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VERIFYING A FISSILE MATERIAL CUT-OFF TREATY

Technical and Organizational Considerations

SHANNON N. KILE AND
ROBERT E. KELLEY

STOCKHOLM INTERNATIONAL PEACE RESEARCH INSTITUTE

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STOCKHOLM INTERNATIONAL PEACE RESEARCH INSTITUTE

Signalistgatan 9
SE-169 70 Solna, Sweden
Telephone: +46 8 655 97 00
Fax: +46 8 655 97 33
Email: sipri@sipri.org
Internet: www.sipri.org

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Preface

The idea of halting the production of fissile material for use in nuclear weapons has gained new salience as part of reinvigorated international efforts to limit the size of global nuclear arsenals and to promote concrete progress towards realizing the vision of a world free of nuclear weapons. This Policy Paper offers a timely and insightful analysis of a key question that will need to be considered when negotiations on a fissile material cut-off treaty (FMCT) are finally opened: what organization should be given the responsibility for verifying compliance with a future FMCT?

Many diplomats and non-governmental experts have assumed that the International Atomic Energy Agency (IAEA) will be given the FMCT verification mission, in light of its extensive experience in implementing nuclear safeguards agreements in both nuclear and non-nuclear weapon states. However, the authors of this Policy Paper challenge this conventional wisdom. They identify a number of technical and organizational constraints that the agency would face were it to add an FMCT verification mission to its existing portfolio. They conclude that negotiators should instead create a dedicated verification body that would be part of the IAEA but would operate autonomously, in coordination and consultation with an independent fissile material cut-off treaty organization (FMCTO) that would be created as a permanent treaty-implementation body.

I would like to express my appreciation to the authors for their work. Robert Kelley has drawn on his insights and experiences from his service as director of the IAEA's Iraq Action Team and as a senior inspector with the agency's Department of Safeguards to offer a unique perspective on the challenges involved in designing an appropriate organizational framework for verifying compliance with an FMCT. Shannon Kile, who heads the SIPRI Nuclear Weapons Project, has written annually about developments in nuclear arms control for the SIPRI Yearbook for nearly two decades.

Thanks are also due to the external referee, to SIPRI researchers Vitaly Fedchenko and John Hart for their valuable comments and support, and to Dr David Cruickshank of the SIPRI Editorial and Publications Department, who edited the text. Finally, I would like to express my deep appreciation and thanks to the Norwegian Ministry of Foreign Affairs for its generous financial support for SIPRI's work in connection with the project 'Achieving concrete, near-term progress in disarmament, arms control and non-proliferation'. This Policy Paper is one of the outcomes of the project's activities.

Dr Bates Gill
Director, SIPRI
Stockholm, August 2012

Summary

In recent years there has been renewed momentum behind international efforts to open negotiations on a verifiable fissile material cut-off treaty (FMCT). Should these efforts finally bear fruit, a key question that will have to be addressed in the negotiations is what organization should be given the responsibility for verifying compliance with the proposed fissile material production ban. One widely mentioned choice for this role is the International Atomic Energy Agency (IAEA), in light of its long experience in implementing nuclear safeguards agreements mandated by the 1968 Treaty on the Non-Proliferation of Nuclear Weapons (Non-Proliferation Treaty, NPT). Many of the tools and procedures developed by the IAEA for safeguards purposes could be directly applied to verifying a future FMCT.

However, the IAEA would be hindered by a number of technical and organizational factors in taking on the FMCT verification mission. It would face particular challenges in verifying treaty compliance in the nuclear weapon-possessing states without changes to its existing safeguards mandate and practices. These would involve replacing subsidiary safeguards arrangements with new agreements to enhance the agency's ability to designate inspectors and technical experts, use advanced instrumentation and verification techniques, and determine other inspection modalities. The agency would also need a strengthened mandate for collecting and analysing data from former military fissile material production facilities while at the same time protecting national security secrets and proliferation-sensitive information.

A future FMCT should provide for the establishment of a dedicated verification body—a standing verification group (SVG)—that would be formally part of the IAEA and would draw on the agency's experience and formidable technical skills in implementing safeguards. The SVG would function autonomously from the IAEA Department of Safeguards in terms of interacting with states parties, planning inspections and drawing conclusions about the compliance of parties with their treaty commitments. The conclusions would be shared with an independent FMCT organization (FMCTO) that would be responsible for overseeing the implementation of the treaty and addressing compliance questions.

The aim would be to create a verification body, tailored specifically for an FMCT, that would have the requisite legal mandate and technical capabilities for inspecting what in some cases will remain highly sensitive nuclear facilities and material contained therein.

Abbreviations

CD	Conference on Disarmament
CSA	Comprehensive safeguards agreement
CSP	Conference of the states parties
CTBT	Comprehensive Nuclear-Test-Ban Treaty
CTBTO	Comprehensive Nuclear-Test-Ban Treaty Organization
CWC	Chemical Weapons Convention
DIV	Design information verification
FMCT	Fissile material cut-off treaty
FMCTO	Fissile material cut-off treaty organization
HEU	Highly enriched uranium
HSP	Hexapartite Safeguards Project
IAEA	International Atomic Energy Agency
IPFM	International Panel on Fissile Materials
LFUA	Limited-frequency unannounced access
NPT	Treaty on the Non-Proliferation of Nuclear Weapons (Non-Proliferation Treaty)
NRTA	Near-real-time accountancy
OPCW	Organisation for the Prohibition of Chemical Weapons
OSI	Open source information
SIAU	Satellite Imagery Analysis Unit
SQP	Small quantities protocol
SVG	Standing verification group
TEP	Tripartite Enrichment Project
VOA	Voluntary offer agreement
WAES	Wide-area environmental sampling

1. Introduction

In 1995 the Conference on Disarmament (CD) adopted a mandate to negotiate a multilateral fissile material cut-off treaty (FMCT) that, as well as 'banning the production of fissile material for nuclear weapons or other nuclear explosive devices' in a 'non-discriminatory' manner, would be 'internationally and effectively verifiable'.[1] It is now widely considered that the credibility of a future FMCT rests on the parties' compliance with it being effectively verified. While questions about whether this is achievable have slowed negotiations in the CD, consensus is emerging that verification is possible, based on the existing system of nuclear safeguards mandated by the 1968 Treaty on the Non-Proliferation of Nuclear Weapons (Non-Proliferation Treaty, NPT).[2]

Most studies to date have assumed that the International Atomic Energy Agency (IAEA) would be given primary responsibility for verifying an FMCT, largely since it has decades of experience with implementing nuclear safeguards agreements with countries around the world. Moreover, the new treaty's verification system would be likely to have significant overlap and convergence with IAEA safeguards in terms of its legal mandate and technical tasks and tools. A decision to give the FMCT verification mission to the IAEA would thereby be consistent with the view held by many states that new organizations should not be created to accomplish objectives for which existing bodies and mechanisms have appropriate capacities and functional synergies.

A number of studies have also proposed that a future FMCT should provide for the establishment of a modest fissile material cut-off treaty organization (FMCTO) to oversee and administer the implementation of the treaty. The proposals have generally envisioned a body modelled on existing international organizations—in particular, the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) and the Organisation for the Prohibition of Chemical Weapons (OPCW)[3]—which have similar functions and tasks as permanent implementation bodies for arms control and disarmament treaties.[4]

[1] Conference on Disarmament, Report of Ambassador Gerald E. Shannon of Canada on consultations on the most appropriate arrangement to negotiate a treaty banning the production of fissile material for nuclear weapons or other nuclear explosive devices, CD/1299, 24 Mar. 1995. CD documents related to fissile materials are available at <http://www.unog.ch/80256EE600585943/(httpPages)/5A258C12510075B2C1257 5DF003E478B>

The use of the term 'fissile material cut-off treaty' throughout this Policy Paper is not intended to prejudge the outcome of future negotiations on the treaty's scope of application.

[2] Treaty on the Non-Proliferation of Nuclear Weapons (Non-Proliferation Treaty, NPT), opened for signature 1 July 1968, entered into force 5 Mar. 1970, INFCIRC/140, 22 Apr. 1970, <http://www.iaea.org/Publications/Documents/Treaties/npt.html>.

[3] The CTBTO will become operational when the 1996 Comprehensive Nuclear-Test-Ban Treaty enters into force. The CTBTO Preparatory Commission (commonly referred to as the CTBTO), based in Vienna, Austria, was established to support and promote the treaty's entry into force, which includes the building of the global International Monitoring System. Comprehensive Nuclear-Test-Ban Treaty (CTBT), opened for signature 24 Sep. 1996, not in force, <http://treaties.un.org/Pages/CTCTreaties.aspx?id=26>.

The OPCW, based in The Hague, the Netherlands, was created to oversee implementation of the 1993 Chemical Weapons Convention and resolve questions of compliance. Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (Chemical

One authoritative group of experts, the International Panel on Fissile Materials (IPFM), put forward in 2009 a draft text for an FMCT that provided for the creation of an FMCTO as the main body for implementing the treaty and addressing compliance concerns.[5] The new body would consist of two organs: a conference of the states parties (CSP), under which subsidiary bodies could be established, and a small secretariat. The CSP would be responsible for overseeing implementation and policy matters, including compliance concerns and issues arising from differing interpretations of the treaty. The secretariat, headed by an executive secretary, would be responsible for the day-to-day administration and implementation of the treaty, working under the supervision of the CSP. The IPFM draft treaty did not provide for the establishment within the FMCTO of a subsidiary body to take on verification tasks, consistent with the widely held view that the main responsibility for FMCT verification should be given to the IAEA.

This Policy Paper examines the technical and organizational aspects of verifying a future FMCT consistent with the 1995 mandate, with a focus on the IAEA's role. It concludes that, although the IAEA would have important comparative advantages in implementing any FMCT verification regime, for that regime to be effective requires adapting the agency's current structure, competences and practices to the new mission. The main recommendation is that negotiators should create two bodies: a dedicated verification body that would be part of the IAEA but would operate autonomously, in coordination with an independent FMCTO that would be created as a permanent treaty-implementation body.

In order to determine the precise technical and organizational framework for an FMCT verification regime, this Policy Paper first sets out the tasks and objectives that any future verifying body will have to carry out and then considers how they can best be fulfilled. Chapter 2 briefly describes a number of key unresolved issues regarding the scope and objectives of an FMCT. Chapter 3 lays out the main inspection tasks under an FMCT in the nuclear weapon-possessing states, in particular those related to the types of facility to be inspected, and highlights several types of analytical tools and techniques for carrying out these tasks. (On the definition of 'nuclear weapon-possessing state' and related terms see box 1.1.) Chapter 4 considers specific inspection methods and approaches of special relevance for an FMCT verification body, taking account of the experiences of the IAEA in implementing safeguards agreements with the nuclear weapon-possessing states. Chapter 5 assesses the compatibility of the IAEA's present mandate and organizational practices with an FMCT verification role and identifies

Weapons Convention, CWC), opened for signature 13 Jan. 1993, entered into force 29 Apr. 1997, <http://treaties.un.org/Pages/CTCTreaties.aspx?id=26>.

[4] Findlay, T. and Meier, O., 'Exploiting synergies between nonproliferation verification regimes: a pragmatic approach', IAEA, European Safeguards Research and Development Association (ESARDA) and Institute of Nuclear Materials Management (INMM), *Nuclear Safeguards: Verification and Nuclear Material Security*, Proceedings of an International Symposium (IAEA: Vienna, 2001), Paper IAEA-SM-367/15/06.

[5] International Panel on Fissile Materials, 'A fissile material (cut-off) treaty: a treaty banning the production of fissile materials for nuclear weapons or other nuclear explosive devices with article-by-article explanations', 2 Sep. 2009, <http://www.fissilematerials.org/ipfm/site_down/fmct-ipfm-sep2009.pdf>.

Box 1.1. The nuclear weapon 'haves' and 'have-nots'

The nuclear weapon states

The 1968 Treaty on the Non-Proliferation of Nuclear Weapons (Nuclear Non-Proliferation Treaty, NPT) defines the nuclear weapon states to be those states that had 'manufactured and exploded a nuclear weapon or other nuclear explosive device prior to 1 January, 1967'. By this definition, only China, France, Russia, the UK and the USA are nuclear weapon states pursuant to the treaty.

The nuclear weapon-possessing states

In addition to the five legally defined nuclear weapon states, four other states are now de facto nuclear weapon states: India, Israel and Pakistan, which have never been parties to the NPT, are known or, in the case of Israel, widely believed to possess nuclear weapons; and the Democratic People's Republic of Korea (DPRK, or North Korea), which was an NPT party prior to its withdrawal in 2003, has demonstrated a military nuclear capability. Collectively, these nine states are referred to here as the nuclear weapon-possessing states.

The non-nuclear weapon states

The NPT defines the non-nuclear weapon states to be all states (whether party to the NPT or not) other than the five nuclear weapon states. The NPT definition thus includes the four de facto nuclear weapon states. As used here, the term applies only to states that do not possess nuclear weapons.

obstacles to the agency taking on the role. Drawing on the evidence in chapters 3–5 and on relevant precedents from the OPCW and the CTBTO, chapter 6 proposes several organizational and operational changes for establishing a dedicated FMCT verification body within the IAEA and considers how the new body would work alongside an independent FMCTO. Chapter 7 presents the conclusions and summarizes the main recommendations.

