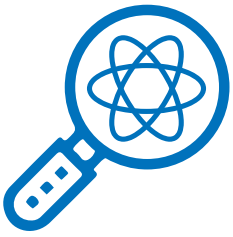
Nuclear Verification

184 **States with safeguards agreements in force** of which

136 **States had additional protocols in force**



over **2 850** **verification activities undertaken**

1 321 **nuclear facilities and locations outside facilities under safeguards**

over **221 000** **significant quantities of nuclear material under safeguards**

over **12 700** **days of in-field verification** and

almost **2 400** **days spent in quarantine**

Conclusions

72 States
all nuclear material remained in peaceful activities

103 States
declared nuclear material remained in peaceful activities

3 States
nuclear material, facilities or other items to which safeguards had been applied remained in peaceful activities

5 States
nuclear material in selected facilities to which safeguards had been applied remained in peaceful activities

Nuclear Verification [1,2]

Objective

To deter the proliferation of nuclear weapons by detecting early the misuse of nuclear material or technology and by providing credible assurances that States are honouring their safeguards obligations, and, in accordance with the Agency's Statute, assist with other verification tasks, including in connection with nuclear disarmament or arms control agreements, as requested by States and approved by the Board of Governors.

Implementation of Safeguards in 2020

Implementing safeguards and other verification activities in 2020 was much more of a challenge as a result of the global COVID-19 pandemic. Nevertheless, with considerable extra effort and adaptation to the new circumstances, the Agency conducted almost the same level of verification activities as in the previous year. The Agency carried out over 2 850 verification activities (2 953 in 2019) and spent more than 12 700 days in the field conducting those activities (13 140 in 2019). This ensured that the Agency was able to draw soundly based conclusions for all States in which safeguards were implemented by the Agency for 2020.

At the end of every year, the Agency draws a safeguards conclusion for each State for which safeguards are applied. This conclusion is based on an evaluation of all safeguards relevant information available to the Agency in exercising its rights and fulfilling its safeguards obligations for that year.

In 2020, safeguards were applied for 183 States[3,4] with safeguards agreements in force with the Agency. Of the 131 States that had both a comprehensive safeguards agreement (CSA) and an additional protocol (AP) in force[5] (see Fig. 1), the Agency drew the broader conclusion that *all* nuclear material remained in peaceful activities for 72 States[6]; for the remaining 59 States, as the necessary evaluation regarding the absence of undeclared nuclear

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1 The designations employed and the presentation of material in this section, including the numbers cited, do not imply the expression of any opinion whatsoever on the part of the Agency or its Member States concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of its frontiers.

2 The referenced number of States Parties to the Treaty on the Non-Proliferation of Nuclear Weapons is based on the number of instruments of ratification, accession or succession that have been deposited.

3 These States do not include the Democratic People's Republic of Korea (DPRK), where the Agency did not implement safeguards and, therefore, could not draw any conclusion.

4 And Taiwan, China.

5 Or an AP being provisionally applied, pending its entry into force.

6 And Taiwan, China.

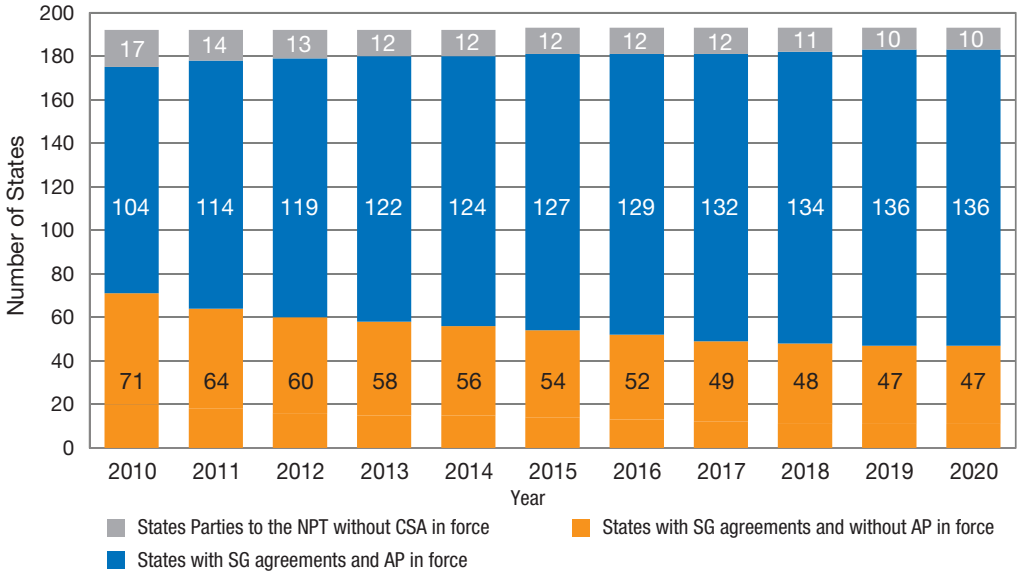

FIG. 1. Number of APs for States with safeguards agreements in force, 2010–2020 (the Democratic People's Republic of Korea is not included).

