IAEA Safeguards

Serving Nuclear Non-Proliferation

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Safeguards

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Foreword by Rafael Mariano Grossi, Director General of the IAEA

By implementing nuclear safeguards, the IAEA makes a vital contribution to international peace and security. The Agency's independent verification work helps to deter the spread of nuclear weapons by providing credible assurances that States are abiding by their international non-proliferation obligations. Through the early detection of any diversion of nuclear material or misuse of technology, the IAEA can alert the world to potential nuclear proliferation. The world is safer because of the dedication and vigilance of our inspectors and their colleagues in technical support and analytical roles at headquarters.

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More nuclear facilities and nuclear material come under IAEA safeguards every year. Many new nuclear power reactors are under construction, while older reactors undergoing decommissioning require continued safeguarding. Combined with the steady increase in the use of nuclear science and technology in industry, medicine, agriculture and other areas, this means that demands on the Agency will continue to grow in the coming years. Funding for IAEA safeguards has not kept pace with the increasing demand for our services. We therefore need to continuously find ways of working more efficiently without compromising performance, for example by making greater use of the latest technologies.

In recent years, the IAEA's safeguards analytical laboratories and IT systems have undergone a major modernisation. The number of States with Additional Protocols in force has risen by around a third to 136 over the past decade, representing more than two-thirds of all States with safeguards agreements in force. The result of both these developments has been a significant enhancement to the effectiveness and efficiency of our independent verification capabilities.

Maintaining the rigorous, transparent, and non-discriminatory implementation of IAEA safeguards across the globe will be a high priority for me as Director General.

Meeting the challenge of nuclear verification by Massimo Aparo, Deputy Director General and Head of the Department of Safeguards

IAEA safeguards are an essential component of worldwide nuclear non-proliferation efforts. The Department of Safeguards deploys around 275 inspectors to verify that countries use nuclear material and technology solely for peaceful purposes.

The demand for safeguards verification continues to increase. For example, from 2010-2018 the amount of nuclear material subject to IAEA safeguards increased by nearly a quarter. However, our budget has not risen commensurately.

We are meeting this challenge by maximising the collaborative contribution of our skilled workforce, streamlining our processes and introducing new technologies in support of our mission.

At present, the IAEA is legally obliged to verify safeguards agreements for 183 States. To meet this obligation to the highest standard, in 2018 our inspectors conducted over 3,000 in-field inspections, design information verifications, and Complementary Accesses, amassing nearly 14,000 days in the field.

"By providing credible assurances that States are meeting their nuclear non-proliferation commitments, the IAEA promotes peace and confidence within the international community."

More than 900 people from 95 countries perform this work, each bringing their own unique skills. Our operations divisions carry out the physical inspections while our technical divisions provide the necessary technical and analytical support. Together they conduct a rigorous evaluation of all safeguards-relevant information, which enables us to draw soundly-based safeguards conclusions.

This work is highly technical. The completion of the Modernization of Safeguards Information Technology (MOSAIC) project in 2018 brought new information technology capabilities to IAEA safeguards, allowing our staff to work more effectively and efficiently. Other modern technologies aiding our verification work include environmental sampling, satellite imagery, remote monitoring, and non-destructive assay systems. It is important that we continue to explore potential technological evolutions in support of our mission.

Within these pages, the reader will find more information on the work of IAEA safeguards. By providing credible assurances that States are meeting their nuclear non-proliferation commitments, the IAEA promotes peace and confidence within the international community.

Introduction

Preventing the spread of nuclear weapons is a complex task. Seventy years after the destructive power of nuclear weapons was first demonstrated, a number of international political and legal mechanisms are in place to help to achieve nuclear non-proliferation objectives. They include political commitments of States, multilateral treaties, other legally binding agreements in which States' non-proliferation commitments are embedded, and, critically, IAEA safeguards. The IAEA plays a crucial independent verification role, aimed at assuring the international community that nuclear material, facilities and other items subject to safeguards are used only for peaceful purposes.

What are IAEA safeguards?

IAEA safeguards are a set of technical measures that allow the IAEA to independently verify a State's legal commitment not to divert nuclear material from peaceful nuclear activities to nuclear weapons or other nuclear explosive devices. Pursuant to the IAEA's Statute, which authorizes the IAEA to establish and administer safeguards, States accept the application of such measures through the conclusion of safeguards agreements with the IAEA (see box on page 5).

The implementation of IAEA safeguards comprises four fundamental processes, namely (i) the collection and evaluation of information, (ii) the development of a safeguards approach for a State, (iii) the planning, conduct and

IAEA safeguards are embedded in legally binding agreements, providing the basis for the IAEA to implement effective verification.

