# VERIFICATIONMATTERS

VERTIC RESEARCH REPORTS ● NUMBER 11 ● SEPTEMBER 2015

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VERTIC

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## About VERTIC

The Verification Research, Training and Information Centre is an independent, not-for-profit non-governmental organization. Our mission is to support the development, implementation and effectiveness of international agreements and related regional and national initiatives. We focus on agreements and initiatives in the areas of arms control, disarmament and the environment, with particular attention to issues of monitoring, review and verification.

VERTIC conducts research and analysis and provides expert advice and information to governments and other stakeholders. We also provide support through capacity building, training, legislative assistance and cooperation.

We engage closely with governments, policy-makers and international organizations, as well as with the private sector and technical, academic and non-governmental communities worldwide.

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# About the Primer

The International Atomic Energy Agency (IAEA) has a statutory mandate to 'apply safeguards, at the request of the parties, to any bilateral or multilateral arrangement [. . .] to any of that State's activities in the field of atomic energy', including any arrangement relating to nuclear disarmament. IAEA Member States will play a vital role in shaping how the agency will prepare for and carry out nuclear disarmament verification.

This primer seeks to facilitate an informed debate at domestic and international levels on the challenges and opportunities of multilateral verification of disarmament through the IAEA. It aims to strengthen capacity among IAEA Member States and other stakeholders in verified nuclear disarmament by providing the reader with an introduction to the main issues associated with an IAEA role in nuclear disarmament verification. In particular, the primer introduces:

- the range of activities associated with nuclear disarmament;
- the tools, techniques, and procedures involved in nuclear disarmament verification;
- the opportunities and challenges presented by IAEA participation in nuclear disarmament verification, and;
- the ways in which stakeholders can build capacity to engage on this issue

The primer is written for professionals and students unfamiliar with the specific subject of disarmament verification, but with an awareness of international security issues. It will be particularly useful for representatives of IAEA Member States who wish to increase their knowledge of the subject and their ability to engage with it. It is not intended to provide comprehensive technical details, nor an exhaustive discussion of the verification issues.

The primer begins by outlining the range of activities involved in nuclear disarmament. It then gives an overview of the general issues associated with an IAEA role in verifying these activities. It subsequently expands upon these general issues by describing the steps involved in verifying each disarmament activity in turn; providing case studies, illustrative charts and graphs, and options for further reading. Key terms are defined in a glossary.

*This Primer is part of VERTIC's ongoing project* Supporting Multilateral Disarmament Verification*, which examines how nuclear disarmament can be verified through multilateral arrangements and explores the potential role that international and multilateral organisations can play in this process. Information and publications from this project can be found here: www.vertic.org*

# Contents









# Glossary

### Additional Protocol (AP)

A protocol additional to a safeguards agreement concluded between the IAEA and a state, following the provisions of the Model Additional Protocol (INFCIRC/540), providing measures for strengthening the effectiveness and improving the efficiency of IAEA safeguards.[1]

### Continuity of knowledge

Continuity of knowledge is a technique to provide continuous monitoring of the existence or presence of an accountable item. Continuity of knowledge demonstrates that an unaltered or uninterrupted custody or control of an item has been maintained by the owner or inspector, depending on the monitoring protocol, that provides confidence that deceptions have not been introduced.[2]

### Complementary access

"access provided by the State to IAEA inspectors in accordance with the provisions of an additional protocol" to "assure the absence of undeclared nuclear material and activities [. . .]", "resolve a question relating to the correctness and completeness of the information provided [. . .]", and "confirm, for safeguards purposes, the declaration of the decommissioned status of a facility".[3]

### Comprehensive Safeguards Agreement (CSA)

An agreement that applies IAEA safeguards to all nuclear material in all nuclear activities in a state, including those concluded between the IAEA and non-nuclear-weapon state party to the NPT (on the basis of INFCIRC/153). Such an agreement provides for the IAEA's right and obligation to ensure that safeguards are applied on all nuclear material in all peaceful nuclear activities within the territory of the state, under its jurisdiction, or carried out under its control anywhere (as required by the NPT).[4]

### Decommissioning

The removal or rendering inoperable of residual structures and essential equipment at a facility, so that it is not used to store and can no longer be used to handle, process or utilise nuclear material.[5]

### Disposition

Steps taken to remove fissile materials from a nuclear weapon programme and prevent their reintroduction to a nuclear weapon programme. Steps may include storage, transfer of custody, and the introduction of physical, chemical, or radiological barriers.

### Dual-use

Describes technology or material that can have both peaceful and non-peaceful uses.[6]

### Fissile material

A subset of nuclear material, describing those materials that undergo fission only at lower energies, including uranium-233, uranium-235, and plutonium-239.

### Safeguards

Measures established and administered by the IAEA, in accordance with its Statute, with the view to verifying the peaceful use of nuclear energy. These measures include, but are not limited to, those implemented through Comprehensive Safeguards Agreements, Additional Protocols to these agreements, and Voluntary Offer Agreements.[7]

### Information barrier

Equipment that takes data from a measurement device, processes the data and provides a pass/fail answer relative to predetermined criteria. An information barrier must protect sensitive or proliferative information from being released to any party unauthorised to receive it.

### Managed access

Procedures and techniques that an agreement permits an inspected party to use in order to limit access by on-site inspectors to sensitive areas and equipment. Designed to prevent the dissemination of proliferation sensitive information, to meet safety or physical protection requirements, or to protect proprietary or commercially sensitive information.[8]

### Monitoring

The means by which information is obtained for verification purposes. May be done remotely or on-site. It may seek to obtain a particular type of information or to detect any activity that is potentially non-compliant.[9]

### Non-Nuclear-Weapon State (NNWS)

A State Party to the NPT that does not possess or otherwise have control over nuclear weapons or other nuclear explosive devices.

### Nuclear disarmament

"The process leading to the realization of the ultimate goal of a world without nuclear weapons and any measure contributing hereto. Nuclear disarmament may also refer to the end state after nuclear weapons are eliminated."[10]

### Nuclear material

Source material or special fissionable material, defined by the IAEA Statute as uranium containing the mixture of isotopes occurring in nature; uranium enriched in the isotopes 235 or 233; uranium depleted in the isotope 235; uranium-233; plutonium-239; thorium; any of the foregoing in the form of metal, alloy, chemical compound, or concentrate; and material containing one or more of the foregoing (in such concentrations as the IAEA Board of Governors shall from time to time determine).[11]

### Nuclear weapon dismantlement

Dismantlement involves the separation of weapons-usable fissile materials at the core of a nuclear weapon from the high explosive materials that detonate a nuclear explosion. More generally, dismantlement is a part of a broader process of nuclear weapon retirement, return, and disassembly.[12]

### Nuclear-Weapon State (NWS)

A State Party to the NPT which has manufactured and exploded a nuclear weapon or other nuclear explosive device prior to 1 January 1967. There are five NWS under the NPT: China, France, Russia, the United Kingdom, and the United States.

### Nuclear weaponisation activities

"Weaponisation activities include weapon design, associated computer simulations, modelling and calculations, activities involving high-explosive lenses, high-energy electrical components, high-flux neutron generators, and implosion testing. [. . .] They can include acquisition of certain non-nuclear materials, such as beryllium, polonium, tritium and gallium."[13]

### Plutonium Management and Disposition Agreement (PMDA)

"The U.S.-Russia Plutonium Management and Disposition Agreement (PMDA), which entered into force on July 13, 2011, commits each country to dispose of at least 34 metric tons of weapon-grade plutonium withdrawn from their respective nuclear weapon programs. Disposition activities on both sides will be subject to bilateral and IAEA monitoring and inspections, to provide confidence that the Parties are disposing of weapon-grade plutonium in accordance with the terms and conditions of the Agreement."[14]

### Proliferative

Describes information that, if transferred to a non-nuclear-weapon state by a nuclear-weapon-state, or received by a non-nuclear-weapon state, would constitute a violation of Article I or Article II of the Nuclear Non-Proliferation Treaty (NPT).

### Sensitive

Describes information that, if transferred to any unauthorised recipient, would constitute a violation of domestic information control procedures.

### Spent fuel reprocessing

The chemical separation of nuclear material from fission products, following dissolution of spent fuel. Reprocessing involves the following steps: fuel receipt and storage, fuel decladding and dissolution, separation of uranium and plutonium and possible other actinides (eg americium and neptunium) from fission products, separation of uranium from plutonium, and purification of uranium and plutonium.[15]

### Trilateral Initiative

A joint venture involving the US, Russia and the IAEA to investigate the technical, legal and financial issues associated with IAEA verification of classified forms of weapons-origin and other fissile material deemed surplus to defence requirements. The aim of the Initiative was to establish a system of verification under which states in possession of nuclear weapons might submit excess fissile material to IAEA monitoring as a guarantee against its reuse in, or diversion to, weapons.

### UK-Norway Initiative

A collaboration between the UK (a NWS) and Norway (a NNWS) to investigate technical and procedural challenges regarding possible future nuclear disarmament verification regimes.

### Uranium enrichment

The process of concentrating specific isotopes of uranium by removing other isotopes. This is a crucial process in the manufacture of uranium fuel for nuclear power stations, and is also required for the creation of uranium-based nuclear weapons.[16]

### Verification

The process of gathering, interpreting and using information to make a judgement about parties' compliance or non-compliance with an agreement. The aim of verification is to establish or increase confidence that all parties are implementing a treaty fairly and effectively.[17]

### Verification system

The sum total of the elements that provide information for making a verification judgement.[18]

### Voluntary Offer Agreement (VOA)

"An agreement concluded between the IAEA and a Nuclear Weapon State which, under the NPT, is not required to accept safeguards but which has voluntarily offered to do so, inter alia, to allay concerns that the application of IAEA safeguards could lead to commercial disadvantages for the nuclear industries of non-nuclear-weapon States. Under such an agreement, a State offers, for selection by the IAEA for the application of safeguards, some or all of the nuclear material and/or facilities in its nuclear fuel cycle."[19]

### Weapons-usable fissile material

Fissile material in a form suitable for the creation of a self-sustaining fission reaction within a nuclear weapon without further isotopic enrichment or chemical processing.

# Notes

1 Adjusted from: IAEA Safeguards Glossary: 2001 Edition, International Nuclear Verification Series, No. 3, The International Atomic Energy Agency, June 2002

2 Adjusted from: Transparency and Verification Options: An Initial Analysis of Approaches for Monitoring Warhead Dismantlement, The Department of Energy Office of Arms Control and Nonproliferation, May 1997

3 Adjusted from: IAEA Safeguards Glossary: 2001 Edition, International Nuclear Verification Series, No. 3, The International Atomic Energy Agency, June 2002

4 Adjusted from: Ibid.

5 Adjusted from: Ibid.

6 Adjusted from: Coming to Terms with Security: A Handbook on Verification and Compliance, VERTIC & UNIDIR, June 2003

7 Adjusted from: P5 Glossary of Key Nuclear Terms, P5 Working Group on the Glossary of Key Nuclear Terms, April 2015

8 Adjusted from: Coming to Terms with Security: A Handbook on Verification and Compliance, VERTIC & UNIDIR, June 2003

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10 P5 Glossary of Key Nuclear Terms, P5 Working Group on the Glossary of Key Nuclear Terms, April 2015

11 Adjusted from: IAEA Statute

12 Adjusted from: Transparency and Verification Options: An Initial Analysis of Approaches for Monitoring Warhead Dismantlement, The Department of Energy Office of Arms Control and Nonproliferation, May 1997

13 Adjusted from: J. Carlson, Russell Leslie, Annette Berriman, Nuclear Weaponisation Activities: What is the Role of IAEA Safeguards?, Australian Safeguards and Non-Proliferation Office, 2006

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16 Adjusted from: P5 Glossary of Key Nuclear Terms, P5 Working Group on the Glossary of Key Nuclear Terms, April 2015

17 Coming to Terms with Security: A Handbook on Verification and Compliance, VERTIC & UNIDIR, June 2003

18 Ibid.

19 IAEA Safeguards Glossary: 2001 Edition, International Nuclear Verification Series, No. 3, The International Atomic Energy Agency, June 2002


NPT Review Conference.
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# 1. Introduction

There are approximately 16,300 nuclear weapons in the world. The vast majority of these weapons are held by the US and Russia. A number of other states - including China, the Democratic People's Republic of Korea (DPRK), France, India, Israel, Pakistan, and the UK hold the remaining weapons.