2. FMCT verification choices

There remain significant differences between CD member states over several fundamental issues left unresolved in the 1995 mandate that will have a direct bearing on the design of an FMCT verification system. These have to do with (*a*) the definition of the fissile material to be subject to verification; (*b*) the treatment of stocks of fissile material produced prior to the treaty's entry into force; and (*c*) the scope of the treaty (i.e. whether verification activities should cover each state party's entire nuclear fuel cycle or should instead focus on a limited core of facilities and activities).[6] Negotiations on these issues will be shaped by decisions about the desired level of assurance to be provided by the verification system and the associated costs to be borne by the states parties. The outcomes will determine the technical requirements and performance criteria of the FMCT verification system and the degree to which it converges with current IAEA safeguards.

Definition of fissile material

Material that can sustain an explosive fission chain reaction is essential for all types of nuclear explosive device. The most common of these fissile materials are highly enriched uranium (HEU) and plutonium of almost any isotopic composition.

However, the 1995 mandate did not define the term 'fissile material', nor is the term used in implementing IAEA safeguards. A number of options have been put forward for defining fissile material for the purpose of future FMCT negotiations.[7] There is general agreement that an FMCT should focus on 'direct-use' nuclear materials, as defined for IAEA safeguards purposes: these are materials 'that can be used for the manufacture of nuclear explosive devices without further enrichment or transmutation'.[8] Many FMCT studies have proposed that direct-use nuclear materials be made subject to verification only in unirradiated form in order to avoid several difficult challenges related to reactors and existing stocks that would require significant inspection resources to address.[9]

[6] For an overview of these issues see Schaper, A., *Principles of the Verification for a Future Fissile Material Cut-off Treaty*, Frankfurt Peace Research Institute (PRIF) Report no. 58/2001 (PRIF: Frankfurt am Main, 2001).

[7] See 'FMCT definitions: "fissile material" and "production"', Options raised by participants at the Australia–Japan Experts Side Event on FMCT Definitions, Conference on Disarmament, Geneva, 14–16 Feb. 2011, <http://www.reachingcriticalwill.org/disarmament-fora/cd/2011/documents>.

[8] IAEA, *IAEA Safeguards Glossary: 2001 Edition*, International Nuclear Verification Series no. 3 (IAEA: Vienna, June 2002), p. 33. Such material includes plutonium whose isotopic composition includes 80% or less plutonium-238; uranium containing a 20% or greater enrichment in the isotope uranium-235; and uranium-233.

[9] For safeguards purposes, the IAEA defines unirradiated direct-use material as 'direct use material which does not contain substantial amounts of fission products' and which would 'require less time and effort to be converted to components of nuclear explosive devices than irradiated direct use material (e.g. plutonium in spent fuel) that contains substantial amounts of fission products'. IAEA (note 8), p. 33.

Other nuclear materials could be made subject to verification under an FMCT. There have been proposals to include other elements in the actinide series, in particular americium and neptunium.[10] In principle, these IAEA-defined 'alternative nuclear materials' can be used in nuclear weapons. In practice, however, this would pose new handling and fabrication problems.[11]

Coverage of pre-existing stocks

The question of how to deal with stocks of fissile material produced before an FMCT enters into force was left unresolved by the 1995 mandate. Many non-nuclear weapon states have contended that the treaty should go beyond banning future fissile material production and cover existing stocks held for weapon purposes. They argue that the existing stockpiles in some nuclear weapon states are so large that a ban on future production would have little practical effect on the number of nuclear weapons that could be produced.[12] In contrast, the nuclear weapon states have all either stated or indicated that existing stocks should not be included in the treaty, arguing that the main purpose of the production ban is to cap global inventories of fissile material. In light of their strong opposition to including existing stocks, this Policy Paper proceeds from the assumption that any FMCT will primarily apply—at least initially—to the future production of fissile material and will leave stocks of previously produced weapon material unconstrained.

A consensus has yet to emerge on the question of whether an FMCT should require states parties to declare and place under international monitoring other categories of pre-existing stock that are not currently dedicated to nuclear weapons. Some studies have proposed that civilian fissile material (primarily in the form of separated reactor-grade plutonium), HEU and plutonium declared excess to military needs, and fissile material designated for non-proscribed military purposes (e.g. HEU reserved for naval propulsion reactors) should be subject to verification.[13] The purpose would be to provide assurance that these stocks were not diverted for weapon use. It remains an open question whether states will accept arrangements, which would be of varying degrees of intrusiveness, for verifying declarations of these stocks under an FMCT. Verifying the non-diversion of HEU reserved for naval reactors would pose special challenges, owing to the concerns of states possessing such reactors about inadvertently revealing classified information about, for example, fuel design.

[10] The actinide series includes the 15 metallic elements with atomic numbers from 89 to 103: actinium, thorium, protactinium, uranium, neptunium, plutonium, americium, curium, berkelium, californium, einsteinium, fermium, mendelevium, nobelium and lawrencium.

[11] Kelley, R. E. and Clayton, E. D., 'Fissible: a proposed new term in nuclear engineering', *Nuclear Science and Engineering*, vol. 91, no. 41 (Dec. 1985).

[12] Rissanen, J., 'Time for a fissban—or farewell?', *Disarmament Diplomacy*, no. 83 (winter 2006). In addition, Pakistan has argued for including pre-existing stocks under an FMCT owing to its concern that a treaty banning only future production would permanently freeze its perceived inferiority in holdings of weapon-usable fissile material vis-à-vis India.

[13] International Panel on Fissile Materials (IPFM), *Global Fissile Material Report 2008: Scope and Verification of a Fissile Material (Cut-off) Treaty* (IPFM: Princeton, NJ, Sep. 2008), pp. 76–85.

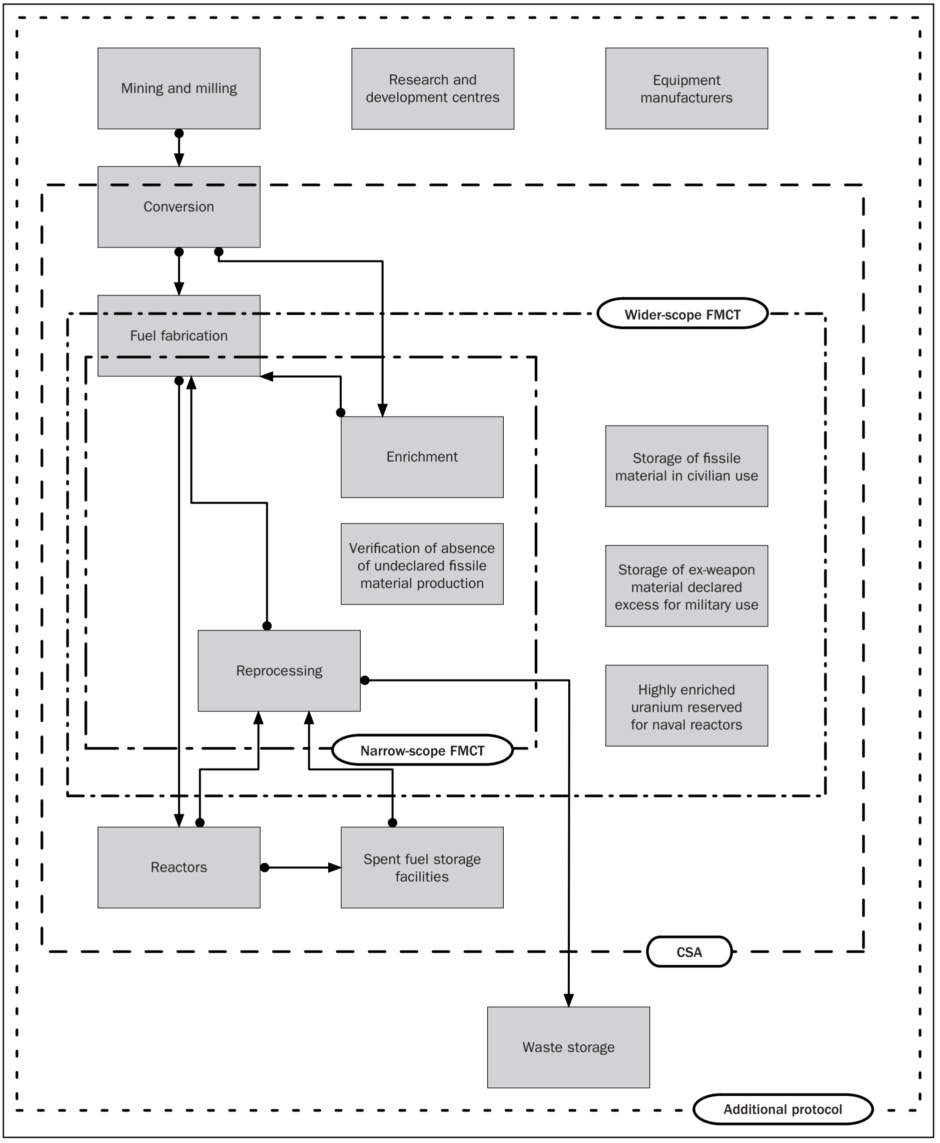

Figure 2.1. Application to the nuclear fuel cycle of IAEA safeguards and proposed FMCT verification arrangements

Note: The dotted lines show the various aspects of the nuclear fuel cycle subject to comprehensive approaches (mirroring IAEA comprehensive safeguards agreements (CSAs) and additional protocols) and focused approaches (both a narrow- and a wider-scope version) to verification of a fissile material cut-off treaty (FMCT). The arrows represent the passage of fissile material through the nuclear fuel cycle, from mining to waste storage.

The scope of FMCT verification

A third issue to be resolved in future negotiations has to do with the scope of an FMCT verification system. One option is a so-called comprehensive approach that would apply to the entire nuclear fuel cycle of a state party (see figure 2.1). The purpose would be to provide the same level of assurance about the non-production of fissile material for weapon purposes in the nuclear weapon-possessing states as is currently provided by the IAEA in implementing comprehensive safeguards agreements (CSAs, see appendix A) in the non-nuclear weapon states. In effect, this would involve extending the comprehensive safeguards system to the nuclear weapon-possessing states. Proponents of this approach point out that, in addition to providing a high degree of assurance, it would offer an important normative advantage in creating a uniform and non-discriminatory standard of verification in both the nuclear weapon possessors and the non-possessors.[14]

Critics of the comprehensive approach say that it has two main drawbacks. First, assuming that the FMCT would not cover pre-existing stocks of material, fully comprehensive safeguards would be ruled out by the fact that the nuclear weapon states would have stocks of military fissile material produced prior to the treaty's entry into force that would not be subject to verification arrangements. Second, applying comprehensive safeguards in the nuclear weapon states, which are not required to have in place state systems of accounting and control (SSAC) comparable to those in non-nuclear weapon states, would be expensive.[15] Inspection resources would have to be increased severalfold over current IAEA levels and would deliver only marginal benefits for the cost since these states are already known to possess nuclear weapons.[16]

In contrast, a non-comprehensive or focused approach would concentrate on the most proliferation-sensitive production facilities and the treaty-relevant fissile material produced by these facilities, with particular attention given to measures to detect undeclared fissile material production facilities or the clandestine production of fissile material for weapon purposes in declared facilities (see figure 2.1). In its most limited form, a state party would be required to declare and make subject to verification all uranium-enrichment and spent fuel-reprocessing plants on its territory, regardless of their operational status or capacity. Under this narrow-scope approach, measures would be applied only to verify the inputs and outputs of declared reprocessing facilities and to verify the absence of HEU production for weapon purposes in declared uranium-enrichment plants. Under a wider-scope approach, verification measures based on nuclear material accountancy could be applied at downstream facilities, such as

[14] Schaper (note 6), pp. 30–31.

[15] Comprehensive safeguards agreements (INFCIRC/ 153) require non-nuclear weapon states parties to establish and maintain individual national systems of accountancy for and control of nuclear material according to guidelines specified by the IAEA. See appendix A.

[16] Persbo, A., 'A verified ban on fissile material production', Conference on Fissile Material, Panel Perspectives, United Nations Institute for Disarmament Research (UNIDIR), Geneva, 21 Aug. 2009, <http://unidir.org/bdd/fiche-activite.php?ref_activite=471>.

storage sites and fuel-fabrication plants, that handle newly produced HEU or newly separated plutonium, to provide assurance about the non-diversion of the material.[17]

One of the main attractions of the narrow-scope approach is that it would greatly simplify the tasks to be carried out by the body responsible for verifying an FMCT while at the same time reducing the associated operational and administrative costs. It is assumed here that negotiators will choose this approach to the FMCT, while leaving open the possibility that the treaty's scope could be broadened later.

[17] See Zhang, H., 'FMCT verification: case studies', IAEA et al. (note 4), Paper IAEA-SM-367/9/04.

3. FMCT verification tasks and tools

As a practical matter, the main focus of activity for any FMCT verification regime will be on the nuclear weapon-possessing states, since the non-nuclear weapon states parties to the NPT have already committed themselves not to produce fissile material for nuclear weapons and are already subject to CSAs. While the five nuclear weapon states produced fissile material for nuclear weapon in the past, in the 1990s four of them publicly declared that they had ceased doing so; the fifth, China, has indicated informally that it has also done so.[18] In contrast, the four de facto nuclear weapon states are known or widely believed to continue to produce fissile material for weapon purposes (see e.g. tables 3.1 and 3.2 below).

Assuming that pre-existing stocks of fissile material are not covered by an FMCT, the verification mission would consist primarily of providing assurance that no uranium enrichment or plutonium reprocessing for nuclear weapon purposes takes place in the nuclear weapon-possessing states after the treaty's entry into force for those states. This would require an inspection regime that focuses on three categories of facility: (*a*) closed-down or decommissioned plants; (*b*) facilities producing fissile material for non-proscribed purposes (e.g. for use in naval propulsion reactors); and (*c*) possible covert and undeclared facilities.

