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# Nuclear Verification<sup>1,2</sup>

## 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 2018

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.

With regard to States with comprehensive safeguards agreements (CSAs), the Agency seeks to conclude that all nuclear material has remained in peaceful activities. To draw such a conclusion, the Agency must ascertain, first, that there are no indications of diversion of declared nuclear material from peaceful activities (including no misuse of declared facilities or other declared locations to produce undeclared nuclear material) and, second, that there are no indications of undeclared nuclear material or activities in the State as a whole.

To ascertain that there are no indications of undeclared nuclear material or activities in a State, and ultimately to be able to draw the broader conclusion that *all* nuclear material has remained in peaceful activities in that State, the Agency assesses the results of its verification and evaluation activities under the State's CSA and additional protocol (AP). Thus, for the Agency to draw such a broader conclusion, both a CSA and an AP must be in force for the State, and the Agency must have completed all necessary verification and evaluation activities and found no indication that, in its judgement, would give rise to a proliferation concern.

For a State that has a CSA but not an AP in force, the Agency draws a conclusion only with respect to whether *declared* nuclear material remained in peaceful activities, as the Agency does not have sufficient tools to provide credible assurances regarding the absence of undeclared nuclear material and activities in the State.

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<sup>1</sup> 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.

<sup>2</sup> 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.

In 2018, safeguards were applied for 182 States<sup>3,4</sup> with safeguards agreements in force with the Agency. Of the 129 States that had both a CSA and an AP in force<sup>5</sup> the Agency drew the broader conclusion that *all* nuclear material remained in peaceful activities for 70 States<sup>6</sup>; for the remaining 59 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 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. During 2018, integrated safeguards were implemented for 67 States<sup>7,8</sup>.

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 the three States for which the Agency implemented safeguards pursuant to item-specific safeguards agreements based on INFCIRC/66/Rev.2, the Agency concluded that nuclear material, facilities or other items to which safeguards had been applied remained in peaceful activities.

As of 31 December 2018, 11 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 Agency continued to facilitate the conclusion of safeguards agreements and APs (Fig. 1), and the amendment or rescission of small quantities protocols (SQPs)<sup>9</sup>. The status of safeguards agreements and APs as of 31 December 2018 is shown in Table A6 in the

<sup>3</sup> 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.

<sup>4</sup> And Taiwan, China.

<sup>5</sup> Or an AP being provisionally applied, pending its entry into force.

<sup>6</sup> And Taiwan, China.

<sup>7</sup> 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, Republic of Korea, Kuwait, Latvia, Libya, Lithuania, Luxembourg, Madagascar, Mali, Malta, Mauritius, Monaco, Montenegro, Netherlands, New Zealand, North Macedonia (the name 'North Macedonia' replaces the former name 'The former Yugoslav Republic of Macedonia' as of 15 February 2019), Norway, Palau, Peru, Philippines, Poland, Portugal, Romania, Seychelles, Singapore, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Tajikistan, Ukraine, United Republic of Tanzania, Uruguay, Uzbekistan and Viet Nam.

<sup>8</sup> And Taiwan, China.

<sup>9</sup> Many States with minimal or no nuclear activities have concluded an SQP to their CSA. Under an SQP, the implementation of most of the safeguards procedures in Part II of a CSA is held in abeyance as long as certain criteria are met. In 2005, the Board of Governors took the decision to revise the standardized text of the SQP and change the eligibility criteria for an SQP, making it unavailable to a State with an existing or planned facility and reducing the number of measures held in abeyance (GOV/INF/276/Mod.1 and Corr.1). The Agency initiated exchanges of letters with all States concerned in order to give effect to the revised SQP text and the change in the criteria for an SQP.

