

Nuclear Verification



189

States* with safeguards agreements in force of which

140 States had additional protocols in force



2975

verification activities undertaken



1 353

nuclear facilities and locations outside facilities under safeguards



230 754

significant quantities of nuclear material under safeguards



14 066

days of in-field verification



271

days spent in quarantine

* The designation employed does not imply the expression of any opinion whatsoever concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of its frontiers.

2022

Conclusions**

**74
States**

**all nuclear material
remained in
peaceful activities**

**106
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 2022

Over the course of 2022, the impact of the COVID-19 pandemic on safeguards implementation diminished markedly. The Agency carried out 3000 verification activities (3000 in 2021) and spent 14 100 days in the field conducting those activities (14 600 in 2021). This ensured that the Agency was able to draw soundly based conclusions for all States for which safeguards were implemented by the Agency for 2022.

At the end of the year, the Agency drew a safeguards conclusion for each State for which safeguards were applied in 2022. This conclusion was based on an evaluation of all safeguards relevant information available to the Agency in exercising its rights and fulfilling its safeguards obligations for 2022.³

In 2022, safeguards were applied for 188 States^{4,5} with safeguards agreements in force with the Agency. Of the 134 States that had both a comprehensive safeguards agreement (CSA) and an additional protocol (AP) in force, the Agency drew the broader conclusion that *all* nuclear material remained in peaceful activities for 74 States⁶; 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 only that *declared* nuclear material remained in

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 For States with a comprehensive safeguards agreement (CSA) in force with an operative small quantities protocol (SQP) based on the original standard text, the Agency's ability to draw a credible and soundly-based annual safeguards conclusion is significantly affected. This is due, *inter alia*, to the fact that the original standard text of the SQP holds in abeyance the requirement for these States to provide to the Agency an initial report on all nuclear material as well as the Agency's right to perform verification activities in these States. In light of such limitations, and given the significant lapse of time since the decision of the Board of Governors in 2005 authorizing the Director General to conclude with each State with an SQP an exchange of letters giving effect to the revised standardized text and the modified criteria, the Agency may no longer be able to draw a safeguards conclusion for such States unless the States concerned respond positively to the repeated calls by the Director General to amend or rescind such SQPs.

⁴ 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.

⁵ And Taiwan, China.

⁶ And Taiwan, China.



Two inspectors demonstrate environmental sampling techniques.

peaceful activities. Similarly, for the 46 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 2022 for 69 States^{7,8}.

Safeguards were also implemented with regard to nuclear material in selected facilities in the five nuclear-weapon States Parties 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 the 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 2022, five 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

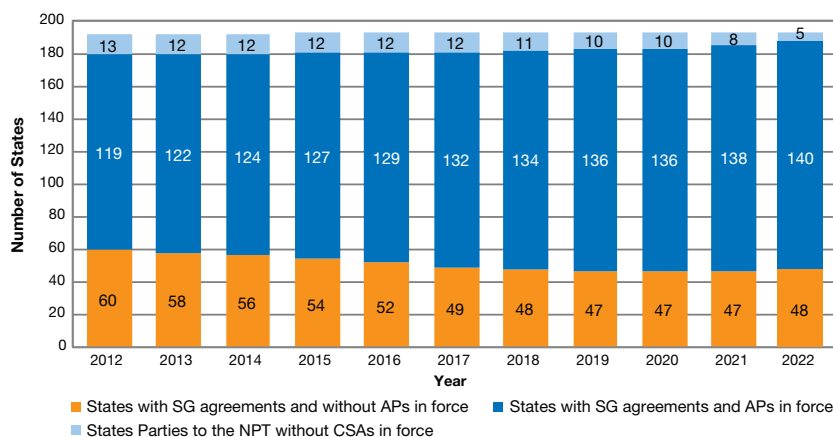
The status of safeguards agreements and APs as of 31 December 2022 is shown in Table A6 in the Annex to this report. During 2022, a CSA with a small quantities protocol (SQP) and an AP entered into force for Cabo Verde and Guinea-Bissau. A CSA with an SQP entered into force for the

⁷ 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, Türkiye, the United Republic of Tanzania, Uruguay, Uzbekistan and Viet Nam.