The IAEA has developed a range of technical and analytical tools for implementing monitoring and verification measures at all three categories of facility. However, an FMCT verification regime would involve a greater focus on facility-specific issues than under the traditional safeguards approach to nuclear material accountancy. In addition, it would have to address the unique inspection challenges posed by facilities that were formerly used to produce nuclear weapon material. These include special considerations arising from the imperative of protecting classified and proliferation-sensitive information.

Closed-down and decommissioned plants

The IAEA defines a closed-down facility as 'an installation or location where operations have been stopped and the nuclear material removed but which has not been decommissioned'. A decommissioned facility is 'an installation or location at which residual structures and equipment essential for its use have been removed or rendered inoperable so that it is not used to store and can no longer be used to handle, process or utilize nuclear material'.[19] A facility is considered to be shut down if its operation is simply halted, nuclear material is still in place and it could be restarted.

The verification of a facility's closed-down status is straightforward. This is 'mainly a matter of verifying that nuclear material has been removed from the

[18] Arms Control Association, 'Fissile material cut-off treaty (FMCT) at a glance', Fact sheet, Apr. 2012, <http://www.armscontrol.org/factsheets/fmct>.

[19] IAEA, 'Model protocol additional to the agreement(s) between state(s) and the International Atomic Energy Agency for the application of safeguards', INFCIRC/540 (Corrected), Sep. 1997, Article 18(c), (d).

facility', which involves both accounting for nuclear material and design information verification (DIV).[20] Verifying the decommissioned status of a facility is more complicated since a list of the essential equipment to be removed from each facility type must be drawn up and checked before it can be considered decommissioned.[21]

The IAEA has considerable experience with safeguarding closed-down and decommissioned facilities. The agency would normally use a combination of remote surveillance technologies (satellite or aerial monitoring) and on-site containment and surveillance measures, including radiation monitoring, video surveillance and photographic records. Instruments could be added, such as temperature sensors on plant piping, that would provide high assurance that the reactors are permanently closed. After initial on-site inspections to confirm that essential equipment had been dismantled and removed, inspection visits to decommissioned facilities would be required only infrequently.[22]

Facilities producing fissile material for non-proscribed purposes

A more difficult task under the FMCT will be to verify that a facility that previously produced fissile material for nuclear weapons now produces the material only for non-proscribed purposes. A related task will be to verify that a plant capable of producing fissile material for weapons is not covertly used to do so.

Verification of uranium-enrichment plants

In the case of uranium enrichment, verification would mainly involve measures being applied at gas centrifuge enrichment facilities (see table 3.1). The IAEA's experience with safeguarding such plants is based on three major projects: the Hexapartite Safeguards Project (HSP), the Tripartite Enrichment Project (TEP) and the IAEA's 'Model safeguards approach to centrifuge enrichment plants'. In the early 1980s the HSP developed a model safeguards approach for centrifuge enrichment plants based on providing for a limited number of unannounced inspections (limited-frequency unannounced access, LFUA) in a plant's cascade hall.[23] In the 1990s the IAEA–Chinese–Russian TEP developed concepts, procedures and techniques to facilitate the implementation of IAEA safeguards at Russian-built enrichment plants because their design and operation made the IAEA's standard safeguards approaches difficult to implement.[24] The 'Model

[20] Boyer, B., Carroll, C. and Fagerholm, R., 'Evaluating the decommissioned status of a LWR and RRCA facility to determine level of effort needed to safeguard facility', IAEA, Institute of Nuclear Materials Management (INMM) and European Safeguards Research and Development Association (ESARDA), *Addressing Verification Challenges: Contributed Papers*, Proceedings of an International Safeguards Symposium, 16–20 Oct. 2006 (IAEA: Vienna, 2007), Paper IAEA-CN-148/40, p. 161.

[21] IAEA (note 8), p. 27.

[22] International Panel on Fissile Materials (note 13), pp. 96–101.

[23] Naito, K., 'Hexapartite safeguards project: a retrospective', IAEA et al. (note 20), Paper IAEA-CN-148/97. The HSP consisted of Australia, Japan, the USA, Euratom, the IAEA and Urenco (owned by Germany, the Netherlands and the UK).

[24] Panasyuk, A. et al., 'Tripartite enrichment project: safeguards at enrichment plants equipped with Russian centrifuges', IAEA et al. (note 4), Paper IAEA-SM-367/8/02.

safeguards approach to centrifuge enrichment plants', which was approved by the IAEA in 2006, applied the safeguards procedures and techniques developed under the HSP and TEP to newer and larger enrichment facilities.[25]

An FMCT verification regime will have to provide credible assurance that an enrichment facility does not produce HEU for use in weapons after the treaty's entry into force. This will require verifying the absence of production at the facility of uranium enriched higher than the declared maximum.[26] One approach to doing so, based on IAEA safeguards, would involve inspectors obtaining LFUA to a centrifuge plant's cascade hall. Once inside, they would then be able to conduct a number of activities, in particular DIV, environmental sampling (so-called swipe sampling) and flow enrichment monitoring.

This approach would be satisfactory if fully applied to all centrifuge enrichment plants. However, it poses potential challenges for an FMCT verification system for three reasons. First, the concept of LFUA, while fundamental to safeguards verification, might be problematic where the facilities to be inspected are in remote, difficult-to-reach locations; this is the case, for example, with the Shaanxi Uranium Enrichment Plant in China and with enrichment plants in Russia. In the latter case, the 1993 Russian–US HEU Purchase Agreement resolved the problem, at additional expense, by assigning monitoring personnel to be permanently placed at the facility site, just outside the enrichment plant.[27] Second, DIV inspections might be problematic to conduct in older facilities, where the key pieces of equipment might not be readily accessible. Finally, environmental sampling, while crucial for verification, can be seen by some states as too intrusive, especially at facilities formerly involved in military production or co-located with areas that are off-limits under an FMCT. For example, it could pick up either old particles or particles of material from the remaining weapon stockpile that could reveal classified nuclear weapon design information. These problems are unlikely to be fully resolved without a revision of information classification policies in the nuclear weapon-possessing states.

An FMCT verification system will also have to provide assurance that HEU produced at an enrichment plant for a non-proscribed purpose (e.g. naval and tritium-production reactor fuel) is completely accounted for and not diverted for use in weapons. This could present some operational difficulties since nuclear weapon-possessing states would be likely to object to safeguards verification procedures that have been developed for HEU-fuelled research reactors on the grounds that classified information might be revealed. Assuming these concerns

[25] Bush, W. et al., 'Model safeguards approach for gas centrifuge enrichment plants', IAEA et al. (note 20), Paper IAEA-CN-148/98.

[26] Fuel for light water reactors typically consists of uranium that is enriched to 3–5% in the isotope uranium-235; HEU for weapons usually consist of more than 90% uranium-235.

[27] Russian–US Agreement Concerning the Disposition of Highly Enriched Uranium Extracted from Nuclear Weapons, signed and entered into force 18 Feb. 1993, <http://www.armscontrol.ru/start/docs/heu93t.htm>. See also Bieniawski, A. J. and Balamutov, V. G., 'HEU Purchase Agreement', *Journal of Nuclear Materials Management*, vol. 25, no. 2 (Feb. 1997). Under the terms of the agreement, the USA agreed to buy, over a 20-year period, 500 tonnes of HEU from dismantled Soviet weapons that Russia would 'blend down' to low-enriched uranium for use as fuel in civilian nuclear reactors.

Table 3.1. Significant uranium-enrichment facilities in the nuclear weapon-possessing states, as of December 2011

Facility name or location	Type	Status	Process[a]	Capacity (thousands SWU/year)[a]
China				
Lanzhou (new)	Civilian	Operational	GC	500
Lanzhou 2	Civilian	Operational	GC	500
Shaanxi	Civilian	Operational	GC	1 000
France				
Eurodif (Georges Besse)	Civilian	Operational	GD	10 800
Georges Besse II[b]	Civilian	Operational	GC	7 500–11 000
India[c]				
Rattehalli	Military	Operational	GC	15–30
North Korea				
Yongbyon[d]	. .	. .	GC	(8)
Pakistan				
Kahuta	Military	Operational	GC	15–45
Gadwal	Military	Operational	GC	. .
Russia				
Angarsk	Civilian	Operational	GC	2 200–5 000
Novouralsk	Civilian	Operational	GC	13 300
Seversk	Civilian	Operational	GC	3 800
Zelenogorsk	Civilian	Operational	GC	7 900
United Kingdom				
Capenhurst	Civilian	Operational	GC	5 000
United States				
Paducah	Civilian	To be shut down	GD	11 300
Piketon, Ohio	Civilian	Being constructed	GC	3 800
Urenco Eunice	Civilian	Operational	GC	5 900
Areva Eagle Rock	Civilian	Planned[e]	GC	3 300–6 000

( ) = uncertain figure; . . = not available; GC = gas centrifuge; GD = gaseous diffusion.

[a] A separative work unit (SWU) is a measure of the effort required in an enrichment facility to separate uranium of a given content of uranium-235 into 2 components, 1 with a higher and 1 with a lower percentage of uranium-235.

[b] This facility is to reach full capacity in 2016

[c] India is believed to be producing highly enriched uranium (enriched to 30–45%) for use as naval reactor fuel.

[d] Other undeclared enrichment plants may exist.

[e] Construction is to begin in 2013.

Source: Glaser, A. and Mian, Z., 'Global stocks and production of fissile material', *SIPRI Yearbook 2012: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 2012).

were adequately addressed, some studies have concluded that appropriate verification arrangements could be devised by measuring the quantity of HEU produced or withdrawn from stocks to make HEU fuel and then confirming that it is actually put into a reactor.[28]

[28] See International Panel on Fissile Materials (note 13), pp. 79–82.

Verification of plutonium-reprocessing plants

Currently there are over a dozen major reprocessing plants on the territories of nuclear weapon-possessing states (see table 3.2). Even after an FMCT enters into force, there will still be plants reprocessing plutonium for civilian purposes in these and other states, as well as some facilities performing military tasks not prohibited by the FMCT. Additionally, some new reprocessing plants might be built.

An FMCT verification regime will have to address two types of diversion scenario: plutonium separation through undeclared activities and low-rate diversion of plutonium from a declared separation process. The IAEA has considerable experience with applying safeguards to modern reprocessing plants that would be relevant for an FMCT, based on the complex effort under way at the Rokkasho Reprocessing Plant in Japan.[29]

Older reprocessing plants, however, would present more difficult verification problems, for two reasons. First, the large spent fuel reprocessing facilities in the nuclear weapon-possessing states were designed, built and operated without IAEA safeguards requirements in mind. This would be likely to represent a major challenge for an FMCT verification regime, since it could be extremely costly and time consuming to conduct the initial DIV at these plants and to retrofit them with the measurement and monitoring systems necessary for effective verification.[30] Second, a spent fuel reprocessing facility always contains a significant amount of 'hold-up' material—that is, residual nuclear material deposited during earlier reprocessing.[31] In theory, such material could be diverted for proscribed purposes, especially if direct measurement—for example, by the application of near-real-time accountancy (NRTA)—was not possible for technical reasons.[32] This would probably be the case at most older reprocessing plants.

Verification of plutonium-production reactors

Since all of the dedicated military plutonium-production reactors in the nuclear weapon states have already been either closed down or decommissioned, their status can be readily verified. Verifying the status of plutonium-production reactors in the de facto nuclear weapon states could be done in a satisfactory way if the inspected state were to allow the necessary procedures and technical tools to be used. The state would have to declare the reactors and provide adequate design information, at least at the level of detail that the IAEA requires for safe-

[29] Johnson, S. J. and Ehinger, M., *Designing and Operating for Safeguards: Lessons Learned From the Rokkasho Reprocessing Plant (RRP)* (US Department of Energy, Pacific Northwest National Laboratory: Richland, WA, Aug. 2010).

[30] Johnson, S., *The Safeguards at Reprocessing Plants under the Fissile Material (Cut-off) Treaty*, International Panel on Fissile Materials (IPFM) Research Report no. 6 (IPFM: Princeton, NJ, Feb. 2009), pp. 2–3.

[31] Hold-up consists of 'nuclear material deposits remaining after shutdown of a plant in and about process equipment, interconnecting piping, filters and adjacent work areas'. IAEA (note 8), p. 35.

[32] IAEA, Department of Safeguards, Division of Concepts and Planning, 'Reprocessing plants', chapter SMC7, Safeguards Manual: Safeguards Criteria, 1 Oct. 2003, p. 12; and IAEA (note 8), p. 46. NRTA is a form of a nuclear material accountancy for bulk handling facilities, such as reprocessing plants, in which the inventory change data is maintained by the facility operator almost in real time.

Table 3.2. Significant plutonium-reprocessing facilities in the nuclear weapon-possessing states, as of December 2011

Facility name or location	Type	Status	Fuel processed	Design capacity (tHM/year)[a]
China				
Pilot Plant, Gansu province	Civilian	Operational	LWR	50–100
France				
La Hague UP2	Civilian	Operational	LWR	1 000
La Hague UP3	Civilian	Operational	LWR	1 000
India				
Trombay	Military	Operational	HWR	50
Tarapur-1	Dual-use	Operational	HWR	100
Tarapur-2	Dual-use	Operational	HWR	100
Kalpakkam	Dual-use	Operational	HWR	100
Israel				
Dimona	Military	Operational	HWR	40–100
North Korea				
Yongbyon	Military	On standby	LWR	100–150
Pakistan				
Nilore	Military	Operational	HWR	20–40
Chashma	Military	Being constructed	HWR?	50–100
Russia				
Mayak RT-1, Ozersk	Civilian	Operational	LWR	200–400
Seversk	Military	To be shut down	LWR	6 000
Zheleznogorsk	Military	To be shut down	LWR	3 500
United Kingdom				
BNFL B205 Magnox	Civilian	To be shut down	LWR	1 500
BNFL Thorp, Sellafield	Civilian	Operational	LWR	1 200
United States				
H-canyon, Savannah River Site	Civilian	Operational	LWR	15

HWR = heavy water reactor; LWR = light water reactor.

