Increasing Transparency of Nuclear-warhead and Fissile-material Stocks as a Step Toward Disarmament

A Preliminary Set of Proposals by the

International Panel on Fissile Materials*

www.fissilematerials.org

On the occasion of the meeting of the
First Preparatory Committee for the
2015 Nuclear Non-Proliferation Treaty Review Conference

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* The International Panel on Fissile Materials (IPFM), founded in 2006, is an independent group of arms-control and nonproliferation experts from 16 countries, including both nuclear weapon and non-nuclear weapon states. Its mission is to analyze and foster policy initiatives to secure, consolidate, and reduce stockpiles of highly enriched uranium and plutonium, the key ingredients in nuclear weapons, and so further progress towards nuclear weapons disarmament, halting the proliferation of nuclear weapons, and ensuring that terrorists do not acquire nuclear weapons. For more information, see www.fissilematerials.org.

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Summary

The "Action Plan on Nuclear Disarmament" agreed at the 2010 nuclear Non-Proliferation Treaty (NPT) Review Conference affirmed that *"nuclear disarmament and achieving the peace and security of a world without nuclear weapons will require openness and cooperation, and … enhanced confidence through increased transparency and effective verification."*

Progress towards verifiable nuclear disarmament can build on important precedents in openness in recent decades by the NPT nuclear-weapon states. The United States, United Kingdom, Russia and France have declared reductions in their nuclear warhead stockpiles. These four states have formally announced an end to all production of fissile materials – highly enriched uranium (HEU) and plutonium – for weapons, and China has suspended production for more than two decades. All five NPT weapon states have released some information about warhead and fissile material stocks and production, but the information released is uneven in coverage and detail.

The International Panel on Fissile Materials (IPFM) proposes that, as a first step toward further transparency, the NPT nuclear-weapon states publish (and commit to subsequent annual updates):

- The total numbers of nuclear weapons in their arsenals as of a specific recent date;
- Their complete holdings of HEU and plutonium as of a specific recent date; including material held abroad and any foreign-owned material held in-country; and
- The portions of their HEU and plutonium stockpiles available for International Atomic Energy Agency (IAEA) safeguards or monitoring.

The weapon states could make the common baseline declarations proposed here as part of their reports to the 2014 NPT Preparatory Committee on progress in meeting their obligations. Weapon states that are in a position to do so could offer more detailed breakdowns of their warhead and fissile material stocks.

Deeper reductions in existing nuclear warhead and fissile material stockpiles will require still greater transparency to allow for effective verification. To prepare for this step, it would be valuable for the weapon states to commit at the 2015 NPT Review Conference to develop information on the histories of their nuclear warhead and fissile material stockpiles, which could later provide the basis for public declarations. These data could include:

- Total nuclear-warhead stockpiles by year, with the numbers of warheads built, retired and dismantled each year; and 5-year plans for future warhead production, deployment, and disassembly;
- Records of HEU and plutonium production, use and disposition, and of the disposition of related wastes; and

- Descriptions of all shutdown fissile material production facilities, their state of shutdown, and current decommissioning or conversion plans.

By the 2015 NPT Review Conference the weapon states also could commit to place irreversibly under IAEA safeguards their civilian fissile materials and all fissile material declared excess for weapons purposes and to join an effort to ensure that the IAEA has the resources to apply such safeguards.

Development and demonstration of verification approaches for nuclear warhead dismantlement and for determining the completeness of declarations of historic fissile-material production would benefit from cooperative projects among the weapon states. These projects preferably should have IAEA participation, and possibly involve interested non-weapon states. These cooperative projects could include studies of methods for:

- Monitoring chain-of-custody of warheads from deployment or storage to dismantlement;
- Verifying dismantlement of plutonium and HEU weapon components; and
- Safeguarded storage and disposition of HEU and plutonium recovered from weapons.

To facilitate future verification of declarations of fissile material production and disposition, weapon states should commit to:

- Catalogue and preserve operating records and waste materials;
- Give priority to transparency projects at facilities facing decommissioning and for waste materials scheduled for disposal or processing; and
- Offer former production facilities as verification test beds and invite partners with similar facilities to join “site-to-site exercises” in verification techniques.

The set of proposals advanced here are intended for NPT weapon states but could be adopted also by the nuclear-weapon states outside the NPT as part of their contributions to reaching the goal of nuclear disarmament.

