PLUTONIUM QUANDARY: WHAT TO DO WITH NUCLEAR MATERIALS THAT COME OUT OF WEAPONS PROGRAMS

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The Challenge

An omnipresent issue in disarmament talks is what to do with the material that comes out of dismantled weapons so that such material is not recovered to produce nuclear weapons or does not fall into the hands of terrorists. As long as the substances that make nuclear weapons continue to exist and the knowledge of how to make nuclear weapons is available nuclear weapons will be produced. This is and is bound to be an unending nightmare for the foreseeable future.

The United States and Russia have declared that each has accumulated about 50 metric tons of weapons plutonium in excess of their military needs. The two countries have started to consider methods to make this plutonium non-usable in weapons production. The storage of plutonium in weapons-ready form is not secure enough since such storage allows for the quick retrieval of plutonium. To ensure that disarmament does indeed take place it is necessary to develop technical barriers so that the rapid recovery of plutonium is prevented. The Plutonium Disposition Agreement between the United States and Russia rests on the idea that the two states must make plutonium retired from weapons harder to recover. One way to secure plutonium, so that it is not ready for use in weapons production, is to mix it. Plutonium is mixed to produce mixed oxide (MOX). Plutonium can also be immobilized using the technology available for the disposal of high-level radioactive wastes. The expense and technical difficulty involved in recovering plutonium from MOX or immobilized waste should make such recovery prohibitive. [1] As the discussions for a potential agreement to secure plutonium were underway, the usefulness of such an agreement came under question. Given the huge amounts of plutonium that exist, what was the real benefit of safeguarding the 50 metric tons that these countries declared in excess of their weapon needs?[2] It seemed like a drop in the ocean. On the other hand, setting in motion an institutional apparatus for the withdrawal and permanent disposition of plutonium not needed for military purposes could be seen as a breakthrough. Knowing that there is an institution in place for the safe and proven withdrawal of plutonium states may have fewer qualms about withdrawing even more plutonium.

The Plutonium Disposition Agreement

The Plutonium Disposition Agreement was signed eventually on September 1, 2000.[3] The purpose of the agreement is to ensure that plutonium is not to be readily available for use after its retirement from military arsenals. This was to be accomplished in two ways:

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[1] See Adam Bernstein, Russia: Introduction to Plutonium Disposition, Nov. 21, 1997 available online http://www.nti.org/db/nisprofs/russia/fissmat/plutdisp/dispovr.htm.

[2] Id.

[3] 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, June 4, 2000 [2000 Agreement].

(1) By fabricating mixed oxide (MOX) fuel consisting of plutonium and uranium oxides for use in MOX reactors or light water reactors;
(2) By immobilizing plutonium at low concentrations with high-level radioactive waste in glass or ceramic forms. [4] The immobilization technique is ideal for creating large and highly radioactive objects that are difficult to steal.

Both the MOX fuel method and the immobilization method make difficult the recovery of plutonium for military purposes. It must be underlined that these methods do not destroy plutonium but simply increase the costs of its recovery. Nuclear materials are considered not separable from other radioactive materials when they have a total external radiation dose rate in excess of 100 rem per hour at a distance of three feet. In this case they are declared self-protected because retrieving them will require extra measures to protect oneself from the radiation. Based on this criterion, immobilized plutonium should remain self-protected for about one hundred to two hundred years. On the other hand, a 100-200 rem dose is rarely fatal. Some terrorists may be willing to receive a dose at this level to achieve their objectives.[5]

The plutonium disposition agreement provides that the United States and Russia are to dispose 68 metric tons of weapons-grade plutonium (34 each), that is enough material to make approximately 17 000 nuclear weapons. This disposition will be accomplished by using the plutonium as MOX fuel in reactors or by immobilizing it with high-level radioactive waste or by any other method agreed by the state parties in writing.[6] Each state undertakes to dispose of no less than two metric tons of plutonium per year by completing the construction and beginning the operation of facilities designated in the agreement no later than December 31, 2007.[7] State parties undertake also to double their disposition rate at the earliest practicable date based on a detailed action plan that could include cooperation with other countries.[8] The United States should make available to Russia $200 million for the activities undertaken by Russia to fulfill its obligations under the agreement[9]— an amount that was not sufficient eventually to jumpstart the Russian disposition program. At the time of the conclusion of the agreement, the Russian program was estimated at over $1.7 billion for a twenty-year period while the United States

