

PROJECT ON MANAGING THE ATOM

IAEA VERIFICATION OF FISSILE MATERIAL IN SUPPORT OF NUCLEAR DISARMAMENT

BY THOMAS E. SHEA AND LAURA ROCKWOOD



HARVARD Kennedy School

BELFER CENTER for Science and International Affairs

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Report by The Project on Managing the Atom

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PROJECT ON MANAGING THE ATOM

IAEA VERIFICATION OF FISSILE MATERIAL IN SUPPORT OF NUCLEAR DISARMAMENT

*A PROPOSAL FOR THE 2015 NPT REVIEW
CONFERENCE TO “COMPLETE AND IMPLEMENT
THE TRILATERAL INITIATIVE” AS CALLED FOR IN
STEP 8 OF THE 13 PRACTICAL STEPS OF THE FINAL
DECLARATION OF THE 2000 NPT REVIEW CONFERENCE*

BY THOMAS E. SHEA AND LAURA ROCKWOOD



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About the Authors

Laura Rockwood is currently a Senior Research Fellow with the Project on Managing the Atom at the Belfer Center at Harvard University's Kennedy School. She retired from the IAEA in November 2013 as the Section Head for Non Proliferation and Policy Making in the Office of Legal Affairs, where she had served since 1985. She was a member of the Trilateral Initiative team, and the lead negotiator for the IAEA in the Joint Working Group responsible for the negotiation of the Trilateral Initiative Model Verification Agreement. At the IAEA, she was involved in all aspects of the negotiation, interpretation and implementation of IAEA safeguards, and was the principal author of the document that became the Model Additional Protocol.

Thomas Shea served for 24 years in the IAEA Department of Safeguards and headed the IAEA Trilateral Initiative Office from its creation until the end of 2003. Shea also headed the IAEA Fissile Material Cut-off Treaty working group as well as a study group that analyzed the Comprehensive Test Ban Treaty before it was completed. He was Section Head for Operations in the IAEA Department of Safeguards, with responsibility for States with extensive nuclear power programs involving plutonium and high enriched uranium production and utilization.

Acknowledgments

Several hundred diplomats, scientists and engineers, and IAEA inspectors and technical support staff were involved in the Trilateral Initiative at the IAEA, and in the Russian Federation, the United States, Japan, the United Kingdom, and Italy. During the six years from 1996–2002, we found common cause and worked together under unprecedented arrangements.

This proposal attempts to build on what was achieved under the Trilateral Initiative to create a fissile material verification framework for the future and thereby encourage progress towards nuclear disarmament.

We (the authors) began our recent effort to produce this proposal with a seminar held at the Vienna Centre for Disarmament and Non-Proliferation (VCDNP) in February of 2014. We described the Trilateral Initiative at a Wilton Park Conference in June of 2014, both under VERTIC sponsorship. Presentations at the Annual Meeting of the Institute of Nuclear Materials Management in July and at the IAEA Safeguards Symposium in October followed, and in December 2014, we presented an outline of our thinking to the Deep Cuts Commission. The current work is supported by John D. and Catherine T. MacArthur Foundation, the Carnegie Corporation of New York, and the Belfer Center for Science and International Affairs at Harvard University's Kennedy School of Government.

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Foreword: Pursuing Opportunities in Difficult Times

In this report, Thomas Shea and Laura Rockwood offer a new path forward for verified nuclear arms reductions, at a time when many other paths seem blocked. The tool they offer, built on a vast amount of careful technical and legal work already done under the Trilateral Initiative of the 1990s and early 2000s, is ready for any state with nuclear weapons to take up, finish the final details, and implement.

There is good reason for the nuclear weapon states to consider moving forward to do just that, placing their excess nuclear material under international monitoring, to confirm that it will never be returned to weapons. At this year's review conference for the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), sharp disagreements between nuclear haves and have-nots seem inevitable, with some have-nots arguing that the nuclear weapon states have failed to meet their disarmament obligations. The nuclear weapon states will point, correctly, to the fact that they have cut estimated global stockpiles of nuclear weapons by four-fifths from their peak and are implementing agreements such as the New START treaty.

But with a deep crisis in U.S.-Russian relations and charges of cheating on the Intermediate-Range Nuclear Forces (INF) Treaty, there seem to be few near-term prospects for deeper reductions; the nuclear weapon states are busily modernizing their nuclear arsenals; with U.S. politics locked in partisan wrangling, the chances of near-term ratification of the Comprehensive Test Ban Treaty (CTBT) are also grim; the Conference on Disarmament remains stymied and unable to begin negotiations of a Fissile Material Cutoff Treaty (FMCT); and despite the remarkable efforts of Ambassador Jaakko Laajava, the Finnish coordinator, no conference on a Middle East weapons of mass destruction free zone has been held in the five years since the last NPT review. In the face of these troubling developments, the P5 will be offering, after years of effort, an agreed glossary of disarmament-related terms.

Ultimately, the success of the non-proliferation regime rests on the support of the governed. The growing sense of alienation from the regime felt by many non nuclear weapon states, particularly in the developing world, is not healthy.¹ While no direct *quid pro quo* is possible, the more the nuclear weapon states (NWS) can do to give the non-nuclear weapon states (NNWS) the sense that they are serious about fulfilling their disarmament obligations, the more political support there is likely to be for measures to strengthen the nonproliferation regime. If the nuclear weapon states want others to accept stronger inspections or better export controls, they need to demonstrate that they are willing to accept verified constraints on their own activities.

That is where the Shea-Rockwood proposal could come in. Any nuclear weapon state, without waiting for others, could offer a clear signal of its commitment to permanently reducing its arsenal by irrevocably placing a substantial portion of the nuclear material from its weapons program under international monitoring. The United States, for example, has already declared hundreds of tons of plutonium and highly enriched uranium (HEU) as excess to its military needs; before the NPT review in 2020, the United States should negotiate an agreement with the

¹ See, for example, Steven E. Miller (with responses from Wael al-Assad, Jayantha Dhanapala, C. Raja Mohan, and Ta Minh Tuan), *Nuclear Collisions: Discord, Reform & the Nuclear Nonproliferation Regime* (Cambridge, Mass.: American Academy of Arts and Sciences, 2012), <https://www.amacad.org/pdfs/nonproliferation.pdf>.

International Atomic Energy Agency (IAEA) to begin placing a large fraction of this material under the kinds of monitoring envisioned in the Shea Rockwood proposal, challenging other countries to do the same. Such a step could substantially change the atmosphere at the next NPT review, contributing to constructive progress. Indeed, placing the excess U.S. plutonium under international monitoring would be a low-cost way to send the signal that it will never be returned to weapons—the most important purpose of a plutonium disposition program whose cost has now ballooned to over \$30 billion.²

In the case of plutonium “pits,” now stored by the thousands in bunkers at Pantex, the U.S. nuclear weapons assembly-disassembly facility near Amarillo, Texas, and at massive storage facilities in Russia, technical approaches to allowing such monitoring without revealing classified information have already been worked out—and demonstrated by U.S. and Russian scientists using a real U.S. pit. Actual implementation could begin within a very few years of a political decision to move ahead. In the case of HEU, there is more work to be done—and the United States and other interested countries should begin funding that work immediately.

Deep reductions in nuclear stockpiles, and their eventual prohibition, will ultimately require verification measures not just for missiles, submarines, and bombers as in the past, but for nuclear weapons themselves and the materials needed to make them.³ Implementing the first stages of the concept Shea and Rockwood offer would be a major step on that necessary road, building experience and allowing problems to be worked out at each stage. Yet it would do nothing to undermine efforts to maintain safe and effective deterrents for as long as they are still needed, and would not put the state that started on the path at a strategic disadvantage if others did not immediately join.

It is time for political leaders to summon the courage to verifiably and irrevocably begin reducing the stocks of material available for nuclear weapons.

Matthew Bunn

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May 2015

² For a discussion of the objectives of plutonium disposition—and an argument that the program is not worth that level of expenditure—see Matthew Bunn, “Plutonium Disposition: What Are We Trying to Accomplish?” (Plutonium Disposition Alternatives Workshop, Union of Concerned Scientists, January 30–31, 2014), <http://live.belfer-center.org/files/plutoniumdisposition.pdf>.

³ For a useful overview of the importance of controlling stocks of the essential ingredients of nuclear weapons, see Harold A. Feiveson Alexander Glaser, Zia Mian, and Frank von Hippel, *Unmaking the Bomb: A Fissile Material Approach to Nuclear Disarmament and Nonproliferation* (Cambridge, Mass.: MIT Press, 2014).

Executive Summary

This paper proposes a framework for IAEA verification of steps toward nuclear disarmament. The proposal is premised on IAEA verification of fissile material, in any form, whether classified or not, that is submitted by any state possessing nuclear weapons, whether party to the NPT or not. The paper identifies technical, legal, and financial solutions to the challenges posed by such verification, and describes a way forward to the full implementation of the proposed framework.

The proposed framework builds on the successes of the 1996–2002 joint project of the Russian Federation, the United States and the IAEA referred to as the “Trilateral Initiative.” The Trilateral Initiative was launched with a view to examining the feasibility of IAEA verification that weapon-origin fissile material declared by the states as excess to their respective defense requirements—including classified forms of fissile material—remained removed from their respective nuclear weapons programs, in furtherance of the states’ commitments under Article VI of the NPT. It received enthusiastic support from the IAEA Board of Governors in 1999; the 2000 NPT Review Conference called for its completion and implementation; and the 2010 NPT Review Conference called on the NWSs to place excess fissile material under IAEA verification and on all states to support the development of appropriate legally binding verification arrangements within the context of the IAEA.

Under the proposed framework, states parties to the NPT could, in fulfillment of the requests made during the 2000 and 2010 NPT Review Conferences, make progress in the implementation of their obligations under Article VI of the NPT. The proposal also provides a mechanism sufficiently flexible that any state possessing nuclear weapons, not just an NPT NWS, could, at its own discretion and in a step-by-step approach, contribute to global verified disarmament.

The proposed framework anticipates the possibility of progressive IAEA verification at the following stages of implementation, with verification expanding in scope and increased relevance to the process of disarmament depending on the readiness of the state concerned and the IAEA:

- Stage 1: Unclassified forms of fissile material
- Stage 2: Pits, secondaries, and other classified fissile material

These two stages, together with the conversion operations to remove classified characteristics from such fissile material, were addressed in the Trilateral Initiative. They require additional technical work and due diligence by the IAEA and the state concerned for these steps to be successful.

The proposal assumes that, at some point, the international community and states possessing nuclear weapons may wish to extend the scope of verification to include additional steps in connection with nuclear disarmament. Accordingly two additional steps are foreseen that would involve IAEA verification and monitoring of nuclear warheads.

- Stage 3: Storage and dismantlement of nuclear warheads

- Stage 4: Removal and monitoring of deployed nuclear warheads identified for elimination

The technical verification method developed under the Trilateral Initiative would form the basis for verification under this proposal. However, additional research and development would be necessary for success, even at the earliest stage. To that end, the framework includes a proposal for the establishment of an IAEA centre (see Annex A) to facilitate fissile material verification in relation to nuclear disarmament. The centre would include a network of complementary laboratories and universities in states interested in participation, including laboratories in non-nuclear-weapon states NNWSs as well as in states possessing nuclear weapons.

The proposal also includes a suggested legal framework under which a model verification agreement, subject to approval by the IAEA Board of Governors, would serve as the basis for bilateral agreements between the IAEA and individual states possessing nuclear weapons. To facilitate that process, and drawing on the experience gained in the development of the Trilateral Initiative Model Verification Agreement, the authors offer a notional “Model Agreement between <A State Possessing Nuclear Weapons> and the International Atomic Energy Agency for Verification in Relation to Nuclear Disarmament” (see Annex B).

Resolving the technical issues associated with verifying progress towards disarmament will not guarantee that states possessing nuclear arms will enter into binding agreements to that effect. But creating the technical capabilities for credible international verification and developing an appropriate legal framework would remove at least two barriers to such progress.

We recommend that the 2015 NPT Review Conference endorse this proposed framework and call upon the NPT states parties and the IAEA to take the steps necessary to secure this essential element of internationally verified nuclear disarmament.

I. Introduction

Article VI of the NPT provides that:

Each of the Parties to the Treaty undertakes to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control.

In 1996, the Russian Federation, the United States, and the IAEA launched a joint project, referred to as the “Trilateral Initiative.” It began as a study to examine the feasibility of IAEA verification of weapon-origin fissile material declared by the states as excess to their respective defense requirements, in furtherance of the states’ commitments under Article VI of the NPT.¹ Classified forms of fissile material were the main focus of the joint efforts.

The three parties established a Joint Working Group to consider the technical, financial, and legal aspects of such verification. By the time the Trilateral Initiative was concluded in 2002, the Joint Working Group had succeeded in developing an approach to verification of plutonium with classified characteristics which would permit the IAEA, in a technical and credible manner, but without access to sensitive nuclear weapons related information, to provide assurances that material submitted to it is plutonium of an isotopic composition consistent with that used in nuclear weapons and above a specified mass. Once accepted for verification by the IAEA, the material would be monitored to provide assurance that the material remained accounted for and was not returned to a military program. A proof-of-principle version of the verification system was demonstrated during the Trilateral Initiative.²

In parallel with the ongoing technical development of the verification system, intensive work began on creating a suitable legal framework. It was concluded that the most efficacious approach would be to develop a model verification agreement that could be used as the basis for the conclusion of individual bilateral agreements between each of the states and the IAEA. The Model Verification Agreement which was eventually drafted drew heavily from INFCIRC/153 (Corr.), the document that serves as the basis for safeguards agreements concluded by the IAEA with the NNWSs parties to the NPT pursuant Article III of the NPT, adapted as necessary to support the intended disarmament mission. The Joint Working Group was also able to make progress on drafting subsidiary arrangements and on specific verification approaches for the lead facility in each state where classified forms of weapon plutonium were planned to be submitted for verification.

The Trilateral Initiative was discussed at length in 1999 by the IAEA Board of Governors, which expressed enthusiastic support for the Initiative as a valuable contribution to arms control and to the fulfillment of the states’ disarmament obligations under the NPT.

¹ The Trilateral Initiative press releases are available on the IAEA website www.iaea.org.

² Cooperative work continued between the United States and Russia, without IAEA participation, following the conclusion of the Trilateral Initiative, in the course of which a full prototype verification system, including the associated equipment, was built and tested.

In the Final Document of the 2000 NPT Review Conference,³ the states parties agreed on “practical steps for the systematic and progressive efforts to implement Article VI of the Treaty on the Non-Proliferation of Nuclear Weapons [NPT] and paragraphs 3 and 4(c) of the 1995 Decision on “Principles and Objectives for Nuclear Non-Proliferation and Disarmament.”⁴ Among those practical steps was Step 8:

8. The completion and implementation of the Trilateral Initiative between the United States of America, the Russian Federation and the International Atomic Energy Agency.

In September 2001, the Director General of the IAEA, the U.S. Secretary of Energy and the Minister of the Russian Federation Ministry of Atomic Energy (MINATOM) announced in a press release their intention to consider plans for the implementation of the Trilateral Initiative the following year. In September 2002, they concluded that the task entrusted to the Joint Working Group had been fulfilled, and, recognizing the value of the groundbreaking work completed under the Trilateral Initiative over the intervening six years, directed the technical experts to begin, without delay, discussions on future possible cooperation within the trilateral format, i.e., the conclusion of agreements between the IAEA and each of the states.⁵ This initial progress notwithstanding, no further work was subsequently carried out on the Trilateral Initiative or under any other trilateral format related to nuclear disarmament.⁶

³ NPT/CONF.2000/28 (Parts I and II).

⁴ NPT/CONF.1995/32 (Part I), Annex, Decision 2, Disarmament. Paragraphs 3 and 4(c) read as follows: “3. Nuclear disarmament is substantially facilitated by the easing of international tension and the strengthening of trust between states which have prevailed following the end of the cold war. The undertakings with regard to nuclear disarmament as set out in the [NPT] should thus be fulfilled with determination. In this regard, the nuclear weapon states reaffirm their commitment, as stated in Article VI, to pursue in good faith negotiations on effective measures relating to nuclear disarmament. 4. The achievement of the following measures is important in the full realization and effective implementation of Article VI, including the programme of action as reflected below: (a) The completion by the Conference on Disarmament of the negotiations on a universal and internationally and effectively verifiable Comprehensive Nuclear-Test-Ban Treaty no later than 1996. Pending the entry into force of a Comprehensive Test-Ban Treaty, the nuclear-weapon states should exercise utmost restraint; (b) The immediate commencement and early conclusion of negotiations on a non-discriminatory and universally applicable convention banning the production of *fissile material* for nuclear weapons or other nuclear explosive devices, in accordance with the statement of the Special Coordinator of the Conference on Disarmament and the mandate contained therein; (c) The determined pursuit by the nuclear-weapon states of systematic and progressive efforts to reduce nuclear weapons globally, with the ultimate goals of eliminating those weapons, and by all states of general and complete disarmament under strict and effective international control.”

