors can probably be modified to burn roughly two tonnes a year of weapon-grade plutonium, but doubling that rate at a later state, as called for in a draft U.S.-Russian agreement, would require shipping plutonium fuel to reactors in other countries, extensive modifications to existing Russian reactors, or disposing of some plutonium as waste. Source: PNNL

Indeed, USEC has continued to call for changes in the deal or U.S. subsidies for continuing in it, as its stock price plummets, its corporate credit rating declines, and it continues to lay off workers.[75]

Even if it were implemented smoothly in the future, the HEU deal as it now stands certainly does not resolve all the key issues posed by excess HEU in Russia. As described in Section IV, there are strong arguments for blending and buying more HEU, and faster. The 75 tonnes blended over the six years since the deal began represents less than 7 percent of the Russian HEU stockpile; although the pace is now going to increase to 30 tonnes per year (if all goes well), a decade hence it will still be true that only about a third of the Russian HEU stockpile will have been addressed. Indeed, the entire 500-tonne deal represents less than half of Russia's total HEU stockpile. Moreover, the deal involves bulk processing and transport—steps that create new vulnerabilities to possible theft—of tens of tonnes of weapons-usable material a year, yet there have not yet been any substantial upgrades to security and accounting at the areas of facilities where the HEU is being blended and processed.

Disposition of Russia's Excess Plutonium

Still less progress has been made in dealing with Russia's excess weapons plutonium. The basic options available—use as reactor fuel or immobilization—are the same as in the United States. But Russia lacks both the money to pay for either of these options and the number of modern, safe reactors needed to burn the material rapidly as fuel. Moreover, Russia refuses to consider the immobilization option, considering the plutonium as a valuable national asset produced with thousands of man-years of labor, not something to be thrown away as waste (see "Russian Perspectives on Plutonium Disposition," p. 58). At their September 1998 summit, President Clinton and President Yeltsin signed an agreement in principle to carry out disposition in stages of fifty tonnes of plutonium on each side, and called for negotiation of a more specific and binding government-to-government agreement laying out how this would be done by the end of 1998.

[75] See, for example, Martha Hamilton, "Uranium Firm to Cut 20% of Jobs," *Washington Post*, February 4, 2000.