States Parties to the 1968 Treaty on the Non-Proliferation of Nuclear Weapons (NPT), 'considering the devastation that would be visited upon all mankind by a nuclear war', have undertaken to 'pursue negotiations in good faith on effective measures relating to nuclear disarmament'. This includes China, France, Russia, the UK, and the US - who are Nuclear Weapon State (NWS) parties to the NPT.

Israel, India and Pakistan are not party to the NPT. India has made many statements to the UN General Assembly in support of nuclear disarmament, including its plans for time bound disarmament to the third Special Session on Disarmament in 1988 and the Conference on Disarmament in 1998. Pakistan has also expressed its support for nuclear disarmament in statements to the Conference on Disarmament in 2007 and 2008. Israel has made statements (including one to the UN General Assembly First Committee in 2008) indicating its support for a Weapons of Mass Destruction Free-Zone in the Middle East.

## 1.1 The value of verification

Verification will play a central role in establishing and sustaining nuclear disarmament agreements. Verification is the process of gathering and analyzing information to make a judgement about parties' compliance with an agreement. It aims to build confidence between the parties, assuring them that their agreement is being implemented effectively and fairly. A verification system achieves this by collecting and analysing information on the behaviour of state parties to demonstrate compliance, and to detect and facilitate responses to non-compliance. The threat of detection and subsequent response can deter a party from pursuing non-compliance.

Exploring nuclear disarmament verification can help encourage nuclear-armed states to consider nuclear disarmament activities. Such states will be more likely to take on legally-binding commitments if they are confident that their efforts are properly recognised, and that attempts to cheat will be detected.

## 1.2 The value of multilateral verification

A state may decide to disarm on its own terms, or in a multilateral agreement with one or several other parties. The verification requirements in each scenario depend upon the relationships between the states involved. A bilateral disarmament agreement between two friendly NWS would be able to draw upon shared understanding of nuclear weapons and high levels of trust, so neither party may feel it necessary to implement a rigorous verification system. However, other states outside this bilateral agreement (who may have less trust in the parties to the agreement) will have few opportunities to gain confidence in its implementation.

A multilateral disarmament agreement among all NWS and Non-Nuclear-Weapon States (NNWS) under the NPT would not be able to rely upon such shared expertise and strong relations. Some parties may have less technical understanding of nuclear weapons than others, and less trust in the disarming states. These parties may demand a more inclusive multilateral approach to verification. Participants in a multilateral approach to verifying such a disarmament agreement may include only NWS, a collection of NWS and some NNWS, or all NWS and NNWS parties to the agreement.

Inclusive approaches to verification may be more technically and politically demanding than exclusive approaches (as discussed below), but they can build trust in a broader array of actors. Such an approach is consistent with the NPT under which all States Parties - not just NWS - have undertaken to pursue negotiations in good faith towards nuclear disarmament. The NPT recognises that if the proliferation and use of nuclear weapons is a concern to all states, then nuclear disarmament should be too.

The confidence built among participants in an inclusive multilateral approach to verification can also be deeper than the trust built among participants to

**Verification typically involves a number of procedures to build confidence in the implementation of an agreement. These procedures, and the tools used, include:**

| Procedure | Tool |
|---|---|
| Declarations of treaty-relevant materials and activities | • Initial (baseline) declarations Periodic (updated) declarations<br>• Final declarations<br>• Notifications |
| Monitoring to confirm declared materials and activities | • Direct observation<br>• Examination of records/ declarations<br>• Indirect observation (sensors) |
| Monitoring to maintain continuity of knowledge of confirmed materials and activities | • Unique identifiers (tags)<br>• Tamper-indicating seals<br>• Design information verification<br>• Surveillance |
| Monitoring to identify undeclared materials and activities | • National Technical Means (satellite imagery, intelligence)<br>• Examination and comparison of records/declarations<br>• Environmental sampling |
| Assessing compliance | • Inspection reports<br>• Consultations<br>• Further access/information<br>• Dispute mechanisms<br>• Non-compliance reporting mechanisms |

an exclusive verification system designed and implemented by a few. The diverse array of expertise offered by the wider international community can generate new ideas and new perspectives on nuclear disarmament verification. NNWS could contribute unique insights to overcome verification challenges that might be insurmountable in a more exclusive setting. Furthermore, a more inclusive approach to verification decreases the likelihood that any one participant might abuse the rights offered by a verification agreement. Verification participants can monitor each other, in addition to any nuclear disarmament activities being undertaken, to identify and respond to any improper behaviour. The verified state may therefore have more confidence that its transparency is not being abused for purposes beyond verification.

## 1.3 The case for an IAEA role in nuclear disarmament verification

Exploring and implementing multilateral approaches to nuclear disarmament verification requires careful coordination. Member States of the NPT agreed in 2010 on 'the importance of supporting cooperation among Governments, the United Nations, other international and regional organizations and civil society aimed at increasing confidence, improving transparency and developing efficient verification capabilities related to nuclear disarmament.' Channelling individual state efforts through an Intergovernmental Organisation can identify and exploit synergies, focus experts on to relevant tasks, and generate a shared understanding of multilateral approaches to nuclear disarmament verification.

The International Atomic Energy Agency (IAEA) may fulfil these functions for nuclear disarmament verification. Its membership encompasses all nuclear-armed states (except the DPRK), as well as the vast majority of non-nuclear-armed states. Its Statute offers it a broad mandate to 'apply safeguards, at the request of the parties, to any bilateral or multilateral arrangement [. . .] to any of that State's activities in the field of atomic energy', including any arrangement relating to nuclear disarmament. Its mandate also requires it to to conduct its activities 'in conformity with policies of the United Nations furthering the establishment of safeguarded worldwide disarmament'.

There is strong support amongst IAEA Member States for an agency role in verifying nuclear disarmament. The IAEA General Conference has heard supportive statements from Member States such as Brazil, Canada, Egypt, Japan, the Republic of Korea, Sweden, and Turkey regarding the IAEA's role in verifying nuclear disarmament in specific or general cases. These have been augmented by Working Papers submitted to the 2015 NPT Review Conference Process (and available through the UN website) by groups of NNWS such as the New Agenda Coalition and the Non-Aligned Movement - representing a total of 124 states.

These words of support have been confirmed by calls from Member States and the UN Security Council for the IAEA to verify aspects of nuclear disarmament in Iraq, South Africa, and Libya. The US and Russia have both called upon the IAEA to verify agreements concerning the transfer of fissile materials from military to civilian programmes. (These examples are discussed in more detail below.)

The IAEA can draw upon a long history verifying nuclear weapons non-proliferation to inform multilateral approaches to nuclear disarmament verification. The IAEA currently applies safeguards in 181 NNWS, as well as Voluntary Offer Agreements (VoAs) with the five NPT NWS covering some or all of their peaceful nuclear activities. The IAEA General Conference and Board of Governors have similar experience debating new verification challenges and overseeing solutions in an inclusive manner. The IAEA has an established array of technical verification procedures, information handling systems, and relationships within the broader UN system that should be utilised, not replicated elsewhere.

## 1.4 Supporting the IAEA's ability to verify nuclear disarmament

The IAEA Department of Safeguards - which fulfils the IAEA verification mandate - has included its role in verifying nuclear disarmament within its Long-Term Research and Development Plan (2012-2023). One of the Department's overarching strategic objectives is to 'contribute to nuclear arms control and disarmament, by responding to requests for verification and other technical assistance'. Member States reiterated their desire for the IAEA to fulfil this objective by passing a resolution at the 2014 General Conference noting that 'the Agency must remain ready to assist, in accordance with its Statute, with verification tasks under nuclear disarmament [. . .] that it may be requested to carry out'.

This resolution was the result of concerted efforts on the part of IAEA Member States to highlight the agency's role in nuclear disarmament. The agency may not be presented with many opportunities to fulfil this role if IAEA Member States do not continue to reiterate and expand upon their support through General Conference resolutions.

The IAEA's ability to remain ready to act upon an opportunity to verify nuclear disarmament depends on building and maintaining capacity suited to the verification tasks it might be asked to carry out. Nuclear disarmament can involve an array of activities (discussed below) and verifying that these have been carried out requires different tools and techniques. The IAEA also depends on political, technical, and financial support from its Member States. The steps that it should take to prepare itself for nuclear disarmament verification need to be approved and supported by IAEA policy-making organs, such as the Board of Governors.

The IAEA Director-General acknowledged in 2013 at the Carnegie International Nuclear Policy Conference that the agency is 'lacking' in the area of nuclear disarmament. Clear instructions from Member States are needed concerning which capabilities the IAEA should have, what procedures it should adopt to develop them, and what support it might receive in this effort. A VERTIC survey of IAEA Member State views conducted between 2014 and 2015 suggests that there is strong support for a broad agency role in nuclear disarmament, encompassing a range of activities from the verification of weapon dismantlement through to the elimination or reversal of nuclear weapons research. However, the survey indicates that Member States have divergent opinions on how the IAEA should prepare for this role, and how this issue should be explored further by the IAEA and others.

## 1.5 Priming a debate on an IAEA role in verifying nuclear disarmament

IAEA Member States will play a vital role in shaping the IAEA's capability to verify nuclear disarmament. Technical and financial support from Member States will determine the sophistication and readiness of the IAEA's disarmament verification capabilities. Political support from Member States within the IAEA Board of Governors and General Conference will ultimately determine how and when such capabilities might be applied. IAEA Member States should therefore be aware of the type of activities that can be involved in verifying nuclear disarmament, and the issues these activities might present the IAEA Secretariat, Member States, and the broader international community.

There are a number of different opportunities for IAEA Member States (and indeed other states) to discuss the agency's role in verifying nuclear disarmament. Multilateral forums such as the IAEA's General Conference, the NPT Review Process, the Conference on Disarmament, and the UN General Assembly allow states to discuss and express their support for this role. Verification initiatives, such as VERTIC's Project Supporting Multilateral Disarmament Verification, the US-led International Partnership for Nuclear Disarmament Verification (IPNDV), and the UK-Norway Initiative, allow NNWS to explore the technical and procedural issues alongside NWS in a collaborative manner.

This primer aims to build capacity among IAEA Member States and other stakeholders in verified nuclear disarmament to engage in an informed debate (at domestic and international levels) on the challenges and opportunities associated with multilateral disarmament verification. It achieves this by providing stakeholders in verified nuclear disarmament with an introduction to the main issues associated with an IAEA role in nuclear disarmament verification. In particular, this primer provides the reader with an introduction to:

- the range of activities associated with nuclear disarmament;
- the tools, techniques, and procedures involved in nuclear disarmament verification;
- the opportunities and challenges presented by IAEA participation in nuclear disarmament verification, and;
- the ways in which stakeholders can build capacity to engage on this issue

It is written for professionals and students unfamiliar with the specific subject but with an awareness of international security issues. It is not intended to provide comprehensive technical details, nor an exhaustive discussion of the verification issues. It provides foundational information, enhanced by graphs, charts, and


IAEA Director-General Addresses 55th IAEA General Conference.
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diagrams, in addition to links to useful reference texts and other sources of information. It is not intended to provide comprehensive technical details, nor an exhaustive discussion of the verification issues.

The primer begins by outlining the range of activities associated with nuclear disarmament. These include nuclear weapon dismantlement; the disposition of fissile material recovered from weapons; the conversion of military fissile material production facilities; the end of nuclear weapons research; and the ongoing monitoring of disarmed states. It describes the steps involved in verifying the completion of these activities, and provides illustrative case studies of multilateral approaches to these tasks to provide an overview of lessons learned from previous examples of multilateral verification of nuclear disarmament. The challenges and opportunities that would arise from IAEA verification of each task are then presented for further discussion.

US President Eisenhower proposes the IAEA to the UN General Assembly.

