TREATMENT OF PRE-EXISTING FISSILE MATERIAL STOCKS IN A FISSILE MATERIAL (CUTOFF) TREATY[1]

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ABSTRACT

An FM(C)T would prohibit production of fissile materials for weapons and be verified by placing under International Atomic Energy Agency (IAEA) safeguards all highly-enriched uranium (HEU) and plutonium produced in a weapon state after the treaty comes into force for that state. Disagreement persists, however, about whether some pre-existing stockpiles of fissile materials in nuclear-weapon states also should come under IAEA safeguards. These stocks fall into four categories: 1) In nuclear weapons and reserved for nuclear weapons and nuclear-weapon R&D (we do not suggest that these materials be placed under safeguards) ; 2) Weapon materials declared excess for military purposes; 3) In the fuel cycles of civilian reactors; and 4) HEU stockpiled for or in the fuel cycles of naval-propulsion and other military reactors.

While the Conference on Disarmament (CD) has yet to start talks on an FM(C)T, the five Nonproliferation Treaty (NPT) weapon states reportedly have agreed on an initial position that the FM(C)T should not apply international safeguards to pre-existing non-weapon stocks because that could complicate the negotiations. Key non-weapon states probably will remind the NPT weapon states, however, of their commitment at the 2000 NPT Review Conference to "place as soon as practicable fissile material designated as no longer required for military purposes under IAEA or other relevant international verification arrangements." It is also relevant that the launch of negotiations at the CD has been blocked for an extended period by Pakistan, citing concerns that India might convert into weapons its large stockpile of unsafeguarded separated civilian plutonium.[2]

In fact, placing most pre-existing stocks under safeguards would not greatly increase the verification costs of an FM(C)T. The technical complexities mostly have already been addressed in: IAEA safeguards in non-weapon states, U.S. monitoring of the blend-down of excess Russian HEU, IAEA monitoring of the blend-down of some U.S. excess HEU, and the IAEA-Russian-U.S. "Trilateral Initiative," which developed techniques for nonintrusive IAEA monitoring of stored plutonium weapon components. The remaining major substantive issue concerns verification of the non-weapon use of HEU in naval fuel cycles--but this problem relates equally to new production and pre-existing stocks and will therefore have to be addressed in the treaty.

INTRODUCTION: THE STOCKPILES

All parties to the forthcoming CD negotiations agree that an FM(C)T should prohibit any further production of fissile materials for weapons. It also is expected that the treaty will permit production under safeguards of fissile materials for non-weapon purposes. This includes separating plutonium for use in civilian nuclear-power programs and producing HEU to fuel reactors for nuclear-powered submarines and ships. There is disagreement, however, about whether *any* pre-existing stockpiles of fissile materials in the NPT weapon states and non-NPT states (collectively henceforth, the nuclear-armed states) should be placed under international safeguards.

Pre-existing stocks can be divided according to whether the fissile materials are:

- *In the nuclear-weapon sector.* HEU and plutonium in: assembled nuclear weapons, separated weapon components in storage, component-production and weapon R&D facilities or otherwise being held for weapon-program purposes;
- *Weapon-origin fissile material declared excess to any military purpose.* Excess weapon HEU and plutonium committed for use in fuel in civilian reactors or disposition in another manner;
- *Civilian.* HEU used or reserved to fuel civilian research-reactors or Russia's nuclear-powered icebreakers, or for other civilian purposes;[3] and plutonium separated from power-reactor fuel and reserved for future use in civilian power-reactor fuel or another method of disposition; and
- *For military, non-explosive uses.* HEU used in or reserved to fuel naval-propulsion and tritium-production reactors.[4]

Figures 1a and 1b show approximate values for these stocks, based on government declarations when they exist and nongovernmental estimates otherwise.[5] The totals for the nuclear-armed states are summarized in Table 1.