Introduction

The "Action Plan on Nuclear Disarmament" agreed at the 2010 nuclear Non-Proliferation Treaty (NPT) Review Conference affirmed *"the need for the nuclear-weapon states to reduce and eliminate all types of their nuclear weapons."*[1] It also was agreed that *"nuclear disarmament and achieving the peace and security of a world without nuclear weapons will require openness and cooperation, and … enhanced confidence through increased transparency and effective verification."*[2]

Under the terms of the Action Plan the NPT nuclear-weapon states agreed further to cooperate with each other and with the broader international community on steps to foster confidence, increase transparency and develop verification capabilities related to nuclear disarmament, to report information that can further openness and verification, and to provide regular reports on progress on such steps.[3] The nuclear-weapon states are expected to report to the Preparatory Committee in 2014 on their progress, with the 2015 Review Conference charged to "take stock and consider the next steps" towards nuclear disarmament.[4]

The five weapon states—China, France, Russia, the United Kingdom and the United States—have met in London (September 2009) and in Paris (June–July 2011) to discuss "issues of transparency and mutual confidence, including nuclear doctrine and capabilities, and of verification."[5] Their next meeting is scheduled for June 2012 in Washington, DC.

NPT non-weapon states and the larger international community have encouraged and supported increased transparency by the weapon states. In some cases, non-weapon states have made specific proposals for transparency measures that could contribute to the disarmament process. For example, at the 2008 NPT Preparatory Committee, Japan suggested categories of information that weapon states might

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[1] For the "Action Plan on Nuclear Disarmament" see *2010 NPT Review Conference Final Document*, Volume 1, New York 2010, pp. 19–21, www.un.org/en/conf/npt/2010.

[2] *Ibid.*

[3] Action 19: *"All States agree on the importance of supporting cooperation among Governments, the United Nations, other international and regional organizations and civil society aimed at increasing confidence, improving transparency and developing efficient verification capabilities related to nuclear disarmament."* Action 20: *"States parties should submit regular reports, within the framework of the strengthened review process for the Treaty, on the implementation of the present action plan …"* Action 21: *"As a confidence-building measure, all the nuclear-weapon States are encouraged to agree as soon as possible on a standard reporting form and to determine appropriate reporting intervals for the purpose of voluntarily providing standard information …"*

[4] Action 5: "*The nuclear-weapon States commit to accelerate concrete progress on the steps leading to nuclear disarmament... [and] are called upon to report … to the Preparatory Committee at 2014.*"

[5] "First P5 Follow-up Meeting to the NPT Review Conference," Statement by the Spokesperson of the Ministry of Foreign and European Affairs, Paris, 1 July 2011, www.franceonu.org/spip.php?article5660.

disclose as part of increased transparency measures.[6] At the 2010 Review Conference, Australia and New Zealand also proposed reporting criteria.[7] Since then, the 10-country Non-Proliferation and Disarmament Initiative (NPDI) has sought to "promote transparency in nuclear disarmament reporting," and to develop "a draft standard nuclear disarmament reporting form."[8] NPDI has presented a model reporting form to the weapon states.

In this memorandum, the International Panel on Fissile Materials (IPFM) lays out at set of options for how NPT nuclear-weapon states could fulfill their transparency commitments through a series of successively more detailed public declarations of the numbers and deployment status of their nuclear warheads and declarations of their fissile material inventories, production, and disposition histories.

Even without immediate verification, an initial set of consistent baseline declarations covering warhead and fissile material inventories would strengthen confidence in the weapon states' commitment to openness and to a verifiable disarmament process. Such declarations, supplemented by reporting of warhead and fissile material production and disposition histories could provide the essential background information required for the negotiation and verification of deep reductions in nuclear arsenals and eventual elimination of nuclear weapons.

In non-nuclear weapon states party to the NPT, all fissile materials are declared by location to the IAEA, although the information is considered "safeguards-confidential" and therefore not made public. These declarations are subject to IAEA verification – including random sampling. In meeting their disarmament commitments, the NPT weapon states eventually also will agree to provide "an initial report on all nuclear material which is to be subject to safeguards." This will require national fissile material accounts covering historical production, utilization and losses in waste. If they have not done so already, weapon states should organize such accounts – and the records and physical data behind them while they are still available.

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[6] This proposal included reporting by the NPT weapon states on: the extent of reduction in nuclear stockpiles; number of reduced nuclear warheads and delivery systems; number of dismantled nuclear warheads and delivery systems, as well as the pace of dismantlement, including the types of dismantled nuclear warheads and delivery systems; aggregate number of nuclear warheads and delivery systems and/or those deployed; years in which the production of fissile material for nuclear weapons was ceased; amount of fissile material declared excess to and removed from nuclear explosive purposes or national security requirements, and plans for its disposition; and plans or intentions for further nuclear disarmament measures. *Working Paper submitted by Japan*, 2008 NPT Preparatory Committee, NPT/CONF.2010/PC.II/WP.10, 28 April 2008.