material and activities for each of these States remained ongoing, the Agency concluded only that *declared* nuclear material remained in peaceful activities. For 44 States with a CSA but with no AP in force, the Agency concluded only that *declared* nuclear material remained in peaceful activities.

For those States for which the broader conclusion has been drawn, the Agency is able to implement integrated safeguards: an optimized combination of measures available under CSAs and APs to maximize effectiveness and efficiency in fulfilling the Agency's safeguards obligations. Integrated safeguards were implemented for the whole of 2020 for 66 States[7,8].

Safeguards were also implemented with regard to nuclear material in selected facilities in the five nuclear-weapon States party to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) under their respective voluntary offer agreements. For these five States, the Agency concluded that nuclear material in selected facilities to which safeguards had been applied remained in peaceful activities or had been withdrawn from safeguards as provided for in the agreements.

For three States not party to the NPT, the Agency implemented safeguards pursuant to item-specific safeguards agreements based on INFCIRC/66/Rev.2. For these States, the Agency concluded that nuclear material, facilities or other items to which safeguards had been applied remained in peaceful activities.

As of 31 December 2020, 10 States Parties to the NPT had yet to bring CSAs into force pursuant to Article III of the Treaty. For these States Parties, the Agency could not draw any safeguards conclusions.

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7 Albania, Andorra, Armenia, Australia, Austria, Bangladesh, Belgium, Botswana, Bulgaria, Burkina Faso, Canada, Chile, Croatia, Cuba, Czech Republic, Denmark, Ecuador, Estonia, Finland, Germany, Ghana, Greece, Holy See, Hungary, Iceland, Indonesia, Ireland, Italy, Jamaica, Japan, Kazakhstan, the Republic of Korea, Kuwait, Latvia, Liechtenstein, Lithuania, Luxembourg, Madagascar, Mali, Malta, Mauritius, Monaco, Montenegro, the Netherlands, New Zealand, North Macedonia, Norway, Palau, Peru, Philippines, Poland, Portugal, Romania, Seychelles, Singapore, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Tajikistan, the United Republic of Tanzania, Uruguay, Uzbekistan and Viet Nam.

8 And Taiwan, China.

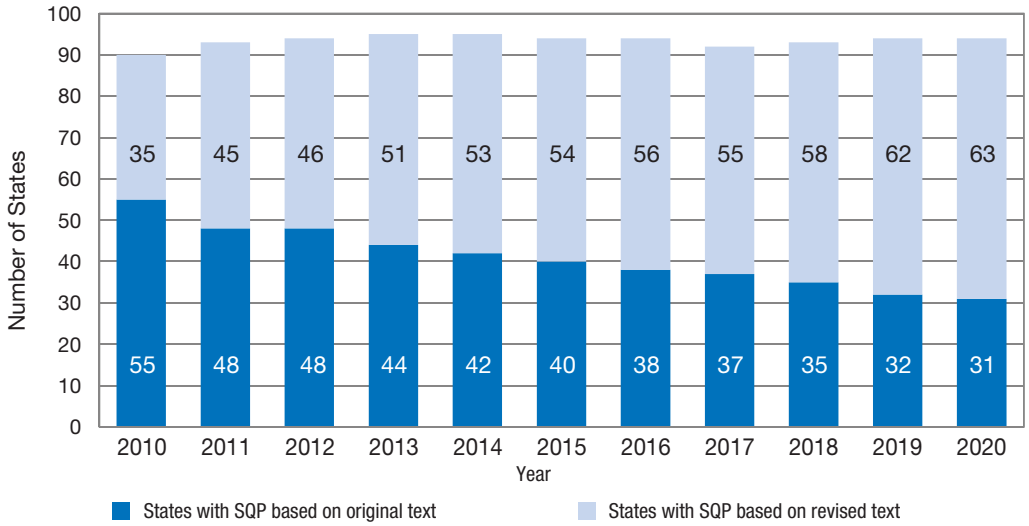

FIG. 2. Number of States with SQPs, 2010–2020.