Table 1. Approximate global stocks of fissile material held by the nuclear-armed states by category of use (metric tons)

	Separated plutonium	Separated HEU
Weapon programs (end 2009)	160	900
Declared excess for military purposes (end 2009)	90	260
Civilian programs (end 2008)	180	70
Military reactor fuel (end 2009)	0	230
TOTALS	430	1460

Measured in weapon equivalents, the quantities of weapon-usable fissile material outside the weapon programs are huge. The HEU stocks translate to the equivalent of about 20,000 and the plutonium stocks translate to about 45,000 nuclear weapons, assuming 25 kg of weapon-grade uranium and 4 or 8 kg of weapon or civilian plutonium respectively for a nuclear weapon.[6] It is to be hoped that large quantities of additional weapons materials will be declared excess as nuclear arsenal reductions proceed. The estimated sizes of the global plutonium and HEU weapon stocks are each still sufficient for about 40,000 fission weapons.

Although, under current conditions, there is little likelihood that much of the material in the pre-existing non-weapon stocks will be converted to weapon use, the reason to subject these stocks to international monitoring in an FM(C)T is to lock this situation in. This is the same rationale for safeguards under the NPT where non-weapon states accept international monitoring to assure that their nuclear materials remain in non-weapon use.

International monitoring of the non-weapon fissile-material stocks in the weapon states also would strengthen international confidence that their nuclear-weapon-stockpile reductions are irreversible. Nuclear disarmament would be reversible if the huge stockpiles of pre-existing civilian, excess-weapon, and naval materials were available for weapon manufacture.

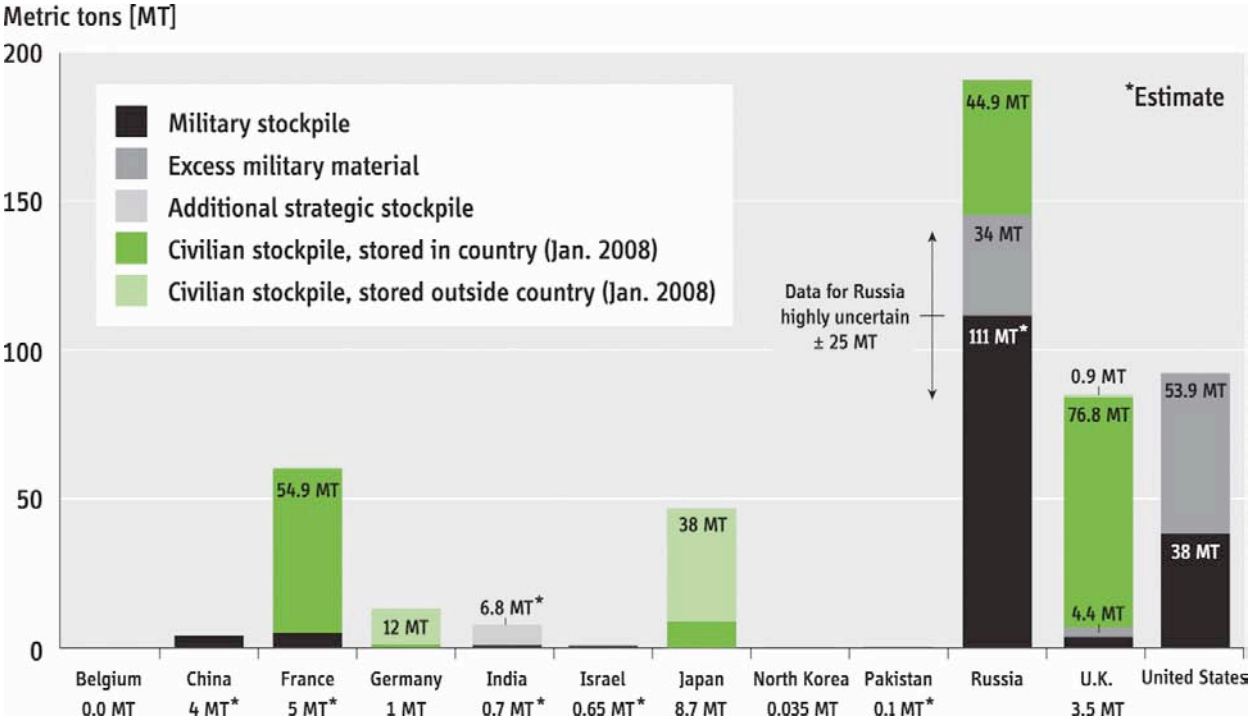

Figure 1a. Global stocks of separated plutonium as of mid-2009.