# 2. What is Nuclear Disarmament?

## 2.1 Why is it important to understand nuclear disarmament processes?

Nuclear weapons, and the programmes nuclear-armed states develop to sustain them, are complex and diverse. As such, nuclear disarmament is also a complex undertaking involving a diverse array of activities. If a nuclear-armed state agrees to disarm, it will be necessary to understand exactly what activities have been agreed to in order to verify that they have occurred.

It is therefore useful to examine multilateral approaches to nuclear disarmament verification through individual disarmament activities that could be included in a disarmament agreement. These can range from the dismantlement of nuclear weapons through to monitoring the disposal of the materials and components that go into them. This section outlines the scale and diversity of nuclear weapon programmes, and describes a spectrum of nuclear disarmament activities. This spectrum is not exhaustive, and disarmament may include a number of activities not discussed here (such as the destruction of nuclear weapon delivery systems). The following sections will discuss each part of this spectrum in turn to identify the activities and issues involved in their verification.

## 2.2 The breadth and depth of nuclear weapon programmes

Developing nuclear weapons is not simple. An actor must first acquire fissile material. It must then develop technologies and facilities that can process this material into weapons-usable fissile material. The actor must then acquire many other non-nuclear technologies and components that can turn weapons-usable fissile material into a weapon. These might include high explosives, detonators, arming mechanisms, safety systems, and delivery vehicles. To achieve all this, it also has to develop an extensive array of scientific and engineering skills that can complete the steps above and subsequently maintain a nuclear arsenal.

The five NWS under the NPT define nuclear disarmament as 'the process leading to the realization of the ultimate goal of a world without nuclear weapons and any measure contributing hereto. Nuclear disarmament may also refer to the end state after nuclear weapons are eliminated.'

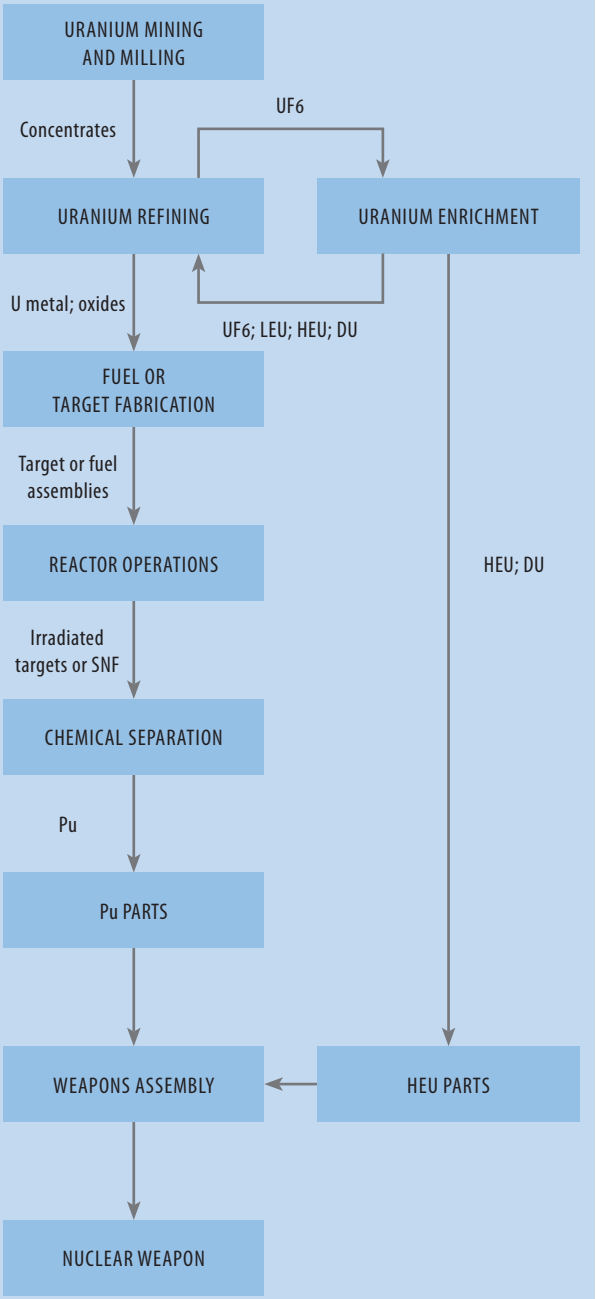
As mentioned above, nuclear weapon programmes exist in an array of sizes and shapes. States with large nuclear arsenals (such as the US and Russia) operate a vast array of facilities that cost many billions of US Dollars per year and employ thousands of scientists, engineers, and administrators. States with smaller nuclear arsenals (such as the UK and France) operate only a small number of nuclear weapon facilities that cost a few billion US Dollars per year. The precise nature of disarmament activities will therefore vary considerably between states.

## 2.3 The spectrum of nuclear disarmament

Nuclear disarmament can be regarded as a spectrum of activities. It is useful to approach this spectrum from the perspective of reversibility. The removal of nuclear weapons from delivery vehicles is a step that can be reversed quickly. Dismantlement of nuclear weapons and destruction of their components is a far more difficult and time-consuming step to reverse. If the facilities and expertise required to reconstitute a nuclear arsenal are removed or re-applied to purely peaceful activities, it becomes very difficult to regenerate a nuclear weapon programme. It is possible to separate nuclear disarmament activities into an illustrative spectrum of nuclear disarmament activities in order of decreasing reversibility:

1. Dismantlement of nuclear weapons
2. Termination of production of weapons-usable fissile material for nuclear weapons

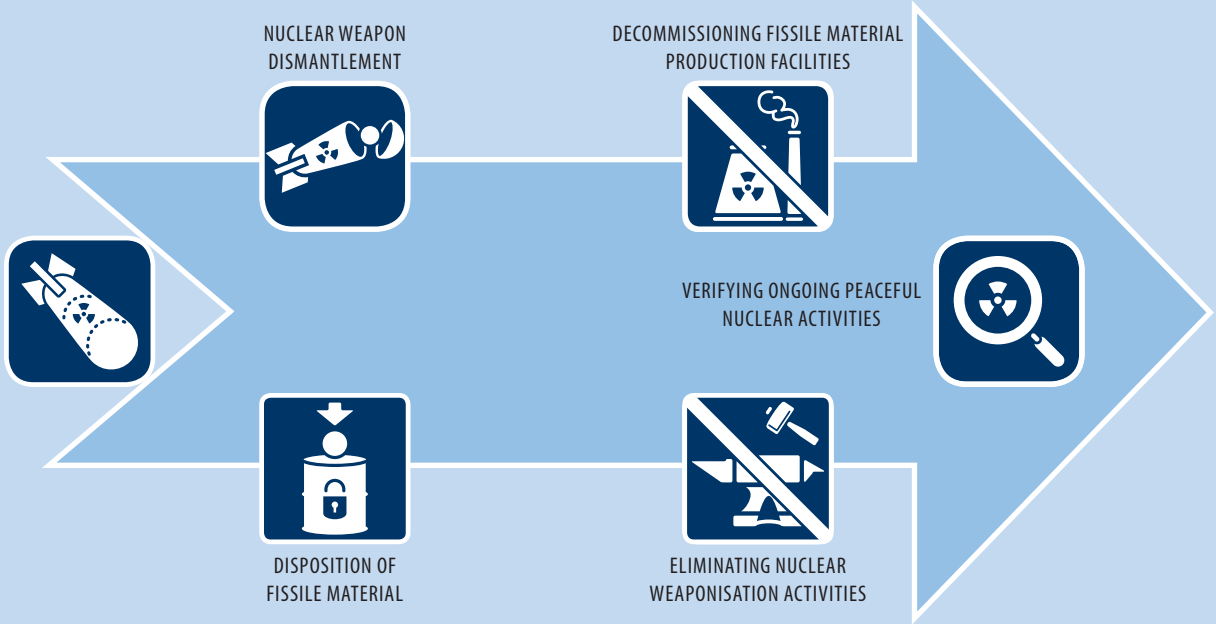
**Figure 2.1** Generic nuclear weapon programme



3. Destruction or conversion of weapons-usable fissile material recovered from dismantled weapons or from stockpiles
4. Elimination or reversal of nuclear weaponisation activities related to the development and maintenance of nuclear arsenals
5. Placement of all remaining civilian nuclear materials and activities under international safeguards, including the monitoring of converted fissile materials recovered from dismantled weapons

Each of these activities involves very different technical procedures, and present very different challenges. To convert a weapons-usable fissile material production facility from military to civilian oversight, under IAEA safeguards, would entail relatively straightforward technical and procedural adjustments. Such a process may not take much more than a year to complete. In contrast, dismantling a large nuclear arsenal would involve a number of logistical challenges, the development of new tools and procedures, and take many years. This process may also generate a number of new safety and security risks. Completing this range of nuclear disarmament

**Figure 2.2** The spectrum of nuclear disarmament



activities would require careful coordination between a variety of domestic stakeholders (such as the military, industry, government, and academia).

## 2.4 Verifying the spectrum of nuclear disarmament

Verifying these activities will also generate many security, safety, and proliferation risks. Verifying the dismantlement of nuclear weapons involves a detailed knowledge of their construction. Information regarding the types of material within a nuclear weapon, their composition, and their integration could be proliferative if accessed by a NNWS. This information may also be too sensitive for a NWS to share. Nuclear weapons also contain explosive, radioactive, and toxic materials that could seriously endanger verifying and verified personnel if improperly handled.

The facilities associated with nuclear disarmament (such as those involved in the construction, dismantlement, and research of nuclear weapons) also use complex technologies. Verifying that these technologies have been


IAEA Inspector Training Exercise.
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adjusted or altered to prevent the production of nuclear weapon components will be challenging to those with little prior knowledge. Many important elements of a nuclear weapon programme are also intangible. Digital files related to nuclear weapon designs are hard to contain. Redirecting nuclear weapon technicians to civilian activities and preventing their involvement in future nuclear weapon activities also poses challenges for disarmament and verification.

Nevertheless, multilateral approaches to verification can overcome many of the challenges associated with verifying nuclear disarmament. The IAEA has verified similar activities in the past. The IAEA verified that South Africa's nuclear weapons programme was dismantled and has since been able to verify that all nuclear material in South Africa, including fissile material removed from dismantled nuclear weapons, continues to be used peacefully. The IAEA has examined the remnants of Libya's undeclared nuclear programme, and is satisfied that any knowledge relating to nuclear weapons has not been re-applied to a nuclear weapon programme. According to former IAEA Director-General Dr Hans Blix, IAEA inspectors 'discovered and mapped Iraq's clandestine nuclear weapons programme, effectively moved to destroy or neutralize it, and activated a long-term monitoring and verification plan to prevent its revival.'


Special session of the IAEA Board of Governors.
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# 3. An Overview of the Issues Associated with an IAEA Role in Nuclear Disarmament Verification

## 3.1 About the IAEA

The International Atomic Energy Agency (IAEA) was established in 1957 to 'accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world.' It is governed by a General Conference (GC) of Member States and an executive body called the Board of Governors (BoG). The GC meets once a year to discuss the agency's budget, pass resolutions, and consider matters brought to it by the BoG. The budget of the IAEA is provided by Member States according to the UN Assessed Contributions System. This is augmented by voluntary extra-budgetary contributions, the provision of technical experts, and in-kind assistance from Member States.

The Statute of the IAEA lays out seven functions, ranging from assisting nuclear research and development to the promotion of nuclear safety standards. One such function is the application of safeguards to a state's nuclear activities to ensure they are not used for prohibited purposes, such as those laid out in the NPT. The Statute states that the IAEA is 'to apply safeguards, at the request of the parties, to any bilateral or multilateral arrangement, or at the request of a State, to any of that State's activities in the field of atomic energy.' The BoG, comprised of 35 Member States, approves all verification agreements, declares violations of these agreements, and considers all other major questions regarding the IAEA's activities.

The Statute also notes (in Article III.B.1) that the IAEA is to conduct its activities in accordance with the UN goals of promoting peace and international cooperation 'and in conformity with policies of the United Nations furthering the establishment of safeguarded worldwide disarmament and in conformity with any international agreements entered into pursuant to such policies.'