Conclusion of safeguards agreements and APs, and amendment and rescission of small quantities protocols

The status of safeguards agreements and APs as of 31 December 2020 is shown in Table A6 in the Annex to this report. During 2020, a CSA with a small quantities protocol (SQP) and an AP was approved by the Board of Governors for Eritrea. A voluntary offer agreement and an AP entered into force for the United Kingdom. An SQP was amended for Haiti.

The Agency continued to facilitate the conclusion of safeguards agreements and APs (Fig. 1), and the amendment or rescission of SQPs. In 2020, the Director General wrote to 31 States with SQPs based on the original standard text calling upon them to amend or rescind them. The Director General stressed that this was essential to address a weakness in the Agency's safeguards system recognized by the Board of Governors 15 years ago, and that the old standard SQP was inadequate for the current safeguards system. By the end of 2020, 69 States had accepted the revised SQP text (which was in force for 63 of these States) and 8 States had rescinded their SQPs (Fig. 2). The Agency continued to implement the *Plan of Action to Promote the Conclusion of Safeguards Agreements and Additional Protocols*, which was updated in September 2020.

Islamic Republic of Iran (Iran)

Throughout 2020, the Agency, in light of United Nations Security Council resolution 2231 (2015), continued to verify and monitor the nuclear-related commitments of the Islamic Republic of Iran (Iran) under the Joint Comprehensive Plan of Action (JCPOA). During the year, the Director General submitted to the Board of Governors and in parallel to the United Nations Security Council four quarterly reports, and four reports providing updates on developments in between the issuance of the quarterly reports, entitled *Verification and monitoring in the Islamic Republic of Iran in light of United Nations Security Council resolution 2231 (2015)*.

During 2020, the Agency interacted with Iran to clarify information relating to the correctness and completeness of Iran's declarations under its Safeguards Agreement and AP. A full and prompt explanation for the presence of uranium particles of anthropogenic origin, including isotopically altered particles of low enriched uranium, at a location in Iran not declared to the Agency, was still pending at the end of the year. Iran's denial of access to Agency inspectors to two other locations in Iran not declared to the Agency led to

a visit to Tehran by the Director General in August. Access was provided soon thereafter. Three reports were submitted by the Director General to the Board of Governors entitled *NPT Safeguards Agreement with the Islamic Republic of Iran*.

Syrian Arab Republic (Syria)

In September 2020, the Director General submitted a report to the Board of Governors entitled *Implementation of the NPT Safeguards Agreement in the Syrian Arab Republic*. The Director General informed the Board of Governors that no new information had come to the knowledge of the Agency that would have an impact on the Agency's assessment that it was very likely that a building destroyed at the Dair Alzour site was a nuclear reactor that should have been declared to the Agency by Syria.[9] In 2020, the Director General urged Syria to cooperate fully with the Agency in connection with all unresolved issues and expressed his willingness to engage with Syria to take concrete steps towards a mutually acceptable solution.

Democratic People's Republic of Korea (DPRK)

In September 2020, the Director General submitted a report to the Board of Governors and the General Conference entitled *Application of Safeguards in the Democratic People's Republic of Korea*. In 2020, no verification activities were implemented in the field, but the Agency continued to monitor developments in the DPRK's nuclear programme and to evaluate all safeguards relevant information available to it. Some of the DPRK's nuclear facilities appeared not to be operating, while activities at some other facilities appeared to continue or were developed further. The Agency has not had access to the Yongbyon site or to other locations in the DPRK. Without such access, the Agency cannot confirm the operational status or configuration/design features of the facilities or locations, or the nature and purpose of the activities conducted therein. The continuation of the DPRK's nuclear programme is a clear violation of relevant United Nations Security Council resolutions and is deeply regrettable.

Enhancing Safeguards

State-level safeguards implementation

The Agency continued to enhance consistency and to develop more robust methods for evaluating the effectiveness of safeguards implementation through a project aimed at improving the development of State-level safeguards approaches (SLAs) using a structured approach. During 2020, the Agency developed SLAs for two States with a CSA and an AP in force, and an SLA for a State with a voluntary offer agreement and an AP in force, based on the updated internal procedures and guidance, following consultations with the States concerned on practical arrangements. These SLAs will be implemented in 2021.

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[9] The Board of Governors, in its resolution GOV/2011/41 of June 2011 (adopted by a vote), had, inter alia, called on Syria to urgently remedy its non-compliance with its NPT Safeguards Agreement and, in particular, to provide the Agency with updated reporting under its Safeguards Agreement and access to all information, sites, material and persons necessary for the Agency to verify such reporting and resolve all outstanding questions so that the Agency could provide the necessary assurance as to the exclusively peaceful nature of Syria's nuclear programme.

