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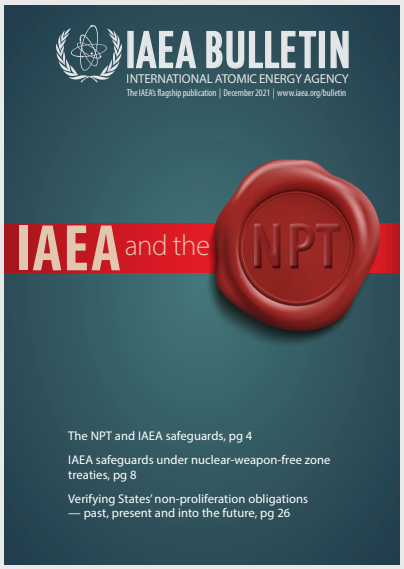
IAEA and the NPT



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IAEA

The International Atomic Energy Agency's mission is to prevent the spread of nuclear weapons and to help all countries — especially in the developing world — benefit from the peaceful, safe and secure use of nuclear science and technology.

Established as an autonomous organization under the United Nations in 1957, the IAEA is the only organization within the UN system with expertise in nuclear technologies. The IAEA's unique specialist laboratories help transfer knowledge and expertise to IAEA Member States in areas such as human health, food, water, industry and the environment.

The IAEA also serves as the global platform for strengthening nuclear security. The IAEA has established the Nuclear Security Series of international consensus guidance publications on nuclear security. The IAEA's work also focuses on helping to minimize the risk of nuclear and other radioactive material falling into the hands of terrorists and criminals, or of nuclear facilities being subjected to malicious acts.

The IAEA safety standards provide a system of fundamental safety principles and reflect an international consensus on what constitutes a high level of safety for protecting people and the environment from the harmful effects of ionizing radiation. The IAEA safety standards have been developed for all types of nuclear facilities and activities that serve peaceful purposes, as well as for protective actions to reduce existing radiation risks.

The IAEA also verifies through its inspection system that Member States comply with their commitments under the Nuclear Non-Proliferation Treaty and other non-proliferation agreements to use nuclear material and facilities only for peaceful purposes.

The IAEA's work is multi-faceted and engages a wide variety of partners at the national, regional and international levels. IAEA programmes and budgets are set through decisions of its policymaking bodies — the 35-member Board of Governors and the General Conference of all Member States.

The IAEA is headquartered at the Vienna International Centre. Field and liaison offices are located in Geneva, New York, Tokyo and Toronto. The IAEA operates scientific laboratories in Monaco, Seibersdorf and Vienna. In addition, the IAEA supports and provides funding to the Abdus Salam International Centre for Theoretical Physics, in Trieste, Italy.

The NPT and the IAEA's critical role in steering nuclear towards peaceful uses

By Rafael Mariano Grossi, Director General, IAEA

Since the dawn of the nuclear age in the middle of the 20th century, the possibilities for the atom have been two-sided like a coin: one face held the destructive power of nuclear weapons; the other, the limitless potential of peaceful nuclear applications.

Since its entry into force in 1970, the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) has been the international legal framework by which nations have worked to steer the use of nuclear science and technology towards peace and development, and away from developing nuclear weapons. The NPT is the centrepiece of global efforts to prevent the spread of nuclear weapons. It promotes cooperation in the peaceful uses of nuclear applications and seeks nuclear disarmament. The IAEA is named several times in past review conferences of the Treaty, including as one of the main vehicles that fosters international cooperation for peaceful nuclear applications (Article IV) and as the organization explicitly entrusted with key nuclear verification responsibilities (Article III).

In 2022, the NPT, so critical to maintaining world peace over half a century, will be under the spotlight at its Tenth Review Conference. To mark the occasion the IAEA Bulletin delves into ways the Agency's work is directly relevant to its implementation.

This edition of the Bulletin explores the many benefits of peaceful nuclear applications with examples from Viet Nam and Bangladesh. We highlight how Indonesia champions nuclear South-South collaboration and touch on new IAEA initiatives such as ZODIAC, for addressing zoonotic disease outbreaks, and NUTEC Plastics, for tackling plastic pollution. It examines nuclear safety and security in Moldova, describes the IAEA's low-enriched uranium bank in Kazakhstan, and shows how we are building capacity for managing nuclear emergencies.

More than 400 IAEA projects have been made possible by funds raised through the Peaceful Uses Initiative (PUI), which originated from a proposal made during the 2010 NPT Review Conference. Since then, PUI has raised more than €200 million to help expand IAEA support to Member States in areas such as health care, agriculture, energy development and more.

IAEA safeguards are a fundamental pillar of the nuclear non-proliferation regime under the NPT. The Bulletin also reviews the Agency's role in nuclear safeguards; profiles its close collaboration with Tajikistan, and explains the importance of COMPASS, our initiative strengthening cooperation with countries; and brings attention to our support in establishing nuclear weapon free zones.

Having up-to-date safeguards agreement in place is important not only for those that use nuclear power, but also for countries with little to no nuclear material, such as those with Small Quantities Protocol (SQP). I call on states with the SQPs based on old standard text to amend or rescind them and encourage all NPT States parties that have not yet done so to conclude an additional protocol (AP).

"The Treaty on the Non-Proliferation of Nuclear Weapons has been the international legal framework by which nations have worked to steer the use of nuclear science and technology towards peace and development, and away from developing nuclear weapons."

— Rafael Mariano Grossi, Director General, IAEA

(Photo: IAEA)

(UN Photo/Sophia Paris)

(Photo: IAEA)

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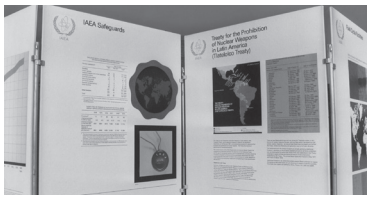

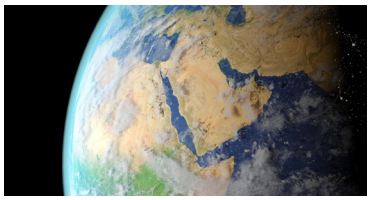

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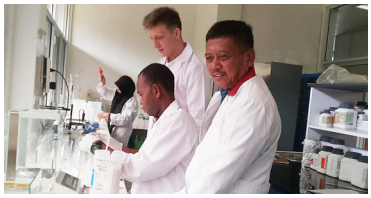


HISTORY

WORLD VIEW

IAEA UPDATES

The NPT and IAEA safeguards

By Ionut Suseanu

The objective of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) is to prevent the spread of nuclear weapons, promote international cooperation in the peaceful uses of nuclear energy and further the goal of achieving nuclear disarmament, as well as general and complete disarmament.

The NPT was opened for signature on 1 July 1968 and entered into force on 5 March 1970. The operation of the Treaty is reviewed every five years at the Review Conference of the Parties to the NPT. On 11 May 1995, the NPT Review and Extension Conference decided to extend the Treaty indefinitely.

The Treaty has 191 Parties, including 186 non-nuclear-weapon States (NNWSs) and 5 nuclear-weapon States (NWSs): China, France, the Russian Federation, the United Kingdom and the United States of America.

The IAEA is not a Party to the NPT. However, under Article III of the Treaty, the IAEA administers international safeguards to verify that NNWSs party to the NPT fulfil the non-proliferation commitments they have made under the Treaty, "with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices." Through its independent verification work, the IAEA plays an indispensable role in the implementation of the Treaty and the prevention of the spread of nuclear weapons.

IAEA safeguards

The establishment and administration of safeguards is one of the main functions of the IAEA under its Statute, which entered into force in 1957. The Statute authorizes the IAEA to "apply safeguards, at the request of the parties, to any bilateral or multilateral

Inspectors like these in yellow suits are a key part of the IAEA safeguards verification activities.
(Photo: IAEA)

arrangement, or at the request of a State, to any of that State's activities in the field of atomic energy."

The IAEA concluded its first safeguards agreement in 1959, long before the NPT entered into force. Since then, both the IAEA legal framework for safeguards and the implementation of safeguards have evolved. This is mainly due to the entry into force of multilateral treaties requiring IAEA safeguards (see page 8), as well as advances in nuclear technology, technological developments in the field of safeguards, practical experience gained by the IAEA from the implementation of safeguards, and the need to strengthen the effectiveness and improve the efficiency of safeguards.