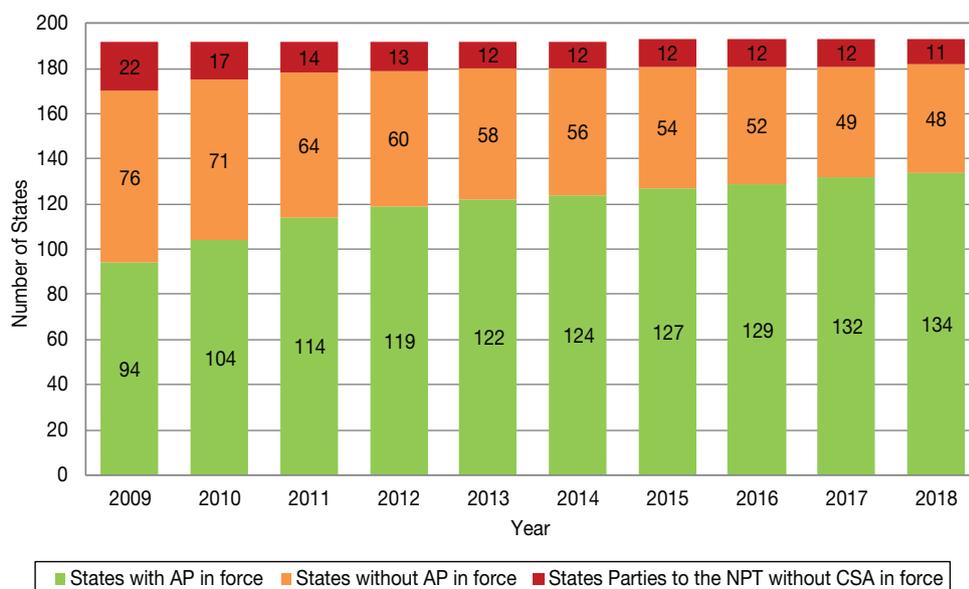


FIG. 1. Number of APs for States with safeguards agreements in force, 2009–2018 (the Democratic People’s Republic of Korea is not included).

Annex to this report. During 2018, a CSA with an SQP and an AP entered into force for Liberia. In addition, the Board of Governors approved a CSA with an SQP for the State of Palestine<sup>10</sup>. An AP entered into force for Serbia. An AP was signed for Algeria, and the Board of Governors approved an AP for Sri Lanka. A voluntary offer agreement and an AP thereto were signed for the United Kingdom. By the end of 2018, safeguards agreements were in force with 183 States and APs were in force with 134 States. An AP continued to be provisionally applied pending its entry into force for the Islamic Republic of Iran.

The Agency continued to implement the *Plan of Action to Promote the Conclusion of Safeguards Agreements and Additional Protocols*<sup>11</sup>, which was updated in September 2018. The Agency organized an outreach workshop for diplomats from Permanent Missions and Embassies located in Berlin, Brussels, Geneva and London (Vienna, 11–12 June), a national workshop for Nepal (Kathmandu, 10–12 December) and country visits to Sao Tome and Principe (18–19 June) and Cabo Verde (21–22 June). During these outreach activities, the Agency encouraged States to conclude a CSA and an AP, and to amend their SQPs. In addition, the Agency held consultations with representatives of a number of Member and non-Member States in Geneva, Jakarta, Lisbon, New York and Vienna at various times throughout the year.

The Agency continued to communicate with States in order to implement the Board of Governors’ 2005 decision regarding SQPs, with a view to rescinding such protocols or amending them to reflect the revised standard text. During 2018, an SQP was rescinded for Malaysia and SQPs were amended for Paraguay, Tonga and the United States of America<sup>12</sup>. By the end of 2018, 64 States had accepted the revised SQP text (which was in force for 58 of these States) and 8 States had rescinded their SQPs.

<sup>10</sup> 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.

<sup>11</sup> Available at: <https://www.iaea.org/sites/default/files/18/09/sg-plan-of-action-2017-2018.pdf>

<sup>12</sup> The United States of America has amended its small quantities protocol to the safeguards agreement reproduced in INFCIRC/366 between the United States of America and the Agency pursuant to Additional Protocol I of the Treaty of Tlatelolco, covering the United States of America’s Protocol I territories.

## Verification and monitoring in the Islamic Republic of Iran in light of United Nations Security Council resolution 2231 (2015)

Throughout 2018, the Agency 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 four reports to the Board of Governors and in parallel to the United Nations Security Council entitled *Verification and monitoring in the Islamic Republic of Iran in light of United Nations Security Council resolution 2231 (2015)* (GOV/2018/7, GOV/2018/24, GOV/2018/33 and GOV/2018/47).

### Syrian Arab Republic (Syria)

In August 2018, the Director General submitted a report to the Board of Governors entitled *Implementation of the NPT Safeguards Agreement in the Syrian Arab Republic* (GOV/2018/35) covering relevant developments since the previous report in August 2017 (GOV/2017/37). 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.<sup>13</sup> In 2018, the Director General renewed his call on Syria to cooperate fully with the Agency in connection with unresolved issues related to the Dair Alzour site and other locations. Syria has yet to respond to these calls.