⁵ See the press release from the General Conference in 2002, reproduced at <http://www.iaea.org/newscenter/pressreleases/iaea-verification-weapon-origin-fissile-material-russian-federation-and>.

⁶ The Trilateral Initiative was a creature of the 1990s, reflective of the unique political environment created by the emergence of the Russian Federation and the permanent extension of the NPT, at a time when Presidents Yeltsin and Clinton found common ground on a range of security issues. The political environment changed with a change in leadership in both countries in 2000. Readers interested in the history of the Trilateral should refer to the working paper published by the Deep Cuts Commission: Shea, Thomas E. and Rockwood, Laura. *Nuclear Disarmament: The Legacy of the Trilateral Initiative* (Deep Cuts Working Paper No. 4, March 2015). IFSH: Hamburg. Available at www.deepcuts.org/publications.

In the “Conclusions and recommendations for follow-on actions” of the Final Document of the 2010 NPT Review Conference,⁷ the states parties agreed on an action plan for nuclear disarmament. In that action plan, the Conference resolved, *inter alia*, that:

Action 16: 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 no longer 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 programs.

Action 17: In the context of action 16, all states are encouraged to support the development of appropriate legally binding verification arrangements, within the context of IAEA, to ensure the irreversible removal of fissile material designated by each nuclear-weapon states as no longer required for military purposes.

The authors of this publication offer a proposal for a framework within which the states parties to the NPT could, in fulfillment of the requests made during the 2000 and 2010 NPT Review Conferences, make progress in the implementation of their obligations under Article VI of the NPT. The proposed framework contemplates IAEA verification in relation to nuclear disarmament focused on fissile material released from military programs, specifically, plutonium and HEU as used in contemporary nuclear weapons. The proposal aims to provide a mechanism sufficiently flexible that any state possessing nuclear weapons, not just an NPT NWS, could, at its own discretion and in a step-by-step approach, participate on an equal basis in the process and thereby contribute to global verified disarmament.

The proposed framework offers one means through which the international community and the states possessing nuclear weapons could take steps towards disarmament, lock in progress as it is made, and help to create the circumstances that will allow such states to take the next steps, confident that in so doing, they will not undermine their national security.



Photo credit: IAEA

The last meeting of the Trilateral Initiative Principals. From left to right, Russian Federation Minister of Atomic Energy Alexander Rumyantsev, Director General of the IAEA Mohamed ElBaradei, and U.S. Secretary of Energy Spencer Abraham during the 2002 IAEA General Conference.

While this proposal is new, the basic issues associated with it are not, and a great deal of practical work on the technical, legal, and financial aspects of the verification of fissile material released from weapons programs was already carried out in the context of the Trilateral Initiative. Accordingly, the proposal articulated in this publication draws on, and expands upon, the technical approach, legal framework, and financial considerations developed under the Trilateral Initiative.

⁷ NPT/CONF.2010/50 (Vol. I).

Part II below discusses the technical challenges associated with IAEA verification of fissile material released from military programs, particularly material with classified characteristics, and offers possible solutions to those challenges, including the future establishment of a dedicated research centre (Annex A).

Part III addresses key legal issues and proposes a legal framework for such verification in the form of a notional model agreement, set out in Annex B, which could serve as the basis for agreements in relation to disarmament between the IAEA and any state possessing nuclear weapons.

Part IV identifies alternative arrangements for financing IAEA disarmament-related verification under the proposed framework

Part V describes a way forward to achieving the objective: IAEA verification of the irreversible removal of fissile material from military programs.

II. Technical Solutions

A. Fissile Material

INFCIRC/153 and the safeguards agreements concluded on the basis of that document relate to “special fissionable material” and “source material” as defined in Article XX of the IAEA Statute. However, the scope of this proposal is limited to fissile material, and in particular to plutonium and HEU of the nature used in contemporary nuclear weapons:⁸

- Plutonium containing 90 percent or more of the isotope Pu-239.
- HEU containing 20 percent or more of the isotope U-235.⁹

These fissile materials are essential for all of today’s nuclear weapons in all nuclear arsenals. Just as the IAEA non-proliferation safeguards system emphasizes controls on the possession, use, and export of nuclear material, similar fissile material controls will be at the center of nuclear disarmament verification.

Every nuclear weapon contains a fission energy component often referred to as the “primary,” which contains a metallic fissile material “pit” encompassed in high explosives. The pit may be made with plutonium metal, HEU metal, or both.

Some nuclear weapons include a “secondary” component that produces additional explosive force principally through the fusion of the hydrogen isotopes deuterium and tritium. The “secondary” is triggered by the primary. Secondaries are assumed to contain additional fissile material (typically, HEU).

B. Fissile Material in Nuclear Arsenals

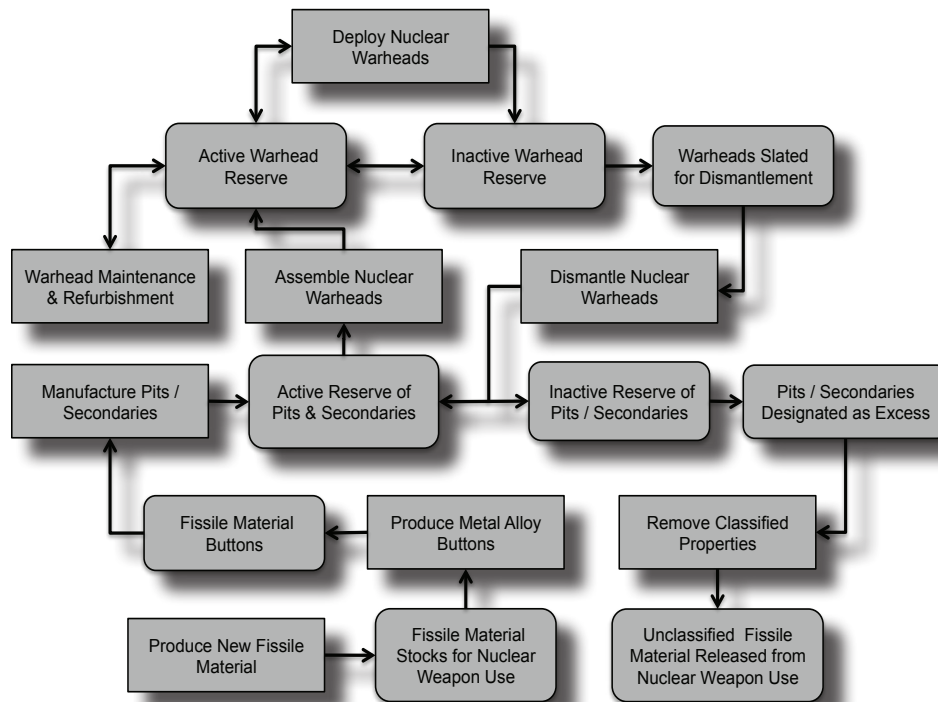
Figure 1 below illustrates the functional steps involving fissile material that a state possessing nuclear weapons would likely employ in maintaining its nuclear arsenal. Proceeding from the bottom left of the figure to the top are the steps followed in deploying a new warhead and in replacing warheads for maintenance or refurbishment. Coming down the right side of the figure are the steps involved in the process of disarmament.

Figure 1 does not include the steps that might be taken to use, export, or dispose of unclassified fissile material.

⁸ Other isotopic mixtures of plutonium, and other nuclear species, including U-233, Np-237 and Am-241, might also be used to make nuclear weapons. Their use would affect the weight of a warhead, the radiation emitted affecting personnel, and/or heat emission. Therefore, these materials are not used in contemporary nuclear weapons and are not considered in this proposal.

⁹ When HEU is used in the primary of a nuclear weapon, it will likely contain 90% of U-235. However, many other enrichments may be employed. This proposal envisages that the nominal enrichment at a given location would be declared, or at least that the enrichment of objects presented for verification would be greater than a specified minimum amount. Uranium containing less than 20 percent U-235 is defined as low enriched uranium, and at the levels used in power reactor fuel, cannot support an explosive nuclear chain reaction, so it is not included in the proposed verification arrangement .

Figure 1



A State possessing nuclear weapons will have the capability to: supply completed warheads to its military forces; service those warheads to maintain their operational readiness; and retire obsolete warheads or eliminate them when/if the State decides to reduce its nuclear arsenal.

C. Verification Requirements for Classified Forms of Fissile Material

Technical methods that would allow the IAEA to verify classified forms of fissile material must satisfy two fundamental conditions:

- 1. No proliferation of sensitive information:** The verification process, procedures, and equipment must not allow any unauthorized person to acquire any information deemed by the state concerned to be sensitive in relation to the design or manufacturing of nuclear weapons.
- 2. Credible verification:** The verification process must enable the IAEA to draw credible, independent, and technically based conclusions so that it can provide the necessary assurances in relation to progress towards nuclear disarmament.

Under IAEA safeguards agreements with NNWSs party to the NPT, the IAEA routinely measures nuclear material using non-destructive assay methods in the field, and analyzes samples of such material at its Safeguards Analytical Laboratory located at Seibersdorf, Austria.¹⁰ These measurements are capable of determining essentially *every* characteristic of the nuclear material. Verification of classified forms of fissile material using these methods would—without

¹⁰ See, for example, STR-368, “International Target Values 2010 for Measurement Uncertainties in Safeguarding Nuclear Materials,” Vienna, 2010.

question—reveal classified characteristics of the material, characteristics that may relate to the design of a nuclear weapon and/or the manufacturing processes. Such measurements cannot be used for the proposed disarmament verification.¹¹ Even if the fissile material presented for verification by the state is unclassified, the verification measures might still require modification if, for example, the unclassified fissile material is located at an installation where nuclear weapon activities are carried out.

D. The Trilateral Initiative Method: “Attribute Verification with Information Barriers”

The methods developed under the Trilateral Initiative provide the foundation for the proposed framework.

Under the Trilateral Initiative, nuclear weapon experts in the United States and the Russian Federation examined alternative methods for IAEA verification of fissile material with classified characteristics. They agreed on one method that would allow the IAEA to verify unclassified attributes of an object presented by the state. The United States and the Russian Federation proposed that in relation to plutonium, verification could be carried out to confirm: the presence of plutonium; the fact that the isotopic composition is typical of plutonium used in nuclear weapons; and that the mass of plutonium in the object presented exceeded a minimum amount specified for each facility where verification would take place. The IAEA agreed to this proposal.

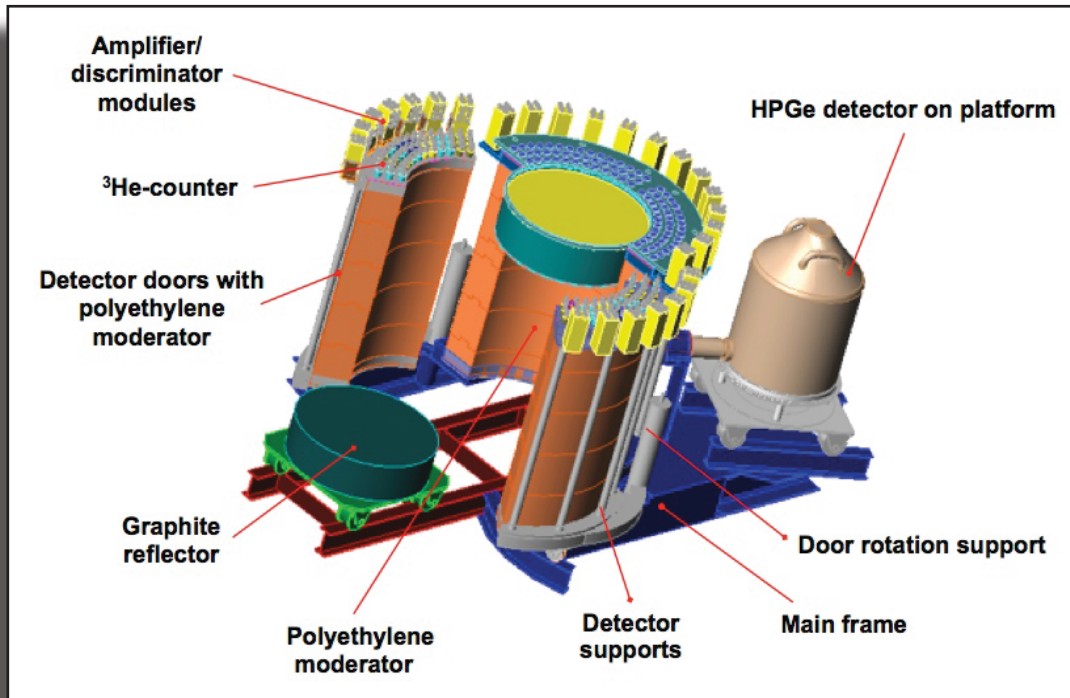
This verification method would:

1. Employ high-resolution gamma spectrometry to confirm that specific gamma rays emitted are those unique to plutonium (*Attribute 1: presence of plutonium*), and to
2. Measure the amounts of the isotopes Pu-239 and Pu-240 present and the ratio of Pu-240 to Pu-239 to determine if the isotopic composition of the plutonium present in the object submitted for verification is typical of plutonium used in nuclear weapons (*Attribute 2: the ratio of ^{240}Pu . $^{239}\text{Pu} \leq 0.1$*).
3. Measure the mass of Pu-240 within an object by measuring the neutrons emitted when Pu-240 fissions spontaneously. This is achieved through neutron multiplicity, a method by which two or three coincident neutrons emitted in each Pu-240 fission event are detected within a short window of time starting after the first neutron is detected. This method is very robust and accurate.
4. Measure the mass of plutonium present in an object by combining steps 2 and 3 and then compare the resulting mass to a threshold amount agreed for each facility where the verification activities are to be implemented. (*Attribute 3: the amount of plutonium present exceeds the stipulated threshold amount.*)

As an object is verified, the readouts that inspectors are allowed to observe indicate that the attributes either *are* or *are not* satisfied. Special circuits called “information barriers” are

¹¹ The laws governing classification are known to differ between states possessing nuclear weapons. In the future, it would be helpful if such laws could be harmonized, and as progress is made towards nuclear disarmament, whether some might be modified or eliminated to simplify verification.

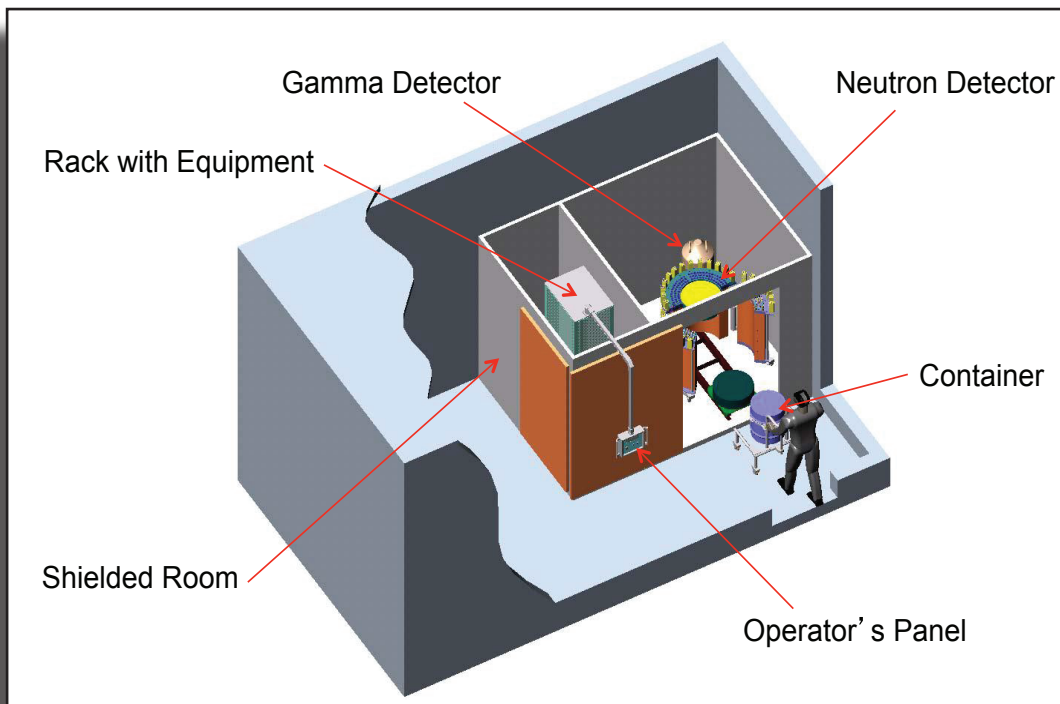
Figure 2



© Institute of Nuclear Materials Management 2010. All Rights Reserved.

A computer drawing of an AVNG system intended for storage containers holding plutonium pits or recast plutonium metal spheres retaining classified characteristics.