[a] Design capacity refers to the highest amount of spent fuel the plant is designed to process and is measured in tonnes of heavy metal (tHM) per year, tHM being a measure of the amount of heavy metal—uranium in these cases—that is in the spent fuel. Actual throughput is often a small fraction of the design capacity.

Source: Glaser, A. and Mian, Z., 'Global stocks and production of fissile material', *SIPRI Yearbook 2012: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 2012).

guards. Remote monitoring tools, in particular satellite imagery, could usefully supplement on-site inspections.

Covert and undeclared facilities

The most challenging task for an FMCT verification system will be to detect covert or undeclared fissile material production facilities on the territory of a state. For the IAEA, this will be functionally equivalent to verifying the completeness of a non-nuclear weapon state's declaration under comprehensive safeguards.

The Model Additional Protocol, which gives the IAEA enhanced investigatory authority, provides a useful precedent for a future FMCT inspectorate (see appendix A). Under additional protocols based on the model, the IAEA has the right to request 'complementary access' to sites in order to resolve inconsistencies in information provided in state declarations.[33] While the specific provisions for such access under an FMCT will depend on decisions about the treaty's verification requirements for the detection of undeclared production facilities, the IAEA has already developed several applicable measures and techniques for this task within the framework of the Model Additional Protocol's strengthened safeguards.

Environmental sampling

The technique of environmental sampling is most effective for verifying activities at, or near, declared or otherwise known nuclear facilities.[34] Samples taken at, or adjacent to, a site could reveal undeclared facilities or activities by detecting characteristic signatures in their effluents, for example, fission products such as krypton-85 and noble gases from reprocessing and HEU from enrichment activities. Following analysis by scientists at the IAEA's Environmental Sample Laboratory, the results can help to provide assurance about the absence of undeclared nuclear material and facilities on the territory of a state.

However, environmental sampling is not useful for the long-range, off-site detection of most nuclear fuel cycle facilities, with the possible exception of plutonium-production reactors and reprocessing facilities. Moreover, the use of off-site environmental sampling for FMCT verification purposes would entail a steep learning curve for the IAEA. The agency has made little investment in krypton-85 detection technologies and has largely deferred the development of techniques to measure noble gases to the CTBTO.[35] The IAEA would therefore have to build a krypton-sampling network similar to the one put into place by the CTBTO or make a cooperative arrangement to share the CTBTO's capabilities. Such practical cooperation would be a positive development in many respects, but experience has shown that it can be difficult to achieve because of differences in the mandates given to international treaty organizations.

Attempts to expand the application of environmental sampling to the entire territory of a state are being made through the work currently under way on wide-area environmental sampling (WAES) techniques. While WAES holds considerable promise in detecting radionuclides emitted by reprocessing or enrichment operations, the technology is not sufficiently mature to be able to reliably

[33] IAEA, INFCIRC/540 (note 19), articles 4–10.

[34] For an overview of environmental sampling techniques see Piksaikin, V. M., Pshakin, G. M. and Roshchenko, V. A., 'Review of methods and instruments for determining undeclared nuclear materials and activities', *Science and Global Security*, vol. 14, no. 1 (Jan.–Apr. 2006).

[35] 'The CTBT noble gas verification component', *CTBTO Spectrum*, no. 8 (2006), pp. 22–23, 25.

detect, for example, aerosol emissions from covert uranium-enrichment facilities.[36]

Analysis of open source information

Analysis of open source information (OSI) can be helpful in verifying the absence of undeclared facilities and activities.[37] The IAEA defines OSI as 'information generally available to the public from external sources, such as scientific literature; official information; information issued by public organizations, commercial companies and the news media; and commercial satellite images'.[38] The analysis of OSI can provide insight into a state's nuclear fuel cycle, including evidence of sensitive fuel cycle activities. It can also provide information about the location of sites and facilities of interest, which can trigger inspections or the targeted acquisition of satellite imagery.

The current IAEA effort in this area is small when compared to the total resources devoted to safeguards inspections. An FMCT verification system accordingly would need to develop a more robust OSI analysis programme that would be designed to look for leads and indicators of undeclared facilities.

Commercial satellite imagery analysis

Satellite imagery has proved valuable to the IAEA as a support tool for preparing inspections and for monitoring the status of safeguarded facilities, including for detecting undeclared activities at declared sites. It also has been useful in confirming or adding credibility to information about the location of possible undeclared sites, and in monitoring locations that may be inaccessible or unobservable through the traditional inspections process. However, it has limited utility in providing initial identification of so-called areas of interest because of the immense volume of imagery that must be acquired and analysed.[39] Since its creation in 2001, the IAEA's Satellite Imagery Analysis Unit (SIAU) has become an integral part of the safeguards inspectorate's planning and operations.

Commercial satellite imagery analysis is a powerful but expensive tool. The SIAU's activities are constrained not only by the high cost of purchasing large volumes of satellite imagery but also by the costs of maintaining specialized personnel and extensive data libraries.[40] In order to make effective use of the SIAU, an arrangement could be agreed whereby an FMCT verification body could contribute, along with the IAEA's Department of Safeguards and other

[36] Kalinowski, M. B. et al., 'Environmental sample analysis', eds R. Avenhaus et al., *Verifying Treaty Compliance: Limiting Weapons of Mass Destruction and Monitoring Kyoto Protocol Provisions* (Springer: Berlin, 2006); and Dillon, G., 'Wide area environmental sampling in Iran', ed. H. Sokolski, *Falling Behind: International Scrutiny of the Peaceful Atom* (US Army War College: Carlisle, PA, Feb. 2008).

[37] Wallace, R. and Lundy, A., 'Using open sources for proliferation analysis', ed. J. E. Doyle, *Nuclear Safeguards, Security, and Nonproliferation: Achieving Security with Technology and Policy* (Butterworth-Heinemann: Burlington, MA, 2008).

[38] IAEA (note 8), p. 97.

[39] Pabian, F., 'Commercial satellite imagery: another tool in the nonproliferation verification and monitoring toolkit', ed. Doyle (note 37).

[40] Chitumbo, K. et al., 'Satellite imagery and the Department of Safeguards', IAEA et al. (note 4), Paper IAEA-SM-367/16/08.

departments, to covering the costs of satellite imagery analysis for the purposes of their respective missions. The joint effort could be reinforced by member state contributions aimed at strengthening the SIAU's analytical methods and diversifying its sources of imagery.

National technical means of intelligence

An FMCT verification system could be usefully supplemented by encouraging states to provide relevant leads and information about suspected undeclared fissile material production facilities. The national technical means (NTMs) of intelligence on which this would be based include a variety of monitoring technologies (telemetry, space-based imagery, radar and electro-optical sensors, etc.) and involve numerous technical intelligence disciplines.

In recent years several cases have highlighted the limits of the IAEA's capabilities to detect covert or undeclared facilities as well as the agency's dependence on information provided by states with extensive intelligence resources in detecting such facilities.[41] Against this background, FMCT negotiators must incorporate a well-defined mechanism to allow the verification organization to receive intelligence information from states related to treaty compliance while at the same time protecting privileged sources.

FMCT verification adequacy

FMCT negotiators will have to decide what should be the appropriate balance between the degree of assurance provided by a proposed verification model and the costs associated with it. This raises the question of whether—or how closely—the technical requirements for an FMCT verification system should correspond to those set for the existing safeguards system.

The technical requirements for comprehensive safeguards are specified in terms of the following four quantified detection goals.

1. *Significant quantity*. This is the approximate amount of nuclear material for which the possibility of manufacturing a nuclear explosive device cannot be excluded.
2. *Detection time*. This is the maximum time that may elapse between a diversion of a given amount of nuclear material and the detection of that diversion by safeguards activities.
3. *Detection probability*. This is the probability, if diversion of a given amount of nuclear material has occurred, that safeguards activities will lead to detection.
4. *False alarm probability*. This is the probability that nuclear material accountancy data would indicate that an amount of nuclear material is missing when, in fact, no diversion has occurred.[42]

[41] See e.g. Kelley, R., 'Critical mass: is Syria pursuing nuclear capability?', *Jane's Intelligence Review*, vol. 22, no. 11 (Nov. 2010).

[42] IAEA (note 8), pp. 22–24.

The detection goals were tailored to fit the main purpose of comprehensive safeguards: to detect with a high degree of certainty and in a timely manner the diversion of the minimum amount of fissile material considered necessary for the production of one nuclear weapon.[43]

For an FMCT verification system, the standard safeguards detection goals arguably should be adjusted in states that already possess nuclear weapons.[44] For example, the minimum amount of fissile material to be verified under an FMCT could be based on a fixed proportion of the amounts of fissile material submitted for verification rather than the minimum amount considered necessary to build a nuclear weapon. Some experts have suggested that this proportion could be 1 per cent of the fissile material inventory submitted for monitoring and verification under an FMCT.[45] This figure was informally adopted as a quantity detection goal in the IAEA–Russia–USA Trilateral Initiative. The initiative was launched in 1996 to develop a system under which Russia and the USA could submit fissile material of weapon origin but deemed to be excess to their military needs to permanent IAEA verification and monitoring without revealing classified warhead design information.[46]

An obvious attraction of proposals to relax safeguards detection goals under an FMCT is that doing so would reduce verification costs in the nuclear weapon-possessing states. However, a decision to adopt revised verification criteria would have to take into account other considerations as well. If the IAEA Department of Safeguards were given the main responsibility for verifying an FMCT, for example, it would be likely to face a number of practical difficulties in implementing, with the same inspectorate, verification criteria with requirements that differed from those for the current safeguards system.[47]

[43] For a critique of the IAEA's technical ability to detect material diversions from enrichment and reprocessing plants in a timely manner see Sokolski, H. D., 'Assessing the IAEA's ability to verify the NPT', ed. Sokolski (note 36), pp. 6–7.

[44] Carlson, J., 'New verification challenges', *Journal of Nuclear Materials Management*, vol. 37, no. 4 (summer 2009), p. 99.

[45] Shea, T. E., 'The Trilateral Initiative: a model for the future?', *Arms Control Today*, vol. 38, no. 4 (May 2008).

[46] Shea (note 45). The Trilateral Initiative participants agreed informally that a change detected in one party's monitored inventory of fissile material greater than 1% would constitute a 'strategic' change that could portend the party's intention to break out of the verification arrangements.

[47] IAEA, 'A cut-off of production of weapon-usable fissionable material: considerations, requirements and IAEA capabilities', Statement made by Tariq Rauf, Head of Verification and Security Policy Coordination, to the Conference on Disarmament, Geneva, 24 Aug. 2006, <http://daccess-ods.un.org/access.nsf/Get?OpenAgent&DS=CD/1795&Lang=E>, p. 27.

4. The design of an FMCT inspection system

One immediate question that will have to be decided when FMCT negotiations finally get under way is what form the new treaty should take. Generally speaking, there will be two main options for negotiators. The first is to draft a single treaty containing both the basic treaty objectives and the details of the verification system. This was the approach taken with the 1993 Chemical Weapons Convention (CWC).[48] The result was widely seen as a treaty that was cumbersome to negotiate and generally inflexible in terms of allowing updates to the verification system.

The second approach is to codify the main political commitments and undertakings in a principal treaty. The detailed verification provisions can be set out in a protocol or secondary agreement. In the case of the NPT, this came in the form of CSAs and additional protocols agreed between states parties and the IAEA, based on model agreements.[49] A major advantage of this approach is that it separates largely political issues from largely technical issues and allows for an adaptable verification system that is sufficiently flexible to be updated over time.

Based on the experiences of implementing IAEA safeguards agreements and the CWC, the following sections highlight inspection methods and requirements that should be taken into account in the drafting an FMCT verification protocol in order to improve the ability of a verification body to do its job.

Inspection rights and privileges

The credibility of the IAEA safeguards system, as it has evolved over four decades, ultimately depends on an effective system of on-site inspections. While there have been important advances in the monitoring technologies and nuclear forensic practices for verifying the compliance of non-nuclear weapon states with their safeguards agreements, the help and goodwill of the states with nuclear facilities and material to be inspected remains an indispensable precondition for the agency to be able to carry out its work.

In practice, the willingness of many states to accept safeguards inspections has been tempered by the restrictions that they place on IAEA inspectors. These restrictions are often set out in the provisions of the state-specific subsidiary arrangements required under CSAs and other safeguards agreements (see appendix A). They impose numerous constraints on IAEA inspection activities,

[48] Chemical Weapons Convention (note 3).

[49] The model agreements are IAEA, 'The structure and content of agreements between the Agency and states required in connection with the Treaty on the Non-Proliferation of Nuclear Weapons', INFCIRC/153 (Corrected), June 1972; and IAEA, INFCIRC/540 (note 19). While the NPT was concluded in 1968 and entered into force in 1970, INFCIRC/153 was concluded in 1972 and the Model Additional Protocol (INFCIRC/540) was adopted in 1997.

such as procedures for designating inspectors, requirements for advance notification of inspections, the right of states to have inspectors accompanied by national officials, restrictions on routine access, limits on the frequency and number of inspections, and explicit itemization of what inspectors may and may not do at a particular declared facility.