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[4] Art III, id.
[5] See Panel on Reactor-Related Options for the Disposition of Excess Weapons Plutonium of National Research Council, Management and Disposition of Excess Weapons Plutonium: Reactor-Related Options, at 47, n. 23 (1995). See also The Physics Department at Idaho State University available online http://www.physics.isu.edu/radinf/risk.htm. At doses up to 100 rem, the cells might not be able to repair the damage and may be changed permanently or die. This is the origin of increased risk of cancer because of radiation exposure. At doses higher than100 rem, one may experience radiation sickness. Radiation sickness is the result of the damage to the intestinal lining so that it cannot perform the basic functions of water intake and nutrients intake. This leads to nausea, diarrhea and general weakness. With doses more than 300 rem, the immune system is damaged. With doses near 400 rem, about 50 percent of the people are expected to die within 60 days after the exposure mostly because of infections.
[6] Art. III, 2000 Agreement, supra note 3. While the United States intends to use 25.5 tons as fuel and to immobilize 8.5 tons Russia intends to use all 34 metric tons as fuel. See Annex on Quantities, Forms, Locations, and Methods of Disposition, id.
[7] Art. IV(2), id.
[8] Art. V(1), id. Article VII and the Annex on Monitoring and Inspections provide details on the inspection and monitoring efforts to be undertaken by the parties. Id.
[9] Art. IX, id.

program (that included both immobilization and the production of MOX fuel) was estimated at $4 billion. [10]

The agreement terminates on the date the states exchange notes confirming that 34 metric tons of plutonium has been disposed of by each of them in compliance with the agreement. Any other plutonium declared in the future as in excess of defense needs could be disposed of under the conditions specified in the agreement.[11] The states designate an Executive Agency for the implementation of the agreement -- the United States Department of Energy (DOE) and the Russian Ministry of Atomic Energy.[12] The Joint Consultative Commission, established under the agreement, will resolve questions about the implementation of the agreement and will consider additional matters necessary to improve the viability and effectiveness of the agreement.[13]

Implementation

Going from words to deeds has not been easy. Russia has yet to engage in the projects it undertook to complete based on the agreement. Russia, when it signed the agreement, did not have large MOX reactors and did not have the means to manufacture MOX fuel. Assuming that MOX fuel could be used in light-water reactors, those reactors would have to undergo technical modifications. Because technological and financial assistance was not forthcoming from the United States and other countries,[14] Russia suspended the plutonium disposition agreement on June 11, 2003. The United States is continuing with its own plutonium disposition program.

The United States plutonium disposition program is supported by the Office of Fissile Materials Disposition within the National Nuclear Security Administration (NNSA) and has three components the Pit Disassembly and Conversion Facility (PDCF) Project, the domestic Mixed Oxide (MOX) Fuel Project, and support for Russian MOX Fuel Project.[15]

- The purpose of the PDCF facility, located at the Savannah River site, is to dismantle pits -- nuclear warhead components containing weapons grade plutonium. After the plutonium is separated an oxide form of plutonium is produced to be used by the MOX Fuel Fabrication Facility (FFF) to make MOX fuel.[16]
- The MOX Fuel Project (MOX FFF) fabricates MOX fuel so that it can be used in commercial light water reactors.[17] The MOX FFF will use the plutonium oxide produced by the PDCF, blend it with commercial uranium oxide to develop the MOX fuel appropriate for commercial reactors.

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[10] Elena Sokova, Plutonium Disposition, July 2002, available online http://www.nti.org/e_research/e3_11a.html.
[11] Art. XIII(4), 2000 Agreement, supra note 3.
[12] Art. XI(1), id.
[13] Art. XII, id.
[14] Germany had signed a trilateral agreement with Russia and France on Russian plutonium disposition that it decided not to renew after its expiration in 2002. See Russia: Archived Plutonium Disposition Developments (1997-2003), NTI available online http://www.nti.org/db/nisprofs/russia/fissmat/plutdisp/plutdevs.htm.
[15] See United States National Nuclear Security Administration http://nnsa.energy.gov/nuclear_nonproliferation/plutonium_disposition.htm.
[16] Id.

[17] The plan is to construct the facility at the Savannah River site. See United States Department of Energy (DOE) available online http://www.ch.doe.gov/html/buttons/programs.htm.

