Nuclear Verification

186

States with safeguards agreements in force of which

138 **States had additional protocols in force**

over

3 000

verification activities undertaken

1 334

nuclear facilities and locations outside facilities under safeguards

226 116

significant quantities of nuclear material under safeguards

over

14 600

days of in-field verification and

more than

2 100

days spent in quarantine

Conclusions*

72 States
all nuclear material remained in peaceful activities

105 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

* 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.

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 2021

Implementing safeguards and other verification activities in 2021 remained challenging as a result of the global COVID-19 pandemic. For example, Agency inspectors and technicians on missions spent a total of more than 2100 days in quarantine outside Austria. Nevertheless, with considerable sustained effort and continued adaptation to the circumstances, the Agency carried out over 3000 verification activities (2850 in 2020) and spent more than 14 600 days in the field conducting those activities (12 700 in 2020). This ensured that the Agency was able to draw soundly based conclusions for all States in which safeguards were implemented by the Agency for 2021.

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 2021, safeguards were applied for 185 States[3,4] with safeguards agreements in force with the Agency. Of the 132 States that had both a comprehensive safeguards agreement (CSA) and an additional protocol (AP) in force (see Fig. 1), the Agency drew the broader conclusion that *all* nuclear material remained in peaceful activities for 72 States[5]; for the remaining 60 States, as the necessary evaluation regarding the absence of undeclared nuclear material and activities for each of these States remained ongoing, the Agency concluded

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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 State 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 And Taiwan, China.

FIG. 1. Agency inspectors wearing personal protective equipment during training.

only that *declared* nuclear material remained in peaceful activities. For 45 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 2021 for 69 States[6,7].

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

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

7 And Taiwan, China.

Agency concluded that nuclear material, facilities or other items to which safeguards had been applied remained in peaceful activities.

As of 31 December 2021, eight 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.

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 2021 is shown in Table A6 in the Annex to this report. During 2021, a CSA with a small quantities protocol (SQP) and an AP entered into force for Eritrea. A CSA with an SQP entered into force for the Federated States of Micronesia. An AP was signed and entered into force for Zimbabwe. Another AP was approved by the Board of Governors for Sierra Leone. SQPs were amended for Belize, Brunei Darussalam, Maldives, Saint Lucia and Sudan. SQPs were rescinded for Malta and the United Arab Emirates.

The Agency continued to facilitate the conclusion of safeguards agreements and APs (Fig. 2), and the amendment or rescission of SQPs. In 2021, the Director General sent letters to non-nuclear-weapon States party to the NPT that had not yet concluded or brought into force CSAs in connection with the NPT, calling upon them to do so. The Director General also sent letters to States with CSAs but without APs, encouraging them to conclude and bring into force APs to their CSAs. In these letters, he also reminded relevant States with original SQPs of his earlier calls for amendment or rescission of the SQPs. At the end of 2021, 96 States with CSAs in force had operative SQPs, of which 70 SQPs were based on the revised standard text. Ten States had rescinded their SQPs (Fig. 3). The Agency continued to implement the *Plan of Action to Promote the Conclusion of Safeguards Agreements and Additional Protocols*, which was updated in September 2021. In April 2021, the Secretariat held a Technical Meeting focused on the Agency's efforts to strengthen safeguards implementation in States with SQPs.

