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Treatment of Pre-existing Fissile Material Stocks in an FM(C)T

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All parties to the forthcoming Conference on Disarmament (CD) negotiations on a Fissile Material (Cut-off) Treaty, or FM(C)T,[1] agree that a treaty should prohibit any further production of fissile materials for weapons once the treaty comes into force. It also is expected that the treaty will permit production under safeguards of fissile materials for non-weapon purposes. This includes separating plutonium for civilian nuclear energy programmes and producing highly enriched uranium (HEU) to fuel reactors for nuclear-powered submarines and ships. There is disagreement, however, about whether *any* pre-existing stockpiles of fissile materials for weapons in the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) nuclear-weapon states and non-NPT 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 currently in assembled nuclear weapons, in weapon components in storage, in process or otherwise being held for weapon programme purposes;
- **Weapon-origin fissile material declared by states as excess to any military purpose**. Excess weapon HEU and plutonium committed for use as fuel in civilian reactors or disposition in such a manner that would require either enrichment or reprocessing or both to reverse;
- **Civilian.** HEU used or reserved to fuel research reactors or Russia's nuclear-powered ice-breakers or for other civilian purposes;[2] plutonium separated from power-reactor fuel and declared to be reserved for future use in civilian power reactors or other disposition; and
- **Military-reactor fuel**. HEU used in or reserved to fuel nuclear-powered naval submarines and ships and tritium-production reactors.[3]

Annex A shows the approximate quantities of these stocks held by the individual NPT nuclear-weapon states and non-NPT states—either based on government declarations or, where governments have not declared stocks, non-governmental

1 Disagreement over the whether the treaty should affect pre-existing stocks is reflected in the name used for the treaty by different states. 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 Cut-off Treaty." Some states that would like the treaty to place some pre-existing stocks under safeguards call it a "Fissile Material Treaty." The International Panel on Fissile Materials' use of FM(C)T reflects both options.

2 A small amount of HEU is used in targets that are irradiated with neutrons to produce medical isotopes. It is expected that, within a decade, this use of HEU will be substituted by low-enriched uranium.

3 Tritium is used in nuclear weapons as a fusion fuel. It is made by neutron capture and has a half-life of about 12 years.

estimates.[4] In round numbers, the total fissile material stocks in these states, in metric tons (t), are as follows:

In weapons programmes	900t HEU and 160t separated plutonium
Declared excess	250t HEU and 90t separated plutonium
In civilian programmes	70t HEU and 180t separated plutonium
In military, non-weapon programmes	380t HEU

In weapon equivalents, the quantity of weapon-usable fissile material outside of weapon stocks is staggering. The HEU stocks translate to the equivalent of over 25,000 nuclear weapons and the plutonium stocks translate to 30,000–60,000 nuclear weapons (assuming 25kg of weapon-grade uranium or 4–8kg of plutonium for a nuclear weapon).

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

International monitoring in the nuclear-weapon states also would strengthen international confidence that their nuclear weapon stockpile reductions are irreversible. Nuclear disarmament would not be irreversible if the huge stockpiles of pre-existing civilian and excess weapon materials were available for weapon manufacture. The importance of irreversibility in disarmament was agreed to in the final document of the NPT 2000 Review Conference where a commitment was made:

> 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 [International Atomic Energy Agency] 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.[5]

Russia and the United States account for more than 95% of the global stockpile of non-weapon HEU and about half of the global stockpile of non-weapon separated plutonium. It is therefore significant that, already in 1995, the two states had committed that:

> 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.[6]

4 See "Nuclear weapon and fissile material stocks and production", in *Global Fissile Material Report 2009*, International Panel on Fissile Materials, 2009, chp. 1.

5 *2000 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons, Final Document*, document NPT/CONF.2000/28 (Parts I and II), p. 15, para. 10.

6 "Joint Statement on the Transparency and Irreversibility of the Process of Reducing Nuclear Weapons", White House, Office of the Press Secretary, 10 May 1995, <www.presidency.ucsb.edu/ws/index.php?pid=51341>.