## 3.2 Legal issues

The IAEA's statutory mandate to verify nuclear disarmament is limited to cases where it is requested to do so by States Parties to a disarmament agreement or by UN Security Council Resolutions. Aside from a ruling from the International Court of Justice, there are no other methods to *require* IAEA verification of nuclear disarmament.

IAEA involvement in nuclear disarmament verification also needs to take into account Member State commitments under the nuclear non-proliferation treaty (NPT). The NPT obliges NWS not to transfer nuclear weapons to any recipient, and not to assist any NNWS to acquire nuclear weapons. NNWS under the NPT have undertaken not to acquire or have control over nuclear weapons, and not to seek or receive any assistance in the manufacture of nuclear weapons. Any nuclear disarmament verification undertaken by the IAEA must not assist NNWS in the production of nuclear weapons, or violate the non-proliferation commitments of States Parties to the NPT in any other way.

**Box 3.1** NPT commitments

**NPT Article I requires NWS:**

- not to transfer to any recipient whatsoever nuclear weapons or other nuclear explosive devices or control over such weapons or explosive devices directly, or indirectly;
- not to in any way to assist, encourage, or induce any NNWS to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices, or control over such weapons or explosive devices.

**NPT Article II requires NNWS:**

- not to receive the transfer from any transferor whatsoever of nuclear weapons or other nuclear explosive devices or of control over such weapons or explosive devices directly, or indirectly;
- not to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices;
- not to seek or receive any assistance in the manufacture of nuclear weapons or other nuclear explosive devices.

The IAEA must also consider which procedures to follow when establishing the legal basis upon which it might verify any future nuclear disarmament agreement. For example, a disarmament agreement negotiated between States Parties may outline the acceptable verification procedures which the IAEA would subsequently have to follow. Alternatively, a UN Security Council resolution requiring IAEA verification of nuclear disarmament may leave the agency with the freedom to determine verification procedures for itself. In either case, the IAEA would likely be consulted during the formation of such agreements or resolutions. The IAEA Board of Governors would also have to approve any verification agreement that the agency entered into with any other party. The General Conference of the IAEA will also have an opportunity to influence the implementation of any such verification agreement by passing resolutions supporting or condemning it.

## 3.3 Political issues

Nuclear-armed states will influence the scope and shape of the IAEA's role in verifying any disarmament activities they might undertake. However, they have yet to voice explicit support for an IAEA role in verifying any future nuclear disarmament activities outside of the 2014 General Conference Resolution (discussed in section 1.4). The Draft Final Document of the 2015 Review Conference of the NPT encouraged States Parties 'to pursue and intensify efforts to develop nuclear disarmament verification capabilities, taking into account the role of the International Atomic Energy Agency in the area of verification'. However, disagreements over language

relating to a Middle East zone free of nuclear weapons prevented this document from receiving the consensus support of NPT States Parties.

Political disincentives to involve the IAEA in nuclear disarmament verification may include a fear of establishing a precedent in one nuclear disarmament activity that other states may apply to future disarmament activities. Furthermore, States Parties negotiating a nuclear disarmament agreement may fear that requesting verification from an external party may be misinterpreted as an expression of distrust. Domestic political forces may also resist multilateral verification through the IAEA in favour of a more manageable state-to-state verification relationship.

Political incentives to involve the IAEA in nuclear disarmament verification include the opportunity to build confidence among a much broader array of actors that can be involved through a multilateral approach. Involving the IAEA in disarmament verification may also demonstrate confidence in the IAEA as a whole, reinforcing the importance of other aspects of the agency's work (such verifying NNWS commitments under the NPT). Setting a precedent for IAEA verification of disarmament may also act as an incentive to involve the agency in verifying other disarmament activities. The US and Russia have invited the IAEA to verify the transfer of weapon-origin fissile material to civilian uses, and in doing so have expanded the IAEA's capabilities in this regard. States Parties to the NPT have since encouraged all NWS to place excess military fissile material under IAEA verification to ensure such material remains permanently outside military programmes.

## 3.4 Financial issues

The IAEA's regular budget is currently constrained by a policy of 'zero real growth' above inflation. Only a portion of this budget goes to nuclear verification (including safeguards implementation, development, corporate services, overall management, and 'other verification activities'); the rest goes to five other major programs. This regular budget is funded by all Member States according to the UN Assessed Contributions System. Core activities that cannot receive funding from the regular budget require voluntary extra-budgetary funds from Member States. Verifying nuclear disarmament will place additional burdens on the IAEA's budget. Without confidence that this budgetary burden can be met, the IAEA's Secretariat or its Member States may limit any future nuclear disarmament verification activities to those that are less expensive but perhaps less significant.

Funding the preparation and implementation of nuclear disarmament verification procedures through voluntary extra-budgetary contributions would allow those with the greatest interest in verification and capacity to support it to bear the greatest financial burden. However, this raises the question of who has the greatest interest in verification, and generates a risk that it will receive only partial or unpredictable funding.

**Box 3.1** IAEA Sub-programme 4.1 - Other Verification Activities

**Projects**

- **4.2.1.001: Verification activities in the Democratic People's Republic of Korea**

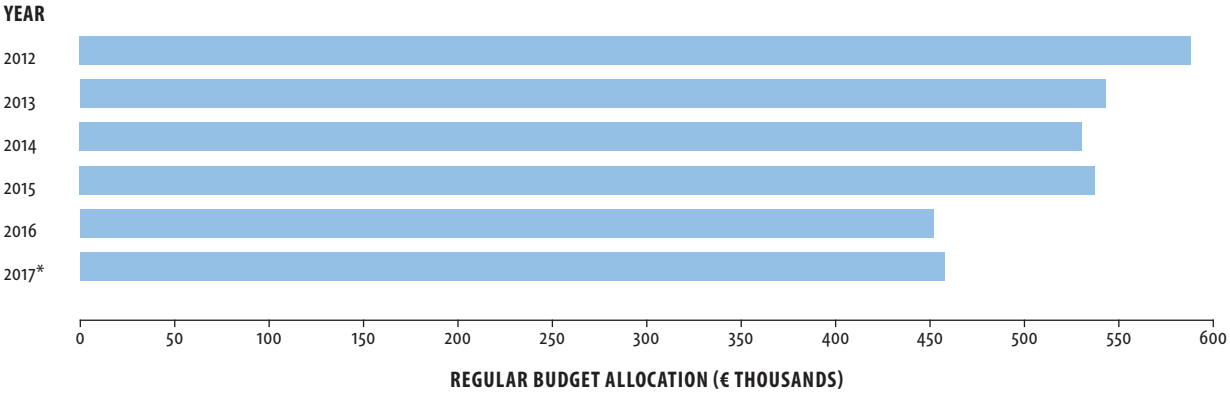
  State evaluation report for the Democratic People's Republic of Korea; plans to implement safeguards or other monitoring and/or verification measures under different scenarios.

- **4.2.1.002: Verification activities related to the PMDA**

  Verification approaches; inspection procedures; statements and documentation on activities, results and conclusions of inspections; equipment requirements; and installed and tested equipment.

| Outcomes | Performance Indicators |
|---|---|
| ● Maintained readiness and preparedness to implement safeguards under INFCIRC/403 and to conduct other verification activities in the Democratic People's Republic of Korea, as approved by the Board of Governors. | ● Percentage of required documents and plans in place to allow for verification activities in the Democratic People's Republic of Korea. |
| ● Necessary legal framework, verification approaches and equipment to conduct verification related to the PMDA in place. | ● Percentage of required arrangements, approaches and systems in place to allow for verification of the PMDA. |

**Figure 3.1** Budget Allocations for 'other verification activities'




**Note:** * Using 1.3% price adjustment.

**Source:** The Agency's Programme and Budget.

Funding the preparation and implementation of nuclear disarmament verification through a form of mandatory assessed contributions would spread the financial risks among all Member States. It would also reflect the shared benefits that can be gained from multilaterally-verified nuclear disarmament. However, this approach may create the impression that all NNWS were paying to remedy an issue created by NWS. Ultimately, the General Conference of the IAEA and its Board of Governors will determine how any preparations for, or implementation of, nuclear disarmament verification will be funded.

## 3.5 Personnel issues

The IAEA will not be able to verify nuclear disarmament activities without relevant expertise. This expertise must deliver unbiased assessments of behaviour without accessing or distributing inappropriate information. Direct experience of nuclear weapon programmes is rare, and it is challenging for the IAEA to obtain such expertise outside of temporary secondments from NWS. IAEA personnel policy rotates the majority of staff out of the agency after three years making it difficult to retain what little nuclear weapon expertise the agency can obtain. Concerns about proliferative and sensitive information also prevent those with knowledge of nuclear weapons transferring this knowledge to those without it.

Seconded personnel from nuclear-armed states can provide valuable cost-free expertise. However, other states might fear that seconded personnel from nuclear-armed states may not feel as bound to the same information control procedures that apply to the international civil servants within the IAEA Secretariat. This perception may dilute the confidence and assurance provided by a multilateral verification process which relies entirely on seconded personnel. Developing an in-house capability to understand and verify all aspects of the nuclear disarmament spectrum would require sustained financial and educational support from Member States. It is also important to consider how such a capability might influence other aspects of the IAEA's work, such as the implementation of safeguards for non-proliferation.

## 3.6 Equipment issues

Verifying aspects of the nuclear disarmament spectrum will require specialised equipment. The IAEA Department of Safeguards Long Term R&D Plan (2012-2023) guides the development of equipment for nuclear verification purposes. The Department, with assistance from Member State Support Programmes (discussed in section 11.3) has developed an inventory of certified equipment that can help verify some nuclear disarmament activities, but not all. Maintaining the capability to verify nuclear disarmament agreements may require integrating new technical specifications into the IAEA's equipment procurement strategy.

Verifying some nuclear disarmament activities will demand equipment that is highly accurate, and which does not release proliferative or sensitive information. Such equipment must also be safe to use in environments that may contain explosive and highly radioactive materials. States involved in verification must also be confident that new equipment is reliable, limited to its agreed purpose, and is resistant to outside interference. IAEA Member States such as the US, Russia, UK, and Norway are already exploring nuclear disarmament verification technologies to meet these demands. These efforts could helpfully be coordinated and expanded to draw upon the expertise available in all Member States.

The UK-Norway Initiative Verification Exercise.
© The Norwegian Defence Research Establishment

# 4. Verifying Nuclear Weapon Dismantlement

## 4.1 How are nuclear weapons dismantled?

Modern nuclear weapons operate by imploding a spherical 'pit' of weapons-usable fissile material with shells of high explosive. In most cases, the resulting fission reaction is then used to ignite a 'secondary' source of fuel - consisting of nuclear material and other light elements. This collection of components is typically called a weapon's 'physics package'. Nuclear weapon dismantlement consists of a number of activities focussing on the removal of this physics package from a weapon casing, and the subsequent separation of the weapons-usable fissile material 'pit' from the high explosives.