[7] The criteria included: nuclear doctrine; fissile material policy on production and control; warhead and delivery vehicle numbers; and strategic and tactical reductions. *Working paper submitted by Australia and New Zealand*, 2010 NPT Review Conference, NPT/CONF.20I0/WP.40, 22 April 2010.

[8] *Statement of the Third Ministerial Meeting of the Non-Proliferation and Disarmament Initiative*, New York, 21 September 2011, www.foreignminister.gov.au/releases/2011/kr_mr_110921a.html. NPDI members are Australia, Canada, Chile, Germany, Japan, Mexico, the Netherlands, Poland, Turkey, and the United Arab Emirates.

At present, not all NPT nuclear-weapon states can be expected to be equally forthcoming or able to become more transparent at the same rate. All could agree, however, on first steps that could be part of the report to the Preparatory Committee in 2014 – this would allow their initial declarations to be considered by the 2015 NPT Review Conference and decisions made about future transparency steps. Weapon states making declarations before 2015 that go beyond the minimal first steps suggested here would help demonstrate to the others that even greater openness is possible and that the benefits of such transparency exceed its costs.

Finally, while directed at the NPT nuclear-weapon states, the proposals offered here could be adopted by nuclear-weapon states that are not party to the NPT as part of their contribution to reaching the agreed goal of nuclear disarmament.[9]

[9] The nuclear-weapon states outside the NPT are Israel, India, Pakistan and North Korea. All of these states have expressed support in principle for the goal of global nuclear disarmament. See *Reducing and Eliminating Nuclear Weapons: Country Perspectives on the Challenges to Nuclear Disarmament*, International Panel on Fissile Materials, Princeton, NJ, 2010, www.ipfmlibrary.org/gfmr09cv.pdf.

I. Baseline declarations that could be made by 2015

In the 2010 NPT "Action Plan," the NPT nuclear-weapon states committed "to undertake further efforts to reduce and ultimately eliminate all types of nuclear weapons, deployed and non-deployed."[10] The Action Plan also noted the "increased transparency of some nuclear-weapon States with respect to the number of nuclear weapons in their national inventories" and encouraged "all nuclear-weapon States to provide additional transparency in this regard."[11]

Some of the NPT nuclear-weapon states have released information about the nature, size, and evolution of their nuclear warhead stockpiles, but with widely varying degrees of detail and timeliness. This information has been released unilaterally in public statements or as part of bilateral agreements (such as U.S.-Russian strategic arms limitation agreements). This information has allowed independent analysts to estimate weapon-state warhead and fissile-material stocks and how they have changed over time.[12]

To make their declarations comparable across countries and over time, the weapon states should develop agreed terminology defining nuclear warheads and warhead components, and their deployment, storage, and stages of dismantlement.[13] The United States and Russia have reached agreement on an extensive glossary of terms as part of their bilateral arms control treaties that may offer a starting point.[14]

With or without agreement on terminology, the nuclear-weapon states could begin to make baseline declarations of their stocks and production of nuclear warheads and fissile materials.

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[10] Action 3, p. 20. *2010 NPT Review Conference Final Document*.

[11] Paragraph 94, p. 14. *op. cit*.

[12] See for instance the *Nuclear Weapons Databooks* for the United States, the United Kingdom, Soviet Union, France, and China published by the Natural Resources Defense Council, Washington, DC. Nuclear warhead numbers are tracked in the "Nuclear Notebook" articles by the Federation of American Scientists published in the *Bulletin of Atomic Scientists*. Stockpiles and production of fissile materials have been tracked by IPFM since 2006 in its annual *Global Fissile Material Report*, available at www.fissilematerials.org.

[13] At their June 2011 meeting, the weapon states agreed in Paris "to continue working on an agreed glossary of definitions for key nuclear terms and established a dedicated working group." "First P5 Follow-up Meeting to the NPT Review Conference," Paris, 1 July 2011. Some of the technical issues and the need for agreed definitions are discussed in *Monitoring Nuclear Weapons and Nuclear-Explosive Materials: An Assessment of Methods and Capabilities*, U.S. National Academy of Sciences, Washington, DC, 2005.

[14] An example of a set of agreed definitions can be found in Protocol 1 of the 2010 Treaty between the United States of America and the Russian Federation on Measures for the Further Reduction and Limitation of Strategic Offensive Arms (New-START Treaty), www.state.gov/documents/organization/140047.pdf.

Warhead Stocks

First steps towards greater transparency that could be adopted by the NPT weapon states in advance of the 2015 NPT Review Conference are:

- Baseline declarations of the total numbers of nuclear warheads in their possession as of a specific recent date and subsequent annual updates.

For weapon states willing to do so, these initial declarations could be disaggregated to include numbers of:

- Operational nuclear warheads, deployed warheads (and associated delivery vehicles), and retired warheads awaiting dismantlement; and
- Separated warhead components in storage (fissile-material in the form of "pits" from fission "primaries" and fission-fusion "secondaries").