Before 1971, when the first comprehensive safeguards agreements (CSA) with an NNWS in connection with the NPT was concluded, the IAEA had implemented safeguards for 32 States under item-specific safeguards agreements.

Since June 1971, 178 NNWSs party to the NPT have brought into force CSAs with the IAEA, and 8 NNWSs have yet to do so. All five NWSs party to the NPT have concluded voluntary offer agreements with the IAEA. Three countries that are not Party to the NPT, India, Israel and Pakistan, have item-specific safeguards agreements in force with the IAEA.

The implementation of safeguards under CSAs between 1971 and 1991was focused mainly on the verification of nuclear material and facilities declared by States. The IAEA's safeguards experience in Iraq and the Democratic People's Republic of Korea in the early 1990s demonstrated that the IAEA's capabilities to detect undeclared nuclear material and activities were limited. Since 1991, several measures have been adopted by the Board of Governors to strengthen the effectiveness and improve the efficiency of IAEA safeguards.

The most important development was the approval of the Model Additional Protocol by the Board of Governors in 1997. Additional protocols (APs) contain important measures that significantly increase the IAEA's ability to detect undeclared nuclear material and activities in a State with a CSA. Since May 1997, 138 States party to the NPT have brought into force APs, including the 5 NWSs.

The IAEA's safeguards responsibilities and workload have increased steadily since 1971. By the end of 2020, the IAEA had applied safeguards for 184 States, including 181 States party to the NPT (176 NNWSs and 5 NWSs); and more than 1300 nuclear facilities and locations were under IAEA safeguards. In 2020, IAEA inspectors conducted more than 3000 inspections in the field.

IAEA safeguards and the NPT Review Conference

From the very beginning of the NPT review process, State Parties expressed strong support for effective IAEA safeguards.

The first Review Conference in 1975 noted that "the verification activities of the IAEA under Article III of the Treaty respect the sovereign rights of States and do not hamper the economic, scientific or technological development of the Parties to the Treaty or international co-operation in peaceful nuclear activities" and recommended that "intensified efforts be made towards the standardization and the universality of application of IAEA safeguards."

The 1995 NPT Review and Extension Conference affirmed that nothing should be done to undermine the verification authority of the IAEA and stressed that IAEA safeguards should be regularly assessed and evaluated. It also affirmed that decisions adopted by its Board of Governors aimed at further strengthening the effectiveness of IAEA safeguards should be supported and implemented and the IAEA's capability to detect undeclared nuclear activities should be increased.

The 2010 Review Conference called upon all State Parties to "ensure that IAEA continues to have all political, technical and financial support so that it is able to effectively meet its responsibility to apply safeguards as required by article III of the Treaty," and encouraged State Parties, within the framework of the IAEA Statute, to "further develop a robust, flexible, adaptive and cost-effective international technology base for advanced safeguards through cooperation among Member States and with IAEA."

Working together to meet safeguards obligations

An ISSAS mission in Tajikistan

By Adem Mutluer

"The ISSAS mission helped us better understand the requirements for safeguards implementation, as well as how we can strengthen our cooperation with the IAEA to streamline the verification process both for us and for the IAEA."

— Ilhom Mirsaidzoda, Director, Nuclear and Radiation Safety Agency, Tajikistan

Across the globe, peaceful nuclear applications — such as nuclear power and medicine — and the benefits they bring are in increasing demand. However, nuclear material and technology can also be used to produce nuclear weapons. To help ensure that nuclear material and technology remain in peaceful use, the IAEA conducts verification activities under a system known as nuclear safeguards. The IAEA also assists States in strengthening the implementation of safeguards through workshops, training courses, a traineeship programme, peer review missions and other forms of assistance.

The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) requires non-nuclear-weapon States party to the Treaty to enter into a legally binding agreement with the IAEA, known as a comprehensive safeguards agreement (CSA) (see article, page 24.) Among the 178 NPT States with a CSA in force, 132 also have an additional protocol (AP) in force. An AP provides the IAEA with greater access to information and locations, and provides the IAEA with further insight into a State's nuclear programme and plans, as well as its nuclear-related trade.

When countries bring a CSA into force, they take on obligations to host safeguards inspections of their nuclear facilities and other related locations, and to provide relevant information to the IAEA. These obligations increase under an AP. Tajikistan brought both a CSA and an AP into force in 2004. Under a CSA, each State is required to establish and maintain a State system of accounting for and control of nuclear material (SSAC). Based on this requirement, the State undertakes to maintain records and reports of all quantities of nuclear material within the State, including material received, produced and shipped by the State.

In order to support the country in meeting these obligations, the Government of Tajikistan requested the IAEA's help in the form of an IAEA State System of Accounting for and Control of Nuclear Material Advisory Service (ISSAS) mission.

Available to all States with a CSA in force, an ISSAS mission reviews and evaluates the performance of a State's SSAC and identifies areas where further cooperation with the IAEA could increase the effectiveness and efficiency of safeguards for both sides. The mission provides recommendations on how to address any areas identified for improvement, as well as good practices. Since 2004, 24 ISSAS missions have been performed in 23 countries.

"Tajikistan is, and has always been, strongly committed to fulfilling its safeguards obligations," said Ilhom Mirsaidzoda, Director of Tajikistan's Nuclear and Radiation Safety Agency. "The ISSAS mission helped us better understand the requirements for safeguards implementation, as well as how we can strengthen our cooperation with the IAEA to streamline the verification process both for us and for the IAEA."

ISSAS missions consist of two parts: a preparatory visit and the evaluation itself. A mission typically includes a review of written material provided by the State, such as respective laws, regulations and procedures; interviews with officials; and the direct observation of the practices and systems in place at the organizations and locations identified. The ISSAS mission team then evaluates its findings and prepares a mission report, including an agreed action plan with the State.

Tajikistan has also tapped into other types of IAEA assistance in safeguards implementation, such as a national training course organized by the IAEA, which took place in Dushanbe in June 2018, and hands-on training in the use of IT software to submit safeguards-related information to the IAEA. Tajikistan's experience is testament to the benefits of a State working together with the IAEA to meet its international non-proliferation obligations, said Takehito Watanabe, nuclear safeguards inspector and safeguards country officer for Tajikistan at the IAEA.

Tajikistan now uses its experience to hold training courses and share its knowledge with its regional partners. "By bringing together our counterparts from across the region to share our knowledge in applying our comprehensive safeguards agreement and our additional protocol, as well as by sharing our experience from hosting an ISSAS mission, we hope that other countries may also benefit from the lessons learned. We would also recommend other countries to take advantage of an ISSAS mission," said Mirsaidzoda.

COMPASS

Strengthening the accounting and control of nuclear material

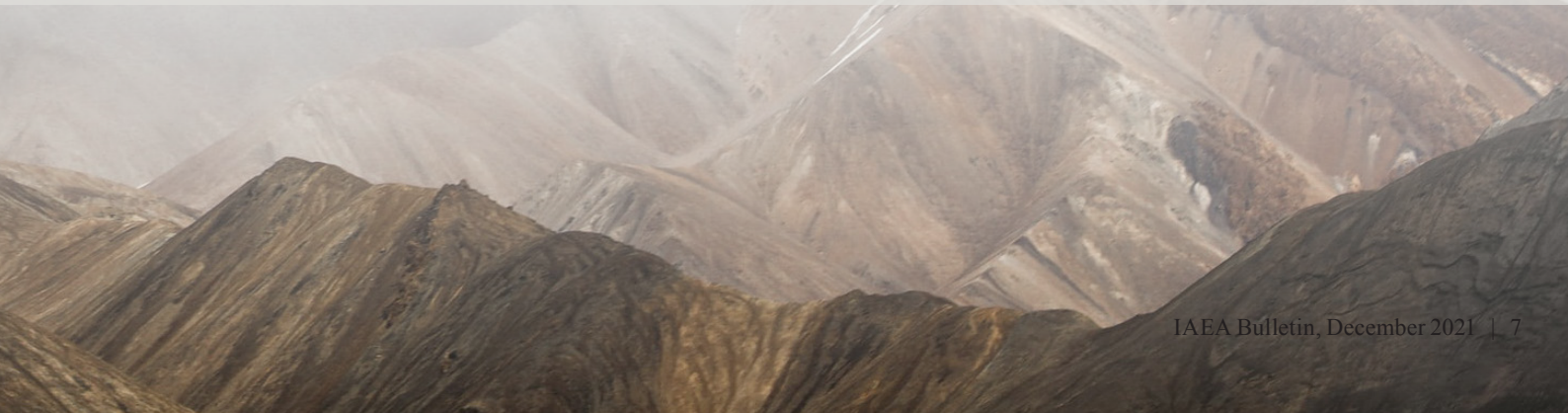
Nuclear material accountancy and control is key in implementing IAEA safeguards — verifying that nuclear material remains in peaceful use. States are required to establish and maintain State systems of accounting for and control of nuclear material (SSACs) subject to safeguards. To strengthen the effectiveness of SSACs, while enhancing cooperation between the State or regional authorities responsible for safeguards implementation (SRAs) and the IAEA, the Comprehensive Capacity-Building Initiative for SSACs and SRAs (COMPASS) was established.