Key safeguards facts in 2018

- 183 States with safeguards agreements in force and 134 States with additional protocols in force
- 212,814 significant quantities of nuclear material under safeguards*
- 1,314 nuclear facilities and locations outside of facilities under safeguards
- 24,800 seals installed on nuclear material, facility critical equipment or IAEA safeguards equipment at nuclear facilities
- 481 environmental samples and 487 nuclear material samples collected
- 3,011 in-field verifications conducted equating to 13,612 days in the field
- 1,563 surveillance cameras connected to nuclear facilities
- 1,097 non-destructive assay systems deployed
- 137 facilities remotely monitored
- €138.6 million regular budget plus €18.9 million extra budgetary
- 918 staff and contractors from 95 countries

* *One significant quantity is the approximate amount of nuclear material for which the possibility of manufacturing a nuclear explosive device cannot be excluded.*

Three types of safeguards agreements and two protocols

- **Comprehensive safeguards agreements (CSAs):** all non-nuclear-weapon States (NNWSs) party to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), as well as States party to the regional nuclear-weapon-free zone treaties (NWFZ Treaties), are required to conclude CSAs with the IAEA. Such agreements are concluded on the basis of INFCIRC/153 (Corrected). A State undertakes to accept IAEA safeguards on all nuclear material in all peaceful nuclear activities within its territory, under its jurisdiction or carried out under its control anywhere. Under these agreements, the IAEA has the right and obligation to ensure that safeguards are applied on all such nuclear material for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices.

- **Small quantities protocols (SQPs)**: as a means to minimize the burden of safeguards activities in CSA States with little or no nuclear activities, the SQP was introduced by the IAEA in the early 1970s. In 2005, the IAEA Board of Governors, as a safeguards strengthening measure, approved a modified text of the SQP.

- **Item-specific safeguards agreements**: agreements of this type cover only nuclear material, facilities and other items specified in the safeguards agreements. They are based on the safeguards procedures established in INFCIRC/66/Rev.2 and its earlier versions. States parties to such agreements undertake not to use nuclear material, facilities or other items subject to the agreement for the manufacture of any nuclear weapon or to further any military purpose. The IAEA implements safeguards pursuant to such agreements in three States that are not party to the NPT.

- **Voluntary offer agreements (VOAs)**: the five NPT nuclear-weapon States have concluded safeguards agreements covering some or all of their peaceful nuclear activities. Under the VOAs, facilities are notified to the IAEA by the State concerned and offered for the application of safeguards. The IAEA applies safeguards under VOAs to nuclear material in selected facilities.

- **Additional protocols (APs)**: these are designed for States having any type of safeguards agreement with the IAEA. States with CSAs which decide to conclude additional protocols must accept all provisions of the Model Protocol Additional to Agreement(s) between State(s) and the IAEA for the Application of Safeguards (published in INFCIRC/540 (Corrected)), which was approved by the IAEA Board of Governors in 1997. States with item-specific or voluntary offer agreements may accept and implement those measures of the Model Additional Protocol that they choose.

evaluation of safeguards activities, including in-the-field and at Headquarters, and (iv) the drawing of safeguards conclusions. These processes are illustrated in figure 1. Throughout these processes, the IAEA performs a variety of safeguards activities, from the measurement of nuclear material items in facilities to the analysis of safeguards relevant information at Headquarters.

The vast majority of safeguards agreements are those that have been concluded by the IAEA with non-nuclear-weapon States (NNWSs) party to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) (see box on page 6). Under the NPT, these States have committed not to produce or otherwise acquire nuclear weapons, to place all of their nuclear material and activities under IAEA safeguards and to allow the IAEA to verify their commitments.