On the basis of the evaluation of information provided by Syria, and all other safeguards relevant information available to it, the Agency found no indication of diversion of declared nuclear material from peaceful activities. For 2018, the Agency concluded for Syria that declared nuclear material remained in peaceful activities.

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

In August 2018, the Director General submitted a report to the Board of Governors and General Conference entitled *Application of Safeguards in the Democratic People's Republic of Korea* (GOV/2018/34–GC(62)/12), which provided an update of developments since the Director General's report of August 2017 (GOV/2017/36 GC(61)/21). The Director General provided a further update in his introductory statement to the Board of Governors on 22 November 2018.

Since 1994, the Agency has not been able to conduct all necessary safeguards activities provided for in the DPRK's NPT Safeguards Agreement. From the end of 2002 until July 2007, the Agency was not able — and, since April 2009, has not been able — to implement any verification measures in the DPRK, and, therefore, the Agency could not draw any safeguards conclusion regarding the DPRK.

In 2018, 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, including open source information and satellite imagery.

<sup>13</sup> 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.

The Executive Group and the DPRK Team, created in August 2017,<sup>14</sup> have intensified their efforts. The DPRK Team has increased monitoring of the DPRK's nuclear programme through more frequent collection of satellite imagery and has enhanced its readiness to promptly undertake any activities it may be requested to conduct in the DPRK. Actions to enhance readiness have included: formulation and updating of verification approaches and procedures; identification of potential inspectors for initial activities in the DPRK and provision of specialized training for them; and ensuring the availability of appropriate verification technologies and equipment to support the initial activities. All of these efforts related to the Agency's enhanced readiness have been conducted within available resources, including extrabudgetary contributions from a number of Member States. Once a political agreement has been reached among the countries concerned, the Agency is ready to return to the DPRK in a timely manner, if requested to do so by the DPRK and subject to approval by the Board of Governors.

In 2018, the Agency continued to monitor the Yongbyon site. The Agency observed indications that were consistent with the operation of the Yongbyon Experimental Nuclear Power Plant (5MW(e)) reactor until mid-August 2018. From mid-August through November 2018 there were indications of intermittent reactor operation, and in December 2018 there were no indications of reactor operation. Starting in the first quarter of 2018, activities were observed near the Kuryong River, which may have been related to changes to the cooling system for the light water reactor (LWR) under construction and/or the 5MW(e) reactor. Between late April and early May 2018, there were indications of the operation of the steam plant that serves the Radiochemical Laboratory. The duration of the steam plant's operation was not sufficient to have supported the reprocessing of a complete core from the 5MW(e) reactor. At the Yongbyon Nuclear Fuel Rod Fabrication Plant there were indications consistent with the use of the reported centrifuge enrichment facility located within the plant. At the LWR, the Agency observed activities consistent with the fabrication of reactor components and the possible transfer of these components into the reactor building.

The Agency has evaluated all safeguards relevant information, including satellite imagery and open source information, about a group of buildings within a security perimeter in the vicinity of Pyongyang. The size of the main building and the characteristics of the associated infrastructure are not inconsistent with a centrifuge enrichment facility. The timeline of construction is not inconsistent with the reported uranium enrichment programme of the DPRK.<sup>15</sup>

The Agency has not had access to the Yongbyon site or to other locations in the DPRK. Without such access, the Agency cannot confirm either the operational status or configuration/design features of the facilities or locations, or the nature and purpose of the activities conducted therein.

The continuation and further development of the DPRK's nuclear programme during 2018, including activities in relation to the Yongbyon Experimental Nuclear Power Plant (5 MW(e)) reactor, the use of the building which houses the reported centrifuge enrichment facility and the construction at the LWR, are clear violations of relevant United Nations Security Council resolutions, including resolution 2375 (2017), and are deeply regrettable.

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<sup>14</sup> GOV/2017/36-GC(61)/21, para. 12.

<sup>15</sup> GOV/2011/53-GC(55)/24, para. 30. In addition, GOV/2011/53-GC(55)/24, para. 50, noted reports on the provision of centrifuge enrichment technology to the DPRK and indications that the DPRK could produce UF<sub>6</sub> prior to 2001.

## Enhancing Safeguards

### *Evolving safeguards implementation*

In July 2018, the Director General submitted a report to the Board of Governors entitled *Implementation of State-level Safeguards Approaches for States under Integrated Safeguards – Experience Gained and Lessons Learned* (GOV/2018/20). This report contains the Secretariat's analysis of experience gained and lessons learned in the updating and implementation of State-level safeguards approaches (SLAs) for States under integrated safeguards, as described in GOV/2013/38 and GOV/2014/41 and Corr.1.