Launched in 2020, COMPASS partners with States to provide support and services related to SSACs and SRAs. COMPASS strengthens cooperation by identifying areas for further collaboration through assistance packages, tailored to a State's specific needs.

As a first step in the COMPASS process, a joint IAEA–State assessment is prepared to identify areas that will benefit from additional assistance. This assessment covers six thematic areas: the SSAC legal and regulatory framework; nuclear material accounting and control, and reporting to the IAEA; national nuclear export and import control systems; SSAC information management systems; inspections by the SRA and facilitation of IAEA verification activities; and SSAC/SRA resources, recruitment, training practices and requirements.

Based on this assessment, an assistance package is developed that can include State-specific outreach, legal and regulatory assistance, safeguards training, technical support, and expert assistance. This package forms the basis of a detailed work plan for agreement with the State, sets a clear timeline, and arranges for monitoring and assessing progress.

Building on 40 years of IAEA safeguards training to Member States, COMPASS optimizes the provision of assistance into one package. Guatemala, Jordan, Malaysia, Rwanda, Saudi Arabia, Turkey, and Uzbekistan were selected to take part in COMPASS's current two-year pilot phase. Thirteen Member State Support Programmes are providing financial and/or in-kind contributions to support COMPASS implementation.



IAEA safeguards under nuclear-weapon-free zone treaties

By Ionut Suseanu

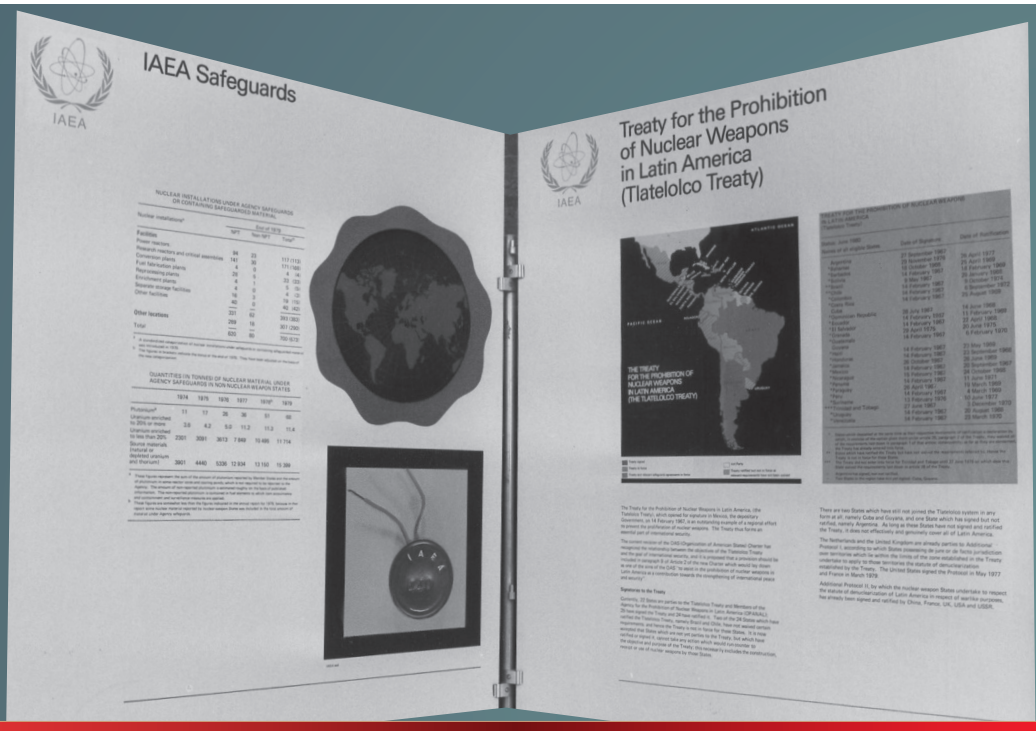
Safeguards agreements between individual States and the IAEA govern the application of the IAEA's nuclear verification work. Currently the IAEA implements safeguards for 185 States all over the world of which 178 have in force comprehensive safeguards agreements (CSA). The conclusion of a CSA with the IAEA is mandatory for all non-nuclear-weapon States party to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). Several groups of countries established regional nuclear-weapon-free zones (NWFZs) before and after the entry into force of the NPT. The regional treaties establishing NWFZs, similarly to the NPT, create safeguards obligations for their State Parties.

The IAEA is responsible for verifying and assuring that States comply with their safeguards agreements concluded with the IAEA in fulfilment of their obligations under the NPT and NWFZ treaties.

Furthermore, at the request of the States concerned, the IAEA provided support during the development process of two of these treaties: the Treaty of Pelindaba, establishing a nuclear-weapon free zone in Africa, concluded in 1996, and the Treaty of Semipalatinsk, establishing a nuclear-weapon free zone in Central Asia, concluded in 2006. The IAEA's support included the provision of technical and legal advice to the States participating in the negotiation process.

The conclusion of a CSA with the IAEA is mandatory for all non-nuclear-weapon States party to the NPT. Several groups of countries established regional nuclear-weapon-free zones (NWFZs) before and after the entry into force of the NPT. The regional treaties establishing NWFZs, similarly to the NPT, create safeguards obligations for their State Parties.

(Photo: IAEA)



Treaty for the Prohibition of Nuclear Weapons in Latin America and the Caribbean (Tlatelolco Treaty)

The Tlatelolco Treaty was the first NWFZ treaty to be concluded. It was opened for signature in 1967, before the entry into force of the NPT. In 1969, the Contracting Parties established the Agency for the Prohibition of Nuclear Weapons in Latin America and the Caribbean (OPANAL). An Agreement between the IAEA and OPANAL was concluded in 1972 and provides for a framework of cooperation between the two organizations on matters of common interest.

All 33 States parties to the Tlatelolco Treaty have concluded CSAs with the IAEA. In addition, three States with territories in Latin America for which, de jure or de facto, they are internationally responsible, have also concluded CSAs with the IAEA under Additional Protocol I of the Tlatelolco Treaty. In total, 20 States parties to the Tlatelolco Treaty have received legislative assistance from the IAEA to develop or further enhance their respective national nuclear legislation.

Through its legislative assistance programme, the IAEA also assists States party to these treaties to put in place national legislation governing the peaceful uses of nuclear energy in order to enable them to implement the international legal instruments related to nuclear non-proliferation and safeguards and other areas of nuclear law such as nuclear safety and security and liability.

The safeguards provisions set out in the NWFZ treaties are similar to those in the NPT, as they require State Parties to conclude CSAs with the IAEA. The Treaty of Semipalatinsk also requires State Parties to conclude an additional protocol (AP) with the IAEA, which grants to the IAEA wider access to information and locations in a country.

Like the NPT, the Rarotonga, Bangkok, Pelindaba and Semipalatinsk Treaties also include provisions requiring IAEA safeguards as a condition of supply by State Parties of source or special fissionable material, or equipment or material specially designed or prepared for the processing, use or production of special fissionable material. The Treaty of Semipalatinsk also requires the conclusion of an AP as a condition of supply of such nuclear material and equipment.