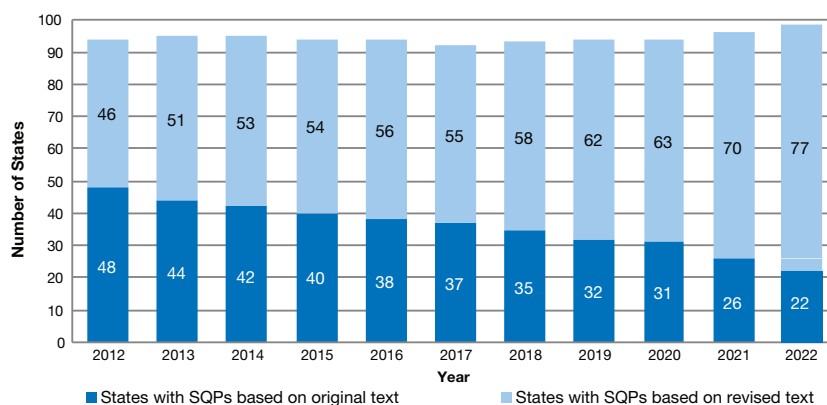
⁸ And Taiwan, China.

State of Palestine⁹. An AP was signed for Sierra Leone. SQPs were amended for the Lao People’s Democratic Republic, Namibia, Suriname and Tuvalu. An SQP was rescinded for Lithuania.

The Agency continued to facilitate the conclusion of safeguards agreements and APs, and the amendment or rescission of SQPs. At the end of 2022, 99 States with CSAs in force had operative SQPs, of which 77 SQPs were based on the revised standard text. Eleven States had rescinded their SQPs. The Agency continued to implement the *Plan of Action to Promote the Conclusion of Safeguards Agreements and Additional Protocols*, which was updated in September 2022.



Number of APs for States with safeguards agreements in force, 2012–2022 (the Democratic People’s Republic of Korea is not included).



Number of States with SQPs, 2012–2022.

Islamic Republic of Iran

Between 16 January 2016 and 23 February 2021, the Agency, in light of UN Security Council resolution 2231 (2015), verified and monitored the Islamic Republic of Iran’s (Iran’s) implementation of its nuclear-related commitments under the Joint Comprehensive Plan of Action (JCPOA). From 8 May 2019 onwards, however, Iran reduced the implementation of those commitments on a step-by-step basis and, from 23 February 2021 onwards, stopped the implementation of those commitments, including the AP. This seriously affected the Agency’s verification and monitoring in relation to the JCPOA, which was exacerbated in June 2022 by Iran’s decision to remove all of the Agency’s equipment previously installed in Iran for surveillance and monitoring activities in relation to the JCPOA. During 2022, the Director General submitted to the Board of Governors, and in parallel to the UN Security Council, 4 quarterly reports and 15 reports providing updates on developments

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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 2022, despite the Agency's continued efforts to engage Iran in order to resolve outstanding safeguards issues related to the presence of uranium particles of anthropogenic origin at locations in Iran not declared to the Agency, limited progress was made. Unless and until Iran clarifies these issues, the Agency will not be able to provide assurance about 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

In August 2022, 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 the Syrian Arab Republic (Syria).¹⁰

Democratic People's Republic of Korea

In September 2022, 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 2022, no verification activities were implemented in the field, but the Agency continued to monitor developments in the nuclear programme of the Democratic People's Republic of Korea (DPRK) and to evaluate all safeguards relevant information available to it. The Agency did not have 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, a clear violation of relevant UN Security Council resolutions, is deeply regrettable.

Enhancing Safeguards

State-level safeguards implementation

The Agency continued to enhance the consistency and effectiveness of safeguards implementation through a project aimed at improving the development and implementation of State-level approaches (SLAs) using a structured approach. Performance targets were embedded in a new dedicated IT application in 2022 to support acquisition path analysis and the development of SLAs. This application simplified the process and facilitated the updating of SLAs for 16 States with the broader conclusion during the year. These SLAs will be implemented in 2023.

Cooperation with State and regional authorities

In 2022, the Agency conducted over 50 training events for personnel responsible for overseeing and implementing State systems of accounting for and control of nuclear material (SSACs) and regional systems of accounting for and control of nuclear material. These events were a combination

¹⁰ 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.



A colleague learns about remaining webinars in the 2022 interactive webinar series.

of in-person and virtual training courses, as well as scientific visits. In total, more than 450 experts from 70 States were trained on safeguards-related topics. This work was carried out with the support of Australia, Japan, the Republic of Korea, the United States of America and the European Commission, and took place in conjunction with the Asia–Pacific Safeguards Network. The Agency updated the safeguards e-learning website on the Cyber Learning Platform for Network Education and Training (elearning.iaea.org), which was visited by more than 700 new users over the course of the year. In total, representatives from 100 States were registered on the safeguards e-learning site by 31 December 2022.