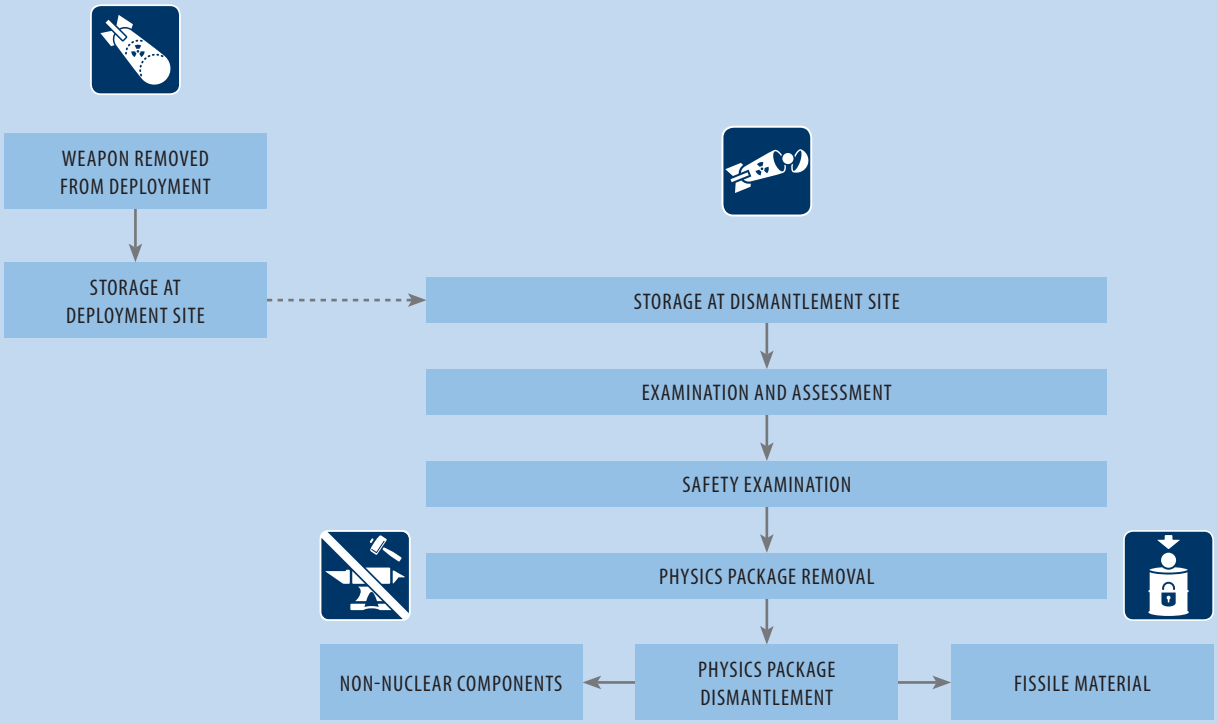
Dismantlement typically begins with the transfer of nuclear weapons from a deployment site (or storage site) to a dismantlement facility. These weapons are then dismantled mechanically, with the separation of the physics package from non-nuclear components such as arming, fusing, and firing systems, parachutes, and batteries. The physics package is then dismantled in purpose-built cells designed to minimise the risks associated with handling high explosives in the proximity of fissile material. Each of these activities can take days to complete, and can be separated by long periods of interim storage or movement. The entire dismantlement process can take up to three weeks to complete, and can involve many different storage and dismantlement facilities.

## 4.2 How is nuclear weapon dismantlement verified?

Verifying nuclear weapon dismantlement is a three-step process. First, a verifying party must be confident that the item passing through the dismantlement process is indeed a nuclear weapon. This may involve the examination of the weapon itself, characteristics or signatures of the weapon - typically its radioactive signature - and associated documentation. This is best achieved at the earliest possible stage of the dismantlement process. It involves confronting safety and security concerns, as well as those relating to proliferative or sensitive information, encountered when handling and examining nuclear weapons. These concerns may be severe if weapons are held on military sites.

Second, a verifying party must be confident that it can follow a confirmed weapon through the dismantlement process. It must be able to detect attempts to divert a confirmed weapon and dismantle a fake weapon. Unique tamper-indicating tags can be used to track confirmed weapons, and seals can be used to indicate

**Figure 4.1** Outline of a nuclear weapon dismantlement process




unauthorised access to containers. However, a weapon may travel through a number of storage locations and containers before dismantlement. This can complicate continuity of knowledge by a verifying party, who may have to remove and replace tags and seals between each movement.

Third, a verifying party must be confident that the components of an confirmed weapon have been separated from each other. One approach to this involves sealing a perimeter around a dismantlement facility and testing whether the components of a confirmed weapon entering the facility leave it in a dismantled state. A verifying party must be able to detect the introduction of any fake weapons into this facility, and the clandestine removal of assembled weapons from this facility.

If this cannot be achieved, a verifying party may have to monitor individual stages of dismantlement *within* a dismantlement facility. This involves identifying, tagging, and sealing collections of weapon components as they are dismantled. This multiplies the safety, security, and proliferation risks for both verified and verifying parties, but may generate greater assurance that dismantlement has occurred. (Verifying that weapon components remain separated is an additional task that will be discussed in section 5.)

## 4.3 Case studies

### South Africa

South Africa developed a small nuclear weapon programme between the 1970s and 1990s. It secretly abandoned this programme in 1990 and dismantled its arsenal of six operational nuclear weapons prior to joining the NPT as a NNWS in 1991. It publically revealed this abandoned programme in 1993 and invited the IAEA to examine aspects of the dismantled programme to provide reassurances that all nuclear material used in the programme was transferred to peaceful uses and placed under IAEA safeguards.

A team of IAEA inspectors was able to visit facilities, examine documentation and interview personnel that were involved in the dismantlement process. The team was able to take environmental samples to confirm the presence and identity of nuclear materials. They were also allowed to visit military sites, view surrogate weapons parts, and examine transfer records of dismantled weapon components. The team was able to build confidence that South Africa had accurately described the scope of its former nuclear weapon programme and that these weapons had been dismantled.

### The UK-Norway Initiative

The UK-Norway Initiative was established in 2007 with the objective of promoting dialogue and understanding of the issues involved in collaboration between NWS and NNWS on nuclear weapon dismantlement verification. This research and development initiative drew on official personnel from the UK and Norway (in addition to non-governmental personnel from VERTIC), and has focussed on equipment development and inspection simulations. The ongoing efforts fall into three main areas of research:

- Managed access procedures, that would allow verifying parties to access sensitive facilities without exposing them to proliferative information or unacceptable safety and security risks. An exercise was held in 2010 to explore the negotiation and implementation of these procedures.
- Information barrier technologies, that aim to filter potentially proliferative measurements of nuclear weapons into unclassified output. Such an output might confirm whether a presented object is or is not consistent with agreed or expected parameters. An information barrier prototype has been developed and tested in laboratory conditions on samples of weapons-usable fissile materials.
- Concepts of 'trust' and 'confidence', that can provide clarity on how parties build or damage trust and confidence during verification. This research draws upon questionnaires, interviews, and focus groups during verification simulations, and has been expanded to include students from academic institutions in the UK, USA, Russia, South Africa, Germany, and Egypt.

## 4.4 Summary of issues

1. Multilateral approaches to nuclear weapon dismantlement verification must take into account the inherently proliferative and sensitive nature of nuclear weapon designs and dismantlement processes. Verification may also require information on facility design and operation, safety and security procedures, and weapon logistics. The extent of permissible verification activities will depend on the NPT commitments and classification procedures of the verified state.
2. Technical and procedural approaches to mitigating verification challenges presented by proliferation and sensitivity issues are being investigated by a number of IAEA Member States. The UK-Norway Initiative has demonstrated that it is possible to facilitate access for NNWS to sensitive facilities without compromising security or non-proliferation obligations. However, participants agree that 'major development is still required to produce verification technologies and procedures in which all parties can build and maintain confidence'.
3. These security and non-proliferation obligations will also complicate the handling of information gathered or produced by verification. A multilateral verification arrangement will involve a diverse array of actors and such an arrangement must include rigorous and credible information controls to prevent the distribution of sensitive or confidential information beyond agreed boundaries.
4. Multilateral approaches to verifying nuclear weapon dismantlement must take into account the resource burdens generated by arsenals that can comprise thousands of nuclear weapons. A statistical approach to verification utilising random sampling techniques to verify a larger dismantlement enterprise may strike a balance between assurance and affordability in comparison to a comprehensive approach.
5. Few IAEA employees have technical knowledge of the components and procedures involved in nuclear weapon dismantlement. Only one member of the IAEA team that verified the dismantlement of South Africa's nuclear weapons had weapons expertise. This US national was later joined by two Russian experts seconded from a Russian nuclear weapon laboratory. These experts have since left the IAEA. The IAEA should consider how to develop and maintain personnel with the knowledge necessary to verify nuclear weapon dismantlement. This knowledge need not be the same as that required to develop nuclear weapons. The IAEA could develop a roster of external experts that could serve as secondees when required, an internal collection of suitably trained staff, or both.

# Further reading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Highly-enriched uranium metal.
Public domain image

# 5. Verifying the Disposition of Fissile Material Recovered from Dismantled Weapons

## 5.1 How to dispose of fissile material recovered from dismantled weapons?

As discussed in the preceding chapter, a nuclear weapon can be considered dismantled once the weapons-usable fissile materials in its core are separated from the high explosives that detonate a nuclear explosion. While these fissile material components remain in a weapons-usable form, they can be reintegrated with other non-nuclear components to reverse the dismantlement process. Similarly, any stockpiles of surplus weapons-usable fissile material components can be used to 'replace' a dismantled weapon.

The fissile material 'pit' at the heart of a nuclear weapon consists of either uranium enriched past 90% in the fissile isotope uranium-235, plutonium purified to contain <7% of the unstable isotopes plutonium-238 and plutonium-240, or a combination of both. These fissile materials are typically kept in a spherical, metallic form, and are coated with other materials to contain radiation and protect them from degradation. Efforts to reintegrate these components into a nuclear weapon can be obstructed by any combination of the fissile material disposition steps listed below (given in order of descending reversibility):

- Monitored storage for an indefinite period of time
- Chemical or physical malformation, including transformation from a metallic form or 'breaking'
- The introduction of chemical or radiological 'barriers' to use, including irradiation or introduction of neutron-absorbing chemicals
- The adjustment of fissile isotopes away from a weapons-usable form. This may include diluting enriched uranium with non-fissile uranium-238, or 'burning' purified plutonium in a nuclear reactor
- The disposal of fissile materials in inaccessible locations, such as deep boreholes or outer space

## 5.2 How is fissile material disposition verified?

The first task for a multilateral verification party would be to confirm that material presented to it is weapons-usable fissile material recovered from dismantled weapons or taken from stores. This task is similar to that involved in confirming the identity of a nuclear weapon prior to its dismantlement. It involves examining

characteristic signatures of the material presented - typically its radioactive emissions - and comparing these to expected quantities.

The proliferative and sensitive nature of weapons-usable fissile material components limits the scope of the conclusions that such examinations can draw. Whereas one nuclear-armed state may be prepared to reveal the approximate ratio of isotopes with weapons-usable fissile material components, another may only be prepared to reveal the presence of a certain isotope in these components. Distinguishing between components that are immediately usable in nuclear weapons and those that are not may require the inspection of shapes, weights, and chemical compositions. Concerns regarding the proliferative or sensitive nature of these characteristics makes it unlikely that they will be shared with a multilateral verification party like the IAEA.

Once the identity of a component has been verified, the tasks associated with verifying its disposition depend upon the disposition steps chosen. Some methods present fewer verification challenges than others:

- The monitored storage of identified components can be achieved through tagging and sealing component containers, in addition to the sealing and surveillance of storage sites. A verifying party may gain confidence that physical malformation has occurred by directly observing the crushing or cutting of tagged and sealed containers. If the characteristic radioactive signatures of the disposed material are not altered by these processes, the identity of stored or malformed components can be reconfirmed.
- It is more challenging to verify that radioactive or chemical barriers have been introduced to weapons-usable fissile material, or that its isotopic compositions has been adjusted. The processes or the location in which these disposition steps are carried out may be sensitive and the verified party may have to use managed access procedures. Furthermore, these processes may destroy the characteristic signatures that could allow a verifying party to maintain continuity of knowledge of a known material as it is adjusted by these processes.

**Figure 5.1** Diagrammatic representation of disposition options

## 5.3 Case studies

### The Trilateral Initiative

The Trilateral Initiative was a joint research and development project carried out by Russia, the US, and the IAEA between 1996 and 2002. The three participants aimed to examine the technical, financial, and legal issues surrounding IAEA verification of weapon-origin fissile material declared by the states as excess to their defence requirements.

The initiative developed an approach to verify whether the mass and radiation signature of fissile material presented was consistent with that used in nuclear weapons. It succeeded in developing and demonstrating a technical system which could do this without revealing sensitive or proliferative information about nuclear weapons. A model verification agreement was drafted and progress was made towards drafting subsidiary arrangements on specific verification approaches. The Trilateral Initiative was abandoned by the US and Russia in 2002, and has since been replaced by the Plutonium Management and Disposition Agreement (below).