Some NWFZ treaties provide for a broader role for the IAEA, such as the possibility of participation in fact-finding missions or inspections in the event that questions concerning compliance with the provisions of the treaties arise.

CSAs concluded by non-nuclear-weapon States in connection with the NPT also satisfy such States' obligations to conclude CSAs under the NWFZ treaties to which they are party. States in Latin America and the Caribbean have concluded CSAs with the IAEA to meet their safeguards obligations under both the Treaty for the Prohibition of Nuclear Weapons in Latin America and the Caribbean and the NPT.

South Pacific Nuclear Free Zone Treaty (Rarotonga Treaty)

The Rarotonga Treaty was the first NWFZ treaty concluded after the entry into force of the NPT. It requires State Parties to conclude safeguards agreements that are either the same or equivalent in scope and effect to those required in connection with the NPT.

Ten States party to the Rarotonga Treaty have concluded CSAs with the IAEA in connection with the NPT and one State Party has concluded a CSA in connection with the NPT and the Bangkok Treaty. Two State Parties, Fiji and Papua New Guinea, have received legislative assistance from the IAEA.

Treaty on the Southeast Asia Nuclear Weapon-Free Zone (Bangkok Treaty)

Article 5 of the Bangkok Treaty requires each State Party that has not done so to conclude an agreement with the IAEA for the application of full-scope safeguards to its peaceful nuclear activities.

All ten State parties to the Bangkok Treaty have concluded CSAs with the IAEA in connection with the NPT, which also meets the requirement to conclude a CSA under the Bangkok Treaty. Nine State Parties have received legislative assistance from the IAEA.

African Nuclear-Weapon-Free Zone Treaty (Pelindaba Treaty)

The Pelindaba Treaty requires each State Party to conclude a CSA with the IAEA. Annex II to the Treaty provides that the safeguards agreement required under the Treaty "shall be, or shall be equivalent in its scope and effect to, the agreement required in connection with the NPT."

In total, 48 States party to the Pelindaba Treaty have concluded CSAs with the IAEA in connection with the NPT, which also meets the requirement to conclude a CSA under the Pelindaba Treaty, and two State Parties have signed but have yet to bring into force such CSAs with the IAEA. Thirty-five State Parties and 8 signatory States have received legislative assistance from the IAEA.

Treaty on a Nuclear-Weapon-Free Zone in Central Asia (Treaty of Semipalatinsk)

Under the Treaty, each State Party is required to conclude a CSA and an AP with the IAEA. All five Central Asian States party to the Treaty have concluded CSAs in connection with the NPT, which also meets the requirement to conclude a CSA under the Treaty of Semipalatinsk. All these States have also concluded APs to their CSAs. Three States party to the Treaty have received legislative assistance from the IAEA.

The IAEA and a nuclear-weapon-free zone in the Middle East

By Nuno Luzio

Five nuclear-weapon-free zones (NWFZ) have been established over the past few decades, with signatory States undertaking, among other obligations, to not have nuclear weapons in the territory of the applicable NWFZ and to conclude comprehensive safeguards agreements with the IAEA (see page 4). There have also been initiatives to set up a zone free of weapons of mass destruction, including nuclear weapons, in the Middle East.

The IAEA has had a role in the context of the establishment of a NWFZ in the Middle East and the application of full-scope IAEA safeguards to all nuclear activities in the region.

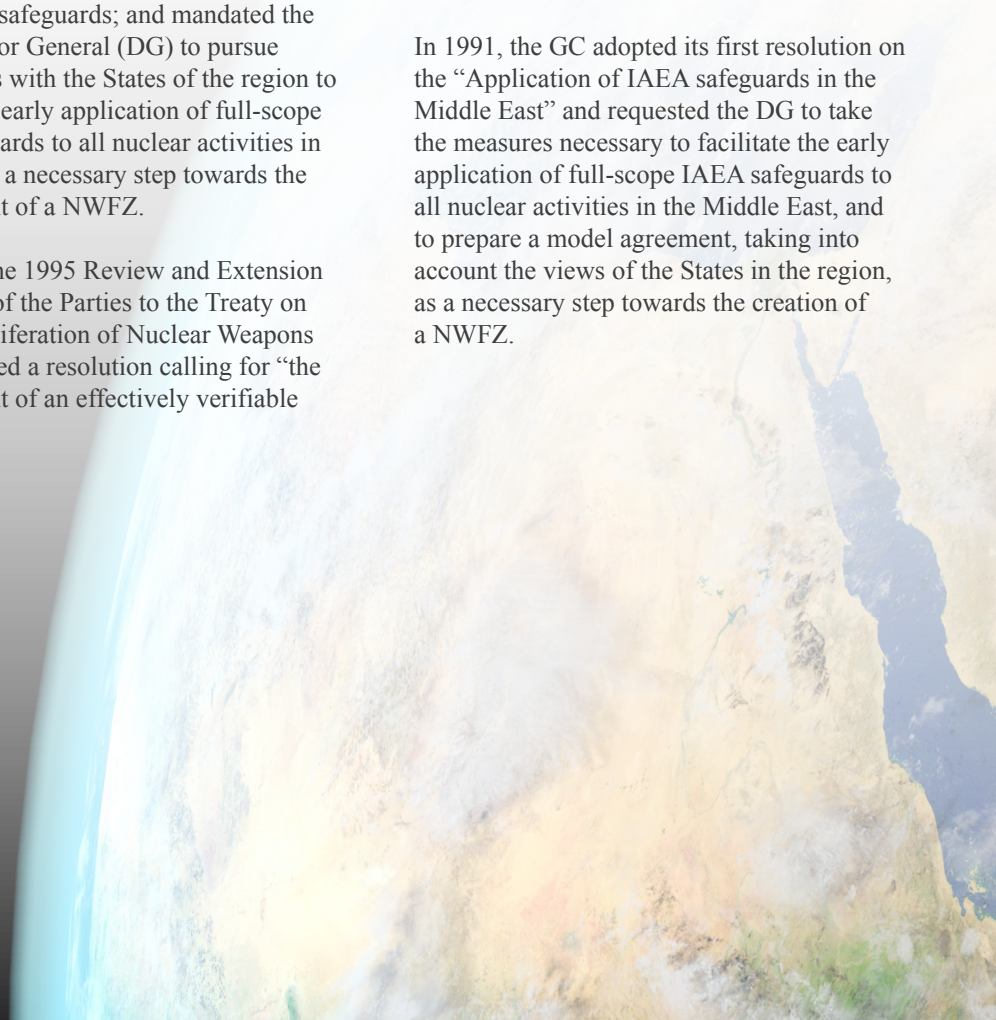
The IAEA's General Conference (GC), in its resolutions on the application of IAEA safeguards in the Middle East, has called upon all parties directly concerned to consider taking steps to establish a mutually and effectively verifiable NWFZ in the region; affirmed the need for all States in the region to accept the application of full-scope IAEA safeguards; and mandated the IAEA Director General (DG) to pursue consultations with the States of the region to facilitate the early application of full-scope IAEA safeguards to all nuclear activities in the region as a necessary step towards the establishment of a NWFZ.

In parallel, the 1995 Review and Extension Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) adopted a resolution calling for "the establishment of an effectively verifiable Middle East zone free of weapons of mass destruction, nuclear, chemical and biological, and their delivery systems". During the subsequent NPT Review Conferences, the importance of the 1995 resolution on the Middle East was reaffirmed, and it was stressed that the resolution remains valid until its goals and objectives are achieved.

An initiative since the 1980s

In 1988, the GC requested DG Hans Blix to prepare a technical study on different modalities for applying safeguards in the Middle East, taking into account the IAEA's experience in applying safeguards. Mr Blix submitted the technical study to the GC in 1989. It contained descriptions of the safeguards agreements concluded between the IAEA and the States concerned as well as a comparison of the various types of safeguards agreements. In that same year, the GC requested the DG to consult with the States concerned with a view to applying IAEA safeguards to all nuclear installations in the region.