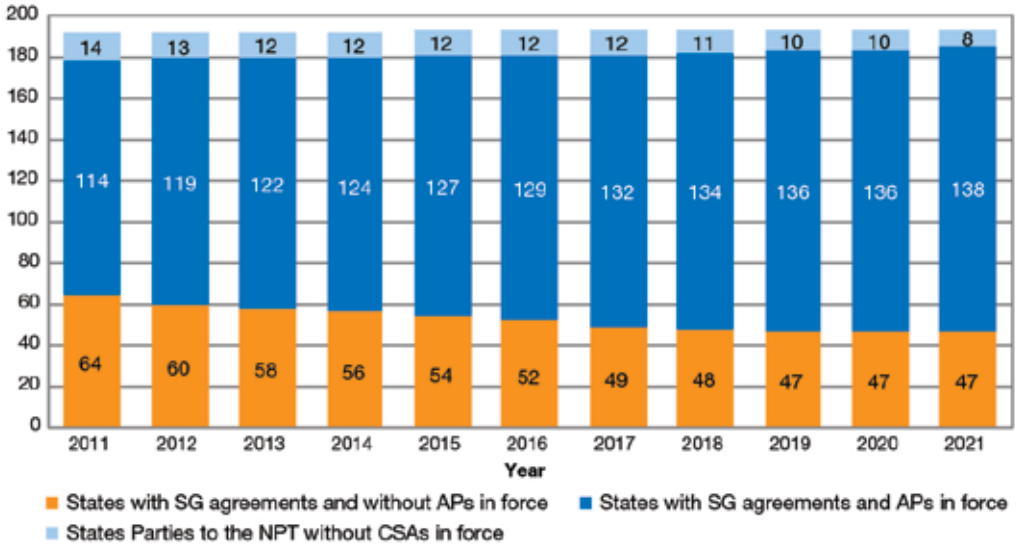

FIG. 2. Number of APs for States with safeguards agreements in force, 2011–2021 (the Democratic People's Republic of Korea is not included).

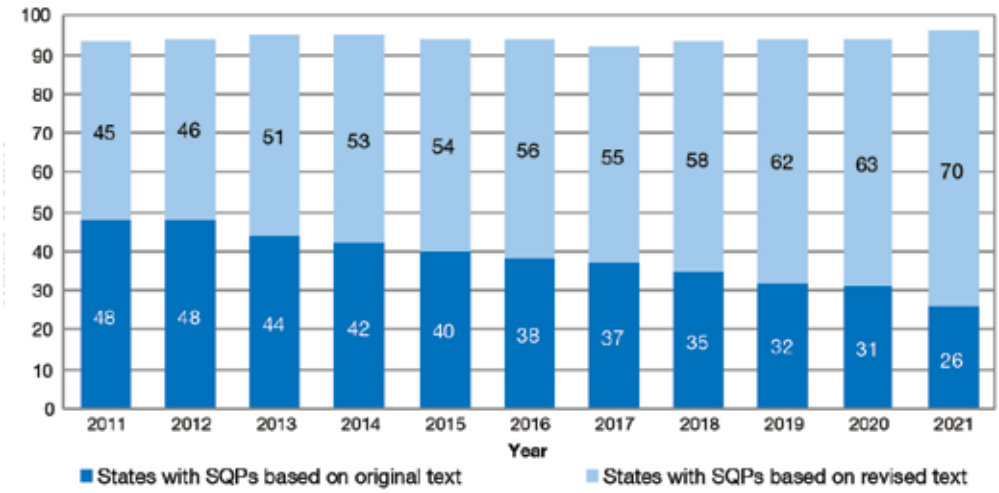

FIG. 3. Number of States with SQPs, 2011–2021.

Islamic Republic of Iran (Iran)

Until 23 February 2021, 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). From 23 February 2021 onwards, however, the Agency's verification and monitoring activities in relation to the JCPOA were seriously affected following Iran's decision to stop the implementation of those commitments, including the AP. During the year, the Director General submitted to the Board of Governors and in parallel to the United Nations Security Council 4 quarterly reports, and 30 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 2021, the Agency continued its efforts to engage Iran in order to clarify and resolve the issues related to the presence of nuclear material particles of anthropogenic origin at three undeclared locations in Iran, and the issues related to a fourth undeclared location in Iran. The lack of progress in clarifying the Agency's questions concerning the correctness and completeness of Iran's safeguards declarations seriously affected the Agency's ability to provide assurance of the exclusively peaceful nature of Iran's nuclear programme. The Director General submitted four reports to the Board of Governors entitled *NPT Safeguards Agreement with the Islamic Republic of Iran*.

Syrian Arab Republic (Syria)

In August 2021, 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[8]. In 2021, the Director General continued to urge Syria to cooperate fully with the Agency in connection with all unresolved issues.

[8] 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.