Cooperation with State and regional authorities

Due to the COVID-19 pandemic, in 2020 the Agency had to postpone many of its international, regional and national training courses aimed at assisting States in building capacity for implementing their safeguards obligations. To address the training needs of States, the Agency developed new safeguards e-learning courses, including a course entitled 'Basics of Safeguards', as well as several modules on nuclear material accounting. Since its launch in September 2020, over 300 people have accessed this course.

To further help States strengthen the effectiveness of their State or regional authority responsible for safeguards implementation (SRA) and of their respective State system of accounting for and control of nuclear material (SSAC), the Agency launched the IAEA Comprehensive Capacity-Building Initiative for SSACs and SRAs (COMPASS) project to provide assistance and services tailored to the needs of the State. The Agency also conducted an on-line regional training course on SSACs together with counterparts in Japan; an on-line webinar on safeguards in bulk handling facilities for staff of the Egyptian Atomic Energy Authority and Nuclear and Radiological Regulatory Authority; and supported two on-line workshops on safeguards implementation in the United Kingdom. In total, 67 experts from 8 countries took part in on-line training events.

Safeguards equipment and tools

Despite the COVID-19 pandemic, in 2020 the Agency ensured that instrumentation and monitoring equipment used by inspectors during in-field verification activities or installed in nuclear facilities continued to function as required. At the end of the year, 1611 unattended safeguards data streams were collected remotely from 142 facilities in 31 States around the world. The Agency also had 1530 cameras operating or ready to use at 260 facilities in 37 States. The transition to the next generation surveillance system (NGSS), to replace earlier generation cameras that have reached the end of their lifecycle, neared completion. By the end of 2020, there were 1180 DCM-C5/DCM-A1 based cameras[10] installed in 33 States.

In 2020, Member State Support Programmes (MSSPs) were essential to enabling the evaluation, design, testing and preparation of new safeguards technology to address new verification challenges. The passive gamma emission tomography (PGET) capability to verify spent fuel was established with the support of the MSSP of the Russian Federation. In 2020, PGET data analysis algorithms were further enhanced with active support from the MSSP of the United States of America.

The Agency continued to develop new sealing technologies and improve the overall security of these instruments. To enhance its sealing systems, the Agency conducted an industry wide search for innovative technologies to serve as a new passive seal. The prototypes were received in late 2020 and evaluated for reliability, ease of use, security and safeguards specific requirements.

Despite pandemic related restrictions, the Agency, in close collaboration with MSSPs, managed to complete the development cycle of the next generation Cherenkov viewing device (XCVD) and authorized the first version for spent fuel verification in Japan. An initial version of a robotized unmanned surface vehicle able to transport the XCVD was successfully tested. Use of a state of the art X ray fluorescent and laser-induced breakdown spectroscopy instrument for verification activities was authorized.

Safeguards analytical services and methodologies

The Agency's Network of Analytical Laboratories consists of the Agency's Safeguards Analytical Laboratories and 24 other qualified laboratories in various

[10] Formerly referred to as NGSS cameras.

FIG. 3. An Agency safeguards analytical chemist analyses nuclear material at the Safeguards Analytical Laboratories.

Member States (Fig. 3). During the year, six additional laboratories for sample analysis and reference material provision were in the process of qualification.

In 2020, the Agency collected 489 nuclear material samples, which were analysed by the Agency's Nuclear Material Laboratory, and 9 heavy water samples, analysed by the Network of Analytical Laboratories. The Agency also collected 460 environmental samples, resulting in analysis of 1013 subsamples.

A new Statistical Evaluation Platform for Safeguards (STEPS) was completed, providing the Agency with a state of the art analytical environment supporting, inter alia, material balance evaluation with upgraded methodologies and streamlined processes. The fourth International Technical Meeting on Statistical Methodologies for Safeguards, aimed at gathering new expertise and extending the network of experts on advanced statistical methodologies and innovative approaches, gathered 27 external participants from 11 countries, as well as internal participants, in an innovative format.

New processes and newly available commercial services, some of them introduced as a result of the global lockdown conditions, allowed the Agency to extend the benefit of commercial satellite imagery and other geospatial data analysis to safeguards implementation. In particular, broader use of synthetic aperture radar sensors and high revisit imagery satellites complemented the now traditional use of high resolution optical imagery.

FIG. 4. Director General Grossi meets with safeguards trainees at the Agency's Headquarters in Vienna in November 2020.