### The Plutonium Management and Disposition Agreement

The Plutonium Management and Disposition Agreement (PMDA) between the US and Russia was signed in 2000 and amended in 2010. It calls on both parties to dispose of 34 metric tonnes of plutonium recovered from nuclear weapons or declared excess to military requirements. The PMDA allows parties to dispose of material through irradiation in nuclear reactors, or through the introduction of chemical and radioactive barriers. In addition to bilateral verification between the US and Russia, the PMDA requires both parties to conclude verification measures with the IAEA. The US is currently uncertain which disposition option it shall pursue. To date, no verification measures with the IAEA have been concluded.

## 5.4 Summary of issues

1. Multilateral approaches to verifying the disposition of weapons-usable fissile materials that has been removed from nuclear weapons must overcome the challenges raised by the proliferative and sensitive nature of such material. There are a number of existing technical and legal tools that can assist such an effort. The Trilateral Initiative has developed a prototype technical system to verify the nature of classified plutonium components without revealing sensitive information. A notional model verification agreement has been published by Harvard University.

2. Verifying the nature of nuclear components or weapons-usable fissile materials containing uranium, or a mixture of plutonium or uranium, will require further technical exploration. Existing model agreements will need to be augmented with subsidiary arrangements that lay out precise verification procedures. The conclusion of verification arrangements with the IAEA under the PMDA or the Trilateral Initiative would be constructive in this regard.
3. There is little understanding of how the further disposition of weapons-usable fissile material might be verified multilaterally. The procedures for introducing radioactive or chemical barriers to material reuse are commonly applied within the civilian sector, but applying these to military materials will present novel technical and procedural challenges.
4. The NPT Review Process has encouraged NWS to submit excess military fissile material to IAEA verification and safeguards. Despite this statement of support, and the success of the Trilateral Initiative, few nuclear-armed states have submitted such material to IAEA verification. Demonstrable success under the PMDA or expanding upon the Trilateral Initiative may generate political incentives and technical advances enabling other nuclear-armed states to pursue verified material disposition.
5. Verifying the disposition of very large stockpiles of weapons-usable fissile material within nuclear-armed states may require a considerable increase of the financial resources available to the IAEA. Disposing of weapons-usable fissile material by converting and selling it for use in civilian nuclear reactors may generate financial resources that could ease this strain. The US-Russia Highly-Enriched Uranium (HEU) Purchase Agreement transformed 500 metric tons of Russian weapons-grade HEU into nuclear fuel, which the US purchased for use in civilian power stations.

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The BlueGene Supercomputer supports US nuclear weapon stockpile stewardship.

# 6. Verifying the Elimination or Reversal of Nuclear Weaponisation Activities

## 6.1 What are nuclear weaponisation activities and how might they be reversed?

A nuclear weapon relies on a core of weapons-usable fissile materials to generate a nuclear explosion. However, achieving this in a controllable and effective manner relies on efforts to research, develop, manufacture, and integrate non-nuclear components and systems that safely maintain the weapon's potential and activate it on command. The range of supporting activities (that is, those other than the acquisition of weapons-usable fissile material) that are necessary to develop and maintain a nuclear arsenal are referred to as nuclear weaponisation activities. These can include weapon design, computer simulations, modelling calculations, high explosives testing, and ultimately nuclear weapon testing.

Removing a state's ability to conduct such activities will complicate efforts to reconstitute a dismantled arsenal of nuclear weapons. However, the tools, techniques, and materials used by these activities are also applied in areas with no association with nuclear weapons; they are dual-use. For instance, electrically driven explosive detonators (such as exploding bridge wire detonators) can be used in both commercial mining operations and in nuclear weapons. As such, a disarming state is highly unlikely to rule out the ongoing use of these tools, techniques, and materials.

Reversing a disarming state's nuclear weaponisation activities may therefore be limited to the destruction or containment of weapons-related products of such activities. Tangible products such as the non-nuclear components of weapons may be physically dismantled or destroyed. Intangible products such as weapon designs or test results may be hard to contain. Tacit knowledge of nuclear weapons will remain while those who possess it are alive and no containment options exist here beyond restrictions on those that possess such knowledge. This disarmament activity may therefore be reinforced by a commitment not to use dual-use technologies or expertise to restart such activities.

## 6.2 How might the elimination or reversal of nuclear weaponisation activities be verified?

Non-nuclear components of dismantled nuclear weapons may be identified at the end of the dismantlement process (see section 4). A verifying party may be able to observe the destruction of some outputs of this process

that are not considered sensitive or proliferative, such as weapons casings, directly. This would generate confidence in both the dismantlement of nuclear weapons and the destruction of products of nuclear weaponisation activities.

However, a multilateral verification party may not be authorised to directly observe more sensitive outputs of weapons dismantlement, such as high explosives. Such components do not emit characteristic radiation signatures (like the nuclear components discussed in sections 4 and 5), and other indicators may have to be used to confirm the presence of these dismantlement products. Such indicators may include weight and chemical composition (for high explosives). Information barrier concepts (discussed in section 4) may be useful here to block the revelation of sensitive aspects of these indicators. If such indicators cannot be used, a verifying party may have to assume that non-nuclear items removed from a dismantlement process are nuclear weapon components.

A verifying party is unlikely to be able to confirm that all intangible products of nuclear weaponisation activities are contained or destroyed. However, domestic security protocols for such products may provide an opportunity to build confidence over this issue. Nuclear-armed states maintain strict internal records on the movement of nuclear weapon information. Managed access to elements of these records may provide some confidence that such information has not been re-applied to nuclear weaponisation activities.

An agreement not to use dual-use technologies for nuclear weaponisation activities is also challenging to verify. A verifying party may gain some confidence that such technologies are not being misused through the provision of information on the peaceful uses of selected technologies (such as the end-use information provided by states importing sensitive technologies from a member of the Nuclear Suppliers Group). This may be augmented by the provision of occasional managed access to the facilities and personnel involved in peaceful uses of selected technologies to confirm the information provided. Both the provision and confirmation of this information would need to take into account commercial and other sensitivities.

## 6.3 Case studies

### South Africa

South Africa developed a small nuclear weapon programme which it subsequently disarmed prior to joining the NPT as a NNWS (see Section 4.3). Part of this disarmament involved converting nuclear weapons-related facilities to conventional military or civilian activities, destroying all the non-nuclear components of weapons in its arsenal, and destroying all technical design and manufacturing information. When this programme was revealed in 1993, South Africa invited the IAEA to verify that these activities had occurred. South Africa briefed an IAEA team on the extent of the nuclear weapon programme. The team was also shown programme

design documentation, explosives research documentation, the remains of destroyed non-nuclear components, and records of weapon dismantlement and component destruction activities. The IAEA continues to conclude that all nuclear materials in South Africa remain in peaceful activities.

### Libya

An undeclared nuclear programme in Libya was revealed to the world in 2003 when clandestine shipments of nuclear equipment was seized, and through subsequent admissions by the Libyan government. Libya, which is a NNWS to the NPT, agreed to dismantle this programme and allow verification by the IAEA in collaboration with the US and UK. Documentation on nuclear weapon design and fabrication, including engineering drawings related to weapons components, was shown to the IAEA. These documents were subsequently transferred to the US, which had earlier received two copies of these documents, under the understanding that they would remain accessible to the IAEA for further examination.

The IAEA also received information on all activities in the country that might contribute to a weapons programme to verify Libyan claims that no other weapons-related information existed. Between 2003 and 2008 the IAEA analysed this information and reviewed the capabilities available at locations that could be used for nuclear weapon related activities. The agency found no indications of nuclear weaponisation activities, and concluded that Libya did not have the capabilities to design or manufacture nuclear weapon components.

## 6.4 Summary of issues

1. The vast majority of designs and components that integrate fissile materials into nuclear weapons are highly sensitive and could be proliferative. A multilateral approach to verifying either their destruction or containment will have to respect domestic commitments and international legal obligations not to distribute proliferative or sensitive information. This would involve stringent controls on the storage and access of any information related to nuclear weaponisation activities that is shared with a multilateral verification party. Information related to nuclear weapon designs recovered from Libya was transferred to the US with the understanding that the IAEA could access this information if required to verify the peaceful nature of Libya's ongoing nuclear activities.
2. Information barrier concepts that are applied to nuclear weapon dismantlement verification (discussed in section 4) may also be applicable to confirming the nature of non-nuclear components of nuclear weapons. Such concepts will need to identify observable component signatures, such as weight or material composition, that can be compared to agreed parameters that characterise such components.

3. Multilateral approaches to verifying the peaceful uses of dual-use technologies must confront the challenges of differentiating between peaceful and weapons-related use of such technology. The IAEA has produced a list of nuclear related dual-use equipment, materials, software and related technologies that may be associated with nuclear weaponisation activities. This list is used to inform export control procedures among Member States, but it can also serve to identify dual-use technologies of concern to nuclear disarmament verification.
4. It is important to consider what information on (and access to) dual-use technologies should be given to help verify the elimination or reversal of nuclear weaponisation activities. The commercial sensitivity of peaceful applications of dual-use technologies should be taken into account, as should the financial burden generated by examining a potentially broad array of such applications.

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Disabling nuclear test shafts in South Africa.
© IAEA Imagebank

# 7. Verifying the Decommissioning of Fissile Material Production Facilities

## 7.1 How are fissile material production facilities decommissioned?

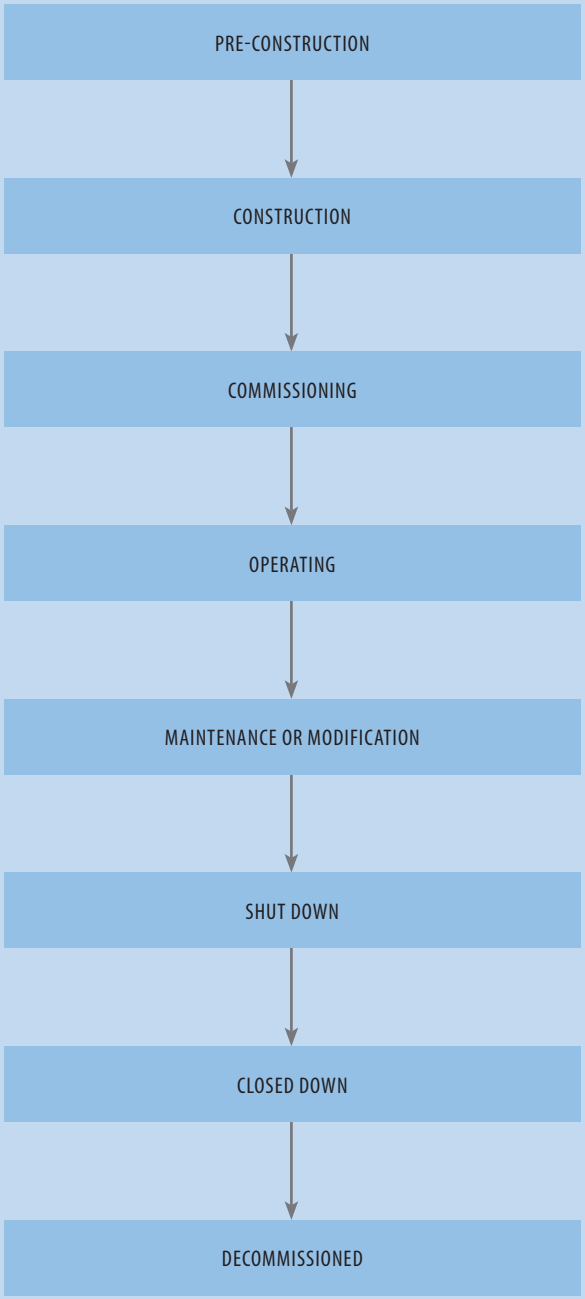
Nuclear weapon programmes rely on a range of facilities to produce and maintain the weapons-usable fissile material components at the heart of nuclear weapons. These components primarily draw on plutonium extracted from spent reactor fuel and uranium enriched in the fissile isotope uranium-235. These materials are chemically converted and machined into nuclear weapon components. Spent fuel reprocessing and uranium enrichment facilities, as well as fissile material conversion and machining facilities, therefore play a central role in manufacturing nuclear weapons. If a nuclear-armed state has dismantled its stockpile of weapons and disposed of all weapons-usable fissile material, it may still be able to reconstitute a nuclear arsenal through such facilities.