Figure 3



© Institute of Nuclear Materials Management 2010. All Rights Reserved.

A schematic representation of the AVNG prototype system.



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The Prototype AVNG System

incorporated in the equipment to prevent any transfer of the actual measurement results to the inspectors.

The Trilateral Initiative experts succeeded in designing a system for “attribute verification by neutron and gamma ray assay using information barriers,” more succinctly referred to as an AVNG system (see Figure 2).

After the Trilateral Initiative was concluded, American and Russian experts continued work on the prototype AVNG system and succeeded in building and testing such a system to the satisfaction of Russian security officials.¹²



Photo Credit: D. MacArthur, LANL

Russian experts explain the AVNG prototype they built at Sarov to American experts after the conclusion of the Trilateral Initiative.

The prototype system demonstrated that the concept could be engineered into functioning equipment, and that security officials could be satisfied that inspectors could verify classified forms of fissile material without revealing sensitive information. The prototype development phase did not involve the IAEA, and did not involve the testing of manufacturing and authentication methods that had been agreed in principle.

In addition to their work on verification methods, the Trilateral Initiative experts also examined how the containment and surveillance methods used by the IAEA in implementing non-proliferation safeguards might be applied in relation to nuclear disarmament.

Implementation of the Trilateral Initiative was to have begun with two storage facilities: the Fissile Material Storage Facility at Mayak in Russia and the K-Area Material Storage Facility at Savannah River in the United States.

The Trilateral Initiative technical experts considered how verification equipment for use by the IAEA could be produced and used in a manner that would meet the objective of credible verification without posing a threat that classified information might be divulged through its use. Under IAEA safeguards carried out for non-proliferation purposes, the IAEA procures equipment from commercial vendors, carries out tests to ensure that the equipment operates as intended,

¹² S. Razinkov, A. Livke, S. Kondratov, J. Thron, M. Bulatov, M. Leplyavkina, D. Sivachev, S. Tsybryaev, and A. V’yushin, *RFNC-VNIIEF, Sarov, Russian Federation*, and D.W. MacArthur, *Los Alamos National Laboratory, Los Alamos, NM, USA*, “The Design and Implementation of the AVNG,” Abstract #302, Proceedings of the 51st Annual Meeting of the Institute of Nuclear Materials Management, Baltimore, MD, July 2010.

and then transports the equipment to the facility where it will be used. During the Trilateral discussions, Russian experts noted that, if the IAEA were to bring equipment to Russia for use on classified forms of fissile material, Russian security officials would take each piece of equipment and examine it for up to 18 months. If the equipment failed their tests, the IAEA would be informed that it had failed, but not why, and the equipment might not be returned to the IAEA. If it passed their tests, however, the equipment would no longer be the same equipment as the IAEA had presented and the IAEA could then not accept it for verification use without its own similar examination. This circular process would make it impossible to produce equipment under predictable arrangements that would suit either party.

In order for the two fundamental conditions to be satisfied, it was agreed that measurement systems would have to be built in each state where they would be used, in accordance with the following arrangements:

1. Russian, U.S., and IAEA technical experts would jointly develop design specifications for the equipment, including detailed hardware drawings.
2. All computations would be performed using processors that would be built for this purpose, which would only have the capability to perform the specified operations, and which would not be programmable for any other purpose.
3. Prototype systems would be designed and tested by the three parties to confirm that the equipment meets all requirements.
4. Upon production of the equipment for actual use, the IAEA, the Russian Federation and the United States would:
 - Agree on the numbers of each pieces of equipment and essential components to be manufactured, taking into account a sustainability plan to maintain operational functionality over an agreed interval;¹³
 - Jointly monitor all stages of producing all verification equipment at all stages of its manufacture, and conduct joint acceptance tests;
 - Select, at random, components, materials, and full systems for testing, independently, by the IAEA and the host state;
 - Transport equipment approved for use to the facility where it would be used;
 - Secure all equipment and replacement modules in a secure installation at the facility, maintaining the equipment in operational standby mode;
 - Install, test, and commission initial equipment sets at the facility by the IAEA and host state officials; and
 - Test, replace, and remove from the facility equipment and replacement modules selected by and for IAEA examination at a designated IAEA location.

¹³ Given the costs and inconvenience of securing approved equipment for such use, a time period of 25 years may be appropriate.

E. Trilateral Technical Workshops

The technical experts met frequently over the six-year period of the Trilateral Initiative. Their major activities consisted of six week-long workshops held at weapons laboratories and other selected facilities in the Russian Federation and in the United States. Technical workshops were also held in other states, with a view to benefitting from their experience in applying relevant safeguards to peaceful nuclear activities:

- A workshop at the British Nuclear Fuels Ltd. complex in Sellafield, United Kingdom, provided an opportunity to observe an automated PuO₂ powder receipt verification system in combination with an automated plutonium storage system under EURATOM safeguards.
- A workshop at the Japan Nuclear Fuel Cycle Development Corporation Plutonium Fuel Production Facility in Tokai-Mura, Japan, enabled the participants to gain extensive insights into the integration of modern verification methods into an operating plutonium storage and mixed oxide fuel production facility under IAEA safeguards.
- A workshop at the Joint Research Centre of the European Commission in Ispra, Italy, at which the Trilateral Initiative experts explored *in situ* verification capabilities and technical measures to facilitate equipment certification and authentication.

While the accomplishments of the Trilateral Initiative were extraordinary, additional work will be required for the proposal outlined in this publication to succeed. For example, developing appropriate verification approaches for HEU fissile material will demand additional work, including the design and production of complex verification equipment.¹⁴ It will be necessary for the IAEA, states possessing nuclear weapons, and NNWSs Parties to the NPT to work together as IAEA member states to examine jointly the fundamental requirements and specific steps necessary to endorse each application.

F. Incremental Verification in Relation to Nuclear Disarmament

The proposed framework accommodates verification of classified forms of fissile material, but it also anticipates verification of fissile material in unclassified forms. In addition, it anticipates that implementation would likely progress in a step-by-step manner as confidence in the credibility and effectiveness of that verification is demonstrated through the following stages of disarmament, and as and when the IAEA and states possessing nuclear weapons agree.

- Stage 1: Unclassified forms of plutonium and/or HEU released from defense programs by a state possessing nuclear weapons, including monitored storage and disposition processes as determined by the state.
- Stage 2: Classified forms of fissile material in the form of nuclear warhead components or other forms of such fissile material which retain classified characteristics associated with geometrical shapes, or composition, including

¹⁴ HEU is more complicated to verify than plutonium, and the verification of combinations of the two would be even more complex. While plutonium verification can be based on the measurement of passive radiation, fissile material containing HEU may require the use of active systems, possibly even small accelerators, to meet the verification requirements.

monitored storage and the conversion of the fissile material submitted to verification to remove its classified characteristics, and the subsequent verification of said material under Stage 1 arrangements.

These two stages, together with the conversion operations to remove classified characteristics from such fissile material, were addressed in the Trilateral Initiative. They require additional technical work and due diligence by the IAEA and the state concerned for these steps to be successful.

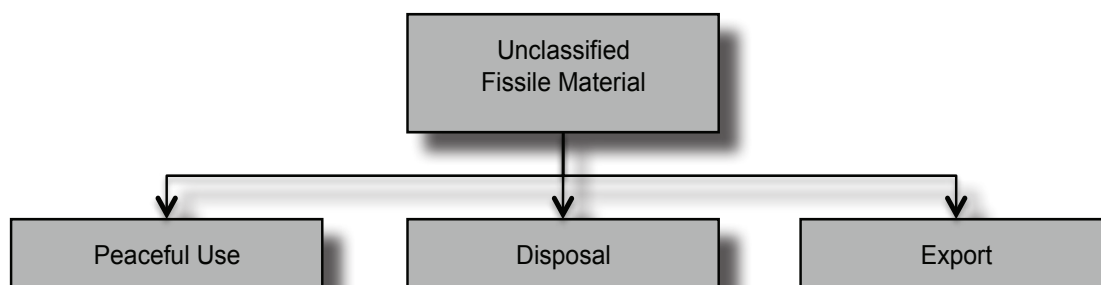
The proposal assumes that, at some point, the international community and states possessing nuclear weapons may wish to extend the scope of verification to include additional steps in connection with nuclear disarmament. Accordingly, two additional steps are foreseen in this proposal that would involve IAEA verification and monitoring of nuclear warheads.

- Stage 3: Detached nuclear warheads identified for elimination, including monitored storage, dismantlement of said warheads with the removal of the fissile material nuclear warhead components and their subsequent verification of said components under Stage 2 arrangements.
- Stage 4: Deployed nuclear warheads identified for elimination, including *in situ* monitoring, verification of demounting, and monitored storage under Stage 3 arrangements.

The notional model agreement and suggested implementation process identified below anticipate that each state possessing nuclear weapons will have to be satisfied, through very close examination of the proposed arrangements, that no sensitive information will be revealed through such verification. In addition, the necessary equipment and procedures will require the state's approval. The IAEA will benefit as additional states possessing nuclear weapons conclude verification agreements, and as incremental progress is made in moving from verification at Stage 1 to verification at the higher stages.

The numbering of the stages reflects the likely order of implementation, beginning with the easiest for all parties to accommodate.

Figure 4



Stage 1: Unclassified forms of plutonium and/or HEU released from defense programs by a State possessing nuclear weapons, including monitored storage and subsequent transfers to peaceful use, to removal from the biosphere, or by export, as determined by the State concerned.

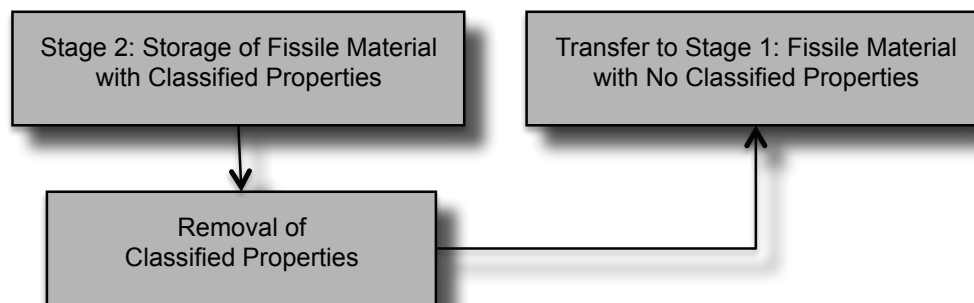
As this stage would involve only unclassified forms of fissile material, the methods and procedures used by the IAEA for safeguarding similar nuclear materials in NNWSs under comprehensive safeguards agreements (CSAs) would normally apply, especially at fuel cycle facilities where plutonium or HEU is used.

Two differences may be anticipated:

1. If the location for the storage or other activities is co-located with or near activities involving nuclear weapons, the security provisions may affect the methods that the IAEA will be allowed to apply. This could impact the use of certain electronic equipment, such as that used in remote monitoring applications.
2. Taking into account the fact that the state will already have nuclear weapons, the verification criteria with respect to significant quantities, detection timeliness, and detection probability used under CSAs should be reconsidered reflecting state-level factors in the context of nuclear disarmament.¹⁵

Provisions related to the export of such fissile material are included in the notional model agreement.

Figure 5



Stage 2: Classified forms of fissile material would be submitted for monitored storage and eventually for conversion to remove the classified characteristics. The material might be in the form of pits and/or secondaries, or other forms that retain classified characteristics.¹⁶ Following the conversion operations, the fissile material would be transferred to Stage 1.

Containers would be presented by the host state to the IAEA and declared as containing fissile material with classified characteristics, indicating whether the object contains Pu and HEU, or only HEU.

¹⁵ For example, during the Trilateral Initiative discussions, the Russian Federation, the United States and the IAEA agreed that the verification goal at each facility should be established as 1 percent of the inventory under verification at any time. This would apply to the number of items or the mass of fissile material, as appropriate.

¹⁶ Under the Trilateral Initiative, the United States planned to submit plutonium pits for IAEA verification. The Russian Federation planned to melt and recast its plutonium pits into plutonium metal spheres containing nominally 2 kilograms of Pu. These spheres would no longer have any sensitive geometric characteristics; however, the isotopic composition would remain classified under Russian law.

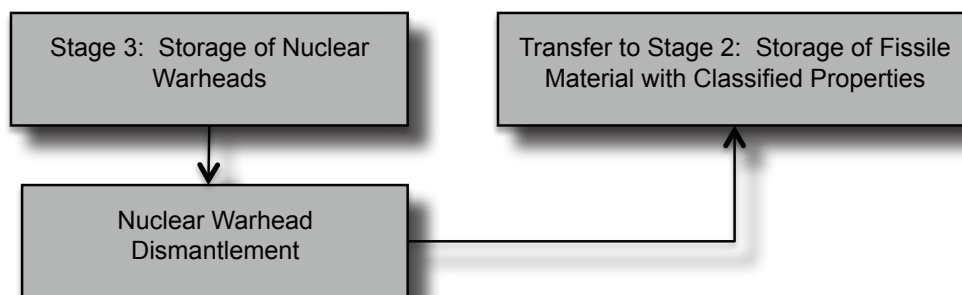
Verification of receipt of the container would be by visual examination of its outer surface and use of an AVNG system. The container would then be sealed and/or placed under monitored storage using approved containment/surveillance equipment. The monitored inventory would be examined and periodically re-verified according to a random sampling plan. Re-verification of facility design information would be permitted at the request of IAEA inspectors.

Verification of the transfer of objects containing material subject to verification to a conversion facility for the removal of classified characteristics would be carried out through visual examination of the outer surface of the objects to be transferred, re-verification using an AVNG system and the sealing of shipping containers.

Verification of conversion would be based on verifying containers going in and unclassified material coming out. The conversion facility would need to be built to accommodate perimeter controls; design information verification should be carried out before the facility is commissioned and periodically thereafter to ensure that any modifications potentially by-passing the controlled perimeter would be detected. Verification of the internal design information would be carried out at least quarterly, at which time the conversion plant would be temporarily shut down and the nuclear material removed.¹⁷

At the conversion facility, shipping containers would be examined, and the containers re-verified by AVNG, according to a random sampling plan. The perimeter of the conversion facility would be monitored at all times to ensure that all fissile material is measured and accounted for. Unclassified fissile material exiting the conversion facility would be measured and the containers sealed pending transfer to a location in Stage 1.

Figure 6



Stage 3: Nuclear warheads to be dismantled would be identified by visual examination using managed access arrangements as necessary, then verified by AVNG, and placed in monitored storage pending dismantlement. The classified components containing fissile material would be transferred to Stage 2.

¹⁷ A facility for removing classified characteristics from fissile material subject to verification would need to be created, or an existing facility modified, so that it enables perimeter control verification; monitoring of classified receipts; verification and re-verification of the process area to confirm the absence of undisclosed ingress or egress; verification of unclassified product; application of containment and surveillance on unclassified forms of fissile material; and the transfer of the material to Stage 1.

Once implementation of Stage 2 has been accomplished, consideration might be given to extending verification to include nuclear warheads. As foreseen in this proposal, the role of the IAEA would be to use a type of AVNG to verify an intact warhead, and to use perimeter monitoring to verify its dismantlement. If two or more states agreed that additional verification was needed to provide the assurance they required to continue steps towards nuclear disarmament, then presumably bilateral inspectors could carry out the additional verification within the perimeter monitored by the IAEA.

IAEA involvement in any verification related to warheads would be controversial, and might come, if at all, only at later stages. Nonetheless, it is possible that, in the future, states might ask the IAEA to take on this role, and the IAEA should be considering relevant concepts. In our proposal, verification of warheads would be carried out through visual examination of the outer surface of the warhead or of a container declared to contain the warhead (as in the case of classified warhead components described above), and through the use of an AVNG system designed specifically for that purpose. The warheads would then be sealed in appropriate containers and/or placed under monitored storage using approved containment/surveillance equipment. The monitored inventory would be examined and periodically re-verified according to a random sampling plan. Re-verification of facility design information would be permitted at the request of IAEA inspectors.

Transfers to the dismantlement facility would be verified through visual examination of the outer surface of the objects to be transferred, and re-verified by AVNG. Shipping containers would be sealed.

Verification at the dismantlement facility would again be based on what went in and what came out—in this case, warheads going in and classified fissile material components coming out. As some facilities are used for both dismantlement and remanufacture, in some cases there might be warheads and fissile material both going in and coming out; verification would be designed to confirm the degree to which the number of warheads coming out was smaller than the number going in.

The dismantlement facility would need to be built to accommodate perimeter controls. Verification of facility design information would be carried out before the facility is commissioned and periodically thereafter to ensure that any modifications potentially by-passing the controlled perimeter would be detected. Verification of the internal design information would be carried out at least quarterly, at which time the dismantlement facility would be temporarily shut down and the nuclear material removed.