Most NPT weapon states have already made public some data relating to their nuclear arsenals. In 2010 the United States released at the NPT Review Conference the exact number of its operational warheads as of 30 September 2009 and declared less precisely that, in addition, it had "several thousand" retired warheads awaiting dismantlement.[15] It also made public that, as of June 2010, it had about 14,000 excess and reserve plutonium pits from dismantled warheads in storage.[16]

Under the START (1994–2009) and New-START (since 2011) Treaties, Russia and the United States also have made public some information on their deployed strategic warheads. They continue to release twice each year release information on their total numbers of deployed Intercontinental Ballistic Missiles (ICBMs), Submarine-Launched Ballistic Missiles (SLBMs) and long-range nuclear bombers, along with the total numbers of nuclear warheads actually deployed on ICBMs and SLBMs and counted (1 each) as deployed on their bombers.[17] They share more detailed information on a confidential bilateral basis.[18] The United States publishes this data, while Russia only shares it on a bilateral basis.

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[15] The United States declared 5113 "operational" warheads as of 30 September 2009; see *Increasing Transparency in the U.S. Nuclear Weapons Stockpile*, U.S. Department of Defense Factsheet, 3 May 2010, www.defense.gov/news/d20100503stockpile.pdf.

[16] "Plutonium Pit Storage," *PantexInfo,* June 2010. U.S. plutonium pits are stored at the Pantex Plant in Amarillo, Texas, which is responsible for U.S. nuclear warhead assembly and disassembly and is a designated "interim staging site" pending pit disposition.

[17] The New-START delivery system and warhead numbers for Russia and the United States as of September 1, 2011 can be found at *New START Treaty Aggregate Numbers of Strategic Offensive Arms,* December 2011, www.fas.org/programs/ssp/nukes/armscontrol/NewSTART-USnumbers090111.pdf. The United States publishes more detailed New-START data, while Russia shares its detailed data with the United States but does not make it public.

[18] Protocol to the Treaty Between the United States of America and The Russian Federation on Measures for the Further Reduction and Limitation of Strategic Offensive Arms (New START Treaty, 2011). The additional information includes the number of deployed warheads at each ICBM and SLBM base and, during inspections, the number of reentry vehicles on each ICBM and SLBM on the selected base site. They also share diagrams of facilities at which inspections may be conducted, the

The United Kingdom has detailed the evolution of its nuclear arsenal and delivery systems since 1952 and has declared that it has reduced to fewer than 160 operational nuclear warheads for deployment on its SLBMs.[19] The United Kingdom also has announced plans to reduce its arsenal to not more than 180 total and 120 operational warheads by the mid-2020s.[20]

France in 2005 declared that it has only about 50 SLBMs and 50 nuclear-capable aircraft (with medium-range air-to-surface missiles), with land-based missiles having been phased out, and has reported the total numbers and types of these nuclear-weapon delivery systems for 1985 and 1995.[21] In 2008, France announced that it had "dismantled its ground-to-ground nuclear missiles, … reduced the number of its nuclear-powered ballistic missile submarines by a third … [and] with respect to the airborne component, the number of nuclear weapons, missiles and aircraft will be reduced by one-third" and that "after this reduction, … [the] arsenal will include fewer than 300 nuclear warheads. That is half of the maximum number of warheads we had during the Cold War."[22] France also declared that "it has no other weapons beside those in its operational stockpile."[23]

In 2004, China indicated that its warhead stockpile was smaller than those of the other four NPT weapon states, but has not updated this statement.[24]

Disaggregated declarations of the numbers of warheads and components, as of a specified date and annual updates (for a possible reporting form, see Table 1) would provide an initial snapshot of the state of the arsenal of each NPT weapon state.

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coordinates of ICBM missile silos and missile basing, submarine bases, and ICBM and SLBM and heavy-bomber production, storage, maintenance, loading and elimination sites, along with technical data on the ICBMs, SLBMs and bombers.

[19] *The Future of the UK's Strategic Nuclear Deterrent: the Strategic Context,* UK House of Commons Defence Committee, 20 June 2006. Also *Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review*, UK Government, October 2010.

[20] UK statement at the UN Disarmament Conference delivered on 4 April 2012, http://ukun.fco.gov.uk/en/news/?view=PressS&id=751944882.

[21] *Fighting Proliferation, Promoting Arms Control and Disarmament: France's Contribution*, Government of France, February 2005, www.diplomatie.gouv.fr/fr/IMG/pdf/maitrise_armement.pdf. According to this official report, in 1985, France had about 125 land-based missiles, about 100 nuclear-capable aircraft and just over 50 SLBMs. In 1995, it had about 50 land-based missiles, 75 nuclear-capable aircraft, and just over 50 SLBMs.