A year later, at the Moscow Nuclear Safety Summit, the leaders of the other G-8 states, including France and the United Kingdom, joined the Presidents of Russia and the United States in the following statement:

> 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 IAEA safeguards* (in the Nuclear Weapon States, under the relevant voluntary offer IAEA-safeguards agreements) as soon as it is practicable to do so.[7]

Nevertheless, today, the argument is often made that inclusion of pre-existing stocks in the FM(C)T negotiations would complicate negotiations and make verification intrusive and difficult. Even the recent report of the International Commission on Nuclear Proliferation and Disarmament (ICNND) argued that:

> 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.[8]

The purpose of this briefing paper is to clarify some misunderstandings relating to the inclusion of pre-existing stocks of fissile materials in an FM(C)T. In particular, the following points are stressed:

- An FM(C)T that placed civilian, excess and naval stocks under IAEA safeguards need not constrain the use of materials already in weapons or reserved for weapon purposes;
- The inclusion of pre-existing civilian stocks of fissile material would not make IAEA monitoring significantly more difficult, nor would it require access by international inspectors to weapons facilities;
- The inclusion of weapon-origin fissile materials that nuclear-weapon states have declared excess would not involve unprecedented new undertakings by those states, nor involve a significant increase in IAEA monitoring after the materials have been reduced to unclassified forms beyond that required for the monitoring of civilian stocks; and
- Naval stocks of HEU cannot indefinitely be kept out of safeguards under an FM(C)T.

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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 true for the International Panel on Fissile Materials (IPFM) Draft Fissile Material (Cut-off) Treaty.[9]

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7 "Moscow Nuclear Safety and Security Summit Declaration", 20 April 1996, <www.g7.utoronto.ca/summit/1996moscow/declaration.html>, emphasis added.

8 *Eliminating Nuclear Threats: A Practical Agenda for Global Policymakers*, ICNND, 2009, p. 111, para. 12.17.

9 "A Fissile Material (Cut-Off) Treaty: A Treaty Banning the Production of Fissile Materials for Nuclear Weapons

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Even in the absence of an FM(C)T, several nuclear-weapon states have already accepted, either in practice or in principle, international or regional safeguards on their civilian stocks:

- France and the United Kingdom have accepted Euratom safeguards on their civilian fissile materials. As the end of 2007, the two states had declared publicly through the IAEA stocks of 55t and 81t of civilian separated plutonium—enough for about 7,000 and 10,000 nuclear weapons respectively;[10] and
- China, France, Russia/the Soviet Union, the United Kingdom and the United States 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.[11] The US voluntary offer is the most expansive of these.[12] Because of severe limitations on its resources and the priority it gives to safeguards in the non-nuclear-weapon states, however, the IAEA has taken advantage of the offers from the nuclear-weapon states only when the facilities offered were of a type unfamiliar to its inspectors that would broaden their experience base.

Under any verified FM(C)T, all future production of fissile material for weapons would be banned. This would require IAEA safeguards at least on all spent-fuel-reprocessing and uranium-enrichment plants. It would also require safeguards to follow any fissile material 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 nuclear-weapon states probably would dominate the safeguards burden of the FM(C)T in the NPT nuclear-weapon states and non-NPT states.[13]

If safeguards were *not* applied to pre-existing civilian plutonium, states and the IAEA would face the complication at MOX-fuel-fabrication facilities and MOX-fuel-using reactors of having

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or Other Nuclear Explosive Devices", IPFM, 15 September 2009, <www.fissilematerials.org/ipfm/site_down/fmct-ipfm-sep2009.pdf>.

10 *Global Fissile Material Report 2009*, IPFM, 2009, appendix 1C, assuming 8kg of plutonium per nuclear weapon.

11 "International safeguards in the nuclear weapon states", in *Global Fissile Material Report 2007*, IPFM, 2007, chp. 6.