In 1991, the GC adopted its first resolution on the "Application of IAEA safeguards in the Middle East" and requested the DG to take the measures necessary to facilitate the early application of full-scope IAEA safeguards to all nuclear activities in the Middle East, and to prepare a model agreement, taking into account the views of the States in the region, as a necessary step towards the creation of a NWFZ.



In 1992, a report by the DG following the 1991 GC resolution identified possible nuclear verification requirements and the means of carrying out such verification in such a zone.

In 2000, the GC requested DG Mohamed ElBaradei to convene a forum where participants from the Middle East and other interested parties could learn from the experience of other regions, and, in consultation with States of the region and other interested parties, to develop an agenda and modalities that would help to ensure a successful forum. DG ElBaradei and, from 2009, DG Yukiya Amano continued these activities towards convening a forum and reported annually to the GC on the results.

In November 2011, the IAEA convened a Forum on Experience of Possible Relevance to the Creation of a NWFZ in the Middle East. The Forum considered the experience of existing NWFZs in creating regional security regimes and achieving disarmament through the establishment of NWFZs. The Chairperson's summary was annexed to the DG's report on the Application of IAEA Safeguards in the Middle East issued on 27 August 2012.

Following the 2011 Forum, DG Amano continued his consultations regarding the early application of comprehensive IAEA safeguards on all nuclear activities in the Middle East and encouraged the development and consideration of new ideas and approaches that could help move the IAEA's mandate forward.

The number and type of safeguards agreements concluded by States in the Middle East (the members of the League of Arab States, as well as Iran and Israel) with the IAEA have evolved. Of the 23 NPT non-nuclear-weapon State Parties of the region, 21 have a comprehensive safeguards agreement in force, 10 of which also have an Additional Protocol in force, which provides the IAEA with broader access to information and locations in each State.

Current status and the way forward

Notwithstanding the continuing broad support for the view that the global nuclear non-proliferation regime would be further strengthened through the establishment of a NWFZ in the Middle East, there continues to be a lack of agreement among States in the region on the substance and modalities of a NWFZ agreement, including on the safeguards obligations they are prepared to undertake.

In September 2021, the GC again adopted a resolution in which, as in previous resolutions, affirmed the urgent need for all States in the Middle East to accept the application of full-scope IAEA safeguards to all their nuclear activities. The resolution called upon all States in the region to take measures, including confidence-building and verification measures, aimed at establishing an NWFZ, and also called upon States in the region to extend their fullest cooperation to the DG in the fulfilment of the tasks entrusted to him by the GC.

Since taking office in December 2019, DG Rafael Mariano Grossi has continued, in accordance with the mandate entrusted to him by the GC, to consult and work with the States of the Middle East region to find the common ground required to develop model agreements as a necessary step towards the establishment of a Middle East NWFZ. "It is an important part of the IAEA's mandate, and I count on the cooperation of all the parties concerned," he said.

Bangladesh nuclear reactor construction progresses ahead of planned 2023 start-up

By Matt Fisher

Bangladesh is pushing ahead with the construction of its first nuclear power plant (NPP), and the IAEA, in line with its mandate, is supporting authorities in the South Asian country in the safe, secure and sustainable introduction of nuclear power. As the country of over 160 million aims to dramatically expand its economy and boost access to electricity, nuclear power is expected to provide 9% of its electricity after the commissioning of the plant in 2023 — six years after the first safety-related concrete was poured.

Once completed, the two reactors at the Rooppur site, some 160 kilometres north-west of the capital, Dhaka, will generate 2400 megawatts of round-the-clock clean electricity. But the introduction of nuclear power in Bangladesh is about more than just energy. The Rooppur project is at the heart of an ambitious initiative to transform a developing country into a developed economy by 2041, in part by scaling up electricity production, with some 2.7 million homes set to be connected to the grid over the next year alone.

Bangladesh is among 28 countries that are considering, planning or starting the introduction of nuclear power. The IAEA assists countries interested in developing peaceful applications of nuclear energy, including nuclear power. The IAEA's Milestones approach provides step-by-step guidance on the infrastructure for a new nuclear power programme.

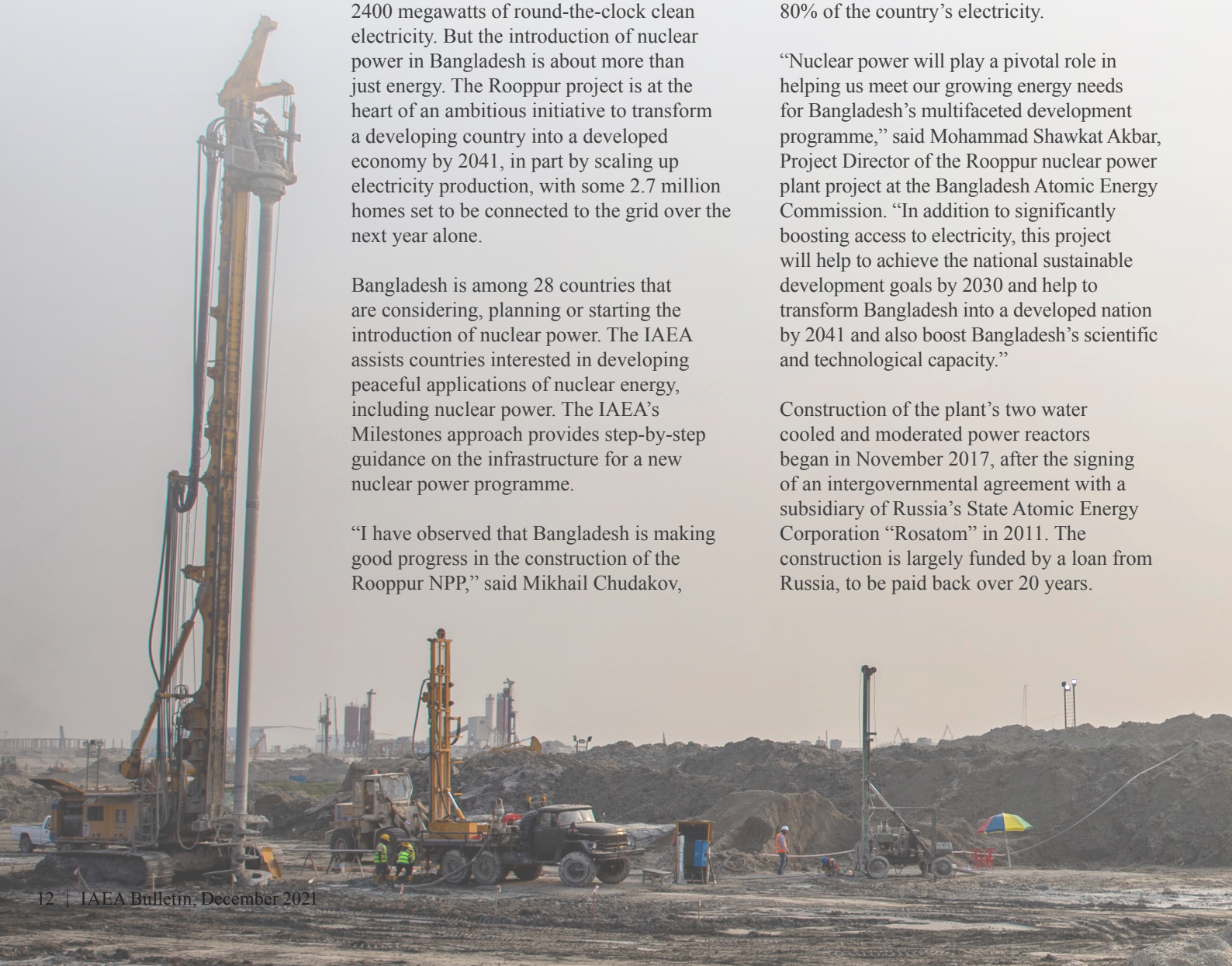
"I have observed that Bangladesh is making good progress in the construction of the Rooppur NPP," said Mikhail Chudakov, IAEA Deputy Director General and Head of the Department of Nuclear Energy, following his visit to the Rooppur site in February 2020, when about a quarter of the plant's construction had been completed. "Bangladesh continues to demonstrate its commitment to introducing reliable, low carbon nuclear power to help drive socio-economic development."