At the dismantlement facility, shipping containers would be examined and re-verified using AVNG according to a random sampling plan. An inspector would mark each warhead or container in a unique manner.

The perimeter of the conversion facility would be monitored at all times to ensure that all fissile material is measured and accounted for.

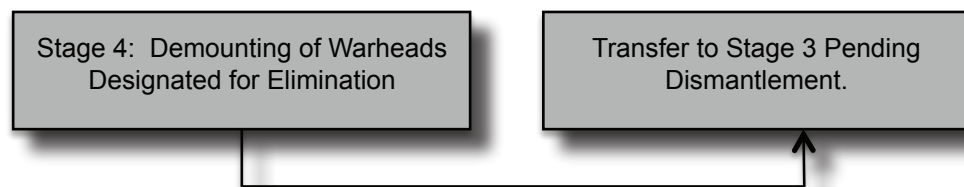
All items to be removed from the warhead and salvaged, including high explosive, deuterium and tritium, and any uranium that is not fissile material, would be screened and removed from the dismantlement facility.

All remaining parts of the dismantled warhead would be shown to the IAEA inspectors, who would verify the unique markings and witness the crushing or shredding of the hardware, preventing its reuse.

The pit, and secondary, where appropriate, would be removed, packaged, and verified using AVNG upon leaving the dismantlement facility; shipping container would be sealed pending transfer to Stage 2.

A future arms reduction agreement could require IAEA verification of nuclear warheads designated for elimination before they are demounted from their delivery systems and transferred to a warhead storage facility pending dismantlement. This would require that implementation of Stage 3 had been proven. It would likely involve engaging the IAEA at military sites, and hence require further development and approval of the processes involved.

Figure 7



Stage 4 inspections would involve visual examination, unique marking of each warhead, visual observation of its removal from its delivery system, AVNG verification of each warhead using specially designed equipment, witnessing of the placement of each warhead in its shipping container, and sealing of the container pending shipment to Stage 3.

G. Suggested Implementation Process

Many of the steps that would be necessary to operationalize the process described above parallel existing practice in implementing non-proliferation safeguards in NNWSs, albeit with modifications where necessary to cope with the two fundamental conditions for disarmament verification identified above.

The following list is intended to be indicative of such steps:

1. Conclude agreement between the state concerned and the IAEA on the basis of the model approved by the IAEA's Board of Governors.
2. Negotiate subsidiary arrangements based on model subsidiary arrangements, modified to suit the scope of the state's offer and the conditions in which verification will be implemented.
3. Secure the consent of the state to the designation of IAEA inspectors.
4. Develop and implement information management systems for state reporting.
5. Commence official visits to relevant locations in the state with a view to agreeing on the appropriate verification approach.

6. State submits initial declaration, defining the scope of the state's offer, providing information about the fissile material and facilities relevant to that offer, and an indication of the timing of relevant actions.
7. Review initial declaration of the state.
8. Commence facility information verification at relevant facilities.
9. Establish and agree on a plan for equipment acquisition and utilization.
10. Acquire, install, and commission the necessary equipment.
11. Commence inspections with a view to verifying the initial inventory (where necessary, using methods involving attribute verification with information barriers).
12. Carry out routine inspections, with ongoing technical support.
13. Report findings to the state.
14. Publish periodic reports for the Board of Governors and the public on the implementation of the agreement(s).

H. Research and Development Requirements

The verification mission proposed by the authors is both similar to existing IAEA safeguards, yet distinctly different, especially for Stage 2 and beyond. IAEA Member State Support Programmes currently assist the IAEA in developing the technical measures required for effective implementation of safeguards in accordance with the Long Term Research and Development Plan of the IAEA's Department of Safeguards.¹⁸ Some of the needs foreseen in relation to this proposal could be met using existing IAEA safeguards equipment. However, new methods and equipment would be needed, especially as implementation progresses to Stage 2 and beyond.

Research and development in support of the proposed disarmament mission can be divided into two categories:

- Category 1: Generic research and development of concepts, technologies, and prototypes. For this type of work, the IAEA should create a network of partner laboratories, universities and non-governmental organizations, and a centralized capability for testing mock-up verification arrangements, examining and evaluating alternatives, focusing R&D, and selecting candidate approaches and equipment for potential use. Funding contributions from non-government sources (such as foundations or individual philanthropists) would be especially appropriate for this type of activity.
- Category 2: Individual internal teams could be created to support IAEA implementation in each state that concludes an agreement based on the model. The team would be

¹⁸ See STR-375, "IAEA Department of Safeguards Long-Term R&D Plan," 2012-2023, Vienna, January 2013 http://www.iaea.org/safeguards/documents/STR_375_-_IAEA_Department_of_Safeguards_Long-Term_R&D_Plan_2012-2023.pdf

responsible for developing alternative proposals for specific equipment, the procurement arrangements for the selected equipment, provisions for the certification of each item of equipment, and inspector training.

To that end, it is proposed that a center responsible for directing future work, in cooperation with the IAEA member states, be created within the IAEA: a Centre for Disarmament Verification Research and Development. Several factors support that proposal:

1. This undertaking is new, and no methods have been tested and approved for implementation by the IAEA. From Stage 2 on, while the technical achievements of the Trilateral Initiative offer solutions, there is no equipment available and no qualified suppliers, and the security needs of states undergoing the very special and unfamiliar process of disarmament verification need to be better understood.
2. The great majority of NNWSs Parties to the NPT are interested in seeing progress made in verification of nuclear disarmament, but, as NNWSs, they have no means to engage in such work directly.
3. Wherever ideas come from, the IAEA will have to be responsible for ensuring that the verification conclusions are based on sound scientific principles, and are credible, accurate, and authentic. Progress towards nuclear disarmament will require no less.
4. The IAEA has experience in creating cooperative research programs on complex topics with multinational dimensions, in creating networks of international laboratories and universities, and in achieving consensus on sensitive nuclear issues.
5. The Centre, as imagined, would serve as a hub for diplomatic encouragement and overcoming basic security concerns and mistrust, and celebrating progress achieved toward the eventual objective of eliminating all nuclear weapons.

The Centre, as imagined in this proposal, could serve the IAEA disarmament role in several ways. Suggestions as to how an IAEA Centre for Disarmament Verification Research and Development could work are presented in Annex A. Also included in that Annex is a table reflecting some of the anticipated R&D needs in support of the implementation of verification at each of the four stages identified above.

III. Legal Solutions

A. Statutory Authority

For many of the same reasons that bilateral verification was insufficient to provide the necessary assurances of the non-proliferation of nuclear weapons, providing credible assurances of nuclear disarmament will inevitably involve international verification. While some have argued that such verification of disarmament would require the creation of a new body with special authority to carry out the verification mission, support for IAEA verification in relation to nuclear disarmament is evidenced by:

- the United States and the Russian Federation, in seeking IAEA verification of fissile material released from defense programs in 1996;
- the Director General, in responding positively to that request;
- the IAEA's Board of Governors, in endorsing the Trilateral Initiative in 1999; and
- the states parties to the NPT in 2000 and 2010, in calling for the completion and implementation of the Trilateral Initiative, in encouraging NWSs to place fissile material designated as no longer required for military purposes under IAEA verification, and in encouraging all states to support the development of appropriate legally binding verification arrangements, within the context of the IAEA, to ensure the irreversible removal of such material from military programs.

The IAEA's legal authority to implement verification in connection with disarmament efforts derives from Article III.A.5 of the IAEA Statute, which authorizes the IAEA, *inter alia*, "to apply safeguards, at the request of the parties, to any bilateral or multilateral arrangement, or at the request of a state to any of that state's activities in the field of atomic energy."¹⁹

IAEA safeguards are generally implemented pursuant to safeguards agreements concluded between states and the IAEA.²⁰ While today the great majority of safeguards agreements are those concluded with NNWSs pursuant to Article III of the NPT, and it has become popular to think of verification in NWSs as "not safeguards," the IAEA's verification authority, whether in an NPT NNWS, an NPT NWS or any other state, all derives from Article III.A.5 of the IAEA's Statute.

Article III.B.4 of the Statute provides further support for that authority in obliging the IAEA to "conduct its activities in accordance with the purposes and principles of the United Nations to promote peace and international co-operation, and in conformity with policies of the United Nations furthering the establishment of safeguarded worldwide disarmament and in conformity with any international agreements entered into pursuant to such policies."

Recalling the Trilateral Initiative, it was the Russian Federation and the United States that asked the IAEA to consider a role in verifying weapon-origin fissile material released from the defense

¹⁹ See <https://www.iaea.org/about/statute>.

²⁰ And in certain circumstances, with regional organizations, such as EURATOM and ABACC.

programs in the two states. It bears noting that there was never any dispute among the parties about the IAEA's authority, pursuant to Article III.A.5, to implement the requested verification. Indeed, references to the IAEA's statutory authority under Article III.A.5, and the support provided for it in Article III.B.4, were explicitly incorporated in the draft Trilateral Initiative Model Verification Agreement.

In May 1999, before embarking on a detailed discussion of the legal and financial issues related to the Trilateral Initiative within the Joint Working Group, the IAEA Secretariat submitted two documents to the Board of Governors for its information. The first was a report by the Director General on the progress that had been made on preparatory activities related to the Trilateral Initiative which had taken place since its inception in 1996.²¹ The report also provided preliminary information on the additional work required to enable the IAEA to engage in the verification of weapon-origin fissile material, including work related to legal issues (the development of a model verification agreement) and financial arrangements (the estimation of costs and identification of financing mechanisms). The second was a detailed report on options for financing IAEA verification of nuclear arms control and reduction measures, which is discussed in more detail below.²²

During its three and a half hour deliberations on the two Secretariat documents, the Board reflected support for the Trilateral Initiative as a valuable contribution to arms control and disarmament and to the fulfillment of the states' disarmament obligations under the NPT. Many Board members expressed support for the principle of mandatory funding as the more appropriate solution for financing IAEA verification under such initiatives.

B. Bilateral Agreements Based on an IAEA Model

Subsequently, the Trilateral Initiative Joint Working Group established a sub-group to discuss the legal framework for IAEA verification of the irreversible removal of weapon-origin fissile material specified by a state from its nuclear weapons program. A number of options were discussed, including two options associated with the existing voluntary offer agreements (VOAs) of the two states.²³

The use of the VOAs was quickly rejected. Not only do they permit the NWSs to submit to, and remove from, safeguards nuclear material and facilities as they see fit, but the IAEA's right to implement safeguards under those agreements is discretionary and depends on the availability of resources. It was decided that such arrangements would not be consistent with the obligatory

²¹ IAEA document GOV/INF/1999/8, "IAEA Verification of Weapon-Origin fissile material in the Russian Federation and the United States of America: Report of the Director General," 21 May 1999.

²² IAEA document GOV/INF/1999/9, "Financing IAEA Verification of Nuclear Arms Control and Reduction Measures: Report of the Secretariat," 21 May 1999.

²³ The text of the 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 is reproduced in IAEA document INFCIRC/288. The text of the Agreement of 21 February 1985 between the Union of Soviet Socialist Republics and the Agency for the application of safeguards in the Union of Soviet Socialist Republics, which entered into force on 10 June 1985, is reproduced in IAEA document INFCIRC/327.

verification requirements contemplated under the Trilateral Initiative, and that the optimum approach would be to develop a new legal framework.

It was concluded that the most efficacious approach would be to develop a model agreement that could be used as the basis for the conclusion of individual bilateral agreements between each of the states and the IAEA. It was also decided that the model should remain as close as possible to the existing IAEA safeguards system implemented in NPT NNWSs pursuant to Article III of the NPT, modified as necessary to meet the disarmament mission.

Over a period of two years, the Joint Working Group was able to agree on all but a few issues in a draft Model Verification Agreement.²⁴

A new legally binding framework would likewise be the optimum approach under the current proposal, and one that could, in principle, be extended to all states possessing nuclear weapons, including those that are not NPT NWSs, and to all stages of disarmament and any form of fissile material. Using a similar approach to that adopted under the Trilateral Initiative, and using the draft Model Verification Agreement prepared under the Initiative as a starting point, the notional model agreement set out in Annex B of this publication is offered as a first step in the development of a model agreement that would, subject to approval by the IAEA Board of Governors, serve as the basis for bilateral agreements between the IAEA and individual states possessing nuclear weapons.

C. Form and Format

Although the scope, objective, and verification activities under the framework proposed in this publication would be different from those reflected in INFCIRC/153 (Corr.) and the Comprehensive Safeguards Agreements (CSAs) concluded on the basis of that document, the notional model agreement set out in Annex B draws extensively on the provisions of INFCIRC/153 for its format and structure. As was discussed in the context of the Trilateral Initiative, INFCIRC/153 is so widely employed that staying as close as possible to it was a practical step that could facilitate the acceptance and implementation of the new model agreement.

As can be seen from Annex B, the structure of the notional model agreement tracks the structure of INFCIRC/153, and much of the language is the same. It is divided into two parts. The first part articulates the basic undertakings, general principles, and the final treaty clauses (e.g., financing, resolution of disputes, entry into force, duration, and amendment of the agreement). The second part provides more detail on the rights and obligations of the state and the IAEA, including provisions on the objective of verification under the agreement, the functions of the national system of accounting for and control of material subject to the agreement, subsidiary arrangements, facility information, record keeping and reporting, inspections, and export/import provisions.

The notional model agreement also includes definitions which track, to a large extent, the definitions used in INFCIRC/153, modified where necessary to accommodate the different

²⁴ One of the key issues that remained unresolved was what would constitute “irreversibility,” i.e., at what point would/should it be possible to terminate safeguards on material subject to the agreement. For more detail on the nature of the issue, see the Deep Cuts Commission Working Paper cited above.

mandate and verification approaches (e.g., the definition of “adjustment” and “batch”). There are a few additional terms specific to the notional model introduced in the definitions, such as: “material subject to this Agreement,” “attribute,” and “attribute verification.”

D. Specific Legal Issues and Choices

The notional model agreement includes basic undertakings on the part of the state and provides for mandatory verification by the IAEA. Under such an agreement, the state would declare fissile material as “material subject to the agreement” and present that material to the IAEA for safeguarding under the agreement. Once the material is accepted under the agreement, the material would remain under safeguards and could not be removed, except as provided for in the agreement.

Specifically, the state would undertake to accept IAEA verification for so long as the material was subject to that agreement for the purpose of promoting international confidence that the material remained removed from the manufacture of nuclear weapons or any other nuclear explosive devices, from research, development, design or testing for such devices, and from any other military purposes. For its part, the IAEA would be obligated to apply verification to materials submitted to and accepted by it, and would have the right to reach independent conclusions related to the verification objectives under each agreement.

The objective of the verification agreement is framed in a nuclear disarmament context, rather than the non-proliferation context of other IAEA safeguards agreements. Instead of the INFCIRC/153 objective of “the timely detection of the diversion of significant quantities of nuclear material,” the objective contemplated in the notional model agreement would be to confirm that the material subject to the agreement “remains removed from the manufacture of nuclear weapons or any other nuclear explosive devices; from research, development, design or testing for such devices, and from any other military purpose so long as the material remains subject to this Agreement.”

Neither the IAEA nor any NPT NWS would wish to be responsible for the proliferation of weapons-sensitive information as a result of the IAEA’s verification activities. Thus, to prevent proliferation through the verification process, the state would have the absolute right and responsibility to protect any information that it considered classified due to its relationship to nuclear weapons.

Just as provided for in CSAs based on INFCIRC/153, subsidiary arrangements would be required to be concluded by the parties with a view to specifying in detail how the procedures laid down in the agreement are to be applied.

In recognition that a state might conclude other verification arrangements imposing verification requirements on material subject to this agreement, provisions are included obliging the state and the IAEA to cooperate with a view to reconciling the verification procedures under the different agreements and avoiding unnecessary duplication of verification activities, subject to the IAEA’s right to reach its conclusions independently.

One issue that remained unresolved at the end of the Trilateral Initiative involved the provisions for termination and irreversibility. Recognizing that the Russian Federation, the United States,

and the IAEA did not reach a consensus on this issue, the authors have included in the notional model agreement the understanding that verification procedures would have to be applied to material subject to the agreement unless and until:

1. The material has been consumed, diluted in such a way that it is no longer usable for any nuclear activity, or has become practicably irrecoverable;
2. The material has been exported to another state under the conditions referred to in Article 6 in accordance with the procedures set out in Article 68; or
3. The material has been transferred to another IAEA verification regime which <the State> and the IAEA agree meets all the objectives of this Agreement.

E. Standing Consultative Committee

One of the novel aspects of the Trilateral Initiative Model Verification Agreement was a provision for the establishment of a standing committee responsible for reviewing and coordinating matters arising in the implementation of all agreements based on the Model Verification Agreement. Even though there would be individual bilateral agreements between each of the states and the IAEA, it was anticipated that the states party to such agreements would have a collective interest in ensuring consistency and coordination in the implementation of those agreements. As additional states possessing nuclear weapons concluded agreements based on the approved model, a formal mechanism for facilitating coordination among the states party to such agreements would be desirable. Accordingly, the notional model agreement includes a protocol establishing a Standing Consultative Committee, which would consist of representatives of the IAEA and representatives of each state that has concluded an agreement on the basis of the approved model agreement.