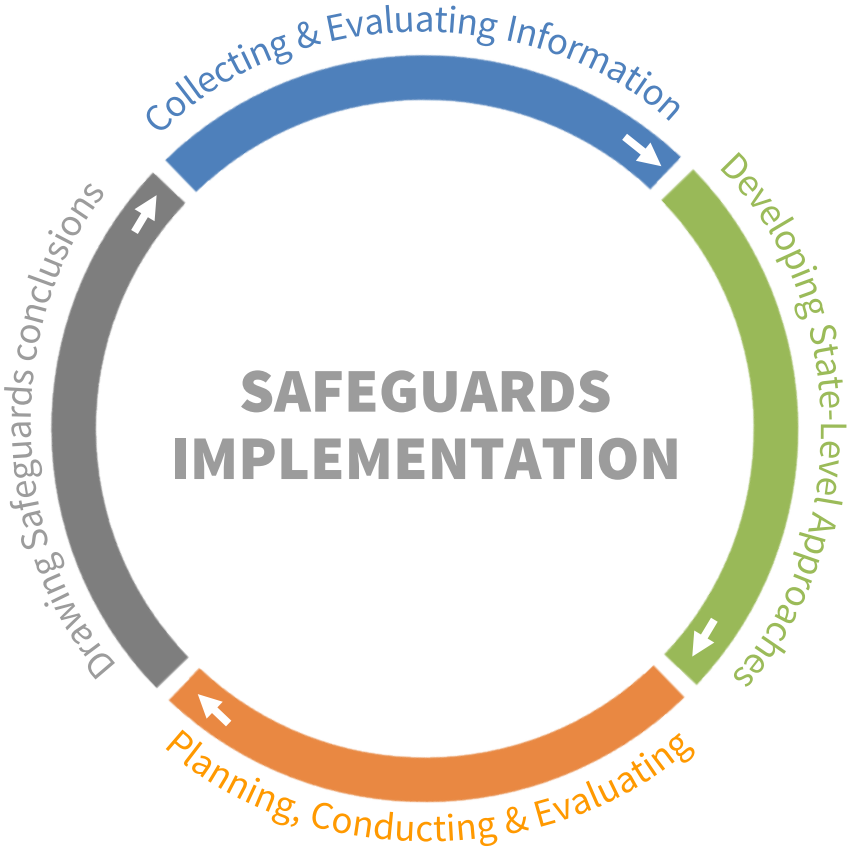


Figure 1. Main steps in safeguards implementation.

Treaty on the Non-Proliferation of Nuclear Weapons

The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) is the centerpiece of global efforts to prevent the further spread of nuclear weapons and weapons technology, to foster the peaceful uses of nuclear energy, and to further the goal of nuclear disarmament. It entered into force in 1970 and now has some 191 Parties.

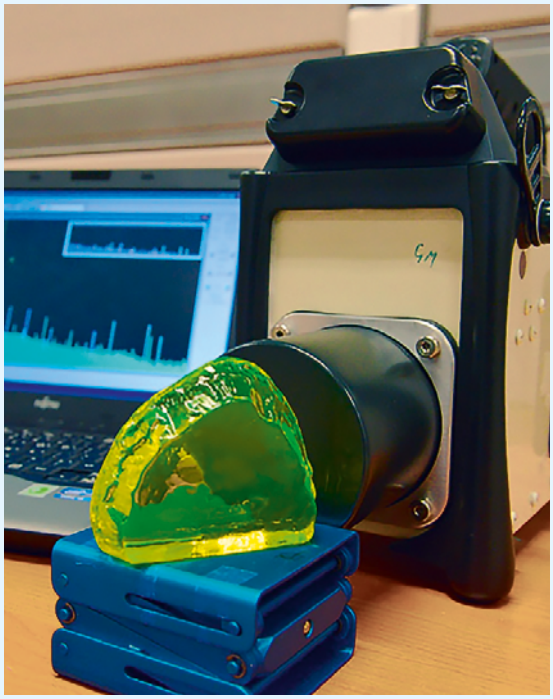
While the IAEA is not a party to the Treaty, it is entrusted with key responsibilities under the Treaty. The IAEA has a specific verification role as the international safeguards inspectorate under Article III of the Treaty. The IAEA also serves as a multilateral channel for facilitating transfers of nuclear technology for peaceful applications to its Member States, in accordance with its Statute.

The NPT involves a balance of rights and obligations for States, differentiating between non-nuclear-weapon States (NNWSs) and nuclear-weapon States (NWSs) – States that manufactured and exploded a nuclear weapon or other nuclear explosive device prior to 1 January 1967 (i.e. China, France, the Russian Federation, the United Kingdom and the United States of America).

Under the NPT, the NWSs committed, inter alia, not to transfer to any recipient nuclear weapons or other nuclear explosive devices and not in any way to assist, encourage or induce any NNWSs to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices. Each NNWS is required to conclude a comprehensive safeguards agreement with the IAEA to enable the IAEA to verify the fulfilment of the State's obligations under the Treaty. Eleven NNWSs that are party to the NPT have yet to conclude a comprehensive safeguards agreement with the IAEA. Three States that are not party to the NPT have concluded item-specific agreements with the IAEA (see box on page 5).

What nuclear material is subject to safeguards?

Nuclear material subject to safeguards includes special fissionable material from which nuclear weapons or other nuclear explosive devices could readily be made (e.g. plutonium-239; uranium-233; uranium enriched in the isotopes 235 or 233) and source material (e.g. natural uranium, depleted uranium or thorium), which cannot be directly used for nuclear weapons. All States are likely to have some nuclear material in their territory. For example, depleted uranium, in which the concentration of uranium-235 is lower than in natural uranium, is often used for non-nuclear purposes, such as shielding for radiation sources in hospitals, industry and agriculture. Radioactive sources that do not contain uranium, plutonium or thorium are not subject to safeguards and need not be reported to the IAEA under a safeguards agreement.



Mobile, high-resolution gamma detector for accurate measurement of the types and isotopic composition of nuclear material.

Similar to the NPT, the Treaty for the Prohibition of Nuclear Weapons in Latin America and the Caribbean (Treaty of Tlatelolco, 1967) requires its parties to conclude a comprehensive safeguards agreement (CSA) with the IAEA – as do the other regional nuclear-weapon-free zone treaties, i.e. the South Pacific Nuclear Free Zone Treaty (Treaty of Rarotonga, 1985), the Southeast Asia Nuclear-Weapon-Free Zone Treaty (Treaty of Bangkok, 1995), the African Nuclear-Weapon-Free Zone Treaty (Treaty of Pelindaba, 1996) and the Central Asian Nuclear-Weapon-Free Zone Treaty (Treaty of Semipalatinsk, 2006).