12 Under its voluntary offer to the IAEA, the United States has committed "to permit the Agency to apply safeguards, in accordance with the terms of this Agreement, on all source or special fissionable material in all facilities within the United States, excluding only those facilities associated with activities with direct national security significance to the United States, with a view to enabling the Agency to verify that such material is not withdrawn, except as provided for in this Agreement, from activities in facilities while such material is being safeguarded under this Agreement"; *Agreement of 18 November 1977 Between the United States of America and the Agency for the Application of Safeguards in the United States of America*, IAEA document INFCIRC/288, December 1981, art. 1.

13 The IAEA had 924 facilities under safeguards in the non-nuclear-weapon states at the end of 2007 (see *Annual Report 2007*, IAEA, 2007, p. 88), but the two operating reprocessing plants in Japan accounted for 20% of its safeguards budget; Shirley Johnson, *Safeguards at Reprocessing Plants under a Fissile Material (Cutoff) Treaty*, Research Report no. 6, IPFM, 2009, p. 1. Japan is the only non-nuclear-weapon state with operating reprocessing plants but five of the nine nuclear-weapon and non-NPT states have civlian reprocessing plants: China, France, India, Russia and the United Kingdom.

to keep separate two classes of plutonium after the FM(C)T comes into force: pre-existing unsafeguarded, and newly produced safeguarded.[14]

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 a few cases, applying IAEA safeguards to civilian fissile materials would require states to segregate civilian and non-weapon military nuclear activities that currently take place in the same facilities. For example, in some states, HEU fuel for civilian reactors is produced in the same facilities as HEU fuel for submarines. This overlap is decreasing, however, as civilian HEU-fuelled reactors are shut down or converted to low-enriched uranium (LEU) fuel. By the time that an FM(C)T comes into force, the cost of segregating the fabrication of civilian HEU fuel should not be great.

The inclusion of weapon-origin fissile materials that nuclear-weapon states have declared excess would not involve unprecedented new undertakings by those states, nor involve a significant increase in IAEA monitoring after the materials have been reduced to unclassified forms beyond that required for the monitoring of civilian stocks

Russia and the United States 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 United States committed to:

> 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.[15]

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

> 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

14 The problem of having to segregate pre-existing from new HEU in civilian use is less likely to arise, since it is unlikely that new HEU will be made for civilian use. There are also a few plutonium-fuelled civilian critical assemblies in the nuclear-weapon states that could escape monitoring in an FM(C)T focused just on newly separated plutonium, since they do not require make-up plutonium. That is, unlike power reactors, relatively little plutonium is fissioned in the critical assemblies, and so there is no need for fresh plutonium replacement fuel. But the savings in verification costs would not be great—perhaps a few percent.

15 *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, art. VII.3, <www.state.gov/documents/organization/18557.pdf>.

> 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 LEU; and, that the LEU delivered to the United States of America pursuant to the Agreement is fabricated into fuel for commercial nuclear reactors.[16]

The IAEA could be made a party to this transparency agreement at least at the blend-down point. In fact, the United States invited the IAEA to verify the blend-down to LEU of 13t of excess HEU at the Portsmouth enrichment plant, where it had produced much of its HEU,[17] and 50t of HEU at the BWXT plant in Lynchburg, where the United States produces naval and research reactor HEU fuel.[18]

Furthermore, in 1996, Russia and the United States joined with the IAEA in launching a Trilateral Initiative "concerning the application of IAEA verification of weapon origin fissile materials"[19] even before they had been reduced to unclassified form. The effort was a technical success but the two states lost interest after Presidents Bush and Putin succeeded Presidents Clinton and Yeltsin, respectively.[20]

Naval HEU fuel cycles cannot be kept free of IAEA monitoring indefinitely

The United States is the only state that has publically declared a separate stockpile of HEU for naval reactor fuel: about 128t of weapon-grade HEU.[21] Historically, the United States has supplied HEU for UK naval-propulsion reactors. A substantial UK reserve can be inferred because the United Kingdom has declared 17.4t of military HEU, which is considerably more than would be required to support its declared nuclear arsenal of less than 200 warheads. In any case, the US stockpile alone would suffice to supply the current needs of the US and UK navies for about 60 years.[22] Russia has not publicly declared a separate stockpile of HEU for naval-reactor fuel but probably has a comparable reserve for future naval-reactor use. France has shifted to LEU fuel for its naval reactors. It is not known whether China uses LEU or HEU. 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 some sort of IAEA monitoring to ensure that it is not diverted to weapon use. As indicated above,

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16 *Memorandum of Understanding Between the Government of the United States of America and the Government of the Russian Federation Relating to Transparency and Additional Arrangements Concerning the Agreement Between the United States of America and the Government of the Russian Federation Concerning the Disposition of Highly Enriched Uranium Extracted from Nuclear Weapons*, 1993, p. 8, art. I.2, <www.ipfmlibrary.org/heu93b.pdf>.