IV. Financing Solutions

As indicated above, in May 1999, the Secretariat submitted to the Board of Governors a report on “Financing IAEA Verification of Nuclear Arms Control and Reduction Measures.” In that report, it identified two categories of options for financing such measures: voluntary funding arrangements and mandatory funding (with variations provided on the mandatory option).

As indicated in that report, a number of key considerations should be taken into account in deciding on the appropriate financing mechanism:

1. The IAEA’s authority to conduct the relevant activities stems from Articles III.A.5 and III.B.1 of the Statute.
2. Effective verification of nuclear arms control and reduction is in the interest of all states.
3. Whatever funding mechanism is selected needs to be predictable and reliable.
4. The mechanism must be sufficiently flexible to accommodate a range of possible future verification tasks.
5. The mechanism has to be compatible with the provisions of the Agency’s Statute.

The mechanism of voluntary funding would involve the establishment of an extra-budgetary fund to which contributions would be made by member states, but could also be made by other entities of people, such as non-governmental organizations and philanthropists. While this approach would have the advantage of flexibility, it would not provide predictability or reliability.

Under the mechanism of mandatory (assessed) funding, the Secretariat identified four options. The first three were: funding in accordance with the regular budget scale of assessment; funding in accordance with the formula for assessed contributions to safeguards costs; funding in accordance with a different formula. All of those options would provide reliable and predictable funding, but might be susceptible to criticism in light of the zero real growth policy of some member states, and demands for a certain balance in the regular budget between verification and non-verification activities. The fourth option was the establishment of a non-regular budget fund based on mandatory assessed contributions.²⁵ It was thought that the last option would not only have the advantage of reliability and predictability, but might also avoid the difficulties associated with regular budget funding.

Although the Board took no decision on the appropriate financing mechanism, many Board members expressed support for the principle of mandatory funding as the more appropriate solution in terms of predictability and reliability.

²⁵ Reference is made in the Secretariat’s report to two examples of special funds based on assessed contributions: the 1973 United Nations Peacekeeping Formula (which took into account the relative capacities of economically developed and less developed countries to contribute, and the special responsibilities of the permanent members of the Security Council); and the NPT Review Conference Formula (whereby costs are apportioned between the NWSs, whose share is 55 percent with the remaining 45 percent divided among the other participating states parties using the UN scale of assessment). A detailed explanation of the financing options considered within the Trilateral Initiative is provided in the Deep Cuts Commission Working Paper cited above.

Consideration was given to the concept of “user pays,” whereby the states possessing nuclear weapons would be responsible for financing the verification of nuclear dismantlement. However, the authors of this publication are of the view that, as for IAEA safeguards implementation under CSAs based on INFCIRC/153, the funding of verification under the proposed framework should be based on a mandatory mechanism, making such funding predictable and reliable. Just as non-proliferation safeguards serve the needs of the entire international community, so would internationally verified disarmament.

Regular financing arrangements would provide secure funding for IAEA staff, operational missions and verification equipment. Mechanisms for continuing the work of the Centre and for educational support, however, would benefit from continued voluntary contributions of all kinds. The establishment of a special non-regular budget fund, which could include the possibility of contributions by non-governmental organizations and interested philanthropists, would, in particular, greatly facilitate the creation of a Centre as described in Annex A.

V. A Way Forward

The 2015 NPT Review Conference offers an opportunity for renewed attention to the achievements of the Trilateral Initiative in addressing the technical, legal and financial aspects of IAEA verification in support of disarmament, and building on those achievements along the lines of the framework proposed herein.

To that end a number of steps could be taken by states parties to the NPT, the IAEA, and the Review Conference, as outlined below, to establish a formal framework for the IAEA to engage in verification in the context of disarmament:

- NWSs should, unilaterally and/or collectively, resume discussions with the IAEA, on the basis of the proposed framework, which builds on the achievements of the Trilateral Initiative, with the aim of concluding agreements with the IAEA to ensure the verifiable irreversible removal of fissile material from military programs as a means of contributing to fulfillment of their disarmament commitments under Article VI of the NPT.
- The IAEA should preserve and build on the legacy of the Trilateral Initiative, possibly through the creation of a unit tasked with providing technical advice in connection with proposals for IAEA verification in the context of disarmament.
- The participants in the 2015 NPT Review Conference should, in its Final Declaration, adopt language to the following effect:

Recalling the 2000 NPT Review Conference calls for the completion and implementation of the Trilateral Initiative between the United States of the America, the Russian Federation and the IAEA and the action plan on nuclear disarmament agreed at the 2010 NPT Review Conference, and the resolution of the IAEA General Conference (GC(58)/RES/14) in which the General Conference noted “that the Agency must remain ready to assist, in accordance with its Statute, with verification tasks under nuclear disarmament or arms control agreements that it may be requested to carry out by the states parties to such agreements,” the Conference calls on the nuclear-weapon states to begin without delay negotiation with the IAEA of agreements for IAEA verification of fissile material to ensure that such material remains permanently outside military programs.

ANNEX A:

IAEA Center for Nuclear Disarmament Verification Research and Development

The unique restrictions and conditions associated with verifying classified forms of fissile material require a mechanism that can engage the international community and find solutions that will meet the security requirements of each State possessing nuclear weapons before inspections can commence. Creating a Centre to coordinate such activities is important; creating it within the IAEA will be essential for solving the specific requirements imposed by each such State as part of its due diligence. Creating such a Centre will require an agreed plan and the approval of the sponsors and of the IAEA. This Annex is intended to facilitate the consultations of what the Centre will do, how it will operate, what capabilities will be required, what type of work will be carried out, when, and by whom.

Objectives and Mission

The Centre will support the proposed disarmament mission through the following categories of work:

1. Carry out generic research and development, including on concepts, technologies, and approaches for verification, including physical methods, attributes, and information barriers.
2. Develop verification equipment adequate for proof-of-principle testing.
3. Develop prototype generic measurement systems and containment and surveillance systems incorporating features as necessary for use under the intense security arrangements anticipated at locations where States possessing nuclear weapons hold classified forms of fissile material.
4. Develop mock-up verification arrangements anticipated in connection with implementation of Stages 2 to 4, select candidate approaches and equipment for potential use, and carry out demonstration exercises and adversarial reviews.
5. Develop procurement policies and arrangements for consideration in each participating State possessing nuclear weapons, including equipment selection, formal design and manufacturing specifications, requirements for monitored production, specification of the numbers of each item of equipment and replacement components to be produced under monitored production, sustainable management program, including ongoing testing and evaluation, and the selection of pieces of equipment for destructive analysis.
6. Anticipating that IAEA inspectors in the Department of Safeguards would implement the verification provisions of each agreement concluded with a

State possessing nuclear weapons, the Centre would create technical teams of experts to support IAEA operations implementation in each State. Each technical team would be involved in developing State-specific proposals for verification equipment, qualifying equipment suppliers in the host State, defining the procurement arrangements for the equipment selected, monitoring the production of equipment to be deployed in the State, certifying each item of equipment, and inspector training.

Location

The Centre should be located within or in close proximity to the Vienna International Centre to facilitate access by IAEA member states and IAEA staff.

Limitations

The Centre should make extensive use of simulators to mimic the properties of fissile material, avoiding the need to have any fissile material or radioactive materials at the Centre. There should be no classified objects at the Centre.

Network of Partner Laboratories/Universities

The Centre should serve as the hub of a network of laboratories and universities interested in supporting or cooperating with the Centre, including through the participation of experts from the partner laboratories and universities in work at the Centre and in joint projects.

Scope of Work

The scope of work to be carried out by the Centre should include, among other efforts:

1. Theoretical studies aimed at developing verification concepts and approaches associated with the four stages of disarmament, and reflecting the model agreement once approved by the IAEA Board of Governors;
2. Architectural investigations for warhead dismantlement installations and fissile material conversion facilities, recognizing the complementary requirements for security and authenticity;
3. Theoretical and experimental physics, chemistry, material science, and computer science, as they relate to the functions of the Centre; and
4. Engineering and manufacturing of verification devices and methods appropriate for maintaining continuity of knowledge on items subject to verification under relevant IAEA agreements, and in locations where activities related to nuclear weapons are carried out.

Physical Installations in Support of Implementation Stages

The Centre should be equipped as necessary to succeed.

Stage 1: No specific physical installations are deemed necessary for Stage 1 implementation.

Stage 2: Work on Stage 2 physical installations should begin as early as possible. The following installations are foreseen.

1. A supply of typical containers used by States possessing nuclear weapons for use with pits, secondaries, and other forms of fissile material with classified characteristics;
2. Object receiving station for visual examination, verification, and application of approved containment and surveillance systems;
3. Storage for classified objects, including both palletized storage of containers and storage of containers in engineered vertical or horizontal storage enclosures;
4. Structure housing a secure processing facility (constructed as per agreement on architectural requirements for facilities for removing classified characteristics from fissile material subject to verification) to enable perimeter control verification and monitoring of classified receipts, verification and re-verification of process area to confirm absence of undisclosed ingress or egress, verification of unclassified product, and application of containment and surveillance on unclassified forms of fissile material before its transfer to Stage 1; and
5. Transfer capabilities to move dummy containers in relation to inspection mock-up exercises.

Stage 3: Work on Stage 3 involving physical installations should begin as progress is demonstrated on Stage 2 work.

1. A supply of dummy warheads and associated transport and shipping containers used by States possessing nuclear weapons;
2. Nuclear warhead receiving station for visual examination, verification, and application of approved containment and surveillance systems;
3. Storage for nuclear warheads including realistic provisions for security controls;
4. Structure housing a secure nuclear warhead dismantlement facility (constructed as per agreement on architectural requirements for dismantlement) to enable perimeter control verification and monitoring of nuclear warhead receipts, verification and re-verification of process area to confirm absence of undisclosed ingress or egress, verification of pits and secondaries, application of containment and surveillance on containers holding pits and secondaries, screening of transfers of high explosive, other valuable materials not containing fissile material, witnessing crushing of remaining warhead parts, and witnessing transfers to Stage 2; and

5. Transfer capabilities to move dummy containers in relation to inspection mock-up exercises.

Stage 4: Work on Stage 4 physical installations should begin as progress is demonstrated on Stage 3 work.

1. A supply of dummy warheads and dummy bomb housings and missile buses, associated transport and shipping containers used by States possessing nuclear weapons;
2. Nuclear warhead demounting station for visual examination and verification of nuclear warhead demounting and application of approved containment and surveillance systems;
3. Interim storage for nuclear warheads including realistic provisions for security controls;
4. Transfer of verified warheads to Stage 3.

Suggested Projects

The topics identified in the following table are intended to be suggestive of the work that could ultimately be carried out at the Centre.

Table: Suggested Projects

Implementation	Scope of Activities	Anticipated R&D
Stage 1	Unclassified plutonium or HEU: storage; peaceful use; disposal or export	When nearby activities involve nuclear weapons, may require appropriate methods that may be less effective or efficient than as for existing IAEA safeguards implementation.
		Fuel assemblies made using fissile material may require special markings and design features, e.g., to prevent fuel assembly reconstitution.
		Can-in-canister deep bore hole verification methods do not exist.
Stage 2	Storage of pits, secondaries, and other classified fissile material; conversion to remove classified characteristics	Prototype attribute verification system for plutonium fissile material.
		Verification alternatives for HEU fissile material.
		Authentication concepts, prototype systems, and procedures.
		Containment/surveillance systems suitable for classified forms of fissile material.
		Mock-up of storage facility for classified forms of fissile material to test and evaluate verification approaches and equipment.
		Design concepts for perimeter control verification of conversion facilities to remove classified characteristics
		Construction of mock-up of conversion facility to perform vulnerability tests and to test and demonstrate verification procedures.
Stage 3	Storage and dismantlement of nuclear warheads	Prototype attribute verification system for warheads containing Pu, HEU or both.
		Authentication concepts, prototype systems, and procedures.
		Containment/surveillance systems suitable for nuclear warheads in storage.
		Construct mock-up of storage facility for nuclear warheads to test and evaluate verification approaches and equipment.
		Design concepts for nuclear warhead dismantlement facilities to facilitate perimeter control verification
		Construct mock-up of nuclear warhead dismantlement facility to test and evaluate verification approaches and equipment.
		Develop methods for verified transfers to Stage 2 facilities.
Stage 4	Demounting deployed warheads identified for elimination and transport to Stage 3 facility.	Develop conceptual approaches, equipment, and managed access procedures as necessary to identify, verify, apply containment and surveillance methods and witness transfers to Stage 3 facilities.
		Using dummy warheads provided by States possessing nuclear weapons, develop and practice procedures, including managed access, marking warheads.

Annex B:

Notional Model Agreement between <a State Possessing Nuclear Weapons> and the International Atomic Energy Agency for Verification in Relation to Disarmament

MODEL AGREEMENT BETWEEN <THE STATE> AND THE INTERNATIONAL ATOMIC ENERGY AGENCY FOR VERIFICATION IN RELATION TO NUCLEAR DISARMAMENT

[WHEREAS <the State> is a nuclear-weapon State party to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), and, in accordance with Article VI of the NPT, has undertaken to “pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control”];

[WHEREAS <the State> possesses nuclear weapons and wishes to contribute to safeguarded worldwide disarmament,]

RECOGNIZING that plutonium containing high concentrations of the isotope Pu-239, and high enriched uranium (HEU) containing high concentrations of the isotope U-235, hereinafter collectively referred to as *fissile material*, are essential to the functioning of all contemporary nuclear weapons, and that incremental verification of the irreversible removal of such materials from military programs would contribute to further progress towards nuclear disarmament,

NOTING the willingness of the International Atomic Energy Agency (IAEA) to verify *fissile material* at any of the following stages of disarmament:

Stage 1: Unclassified forms of *fissile material*;

Stage 2: Pits, secondaries and other *classified fissile material*;

Stage 3: Storage and dismantlement of nuclear warheads;

Stage 4: Removal and monitoring of deployed nuclear warheads identified for elimination.

WHEREAS, pursuant to Article III.A.5 of the Statute of the IAEA (hereinafter referred to as the “Statute”), the IAEA is authorized to conclude a safeguards agreement at the request of a State to any of that State’s activities in the field of atomic energy;

WHEREAS, pursuant to Article III.B of the Statute, the IAEA shall conduct its activities in accordance with the purposes and principles of the United Nations to promote peace and international co-operation, and in conformity with policies of the United Nations furthering the establishment of safeguarded worldwide disarmament and in conformity with any international agreements entered into pursuant to such policies;

NOW, THEREFORE, <the State> and the IAEA agree as follows:

PART I

BASIC UNDERTAKINGS

Article 1

- a. <The State> shall accept IAEA verification, in accordance with the terms of this Agreement, on all *material subject to this Agreement* for the purpose of promoting international confidence that such material remains removed from the manufacture of nuclear weapons or any other nuclear explosive devices, from research, development, design or testing for such devices, and from any other military purpose so long as the material remains subject to this Agreement.
- b. <The State> undertakes not to remove from IAEA verification under this Agreement *material subject to this Agreement*, except as provided for in this Agreement.
- c. <The State> and the IAEA shall co-operate to facilitate the effective and efficient implementation of the verification procedures and technologies provided for in this Agreement.

Article 2

- a. The IAEA shall have the right and obligation to apply verification procedures, in accordance with the terms of this Agreement, to all *material subject to this Agreement* for the sole purpose of verifying that such material remains removed from the manufacture of nuclear weapons or any other nuclear explosive devices, from research, development, design or testing for such devices, and from any other military purpose so long as the material remains subject to this Agreement.
- b. In carrying out its rights and obligations under this Agreement, the IAEA shall have the right to reach independently its conclusions related to achievement of the verification objectives of this Agreement.

IMPLEMENTATION OF VERIFICATION

Article 3

- a. <The State> and the IAEA shall seek to implement this Agreement in a manner designed to:
 - i. Avoid undue interference in the operation of any *facility* containing *material subject to this Agreement*;
 - ii. Prevent unauthorized access by IAEA inspectors to *classified* information related to nuclear weapons;
 - iii. Provide sustainable access to verification equipment supply, maintenance and repair to assure that IAEA verification findings are accurate and reliable;
 - iv. Be consistent with prudent management practices required for the economic and safe operation of such a *facility*; and
 - v. Achieve cost effective verification by concentrating the verification procedures on *material subject to this Agreement* from which nuclear weapons could readily be assembled or manufactured.
- b. Subject to the IAEA's right to reach independently its conclusions under this Agreement, <the State> and the IAEA shall co-operate with a view to reconciling verification procedures, and avoiding unnecessary duplication of verification activities, under other agreements with respect to *material subject to this Agreement*.