In the nuclear weapon-possessing states, the requirements for safeguards transparency and disclosure must be balanced by the imperative of protecting national security secrets and proliferation-sensitive information. These states have regularly invoked this imperative as the rationale for placing detailed restrictions on safeguards inspection arrangements on their territories. In some cases, however, these restrictions could seriously impede the work of an FMCT verification body in determining that a nuclear weapon-possessing state is in compliance with its treaty obligations, particularly in providing credible assurance about the absence of undeclared plutonium-reprocessing and uranium-enrichment activities on its territory.

Designation of inspection equipment and instrumentation

States routinely restrict inspection equipment and the manner in which it can be used by safeguards inspectors. In some cases these restrictions serve to complicate the inspectorate's planning and logistics. For example, in the experience of one of the present authors, one of the nuclear weapon-possessing states refuses to allow any electronic media used by safeguards inspection teams to be taken out of the country. As a result, inspectors must review on site some kinds of collected data, such as images taken by video cameras. This adds to travel costs and extends duty assignments by several days. It also decreases the ability of personnel at IAEA headquarters to visualize field conditions and limits oversight of inspections for quality control purposes. Moreover, the IAEA's experience with safeguards inspections has been that if one state manages to restrict or prohibit a specific item of equipment, then others will invariably demand equal treatment.

These deficiencies could be addressed during the drafting of an FMCT verification protocol by explicitly providing for the use by inspectors of key categories and items of equipment. The provisions should define inspection equipment in general terms, so that the adoption of new technologies by inspectors would not require the renegotiation of basic agreements. For example, language allowing the use of generic 'digital image recording systems with on-board storage' would be preferable to that specifying a particular model or design of camera. This would avoid the problems experienced by the OPCW, which has been unduly restricted in its equipment lists because they were specified in too much detail in the original treaty language. In addition, an FMCT verification protocol should provide for the periodic convening of an expert-level technical working group to update the lists of approved inspection equipment.

Designation of inspectors

The designation of inspectors can be a problem in arms control treaty verification arrangements. States have a legitimate interest in barring entry to individuals they believe may be involved in espionage to gather military and commercial information. Some states, however, abuse this right to keep the number of designated safeguards inspectors so low as to impede the inspectorate's logistics and operational planning.

The de facto nuclear weapon states currently limit the designation of inspectors by the IAEA in several ways. For example, the detailed arrangements for the implementation of the IAEA's item-specific safeguards agreements with India, Israel and Pakistan contain unduly restrictive provisions that can be used to limit inspector rosters to a size that effectively excludes inspectors from many countries. In addition, these states exercise the right to reject designated inspectors on short notice and without explanation. As a result, they can exclude the agency's best inspectors. Another practical consequence of these restrictions is the resulting pressure on the IAEA to reduce costs by only carrying out inspections when designated inspectors are available to visit two or more countries on one mission, which can limit the intensity of inspection activities. The cumulative effect of these constraints has been to reduce the effectiveness of safeguards inspections.

A different approach to inspector designation was incorporated in the Chemical Weapons Convention.[50] The OPCW annually updates its list of approved inspectors. A state party has no right to strike off names from the list immediately prior to a challenge inspection; this can only be done as part of the regular annual updating. If there is no response by a state party within 30 days of receipt of the list, this is understood as acceptance of the list by the state party.

A similar approach to designating inspectors was adopted in the Model Additional Protocol, which establishes a useful precedent for a future FMCT verification body. Under additional protocols based on the model (see appendix A), all safeguards inspectors approved by the IAEA Board of Governors are considered to be designated to any state with an additional protocol in force.[51] The acceptance of an individual inspector is assumed, unless a state informs the IAEA Director General otherwise within three months. As with comprehensive safeguards agreements, if a state were to repeatedly reject competent inspectors, with the intention of impeding meaningful inspections (as determined presumably by the IAEA Secretariat), this would be grounds for the Director General to refer the matter to the Board for consideration and action.

In addition, the Model Additional Protocol requires states to issue multiple-entry visas to safeguards inspectors.[52] This requirement was introduced in order to avoid the situation under the CSA system in which the visa application process required by many states for each inspection introduced weeks of delay and gave states early warning of an impending inspection.[53] In practice, however, many states still ignore this requirement.

[50] Chemical Weapons Convention (note 3), Verification Annex, Part II.
[51] IAEA, INFCIRC/540 (note 19), Article 11.
[52] IAEA, INFCIRC/540 (note 19), Article 12.
[53] Joyner, D. H., *Interpreting the Nuclear Non-Proliferation Treaty* (Oxford University Press: Oxford, 2011), p. 63.

Use of sampling and other verification techniques

Some states have prohibited or placed limits on the use of technical tools and scientific techniques by IAEA inspectors that are essential for fulfilling safeguards verification tasks. In particular, the restrictions routinely placed on the use of physical sampling and other technical tools, especially at enrichment and reprocessing plants, need to be addressed during the negotiation of an FMCT verification protocol. The protocol should explicitly provide for the right of inspectors to use physical sampling techniques and, if necessary, to remove samples from a site for laboratory analysis. The inclusion of such provisions would be important for enhancing the effectiveness of an FMCT verification system as well as building international confidence about the parties' compliance with the treaty.

Similar provisions could be added for new types of technical tools and methods, including those based on so-called novel technologies (e.g. laser-based spectrometry and optically stimulated luminescence systems). These are being developed under the auspices of the IAEA's Novel Technologies Project for the detection of undeclared nuclear material, activities and facilities.[54] They would be directly applicable to the FMCT verification mission, in addition to supporting safeguards implementation.

Managed-access procedures

The current safeguards system faces a special challenge in the nuclear weapon-possessing states. In many cases, activities that are declared and subject to safeguards inspection are adjacent to, or co-located with, activities that are not subject to safeguards (e.g. nuclear weapon assembly and disassembly, weapon material recycling etc.); the latter are not declared—as distinct from undeclared—and cannot be inspected.

The drafting of FMCT-specific inspection provisions would therefore have to include so-called managed-access procedures for carrying out inspections of facilities declared by nuclear weapon-possessing states that require verification but which may be co-located with non-declared facilities or non-declared nuclear material from pre-existing stocks. This would involve formulating a detailed approach to inspections that would attempt to balance the inspectorate's need for access to facilities in order to verify the absence of clandestine enrichment and reprocessing activities with the legitimate concerns of states about protecting national security secrets and proliferation-sensitive information.

FMCT negotiators could use as a model two functionally similar sets of managed-access inspection procedures from existing international legal agreements. The first is the elaborate procedures developed in connection with the

[54] For a description of the IAEA's Novel Technologies Project see Khlebnikov, N., Parise, D. and Whichello, J., 'Novel technologies for the detection of undeclared nuclear activities', ed. Sokolski (note 36).

challenge inspection system of the Chemical Weapons Convention.[55] Many of the general procedures set out in the CWC would be directly relevant for an FMCT verification body, although there would be obvious differences with respect to the specific instrumentation and technical tools used by inspectors. The second set is contained in the Model Additional Protocol, which specifies both off-site and on-site arrangements by which IAEA safeguards inspectors can carry out enhanced investigations in non-nuclear weapon states. These are conditioned on the requirement that such arrangements 'shall not preclude the Agency from conducting activities necessary to provide credible assurance of the absence of undeclared nuclear material and activities at the location in question'.[56]

Under an FMCT, in most managed-access situations the inspectorate could use simple safeguards verification techniques. However, in some cases it would be problematic for FMCT inspectors to use in former nuclear weapon production facilities the tools and techniques employed by IAEA inspectors in the non-nuclear weapon states. Particular concern has been raised about the use of environmental swipe sampling, which could be used to identify the isotopic composition and morphology of particles of weapon material and reveal classified nuclear weapon design information.[57] This and related concerns—such as those about the facilities at which naval reactor fuel is fabricated—would have to be addressed explicitly during the negotiation of an FMCT verification protocol.

Challenge inspections under an FMCT

The concept of challenge inspections could be built into an FMCT verification system based on the CWC model. This permits a state party, on identifying a concern about another party's compliance with the convention, to request that the OPCW Technical Secretariat conduct a challenge inspection. Under a so-called red light approach, the inspection is implemented by the Technical Secretariat unless the OPCW's 41-member Executive Council decides, by at least a three-quarters majority vote, to reject the request.[58] In practice, the challenge inspection procedure has never been invoked since the CWC's entry into force in 1997, although compliance concerns had been raised. Similarly, the special inspection procedures provided for in CSAs are largely dormant.[59] In both cases, this reluctance has been due primarily to political assessments made by states parties of the unpredictable and potentially negative consequences of calling for an inspection. Parties to the CWC have instead chosen to clarify compliance concerns through the OPCW's routine verification mechanism or through the measures for bilateral consultation and other forms of clarification provided for in the CWC.

[55] See Hart, J., *On-site Inspections in Arms Control and Disarmament Verification*, Verification Research, Training and Information Centre (VERTIC) Research Reports no. 4 (VERTIC: London, Oct. 2002), pp. 50–53.

[56] IAEA, INFCIRC/540 (note 19), Article 7(a).

[57] International Panel on Fissile Materials (note 13), pp. 79–82.

[58] Chemical Weapons Convention (note 3), Article IX and Verification Annex, Part X.

[59] IAEA, INFCIRC/153 (note 49), paras 73, 77.

The CWC parties' reliance on these and other confidence-building measures presents a useful precedent for the design of a future FMCT verification system. One of the basic aims of the system should be to encourage states parties to undertake steps to enhance transparency and build confidence about their compliance behaviour.[60] This would be consistent with a traditional view of multilateral arms control and disarmament treaty regimes: that they should include concrete provisions for the states parties to be able to demonstrate compliance to each other under what ideally should be a cooperative understanding of mutual obligations and responsibilities.

[60] Hart (note 55).

5. The role of the IAEA in verifying an FMCT

The IAEA's comparative advantages in verifying an FMCT

The case for the IAEA to adopt or absorb the FMCT verification mission is a compelling one in terms of expertise, technical capabilities and cost effectiveness. The IAEA is an independent intergovernmental organization in the United Nations system and has a total staff of more than 2200, including approximately 250 safeguards inspectors.[61] The agency has in place sophisticated methodologies and procedural routines for nuclear material accounting and control that, along with a process for state evaluation, form the basis of its nuclear safeguards system. In addition, the definition of 'safeguards' set out in the IAEA's statute is sufficiently flexible to accommodate an expansion of the agency's current safeguards mission.[62] Indeed, the statute expressly provides for the IAEA to take on assignments aimed at promoting worldwide nuclear disarmament—one of the underlying goals of the FMCT. In addition, a number of international conventions and treaties have already given roles to the IAEA related to its work in promoting safe, secure and peaceful nuclear technologies.[63]

As many studies have noted, there are obvious synergies and convergences between the main objectives and tasks of the existing safeguards system and those of a future FMCT verification system. The cornerstone of IAEA safeguards is the comprehensive safeguards agreement (see appendix A). All non-nuclear weapon states parties to the NPT are obligated to implement this type of traditional safeguards agreement, which is based on nuclear material accountancy measures and intended to provide assurance of the non-diversion of declared nuclear material. Following the findings of undeclared nuclear activities in Iraq and North Korea in the early 1990s, CSAs have been supplemented by new voluntary agreements based on the Model Additional Protocol (see appendix A).[64] These require states to provide expanded declarations covering all aspects of their nuclear fuel cycle activities and to grant the IAEA broader rights of access to nuclear-related locations and activities.

The IAEA's strengthened safeguards system seeks to provide credible assurance of not only the non-diversion of declared nuclear material, but also the absence of undeclared nuclear material and activities.[65] This entails two technical

[61] Monterey Institute for International Studies, Center for Non-Proliferation Studies, 'International Atomic Energy Agency (IAEA) Secretariat', Inventory of International Nonproliferation Organizations and Regimes, 12 Oct. 2010, <http://cns.miis.edu/inventory/organizations.htm>; and Potterton, L., 'Training the IAEA inspectors', *IAEA Bulletin*, vol. 51, no. 2 (Apr. 2010).

[62] Statute of the IAEA, opened for signature 26 Oct. 1956, entered into force 29 July 1957, <http://www.iaea.org/About/statute.html>, articles III and XII.

[63] See IAEA, 'Treaties, conventions & agreements related to the IAEA's work', <http://www.iaea.org/Publications/Documents/Treaties/>.

[64] IAEA, INFCIRC/540 (note 19).

[65] IAEA, *IAEA Safeguards: Staying Ahead of the Game* (IAEA: Vienna, July 2007), pp. 9, 11.

verification objectives: (*a*) to detect in a timely manner the diversion of specified 'significant quantities' of declared nuclear material from peaceful use to proscribed military purposes; and (*b*) to detect undeclared nuclear material and activities on the state's territory.[66] Many of the methodologies and techniques developed by the IAEA pursuant to these objectives would be directly applicable to the FMCT verification mission.

The combination of CSAs and additional protocols provides the basis for non-nuclear weapon states to demonstrate compliance with an FMCT. These states have already given a commitment not to produce fissile material for nuclear weapons. Accordingly, non-nuclear weapon states that had both agreements in force would have no further verification obligations under the treaty.