The Agency launched a series of interactive webinars aimed at enhancing national authorities' understanding of their Agency safeguards obligations, and supporting effective and efficient safeguards implementation. Five webinars were held, covering topics such as strengthening SSACs, AP reporting and ISSAS missions. With an average of 190 participants for each session, a total of over 1500 individuals representing over 100 States participated.

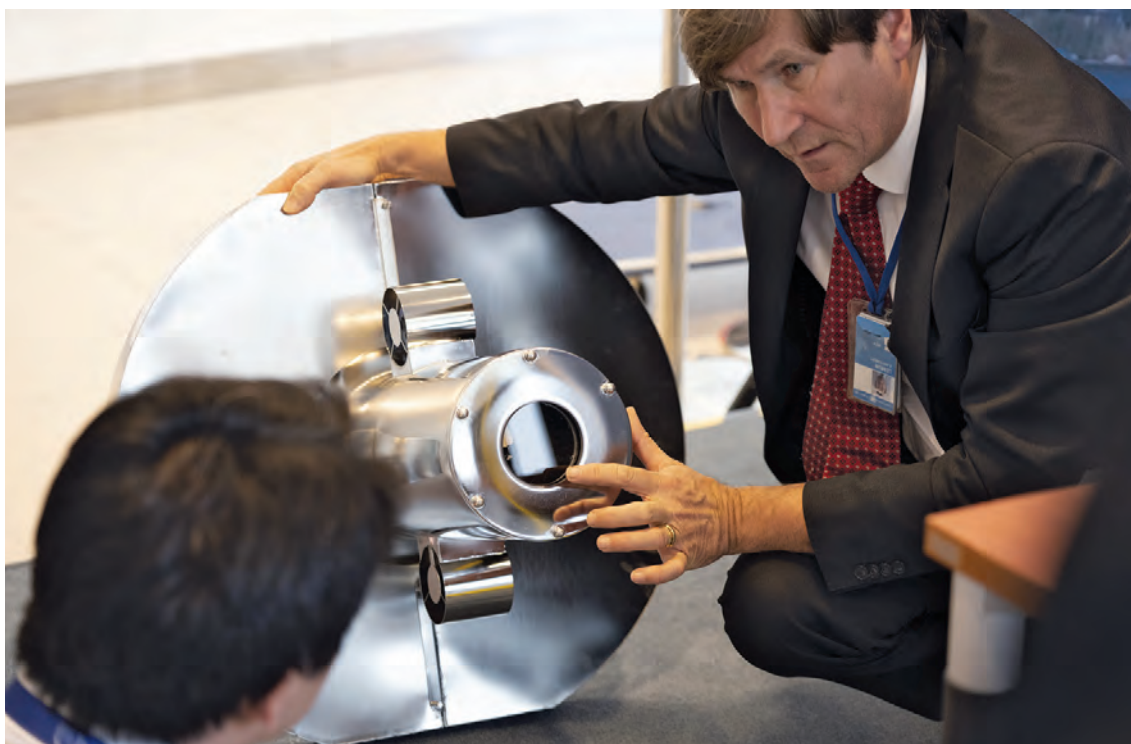
To further help States strengthen the effectiveness of their State or regional authority responsible for safeguards implementation (SRA) and of their respective SSACs, the Agency continued to implement the IAEA Comprehensive Capacity-Building Initiative for SSACs and SRAs (COMPASS) in the seven participating States. Areas of assistance under the initiative included training, stakeholder outreach, legislation and regulation, information management and technology, equipment, and normative documentation. During 2022, 11 Member States contributed in-kind support to the implementation of 18 COMPASS activities, including scientific visits, expert visits, SSAC webinars, and the development of safeguards procedures and national training plans.

Safeguards equipment and tools

Notwithstanding residual travel restrictions due 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 satisfactorily. By the end of the year, 1782 unattended safeguards data streams were being collected remotely from 159 facilities in 32 States¹¹ around the world. The Agency also had 1414 cameras operating or ready to use at 238 facilities in 35 States¹² and the transition to the latest generation of surveillance systems (based on DCM-C5/-A1 camera modules) was more than 90% complete.

¹¹ And Taiwan, China.

¹² And Taiwan, China.



A member of the NDA Instruments team explains the robotized Cherenkov viewing device.

In 2022, Member State Support Programmes (MSSPs) remained essential to enabling the testing and validation of new safeguards technologies to address new verification challenges. The next generation Cherenkov viewing device was used routinely at facilities with large inventories of low burnup and/or long-cooling-time spent fuel assemblies. The robotized Cherenkov viewing device was successfully tested thanks to MSSP support and was used for safeguards verification in one Member State.