Why do IAEA safeguards matter?

Nuclear energy has the potential to contribute to health and prosperity throughout the world. However, it may also be used for the development of nuclear weapons. The implementation of IAEA safeguards, therefore, serves as an important confidence building measure, through which a State can demonstrate – and other States can be assured – that nuclear material is being used only for peaceful purposes. The IAEA was established in 1957 to help reconcile the dual nature of the atom; so that nuclear energy could be placed in the service of peace and the development of humankind while protecting against its misuse.

Practically all countries around the world use nuclear applications for a variety of peaceful purposes, including food and water security, energy, industrial applications and human health. Only a few of these activities involve the type of nuclear material that could potentially be diverted to nuclear weapons or other nuclear explosive devices (see box on page 7).

Next Generation Surveillance System (NGSS) Cameras installed at the Department of Safeguards' laboratories for testing prior to installation in nuclear facilities.

How are IAEA safeguards applied in practice?

Safeguards processes

Collecting and evaluating information

The IAEA collects and processes safeguards relevant information about a State from three sources: information provided by the State itself (e.g. reports and declarations); safeguards activities conducted by the IAEA in the field and at Headquarters (e.g. in-field verification, evaluation of nuclear material accounting information); and other relevant information (e.g. from open sources and third parties). The IAEA conducts ongoing reviews of such information to assess internal consistency of State-declared information, and its consistency with the information generated and collected by the IAEA. Any anomalies, questions or inconsistencies are identified and addressed in a timely manner through consultations with the State and further action taken, as necessary.

Information provided by a State regarding its nuclear material and activities represents the great majority of information used by the IAEA for safeguards implementation. For States with CSAs and APs in force, information is provided to the IAEA in the form of nuclear material accounting reports, advance notifications of transfers of nuclear material and facility design information, and information about the State's other nuclear and nuclear-related activities.

One of the questions that the evaluation of safeguards activities seeks to answer is whether a State's declarations about its nuclear programme and plans are consistent with other safeguards relevant information available to the IAEA. Such information includes information from open sources (e.g. public government and operator publications, scientific and technical literature, etc.) as well as third party information (i.e. parties other than the State itself). The latter, which constitutes a very small part of information available to the IAEA, is made available to the IAEA by a State or an organization on a voluntary basis. This information, once validated, is thoroughly analysed by the IAEA and corroborated with other safeguards relevant information available to it. During this process the IAEA engages with States and takes follow-up actions to address the correctness and completeness of their declarations.

Strengthening measures under the Additional Protocol

Additional Protocols (APs) concluded with States with comprehensive safeguards agreements (CSAs) equip the IAEA with important additional verification measures that provide for **broader access to information** about the State's nuclear programme, **increased physical access** by the IAEA and **improved administrative arrangements**.

These **additional measures** include: (i) State provision of information about, and IAEA access to, all parts of a State's nuclear fuel cycle, from uranium mines to nuclear waste and other locations where nuclear material intended for non-nuclear uses is present; (ii) State provision of information on, and IAEA short-notice access to, all buildings on a site; (iii) State provision of information about, and IAEA access to, a State's nuclear fuel cycle research and development activities not involving nuclear material; (iv) State provision of information on the manufacture and export of sensitive nuclear-related equipment and material, and IAEA access to manufacturing and import locations in the State; (v) IAEA collection of environmental samples beyond declared locations, when deemed necessary by the IAEA; and (vi) a simplified procedure for designation of IAEA inspectors, the issuance of multiple entry/exit visas and IAEA use of internationally established systems of communications.

Under an AP, the IAEA may carry out **complementary access** to assure the absence of undeclared nuclear material and activities, to resolve a question or an inconsistency relating to correctness and completeness of the information provided by a State, and to confirm the decommissioned status of a facility or locations outside of facilities (LOFs), such as in hospitals, where nuclear materials are used.

One example of a valuable open source of information is commercially available satellite imagery. Satellite imagery is used to routinely evaluate information provided by States regarding their nuclear activities, to assist in planning inspections and visits to facilities to verify design information, and to help in relation to complementary access under the Additional Protocol (AP).

Developing safeguards approaches

The IAEA develops State-level safeguards approaches (SLAs) for States using a structured, technical method to analyse the plausible paths by which nuclear material suitable for use in a nuclear weapon or other nuclear explosive device could be either acquired (for States with a CSA) or diverted from safeguarded facilities (for States with item-specific safeguards agreements or voluntary offer agreements (VOAs)). On this basis, technical objectives associated with the steps along such a path are established and serve to guide the planning, conduct and evaluation of safeguards activities for that State. To address the technical objectives, specific safeguards measures are identified in accordance with a State's safeguards agreement.