There are also important technical synergies between IAEA safeguards and a future FMCT verification system. In particular, the agency's tools for safeguarding nuclear material and facilities (on-site inspections, containment and surveillance measures etc.) could be employed to monitor and verify compliance with an FMCT. Some of the IAEA's specialized analytical capabilities could be similarly employed, such as nuclear forensic techniques that can determine the age of nuclear material and, thus, whether it was produced before a certain date.[67] To the extent that many of these tools could be applied 'off the shelf' (i.e. without adaptation), they could contribute to making an FMCT verification system more efficient and cost effective.

Factors affecting the IAEA's suitability as an FMCT verification body

Despite the numerous synergies and convergences with safeguards, the negotiators of an FMCT will have to assess to what extent—or in what form—the treaty's verification mission could be added to the IAEA's existing portfolio of safeguards responsibilities. This is because the design of the verification system must take into account not only the technical requirements, but also the organizational competences and mandate that are appropriate and necessary for the new mission. There are at least three organizational and budgetary considerations that suggest that the IAEA, in particular the Department of Safeguards, would require adjustment and strengthening in order for the agency to take on primary responsibility for verifying an FMCT.

1. *Limited safeguards experience in the nuclear weapon-possessing states.* The IAEA's experience with safeguards in the nuclear weapon-possessing states has primarily involved implementing voluntary offer agreements with the five nuclear weapon states; and older, facility-specific agreements with the three de facto nuclear weapon states that have never been party to the NPT (see appendix A). The main focus of activity for any FMCT verification regime will be on these states since the non-nuclear weapon state parties to the NPT have already

66 IAEA (note 8), p. 13.

67 See Fedchenko, V., 'Nuclear forensic analysis', *SIPRI Yearbook 2008: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 2008), pp. 417–27.

committed themselves not to produce fissile material for nuclear weapons and most are subject to CSAs.

In practice, both nuclear weapon and non-nuclear weapon states have routinely restricted the IAEA's ability to carry out permitted verification activities, such as on-site inspections at declared facilities. They have used the subsidiary arrangements to their safeguards agreements with the IAEA to place restrictions on the designation of inspectors and associated technical experts, the use of technical tools and scientific techniques, and the access of inspectors to declared facilities.

The IAEA's acquiescence to these limitations raises doubts about whether agency inspectors would be sufficiently empowered and have adequate institutional backing to be able to detect and deter proscribed activities under an FMCT. For example, the IAEA Secretariat has been unable to conclude subsidiary arrangements with Pakistan pursuant to the implementation of the facility-specific safeguards agreements for the plutonium-reprocessing plants in Chashma, Punjab, and in Nilore (New Labs), near Islamabad.[68] While the Chashma plant was originally designated as a civilian facility, it has no civil use and is being refurbished to support Pakistan's military plutonium production programme, a direct challenge to the purpose of the FMCT (see table 3.2 above).[69] The unwillingness of the IAEA Secretariat to confront this situation raises doubts about how assertive it will be in verifying a state's compliance with a future ban on the production of military fissile material.

2. *Compatibility of the IAEA's approach to safeguards with the FMCT verification mission.* Although the IAEA is adopting 'information-driven' safeguards that takes a more holistic approach to evaluating a state's activities, it remains focused on nuclear material accountancy developed to verify declared production and stocks of nuclear material.[70] In contrast, verification of an FMCT will, at least initially, focus on fissile material production facilities in the nuclear weapon-possessing states. The IAEA accordingly would need to move beyond nuclear material accountancy procedures to gain familiarity with the technical and design characteristics of specific facilities in these states, including those that are currently not subject to safeguards. This task would pose a number of complex challenges for traditional safeguards inspection practices: for example, the IAEA would need to overcome the limited access to older facilities not designed with safeguards in mind; restrictions on the use of techniques such as environmental sampling due to the presence of material excluded from verification on national security grounds; and other confidentiality restrictions.

3. *Cost of verifying an FMCT in the nuclear weapon-possessing states.* The IAEA would require increased funding to be able to effectively carry out the FMCT verification mission, especially during the treaty's initial implementation phase.

[68] See Weissman, S. and Krosney, H., *The Islamic Bomb: The Nuclear Threat to Israel and the Middle East* (Times Books: New York, 1981), pp. 221–22.

[69] Agreement between the International Atomic Energy Agency, France and Pakistan for the Application of Safeguards, signed and entered into force 18 Mar. 1976, INFCIRC/239, 22 June 1976.

[70] IAEA (note 65), p. 16.

The amount of the increase is difficult to calculate based on current safeguards efforts, since the IAEA—for reasons of cost-effectiveness—conducts relatively few safeguards activities in states that already possess nuclear weapons. The Department of Safeguards lacks sufficient information about the relevant parameters for many facilities in these states (e.g. the type, status and location of the facility and the type and amount of nuclear material) needed to assess precisely the verification activities likely to be involved. The cost of verifying an FMCT will depend, first and foremost, on the choices made by negotiators about the level of assurance to be provided by the verification system (that is, about the scope of the treaty).[71]

Finally, in addition to these organizational and budgetary considerations, it remains an open question whether the states that are not party to the NPT would agree to give the IAEA responsibility for verifying an FMCT. At least some of these states are likely to reject such an arrangement as an unwelcome 'back door to the NPT'. Hence, a key challenge facing negotiators will be to allay potential objections about the conflation of the two treaties. In practice, this means that the IAEA should devise organizational arrangements and inspection modalities for performing the FMCT verification role in parallel with, rather than as a formal part of, its NPT-mandated safeguards role.

[71] Bruno Pellaud, a former IAEA deputy director-general responsible for safeguards, has estimated the annual cost of verifying an FMCT, assuming various scopes for the treaty. Pellaud, B., 'Focusing on FMCT verification', *A Fissile Material Cut-off Treaty: Understanding the Critical Issues* (United Nations Institute for Disarmament Research: Geneva, 2010), pp. 73–75.

6. A proposal for the structure and operation of an FMCT verification body

A future verification system for a fissile material cut-off treaty will have many functional similarities with those of two existing multilateral arms control and disarmament treaties—the 1993 Chemical Weapons Convention and the 1996 Comprehensive Nuclear-Test-Ban Treaty (CTBT).[72] However, the IAEA's existing safeguards expertise and technical competence mean that, unlike the CWC and the CTBT, an FMCT should not provide for the establishment of a new, treaty-based inspectorate to carry out verification activities as part of an FMCTO.[73] This would obviate the need to create an expensive bureaucracy that would duplicate existing IAEA capabilities for monitoring and verifying nuclear materials and facilities.

At the same time, the distinctive tasks for an FMCT verification body (outlined in chapters 3 and 4) and the difficulties (highlighted in chapter 5) that the IAEA has encountered in implementing some of its current safeguards tasks suggest that the role of verifying an FMCT should not simply be folded in with the IAEA's existing portfolio of responsibilities. Instead, a standing verification group (SVG), tailored specifically for verifying and monitoring the compliance of the nuclear weapon-possessing states with their FMCT obligations, should be created under the supervision of the IAEA Director General but separate from the IAEA Department of Safeguards. The SVG would operate in close coordination with an FMCTO, with their respective legal mandates and competences to be specified in the new treaty, but it would be formally subordinate to the FMCTO in the role of addressing treaty implementation and compliance issues.

The structure of the standing verification group

The FMCT standing verification group would be organizationally subordinate to the IAEA Director General but would have considerable autonomy in terms of planning and conducting field operations (see figure 6.1). It would also have a mandate, codified in an FMCT verification protocol, for interacting with member states through the Director General's Office. This would include a requirement to negotiate new bilateral agreements specifying technical and administrative procedures not constrained by safeguards agreements. At the same time, the SVG would be able to readily draw on the expertise and technical skills of any IAEA department in gathering and processing information for verification purposes for its own mission.

[72] Chemical Weapons Convention (note 3); and Comprehensive Nuclear-Test-Ban Treaty (note 3).
[73] For a proposed FMCTO structure and function see International Panel on Fissile Materials (note 5).

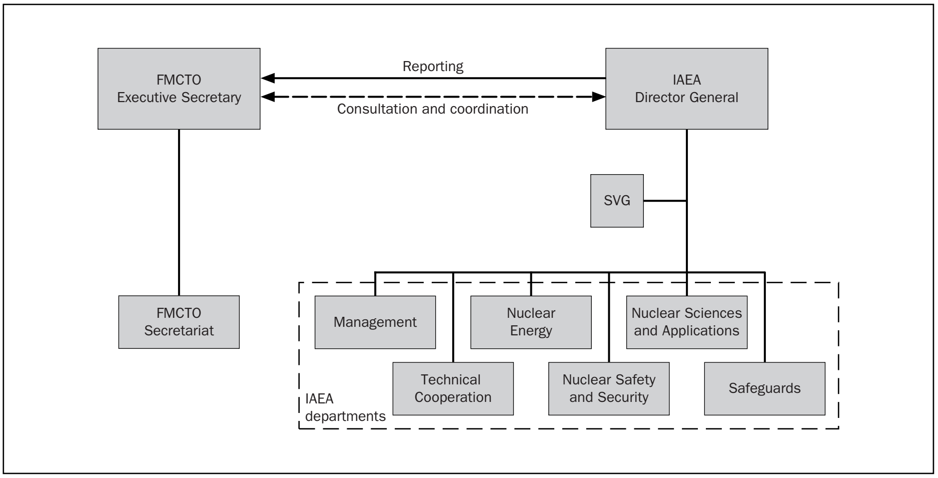

Figure 6.1. The relationship between the IAEA and the proposed FMCTO and standing verification group

FMCTO = Fissile material cut-off treaty organization; IAEA = International Atomic Energy Agency; SVG = Standing verification group.

There is a relevant organizational precedent for the SVG: the IAEA's Iraq Action Team, which operated in Iraq in the aftermath of the 1991 Gulf War (see box 6.1). Although its coercive and highly intrusive verification and disarmament mission would obviously not be shared by the SVG, the Action Team's organizational structure and practices within the IAEA would provide a useful model for the proposed body.

As proposed here, the SVG would consist of three administrative divisions, each headed by a director.

1. *Planning and operations*. This division would be responsible for planning, directing and carrying out on-site inspections and other monitoring and verification activities pursuant to implementing the FMCT. It would also prepare an operations manual stipulating methodologies and procedures for conducting on-site inspections.

2. *Collection, analysis and assessment*. This division would analyse and assess data resulting from the FMCT inspection team's own field activities. It would also evaluate external information such as open source literature, satellite imagery and external input from states to identify problem areas for inspection in addition to declared activities.

3. *Training and technical support*. This division would be responsible for training and designating FMCT inspectors. It would also provide technical support for inspection activities. This support could involve the development of specialized instrumentation and equipment for FMCT verification purposes that could be shared with the IAEA.

Box 6.1. The Iraq Action Team

The Iraq Action Team, formally known as the Iraq Nuclear Verification Office (INVO), was an autonomous unit within the IAEA set up by the Director General in 1991 pursuant to the implementation of United Nations Security Council Resolution 687 ending hostilities with Iraq.[a] The Action Team operated as part of the broader effort led by the United Nations Special Commission (UNSCOM), which was established by the Security Council in Resolution 687 as its subsidiary body responsible for supervising the removal and destruction of Iraqi weapons of mass destruction and relevant delivery systems and implementing measures to prevent their reconstitution.

The Action Team had a twofold mandate in Iraq: to remove and destroy nuclear-related material and equipment; and to manage an ongoing monitoring and verification programme. It reported the results of its technical analyses to the IAEA Director General, who reported the findings to the UN Security Council.

The Action Team used matrix management to assemble multinational teams of inspectors made up of experts and scientists drawn from across the IAEA as well as from IAEA member states. It made extensive use of the personnel and equipment of the IAEA Department of Safeguards in carrying out inspections but remained administratively independent of the department. For the analytical portion of its mission, the Action Team was allowed to recruit personnel with diverse expertise in areas such as the nuclear fuel cycle, radiation detection and measurement, analytical chemistry, and nuclear weapon design. This mandate permitted the formation of a versatile team that was able to investigate a wide range of topics from uranium mining to nuclear weapon testing, including areas where the IAEA was either technically weak or reluctant to explore.[b] The Action Team left Iraq in the run-up to the US-led invasion in March 2003. Its mandate was not terminated by the UN Security Council until June 2007.[c]

[a] UN Security Council Resolution 687, 3 Apr. 1991.

[b] For a description of the Action Team's organization and inspection activities see Dillon, G. B., 'The IAEA in Iraq: past activities and findings', *IAEA Bulletin*, no. 44 (Feb. 2002), pp. 13–16.

[c] UN Security Council Resolution 1762, 29 June 2007.

The creation of an SVG under the IAEA Director General's Office will require an increase in the agency's budget in order for the new body to be able to fully implement its FMCT verification mandate. Detailed estimates of the resources needed to adequately support the SVG will have to await the outcome of negotiations on the scope of the treaty's verification regime. To avoid objections from some member states about perceived inequities in the allocation of resources to different budget categories, the IAEA could consider adopting a 'user fee' approach to funding the SVG.[74] Under this approach, the additional cost of applying verification and monitoring measures to facilities subject to an FMCT in the nuclear weapon-possessing states (i.e. the costs above current safeguards arrangements) would be borne by these states since they will be the main focus of the treaty's verification regime.

The IAEA Department of Management could readily add the new body to its portfolio of support responsibilities related to personnel and recruitment, health and safety, travel and conference services, and so on. The IAEA Director General's Office would oversee the SVG's activities and assess its technical and personnel requirements.