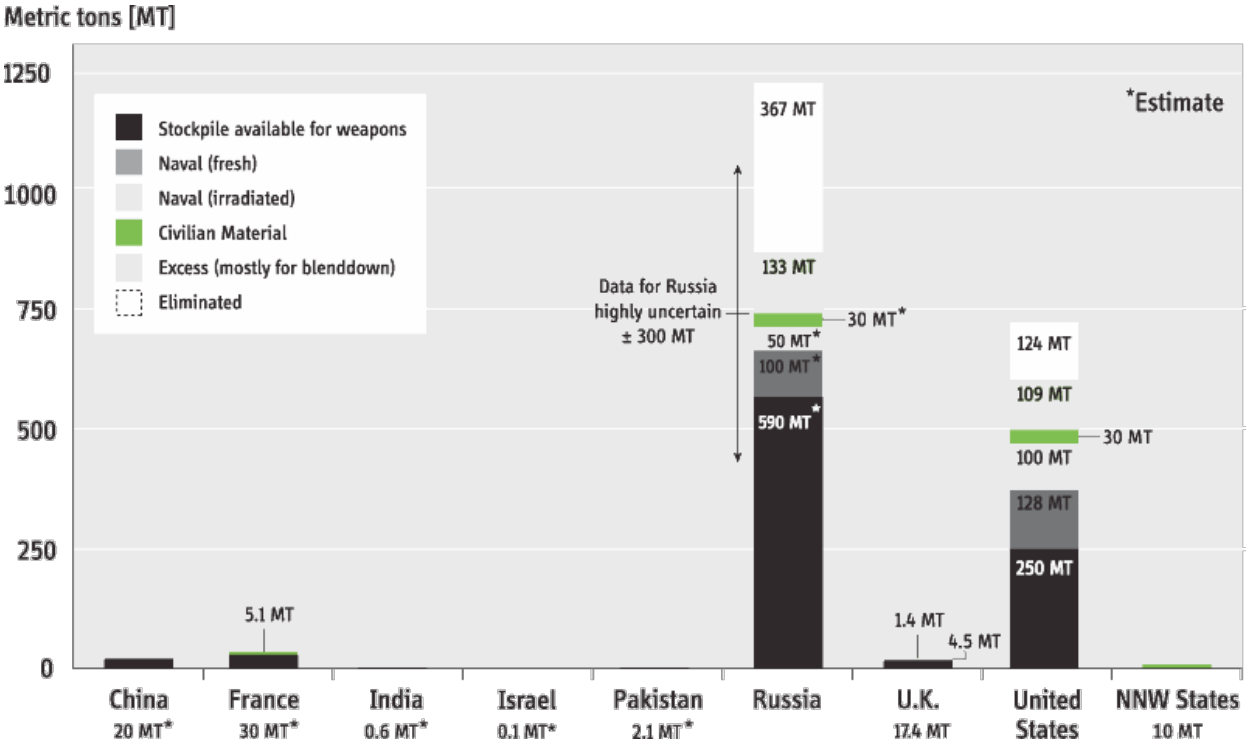

Figure 1b. Global stocks of HEU as of mid-2009.

WEAPON-STATE COMMITMENTS ON NON-WEAPON STOCKS

The importance of irreversibility in disarmament was agreed to in the final document of the NPT 2000 Review Conference, where commitments were made:[7]

> "by all [NPT] nuclear-weapon States to place, as soon as practicable, fissile material designated by each of them as no longer required for military purposes under IAEA or other relevant international verification and arrangements for the disposition of such material for peaceful purposes, to ensure that such material remains permanently outside of military programmes."