Constraining the production and processing of fissile materials for nuclear weapon purposes can reinforce steps taken towards nuclear disarmament by complicating the reversal of material disposition steps described in section 5. However, it can be challenging to distinguish between the production and processing of fissile material for civilian purposes, for military reactors, and for nuclear weapons. A disarming state would be unlikely to abandon all of these capabilities by closing all related facilities.

A disarming state is more likely to place a portion of its fissile material production facilities under IAEA safeguards (discussed in section 8) to verify that they are not used to rebuild a nuclear arsenal. A disarming state may also be encouraged to decommission such facilities to complicate any future attempts to re-arm, and to reduce the overall financial burden of verifying disarmament. It might do so to reduce its excess material production capacity after disarmament, to reduce the complications of subjecting former military facilities (which may remain on larger military sites) to long-term IAEA safeguards.

The IAEA defines the life cycle of a nuclear facility in eight phases. These comprise pre-construction, construction, commissioning, operating, maintenance or modification, shut down, closed down, and decommissioned. A decommissioned facility is one in which 'structures and equipment essential for its use have been removed or rendered inoperable'. Such a facility cannot store and cannot 'handle, process or utilize nuclear material'.

**Figure 7.1** IAEA life cycle of facilities




Spent fuel reprocessing facilities and uranium enrichment facilities can be decommissioned by removing all nuclear materials from storage and process stages, removing key equipment, and dismantling supporting infrastructure. Decommissioning spent fuel reprocessing facilities, which often contain large quantities of radioactive materials, can be a hazardous and time-consuming process.

## 7.2 How is the decommissioning of fissile material production facilities verified?

The Additional Protocol (AP) to Comprehensive Safeguards Agreements (CSA) enables the agency to inspect decommissioned facilities in states with this instrument in force to confirm their status. When NNWS develop a nuclear facility, they must declare and detail relevant technical features of these facilities to the IAEA through a Design Information Questionnaire. Any changes made to a facility through its lifetime - including its decommissioning - must be declared to the IAEA through updates to this Design Information Questionnaire. NNWS therefore notify the IAEA of the steps involved in decommissioning any nuclear facility. The implementation of these steps is then verified by the IAEA through Design Information Verification inspections, which confirm that key facility equipment has been removed or rendered inoperable.

A multilateral verification party may apply these procedures in disarming states to verify the decommissioning of fissile material production facilities. Such a state may submit information to the IAEA

describing how a facility operates, and how it has been decommissioned so that it cannot handle, process or utilize nuclear material. The IAEA would then be able to verify this information through on-site inspections and satellite imagery. In some extreme cases (discussed below) these inspections may be reinforced by placing seals on key components and installing surveillance.

## 7.3 Case study

### The Democratic People's Republic of Korea (DPRK)

In 1994, under a process called the 'Agreed Framework', the Democratic People's Republic of Korea (DPRK) stated that it would shut down and eventually decommission a number of nuclear facilities, including a nuclear reactor and a spent fuel reprocessing facility. States Parties to the Agreed Framework invited the IAEA to verify these activities. The agency was able to place seals on key access points within these facilities, install monitoring devices, and station a small team of inspectors at the Yongbyon nuclear site to carry out short-notice inspections. The DPRK was able to carry out maintenance of both facilities during this freeze, which were reactivated within months of the collapse of the Agreed Framework (when IAEA inspectors were required to leave).

International negotiations, known as the Six-Party talks, later produced an agreement that the DPRK would shut down a number of nuclear facilities, and the IAEA was again invited to verify these actions. The IAEA implemented an ad-hoc verification arrangement that allowed it to identify key equipment and install containment and surveillance measures at a nuclear fuel fabrication plant, the spent fuel reprocessing facility, and a nuclear power plant. An on-site team of IAEA inspectors was subsequently able to observe the removal and storage of this equipment and the flushing-out of nuclear materials. IAEA inspectors were ultimately ejected from the DPRK in 2009.

## 7.4 Summary of issues

1. The IAEA can draw on experience verifying the decommissioning of large-scale fissile material production facilities in those NNWS with an Additional Protocol to their Comprehensive Safeguards Agreement. The IAEA has a number of established tools and procedures for verifying the decommissioning of such facilities.
2. Previous IAEA verification of the decommissioning of fissile material production facilities in NNWS indicate that it is challenging to account for and verify the movement of large quantities of fissile materials that are typically held-up in such facilities. In the case of military fissile material production facilities, these materials may present sensitive or proliferative information.

3. The design and construction characteristics of facilities dedicated to the production of military fissile materials may also present sensitive or proliferative information. The provision of information regarding the decommissioning of such facilities, and the verification of such information, would need to be carried out in a manner that respects domestic and international obligations regarding the distribution of such information.
4. Facilities dedicated to the production of military fissile materials may be located in military sites with activities unrelated to nuclear disarmament. Ongoing access by a verifying party to such facilities would need to avoid intrusion on legitimate and unrelated activities.
5. The burdens associated with verifying the removal or destruction of key equipment, and the continued absence of such equipment, are small relative to the burdens associated with long-term monitoring of an active facility.

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Isar II nuclear power plant.
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# 8. Verifying the Ongoing Peaceful Nuclear Activities of a Disarmed State

## 8.1 How might a disarmed state return to armament?

The nuclear materials that generate nuclear weapons are inherently dual-use. Nuclear materials can be used as fuel for nuclear reactors, as targets for the generation of medical isotopes, and for scientific research. However, they might also be processed into a form that can be used in nuclear weapons. NNWS under the NPT are required to implement a Comprehensive Safeguards Agreement (CSA) with the IAEA to demonstrate the peaceful nature of their nuclear activities. This agreement requires them to record and declare all their nuclear materials and facilities, and to allow IAEA inspectors to verify that information.

However, CSAs do not provide the IAEA with many opportunities to detect undeclared nuclear materials or activities. The IAEA has introduced a voluntary Additional Protocol (AP) to CSAs to remedy this. States that have implemented an AP provide the IAEA with additional information regarding their nuclear activities, and allow the IAEA to verify this information through complementary access inspections. The AP also allows the IAEA to conduct wide-area environmental sampling to detect undeclared nuclear activities.

NWS have no obligation to accept IAEA safeguards on all nuclear materials and activities. These states have implemented voluntary offer agreements (VoAs) with the IAEA under which they designate certain nuclear materials and facilities for safeguards. The IAEA does not have the resources to permit the comprehensive implementation of all VoAs. Some nuclear-armed states are required to place aspects of their civilian nuclear programmes under IAEA safeguards as a result of agreements other than the NPT (such as the Euratom treaty or the US-India Civil Nuclear Agreement).

The expansion of IAEA safeguards to all peaceful nuclear materials and activities in a disarmed state (through the modification of existing VoAs or otherwise) will make a vital contribution to building confidence in nuclear disarmament. If a nuclear armed state has conducted all of the nuclear disarmament activities described above, it will still maintain some aspects of the knowledge and capabilities required to reconstitute a nuclear arsenal. Furthermore, the nuclear disarmament verification efforts described above may have failed to detect the concealment of materials or facilities. Requiring the IAEA to apply safeguards to *all* nuclear materials that remain in a disarmed state will be necessary to establish confidence that this state has disarmed, and will remain disarmed. The IAEA has been able to verify this in a number of states who have undertaken

**Box 8.1** The FMCT

The Fissile Material (Cut-off) Treaty (FMCT) would seek to limit the production of fissile materials for nuclear weapon purposes. It could place restraints on future production, or on total stockpiles, of fissile materials. These restraints might involve the decommissioning of fissile material production facilities.

The FMCT could be verified by the IAEA. This would involve:

- Verifying declared fissile materials outside nuclear weapon programmes
- Verifying the transfer of nuclear materials removed from nuclear weapon programmes
- Verifying the non-weapon usage of all fissile material production

The FMCT is currently under negotiation in the Conference on Disarmament. Current draft texts include:

- United States of America - White Paper on a Fissile Material Cutoff Treaty, Working paper submitted by US to the Conference on Disarmament (CD/1782)
- A Fissile Material (Cut-Off) Treaty: A Treaty Banning the Production of Fissile Materials for Nuclear Weapons or Other Nuclear Explosive Devices, Draft for discussion prepared by the International Panel on Fissile Materials (IPFM)
- French draft for a Treaty Banning the Production of Fissile Materials for Nuclear Weapons or Other Nuclear Explosive Devices, Working paper submitted by France to the 2015 NPT Review Conference

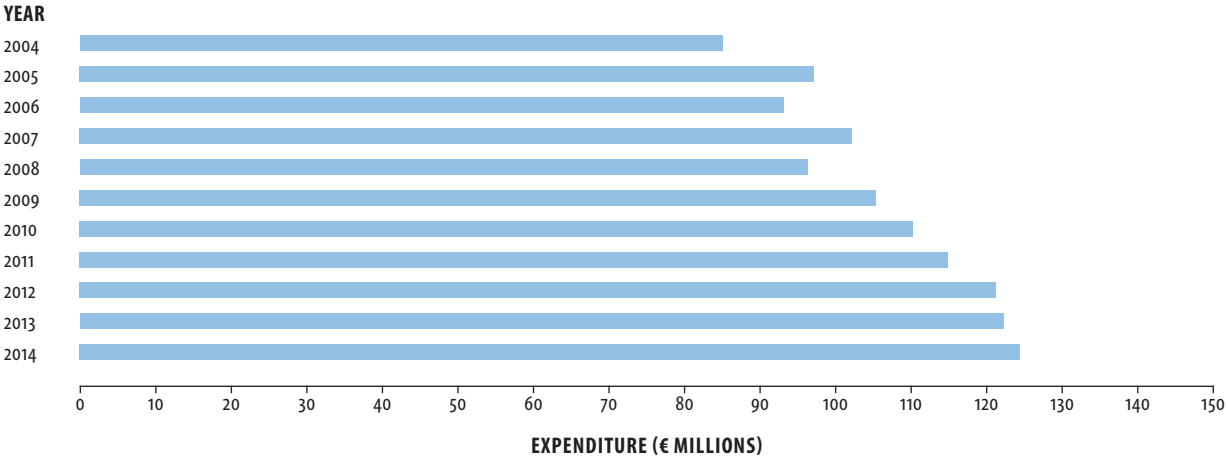
some or all of the disarmament activities described above, including South Africa and Iraq (discussed below), as well as former Soviet Union states who once held nuclear weapons on their territory.

## 8.2 How might safeguards be applied to a disarmed state?

The objective of IAEA safeguards under a CSA is 'the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons [. . .] or for purposes unknown, and deterrence of such diversion by the risk of early detection'. Safeguards applied to a disarmed state will aim to achieve the same objective. However, the criteria for defining 'timely detection' and 'significant quantities' of nuclear material are likely to be considerably more demanding. A disarmed state may be able to call upon its remaining nuclear expertise to rebuild nuclear weapons from smaller amounts of material than NNWS, in a smaller timescale. The IAEA's tools for safeguarding civilian nuclear sites - such as containment and surveillance technologies, environmental sampling, and tamper-indicating seals - will be applicable in a disarmed state. They may have to be applied more frequently and examined more rigorously to deliver confidence that these more stringent safeguards criteria are met.

A second objective of IAEA safeguards under a CSA is the detection of undeclared nuclear material and activities. This objective would also be applied to safeguards in a disarmed state, but it will be harder to provide multilateral assurances that this has been achieved in a disarmed state than it is in a NNWS. Multilateral approaches to nuclear disarmament verification will have to examine and verify historical records of fissile material production to gain confidence that all fissile materials (including those that were integrated into nuclear weapons) have been declared. Nuclear-armed states are under no external obligation to maintain an accurate nuclear material accounting system, and these records may be incomplete or inaccessible. A multilateral verification party will also need to gain confidence that all fissile material production facilities have been declared. The IAEA's tools for detecting undeclared nuclear activities - such as satellite imagery, open source intelligence,

**Figure 8.1** IAEA regular budget expenditures on nuclear verification




**Note:** Expenditure given at year-on-year prices

**Source:** IAEA Annual Reports.

and environmental sampling - will be applicable to a disarmed state. The expanded declarations required under the AP may also be applied to a disarmed state. Many of these declarations, such as those regarding facilities associated with nuclear fuel cycle research and development, may already be declared by a disarming state through the activities described above.