17 David M. Gordon et al., "IAEA Verification Experiment at the Portsmouth Gaseous Diffusion Plant", Brookhaven National Laboratory, 1998, <www.osti.gov/bridge/purl.cover.jsp?purl=/639787-wpGE11/webviewable/>.

18 R. Thiele et al., "The SAPPHIRE and 50 MT Projects at BWXT, Lynchburg, VA", IAEA document SM-367/8/01/P, 2001, <www-pub.iaea.org/MTCD/publications/PDF/SS-2001/PDF files/Session 8/Poster 8-01-P.pdf>.

19 "Trilateral Statement to the Press", IAEA document PR 96/19, 17 September 1996.

20 "Weapon-origin Fissile Material: The Trilateral Initiative", in *Global Fissile Material Report 2008*, IPFM, 2008, chp. 6.

21 "Remarks Prepared for Energy Secretary Sam Bodman", 2005 Carnegie International Nonproliferation Conference, Washington DC, 7 November 2005, p. 11, <www.carnegieendowment.org/static/npp/2005conference/presentations/bodman_remarks.pdf>. Bodman originally declared that 160t of excess weapon material would be allocated to the naval stockpile but more recently it was estimated that only 128t 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", 50th Annual Meeting of the Institute of Nuclear Materials Management, Tucson, July 2009.

22 Ole Reistad and Styrkaar Hustveit, "HEU Fuel Cycle Inventories and Progress on Global Minimization", *Nonproliferation Review*, vol. 15, no. 2, 2008, pp. 265–87.

for Russia, the United Kingdom and the United States, such production may not be necessary for several decades.

Nevertheless, during this period, the pre-existing stocks of HEU 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 significant as Russia, the United States and eventually the other nuclear-weapon-possessing states draw down their nuclear-weapon arsenals and dispose of their excess fissile materials. Annex B shows the relative size of current naval HEU reserves to the HEU in weapons if the nuclear-weapon-possessing states move to smaller numbers of nuclear weapons and declare excess the HEU no longer needed for weapons. 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 would be helpful.

This would be easiest to do once the naval HEU reserves were in unclassified form—although non-intrusive 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, when HEU was required to fabricate new naval-reactor cores, a state would have to declare to the IAEA the amount of HEU that it required for the purpose. This would require states to be willing to declare to the IAEA the quantities of HEU in specific cores. Although some states currently classify this information, revealing it would not appear to reveal sensitive performance characteristics, such as the maximum power output of the core or how rapidly the power output can change or how resistant the core would be to damage resulting from the explosions of nearby torpedoes or depth charges. The verification challenge, which has not been completely worked out yet, would be to be able to determine non-intrusively that the fabricated “cores” contained the agreed amount of HEU and that the objects designated as “cores” were installed and sealed into naval reactor pressure vessels.[23]

23 “HEU in the naval-reactor fuel cycle”, *Global Fissile Material Report 2008*, IPFM, 2008, chp. 7.