In the 2010 NPR Review Conference Final Declaration, the nuclear-weapon states were "encouraged" to follow through on this commitment.[8]

Russia and the United States account for about 98 percent of the weapon-state stockpile of non-weapon HEU and about half of the global stockpile of non-weapon separated plutonium. It is therefore significant that, in 1995, the two countries committed that:[9]

> "Fissile materials removed from nuclear weapons being eliminated and excess to national security requirements will not be used to manufacture nuclear weapons…
>
> "Fissile materials from or within civil nuclear programs will not be used to manufacture nuclear weapons."

A year later, at the Moscow Nuclear Safety Summit, the leaders of the other G8 states, including France and the UK, joined the Presidents of Russia and the United States in the following statement:[10]

> "We pledge our support for efforts to ensure that all sensitive nuclear material (separated plutonium and highly enriched uranium) designated as not intended for use for meeting defence requirements is safely stored, protected *and placed under I.A.E.A. safeguards* (in the Nuclear Weapon States, under the relevant voluntary offer I.A.E.A.-safeguards agreements) as soon as it is practicable to do so" [emphasis added].

Nevertheless, today, fourteen years later, the NPT nuclear-weapon state appear to believe that including the issue of pre-existing stocks in the FM(C)T negotiations would delay the treaty coming into force and make verification intrusive and difficult. Even the recent report of the International Commission on Nuclear Proliferation and Disarmament (ICNND) accepted this argument, stating that:[11]

> "The difficulty of making the treatment of stocks a formal part of the treaty negotiations now starting – such that the objective would, in effect, be an "FMT" (Fissile Material Treaty) rather than an FMCT – is that this would be a far more complicated exercise, needing altogether more intrusive and sensitive verification arrangements, involving close scrutiny of military facilities."

SAFEGUARD CHALLENGES FOR PRE-EXISTING NON-WEAPON STOCKS

The purpose here is to clarify some misunderstandings relating to safeguarding pre-existing stocks of fissile materials in an FM(C)T. In particular, we make the following points:

- An FM(C)T that placed only civilian, excess and naval stocks under IAEA safeguards would, by definition, not constrain the weapon use of materials already in weapons or reserved for weapons or weapons R&D;
- The placement under safeguards of pre-existing civilian stocks of fissile material would simply apply to the civilian sectors of the weapon states the same safeguards that are applied in the non-weapon states;

- The placement under safeguards of weapon-origin fissile materials that nuclear weapon states have declared excess, after the materials have been reduced to unclassified forms, would not require IAEA monitoring beyond that required for the monitoring of civilian stocks; and
- Arrangements developed to monitor HEU newly produced for naval-reactor fuel could equally well be applied to pre-existing stocks reserved for this purpose.

An FM(C)T that placed civilian, excess and naval stocks under IAEA safeguards would not constrain the use of materials already in weapons or reserved for weapon purposes. This would seem obvious. As the ICNND statement quoted above illustrates, however, when "pre-existing" stocks are referred to, many assume that *all* pre-existing stocks, including weapon stocks are being put on the table. For some proposals, this may be true but it is not for the IPFM Draft Fissile Material (Cutoff Treaty).[12]

The inclusion of pre-existing civilian stocks of fissile material would simply apply to the civilian sectors of the weapon states the same safeguards that are applied in the non-weapon states. Even in the absence of an FM(C)T, several nuclear weapon states have already accepted, either in practice or in principle, Euratom or IAEA safeguards on their civilian stocks:

- France and the U.K. have accepted Euratom safeguards on their civilian fissile materials, including, as the end of 2008, stocks of 56 and 82 tons of separated civilian plutonium respectively;[13] and
- The U.S., U.K., France, Soviet Union/Russia and China have all made voluntary offers to allow IAEA safeguards "on source or special fissionable material [in peaceful nuclear facilities] to be designated by those governments." The U.S. voluntary offer is the most expansive of these, covering all civilian nuclear activities and materials.[14] Because of severe limitations on its resources and the priority it gives to safeguards in the non-weapon states, however, the IAEA has taken advantage of the offers from the weapon states only when it would broaden its inspectors' experience base.