The MOX FFF may be stopped in its tracks eventually. Efforts to convince utilities to use MOX fuel have not produced much positive feedback. Commercial reactors need stable fuel supplies. Such stable supplies are not necessarily guaranteed the way the plutonium disposition program is designed. The burning of MOX fuel in commercial reactors does not enjoy the support of the NGO community and environmental organizations have expressed opposition to such a program. The fact that the plutonium program is linked with the Russian program through a bilateral treaty generates more uncertainty about its future.

The Russian MOX Project is an adaptation of the design of the United States MOX FFF oriented to help Russia implement the plutonium disposition agreement. The idea is to replicate the United States MOX FFF design by adapting it to account for differences in environmental conditions and regulatory requirements in Russia.[18] In 2010 the United States and Russia signed a Protocol to the Plutonium Disposition Agreement hoping to revive the agreement.[19] Whether this protocol will revitalize the Russian disposition program remains to be seen.

The 2010 Protocol to the Plutonium Disposition Agreement

The 2010 protocol[20] has mandated a number of changes to the 2000 agreement. The United States abandons the immobilization method of plutonium disposition and concentrates solely on the MOX option. According to article III of the agreement the United States is to dispose its 34 metric tons of plutonium in light water reactors while Russia is to use its BN-600 fast reactor and its BN-800 fast reactor to dispose its 34 metric tons of plutonium. The agreement is more flexible in that it allows the states to achieve a disposition rate "of no less than 1.3 metric tons per year"[21] and to increase the disposition rate "to the extent practicable."[22] The government of the United States is to make available to Russia $400 million for the activities undertaken by Russia for the execution of the agreement.[23] The United States plans to complete its Mixed Oxide Fuel Fabrication Facility in 2016 and to begin the disposition of plutonium the four light water reactors in 2018.[24] Russia plans to finish the construction of the BN-800 in 2013 the latest and the completion of the modification of the BN-600 (so that it can use MOX fuel) in 2014 the latest.[25] It targets to finish the construction of the facility for the fabrication of MOX fuel that would be used in the BN reactors in 2012 the latest.[26] While this makes the Russian program look more accelerated than the US program, the disposition of plutonium is targeted to begin in

[18] Id.
[19] Signing of the Plutonium Disposition Protocol, Press Release, United States Department of State, Apr. 13, 2010 available online http://www.state.gov/secretary/rm/2010/04/140120.htm.
[20] 2010 Protocol to Plutonium Disposition Agreement, Apr. 13, 2010 [hereinafter 2010 Protocol].
[21] Compare art. IV of 2010 Protocol with art. IV of 2000 Agreement which required parties to "dispose of no less than two (2) metric tones per year."
[22] Compare art. V(1) of 2010 Protocol with art. V(1) of 2000 Agreement which required parties to develop a detailed action plan to at least double the disposition rate at the earliest practicable date.
[23] Art. IX, 2010 Protocol, supra note 20.
[24] Annex on Key Program Elements, id.
[25] Id.
[26] Id.

2018.[27] It is estimated that it would take 20-25 years to dispose of the 34 metric tons of plutonium.[28]

While each party is responsible for "ensuring safety and ecological soundness of disposition plutonium activities"[29] critics have argued that the immobilization is a less expensive and safer means for the disposition of plutonium. This is especially because the MOX option does not guarantee that fuel produced using MOX reactors will not be used again for the construction of nuclear weapons. Because of this risk, the 2010 protocol includes additional provisions that would prevent weaponization of plutonium fuel.[30]

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The plutonium disposition agreement and associated 2010 protocol demonstrates that the stumbling blocks to disarmament have to do not only with the lack of will of those who would rather not disarm but also with the practical difficulties of verification and the question of what to do with the radioactive materials that come out of nuclear weapons programs.

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[27] Id.

[28] Elena Sokova, Plutonium Disposition, Sept. 16, 2010 available online http://www.nti.org/e_research/e3_plutonium_disposition.html.

[29] See Art. VII(1)(a), 2000 Agreement and 2010 Protocol, supra notes 3 and 20.

[30] For instance it is provided that the " radial blanket of the BN-600 reactor will be completely removed before disposition of conversion product begins in it, and the BN-800 will be operated with a breeding ratio of less than one for the entire term of this Agreement." See art. III(3), 2010 Protocol, supra note 20. See also art. VI (3)-(4), id.