[74] The IAEA divides its regular budget into 6 categories, the largest of which is for nuclear verification activities. IAEA, *The Agency Programme and Budget 2012–2013*, GC(55)/5 (IAEA: Vienna, Aug. 2011).

The operation of the standing verification group

Use of multidisciplinary teams

The SVG should use a standard matrix management scheme—in which teams set up to undertake a specific project can draw personnel with the relevant skills from their respective functional departments—adopted by other UN organizations. The aim would be to draw on the IAEA's extensive experience and technical skills in gathering and processing information for carrying out state evaluations under the safeguards system. In doing so, the SVG could utilize personnel not only from the Department of Safeguards but also from other departments, such as those of Nuclear Safety and Security, Nuclear Energy, and Technical Cooperation, that have specialized expertise and capabilities relevant for the FMCT verification mission. The SVG could also call on personnel from outside the IAEA with expertise in areas that the IAEA might lack. This would allow the SVG to bring in, for example, outside inspectors with nuclear weapon expertise, especially for carrying out verification tasks at former military production facilities that could involve access to proliferation-sensitive information.

One advantage of this organizational approach is that it would allow the SVG to bring together, in a geographically balanced team, personnel with complementary expertise related to all aspects of fissile material production for weapon purposes. In doing so, it would avoid an important shortcoming in the Department of Safeguards, where inspectors' technical skills are often not matched to the nuclear facilities in the geographic region for which they are responsible. For example, personnel with experience in inspecting enrichment and reprocessing facilities are mainly employed in the sections responsible for safeguards inspections in the Americas, Europe and Japan, rather than regions such as South Asia, where the inspection of such facilities can be more problematic. Inspectors deployed in one division who could contribute to technical solutions in another geographic division are not routinely dispatched to countries other than those covered by their regular inspections.

In order to overcome these limitations, the proposed SVG would need to develop its own specialized inspector training procedures, separate from those of the Department of Safeguards.[75] This would allow personnel in other agency departments (e.g. those in the Department of Nuclear Energy who have technical competences and skills of value for the FMCT verification mission) to be designated as FMCT inspectors. Currently, technical experts may accompany IAEA inspection teams as advisors, but many states will not allow them to enter declared nuclear facilities if they are not designated safeguards inspectors.

The highly specialized nature of some FMCT monitoring and verification tasks means that the SVG would have to place a premium on recruiting and retaining an experienced cadre of inspectors and analysts in critical areas, including

[75] New safeguards inspectors are approved by the IAEA Secretariat after completing a multi-part training course; those who have relevant technical expertise but who have not completed the course are excluded from conducting safeguards inspections.

nuclear fuel cycle technologies, information analysis and environmental sample analysis. The IAEA Secretariat normally encourages staff rotation in order to promote turnover and to acquire the latest skills and knowledge. While the standard term of employment for professional staff is usually a maximum of seven years, the Department of Safeguards has a higher percentage of professional staff on extended long-term contracts than the other IAEA departments.[76] In the case of the SVG, personnel drawn from any department who had specialized skills and expertise required for the FMCT verification mission could be given equal priority to Department of Safeguards inspectors and analysts when being evaluated for contract extensions.

Replacement of subsidiary safeguards arrangements

The restrictions routinely imposed by states on IAEA safeguards inspection activities should be addressed during the drafting of an FMCT verification system. A future FMCT verification body would be in a weak negotiating position in relation to the states parties if existing safeguards subsidiary agreements were to become by default the basis for on-site inspections under an FMCT. However, if the new treaty or its verification protocol required states parties to agree on inspection arrangements with the new verification body independent of previous arrangements with the IAEA, then the prospects for the SVG to carrying out effective inspections would be improved. While it can often be undesirable to incorporate highly specific language in treaties, there are areas where the SVG will need clear treaty-defined rights and privileges to support its negotiation of more effective inspection and monitoring arrangements with states parties.

Above all, an FMCT must stipulate that inspectors designated by the proposed SVG would have greater legal authority to carry out monitoring and verification activities than is the case with inspectors from the IAEA Department of Safeguards. This would require, among other things, new FMCT-specific verification arrangements in the nuclear weapon-possessing states that are better suited to the scope and objectives codified in the FMCT.

The main purpose of replacing the existing subsidiary arrangements would be to prevent the SVG from being trapped in an unduly restrictive bilateral agreement with a state. With respect to access rights, for example, new arrangements could address the frequent problems arising from restrictions on issuing visas to safeguards inspectors. Similarly, as with the Model Additional Protocol, inspectors designated by the SVG could not be refused by states parties after an initial consultation.

The relationship between the standing verification group and the FMCTO

The creation of an independent FMCTO would serve to reinforce an important distinction: that while the central obligation codified in the FMCT usefully supports the disarmament goal of the NPT, the two treaties are separate legal

[76] IAEA, *The Agency's Accounts for 2009*, GC(54)/3 (IAEA: Vienna, July 2010), p. 40.

instruments. This would help to allay potential objections from non-parties to the NPT about a conflation of the two treaties.

At the same time, the FMCTO's mandate and role—in particular with regard to verification—would have to be carefully defined and delimited in relation to those of the IAEA. This could be based on a memorandum of understanding defining the tasks and responsibilities of the SVG and stipulating the legal, administrative and operational aspects of the IAEA's relationship with the FMCTO.

One obvious goal of the relationship would be to avoid a wasteful duplication of effort in collecting, analysing and assessing information about nuclear facilities and material that are subject to verification under an FMCT. The SVG would be given principal responsibility for carrying out these tasks, under the supervision of the IAEA Director General's Office. For its part, the FMCTO would be responsible for the handling of state evaluation reports and other information provided by the SVG to assist the states parties in making judgements about treaty compliance issues. The FMCTO would also be responsible for handling and judging politically sensitive questions that might arise in the course of treaty verification activities, in its role as a subsidiary body to an FMCT conference of states parties.

Confidentiality policy

In defining the relationship between the IAEA and the proposed FMCTO, treaty negotiators would also have to address confidentiality issues arising from the sharing of information provided by states parties or collected by inspectors in the course of their verification activities. Because much of this information would be restricted or otherwise deemed to be sensitive, states parties are likely to object to cooperative arrangements that could result in the release of confidential information to non-states parties or to verification organizations associated with other treaty regimes. Hence, the creation of a standing verification group would have to be accompanied by the adoption of principles for designating information as being confidential and procedures for its subsequent sharing between the IAEA and the FMCTO.

The IAEA has considerable experience in dealing with confidential information and its protection, and with balancing this against the need for transparency, both within and beyond the agency.[77] The IAEA Secretariat has also developed conditions of staff employment regarding the protection of confidential information and procedures for dealing with a breach or alleged breach of confidentiality. In the initial stages of FMCT implementation, the IAEA Secretariat would presumably err on the side of caution in protecting confidential information in order to convince parties that sensitive information about nuclear weapon design and fabrication could be adequately protected. The relative balance could be adjusted in light of experience gained by the SVG and as states parties were reassured by its track record in handling confidential information.

[77] McLaughlin, J., 'Confidentiality and verification: the IAEA and OPCW', *Trust & Verify*, no. 114 (May–June 2004).

Benefits for the IAEA

The creation of an autonomous FMCT verification body within the IAEA could bring a number of benefits to the agency as a whole. First, it could help to create a new safeguards culture by reinforcing changes set in motion with the IAEA's adoption, in 2007, of an information-driven approach to safeguards.[78] The agency's goal is to create a more flexible and customized system of state-level evaluations: that is, to move away from a mechanistic approach to safeguards implementation driven by predetermined criteria to a more holistic one that takes into account a broader range of state-specific factors.[79] As part of the information-driven approach, the agency has increasingly turned to the use of multidisciplinary analytical teams to evaluate information for planning and implementing verification activities as well as for drawing safeguards conclusions for each state.[80] A similar system of collaborative analysis and peer review, involving expertise drawn from across the agency, would form the basis of the proposed standing verification group's analytical work.

Second, the creation of an SVG would help to promote a shift in the IAEA's organizational culture in the direction of greater internal transparency and openness, consistent with the requirements of an information-driven approach to safeguards. In particular, it could contribute to breaking down the traditional tight compartmentalization of the Department of Safeguards, which has sometimes resulted in information about state compliance being too closely held within certain offices.[81] In doing so, an SVG would reinforce a more holistic approach to state evaluations that would lead to improved risk-assessment and priority-setting capabilities for the FMCT verification mission.

Finally, the creation of an SVG would be an opportunity to strengthen and expand joint support activities into agency-wide support groups. These could include, for example, cutting-edge satellite imagery and instrumentation development programmes that would benefit not only the SVG but also the Department of Safeguards and other agency departments such as the Department of Nuclear Safety and Security. This collaborative approach would allow the IAEA to make more effective and assertive use of remote surveillance and on-site monitoring technologies in support of core agency missions; it could be further developed with voluntary contributions from states parties, either in the form of cash disbursements or the provision of technology, expertise and laboratory facilities under the IAEA's Member States Support Programme for safeguards. Such an approach would be especially valuable at a time when the IAEA is unlikely to receive significant increases to its regular budget.

[78] IAEA (note 65), p. 16.

[79] Nackaerts, H., Head of the IAEA Department of Safeguards, 'A changing nuclear landscape: preparing for future verification challenges', Statement, International Forum on Peaceful Use of Nuclear Energy and Nuclear Non-proliferation, Vienna, 2 Feb. 2011, <http://www.iaea.org/newscenter/statements/ddgs/2011/nackaerts020211.html>.

[80] IAEA, *IAEA Annual Report 2010*, GC(55)/2 (IAEA: Vienna, July 2011), p. 87.

[81] International Commission on Nuclear Non-proliferation and Disarmament (ICNND), *Eliminating Nuclear Threats: A Practical Agenda for Global Policymakers* (ICNND: Tokyo/Canberra, 2009), pp. 91–92.

7. Conclusions

Most studies to date have concluded that compliance with a universal ban on the production of fissile material for weapon purposes—that is, the central undertaking to be codified in any future fissile material cut-off treaty—could be effectively verified. The specific technical requirements of an FMCT verification system will depend on the choices to be made about the level of assurance to be provided by the treaty and the costs to be borne by the states parties. However, the generic verification tasks and objectives are well established and would involve significant functional synergies and convergences with those of the existing IAEA safeguards system. A verification system could be structured in a manner that would inspire international confidence in the credibility of its findings and assessments of compliance by states parties with the new treaty.

The case for the IAEA to assume primary responsibility for verifying an FMCT is a compelling one in terms of expertise, technical capabilities and cost effectiveness. However, in order to overcome a number of likely obstacles arising from its current safeguards practices and organizational routines, the agency should create a dedicated body—a standing verification group—tailored specifically for an FMCT. The new body would have the requisite mandate and capabilities for specialized verification tasks under an FMCT, including inspecting what in some cases will remain highly sensitive nuclear facilities and the material contained therein.

The states to be inspected under a FMCT verification regime would undoubtedly see disadvantages in working with a new body that had different rules, procedures and designations from those developed under the IAEA safeguards system. To be effective as an inspectorate, however, the SVG must start with a clean slate in terms of its relationship with inspected states. In particular, the SVG should not be limited by the IAEA's long-standing safeguards practices or be bound by its existing subsidiary safeguards agreements with the nuclear weapon-possessing states.

During the drafting of an FMCT, attention must be given to several action points aimed at addressing potential problems related to inspection mandates and modalities.

1. The Model Additional Protocol to the NPT should become the model for inspector designation for the FMCT mission, in order to avoid situations in which state-imposed restrictions cause major planning and logistical problems for the IAEA safeguards inspectorate.

2. The proposed SVG should train and designate experts for FMCT-specific verification tasks, including in the fields of nuclear energy and nuclear safety and security, rather than for traditional safeguards verification based on nuclear material accountancy.

3. An FMCT verification protocol should provide for the use by inspectors of key categories and specific items of equipment, including for the removal of data

obtained through them for headquarters analysis. Inspection equipment should be defined in general terms, so that the adoption of new technologies by inspectors would not require the renegotiation of basic agreements.

The SVG would analyse and evaluate the information obtained from inspection activities as the basis for drawing conclusions about the state parties' treaty compliance. The conclusions would be shared with an FMCT organization, an independent executive body that would be responsible for overseeing the implementation of the treaty and addressing compliance questions. This coordination and consultation role would require the adoption of principles for designating information as being confidential and procedures for its subsequent sharing between the IAEA and the FMCTO.

Ultimately, the creation of an SVG could strengthen the existing safeguards structure. It would provide opportunities for expanding joint support activities into IAEA-wide support groups. It would also promote the use of multidisciplinary analytical teams and practices, including enhanced peer review, while providing instructive examples of new approaches to traditional problems. In addition, the SVG would allow the FMCT verification system to promptly begin operational activities, using the full resources of the IAEA, without having to essentially start from scratch, as in the cases of the OPCW and the CTBTO. Finally, by operating in parallel with—rather than as formally part of—the IAEA's NPT-mandated safeguards role, the SVG could help allay objections from non-parties to the NPT about a perceived convergence of the two treaties (i.e. that the FMCT represented a 'back door to the NPT')

As many proponents of an FMCT have noted, the negotiation and entry into force of a ban on the production of fissile material for weapon purposes would make an important contribution to global efforts to limit the size and prevent the spread of nuclear weapon arsenals. In principle, its verification is possible, and this is far less contested than the verification of the comprehensive nuclear test-ban once was. There are no technical obstacles that cannot be overcome if the political will is there. Even if the prospects for near-term progress remain uncertain, it is important that the idea of the FMCT is not lost and that the imperative of opening negotiations is kept on the international agenda.