Credible conclusions depend on the independent, impartial and rigorous technical implementation of safeguards.

Planning, conducting and evaluating safeguards activities

Based on an SLA, the IAEA prepares an annual implementation plan which specifies the safeguards activities, both in the field and at Headquarters, which the IAEA plans to conduct in a given year for the State. Once an activity has been conducted, the IAEA evaluates the extent to which that activity has attained the technical objective(s) and identifies any questions, inconsistencies or anomalies necessitating further follow-up activities, which may then be incorporated into an updated plan.

The IAEA and Iran

On 14 July 2015, the IAEA and Iran agreed on a Road-map for the clarification of past and present outstanding issues regarding Iran's nuclear programme. It set out a timeline of activities for the IAEA and Iran to complete before the end of the year. In early December 2015, the IAEA Director General provided a report to the IAEA Board of Governors on the final assessment of these issues. On 15 December 2015, the Board of Governors adopted a resolution in which, inter alia, it noted that all activities in the Road-map had been implemented in accordance with the agreed schedule and that "this closes the Board's consideration of this item".

Also on 14 July 2015, the EU3+3 (China, France, Germany, the Russian Federation, the United Kingdom, the United States of America and the European Union) and Iran agreed on the Joint Comprehensive Plan of Action (JCPOA). In the same month, the UN Security Council adopted resolution 2231 (2015) requesting – inter alia – the IAEA Director General to undertake the necessary verification and monitoring of Iran's nuclear-related commitments as set out in the JCPOA. On 16 January 2016, the Director General confirmed that Iran had taken the initial actions specified in the JCPOA. 'Implementation Day' occurred on the same day, thereby paving the way to begin verifying and monitoring Iran's nuclear-related commitments under the JCPOA.

On 16 January 2016, the report on Verification and Monitoring in the Islamic Republic of Iran in light of United Nations Security Council Resolution 2231 (2015) was approved for release.

In-field safeguards activities are complemented by activities at Headquarters. These include the processing, review and validation of information from States, resulting from in-field safeguards activities and generated from the equipment installed at nuclear facilities, and from open and other sources. Headquarters activities generate safeguards relevant information as a result of the review of data remotely transmitted from safeguards equipment and cameras installed at nuclear facilities around the world, verification of seals, evaluation of analytical results from safeguards samples collected in the field and material balance evaluation. Great effort is made to ensure consistency in the evaluation of safeguards relevant information.

3D laser scanning allows for detection of design changes within a nuclear facility.

In the conduct of its safeguards activities in the field and at Headquarters, the IAEA utilizes instrumentation, technical measures and various techniques to verify information provided by States. New and improved technologies continue to provide an important basis for more effective and efficient safeguards implementation.

In-field safeguards activities

IAEA inspectors perform a variety of verification activities in the field.

Nuclear material accountancy is analogous to an audit of a bank: the inspector compares what is on the nuclear material accounting records, books and reports of a facility with what has been reported by the State to the IAEA and, crucially, that the nuclear material is actually present at the facility as declared.

During the **design information verification**, inspectors compare the design information that the State has submitted to the IAEA with in-field observations to confirm that the information provided by the State is correct and complete, and the facility has not been misused.

IAEA inspectors taking environmental swipe samples.

An IAEA inspector taking measurements in the field.

Environmental samples may be taken for analysis in order to verify that the facility is used as declared. These samples allow an analysis of traces of materials that can reveal information about nuclear material or activities (e.g. separated plutonium or highly enriched uranium at a facility) that have not been declared to the IAEA.

Inspectors verify the inventory of nuclear material using a range of **measurement techniques**. These techniques include item counting, weighing, non-destructive assay with radiation detectors and sample taking for detailed, destructive analysis at IAEA laboratories. **Non-destructive assay** can be used to determine the presence of nuclear material in an item, or the amount of nuclear material in an item, without physically changing the item. **Destructive analysis** produces a very accurate determination of the concentration of nuclear material in a small sample of material taken from a facility. The sample material is destroyed in the measurement process.

Containment and surveillance techniques, such as the application of seals and the use of **cameras and detectors** installed at the facility, may be used to provide continuity of knowledge over nuclear material and facilities between inspections by preventing undetected access to nuclear material or undeclared operation of the facility. Unattended systems, some of which remotely transmit data to Headquarters in Vienna, further support effective and efficient continuity of knowledge.

Type of safeguards conclusions per legal agreement

For States with a CSA and an Additional Protocol in force, if the IAEA's Secretariat has completed all evaluations and found no indication of the diversion of declared nuclear material from peaceful activities and no indication of undeclared nuclear material or activities for the State as a whole, the Secretariat concludes that *all* nuclear material remained in peaceful nuclear activities.