The Agency started to replace traditional E-CAP metal seals with field verifiable passive seals, providing inspectors with the possibility of verifying the seals' integrity on site, reducing the effort related to the repatriation of passive seals to Agency Headquarters for verification. In 2022, the active universal asymmetric seal was authorized and will start, in 2023, to replace the electronic optical sealing system, providing the Agency with an optimized life cycle cost. The laser curtain for containment, which uses lasers to detect possible intrusion in a safeguarded area in a nuclear facility, was used for the first time in 2022.

A new high resolution cadmium zinc telluride detector was validated by Agency technical experts. Its integration into various non-destructive assay systems will support the standardization of parts and reduce the need for specific training for inspectors.

Safeguards analytical services and methodologies

As of December 2022, the Agency's Network of Analytical Laboratories (NWAL) consisted of the Agency's Safeguards Analytical Laboratories and 25 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 2022, the Agency collected 604 nuclear material samples for nuclear material accountancy and 117 uranium samples for material characterization. The large majority of these were analysed by the Agency's Nuclear Material Laboratory. In addition, five heavy water samples were collected for analysis by the NWAL. The Agency also collected 516 environmental samples.

Developing the Safeguards Workforce

In 2022, the Agency conducted 45 distinct safeguards staff training courses (as some were held more than once, a total of 92 offerings were provided overall, of which 26 were held outside Vienna), helping to provide safeguards inspectors, analysts and support staff with the necessary core and functional competencies. The Introductory Course on Agency Safeguards for Agency inspectors was held for 12 new inspectors. The Department of Safeguards also conducted a webinar series on seven key topics in safeguards implementation, building capacity and establishing a culture of continuous learning for all staff in the Department.

The Safeguards Traineeship Programme for young graduates and junior professionals commenced in February 2022, involving nine participants (including five women) from Algeria, Cameroon, Costa Rica, Guyana, Nigeria, Panama, Tajikistan, the United Republic of Tanzania and Yemen.

Partnerships

The Agency forged new partnerships in support of Agency safeguards during the course of the year. To further broaden the support base for Agency safeguards, the Agency also signed Practical Arrangements with the Open Nuclear Network and the Henry L. Stimson Center. The Agency published *Enhancing Capabilities for Nuclear Verification: Resource Mobilization Priorities* in 2022 to support its resource mobilization for safeguards by identifying a prioritized set of capabilities for which the Department is seeking partner support.

Safeguards Symposium

In 2022, the Agency organized its 14th Symposium on International Safeguards with the theme 'Reflecting on the Past and Anticipating the Future'. The Symposium reflected on the experience gained and lessons learned over the course of decades of safeguards implementation; anticipated new challenges and opportunities; and identified the actions, stakeholders and partnerships necessary to prepare for continued Agency success in the decades ahead. Some 700 registered participants, of whom 36% were women, from 124 States and 15 organizations attended the event. The Symposium's programme, video recordings, papers, e-posters and more are available on the Symposium website. The updated *IAEA Safeguards Glossary* was launched during the Symposium.



The Director General meets the 2022 Safeguards Traineeship Programme participants.

A New Field Verifiable Passive Seal for Safeguards

Seals are a key part of every Agency inspector's verification toolkit. Annually, nearly 30 000 seals — attached to nuclear material, facility-critical equipment or the Agency's own safeguards equipment — are verified in nuclear facilities around the world. Seals are one way to maintain continuity of knowledge for nuclear material. Verifying that a seal has not been tampered with proves that no nuclear material has been moved from a sealed container. Similarly, seals guarantee the integrity of the Agency's on-site safeguards equipment, such as video cameras.

In 2022, the Agency began to replace the traditional passive seal deployed since the 1960s with a new field verifiable passive seal (FVPS). In developing the new seal, Agency experts considered advancements in materials, modern technologies and machining techniques in order to satisfy the highly specialized requirements of an effective seal. The iterative process, from concept to fully functional, secure and authorized seal, took 12 months of dedicated work by Agency staff, including designing, prototyping, destructive testing and assessment of thousands of seal variations. Significant work was also undertaken in 2022 to ensure that the FVPS sealing system was fully integrated within the Agency's safeguards systems and that all required resources were in place to support the launch of this new capability. Considerable financial and technological support provided by a Member State was instrumental in the successful development of the FVPS.