Appendix A. Categories of IAEA safeguards agreement

The IAEA's safeguards system consists of several different types of agreement. While the safeguards agreements differ in their legal mandates and scope of application, they all involve three basic tasks for the IAEA: nuclear material accounting; containment and surveillance; and on-site inspections. The technical and administrative procedures for implementing the agreements are set out in subsidiary arrangements, which are concluded between the IAEA Secretariat and a member state simultaneously with, or subsequent to, the conclusion of their safeguards agreement.

Safeguards in the non-nuclear weapon states[82]

Comprehensive safeguards agreements (CSAs, based on INFCIRC/153 (Corrected))[83]

Comprehensive safeguards agreements place safeguards on all peaceful nuclear activities and all nuclear material on the territory of a non-nuclear weapon state party to the NPT in order to verify that they are not misused for military purposes. They provide the legal basis for the IAEA's system of nuclear material accountancy designed to verify that a state's declarations of nuclear material subject to safeguards (so-called source and special fissionable material) are correct: that is, that they accurately describe the types and quantities of the state's declared nuclear material holdings. All states with CSAs in force are required to establish and maintain a state system of accounting and control (SSAC) for their nuclear material subject to safeguards, which sets out measures—based on agreed standards—for the accounting and reporting of the material.[84]

The IAEA carries out different types of on-site inspection and visit under CSAs. These may include auditing the facility's accounting and operating records and comparing these records with the state's accounting reports to the agency; verifying the nuclear material inventory and inventory changes; taking environmental samples; and applying containment and surveillance measures (e.g. the application of seals and installation of surveillance equipment).

The subsidiary arrangements to a CSA set out the technical and administrative procedures for specifying how the agreement's provisions are to be applied. They consist of a general part, applicable to all common nuclear activities of the state

[82] IAEA, 'The safeguards system of the International Atomic Energy Agency', <http://www.iaea.org/OurWork/SG/documents/safeg_system.pdf>; and IAEA (note 65).

[83] IAEA, INFCIRC/153 (note 49); and IAEA, Board of Governors, 'The standard text of safeguards agreements in connection with the Treaty on the Non-Proliferation of Nuclear Weapons', Note by the Director General, GOV/INF/276, 22 Aug. 1974, annex A.

[84] IAEA, INFCIRC/153 (note 49), paras 7, 31–32.

concerned, and a facility attachment, describing arrangements specific to each safeguarded facility.

The NPT obliges all non-nuclear weapon states parties to conclude CSAs with the IAEA. As of 1 June 2012, 172 of the NPT's 185 non-nuclear weapon states parties had CSAs in force with the IAEA.

Small quantities protocols (SQPs)[85]

A small quantities protocol to a CSA is concluded between the IAEA and a state that has less than a specified minimal quantity of nuclear material (originally defined as not more than 'one kg in total of special fissionable material') and no such material in a nuclear facility.[86] The protocol suspends the implementation of most of the CSA's detailed safeguards implementations provisions.

In 2005 the IAEA Board of Governors concluded that SQPs constituted a weakness in the agency's overall ability to detect clandestine nuclear activity. It accordingly revised the SQP reporting and inspection provisions, including the reinstatement of the agency's right to conduct inspections in states with SQPs. The modified text of the SQP requires states to provide the agency with 'initial reports' of all relevant nuclear material and to allow the IAEA to verify those reports via inspections. It also effectively allows the IAEA to monitor nuclear facilities in all NPT states regardless of whether the facilities contain nuclear material.[87]

As of 1 June 2012, 95 of the NPT's 185 non-nuclear weapon states parties had SQPs in force with the IAEA.

Additional protocols (modelled on INFCIRC/540 (Corrected))[88]

The Model Additional Protocol was adopted by the IAEA in 1997 as part of its strengthened safeguards system in order to enhance the IAEA's capability to detect and deter undeclared nuclear material or activities. Additional protocols to a CSA based on the model require the signatory state to provide the IAEA with expanded declarations covering all aspects of its nuclear fuel cycle activities, from uranium mines to nuclear waste; grant the IAEA broader rights of access to safeguards-relevant locations; and enable it to use the most advanced verification technologies. Specifically, the additional protocols give the IAEA the right and obligation to verify that a state's declarations of nuclear material subject to safeguards are correct (i.e. they accurately describe the types and quantities of the state's declared nuclear material holdings) and complete (i.e. they include all nuclear material and activities in the state that are subject to safeguards).

The additional protocols provide the IAEA with new or enhanced investigatory powers, including authority to conduct short-notice inspections at all buildings

[85] IAEA, GOV/INF/276 (note 83), annex A; and IAEA, Board of Governors, 'The standard text of safeguards agreements in connection with the Treaty on the Non-Proliferation of Nuclear Weapons', Revision of the standardized text of the 'Small Quantities Protocol', GOV/INF/276/Mod.1, 21 Feb. 2006.

[86] IAEA, GOV/INF/276 (note 83), annex A.

[87] IAEA, GOV/INF/276/Mod.1 (note 85).

[88] IAEA, INFCIRC/540 (note 19).

on a nuclear site; obtain information on the manufacture and export of sensitive nuclear-related technologies; inspect other nuclear-related locations, even where safeguarded nuclear material is not present; and collect environmental samples at non-declared locations and facilities.

As of 1 June 2012, 111 of the NPT's 185 non-nuclear weapon states parties had additional safeguards protocols in force with the IAEA.

Safeguards in the nuclear weapon-possessing states

While the IAEA has developed impressive technical and organizational capabilities for carrying out its existing safeguards mission in the non-nuclear weapon states, it has limited experience in implementing safeguards agreements in the legally recognized nuclear weapon states and the de facto nuclear weapon states.

The nuclear weapon states: voluntary offer agreements (VOAs)

The five nuclear weapons states are exempt from NPT-mandated safeguards on their nuclear material and facilities. However, as a transparency gesture they have all entered into voluntary offer agreements with the IAEA, which provide for them to voluntarily offer nuclear material and facilities on their territories from which the IAEA may select to apply safeguards. In addition, all nuclear facilities in France and the United Kingdom, except those dedicated to nuclear weapon and naval reactor programmes, are subject to safeguards administered by the European Atomic Energy Community (Euratom) in collaboration with the IAEA.

The VOAs cover the civilian nuclear fuel cycles, or parts thereof. They are intended to allay concerns that the application of IAEA safeguards in non-nuclear weapon states could lead to commercial advantages for the nuclear industries of the nuclear weapon states. The nuclear weapon states submit to the IAEA a list of facilities and material eligible for safeguards inspections. VOAs follow the format of CSAs. As with CSAs, the operators of facilities selected for safeguards provide the IAEA with detailed physical descriptions of the facilities and their nuclear material flows, which form the basis for implementing safeguards.

VOAs differ from CSAs in the scope of material and facilities covered. For example, the nuclear weapon states have the right to exclude from declaration and access all nuclear sites, activities and information that they deem to have direct national security significance (the so-called national security exclusion). They may also apply managed-access procedures at safeguarded facilities as they deem necessary and appropriate to protect proprietary commercial and proliferation-sensitive information from inadvertent disclosure. VOAs also allow states to withdraw offered material and facilities from safeguards.

Unlike in non-nuclear weapon states, where the IAEA is obligated to inspect all facilities where nuclear material is used, the IAEA is under no obligation to carry out annual safeguards inspections in all of the nuclear weapon states. In practice it conducts few safeguards activities in these states since the IAEA Secretariat does not consider them to be cost effective given that the states already possess nuclear weapons. Accordingly, from each state's list of offered facilities and material, the IAEA annually selects only some for the application of safeguards.

The nuclear weapon states: additional protocols

In addition to VOAs, all five nuclear weapon states have signed and brought into force additional protocol agreements with the IAEA as voluntary confidence-building measures. The nuclear weapon states undertake in their respective protocol agreements to report imports and exports of nuclear material and of specified equipment and non-nuclear material. This information is intended to assist the IAEA in verifying implementation of safeguards agreements in the non-nuclear weapon states.[89]

The agreements adopted by the nuclear weapon states have incorporated most of the standard provisions of the Model Additional Protocol, with some adjustments to the managed-access procedures. For example, the United States negotiated with the IAEA an additional protocol that includes the possibility for the agency to conduct 'complementary access' inspections to resolve questions pertaining to safeguarded activities or material, conditioned on the basis of the national security exclusion.[90] In contrast, Russia and China concluded additional protocols that do not allow IAEA inspectors physical access to any facilities.[91]

The de facto nuclear weapon states: item-specific safeguards agreements (based on INFCIRC/66/Rev. 2)[92]

Three de facto nuclear weapon states—India, Israel and Pakistan—still implement an older type of safeguards agreement that predates the NPT. This type of agreement provides for the application of IAEA safeguards to specific nuclear facilities, material and technology, as well as non-nuclear material (such as heavy water), usually as a condition for the transfer of the items from a supplier to a recipient state. Their purpose is to verify that the specified items are not used for military or other proscribed purposes. Although INFCIRC/66/Rev.2 does not formally provide for subsidiary arrangements, most agreements based on it include a specific reference to them. In practice, all three states with such agreements have negotiated detailed arrangements with the IAEA for the implementation of safeguards.

At the end of 2011, more than a dozen facilities in India, Israel and Pakistan were under item-specific safeguards or contained safeguarded material. These facilities included power reactors, research reactors and critical assemblies,

[89] See Monterey Institute for International Studies, Center for Non-Proliferation Studies, 'Additional protocol', Nuclear Threat Initiative (NTI), 13 June 2012, <http://www.nti.org/treaties-and-regimes/international-atomic-energy-agency/iaea-additional-protocol-status/>.

[90] US Nuclear Regulatory Commission (NRC), 'International safeguards', 20 Oct. 2010, <http://www.nrc.gov/about-nrc/ip/intl-safeguards.html>.

[91] Monterey Institute for International Studies (note 89).

[92] IAEA, 'The agency's safeguards system', INFCIRC/66/Rev.2, 16 Sep. 1968.

nuclear fuel fabrication plants, reprocessing facilities, and sealed storage sites.[93] While the safeguards verification requirements at any given facility declared under item-specific safeguards agreements are similar to those established in CSAs, specific differences arise from the limited scope of application of the older agreements.

India, Israel and Pakistan all possess fissile material production facilities that are not subject to safeguards. These facilities, for the most part, can be located on maps and in satellite imagery but remain off limits for safeguards inspections. In addition, separated plutonium and other relevant nuclear material are known or believed to exist at specific sites but are not subject to safeguards. For example, as part of the 2005 Indian–US Civil Nuclear Cooperation Initiative, India included in the military sector much of the plutonium separated from its spent power-reactor fuel. This plutonium was not placed under safeguards in the 'India-specific' safeguards agreement signed by the Indian Government and the IAEA in February 2009.[94]

The de facto nuclear weapon states: the case of North Korea

North Korea presents a special case with respect to safeguards implementation. It concluded a CSA with the IAEA in 1992, although the agreement was never fully implemented because of discrepancies discovered by the agency in North Korea's initial report on its nuclear material inventory. The agreement lapsed when North Korea withdrew from the NPT in 2003. Pursuant to a subsequent ad hoc arrangement, the agency continued to implement monitoring and verification measures at several North Korean nuclear sites until 2009.[95]

The IAEA considers that an older facility-specific agreement (based on INFCIRC/66), covering a small research reactor supplied by the Soviet Union, remains in force but has not sought to resume the application of safeguards at the reactor.

[93] IAEA (note 80), table A5.

[94] Agreement between the Government of India and the International Atomic Energy Agency for the Application of Safeguards to Civilian Nuclear Facilities, signed 2 Feb. 2009, entered into force 11 May 2009, INFCIRC/754, 29 May 2009. In addition, India and the IAEA signed an additional protocol on 15 May 2009, but as of 1 June 2012 India had not ratified the agreement.

[95] For a history of North Korea's pursuit of a nuclear weapon capability and its interactions with the IAEA see Pollack, J. D., *No Exit: North Korea, Nuclear Weapons and International Security*, International Institute for Strategic Studies Adelphi Papers nos 418–19 (Routledge: Abingdon, 2011).

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STOCKHOLM INTERNATIONAL
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Verifying a Fissile Material Cut-off Treaty: Technical and Organizational Considerations

The renewed momentum behind international efforts to negotiate a fissile material cut-off treaty (FMCT) has focused attention on how the proposed ban on the production of fissile material will be verified: what type of organization should be given this responsibility and what technical expertise will it require?

The International Atomic Energy Agency (IAEA) is often identified as the obvious choice for this role, given its long experience in implementing nuclear safeguards agreements. Many of the tools and procedures developed by the IAEA for safeguards purposes could be directly applied to verifying a future FMCT. However, without changes to its existing safeguards mandate and practices, the IAEA would be hindered in verifying treaty compliance in the nuclear weapon-possessing states. This Policy Paper proposes an alternative arrangement that, while taking advantage of the IAEA's experience and expertise, creates a verification body tailored specifically for an FMCT with the requisite legal mandate and technical capabilities.

Shannon N. Kile (United States) is a Senior Researcher and Head of the Nuclear Weapons Project of the SIPRI Arms Control and Non-proliferation Programme. His principal areas of research are nuclear arms control and non-proliferation, with a special interest in the nuclear programmes of Iran and North Korea.

Robert E. Kelley (United States) is a former IAEA senior safeguards inspector and director of the Iraq Action Team. He is a veteran of over 35 years in the US Department of Energy nuclear weapons complex, most recently at Los Alamos National Laboratory.

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