Annex A. National Stockpiles of Fissile Materials

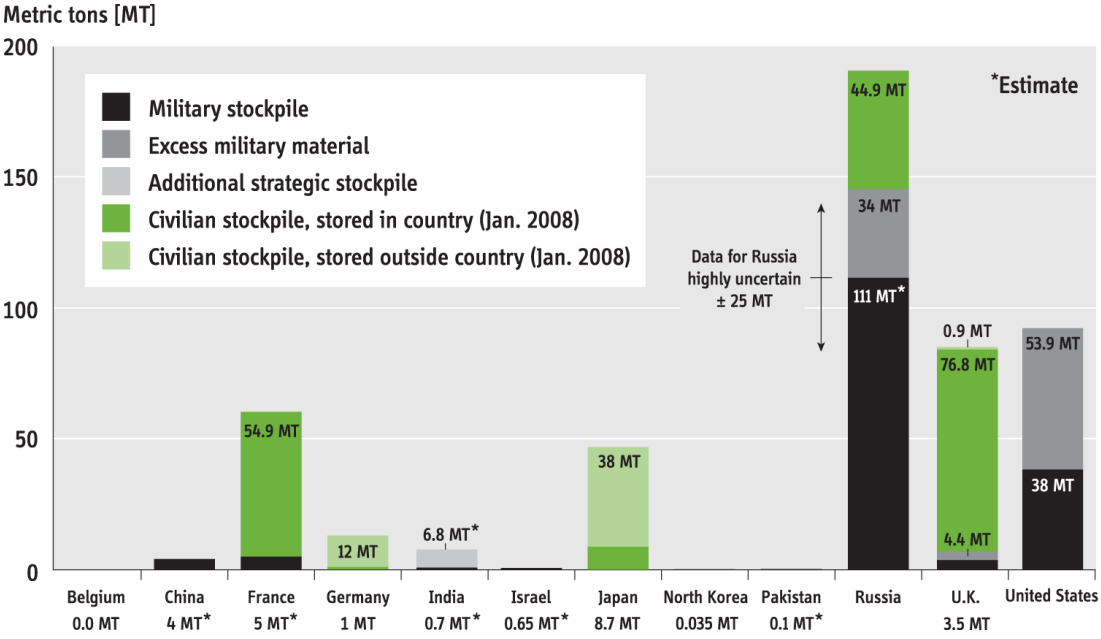

Figure 1. National stocks of separated plutonium

Source: Global Fissile Material Report 2009, *IPFM, 2009, p. 16.*

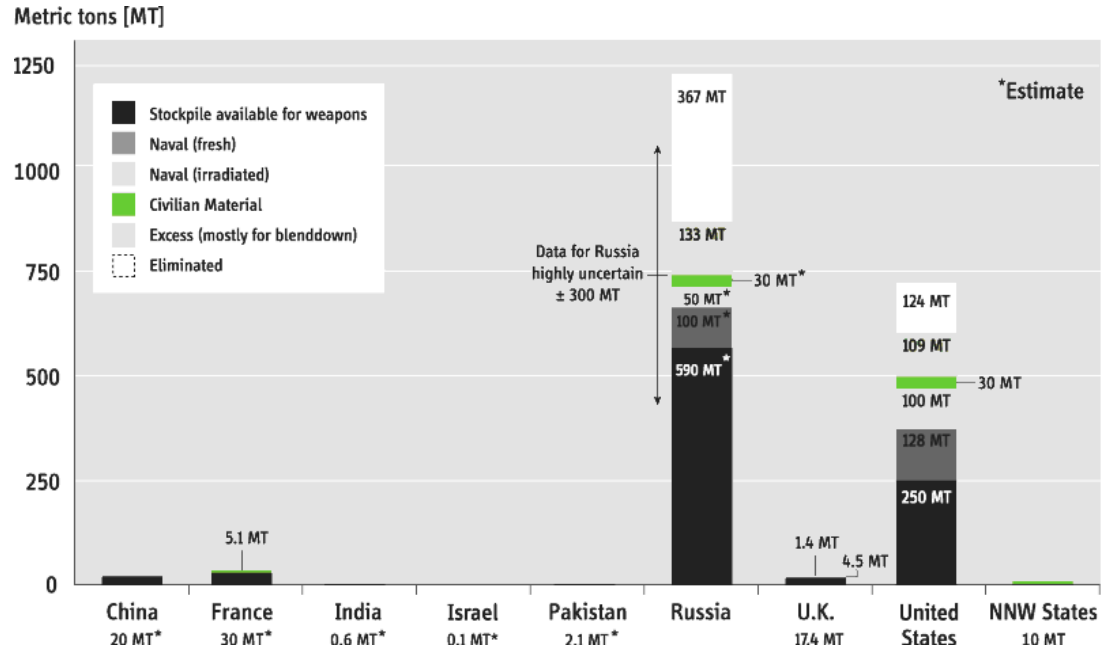

Figure 2. National stocks of HEU as of mid-2009

Source: Global Fissile Material Report 2009, *IPFM, 2009, p. 13.*

Annex B. Fissile material stockpiles in a disarming world

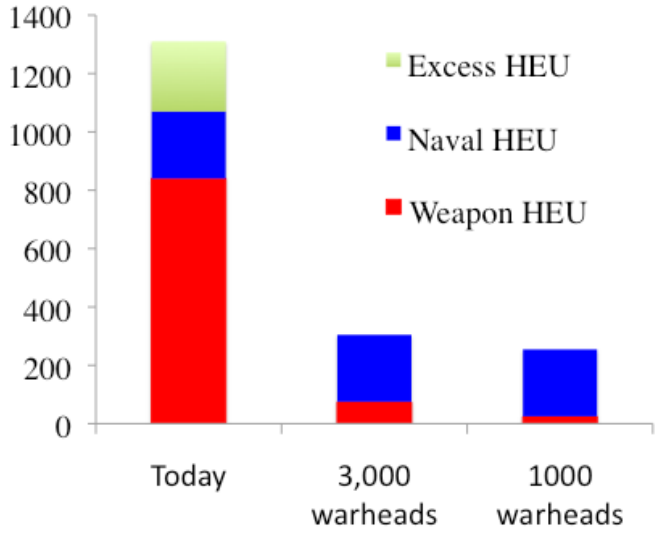

Figure 3. Global stockpiles of HEU in metric tons, today and in the future

The shadow on nuclear disarmament thrown by naval reserves of HEU will grow as the weapon stockpiles are