Article 4

Material subject to this Agreement shall remain subject to this Agreement until such time as the IAEA determines that:

- a. Material has been substituted therefore in accordance with Article 5 of this Agreement;
- b. The material has been consumed, diluted in such a way that it is no longer usable for any nuclear activity, or has become practicably irrecoverable;
- c. The material has been exported to another State under the conditions referred to in Article 6 in accordance with the procedures set out in Article 68; or
- d. The material has been transferred to another IAEA verification regime which <the State> and the IAEA agree meets all the objectives of this Agreement.

Article 5

- a. For uranium subject to this Agreement which has been down-blended to less than 20 percent enriched, <the State> may place under this Agreement as a substitute other low enriched uranium not otherwise subject to this Agreement or other verification obligations to the IAEA that the IAEA has determined is at least equivalent in amount and composition to that which would be subject to verification under this Agreement. The detailed arrangements for the implementation of this provision shall be specified in the Subsidiary Arrangements.
- b. For plutonium subject to this Agreement which has been irradiated to a level specified in the Subsidiary Arrangements, <the State> may place under this Agreement as a substitute plutonium not otherwise subject to this Agreement or other verification obligations to the IAEA that the IAEA has determined is at least equivalent in isotopic composition and amount of Pu-239 to that of the plutonium subject to verification under this Agreement. The detailed arrangements for the implementation of this provision shall be specified in the Subsidiary Arrangements.

Article 6

- a. <The State> shall not export to any State any *material subject to this Agreement* which has *classified* characteristics.
- b. <The State> shall not export to any State any *fissile material subject to this Agreement* unless such material will be subject to verification under an agreement between the importing State and the IAEA that <the State> and the IAEA agree is similar in scope and application to those of this Agreement.
- c. <The State> shall not export to any State any other *material subject to this Agreement* unless <the State> receives commitments from the recipient State that such material will not be used for the manufacture of nuclear weapons or any other nuclear explosive devices, for research, development and design or testing for such devices, or for any other military purpose; that the material will be subject to safeguards in that State pursuant to a comprehensive safeguards agreement with the IAEA; and that the same conditions will apply to any retransfer of the material.

Article 7

Prior to any export of *material subject to this Agreement*, <the State> and the IAEA shall enter into arrangements to permit the IAEA, subject to the conditions set out in Article 11 of this Agreement, to verify the material prior to its export.

Article 8

Unless otherwise specified by <the State>, the IAEA shall cease to carry out verification activities under this Agreement at a *facility* when the IAEA and <the State> have agreed that all *material subject to this Agreement* has been removed from the *facility*.

NATIONAL SYSTEM OF ACCOUNTING FOR AND CONTROL OF MATERIAL SUBJECT TO THIS AGREEMENT

Article 9

- a. <The State> shall maintain a system of accounting for and control of all *material subject to this Agreement*. IAEA verification of *material subject to this Agreement* shall be applied in such a manner as to enable the IAEA to verify the findings of <the State's> system of accounting for and control of all *material subject to this Agreement*. The IAEA's verification shall include, inter alia, independent measurements and observations conducted by the IAEA in accordance with the procedures specified in Part II below.
- b. In relation to *classified* forms of *material subject to this Agreement*, should a verification test applied by the IAEA fail to confirm declared characteristics, <the State> and the IAEA shall agree on arrangements under which the item or items involved are re-verified, and if the results remain in question, on steps to de-list the item from the declared inventory and to remove it from the locations where *material subject to this Agreement* remain under verification.

PROVISION OF INFORMATION

Article 10

To ensure the effective implementation of this Agreement, the IAEA shall be provided, in accordance with the provisions set out in Part II below, with information concerning *material subject to this Agreement* and information about the *facilities* relevant to verifying such material. The IAEA shall be entitled to receive only the minimum amount of information and data consistent with carrying out its responsibilities under this Agreement.

CLASSIFIED INFORMATION

Article 11

- a. [Bearing in mind the obligation of <the State> under Article I of the NPT,] (N) notwithstanding any other provision of this Agreement, <the State> shall not provide, nor may the IAEA require access to, any information that <the State> considers *classified* due to its relationship to nuclear weapons design or manufacturing.
- b. The IAEA shall not have access to other information considered by <the State> to be *classified*, except as may be agreed to by <the State>.
- c. <The State> shall establish security arrangements to prevent IAEA inspectors from acquiring any information that <the State> considers *classified*, except as may be provided in accordance with paragraph b. above. <The State> and the IAEA will review any such arrangements and agree on practical modalities to enable the IAEA to meet its obligations under this Agreement while respecting the security arrangements.

PROTECTION OF CONFIDENTIAL INFORMATION

Article 12

- a. The IAEA shall take every precaution to protect commercial and industrial secrets and other confidential information identified by the State as requiring protection coming to its knowledge in the implementation of the Agreement. Except with the consent of <the State>, the IAEA shall not publish or communicate to any State, organization or person any information obtained by it in connection with the implementation of the Agreement. However, specific information relating to such implementation in <the State> may be given to the Board of Governors and to such IAEA staff members as require such knowledge by reason of their official duties in connection with IAEA verification under this Agreement, but only to the extent necessary for the IAEA to fulfil its responsibilities in implementing the Agreement. Summarized information on *material subject to this Agreement* shall be published upon decision of the Board.
- b. The IAEA shall, at the request of <the State>, be prepared to examine on premises of <the State> information for a *facility* which <the State> regards as being of particular sensitivity. Such information need not be physically transmitted to the IAEA provided that it remains available for ready further examination by the IAEA on premises of <the State>.
- c. With respect to *facility* information referred to in paragraph b. above, <the State> shall, in accordance with procedures developed with the Agency, make arrangements to store on premises of <the State> copies of all such information, and shall facilitate access by IAEA inspectors to these documents. The IAEA shall secure its copies of *facility* information and related materials using IAEA seals on agreed containment enclosures.

IAEA INSPECTORS

Article 13

- a. The Director General shall notify <the State> of the Board's approval of any IAEA official as an inspector. Unless <the State> advises the Director General of its rejection of such an official as an inspector for <the State> for the purposes of this Agreement within three months of receipt of notification of the Board's approval, the inspector so notified to <the State> shall be considered designated to <the State> for the purposes of this Agreement.
- b. The Director General, acting in response to a request by <the State> or on the Director General's own initiative, shall immediately inform <the State> of the withdrawal of the designation of any official as an inspector for <the State> for the purposes of this Agreement.
- c. <The State> shall take the necessary steps to ensure that IAEA inspectors designated in accordance with paragraph a. of this Article can effectively discharge their functions under this Agreement.

VISAS

Article 14

<The State> shall, within one month of the receipt of a request therefor, provide the designated inspector specified in the request with appropriate multiple entry/exit and/or transit visas, where required, to enable the inspector to enter and remain on the territory of <the State> for the purpose of carrying out his/her functions under this Agreement. Any visas required shall be valid for at least one year and shall be renewed, as required, to cover the duration of the inspector's designation to <the State>.

PRIVILEGES AND IMMUNITIES

Article 15

<The State> shall apply to the IAEA (including its property, funds and assets) and to its inspectors and other officials, performing functions under this Agreement, the relevant provisions of the Agreement on the Privileges and Immunities of the International Atomic Energy Agency.

THIRD PARTY LIABILITY FOR NUCLEAR DAMAGE

Article 16

<The State> shall ensure that any protection against third party liability in respect of nuclear damage, including any insurance or other financial security, which may be available under its laws or regulations shall apply to the IAEA and its officials for the purpose of the implementation of this Agreement in the same way as that protection applies to nationals of <the State>.

SETTLEMENT OF CLAIMS

Article 17

Any claim by <the State> against the IAEA or by the IAEA against <the State> in respect of any damage resulting from the implementation of this Agreement, other than damage arising out of a nuclear incident, shall be settled in accordance with international law.

FINANCIAL CLAUSES

Article 18

<The State> and the IAEA will each be responsible for the expenses it incurs in carrying out its responsibility under this Agreement. However, if <the State> or persons under its jurisdiction incur extraordinary expenses as a result of a specific request by the IAEA, the IAEA shall reimburse such expenses provided that it has agreed in advance to do so. In any case, the IAEA shall bear the cost of any additional procedures which inspectors may request.

RESOLUTION OF DISCREPANCIES AND ANOMALIES

Article 19

- a. <The State> and the IAEA shall co-operate in resolving discrepancies and anomalies arising in the course of implementation of this Agreement through consultations as soon as such discrepancies or anomalies are identified. In the event that it is not possible to resolve a discrepancy or anomaly through consultations, it shall be reported to the Director General.

- b. If the Board, upon report of the Director General, decides that an action by <the State> is essential and urgent in order to ensure compliance with this Agreement, the Board shall be able to call upon <the State> to take the required action without delay, irrespective of whether procedures for the settlement of a dispute have been invoked.
- c. If the Board, upon examination of relevant information reported to it by the Director General, finds that the IAEA is not able to verify that *material subject to this Agreement* remains accounted for under this Agreement, the Board may make the reports provided for in paragraph C of Article XII of the Statute and may also take, where applicable, the other measures provided for in that paragraph. In taking such action, the Board shall take account of the degree of assurance provided by the verification measures that have been applied and shall afford <the State> every reasonable opportunity to furnish the Board with any necessary reassurance.

INTERPRETATION AND APPLICATION OF THE AGREEMENT AND SETTLEMENT OF DISPUTES

Article 20

- a. <The State> and the IAEA, at the request of either, shall consult on any issue arising out of interpretation or application of this Agreement.
- b. <The State> shall have the right to request that any question arising out of the interpretation or application of this Agreement be considered by the Board. <The State> shall be invited by the Board to participate in the discussion of any such question by the Board.
- c. Any dispute arising out of the interpretation or application of this Agreement, except a dispute with regard to a finding by the Board of Governors under Article 19.c. or an action taken by the Board pursuant to such a finding, which is not settled by negotiation or another procedure agreed to by <the State> and the IAEA shall, at the request of either, be submitted to such binding third-party dispute settlement procedure as may be agreed between the parties within 60 days of said request. In the absence of such an agreement, either party may submit the dispute to the Board of Governors for resolution.

Article 21

The rights and obligations of <the State> and the IAEA under this Agreement shall not, and are not intended to, affect the rights and obligations of either party under any other agreement.

AMENDMENT OF THE AGREEMENT

Article 22

- a. <The State> and the IAEA shall, at the request of either, consult each other on amendments to this Agreement.
- b. All amendments shall require the written agreement of <the State> and the IAEA.
- c. Modifications to the scope of the Agreement, the *facilities* wherein safeguards under this Agreement will be implemented, and the designation of *material subject to this Agreement* may be made through communications between <the State> and the IAEA, without amendment to the Agreement.

ENTRY INTO FORCE

Article 23

- a. This Agreement, and any amendment thereto, shall enter into force on the date on which the IAEA receives from <the State> written notification that <the State>'s statutory and/or constitutional requirements for entry into force have been met.
- b. <The State> may, at any date before this Agreement enters into force, declare that it will apply this Agreement provisionally.
- c. The Director General shall promptly inform all Member States of the IAEA of any declaration of provisional application of, and of the entry into force of, this Agreement.

DURATION AND TERMINATION

Article 24

- a. This Agreement shall remain in force indefinitely. However, if all *material subject to this Agreement* is removed from the scope of this Agreement in accordance with Article 4 above, <the State> and the IAEA may agree to terminate this Agreement.
- b. This Agreement may be terminated by <the State> if it decides that extraordinary events, related to the subject matter of this Agreement, have jeopardised its supreme interests. It shall give notice of such termination to the IAEA three months in advance. Such notice shall include a statement of the extraordinary events it regards as having jeopardized its supreme interests.

PART II

OBJECTIVE OF VERIFICATION

Article 25

- a. The objective of the verification procedures under this Agreement is to confirm that all *material subject to this Agreement* remains removed from the manufacture of nuclear weapons or any other nuclear explosive devices; from research, development, design or testing for such devices, and from any other military purpose so long as the material remains subject to this Agreement.
- b. The use of material accountancy, including agreed methods for the verification for *material subject to this Agreement* with *classified* characteristics, is of fundamental importance. Containment and surveillance techniques shall be used to the maximum degree practical to maintain continuity of knowledge of verified material in order to minimize the need for re-verification.
- c. The technical conclusion of the IAEA's verification activities shall be a statement, in respect of each *material balance area* and with respect to <the State> as a whole in relation to *material subject to this Agreement*, confirming the reports provided by <the State>, as specified in this Agreement, concerning *material subject to this Agreement*, and confirming that such material remains accounted for under this Agreement.

FUNCTIONS OF THE NATIONAL SYSTEM OF ACCOUNTING FOR AND CONTROL OF MATERIAL SUBJECT TO THIS AGREEMENT

Article 26

- a. Pursuant to Article 9, and subject to Article 11, the IAEA shall make use of <the State's> system of accounting for and control of *material subject to this Agreement* and shall avoid unnecessary duplication of <the State's> accounting and control activities.
- b. <The State's> system of accounting for and control of all *material subject to this Agreement* shall be based on a structure of *material balance areas*, and shall make provision as appropriate and specified in the Subsidiary Arrangements taking into account restrictions on *classified* information and the provisions of Article 4 for the establishment of such measures as:

- i. A measurement system for the determination of the quantities of *material subject to this Agreement* received, produced, shipped, lost or otherwise removed from inventory, and the quantities on inventory;
- ii. The evaluation of precision and accuracy of measurements and the estimation of measurement uncertainty;
- iii. Procedures for identifying, reviewing and evaluating differences in shipper/ receiver measurements;
- iv. Procedures for taking a *physical inventory*;
- v. Procedures for the evaluation of accumulations of unmeasured inventory and unmeasured losses;
- vi. A system of records and reports showing, for each *material balance area*, the inventory of *material subject to this Agreement* and the changes in that inventory including receipts into and transfers out of the *material balance area*;
- vii. Provisions to ensure that the accounting procedures and arrangements are being operated correctly; and
- viii. Procedures for the provision of reports to the IAEA in accordance with Articles 43 to 53 below.

SUBSIDIARY ARRANGEMENTS

Article 27

- a. The IAEA and <the State> shall make Subsidiary Arrangements which shall specify in detail, to the extent necessary to permit the IAEA to fulfil its responsibilities under this Agreement in an effective and efficient manner, how the procedures laid down in this Agreement are to be applied, taking into account the restrictions referred to in Article 11. The Subsidiary Arrangements may be extended or modified by agreement between <the State> and the IAEA without amendment of this Agreement.
- b. The Subsidiary Arrangements shall be elaborated and shall enter into force at the same time as, or as soon as possible after the entry into force of this Agreement. <The State> shall provide the IAEA promptly with the information required for completing the Subsidiary Arrangements. Upon entry into force of this Agreement, the IAEA shall be entitled to verify design information provided for in Articles 28 through 34 below.

FACILITY INFORMATION

General

Article 28

Pursuant to Article 10 above:

- a. Information in respect of *facilities* referred to in Article 46.c. shall be provided to the IAEA as early as possible to enable <the State> and the IAEA to agree on verification arrangements, including any modifications as necessary to assure that their respective requirements can be met in an efficient manner, and in any event not later than, the date on which the relevant initial or supplemental report under Article 46.a. or b. is provided to the IAEA. <The State> shall seek not to introduce *material subject to this Agreement* into such a *facility* until the initial verification of design information has been completed and the results of that verification are included in the Subsidiary Arrangements pursuant to Article 32 below unless it agrees to ad hoc inspections as provided for in Article 56.
- b. <The State> may create a temporary *facility* for the verification of *fissile material* with *classified* characteristics when such an arrangement will further the purposes of this Agreement.
- c. Information in respect of facilities into which <the State> intends to transfer *fissile material* which is already subject to this Agreement shall be provided to the IAEA as early as possible, but not later than a minimum of 180 days in advance of such transfer. <The State> shall not introduce *material subject to this Agreement* into such a *facility* until the initial verification of design information has been completed and the results of that verification are included in the Subsidiary Arrangements pursuant to Article 32 below unless it agrees to ad hoc inspections as provided for in Article 56.

Article 29

The information in respect of each *facility* referred to in Article 28 shall include, when applicable, and subject to the provisions of Article 11:

- a. The identification of the *facility*, stating its general character, purpose, geographic location, and the name and address to be used for routine business purposes;
- b. A description of the general plan of the *facility* with reference, to the extent feasible, to the form, location and flow of *material subject to this Agreement*.
- c. Information on the *facility* relating to *fissile material* accountancy, taking into account any restrictions imposed by *classified* information, and
- d. A description of the existing and proposed procedures at the *facility* for *fissile material* accountancy and control, with special reference to *material balance areas* established by the

operator, measurements of flow, procedures for *physical inventory* taking, container control measures, and containment/surveillance measures.