Democratic People's Republic of Korea (DPRK)

In August 2021, 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 2021, 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 the consistency and effectiveness of safeguards implementation at the State level through a project aimed at improving the development and implementation of State-level safeguards approaches (SLAs) using a structured approach. In September, the Secretariat held a Technical Meeting on improving consistency in the implementation of SLAs. During 2021, based on updated internal procedures and guidance, the Agency continued to update SLAs for States with the broader conclusion.

Cooperation with State and regional authorities

In 2021, the Agency conducted, virtually and in person, 16 international, regional and national training courses, including courses with counterparts in Japan, the Republic of Korea, the Russian Federation and the United States of America. In total, more than 200 experts from some 50 States were trained on safeguards related topics, including two courses specifically for States with SQPs. The Agency hosted six webinars, each with a focus on addressing the specific needs of the States involved. These courses provided participants with the knowledge and skills to help strengthen their State system of accounting for and control of nuclear material (SSAC) and the implementation of safeguards.

The Agency continued to make use of its learning management system — the Cyber Learning Platform for Network Education and Training — to develop and host courses for anyone with a NUCLEUS account, thereby increasing global access to learning opportunities regarding safeguards related topics. The platform also provides resources for participants enrolled in SSAC training courses. By the end of the year, there were over 1000 enrolled users.

To further help States strengthen the effectiveness of their State or regional authority responsible for safeguards implementation (SRA) and of their respective SSAC, the Agency continued the implementation of the IAEA Comprehensive Capacity-Building Initiative for SSACs and SRAs (COMPASS) to provide assistance and services tailored to the needs of each of the seven participatory States (see case study). The Agency published *IAEA Safeguards and SSAC Advisory Service (ISSAS) Guidelines* (IAEA Services Series No. 13 (Rev. 1)), which includes a guide for States on conducting self-assessments.

FIG. 4. The XCVD in use during training.

Safeguards equipment and tools

Despite the travel restrictions owing to the COVID-19 pandemic, the Agency ensured that instrumentation and monitoring equipment used by inspectors during in-field verification activities or installed in nuclear facilities continued to operate. By the end of the year, 1640 unattended safeguards data streams were being collected remotely from 148 facilities in 32 States[9] around the world. The Agency also had 1378 cameras operating or ready to use at 254 facilities in 35 States[10], and the transition to the latest generation of surveillance systems (based on DCM-C5/-A1 camera modules) was 85% complete. In 2021, six additional unattended monitoring systems were installed in two States, which meant that by the end of the year, 182 such systems were installed in 24 States.

The Agency's passive gamma emission tomography system was routinely used by inspectors to verify damaged fuel assemblies transitioning to dry storage.

The Agency successfully qualified a new passive seal that will now be introduced as a replacement for the traditional E-CAP metal seal. In parallel, the development of a new active seal progressed according to plan.

Agency experts were able to generalize the authorization of the next generation Cherenkov viewing device (XCVD) for verification activities in all Member States (Fig. 4). The palmtop Raman Analyser was authorized, supporting over 125 nuclear material signatures to enhance field verification efficiency by offering immediate nuclear material identification.

9 And Taiwan, China.

10 And Taiwan, China.

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

In 2021, the Agency collected 705 nuclear material samples for nuclear material accountancy, and 144 nuclear material samples for material characterization. The large majority of these were analysed by the Agency's Nuclear Material Laboratory. In addition, seven heavy water samples were collected for analysis by the Network of Analytical Laboratories. The Agency also collected 473 environmental samples, resulting in analysis of 1074 subsamples.

The new Statistical Evaluation Platform for Safeguards was fully deployed and further enhanced, providing the Agency with a state of the art analytical environment supporting, inter alia, material balance evaluation with upgraded statistical methodologies and streamlined processes. The 'Environmental Sampling Environment Enhancement' project to modernize and integrate the environmental sampling database and modelling/evaluation tools was initiated in 2021. Despite the challenging circumstances brought about by the COVID-19 pandemic, the international target values revision project 'ITV-2020' was successfully carried out based on the deployment of a collaborative virtual platform.