Developing the Safeguards Workforce

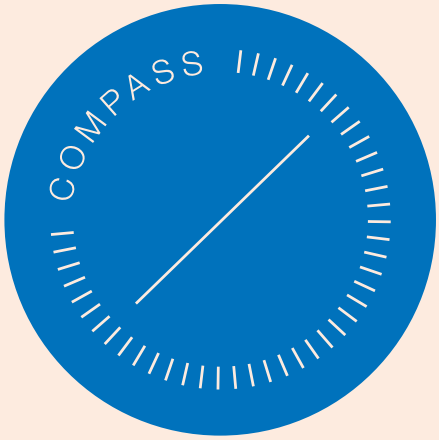
In 2020, the Agency conducted 39 safeguards training courses to provide safeguards inspectors, analysts and supporting staff with the necessary competencies. Re-development and re-design of training courses enabled the delivery of some blended and on-line courses to safeguards staff, including part of the inspector induction training, departmental basic training and safety training (Fig. 4). An industrial safety component has been integrated into the inspector induction training as part of the ongoing effort to design an industrial safety training module. Six 'Introduction to Safeguards' workshops were held for 90 non-safeguards staff.

Preparing for the Future

As part of its strategic foresight and planning activities for nuclear safeguards, the Agency held a workshop to identify new opportunities, explore challenges and deepen its understanding of emerging technologies. The workshop generated ideas relating to the use of artificial intelligence in reviewing data from Agency surveillance cameras, novel approaches for verifying spent nuclear fuel, visualization techniques for analysis, and imagery and multimedia data for the detection of undeclared nuclear material and activities. The workshop informs the *Research and Development (R&D) Plan and the biennial Development and Implementation Support Programme for Nuclear Verification* that communicate to Member States the support needed to improve the Agency's technical capabilities.

CASE STUDY

A New Initiative to Strengthen Accounting for and Controlling Nuclear Material



Nuclear material accountancy and control is a key measure in the implementation of Agency safeguards, which ensures that nuclear material remains in peaceful use. States are required to establish and maintain effective national systems of accounting for and control of nuclear material subject to safeguards.

A new initiative launched by the Agency in 2020 provides further support to national authorities responsible for accounting for and controlling nuclear material and providing safeguards declarations to the Agency for its independent verification. The initiative, called COMPASS, uses a tailored approach for each participating State to build on the Agency's existing support to countries in the area of nuclear safeguards.

"Robust cooperation between the IAEA and the State is essential to perform safeguards effectively and efficiently, and COMPASS will strengthen this," said Bernardo Ribeiro, an Agency Safeguards Officer and point of contact for the COMPASS initiative. "Using existing capacity development programmes as a foundation, this initiative will identify areas for further collaboration and offer customized assistance packages."

The establishment and maintenance of State systems of accounting for and control of nuclear material (SSACs), set up by State or regional authorities responsible for safeguards implementation (SRAs), form the basis for a State's reporting to the Agency on nuclear material subject to safeguards. COMPASS, which stands for the IAEA Comprehensive Capacity-Building Initiative for SSACs and SRAs, supports this key part of a State's safeguards responsibilities.

"Over the years, the IAEA has offered States support in safeguards implementation," said Susan Pickett, Head of the Safeguards Training Section at the Agency. "What COMPASS does is build further on this history of assistance to States and optimize the provision of various forms of assistance in one package."

An SSAC is a set of technical measures established by a State to account for and control nuclear material. Such measures include, for example, the establishment of a measurement system for determining the quantities of nuclear material received, produced, shipped, lost or removed from an inventory and reporting such nuclear material to the Agency. Such reporting, in turn, provides the basis for applying Agency safeguards and verifying independently such nuclear material.

"Through COMPASS, Malaysia is proud to be at the forefront of States in strengthening both SRA and SSAC capabilities", said Ibrahim Muhamad, Director of the Nuclear Installation Division at the Atomic Energy Licensing Board, an agency under the Malaysian Ministry of Science, Technology and Innovation. "Malaysia continues to demonstrate its commitment to effective and efficient nuclear safeguards, and the peaceful use of nuclear material to promote nationwide economic growth."

By identifying specific areas of engagement between a particular State and the Agency, COMPASS will address the individual needs of States to enhance the capacity of their SSAC and SRA.

By the end of 2020, the COMPASS pilot phase was under way in cooperation with seven countries. Upon successful completion of this pilot phase, the initiative will be made available, upon request, to every State that has concluded a safeguards agreement with the Agency.