Article 30

Subject to the provisions of Article 11, other information relevant to verification shall be made available to the IAEA in respect of each *facility* for which *facility* information is required to be provided, in particular on organizational responsibility for *fissile material* accountancy and control. <The State> shall make available to the IAEA supplementary information on the health, security and safety procedures which the IAEA shall observe and with which the inspectors shall comply at the *facility*.

Article 31

Facility information in respect of modifications relevant for verification purposes shall be provided for examination sufficiently in advance for the verification procedures to be adjusted when necessary.

Purposes of examination of facility information

Article 32

Facility information made available to the IAEA shall be used for the following purposes:

- a. To identify the features of *facilities* and *material subject to this Agreement* relevant to the verification of *material subject to this Agreement* in sufficient detail to facilitate verification;
- b. To determine *material balance areas* to be used for IAEA accounting purposes and to select those *strategic points* which are *key measurement points* and which will be used to determine flows and inventories of *material subject to this Agreement*; in determining such *material balance areas* the IAEA shall, inter alia, use the following criteria:
 - i. In determining the *material balance area*, advantage should be taken of any opportunity to use containment and surveillance to help ensure the completeness of flow measurements and thereby simplify verification and concentrate efforts at *key measurement points*;
 - ii. A number of *material balance areas* in use at a *facility* or at distinct sites may be combined in one *material balance area* to be used for IAEA accounting purposes when the IAEA determines that this is consistent with its verification requirements; and

- iii. If <the State> so requests, a special accounting area may be established to protect *classified* or commercially sensitive information;
- c. To establish the nominal timing and procedures for taking of *physical inventory* for IAEA accounting purposes;
- d. To establish the records and reports requirements and records evaluation procedures;
- e. To establish requirements and procedures for verification of the reports with respect to *material subject to this Agreement*; and
- f. To select appropriate combinations of containment and surveillance methods and techniques and the *strategic points* at which they are to be applied.

The results of the examination of the *facility* information shall be included in the Subsidiary Arrangements.

Re-examination of facility information

Article 33

Facility information shall be re-examined in the light of changes in operating conditions, of developments in verification technology or of experience in the application of verification procedures, with a view to modifying the action the IAEA has taken pursuant to Article 32 above.

Verification of facility information

Article 34

- a. The IAEA, in co-operation with <the State>, may send inspectors to *facilities* to verify the design information provided to the IAEA pursuant to Articles 29 to 31 above for the purposes stated in Article 32.
- b. *Facility* information shall be re-verified at periodic intervals to confirm that the assumptions underlying the verification approach remain valid.

RECORDS SYSTEM

General

Article 35

In establishing a system of accounting for and control of *material subject to this Agreement*, <the State> shall arrange that records are kept in respect of each *material balance area*, taking into account the provisions of Article 11. The Subsidiary Arrangements shall describe the records to be kept in respect of each *material balance area*.

Article 36

<The State> shall make arrangements to facilitate the examination of records by inspectors.

Article 37

The records shall be retained during the period that *material subject to this Agreement* remains at the *facility*, and thereafter, for at least five years.

Article 38

The records shall consist, as appropriate, of:

- a. Accounting records of all *material subject to this Agreement*; and
- b. Operating records for all *facilities* containing *material subject to this Agreement*.

Article 39

The system of measurements on which the records used for the preparation of reports are based shall either conform to the latest international standards or be equivalent in quality to such standards.

Accounting records

Article 40

The accounting records shall set forth the following in respect of each *material balance area*:

- a. All *inventory changes*, so as to permit a determination of the *book inventory* at any time;
- b. All measurement results that are used for determination of the *physical inventory*, and
- c. All *adjustments* and *corrections* that have been made in respect of *inventory changes*, *book inventories* and *physical inventories*.

Article 41

For all *inventory changes* and *physical inventories* the records shall show, in respect of each *batch of material subject to this Agreement*: material identification, *batch data* and *source data*. Furthermore, the date of the *inventory change* and, when appropriate, the originating *material balance area* and the receiving *material balance area* or the recipient, shall be indicated for each *inventory change*.

Operating records

Article 42

So far as is consistent with Article 11, the operating records shall set forth, as applicable, in respect of each *material balance area*:

- a. Those operating data which are used to establish changes in the number, identity, location or integrity of containers, the quantities and the composition of *material subject to this Agreement*,
- b. The data obtained from the calibration of tanks and instruments and from sampling and analyses, the procedures to control the quality of measurements and the derived estimates of random and systematic error;
- c. A description of the sequence of the actions taken in preparing for, and in taking, a *physical inventory* in order to ensure that it is correct and complete; and
- d. A description of the actions taken in order to ascertain the cause and magnitude of any accidental or unmeasured loss that might occur.

REPORTS SYSTEM

General

Article 43

<The State> shall provide the IAEA with reports as detailed in Articles 44 to 53 below in respect of *material subject to this Agreement*.

Article 44

Reports shall be made in English.

Article 45

Reports shall be based on the records kept in accordance with Articles 35 to 42 above and shall consist, as appropriate, of accounting reports and special reports.

Accounting reports

Article 46

- a. Upon entry into force of the Agreement, <the State> may specify in an initial report to the IAEA material of the type identified in Article 70.o. for the purpose of making it subject to IAEA verification under this Agreement. The report shall include the following information:
 - i. for containers of *material subject to this Agreement* for which mass cannot be declared without disclosing information requiring protection under Article 11:
 - (a) the total number of items or containers specified by <the State>;
 - (b) the location of the items or containers, and the date as from when the containers can be verified for acceptance under the verification arrangements;
 - (c) for each container of plutonium:
 - [1] container type and identification;
 - [2] the *attribute* that it contains plutonium;

- [3] the *attribute* that the plutonium has a Pu-240 to Pu-239 ratio of less than 0.1;
 - [4] the *attribute* that the mass of plutonium is greater than a value to be established in the Subsidiary Arrangements;
- (d) for each container of HEU:
- [1] container type and identification
 - [2] the fact that it contains HEU;
 - [3] the *attribute* that the *enrichment* is equal to or exceeds 20 percent;
 - [4] the *attribute* that the mass of HEU is greater than a value to be established in the Subsidiary Arrangements.
- (e) a container of both plutonium and HEU may be declared as a container holding plutonium or as a container holding HEU as provided for in subparagraphs a.(i)(c) and a.(i)(d) of this Article, respectively.
- ii. for *material subject to this Agreement* for which mass can be declared without disclosing information requiring protection under Article 11, but which has other *classified* characteristics:
- (a) the total mass of each type of *material subject to this Agreement*;
 - (b) the location of the material, and the date as from when the *fissile material* can be verified for acceptance under the verification arrangements;
 - (c) the number of *batches* of each type of *material subject to this Agreement* and the identity of each *batch*;
 - (d) the number, type and identity of all items of *material subject to this Agreement* in each *batch*;
 - (e) the physical form and chemical composition of the *material subject to this Agreement* in each *batch*, except that, should <the State> deem that the information required in this provision would reveal information requiring protection under Article 11, <the State> may indicate “*classified*” in lieu of providing the specific information requested;
 - (f) the isotopic composition of the *material subject to this Agreement*, and for plutonium, the content of americium and the date of analysis, except that, if the isotopic composition is deemed by <the State> to require protection under Article 11, <the State> shall declare the *attribute*, as appropriate, that, for uranium, the *enrichment* is equal to or exceeds 20 percent, or that, for plutonium, the Pu-240 to Pu-239 ratio is less than 0.1;

- (g) derived estimates of random and systematic error for the amounts declared.
- iii. or *material subject to this Agreement* for which mass and all other characteristics can be declared without disclosing information requiring protection under Article 11:
- (a) the total mass of each type of *material subject to this Agreement*;
 - (b) the location of the *material subject to this Agreement*, and the date as from when the *material subject to this Agreement* can be verified for acceptance under the verification arrangements;
 - (c) the number of *batches* of each type of *material subject to this Agreement* and the identity of each *batch*;
 - (d) the number, type and identity of all items of *material subject to this Agreement*;
 - (e) the physical form and chemical composition of the *material subject to this Agreement* in each *batch*;
 - (f) the isotopic composition of the *material subject to this Agreement*, and for plutonium, the content of americium and the date of analysis;
 - (g) derived estimates of random and systematic error for the amounts declared.
- b. <The State> may, at any time after submission of its initial report, specify in supplemental reports to the IAEA additional material of the type identified in Article 70.o. for the purpose of making it subject to IAEA verification under this Agreement. Any supplemental report shall include the same information as is required pursuant to paragraph a. above.
- c. <The State> shall report to the IAEA each *facility* at which the material referred to in paragraphs a. or b. of this Article will be made available for verification. Such report shall accompany the reports referred to in paragraphs a. and b. of this Article, respectively.
- d. The requirements for the provision of information are to be reviewed periodically to determine whether there is additional information about *material subject to this Agreement* the provision of which would facilitate IAEA verification under this Agreement, including other characteristics of such material that will not reveal *classified* characteristics.

Article 47

For each *material balance area*, <the State> shall provide the IAEA with the following accounting reports:

- a. *Inventory change* reports showing changes in the inventory of *material subject to this Agreement*. The reports shall be dispatched as soon as possible and in any event within 30 days after the end of the month in which the *inventory changes* occurred or were established; and
- b. Material balance reports showing the material balance based on a *physical inventory* of *material subject to this Agreement* actually present in the *material balance area*. The reports shall be dispatched as soon as possible and in any event within 30 days
- c. The reports shall be based on data available as of the date of reporting and may be corrected at a later date as required.

Article 48

Inventory change reports shall specify identification and *batch data* for each *batch* of *material subject to this Agreement*, the date of the *inventory change* and, as appropriate, the originating *material balance area*, the receiving *material balance area* and the recipient. These reports shall be accompanied by explanatory notes:

- a. Explaining the *inventory changes* on the basis of the operating data contained in the operating records provided for under Article 42.a. above; and
- b. Describing, as specified in the Subsidiary Arrangements, the anticipated operational programme, particularly the taking of a *physical inventory*.

Article 49

<The State> shall report each *inventory change*, *adjustment* and *correction* either periodically in a consolidated list or individually. The *inventory changes* shall be reported in terms of *batches*; small amounts, such as analytical samples, as specified in the Subsidiary Arrangements, may be combined and reported as one *inventory change*.

Article 50

The IAEA shall provide <the State> with statements of *book inventory* of *material subject to this Agreement*, for each *material balance area*, as based on the *inventory change* reports for the period covered by each such statement.

Article 51

Material balance reports shall include the following entries, unless otherwise agreed by the IAEA and <the State>:

- a. Beginning *physical inventory*;
- b. *Inventory changes* (first increases, then decreases);
- c. Ending *book inventory*;
- d. *Shipper/receiver differences*;
- e. Adjusted ending *book inventory*;
- f. Ending *physical inventory*; and
- g. *Material unaccounted for*, if any.

A statement of the *physical inventory* listing all *batches* separately and specifying *material subject to this Agreement* identification and *batch data* for each *batch* shall be attached to each material balance report.

Special reports

Article 52

<The State> shall make special reports without delay:

- a. If any unusual incident or circumstances lead the State to believe that there is or may have been loss of *material subject to this Agreement* that exceeds the limits to be specified for this purpose in the Subsidiary Arrangements; or
- b. If the containment has unexpectedly changed from that specified in the Subsidiary Arrangements to the extent that undetected removal of *material subject to this Agreement* has become possible.
- c. If any unusual incident or circumstances during international transfers lead <the State> to believe that there is or may have been loss of *material subject to this Agreement*, including the occurrence of significant delay during the transfer.

Amplification and clarification of reports

Article 53

At the IAEA's request <the State> shall supply amplifications or clarifications of any report, in so far as relevant for the purpose of verification, subject to the provisions of Article 11.

INSPECTIONS

General

Article 54

The IAEA shall have the right to make inspections as provided for in Articles 55 to 63 below.

Purposes of inspections

Article 55

The IAEA may make routine inspections at a *facility* upon completion of the initial verification of design information and entry into force of the relevant Subsidiary Arrangements in order to:

- a. Verify the information contained in reports provided pursuant to Article 46 and 47;
- b. Verify that reports are consistent with records;
- c. Taking into account the requirements of Article 11, verify the location, identity, quantity and composition of all *material subject to this Agreement* as declared in the reports provided by the State;
- d. Verify information on the possible causes of anomalies, *shipper/receiver differences* and uncertainties in the *book inventory*; and
- e. Identify, and if possible verify the quantity and composition of, *material subject to this Agreement* in accordance with Articles 68 and 69 below, before its transfer out of or upon its transfer into <the State>.

Article 56

Upon agreement with <the State>, the IAEA may make ad hoc inspections for the purposes specified in Article 55 at any *facility* which contains *material subject to this Agreement* for which Subsidiary Arrangements are not in force.

Article 57

The IAEA may make special inspections subject to the procedures laid down in Article 61 below:

- a. In order to verify the information contained in special reports; or

- b. If the IAEA considers that information made available by the State, including explanations from the State and information obtained from routine inspections, is not adequate for the IAEA to fulfill its responsibilities under this Agreement.

Scope of inspections

Article 58

For the purposes stated in Articles 55, 56 and 57 above, the IAEA may, as appropriate, taking into account the requirements of Articles 11 and 12 and following agreed procedures spelled out in the Subsidiary Arrangements:

- a. Examine the records kept pursuant to Articles 35 to 42;
- b. Conduct independently *attribute* verification, item and container counting, or measurements on all *material subject to this Agreement*;
- c. Verify the identity, location and integrity of containers accepted for verification under this Agreement;
- d. Verify the functioning and calibration of instruments and other measuring and control equipment;
- e. Apply and make use of surveillance and containment measures; and
- f. Use other objective methods that have been demonstrated to be technically feasible as agreed by <the State>.

Article 59

Within the scope of Article 58 above, the IAEA shall be enabled, where applicable:

- a. To observe that samples at *key measurement points* for material balance accounting pursuant to Article 58.e. are taken in accordance with procedures which produce representative samples, to observe the treatment and analysis of the samples and to obtain duplicates of such samples;
- b. To observe that the measurements of *material subject to this Agreement at key measurement points* for material balance accounting are representative, and to
- c. To make arrangements with <the State> that, if necessary:
 - i. Additional measurements are made and additional samples taken for the IAEA's use;

- ii. The IAEA's standard analytical samples are analyzed;
 - iii. Appropriate reference materials are used in calibrating instruments and other equipment; and
 - iv. Other calibrations are carried out;
- d. To arrange to use agreed equipment for independent counting, measurement and surveillance, and if so agreed and specified in the Subsidiary Arrangements, to arrange to install such equipment;
 - e. To apply its seals and other identifying and tamper-indicating devices to containments, if so agreed and specified in the Subsidiary Arrangements; and
 - f. To make arrangements with <the State> for the shipping of any samples taken for the IAEA's use.

Access for inspections

Article 60

- a. For the purposes specified in Article 55.a. to d. above, the IAEA's inspectors shall have access only to the *strategic points* specified in the Subsidiary Arrangements and to the records maintained pursuant to Articles 35 to 42.
- b. For the purposes specified in Article 55.e. above, the inspectors shall have access to any location of which the IAEA has been notified in accordance with Articles 68.b.(iii) and 69.b.(iii) below.
- c. For the purposes specified in Article 56, and until such time as the *strategic points* have been specified in the Subsidiary Arrangements, for *facilities* for which <the State> has agreed to accept ad hoc inspections, the IAEA's inspectors shall have access to any location where a report pursuant to Articles 46, 62 or 69 indicates that *material subject to this Agreement* is present.
- d. In the event of <the State> concluding that periodic safety examinations of *material subject to this Agreement* or any unusual circumstances require extended limitations on access by the IAEA, <the State> and the IAEA shall promptly make arrangements with a view to enabling the IAEA to discharge its verification responsibilities in the light of these limitations. The Director General shall report each such arrangement to the Board.

Article 61

In circumstances which may lead to special inspections for the purposes specified in Article 57 above <the State> and the IAEA shall consult forthwith. As a result of such consultations the IAEA may obtain access in agreement with <the State> to information or locations in addition to the access specified in Article 60 above for routine inspections. Any disagreement concerning the need for additional access shall be resolved in accordance with Article 20 of this Agreement; in case action by <the State> is essential and urgent, Article 19 above shall apply.

Notice of inspections

Article 62

The IAEA shall give advance notice to <the State> before arrival of inspectors at *facilities* as follows:

- a. For special inspections pursuant to Article 57 above, as promptly as possible after the IAEA and <the State> have consulted as provided for in Article 61, it being understood that notification of arrival normally will constitute part of the consultations;
- b. For routine inspections pursuant to Article 55 above, the time for advance notice shall be agreed in the Subsidiary Arrangements; and
- c. For ad hoc inspections pursuant to Article 56, the time for advance notice shall be agreed in the General Part of the Subsidiary Arrangements.