During 2018, the Agency developed SLAs for five States with a CSA. This brings the total number of States with a CSA for which an SLA has been developed to 130. These 130 States hold 97% of all nuclear material (by significant quantity) under safeguards in States with a CSA and include 67 States with a CSA and an AP in force for which the broader conclusion has been drawn; 35 States with a CSA and an AP in force for which the broader conclusion has yet to be drawn; and 28 States with a CSA but no AP in force. For those States where SLAs are not implemented, in-field safeguards activities are based on the Safeguards Criteria, and new techniques and technologies are implemented, as applicable, to strengthen effectiveness and improve efficiency.

### *Cooperation with State and regional authorities*

To assist States in building capacity for implementing their safeguards obligations, the Agency conducted 13 international, regional and national training courses for those responsible for overseeing and implementing the State and regional systems of accounting for and control of nuclear material. In total, more than 250 participants from some 50 countries were trained on safeguards related topics. The Agency also participated in three other training activities organized by Member States on a bilateral basis. All of these activities were supported financially or in kind through Member State Support Programmes.

In April, the Agency published *International Safeguards in the Design of Facilities for Long Term Spent Fuel Management* (IAEA Nuclear Energy Series No. NF-T-3.1) to provide guidance on the early consideration of safeguards measures in the design and construction of a nuclear facility. The Agency, upon request, conducted an IAEA State System of Accounting for and Control of Nuclear Material Advisory Service (ISSAS) mission to Mexico. It also participated in two Integrated Nuclear Infrastructure Review (INIR) missions, to the Niger and Saudi Arabia, both of which included, inter alia, the provision of advice to the host countries on how to systematically enhance the capabilities necessary for the application of safeguards while embarking on a nuclear power programme.

### *Safeguards equipment and tools*

Throughout 2018, the Agency ensured that the instrumentation and monitoring equipment installed in nuclear facilities around the world, which is vital to effective safeguards implementation, continued to function as required. During the year, 1097 portable and resident non-destructive assay systems comprising 2366 separate pieces of equipment were prepared and assembled for safeguards use. By the end of the year, the Agency had installed a total of 171 unattended monitoring systems in 24 States. It also had 1563 cameras operating at 277 facilities in 37 States<sup>16</sup>. By the end of 2018, remote data transmission infrastructure ensured the collection of 1102 unattended safeguards data streams from 137 facilities in 29 States. Of these, 414 data streams were produced by surveillance systems, 128 by unattended monitoring systems and 560 by electronic seals.

<sup>16</sup> And Taiwan, China.

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*“By the end of the year, the Agency had installed a total of 171 unattended monitoring systems in 24 States.”*

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The Agency continued to implement the next generation surveillance system, replacing outdated surveillance units. By the end of 2018, a total of 881 next generation surveillance system cameras had been installed in 29 States<sup>17</sup>. In 2018, a passive gamma emission tomography (PGET) unit deployed at a nuclear power plant was successfully operated from the Agency's Headquarters, demonstrating the feasibility of remote operation of the system. The PGET system is able to detect missing or replaced rods in spent fuel assemblies, thus providing the Agency with an unprecedented capability of verifying irradiated items.

In 2018, the Agency continued cooperative efforts with Member States, the Brazilian–Argentine Agency for Accounting and Control of Nuclear Materials (ABACC) and the European Commission. These focused on procurement, acceptance testing, installation and maintenance of safeguards equipment designated for joint use, and staff training.

The Agency continued to undertake activities aimed at identifying and evaluating emerging instrumentation technologies that could support safeguards implementation. These activities were performed in close cooperation with Member State Support Programmes. In 2018, the next generation Cherenkov viewing device was tested in the field. One of the field tests was conducted in conjunction with the deployment of three robotized unmanned surface systems. This enabled the Agency to validate the feasibility of automating the verification of spent fuel stored under water.

### *Safeguards analytical services*

The Agency's Network of Analytical Laboratories consists of the Agency's Safeguards Analytical Laboratory and 22 other qualified laboratories in Australia, Brazil, China, France, Hungary, Japan, the Republic of Korea, the Russian Federation, the United Kingdom, the United States of America and of the European Commission. Additional laboratories for sample analysis and reference material provision were in the process of qualification in Argentina, Belgium, Canada, Germany, the Netherlands and the United Kingdom.