For States with a CSA but without an Additional Protocol in force, if the IAEA's Secretariat found no indication of the diversion of *declared* nuclear material from peaceful activities the Secretariat concludes that declared nuclear material remained in peaceful nuclear activities.

Under item specific safeguards agreements, if the IAEA's Secretariat found no indication of the diversion of nuclear material or of misuse of the facilities or other items to which safeguards had been applied, the Secretariat concludes that nuclear material facilities and other items to which safeguards had been applied remained in peaceful activities.

For States with voluntary offer safeguards agreements, if the IAEA's Secretariat found no indication of the diversion of nuclear material to which safeguards had been applied, the Secretariat concludes that nuclear material from which safeguards had been applied in selected facilities was not withdrawn from safeguards, except as provided for in the agreements, and remained in peaceful activities.

For States with no safeguards agreements in force, the IAEA's Secretariat cannot draw any safeguards conclusions.

Safeguards implementation requires the availability of appropriately prepared, calibrated, tested and well-maintained equipment. The IAEA has accumulated considerable experience in the management of safeguards equipment and this is highlighted by its large equipment inventory and list of equipment authorized for inspection use. For example, unattended monitoring systems may work with a remote transmission capability and are increasingly being used in nuclear facilities to reduce in-field inspection activities. These systems have the ability to transmit authenticated real time verification data from the field in a cost effective manner.

A very powerful verification technique used by the IAEA is environmental sampling. Environmental sampling is effective in detecting undeclared nuclear material and activities. It involves collecting swipe samples in order to analyse them for traces of materials that can reveal information about the presence of nuclear material or nuclear activities conducted.

The nuclear material and environmental samples taken by IAEA inspectors during in-field verification activities are analysed at the IAEA Safeguards laboratories in Seibersdorf, Austria. The laboratories provide the IAEA with a set of independent verification capabilities in areas such as the analysis of uranium and plutonium. These laboratories are responsible for processing, screening, distributing, analyzing, and archiving samples. This work is critical for the evaluation of safeguards verification activities. The IAEA's analytical capabilities are further enhanced through coordination and cooperation with a wider Network of Analytical Laboratories (NWAL), comprising an additional 22 laboratories of IAEA Member States and the European Commission.

Drawing safeguards conclusions

The products of IAEA safeguards implementation activities are annual safeguards conclusions drawn and reported by the IAEA's Secretariat to the Board of Governors in the Safeguards Implementation Report (SIR). In order to draw a safeguards conclusion for each State with a safeguards agreement in force, the IAEA needs to have conducted a sufficient level of safeguards activities and performed a comprehensive evaluation of all safeguards relevant information available to it

about a State. It also needs to have addressed anomalies, questions or inconsistencies identified in the course of its safeguards activities, and assessed whether there are any indications that, in its judgement, would constitute a safeguards concern. The type of conclusion varies according to the type of safeguards agreement in force (see box on page 5).

How have IAEA safeguards evolved?

IAEA safeguards have evolved over the past 60 years as a result of technological change, practical experience and the need to strengthen their effectiveness and improve their efficiency (for an overview of some key developments, see figure 2 below). The events that have had the most profound impact on IAEA safeguards can be said to be: the introduction of comprehensive safeguards pursuant to the NPT and the Treaty of Tlatelolco in the early 1970s; the discovery of a clandestine nuclear weapons development effort in Iraq in 1991 (part of which had been concealed by Iraq within its declared nuclear programme); and the IAEA's experience in relation to the Democratic People's Republic of Korea (DPRK). In particular, the Iraq experience highlighted the shortcomings of the implementation of safeguards for States with CSAs – being primarily focused on declared nuclear material – and provided the catalyst for strengthening IAEA safeguards.

Formative years

The IAEA concluded its first safeguards agreement in 1959 with Canada, but it was not until 1961 that the Board of Governors of the IAEA approved a first safeguards document containing the principles and procedures for the application of safeguards (INFCIRC/26).

Throughout the 1960s, more and more countries began to request the IAEA to apply safeguards to nuclear material and facilities which they received under bilateral nuclear cooperation agreements. Those countries concluded with the IAEA item-specific safeguards agreements (based on INFCIRC/26 and its subsequent revisions), also known as INFCIRC/66-type agreements, under which the IAEA applies safeguards to specific items subject to the agreements to verify that such items are used only for peaceful purposes.

It was not until 1971, following the entry into force of the NPT and the Treaty of Tlatelolco, that the IAEA started to conclude CSAs with States party to those treaties. Those agreements were concluded on the basis of another safeguards document (INFCIRC/153 (Corrected)) that laid the basis for negotiating CSAs and which was approved by the IAEA Board of Governors in 1971.

Changing expectations

The IAEA's experience in Iraq and the DPRK demonstrated that, although IAEA safeguards had worked well with regard to verification activities on *declared* nuclear material and facilities, the IAEA was not well-equipped to detect *undeclared* nuclear material and activities in States with CSAs. This set the stage and provided the catalyst for far-reaching efforts to strengthen the safeguards system.