With electricity demand rising by about 7% annually, Bangladesh is looking to expand as well as diversify and decarbonize its electricity sector through the addition of nuclear power and renewables, both of which are among the lowest emitters of greenhouse gases. Currently, natural gas provides nearly 80% of the country's electricity.

"Nuclear power will play a pivotal role in helping us meet our growing energy needs for Bangladesh's multifaceted development programme," said Mohammad Shawkat Akbar, Project Director of the Rooppur nuclear power plant project at the Bangladesh Atomic Energy Commission. "In addition to significantly boosting access to electricity, this project will help to achieve the national sustainable development goals by 2030 and help to transform Bangladesh into a developed nation by 2041 and also boost Bangladesh's scientific and technological capacity."

Construction of the plant's two water cooled and moderated power reactors began in November 2017, after the signing of an intergovernmental agreement with a subsidiary of Russia's State Atomic Energy Corporation "Rosatom" in 2011. The construction is largely funded by a loan from Russia, to be paid back over 20 years.

Construction of Bangladesh's first nuclear power plant.
(Photo: IAEA)



The IAEA has supported Bangladesh through its technical cooperation programme and the Peaceful Uses Initiative (see box on page 21). This support includes Integrated Nuclear Infrastructure Review (INIR) missions, which assess a country's progress against the Milestones approach and make recommendations.

"Bangladesh is making great efforts to implement the remaining recommendations and suggestions made, including bolstering human resource development efforts," said Eric Mathet, Senior Nuclear Infrastructure Engineer at the IAEA. "This includes an ongoing initiative to train around 1000 staff from the operator. Bangladesh has also participated in scientific visits and other training courses offered by the IAEA," he added.

Recent developments include the arrival and installation of Unit 1's reactor pressure vessel, in October 2021. Bangladesh also recently finalized its Radioactive Waste and Used Nuclear Energy Management National Policy, which provides for the repatriation of spent nuclear fuel to Russia after interim on-site storage. It also established the Radioactive Waste Management Company, which will dispose of radioactive waste from a variety of sectors, including medicine.

"Bangladesh is closely working with the IAEA in developing our nuclear power programme, and the IAEA Milestones approach has been instrumental in helping us fulfil all of the associated requirements," said Akbar. "The INIR missions have also been valuable in assisting us in identifying areas which require additional attention for developing and implementing our national nuclear infrastructure in a responsible and orderly manner."

Energy consumption has long been linked to higher living standards. Expanding access to clean and reliable electricity can help Bangladesh to drive economic development and limit greenhouse gas emissions through reduced use of fossil and other fuels. In this way, nuclear power can contribute to achieving the United Nations Sustainable Development Goals.

Besides the INIR missions it has already hosted, Bangladesh has requested that an Integrated Regulatory Review Service mission be conducted in 2022 to examine its legal and governmental framework as well as its regulatory infrastructure for nuclear safety. The IAEA also completed a Technical Safety Review — Design Safety peer review of selected parts of the plant's design safety documentation in 2018. Additional peer reviews are also expected, including a final INIR phase 3 mission shortly before reactor operations commence.

"Nuclear power will play a pivotal role in helping us meet our growing energy needs for Bangladesh's multifaceted development programme."

— Mohammad Shawkat Akbar, Project Director, Bangladesh Atomic Energy Commission

Nuclear science and technology support Viet Nam's development

By Puja Daya

Improved hospital capacities, cleaner rivers and higher yielding crops are just some of the myriad benefits nuclear technology has brought to Viet Nam in recent years.

"Nuclear techniques and science are powerful tools for the country, and Viet Nam's growing commitment to these proven applications will continue to provide benefits."

— Petra Nabil Salame, Programme Management Officer for Viet Nam, IAEA

"The Government of Viet Nam confirms its consistent policy of atomic energy application for peaceful purposes to reap the many benefits of this technology for the country's socio-economic development," said Tran Bich Ngoc, Executive Deputy Director General of the Vietnam Atomic Energy Agency.

Since joining the IAEA in 1957, Viet Nam's cooperation with the IAEA has continuously strengthened. In 2018, the Viet Nam Atomic Energy Institute was designated as an IAEA Collaborating Centre for water and the environment. It applies nuclear and isotopic techniques in integrated watershed and coastal area management for socio-economic development.

For years the Nhue River in Viet Nam suffered from excessive plant and algae growth to the extent that fishing, tourism and irrigation were affected. This threatened the well-being of over 200 000 people. Using stable isotopes, Vietnamese experts supported by the IAEA and the Food and Agriculture Organization of the United Nations (FAO) identified excessive fertilizer use on nearby farms as the culprit. Farmers have since changed their fertilizer practices, which has led to reduced run-off and pollution and improved water quality.

Enhancing food security and safety

Pollution is but one worry for Viet Nam's waterways; the Mekong River is severely affected by drought and increasing salinity. Climate change is exacerbating these problems and threatening food security. Through seed irradiation, Vietnamese scientists have developed new varieties of rice that are drought tolerant and higher yielding, which has benefited over 300 000 farmers.

In 2019, Viet Nam irradiated on average 200 tonnes of fresh export fruits per week to protect produce from pests and retain its nutrients, flavours, textures and colours — a prerequisite for export. With the help of the IAEA and the FAO in using such techniques, experts in Viet Nam are making sure their country does not suffer the financial consequences of import bans.

Improving cancer care

Cancer is a major cause of death and a burden on Viet Nam's health care system, which, until a few years ago, lacked radiotherapy equipment and a cancer control network. In 2018, the World Health Organization (WHO) announced that Viet Nam suffered from approximately 165 000 cancer cases and 115 000 cancer-related deaths per year.

Acting on this, in 2019, the country's Ministry of Health and the World Bank reached out to the IAEA for help. The IAEA offered advice to improve cancer care by establishing radiology and radiation oncology facilities and by providing training for health professionals in the latest treatment technologies.

"A few years ago, members of an IAEA and WHO joint mission helped the Government to increase awareness of and support for

cancer control, as well as the capacity of the current system for cancer control," said Pham Thi Quynh Nga, a WHO Technical Officer. With the help of the IAEA, the World Bank and the WHO, Viet Nam now provides its citizens with a comprehensive range of cancer care services, with 44 radiotherapy facilities across the country.

Controlling the spread of animal and zoonotic diseases

Thanks to quick action by the IAEA, the FAO and Viet Nam's National Centre for Veterinary Diagnosis (NCVD), the country's pork industry escaped a devastating wave of African swine fever (ASF) in 2019. Immediately after the news of the ASF outbreak in China, the Joint FAO/IAEA Centre of Nuclear Techniques in Food and Agriculture trained veterinary experts in Viet Nam in diagnosing infectious animal diseases. With this knowledge, Vietnamese experts were able to diagnose ASF early and implement measures to protect pig farms.

Alongside ASF, Viet Nam was exposed to lumpy skin disease — a disease which affects cattle, reducing milk production and rendering them unfit for consumption. Through knowledge sharing via the IAEA's Veterinary Diagnostic Laboratory (VETLAB) Network, experts at the Joint FAO/IAEA Centre are working with Vietnamese laboratories, researchers and veterinary authorities to better understand and stop the spread of the virus that causes the disease.

The IAEA's Zoonotic Disease Integrated Action (ZODIAC) initiative seeks to address zoonotic diseases through collaboration between human and animal health experts. Viet Nam plays an active role in the identification, monitoring, tracing and early detection of zoonotic disease pathogens, and is participating in global interventions and responses to potential outbreaks.

"The many ways in which the IAEA assists Viet Nam — through its programmes, initiatives and projects — supports sustainable development," said Petra Nabil Salame, Programme Management Officer for Viet Nam at the IAEA. "Nuclear techniques and science are powerful tools for the country, and Viet Nam's growing commitment to these proven applications will continue to provide benefits."

Renovating for the future

The Renovation of the Nuclear Applications Laboratories (ReNuAL) project was launched by the IAEA at the request of countries in order to upgrade infrastructure and provide new space and equipment for the IAEA's eight nuclear applications laboratories in Seibersdorf, Austria. As of the end of November 2021, more than 40 countries have made contributions to the construction, modernization and refurbishment of the laboratories. The project is expected to be completed in early 2024, if the remaining €6.7 million needed for the project can be raised by the time of the contract signing in 2022.