Such notice of inspections shall include the names of the inspectors and shall indicate the *facilities* to be visited and the periods during which they will be visited. If the inspectors are to arrive from outside <the State> the IAEA shall also give advance notice of the place and time of their arrival in <the State>.

Conduct and visits of inspectors

Article 63

Inspectors, in exercising their functions under Articles 34 and 55 to 59 above, shall carry out their activities in a manner designed to avoid hampering or delaying the construction, commissioning or operation of *facilities*, or affecting their safety or security. In particular inspectors shall not operate any *facility* themselves or direct the staff of a *facility* to carry out any operation. If inspectors consider that in pursuance of Articles 56 and 57, particular operations in a *facility* should be carried out by the operator, they shall make a request therefor.

Article 64

When inspectors require services available in <the State>, including the use of equipment, in connection with the performance of inspections, <the State> shall facilitate the procurement of such services and the use of such equipment by inspectors, subject to the provisions of Article 11 of this Agreement.

Article 65

<The State> shall have the right to have inspectors accompanied during their inspections by representatives of <the State>, provided that inspectors shall not thereby be delayed or otherwise impeded in the exercise of their functions.

DISMANTLEMENT OF NUCLEAR WARHEADS AND CONVERSION OF CLASSIFIED MATERIAL

Article 66

- a. <The State> may establish a special accounting area pursuant to Article 32.b.(iii), for the purpose of dismantling nuclear warheads or for converting *material subject to this Agreement* with *classified* characteristics into *material subject to this Agreement* without *classified* characteristics.
- b. <The State> shall provide design information on the physical layout wherein the special accounting area is created. The IAEA shall be allowed to verify the physical layout in order to establish a perimeter monitoring system for the purpose of verifying all *material subject to this Agreement* entering such a special accounting area, and all *material subject to this Agreement* being removed from the special accounting area.
- c. As agreed, the IAEA shall with the assistance of <the State> establish, maintain and operate a perimeter monitoring system for the purpose of verifying indirectly the operations carried out therein. At a special accounting area created for dismantling nuclear warheads, the IAEA shall be permitted to observe and confirm that the mechanical components of each nuclear warhead are crushed preventing any further use.
- d. At periodic intervals, the IAEA shall be allowed to re-verify this design information to ensure that the information is complete and accurate, and in particular, that no undeclared ingress or egress points exist which could circumvent the perimeter monitoring system. Such re-verification activities shall be carried out only at such times as there is no *material subject to this Agreement* with *classified* characteristics in the special accounting area.
- e. <The State> may implement managed access procedures agreed with the IAEA in order to protect sensitive equipment from observation by IAEA inspectors.

- f. <The State> may introduce other *nuclear material* into such a special accounting area created for the purpose of converting *material subject to this Agreement* with *classified* characteristics into *material subject to this Agreement* without *classified* characteristics.” <The State> shall submit to the IAEA a supplemental report with respect to such other material in accordance with Article 46.b.
- g. Notwithstanding the provisions of Article 46, the supplemental report for such material shall include, with respect to such material, all of the information identified in Article 46.a.(iii), *mutatis mutandis*, that can be reported consistent with the purpose in paragraph a. above and with Article 11.
- h. Notwithstanding the requirements of Articles 40 and 47, the *book inventory* and the *physical inventory* for a special accounting area shall be considered to be zero. <The State> shall operate the special accounting area so as to minimise the amount of *material subject to this Agreement* in that area. Notwithstanding the requirements of Article 58, <the State> shall not be required to make *material subject to this Agreement* available for direct verification while it is in a special accounting area.
- i. The IAEA shall be able to verify that all *material subject to this Agreement* introduced into such a special accounting area remains accounted for under this Agreement, but shall not be required to provide the statements required by Article 50 for such special accounting areas. The IAEA shall have the right to employ procedures, as specified in Subsidiary Arrangements, which are designed to ensure that *material subject to this Agreement* remains accounted for during and following conversion.

STATEMENTS ON THE IAEA’S VERIFICATION ACTIVITIES

Article 67

The IAEA shall inform <the State> of:

- a. The results of inspections, at intervals to be specified in the Subsidiary Arrangements; and
- b. The conclusions it has drawn from its verification activities in <the State,> in particular by means of statements in respect of each *material balance area* which shall be made as soon as possible after a *physical inventory* has been taken and verified by the IAEA and a material balance has been struck.

EXPORTS OF MATERIAL SUBJECT TO THE AGREEMENT

Article 68

- a. <The State> shall not export *material subject to this Agreement* with any *classified* characteristics.
- b. <The State> shall notify the IAEA of any intended export of unclassified *material subject to this Agreement* as much in advance as possible of the expected export of the material in question, normally at least two months before the material is to be prepared for shipping. The IAEA and <the State> may agree on different procedures for advance notification. The notification shall specify:
 - i. the identification and the expected quantity and composition of the material in question, and the *material balance area* from which it will be exported;
 - ii. the State for which the material is destined;
 - iii. the dates on and locations at which the material is to be prepared for shipping;
 - iv. the approximate dates of dispatch and arrival of the material;
 - v. at what point of the transfer the recipient State will assume responsibility for the material for the purposes of this Agreement, and the probable date on which this point will be reached;
 - vi. that <the State> has received from the recipient State the commitments referred to in Article 6.c. above.
- c. The purpose of this notification shall be to enable the IAEA to verify the quantity of the material and the composition of the material before it is exported and, if the IAEA so wishes or <the State> so requests, to affix seals to the material when it has been prepared for shipping.
- d. The other provisions of this Article notwithstanding, the transfer shall not be delayed by any action taken or contemplated by the IAEA pursuant to the notification referred to in paragraph b. above.

IMPORTS OF MATERIAL SUBJECT TO THIS AGREEMENT

Article 69

- a. Prior to the import into <the State> of material subject to a similar agreement in another nuclear-weapon State party to the NPT, arrangements shall be made between <the State> and

the IAEA to permit the IAEA to verify, subject to the conditions set out in this Agreement, the material upon its import into <the State>.

- b. <The State> shall notify the IAEA of the expected import into <the State> of material referred to in paragraph a. above as much in advance as possible of the expected arrival of the material and in any case not later than one month before the date on which the <the State> assumes responsibility therefore. The IAEA and <the State> may agree on different procedures for advance notification. The notification shall specify:
 - i. the identification, the expected quantity, and the composition of the material required to be subject to this Agreement;
 - ii. at what point of the transfer of responsibility for the material will be assumed by <the State> for the purposes of the Agreement, and the probable date on which this point will be reached; and
 - iii. the expected date of arrival, the location to which the material is to be delivered and the date on which it is intended that the material should be unpacked.
- c. The purpose of this notification shall be to enable the IAEA to verify, subject to the conditions set out in this Agreement, the material upon its import into <the State>. Verification of the material in the shipper State by the IAEA may be accepted for the purposes of verifying the receipts in <the State>, provided that containment and/or surveillance measures have been applied continuously and successfully from the time of the verification in the shipper State until such measures are verified upon receipt in <the State>.
- d. The other provisions of this Article notwithstanding, unpacking shall not be delayed by any action taken or contemplated by the IAEA pursuant to the notification referred to in paragraph b. above.

DEFINITIONS

Article 70

For purposes of this Agreement:

- a. “Adjustment” means an entry into an accounting record or a report showing a *shipper/receiver difference, material unaccounted for* or a *rounding adjustment*.
- b. “Attribute” means one of the agreed parameters characterizing either the mass or the isotopic composition of *material subject to this Agreement* when the actual mass or isotopic composition, respectively, cannot be reported because it is *classified*.
- c. “Attribute verification” means the determination, through agreed methods of physical measurements and by means of instrumentation with information barriers which prevent

revealing *classified* information, of the fact that the *material subject to this Agreement* possesses a given *attribute*.

- d. “Batch” means a portion of *material subject to this Agreement* handled as a unit for accounting purposes at a *key measurement point* and for which the composition and quantity are defined by a single set of specifications or measurements. A *batch of material subject to this Agreement* may be a single container or a group of containers holding discrete items or bulk materials.
- e. “Batch data” means the number of containers, items or, as appropriate, the total weight of each element, of *material subject to this Agreement* and the isotopic composition when appropriate, taking into account Article 11 of this Agreement. When reported pursuant to Article 46.a.(ii) and (iii) the units of account shall be as follows:
 - i. Grams of contained plutonium;
 - ii. Grams of total uranium and grams of contained U-235 plus U-233; and

For reporting purposes, where appropriate, the weights of individual items in the *batch* shall be added together before rounding to the nearest unit.

- f. “Book inventory” of a *material balance area* means the algebraic sum of the most recent *physical inventory* of that *material balance area* and of all *inventory changes* that have occurred since that *physical inventory* was taken.
- g. “Classified” means determined by <the State> in the interest of its national security and/or treaty commitments to require protection against unauthorised disclosure under the laws and regulations of <the State>.
- h. “Correction” means an entry into an accounting record or a report to rectify an identified mistake or to reflect an improved measurement of a quantity previously entered into the record or report. Each *correction* must identify the entry to which it pertains.
- i. “Enrichment” means the ratio of the combined weight of the isotopes U-233 and U-235 to that of the total uranium in question.
- j. “Facility” means:
 - i. a reactor, a critical *facility*, a conversion plant, a fabrication plant, a reprocessing plant, an isotope separation plant or a separate storage installation; or
 - ii. any location where *material subject to this Agreement* is customarily used.
- k. “Fissile material” means plutonium containing 90% or more of the isotope Pu-239, and HEU containing 20% or more of the isotope U-235.
- l. “Inventory change” means an increase or decrease, in terms of *batches*, of *material subject to this Agreement* in a *material balance area*; such a change shall involve one of the following, or such other *inventory changes* as may be agreed in the Subsidiary Arrangements:

- i. Increases:
 - (a) Import;
 - (b) Domestic receipt: supplemental reports pursuant to Article 4.b or receipts from other *material balance areas*; and *nuclear material* processed together with *material subject to this Agreement*;
 - (c) Production: *nuclear material* produced from *material subject to this Agreement*; and
 - (d) Substitution: pursuant to Article 5, *nuclear material* submitted to verification under this Agreement as a substitute for *material subject to this Agreement* corresponding to the decreases under sub-paragraph 1.(ii)(f) of this Article.
- ii. Decreases:
 - (a) Export;
 - (b) Domestic shipment: shipments under this Agreement to other *material balance areas*;
 - (c) Nuclear loss: loss of *material subject to this Agreement* due to its transformation into other element(s) or isotope(s) as a result of nuclear reactions;
 - (d) Measured discard: *material subject to this Agreement* which has been measured, or estimated on the basis of measurements, and disposed of in such a way that it is not suitable for further nuclear use;
 - (e) Retained waste: *material subject to this Agreement* generated from processing or from an operational accident, which is deemed to be unrecoverable for the time being but which is stored;
 - (f) Substitution: pursuant to Article 5, *material subject to this Agreement* removed from verification corresponding to the amount of *nuclear material* submitted to verification under Article 70.1.(i)(d);
 - (g) Other loss: for example, accidental loss (that is, irretrievable and inadvertent loss of *material subject to this Agreement* as the result of an operational accident) or theft; and
 - (h) Other removal from the inventory pursuant to Article 4: removal from the inventory pursuant to Article 4 which is not covered by sub-paragraphs 1.(ii)(a) through 1.(ii)(g) of this Article.
- m. “Key measurement point” means a location where *material subject to this Agreement* appears in such a form that it may be measured to determine material flow or inventory, and for *fissile material* which has *classified* mass, where containers may be identified, counted and relevant

attributes verified. *Key measurement points* thus include, but are not limited to, the inputs and outputs (including measured discards) and storages in *material balance areas*.

- n. “Material balance area” means an area in or outside of a *facility* such that:
- i. The quantity of *material subject to this Agreement*, or for *material subject to this Agreement* which has *classified* mass, the number of containers of such material, in each transfer into or out of each *material balance area* can be determined; and
 - ii. The *physical inventory* of *material subject to this Agreement* in each *material balance area* can be determined when necessary, in accordance with specified procedures in order that the material balance for verification purposes can be established.
- o. “Material subject to this Agreement” means:
- i. All *fissile material* specified by <the State> as released from defence programmes, and submitted by the State and accepted by the IAEA for verification under this Agreement;
 - ii. Any *nuclear material* substituted for material referred to in sub-paragraph n.(i) of this Article in accordance with Article 5; and
 - iii. *Nuclear material* produced from or processed together with material referred to in sub-paragraphs n.(i) or n.(ii) of this Article;
- except as provided in Article 4.
- p. “Material unaccounted for” means the difference between *book inventory*; and
- q. “Nuclear material” means any source or any special fissionable material as defined in Article XX of the Statute of the IAEA. The term source material shall not be interpreted as applying to ore or ore residue. Any determination by the Board under Article XX of the Statute after the entry into force of this Agreement which adds to the materials considered to be source material or special fissionable material shall have effect under this Agreement only upon acceptance by <the State>.
- r. “Physical inventory” means the number of containers of *material subject to this Agreement* which have *classified* mass and the sum of all the measured or derived estimates of *batch* quantities of all other *material subject to this Agreement* on hand at a given time within a *material balance area*, obtained in accordance with specified procedures.
- s. “Rounding adjustment” means the quantity to be added to a rounded sum to make it equal to the sum of rounded terms.
- t. “Shipper/receiver difference” means the difference between the quantity of *material subject to this Agreement* in a *batch* as stated by the shipping *material balance area* and as measured at the receiving *material balance area*.

- u. “Source data” means those data, recorded during measurement or calibration or used to derive empirical relationships, which identify *material subject to this Agreement* and provide *batch data*. *Source data* may include, for example, agreed attributes for material with *classified* characteristics, weight of compounds, conversion factors to determine weight of element, specific gravity, element concentration, isotopic ratios, relationship between volume and manometer readings and relationship between plutonium produced and power generated.
- v. “Strategic point” means a location selected during examination of design information where, under normal conditions and when combined with the information from all *strategic points* taken together, the information necessary and sufficient for the implementation of verification measures is obtained and verified; a *strategic point* may include any location where attributes are verified or key measurements related to material balance accountancy are made and where containment and surveillance measures are executed.

PROTOCOL

STANDING CONSULTATIVE COMMITTEE

Article 1

- a. With a view to facilitating the implementation of this Agreement, a Standing Consultative Committee shall be established, composed of representatives of <the State> and of other States which have in force with the IAEA agreements similar to this Agreement for IAEA verification in relation to nuclear disarmament.
- b. The Standing Consultative Committee shall review and coordinate matters arising in the course of the implementation of this Agreement, and other similar agreements that may have a bearing on the implementation of this Agreement or such other agreements, including with respect to:
 - i. The review of measures to be taken by the State or States concerned and the IAEA, including resource forecasts;
 - ii. Technical provisions for the verification of *fissile material* with *classified* characteristics, including the adequacy of protective measures to prevent access to *classified* information and the authentication measures applied to ensure the credibility of IAEA verification;
 - iii. Communications with representatives of States possessing nuclear weapons considering concluding agreements similar to this Agreement for the purpose of informing said States on the operation of such agreements;
 - iv. Research, development and testing of new methods intended for implementation under this Agreement, and similar agreements, which are specific to such agreements;
 - v. Proposed modifications to Part II of the Subsidiary Arrangements;
 - vi. The reporting of results of the implementation of this Agreement and similar agreements;
 - vii. Annual verification implementation reports prior to their submission to the Board of Governors; and
 - viii. Any other matter referred to it by any member of the Committee.

Article 2

- a. Neither the resolution of discrepancies or anomalies, as provided for in Article 19 of this Agreement, nor consultations on issues related to the interpretation or application of this

Agreement and the settlement of disputes, as provided for in Article 20 of this Agreement, shall be delayed or otherwise impeded by the Standing Consultative Committee.

- b. The Standing Consultative Committee may be convened by any member as deemed necessary, but in any case shall meet not less than once each year.
- c. The members of the Standing Consultative Committee shall consult on the elements to be included in statements to the Board of Governors and to the public on the verification activities under this Agreement and other similar agreements.
- d. The presidency of the Standing Consultative Committee shall rotate on an annual basis among the parties which are members of the Standing Consultative Committee.

About the Project on Managing the Atom

The Project on Managing the Atom (MTA) is the Harvard Kennedy School's principal research group on nuclear policy issues. Established in 1996, the purpose of the MTA project is to provide leadership in advancing policy-relevant ideas and analysis for reducing the risks from nuclear and radiological terrorism; stopping nuclear proliferation and reducing nuclear arsenals; lowering the barriers to safe, secure, and peaceful nuclear-energy use; and addressing the connections among these problems. Through its fellows program, the MTA project also helps to prepare the next generation of leaders for work on nuclear policy problems. The MTA project provides its research, analysis, and commentary to policy makers, scholars, journalists, and the public.

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