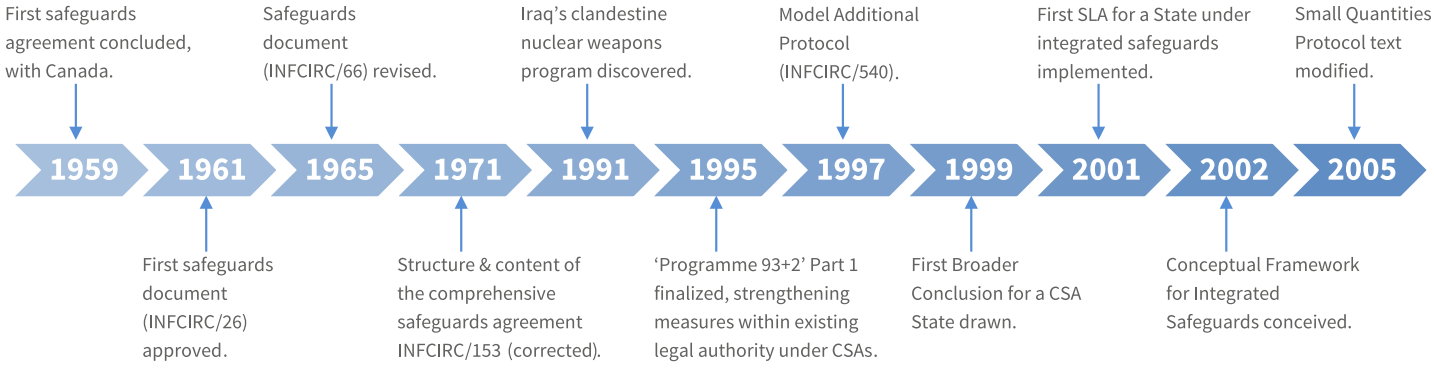
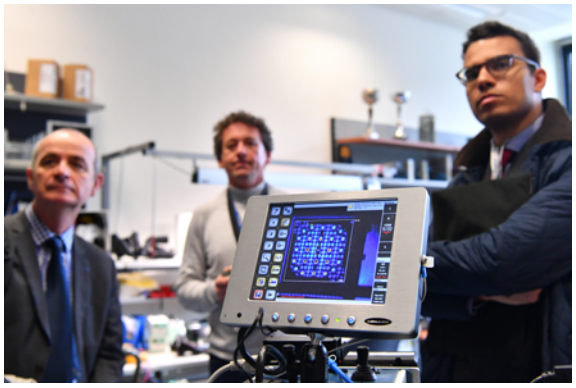


Figure 2. Some key developments in IAEA safeguards.



A demonstration of safeguards verification equipment to representatives from IAEA Member States.

At the end of 1993, the IAEA embarked on a broad programme ('Programme 93+2') to further strengthen safeguards implementation under CSAs by enhancing the IAEA's ability to consider a State as a whole. As part of 'Programme 93+2', measures designed to improve the IAEA's ability to detect undeclared nuclear material and activities in States with CSAs were presented to the IAEA Board of Governors. Some of these measures – such as the early provision of design information, environmental sampling and the use of satellite imagery – could be implemented under the existing legal authority provided for in CSAs ('Part 1 measures'), while others – such as access to other buildings on the site of a facility and additional declarations from the State regarding nuclear-related research and development – required complementary legal authority in order to be implemented ('Part 2 measures'). In 1997, the IAEA Board of Governors approved the Model Additional Protocol designed to provide for additional measures to strengthen the IAEA's ability to detect undeclared nuclear activities in a State.

Additional Protocol

The Additional Protocol (AP) is very important for the effectiveness and efficiency of safeguards. An AP is not a free-standing legal instrument. It can only be concluded in relation to a safeguards agreement. The additional measures provided for in an AP include provision of information about, and inspector access to, all aspects of a State's nuclear fuel cycle. This 'fills the gaps' in the information reported under CSAs. By enabling the IAEA to obtain a much fuller picture of a CSA State's nuclear programme, plans, nuclear material holdings and trade, an AP helps to provide much greater assurance regarding the absence of undeclared nuclear material and activities in the State.

The Additional Protocol provides the IAEA with important supplementary tools which significantly increase the IAEA's ability to verify the peaceful use of all nuclear material in a State with a comprehensive safeguards agreement.

As at the end of 2018, 134 States have an AP in force, or over 70% of all States with safeguards agreements in force. Another 16 States have signed an AP but have not yet brought it into force.

Consideration of the State as a whole

The IAEA started to consider a 'State as a whole' in the implementation of safeguards for States with CSAs in the early 1990s. It started to better integrate and assess all of the information available to it about a State's nuclear activities and plans, and produced its first State evaluation report in 1995. The Additional Protocol in particular provided the IAEA with increased information about the State's nuclear and nuclear-related activities and capabilities, and added to the IAEA's ability to consider the State as a whole. In 1999 the IAEA drew its first so-called 'Broader Conclusion' for a State as a whole, namely that 'all nuclear material remained in peaceful activities'.