[22] Speech by Nicolas Sarkozy, President of the French Republic, Presentation of Le Terrible in Cherbourg, 21 March 2008, www.ipfmlibrary.org/sar08.pdf.

[23] *Ibid.*

[24] China's Foreign Ministry declared in April 2004 that China "possesses the smallest nuclear arsenal" among the nuclear-weapon states of the NPT, *Nuclear Disarmament and Reduction of [sic!],* Ministry of Foreign Affairs of the People's Republic of China, Fact Sheet China, 27 April 2004, www.fmprc.gov.cn, mirrored at www.ipfmlibrary.org/prc04.pdf.

	INVENTORY
Total number of warheads as of [DATE]	
Operationally deployed warheads (strategic)	
Operationally deployed warheads (tactical)	
Warheads in active reserve	
Warheads in inactive reserve (no tritium)	
Retired warheads in dismantlement queue	

Warhead components in storage, primaries	
Warhead components in storage, secondaries	

Table 1. A possible reporting form for nuclear warheads by deployment status. This information could be refined further by warhead type/designation.

Fissile Material Stocks

As part of their baseline declarations, by 2015, NPT nuclear-weapon states also could make public their:

- Total holdings of plutonium and HEU as of a specific recent date.

The United States has made detailed declarations for both its HEU and plutonium stockpiles as of 1996 and 1994 respectively and provided some subsequent updates.[25] These U.S. declarations included the amounts of plutonium and HEU that was received from or transferred to other countries, although the amount of HEU transferred to the United Kingdom under a military cooperation agreement was kept secret.

The United Kingdom, in 1998, revealed its total fissile material stocks.[26] France and China have not made public any information on their total fissile material stocks. Independent, albeit uncertain, estimates of fissile material stocks exist for all the weapon states.[27]

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[25] *Plutonium: The First 50 Years: United States Plutonium Production, Acquisition and Utilization from 1944 through 1994*, U.S. Department of Energy, 1996, www.ipfmlibrary.org/doe96.pdf (as of this writing, an update had been prepared but not yet released); and *Highly Enriched Uranium: Striking a Balance. A Historical Report on the United States Highly Enriched Uranium Production, Acquisition, and Utilization Activities from 1945 through September 30, 1996*, Draft, Rev. 1., U.S. Department of Energy, January 2001 (publicly released in 2006), www.ipfmlibrary.org/doe01rev.pdf; updated in *Highly Enriched Uranium Inventory: Amounts of Highly Enriched Uranium in the United States*, U.S. Department Of Energy, 2006, www.ipfmlibrary.org/doe06f.pdf.

[26] The 1998 Strategic Defence Review acknowledged that, at that time, the UK military stocks of fissile materials consisted of "7.6 tonnes of plutonium [and] 21.9 tonnes of highly enriched uranium" and also declared 4.4 tons of plutonium excess to military purposes. This surplus material included only 0.3 tons of weapon-grade plutonium, however. All numbers are from "Supporting Essay Five: Deterrence, Arms Control, and Proliferation," §26 in *The Strategic Defence Review*, UK Ministry of Defence, July 1998, www.ipfmlibrary.org/mod98.pdf.

[27] D. Albright, F. Berkhout and W. Walker, *Plutonium and Highly Enriched Uranium 1996,* Oxford University Press, 1997; more recently, annual updates by IPFM, in particular, *Global Fissile Material*

Since 1997, the NPT weapon states have declared civilian plutonium stocks annually as part of their INFCIRC/549 declarations to the IAEA.[28] China made its first non-zero declaration in 2011. The United Kingdom and France also declare stocks of civilian HEU in their INFCIRC/549 declarations.

To avoid ambiguities and to allow for consistency checks, the baseline national declarations of fissile materials should list separately:

- HEU and plutonium in other countries and any foreign-owned material in country.

In these initial declarations, weapon states also could declare:

- The portions of their HEU and plutonium stockpiles available for IAEA safeguards.

Material in this last category could be civilian or excess military material. Some of this material may already be under international safeguards, be eligible for safeguards, or have been declared as civilian to the IAEA. Civilian fissile materials in France and the United Kingdom, for example, are under Euratom safeguards and the United States declares its excess military plutonium annually as civilian to the IAEA in its INFCIRC/549 declarations. States able to provide more detailed declarations could break down the total quantities of HEU and plutonium further (Table 2).

Non-NPT weapon states could consider making baseline declarations that only list fissile material stocks available and not available for safeguards, since such declarations would not reveal information on actual nuclear warhead numbers.