Under any verified FM(C)T, all future production of fissile material for weapons would be banned. This would require IAEA safeguards on spent-fuel-reprocessing and uranium-enrichment plants. It would also require safeguards to follow any fissile material newly produced at these facilities. This would result in IAEA safeguards on mixed-oxide (MOX, uranium-plutonium) fuel-fabrication plants during their fabrication of fuel containing plutonium produced after the FM(C)T comes into force. Safeguards on reprocessing plants in the weapon states probably would dominate the safeguards burden of the FM(C)T in the NPT weapon states and non-NPT states.[15]

If safeguards were *not* applied to pre-existing civilian plutonium, the IAEA would face the complication of having to distinguish two classes of plutonium at MOX-fuel-fabrication facilities and MOX-fuelled reactors in the nuclear-armed states after the FM(C)T comes into force: pre-existing unsafeguarded, and newly produced safeguarded.[16]

As long as military and civilian nuclear activities are segregated in different facilities, subjecting civilian fissile materials to IAEA monitoring would not require access to military nuclear sites.

In Russia and the United States, at least, applying IAEA safeguards to civilian fissile materials would require countries to segregate civilian and naval HEU fuel production that currently take place in the same sites. This overlap is decreasing, however, as civilian HEU-fueled reactors are shut down or converted to low-enriched fuel.

The inclusion of weapon-origin fissile materials that nuclear weapon states have declared excess would not require IAEA monitoring beyond that required for the monitoring of civilian stocks after the materials have been reduced to unclassified forms. Russia and the U.S. have each declared excess to their future military needs hundreds of tons of fissile material from Cold War weapons. In 2000, in their "Agreement…Concerning the Management and Disposition of Plutonium Designated as no Longer Required for Defense Purposes," Russia and the U.S. committed to:[17]

> "begin consultations with the International Atomic Energy Agency (IAEA) at an early date and undertake all other necessary steps to conclude appropriate agreements with the IAEA to allow it to implement verification measures beginning not later in the disposition process than: (a) when disposition plutonium or disposition plutonium mixed with blend stock is placed into the post-processing storage location of a conversion or conversion/blending facility; or (b) when disposition plutonium is received at a fuel fabrication or an immobilization facility, whichever (a) or (b) occurs first for any given disposition plutonium."

In effect, this is a commitment to subject the disposition of excess weapon plutonium to IAEA safeguards once the plutonium is in unclassified form. Russia and the United States also have a bilateral transparency agreement in the "HEU Deal" under which the U.S. is purchasing 500 tons of excess Russian weapon-grade HEU after it is blended down to LEU:[18]

> "In order to ensure that the objectives of the Agreement are fulfilled, the Parties shall implement transparency and access measures to guarantee, inter alia: that the HEU subject to the Agreement is extracted from nuclear weapons and that this same HEU enters the oxidation facility and is oxidized therein; that the declared quantity of HEU is blended down to low-enriched uranium (LEU); and, that the LEU delivered to the [U.S.] is fabricated into fuel for commercial nuclear reactors."