In 2018, the Agency collected 487 nuclear material samples that were analysed by the Agency's Nuclear Material Laboratory. The Agency also collected 481 environmental samples, which resulted in analysis of 1020 subsamples; a total of 192 of these subsamples were analysed at the Agency's Environmental Sample Laboratory (Fig. 2) and the Nuclear Material Laboratory, with the remainder analysed by other laboratories in the Network of Analytical Laboratories.

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*“The Agency also collected 481 environmental samples, which resulted in analysis of 1020 subsamples”*

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FIG. 2. Analysing results at the Agency's Environmental Sample Laboratory, Seibersdorf, Austria.

<sup>17</sup> And Taiwan, China.



FIG. 3. Agency safeguards inspectors in training at the E. Andronikashvili Institute of Physics in Tbilisi.

## Support

### *Developing the safeguards workforce*

In 2018, the Agency conducted two Introductory Courses on Agency Safeguards, for a total of 30 newly recruited inspectors. During the year, it conducted 165 safeguards training courses to provide safeguards inspectors and analysts with the necessary technical and behavioural competencies. The 2018 Safeguards Traineeship Programme was successfully completed by six trainees from Cameroon, Jordan, Kenya, Thailand, Turkey and Viet Nam. To enhance practical competencies for safeguards implementation in the field, a number of courses were held at nuclear facilities (Fig. 3) to train safeguards staff in a realistic, effective, consistent and integrated manner. These training courses provide participants with the understanding and skills necessary to prepare, conduct and report on inspections, and conduct design information verification activities and complementary accesses. Other courses were held at the Agency's Headquarters with the aim of developing skills for processing safeguards relevant data, for example, by developing analytical skills relevant to the effective use of collaborative analysis tools. New training courses were also developed in 2018, including a refresher training course on the legal basis for safeguards and a training course on accelerators and associated proliferation risks. The Agency continued to engage with Member State Support Programmes in the development of tools for training and in the conduct of courses at nuclear facilities.

## Significant Safeguards Projects

### *Information technology: MOSAIC*

The Agency completed the planned modernization of safeguards information technology (IT) on schedule on 15 May 2018, within scope and budget. The modernization, completed under the Modernization of Safeguards Information Technology (MOSAIC) project, has enhanced existing tools and software applications in the safeguards IT system, introduced new IT tools and software applications relevant to safeguards implementation, and strengthened information security. Through the completion of the modernization activities, the Department of Safeguards has established an IT system that, inter alia,



FIG. 4. Demonstration of virtual reality technologies at the thirteenth Symposium on International Safeguards, held at the Agency's Headquarters in Vienna in November.

provides for effective and efficient collection, processing and evaluation of safeguards relevant information; increased facilitation of the conduct of diversion and acquisition path analysis; greater assistance to inspectors in conducting safeguards activities in the field and at Agency Headquarters; better underpinning of the Agency's safeguards techniques and technologies; and the continued drawing of soundly based safeguards conclusions. Building on the experience gained during the MOSAIC project, the Agency has incorporated best practices into the provision and maintenance of safeguards IT.

### *Safeguards Symposium*

In November, the Agency hosted the Symposium on International Safeguards: Building Future Safeguards Capabilities at its Headquarters in Vienna. The symposium focused on identifying innovative technologies that might be exploited for safeguards purposes; strengthening existing partnerships and creating new ones; and improving the day to day work of safeguards implementation (Fig. 4). More than 800 people from 90 Member States participated in the symposium. Thanks to substantial support from several Member State Support Programmes, organizations and exhibitors, 90 individuals received travel support to attend the event, resulting in improved geographic diversity among the participants.

### **Preparing for the Future**

The Agency published the *Research and Development Plan — Enhancing Capabilities for Nuclear Verification (STR-385)* and the *Development and Implementation Support Programme for Nuclear Verification 2018–2019 (STR-386)* in early 2018. The biennial meeting of the Member State Support Programme coordinators took place in February, at which the Secretariat informed Member States about its needs regarding improvements to the Agency's technical capabilities. The Development and Implementation Support Programme for Nuclear Verification comprises 285 support programme tasks in 25 projects. At the end of 2018, 20 Member States<sup>18</sup> and the European Commission had formal support programmes with the Agency.

<sup>18</sup> Argentina, Australia, Belgium, Brazil, Canada, China, Czech Republic, Finland, France, Germany, Hungary, Japan, Republic of Korea, Netherlands, Russian Federation, South Africa, Spain, Sweden, United Kingdom and United States of America.