Report 2010, Balancing the Books: Production and Stocks, International Panel on Fissile Materials, Princeton, NJ, December 2010, www.ipfmlibrary.org/gfmr10.pdf.

[28] IAEA, *Communications Received from Certain Member States Concerning their Policies Regarding the Management of Plutonium,* INFCIRC/549, documents available at www.iaea.org/Publications/Documents/Infcircs/.

	HEU	Plutonium
Inventory as of [DATE]		
Civilian, available for IAEA safeguards		
Excess military, available for IAEA safeguards		
Civilian, not available for IAEA safeguards		
Excess military, not available for IAEA safeguards		
Military, in irradiated fuel		
Military, reserved for non-weapon purposes		
Military, available for weapons		

Table 2. A possible reporting form for a fissile-material declaration that disaggregates the baseline categories for fissile materials. Material available for weapons includes material for or in warheads that are deployed, in reserve, awaiting dismantlement, and in components. In addition, average isotopics (uranium-235 content in HEU and plutonium-239 content in plutonium) could be specified. This would allow for further consistency checks of the declarations.

IAEA Monitoring and Irreversibility

Action 16 of the 2010 NPT Review Conference Final Document states:

> *"The nuclear-weapon States are encouraged to commit to declare, as appropriate, to the International Atomic Energy Agency (IAEA) all fissile material designated by each of them as not required for military purposes and to place such material as soon as practicable 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 military programmes."*

To meet this commitment, the NPT weapon states could declare and place under IAEA safeguards:

- All plutonium and HEU in civilian use.
- All plutonium and HEU recovered from excess weapons or the nuclear-weapons complex and declared excess for weapon purposes.
- All plutonium and HEU in fissile material going to waste disposal sites.

Russia and the United States are disposing of significant quantities of excess weapons HEU and plutonium. Russia is expected to complete in 2013 the blend-down of 500 tons of excess weapon-grade HEU into low-enriched uranium for sale to the United States for use in power reactor fuel. This blend-down is being monitored on a bilateral basis. The United States has similarly blended down 135 tons of excess HEU, some of it under IAEA monitoring.

Russia and the United States are expected by the end of 2012 to conclude IAEA verification arrangements for their agreement on disposition of 34 tons each of

plutonium declared excess for weapons purposes.[29] No plutonium has been disposed of yet under this program.

In principle, the IAEA could monitor containers holding fissile materials declared excess while they were still in the form of nuclear warhead components, whose mass, composition and other details may be classified, using the techniques developed as part of the Trilateral Initiative between the IAEA, the United States, and Russia during 1996–2002.[30]

Action 16 does not commit weapon states to declare and place under IAEA safeguards HEU allocated for military naval fuel. Nuclear weapon states could in principle still do so, however, and use the provision of the NPT that allows any state, even non-weapon states, to withdraw fissile material from safeguards for use in military but non-weapons activities.[31]

This use of fissile material is significant because the quantities of HEU reserved for naval reactor fuel are huge. The United States alone has set aside for naval fuel a stockpile of 130 tons of weapon-grade uranium – enough for more than 5,000 nuclear weapons.[32] In addition to the United States, the United Kingdom and Russia all operate HEU-fueled naval reactors. France and (we believe) China do not use HEU in their naval fuel.[33]

In the United States, about three tons of plutonium has been sent to the Waste Isolation Pilot Plant (WIPP) in New Mexico for geological disposal. To establish confidence in declarations of fissile material going to waste, weapon states should agree to declare the amount of fissile material in each waste package; allow the IAEA to do independent assays on random waste drums containing significant amounts of fissile material; and monitor the perimeter of the waste facility.

Expanding IAEA safeguards into the nuclear-weapon states will require supplementing the IAEA safeguards budget.

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[29] The Plutonium Management Disposition Agreement, signed in 2000 and amended in 2010, commits the United States and Russia each to dispose of 34 tons of excess plutonium starting in 2018.

[30] For details about the U.S.-Russia-IAEA Trilateral Initiative, see *Global Fissile Material Report 2008,* Chapter 6, IPFM, September 2008. See also discussion on cooperative transparency projects below.

[31] IAEA, *The Structure and Content of Agreements Between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons,* INFCIRC-153 (corrected), Paragraph 14, "Non-Application of Safeguards to Nuclear Material to be Used in Non-Peaceful Activities."

[32] *Global Fissile Material Report 2011*, IPFM, January 2012.

[33] France previously used HEU to fuel naval reactors but has moved to LEU fuel.

II. Declarations to support future deep reductions agreements

Irreversible reductions to low numbers of warheads and much smaller stockpiles of fissile materials for military purposes will require still greater transparency for effective verification. Therefore, the NPT weapon states should acknowledge the future need to provide public information on both warhead and fissile material production histories and anticipated developments in their stockpiles. They should commit at the 2015 Review Conference to begin to prepare such information for later disclosure in the context of deep-cut agreements.