The IAEA could be made a party to this transparency agreement at the latest at the blend-down point. In fact, the United States invited the IAEA to verify the blend-down to LEU of 13 tons of its excess HEU at the Portsmouth enrichment plant and 50 tons of HEU at the BWXT plant in Lynchburg, VA where the U.S. produces naval and research reactor HEU fuel. [19]

Furthermore, in 1996, Russia and the U.S. joined with the IAEA in launching a "Trilateral Initiative" "concerning the application of IAEA verification of weapon origin fissile materials" even before they had been reduced to unclassified form. The effort was a technical success but the two countries lost interest after Presidents Bush and Putin succeeded Presidents Clinton and Yeltsin respectively.[20]

Safeguards developed to monitor HEU newly produced for naval-reactor fuel could equally well be applied to pre-existing stocks reserved for this purpose. The United States is the only country that has publicly declared a separate stockpile of HEU for naval reactor fuel: about 128 tons of weapon-grade HEU.[21] This stockpile alone would suffice to supply the current needs of the U.S. nuclear navy for about 60 years.[22] Russia probably has a comparable reserve for future naval-reactor use. France has shifted to LEU fuel for its naval reactors and China reportedly also uses LEU. India is believed to use HEU in its prototype submarine propulsion reactor and currently does not have a large HEU stockpile.

Under an FM(C)T, freshly produced HEU for naval reactors will have to be subjected to international monitoring to ensure that it is not diverted to weapon use. For several decades, however, pre-existing stocks of HEU reserved for naval-reactor use will constitute a potential source of weapon-grade material that could be diverted to weapons. This diversion potential

from naval HEU reserves will loom increasingly large as the U.S., Russia and eventually the other nuclear armed states draw down their nuclear-weapon arsenals and dispose of their excess fissile materials. The current U.S. naval HEU stockpile is sufficient by itself to produce 5,000 nuclear warheads. Disarmament therefore would be stabilized by shifting naval reactors from HEU to LEU fuel, which would make it possible to shrink the global naval HEU stockpile in parallel with the nuclear-weapon HEU stockpile.

In the meantime, monitoring of the naval HEU reserves will be helpful. This would be easiest to do once the naval HEU reserves were in unclassified form – although nonintrusive monitoring of excess HEU components in sealed canisters might also be developed as was the case for excess plutonium components in the Trilateral Initiative.

If international monitoring of naval HEU stockpiles were agreed, then, when HEU is required to fabricate new naval-reactor cores, a country would have to declare to the IAEA the amount of HEU that it required for the purpose. This would require countries to be willing to declare to the IAEA the quantities of HEU in specific cores. Although some countries currently classify this information, revealing it would not reveal sensitive performance characteristics. The verification challenge would be to be able to determine non-intrusively that all the HEU metered out for naval fuel use ended up in fabricated reactor fuel and production waste and that the fuel was installed and sealed into naval reactor pressure vessels.[23]

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1. States that prefer a treaty in which safeguards apply only to fissile material produced after the treaty comes into force refer to it as a "Fissile Material Cutoff Treaty." Some states that would like the treaty to place some pre-existing stocks under safeguards call it a "Fissile Material Treaty." Our use of FM(C)T reflects both options.

2. Zia Mian and A.H. Nayyar, "Playing the Nuclear Game: Pakistan and the Fissile Material Cutoff Treaty," *Arms Control Today*, April 2010, www.armscontrol.org/act/2010_04/Mian.

3. A small amount of HEU is used in neutron targets to produce medical isotopes. Within a decade, HEU used for this purpose should have been replaced by low-enriched uranium.

4. Tritium is used in nuclear weapons as a fusion fuel. It is made by neutron capture in reactors.

5. "Nuclear weapon and fissile material stocks and production" in *Global Fissile Material Report 2009,* chapter 1, http://www.fissilematerials .org

6. For modern warheads see *Management and Disposition of Excess Weapons Plutonium*; Washington, D.C., National Academy Press, 1994, p. 19, note 2. The IAEA assumes that 25 kg of U-235 in HEU or 8 kg of plutonium are sufficient to make a first-generation nuclear weapon, including losses, *IAEA Safeguards Glossary*, 2001.

7. *2000 NPT Review Conference Final Document*, "Article VI and Preambular Paragraphs 8 to 12," para. 15.10, http://www.armscontrol.org/act/2000_06/docjun.