In 2001, the IAEA started developing and implementing State-level Approaches (SLAs) for States for which the IAEA had drawn a 'Broader Conclusion'. An SLA is a customized approach to implementing safeguards for an individual State. For such States, the IAEA began to implement 'integrated safeguards', integrating in an optimal way the safeguards measures available to the IAEA under a State's CSA and AP. During 2018, integrated safeguards were implemented for 67 States.

IAEA Safeguards Laboratories, Seibersdorf, Austria.

Over recent years, the IAEA Secretariat has further developed the consideration of a State as a whole in the implementation of safeguards in the context of the State-level concept (SLC). This refers to the general notion of implementing safeguards in a manner that considers a State's nuclear and nuclear-related activities and capabilities as a whole, within the scope of the State's safeguards agreement. The IAEA Secretariat has updated current SLAs and is developing new SLAs for other States.

What are the current trends in IAEA safeguards?

The global nuclear landscape is changing rapidly and will likely continue to do so. Every day – across the world – more nuclear facilities and material come under IAEA safeguards. Nuclear power is expanding – in countries already using it, as well as in States introducing it. Since 2010, the number of nuclear facilities and locations outside of facilities under safeguards has risen by 12 per cent and the quantity of nuclear material under safeguards by 24 per cent. Facilities undergoing decommissioning may also involve a large safeguards effort to verify nuclear material packaging, movement and disposition. In addition, the number of safeguards agreements entering into force is increasing. These global trends look set to continue.

International nuclear cooperation between States is intensifying with an expansion of trade and services in nuclear related equipment, items and materials. Technologies are also changing. Many older nuclear plants are being modernized and new facilities are becoming more technologically sophisticated. The geographical focus of these expanding programmes also continues to change. These trends are not only a macro-level phenomenon; they are an everyday reality for the IAEA. In short, demands on IAEA safeguards are growing and becoming more complex.

For the foreseeable future, the IAEA's regular budget is not likely to grow to meet these increasing demands. Indeed, it has been virtually static for some time already. The IAEA depends on the financial contributions of its Member States, many of which are under pressure to reduce public expenditure.

Current safeguards challenges and opportunities

The challenges to the safeguards system today are profound, varied and continue to grow.

Challenges include the increasing amount of nuclear material under safeguards; the rising number of nuclear facilities and locations outside of facilities which require safeguards; the accelerating pace of technological change and globalization; and the growing volume and diversity of safeguards-relevant data. Furthermore, events such as diplomatic breakthroughs, natural disasters, and war require significant, swift and innovative responses. The Department of Safeguards at the IAEA has to be agile, while still acting within its legal mandate.

The Department of Safeguards is making major improvements in productivity, modernizing infrastructure and business practices, and enhancing organizational agility. This will allow the IAEA to tackle new and current challenges by tapping into new-found efficiencies, without putting at risk the credibility of the safeguards conclusions it draws.

An example of this is the Modernization of Safeguards Information Technology (MOSAIC) programme, 2015-2018, which ensured that the Department's IT system supports safeguards implementation processes into the future. MOSAIC developed software applications that help staff across the Department work more effectively and efficiently. The introduction of new and improved IT applications and their integration with existing software has allowed for better planning, conducting, reporting and quality assessment of safeguards activities.

The Department also continues to improve its technical capabilities, deploying ever-advancing equipment for the measurement, monitoring and containment of nuclear material. Equipment developed for, and deployed in, the field is checked as user-friendly, rugged enough to be shipped around the world and capable for use in a number of different environments. The Department constantly monitors developments in commercial technology to identify any innovation that could enhance capabilities.

In addition, by continually improving capabilities in environmental sampling and nuclear material analysis, the Department continues to ensure a high level of sensitivity, reliability, and timeliness in safeguards measurements and analysis. The Department regularly examines ways of reducing sample sizes, applying more in situ analysis, and working with States to reduce the packaging and shipping time of nuclear materials, environmental sampling and safeguards equipment.

At the same time, the IAEA's and States' obligations under safeguards agreements remain the same. Their implementation cannot be relaxed – whether to save money or for any other reason.

As long as the nuclear world continues to change, IAEA safeguards will need to adapt and change with it. Managing change is not new to the IAEA. Further improvements and optimization are needed to guarantee an effective, reliable and credible safeguards system. In this context, it is essential that the IAEA continues to improve its productivity by striving for greater efficiency without compromising the effectiveness of its work and its ability to continue drawing soundly-based conclusions.

Demands on IAEA safeguards are rapidly growing and becoming more complex.

With the support of its Member States, the IAEA will continue to live up to the expectation of the international community by verifying the peaceful use of nuclear energy thereby contributing to the non-proliferation of nuclear weapons.

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Safeguards

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