ReNuAL 2, the last phase of the project, builds upon previous ReNuAL activities, including the opening of the new Insect Pest Control Laboratory building and the Yukiya Amano Laboratories building, which houses the Animal Production and Health Laboratory, the Food and Environmental Protection Laboratory, and the Soil and Water Management and Crop Nutrition Laboratory. Under ReNuAL 2, a modern building will be constructed to house the Plant Breeding and Genetics Laboratory, the Terrestrial Environment Laboratory and the Nuclear Science and Instrumentation Laboratory. The construction of new and improved greenhouses and the refurbishment of the Dosimetry Laboratory facilities are also taking place.

How developing countries are helping each other use nuclear technologies

By Elodie Broussard

Thanks in part to their active collaboration with the IAEA over decades, many developing countries have significantly enhanced their capacities in nuclear technology and have been using these technologies to reach their development goals. Some of these countries are now able to support other developing countries through a framework known as South–South cooperation.

South–South cooperation refers to technical cooperation support between developing countries. It covers many areas of the United Nations development agenda, such as agricultural development, health and climate change, and is of growing importance in addressing global challenges.

"The COVID-19 pandemic is the most complex immediate challenge facing our world and it is undermining hard-won social, economic and environmental gains. In such trying times, the solidarity that underpins South–South cooperation has once again proven vital for developing countries," said United Nations Secretary-General António Guterres on the 2021 International Day for South–South Cooperation. "As the world seeks to ramp up COVID-19 response and recovery and tackle the existential threat of climate change, South–South and triangular cooperation is more essential than ever."

As part of the IAEA's contribution to global efforts to achieve sustainable development, in March 2019, on the occasion of the Second High-level United Nations Conference on South–South Cooperation, the IAEA reiterated its commitment to expanding South–South cooperation in the use of peaceful nuclear technologies. Indonesia is one of the countries now actively supporting this approach.

"For over 60 years, Indonesian experts have been working with the IAEA to build their nuclear capacities," said Jane Gerardo-Abaya, Director of the IAEA's Division for Asia and the Pacific. "Now, as a developing country with a high level of expertise, Indonesia has become a resource for neighbouring countries and is helping to promote regional self-reliance and strengthen local ownership of nuclear science and technology."

In February 2018, Indonesia's Ministry of Research and Technology signed Practical Arrangements with the IAEA to strengthen its support for other countries. Indonesian experts, in part through IAEA technical cooperation projects, have transferred

Scientists conducting research during their fellowships hosted in Indonesia. (Photo: BATAN)

knowledge to and advised experts from several countries in Africa and in Asia and the Pacific. Between 2016 and 2019, 43 scientists from African and Asian countries benefitted from fellowships and training at Indonesian nuclear science institutions, and during the same period, 29 experts from Indonesia contributed to IAEA projects in Africa and in Asia and the Pacific.

Indonesia will play a key role in the IAEA's new Nuclear Technology for Controlling Plastic Pollution (NUTEC Plastics) initiative. NUTEC Plastics provides a platform for cooperation to combat plastic pollution and leverage the resources, knowledge and networks of participating countries. Indonesia is aiming to reduce its marine litter by 70 per cent in the next four years. With support from NUTEC Plastics, it plans to build a pilot facility that uses irradiation to recycle plastics, and will share its gained expertise with specialists from other countries.

"Indonesia has widely benefitted from the IAEA technical cooperation programme, ranging from human resources capacity building to equipment and facilities development. This programme has enabled Indonesia to advance its capabilities in research, development and the use of nuclear technologies in various fields, such as food and agriculture, health and nutrition, water and environment, and industrial applications," said Dimas Irawan, Science Attaché at the Indonesian Embassy in Vienna. "With the knowledge and experience gained, we can now support other countries."

New crop varieties

The IAEA has supported scientists from Indonesia's National Nuclear Energy Agency (BATAN) in developing new crop varieties that enable local farmers to increase productivity despite adverse weather and soil conditions. BATAN's Center for Isotopes and Radiation Application (CIRA) has developed a wide variety of plants using seed irradiation techniques, receiving awards from the IAEA Director General in 2014 and 2021 for its outstanding achievements. In 2017, CIRA became an IAEA Collaborating Centre and an active hub for South–South knowledge transfer.

CIRA has hosted fellowships, scientific visits and training courses on food and agriculture to expand the expertise of scientists from Africa and from Asia and the Pacific. In 2017, Mozambican technicians were hosted at CIRA to conduct trials on new strains of climate-smart cereal crops that could improve yields in Mozambique.

"The training provided me with the skills and knowledge to support the production of promising new varieties of sorghum in Mozambique," said Nelson Moiana, one of the technicians involved in the training. "Sorghum has a great potential to help farmers increase their income and to stimulate economic growth in rural areas. Its cultivation also contributes to better soil management and sustainable agriculture development."

Health

In 2018 and 2019, regional training courses on human health took place at the BATAN laboratory and the Dharmais Cancer Center Hospital in Jakarta within the framework of the African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology — one of the four IAEA regional cooperation agreements that support South–South cooperation. The training courses were attended by medical practitioners from Algeria, Burkina Faso, Cameroon, Egypt, Ethiopia, Mauritius, Morocco, Niger, Nigeria, Senegal and South Africa. These were in addition to other training courses held at the Dharmais Cancer Center Hospital that welcomed fellows in nuclear medicine and diagnostic imaging from Zambia.

Management of radioactive waste

In the field of radioactive waste management, researchers from Bangladesh, Cambodia, Libya, Mongolia, Myanmar, Nepal and the Palestinian Territories have taken part in several fellowships and scientific visits hosted in Indonesia. This enabled the researchers to learn how to better manage disused sealed radioactive sources originally used in medicine, agriculture, industry and research, that can be a threat to human health and the environment if not properly controlled.

"The Indonesian Government will uphold its commitment to continued cooperation with the IAEA, including sharing expertise and knowledge with other Member States through various cooperation channels," Irawan said.

"Indonesia has widely benefitted from the IAEA technical cooperation programme, ranging from human resources capacity building to equipment and facilities development. […] With the knowledge and experience gained, we can now support other countries."

— Dimas Irawan, Science Attaché, Permanent Mission of Indonesia to the UN in Vienna

Fully stocked and operational

IAEA LEU Bank provides reserve of main ingredient of nuclear fuel

By Nicole Jawerth

The IAEA's Low Enriched Uranium (LEU) Bank is now fully stocked and operational. Owned by the IAEA and hosted by Kazakhstan, the IAEA LEU Bank aims to provide assurance to countries and to serve as a mechanism of last resort in case the supply of LEU to a nuclear power plant is disrupted due to exceptional circumstances and a Member State is unable to secure LEU from the commercial market or by any other means.

LEU is the basic ingredient in the fabrication of nuclear fuel. It is made by enriching naturally occurring uranium to make it suitable for energy production.

In October and December 2019, shipments of LEU arrived at the Ulba Metallurgical Plant (UMP) in Ust-Kamenogorsk, Kazakhstan. These shipments completed the LEU Bank's stock of 90 tonnes of LEU, typically sufficient for one fuel load of a 1000 megawatt (MWe) Light Water Reactor's core or three core reloads.

"I am very pleased that the IAEA met the challenge and delivered on what the international community requested," said IAEA Director General Rafael Mariano Grossi.

Ambitious undertaking

The LEU Bank is one of the IAEA's most ambitious undertakings since the IAEA was founded in 1957. Since the decision by the Board of Governors in 2010 to establish the Bank, bringing the LEU Bank project to fruition required concerted efforts involving many areas of the IAEA's activities. The project included:

- Negotiating a legal framework for the IAEA LEU Bank with Kazakhstan and the operator, the Ulba Metallurgical Plant (UMP), in the eastern city of Ust-Kamenogorsk;
- Designing and building an LEU storage facility, in line with IAEA safety standards and security guidance;
- Supporting the Government of Kazakhstan in enhancing its legal and regulatory framework in relation to the facility;
- Concluding transit agreements with China and Russia for the transport of the LEU to and from the site, as well as separate transport contracts with transport companies in China, Kazakhstan and Russia, China; and
- Acquiring 90 tonnes of LEU, from two vendors, in what was the IAEA's largest single procurement undertaking to date.