In the area of open sources, including satellite imagery, the Agency continued to diversify its sources of safeguards relevant information, benefiting, for instance, from new subscriptions related to science and technology publications and new remote sensors. With a view to addressing the constantly growing amount of information available to it and better extract safeguards relevant information, the Agency initiated a number of actions in the field of artificial intelligence to enhance analytical effectiveness and efficiency related to the use of text and image sources.

Developing the Safeguards Workforce

In 2021, the Agency conducted 49 distinct safeguards training courses (as some were held more than once, a total of 89 training courses were provided overall, of which 18 were held outside Vienna) helping to provide safeguards inspectors, analysts and support staff with the necessary core and functional competencies. Seven courses on industrial safety were held in 2021. The Introductory Course for Agency Inspectors, which comprises ten modules and lasts for six months, was held for nine new inspectors.

The 2021 Safeguards Traineeship Programme for young graduates and junior professionals commenced in February 2021, involving nine participants from Angola, Indonesia, Jordan, Malaysia, Saudi Arabia, Senegal, Sri Lanka, Tunisia and the United Arab Emirates.

FIG. 5. The signing to establish the Swiss Member State Support Programme.

Preparing for the Future

In 2021, Member State Support Programmes (MSSPs) remained essential to enabling the evaluation, design, testing and preparation of new safeguards technologies to address new verification challenges. A new MSSP was established for the first time since 2013 — the Swiss Support Programme (Fig. 5). To further broaden the support base for Agency safeguards, the Agency also forged new partnerships by signing Practical Arrangements with five 'non-traditional' entities.

CASE STUDY

Agency Assists Countries to Meet Their Safeguards Obligations Effectively and Efficiently

Nuclear material accountancy and control is a safeguards measure of fundamental importance for the Agency's safeguards mission. The IAEA Comprehensive Capacity-Building Initiative for SSACs and SRAs (COMPASS) is aimed at strengthening the effectiveness of State systems of accounting for and control of nuclear material (SSACs) while enhancing cooperation between the State or regional authority responsible for safeguards implementation (SRA) and the Agency. Building on 40 years of support for the implementation of safeguards, COMPASS uses a tailored approach for each country participating in this initiative.

States establish and maintain SSACs as part of their safeguards obligations. Activities performed by an SSAC include the establishment of a measurement system to determine the quantities of nuclear material received, produced, shipped or removed from inventories, and then reporting this to the Agency. Such reporting, in turn, provides the basis for the Agency's independent verification of such nuclear material.

By identifying specific areas where States can benefit from further safeguards related assistance, COMPASS allows the Agency and national counterparts to agree on a customized work plan that addresses individual needs and supports States in strengthening the capacity of their SSACs and SRAs. This ranges from the provision of safeguards-related legislative and regulatory assistance, safeguards training, equipment and information technology (IT) support, to expert assistance. In 2021, the Agency began to roll out COMPASS activities to all seven COMPASS States trialling the initiative: Guatemala, Jordan, Malaysia, Rwanda, Saudi Arabia, Türkiye and Uzbekistan.

Participants from a COMPASS pilot State are shown how safeguards measures are applied at a nuclear facility.

CASE STUDY

Over the course of the year, several in-person and on-line safeguards training courses and workshops were held. In one event held in Vienna, participants were given the opportunity to visit a nuclear facility to see how safeguards measures are applied in practice. Legislative and regulatory support was also provided during the year to help the participating States strengthen their safeguards-related legislation and regulatory frameworks. In addition, hand-held radionuclide identification devices were delivered to enhance technical capacity in implementing safeguards. IT equipment with appropriate software and support was also supplied for a number of States to facilitate the secure collection, processing and transmission of nuclear material accountancy data.

In 2021, all seven COMPASS States agreed to their respective two-year work plans. To enable the effective implementation of these plans, 13 Member State Support Programmes and other supporting States are providing financial and/or in-kind contributions to COMPASS.

"COMPASS is already delivering on its key areas of assistance to the pilot States," said Massimo Aparo, Deputy Director General and Head of the Department of Safeguards. "I look forward to continuing the roll-out of work plans with pilot States over the course of 2022 and seeing the associated benefits in safeguards implementation."