Warhead Stockpile Histories

In the case of warheads, information to be prepared for future declarations should include:

- Total nuclear-warhead stockpiles by year and warheads built, retired, and dismantled each year.

The United States has already made public information on total and dismantled nuclear weapons.[35] The United Kingdom and France have indicated that significant numbers of warheads that were in their arsenals are no longer operational—but have not revealed whether these warheads have been dismantled or not.

States that are concerned about revealing too much information about their current nuclear stockpiles could begin by revealing the data for warhead-types that no longer exist.

The nuclear-weapon states also could increase confidence and transparency by declaring their:

- Plans for future warhead production, life-extension, deployment, and disassembly for the next five years.

The five-year plans – which could be timed to match the five year NPT Review Conference cycle – could be updated each year to indicate progress in meeting them.[36] They also could include schedules for production, life-extensions and dismantlement of delivery systems. Such information is already publicly available about U.S. warheads and delivery systems because of the U.S. Congressional budgetary process.

Fissile Material Production and Disposition Histories

Four of the five NPT nuclear-weapon states have announced an end to plutonium production for weapons and HEU production for all military purposes, and China is

[35] *Increasing Transparency in the U.S. Nuclear Weapons Stockpile*, U.S. Department of Defense Factsheet, 3 May 2010.

[36] A five-year planning horizon was suggested in *Monitoring Nuclear Weapons and Nuclear-Explosive Materials,* Committee on International Security and Arms Control, National Academy of Sciences, Washington, DC, 2005, Chapter 2 ("Nuclear Weapons") and Table 2-1.

believed to have halted production for more than two decades.[37] It is in this context that Action 18 of the 2010 NPT Review Conference Final Document states:

> *"All States that have not yet done so are encouraged to initiate a process towards the dismantling or conversion for peaceful uses of facilities for the production of fissile material for use in nuclear warheads or other nuclear explosive devices."*

- As a first step, weapon states could declare all shutdown fissile material production facilities, the state of shutdown, and their current decommissioning or conversion plans.
- As a second step, weapon states could release detailed data on HEU and plutonium production and related waste production and disposal records.

It is relevant to note that, in May 2008, to back up its declaration of its plutonium stockpile, North Korea provided about 18,000 pages of records on operation of its plutonium production reactor and the associated reprocessing facility since 1986.[38]

[37] *Global Fissile Material Report 2010*, IPFM, December 2010.

[38] *Update on the Six-Party Talks*, U.S. State Department, Washington, DC, 10 May 10, 2008, http://2001-2009.state.gov/r/pa/prs/ps/2008/may/104558.htm.

III. Cooperative verification projects

As part of their meetings in 2009 and 2011, the NPT nuclear-weapon states have "shared information on their respective bilateral and multilateral experiences in verification."[1] By the 2015 NPT Review Conference, the weapon states could agree to pursue new bilateral, trilateral, and multilateral cooperative projects with IAEA participation to develop and demonstrate verification approaches for both warhead dismantlement and declarations of past fissile-material production.

Warhead Dismantlement

The main rationale behind verifying warhead dismantlement is to provide confidence that actual warheads are destroyed and that the fissile material they contained is recovered and accounted for. In general, the dismantlement process can be divided in several stages, each posing different verification challenges:

- Monitoring the chain of custody of warheads from deployment or storage to dismantlement using tags and seals on their containers;
- Verified dismantlement of warheads going into a dismantlement process and the component containers coming out;
- Monitoring of the recovered HEU and plutonium components;
- Verified dismantlement of the plutonium and HEU components; and
- Monitored disposition of recovered HEU and plutonium.

In the 1990s, U.S. and Russian weapon laboratories cooperated in developing chain-of-custody arrangements to allow Russian inspectors to verify U.S. warhead dismantlement.[2] The United Kingdom and Norway have conducted a five-year long warhead dismantlement exercise involving a dummy warhead, and have been sharing the results of this effort with both weapon states and non-weapon states.[3] Both these efforts could be resumed and extended to include all the NPT weapon states, the IAEA, and some non-weapon states.

During 1996–2002, the United States, Russia, and the IAEA also engaged in a Trilateral Initiative to develop tools and procedures to enable the non-intrusive monitoring of plutonium-containing weapon components in storage. This effort could be resumed and expanded to include the other nuclear-weapon states and to cover weapon components containing HEU.

As noted earlier, Russia and the United States have been carrying out programs to dispose of HEU declared excess to military purposes. As part of this effort, the parties established transparency measures to provide the United States assurance

[1] "First P5 Follow-up Meeting to the NPT Review Conference," Paris, 1 July 2011.