reduced. The amount of weapon-grade HEU in naval use (250t) would be sufficient to make approximately 10,000 nuclear warheads (the vertical axis of the chart represents metric tons).

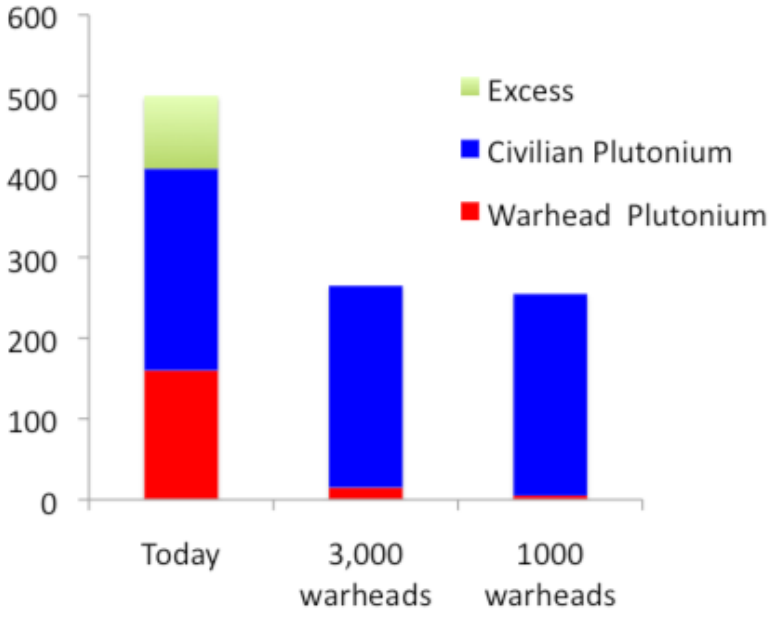

Figure 4. Global stockpiles of plutonium in metric tons, today and in the future

The shadow thrown over nuclear disarmament by today's civilian plutonium stocks would also be huge. The amount of reactor-grade plutonium in civilian use (240t) would be sufficient for 40,000 first-generation Nagasaki-type bombs (the vertical axis of the chart represents metric tons).

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