Additional declarations, such as the ongoing activities of personnel with knowledge of nuclear weapons, and accompanying inspection rights may be required to provide confidence that clandestine nuclear activities will be detected.

## 8.3 Case study

### Iraq

The 1991 Gulf War in Iraq revealed a clandestine nuclear weapon programme that was not declared by Iraq or detected through its CSA with the IAEA. The UN Security Council subsequently asked the IAEA to develop and implement a verification programme that would confirm the dismantlement of this programme.

The first phase of this programme identified a number undeclared nuclear materials and facilities through the examination of Iraqi declarations, an array of on-site inspections, and the provision of intelligence from third parties. The second phase of this programme involved the ongoing monitoring and verification of Iraq's remaining nuclear

material and activities. UN Security Council resolutions provided the IAEA with unprecedented verification tools and access rights during both these phases. However, cooperation between Iraq and the IAEA broke down in 1998.

The agency was able to return to Iraq in 2002 under a different verification arrangement, but its conclusions did not assure all Member States that all nuclear materials and activities in Iraq were peaceful. As of December 2014, the IAEA has concluded that declared nuclear material in Iraq remains in peaceful activities. Evaluations regarding the absence of undeclared nuclear material and activities in Iraq remain ongoing.

## 8.4 Summary of issues

1. The IAEA's existing toolbox of safeguards equipment and procedures can and should be applied to verify the ongoing peaceful nuclear activities of a disarmed state. This is the case in South Africa, and former Soviet Union states that once held nuclear weapons on their territory. States Parties to the NPT argued in 2015 that CSAs and APs should be universally applied once the complete elimination of nuclear weapons has been achieved.
2. The remaining nuclear capabilities of a disarmed state will make it harder to gain assurance that all nuclear activities are purely peaceful. A disarmed state may be able to call upon its remaining nuclear expertise to rebuild nuclear weapons from smaller amounts of material than NNWS, in a smaller timescale. The application of existing tools and procedures may have to be more intense and frequent in a disarmed state than it would otherwise be in a NNWS. The frequency and intensity of inspections under the CSA and AP can be adjusted without creating new agreements.
3. Verifying the ongoing peaceful nuclear activities of a disarmed state may require information on and access to nuclear materials and facilities that goes beyond that provided by existing IAEA tools and procedures (such as the CSA and AP). This may require supplementary protocols to existing legal agreements that a disarming state may be unprepared to accept in perpetuity. These protocols may be designed to expire when the IAEA can confirm that there are no undeclared nuclear materials or activity within a disarmed state. New equipment and procedures may also be needed to overcome the size and complexity of fissile material production facilities in disarming states.
4. Nuclear-armed states (particular the US and Russia) possess the vast majority of global fissile material stocks and production capacity. Expanding the application of IAEA safeguards to cover all nuclear materials and activity in disarmed states and non-nuclear-weapon states will require a significant increase in the IAEA's safeguards budget and resource-base. Nuclear disarmament activities that introduce significant obstacles between nuclear materials and the potential reconstitution of nuclear weapons (such as long-term disposition and facility decommissioning, discussed above) may reduce the IAEA's ongoing safeguards burden.

# Further reading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# 9. The IAEA's Role in Disarmament Verification: Overview of Key Issues

The five NWS under the NPT define nuclear disarmament as 'the process leading to the realization of the ultimate goal of a world without nuclear weapons and any measure contributing hereto. Nuclear disarmament may also refer to the end state after nuclear weapons are eliminated.' A nuclear disarmament agreement may involve a range of activities beyond the dismantlement of nuclear weapons.

Verification builds confidence in nuclear disarmament by collecting information on disarming states, and by detecting failures to comply with a disarmament agreement. Multilateral approaches to verification can build confidence in more parties than a bilateral approach to verification. Multilateral approaches can also draw upon greater expertise and capacity to build a more effective and efficient verification system.

Multilateral approaches to verifying nuclear weapon dismantlement must overcome a number of challenges. The biggest challenge is the proliferative and sensitive nature of nuclear warheads and their design. It is challenging to confirm whether an item presented for dismantlement is a nuclear weapon without revealing information on its design. Verifying that a confirmed weapon has been dismantled involves tracing a weapon through a complicated and sensitive process that presents a number of proliferation and security risks. The UK is currently exploring technical approaches to manage these problems through information barriers and managed access through separate projects with the US and Norway.

Weapons-usable fissile material recovered from dismantled weapons or drawn from excess stockpiles can be used to reconstitute a dismantled arsenal. Verifying the disposition of such material can provide some assurances against this risk. Multilateral verification must be able to confirm that material entering a disposition process is indeed weapons-usable without accessing proliferative or sensitive information. The Trilateral Initiative between the US, Russia, and IAEA has successfully demonstrated this can be achieved for classified plutonium components.

Verifying that the products of nuclear weaponisation activities have been destroyed or contained, and that these activities will not be undertaken in the future, can generate further assurance in nuclear disarmament. Aside from the proliferation concerns mentioned above, a multilateral verification party will have to confront the challenges of differentiating between peaceful activities and nuclear weaponisation activities. Once it has done

this, it must consider what information and access might be required to build assurance in disarmament without placing too much burden on itself or the verified state.

The ongoing peaceful nature of nuclear activities in a disarmed state can be verified through existing multilateral approaches in NNWS under the NPT. However, these approaches may have to be applied with greater frequency and intensity to provide sufficient confidence that fissile materials within a disarmed state are not diverted towards nuclear weapons. Expanding the IAEA's system of safeguards from NNWS to any future disarmed states will require a significant increase in the agency's budget.

The IAEA has verified a range of disarmament activities in the past. For example, the IAEA determined that South Africa's nuclear weapons were dismantled in the early 1990s. It has since been able to conclude that all nuclear material in South Africa continues to be used peacefully. The IAEA has examined the remnants of Libya's undeclared nuclear programme, and is satisfied that any knowledge relating to nuclear weapons has not been re-applied to nuclear arms. According to former IAEA Director-General Dr Hans Blix, IAEA inspectors 'discovered and mapped Iraq's clandestine nuclear weapons programme, effectively moved to destroy or neutralize it, and activated a long-term monitoring and verification plan to prevent its revival.'

# 10. Building Capacity among IAEA Member States to Strengthen Debate on Disarmament Verification

The 58th General Conference of the IAEA noted that the agency must remain ready to assist, in accordance with its Statute, with verification tasks under nuclear disarmament agreements that it may be requested to carry out by the States Parties to such agreements. IAEA Member States will play a vital role in shaping the IAEA's capability to verify nuclear disarmament.

IAEA Member States can draw on a range of domestic expertise to explore issues related to multilateral verification of disarmament. These issues are broad (comprising the legal, political, financial, and technical issues outlined in section 3), and a debate on multilateral disarmament verification can benefit from equally broad contributions from government officials, non-governmental organisations, academia, and industry. Member States can build capacity among these stakeholders by exploring the verification of disarmament activities (outlined in section 2) through practical exercises, technical and legal analysis, cost and capability assessments, and engagement with other states. A number of opportunities exist for Member States to build capacity in nuclear disarmament verification and engage in debate on the opportunities and challenges it presents:

## 10.1 Verification initiatives

The Verification Research, Training, and Information Centre (VERTIC) produces workshops and seminars to explore and develop capacity in multilateral approaches to nuclear disarmament verification. These include seminars exploring historic cases of disarmament verification, workshops to develop and explore hypothetical disarmament verification agreements, and simulations to explore the verified disarmament of hypothetical nuclear weapon programmes. VERTIC also engages directly with IAEA Member States to explore views on the agency's role in verifying nuclear disarmament. More information can be found at www.vertic.org.

The US Department of State and the Nuclear Threat Initiative (NTI) have created an International Partnership for Nuclear Disarmament Verification (IPNDV). This seeks to assess and, potentially, develop approaches to address monitoring and verification challenges across the nuclear weapons lifecycle. More information can be found at www.nti.org.

The UK-Norway Initiative continues to explore information barrier and managed access concepts for nuclear warhead dismantlement verification. The Initiative announced in 2015 that it will seek to work with additional parties during its next programme of activities.

## 10.2 Multilateral forums

IAEA Member States can discuss multilateral verification of nuclear disarmament in the agency's General Conference. Resolutions passed at the 2014 General Conference have noted the IAEA's requirement to remain ready to assist in nuclear disarmament verification. Member States have the option of requesting more information from the IAEA Secretariat as to how it aims to achieve this.

The NPT Review Process provides opportunities for States Parties to explore the IAEA's role in verifying nuclear disarmament. States Parties can work together in groups such as the Non-Aligned Movement, the New Agenda Coalition, and the Non-Proliferation and Disarmament Initiative to submit Working Papers or suggested language on this role to the Review Process.

The broader UN Framework allows a number of opportunities to discuss and express views on an IAEA role in verifying nuclear disarmament. This includes the UN General Assembly First Committee on Disarmament and International Security and the UN Conference on Disarmament. UN General Assembly resolutions may also generate new opportunities to discuss these issues.

# 11. How Can IAEA Member States Enhance the IAEA's Ability to Verify Nuclear Disarmament?

## 11.1 Generating dialogue

Statements and resolutions over the last 5 years by IAEA Member States (see section 1) indicates that there is strong support for an agency role in verifying nuclear disarmament. VERTIC's 2015 survey of Member State views suggests that they may support a wide-ranging role; encompassing the verification of nuclear weapon dismantlement to the elimination or reversal of nuclear weaponisation activities. The survey also indicates that Member States may have divergent opinions on how the IAEA should prepare for this role, and how this issue should be explored further by the IAEA and others.

Member States will dictate the role the IAEA can play in verifying nuclear disarmament, and the capabilities it maintains to fulfil this role. Member States could therefore initiate discussions on the bilateral and multilateral level with each other and with the IAEA Secretariat to investigate perspectives on this issue. These discussions can serve to highlight areas of agreement and disagreement, and allow Member States to develop common positions on the desired role and capabilities of the IAEA in verifying nuclear disarmament.

Member States can voice their positions on this matter at the IAEA General Conference. States might request a report from the IAEA Director-General on the potential role and current level of agency readiness to engage with disarmament verification tasks. Discussions on this matter could eventually be introduced to the IAEA General Conference as a specific agenda issue.

## 11.2 Engaging with the IAEA's ability to verify nuclear disarmament

The 2014 IAEA General Conference noted that the agency 'must remain ready to assist, in accordance with its Statute, with verification tasks under nuclear disarmament'. This resolution was the result of concerted efforts on the part of IAEA Member States to recognise the agency's role in nuclear disarmament. The agency may not be presented with many opportunities to fulfill this role if IAEA Member States do not continue to reiterate and expand upon their support through General Conference resolutions.

Member States can express support for the IAEA's role in verifying nuclear disarmament by encouraging nuclear-armed states to subject excess military fissile material to IAEA safeguards. As discussed above, The Trilateral

Initiative has demonstrated the IAEA's ability to verify classified plutonium weapon components for disposition into peaceful purposes. A study by former IAEA employees provides a model agreement for subjecting excess material to safeguards, which can be found here: http://belfercenter.ksg.harvard.edu/files/iaeaverification.pdf

## 11.3 Technical assistance

IAEA Member State Support Programmes provide an opportunity for Member States to contribute equipment, material, and expertise to the ongoing evolution of IAEA verification capabilities. Member States can provide the IAEA with equipment development assistance, facilities for inspector training, laboratories for independent sample analysis, open source information, and extrabudgetary financial contributions. As of the end of 2014, 20 States and the European Commission had formal support programmes with the IAEA. The agency communicates its research and development needs to these support programmes through its Research and Development Programme for Nuclear Verification.

VERTIC