[2] *Global Fissile Material Report 2009*, Chapter 5, IPFM, October 2009.

[3] "UK statement at the UN Disarmament Conference," 4 April 2012, http://ukun.fco.gov.uk/en/news/?view=PressS&id=751944882.

that the LEU was derived from weapon-grade metal and Russia confidence that the LEU is used for fuel.[4] Work is still underway on the verification arrangements for plutonium disposition.

Past Fissile Material Production

Verifying declarations of past fissile material production would require access to former fissile material production sites. Once nuclear-weapon states release information on the production histories of materials by site and facility, they could also agree on the terms of access to these sites to foreign partners or multilateral or international teams with IAEA participation to carry out measurements to check declarations of quantities and types of fissile materials produced there.

Since most of the facilities used for fissile material production for weapons are now shut down and many are scheduled for decommissioning, to allow for future verification, weapon states should as soon as possible:

- Catalogue and preserve operating records and waste materials.

States also could pursue new cooperative projects to develop the methods of "nuclear archaeology," which uses nuclear-forensic analysis of samples from structural or waste materials to obtain evidence relating to the operating history of nuclear production facilities. The United States started to develop and demonstrate nuclear archaeology methods in the 1990s for graphite-moderated production reactors, with some cooperation from the United Kingdom, France, and Russia.[5] New nuclear archaeology projects are needed, however, to deal with other kinds of facilities used for fissile material production and to recover useful forensic information from wastes associated with fissile material production. These projects could cover:

- Dedicated production reactors (graphite and heavy-water moderated).
- High-level waste from military reprocessing.
- Gaseous diffusion, electromagnetic, and centrifuge uranium enrichment facilities that were used for HEU production.
- Depleted uranium stored at enrichment facilities.

As an example, Table 3 lists the main plutonium (and tritium) production reactors in NPT nuclear-weapon states. With the shutdown of the Russian ADE-2 reactor in April 2010, none of these facilities remains operational. Some are now open to visitors. The U.S. Hanford B reactor has been declared a National Historic Landmark and opened for public tours.[6] In 2009, France invited observers to witness

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[4] *Global Fissile Material Report 2007*, Chapter 2, IPFM, 2007.

[5] The concept was proposed in Steve Fetter, "Nuclear Archaeology: Verifying Declarations of Fissile-Material Production," *Science & Global Security,* 3, 1993, pp. 237–259. For a summary of U.S. efforts, see Thomas W. Wood, Bruce D. Reid, John L. Smoot, and James L. Fuller, "Establishing Confident Accounting for Russian Weapons Plutonium," *Nonproliferation Review,* Summer 2002, pp. 126–137.

[6] *Hanford Site Tours*, Department of Energy, www.hanford.gov/page.cfm/HanfordSiteTours.

dismantlement of its enrichment and plutonium production complexes at Pierrelatte and Marcoule.[7] China has revealed an unfinished underground plutonium production complex ("Project 816") at Fuling in Sichuan Province and opened it up for tourists.[8]

	Graphite Reactors	Heavy Water Reactors
United States	Hanford 9 reactors (B, D, F, H, DR, C, KW, KE, N)	Savannah River 5 reactors (R, P, K, L, C)
Russia	Mayak 5 reactors (A, AV-1, -2, -3, AI-IR) Seversk 5 reactors (I-1, IE-2, ADE-3, -4, -5) Zheleznogorsk 3 reactors (AD, ADE-1, -2)	Mayak 4 reactors (OK-180, -190, -190M, LF-2)
United Kingdom	Sellafield 6 reactors (Windscale and Calder Hall) Chapelcross 4 reactors	n/a
France	Marcoule 3 reactors (G1, G2, G3)	Marcoule 2 reactors (2 x Célestin)
China	Jiuquan 1 reactor Guangyuan 1 reactor	n/a

Table 3. Main plutonium (and tritium) production reactors in NPT nuclear weapon states. All these plants are now shut down and in various stages of decommissioning.

Many former military fissile material production facilities have been shut down for decades and are in various stages of decommissioning. So far, however, these facilities have not been used for nuclear archaeology projects. Weapon states could choose a former production reactor or enrichment plant for projects to develop and test verification approaches. "Partner sites" in other countries could be offered to jointly demonstrate these methods. By limiting such activities initially to single facilities at selected sites, weapon states would not reveal information about their total past fissile material production before they are ready to do so. Priority should be given to transparency projects at facilities scheduled for decommissioning and waste materials that are scheduled for further processing or elimination.

[7] *France TNP: Turning Commitments into Actions,* www.francetnp2010.fr/spip.php?article110.

[8] *Global Fissile Material Report 2010*, Chapter 7, IPFM, December 2010.