8. *2010 NPT Review Conference, Draft Final Document,* Action 16, http://www.reachingcriticalwill.org/legal/npt/revcon2010/DraftFinalDocument.pdf

9. "Joint [Summit] Statement on the Transparency and Irreversibility of the Process of Reducing Nuclear Weapons," White House, Office of the Press Secretary, 10 May 1995, http://www.presidency.ucsb.edu/ws/index.php?pid=51341.

10. "Moscow Nuclear Safety and Security Summit Declaration," 20th April 1996, http://www.g7.utoronto.ca/summit/1996moscow/declaration.html.

11. *Eliminating Nuclear Threats: A Practical Agenda for Global Policymakers,* Report of the International Commission on Nuclear Non-proliferation and Disarmament, 2009, para. 12.17.

12. International Panel on Fissile Materials, "A Fissile Material (Cut-Off) Treaty" 15 September, 2009, CD/1878, http://www.fissilematerials.org/ipfm/site_down/fmct-ipfm-sep2009.pdf.

13. IAEA, INFCIRC/549/add5/13 and INFCIRC/549/add8/12 (2009).

14. *Global Fissile Material Report 2007*, chapter 6.

15. The IAEA had 924 facilities under safeguards in the non-weapon states at the end of 2007, IAEA, *Annual Report 2007*, Table A5, but the two operating reprocessing plants in Japan accounted for 20% of the IAEA safeguards budget, Shirley Johnson, *Safeguards at Reprocessing Plants under a Fissile Material (Cutoff) Treaty*, IPFM Research Report #6, 2009, p. 1. Japan is the only non-weapon state with reprocessing plants but five of the nine nuclear-armed states have civilian reprocessing plants: China, France, India, Russia and the U.K.

16. There are a few plutonium-fueled civilian critical assemblies in the weapon states that could escape monitoring in an FMCT focused just on newly separated plutonium, since they do not require makeup plutonium. It is unlikely that new HEU will be made for civilian use.

17. "Agreement between the Government of the United States of America and the Government of the Russian Federation Concerning the Management and Disposition of Plutonium Designated as no Longer Required for Defense Purposes and Related Cooperation," 2000, Article VII.3, http://www.state.gov/documents/organization/18557.pdf.

18. "Memorandum of understanding between the Government of the [U.S.] and the government of [Russia] relating to transparency and additional arrangements concerning the agreement between the government of the [U.S.] and the government of [Russia] concerning the disposition of highly enriched uranium extracted from nuclear weapons," http://www.ipfmlibrary.org/heu93b.pdf.

19 David M. Gordon et al, "IAEA Verification Experiment at the Portsmouth Gaseous Diffusion Plant," Brookhaven National Laboratory, BNL-65714, 1998, http://www.osti.gov/bridge/purl.cover.jsp?purl=/639787-wpGE11/webviewable/; R.Thiele et al, "The SAPPHIRE and 50 MT Projects at BWXT, Lynchburg,VA," IAEA-SM-367/8/01/P, 2001, http://www-pub.iaea.org/MTCD/publications/PDF/SS-2001/PDF%20files/Session%208/Poster%208-01-P.pdf.

20. *Global Fissile Material Report 2008*, chapter 6.

21. "Remarks Prepared for Energy Secretary Sam Bodman," 2005 Carnegie International Nonproliferation Conference, Washington, DC, November 7, 2005, p. 11, http://www.carnegieendowment.org/static/npp/2005conference/presentations/bodman_remarks.pdf. Secretary Bodman originally declared that 160 tons of excess weapon material would be allocated to the naval stockpile but it was estimated more recently that only 128 tons of this material will meet the US Navy's standards, Robert M. George, Department of Energy, Office of Fissile Materials Disposition Program, "U.S. HEU Disposition," International Nuclear Materials Management Annual Meeting, Tucson, July 2009.

22. Ole Reistad and Styrkaar Hustveit, "HEU Fuel Cycle Inventories and Progress on Global Minimization," *Nonproliferation Review* (2008), 15:2, pp. 265-287.

23. *Global Fissile Material Report 2008*, chapter 7.