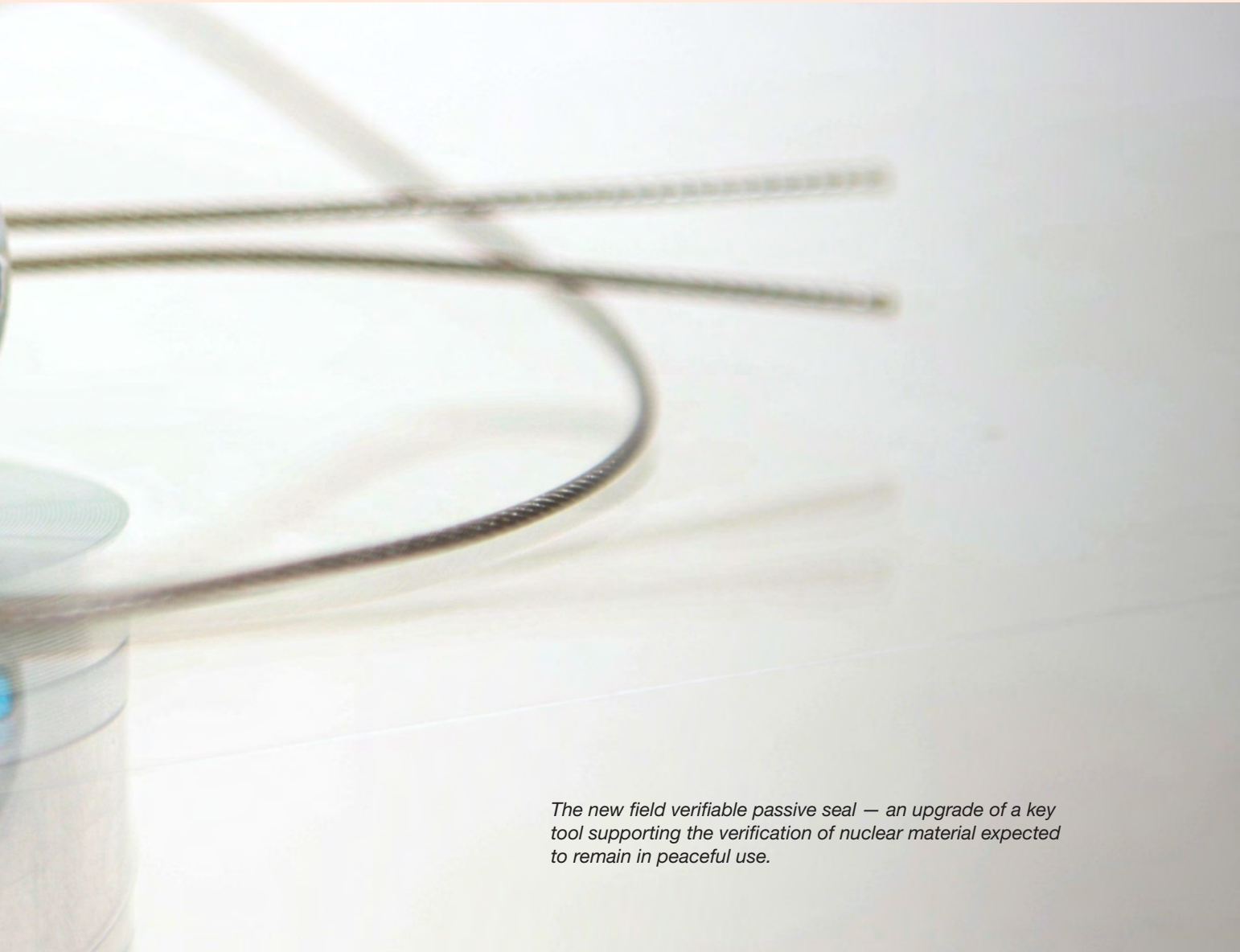


The result is a state-of-the-art seal made from aluminium and polycarbonate, unlike the traditional seal, which was made from copper and brass. The new seal requires no tools to apply, no maintenance while deployed and no batteries. Its components have unique features and pattern designs etched into their surfaces that cannot be replicated without detection. This makes the new seal even more secure and enables the verification and reporting carried out by inspectors to be streamlined.

With the traditional seal, the wire needed to be cut and the seal brought back to Headquarters for verification. In contrast, the device used to verify the new seal contains dedicated software that enables verification to take place in the field by checking reference images and data, which informs the inspector about where, when and by whom the seal was originally attached and verified.

“The FVPS is a significant upgrade to an important tool for IAEA inspectors,” said Massimo Aparo, Deputy Director General and Head of the Department of Safeguards. “This state-of-the-art seal will strengthen the effectiveness and efficiency of Agency safeguards.”

In 2022, the Agency produced and deployed several of the new seals. The Agency plans to expand their use in 2023, with the FVPS eventually replacing all of the traditional seals, especially those currently applied in areas that are hard to access.



The new field verifiable passive seal — an upgrade of a key tool supporting the verification of nuclear material expected to remain in peaceful use.