Here, for the first time since the cylinders were filled with LEU at the Orano Cycle facility in France, their UX-30 Overpack protective packing was removed to prepare them for acceptance and final storage at the IAEA LEU Bank.
(Photo: Katy Laffan/IAEA)

The first LEU shipment from French nuclear company Orano was transported by truck to a French port, by ship to Russia, and then by train to Kazakhstan. Upon arrival at the site, the 32 cylinders of LEU were checked by IAEA experts on the ground.

"Because of the long journey, it took more than four weeks to transport the LEU to the site. It required coordination among many players," said Marta Ferrari, who was in charge of the project at the time of the fuel transport in 2019. "We gained valuable experience, as well as confidence, that we can use this transport route in case a country requests a supply of LEU."

For the second shipment, Kazakhstan's Kazatomprom, the world's largest producer of natural uranium, delivered 28 cylinders of LEU to the facility at the UMP. The uranium, which originated from Kazakhstan, was enriched at a facility in Russia and the LEU was transported by train to the site in eastern Kazakhstan, where it was checked and officially accepted by IAEA experts.

Establishment and operation

The establishment and operation of the IAEA LEU Bank are fully funded by voluntary contributions from IAEA Member States and other donors, who initially pledged US $150 million to cover set up and estimated operational costs until 2036. Donors include the European Union, Kazakhstan, Kuwait, Norway, the Nuclear Threat Initiative, the United Arab Emirates and the United States of America. Kazakhstan also contributed in kind by hosting the IAEA LEU Bank.

UMP, as the facility operator, has the prime responsibility for the safety and security of the IAEA LEU Bank and will apply IAEA safety standards and nuclear security guidance documents. "The IAEA will continue to actively manage the LEU Bank to ensure that the LEU is ready to ship in a timely manner should a Member State, meeting all conditions, request delivery," said Mikhail Chudakov, IAEA Deputy Director General and the Project Executive for the IAEA LEU Bank. This includes recertification of the sixty 30B cylinders that contain the LEU at a prescribed frequency to ensure that the cylinders meet the requirements for international transport, he added. Recertification of the 30B cylinders is based on the revised ISO Standard for the transport of uranium hexafluoride (ISO 7195:2020).

Other assurances of supply mechanisms established with the IAEA's approval include a guaranteed physical reserve of LEU maintained by the Russian Federation at the International Uranium Enrichment Center in Angarsk, Russian Federation, and an assurance of supply guaranty by the United Kingdom for supplies of LEU enrichment services.

LEU is used in nuclear power reactors. Globally, as of 2021, there are around 440 nuclear power reactors in operation, supplying about 10 per cent of the world's electricity and more than a quarter of all low-carbon electricity. In addition, 51 nuclear power reactors are under construction.

Minimizing the use of high enriched uranium

With the aim of reducing security and proliferation risks, over the past few decades the IAEA has helped countries to convert research reactor fuels from high enriched uranium (HEU) to low enriched uranium (LEU). This is part of global efforts, coordinated by the IAEA, to minimize the civilian use of HEU, an ingredient that can be used to create a nuclear device intended for malicious use.

Most of today's research reactors were built in the 1960s and 1970s for use in science, industry, education and training. Technology at the time required HEU to perform experiments for scientific research, but today much of this research can be carried out using LEU, in which the concentration of uranium-235 is below 20%.

The IAEA has supported HEU to LEU fuel conversions, as well as HEU repatriations, in 21 countries. It has also supported HEU minimization through technical cooperation projects, fact-finding missions, coordinated research projects, Technical Meetings, consultancy meetings and procurement assistance.

The most recent conversion took place in Nigeria in December 2018.

IAEA course builds capacity to manage nuclear or radiological incidents and emergencies

By Joanne Liou

"We have two ways to learn how to respond to a radiation emergency: through training and exercises or by responding to a real emergency."

— Raul dos Santos, Head, Emergency Division, National Nuclear Energy Commission, Brazil

Responders to nuclear or radiological incidents and emergencies play a pivotal role in protecting people and the environment. In order to do this effectively, responders need to know which steps to take and when. That's where training and preparedness come in, which is an area of work supported through the IAEA's Peaceful Uses Initiative (PUI) (see Box on page 21).

"Despite precautions taken during the design and operation of nuclear installations, as well as advances in science and technology, a failure, intentional act or mishap could lead to an emergency involving radioactive sources," said Raul dos Santos, Head of the Emergency Division of Brazil's National Nuclear Energy Commission (CNEN). "Members of civil protection services, fire departments, law enforcement, medical services, etc. need to receive continuous education on how to identify a radiation emergency and implement protective measures."

To help responders develop and maintain the relevant skills, the IAEA's School of Radiation Emergency Management provides training to strengthen national, regional and international capacities to respond to nuclear or radiological incidents and emergencies, such as an accident during the transport of a radioactive source or the misuse of radioactive material.

Since the launch of the School in 2015, the IAEA has held 12 training courses in 9 countries, which have been attended by nearly 500 participants from 80 countries. The comprehensive two-to-three-week course covers all aspects of emergency preparedness and response (EPR).

The School was designed by the IAEA to provide participants with a comprehensive understanding of the basic principles of nuclear or radiological EPR based on IAEA safety standards and associated technical guidance. The IAEA's Incident and Emergency Centre is the global focal point for international EPR for nuclear and radiological incidents and emergencies regardless of their cause, such as an accident or a malicious act.

"During the course, participants discuss how to address the main aspects of EPR at national and local levels, which they then take back to their countries and use in their roles as regulators, operators, municipality workers or emergency responders, such as firefighters or law enforcement officers," said Svetlana Nestoroska Madjunarova, Emergency Preparedness Coordinator at the IAEA. "The School is aimed at supporting Member States in developing a cadre of professionals trained to handle different aspects of EPR as required in the international safety standards in the area."

Participants complete an initial mandatory e-learning module and test, which complements lectures, practical exercises, discussions on case studies and visits to

different facilities. The curriculum covers topics such as all-hazards emergency management system, protecting the public and emergency workers, providing information to the public, monitoring and mitigating radiological and non-radiological consequences.

Learning from the past

Participant feedback has helped to continuously improve the School. One such change has been the addition of more case studies for experiential learning based on real events.

"History demonstrates that an emergency involving radioactive sources can occur in any country around the world, and it is of paramount importance to be prepared to face any radiation emergency," dos Santos said. "We have two ways to learn how to respond to a radiation emergency: through training and exercises or by responding to a real emergency."

During a regional training course held in Rio de Janeiro in 2019, 36 participants from 15 countries across Latin America and the Caribbean took part in a radiological emergency exercise based on the 1987 Goiânia accident in Brazil. The School, hosted by CNEN and delivered through the IAEA technical cooperation programme, was funded by the PUI.

"The use of case studies can facilitate the students' awareness of many different aspects of preparedness and response. Lessons identified during the response to emergencies and accidents can save lives," said dos Santos, who was also one of the nine Spanish-speaking lecturers at the School in Rio de Janeiro.

Due to the pandemic, the School was not held in 2020 and 2021. The next School for the Latin America and the Caribbean region is planned for 2022. Further Schools are also being planned for experts from countries in regions around the world, such as small island developing States from the Caribbean and the Pacific, as well as for countries in Africa and Europe.

By the end of the School, participants not only gain competence in EPR management, but they also gain a network of fellow EPR leaders. "We realize that these training programmes create a space where professional links are developed," Nestoroska Madjunarova said. "A community is created, and participants continue to stay in touch and exchange information and experiences after the School, which will improve knowledge sharing and cooperation among EPR professionals from different Member States and, consequently, contribute to improved harmonization globally."

PEACEFUL USES INITIATIVE

IAEA Peaceful Uses Initiative (PUI) funds IAEA projects for the peaceful uses of nuclear technology. It originated at the 2010 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), when the United States of America proposed to raise US $100 million over the following five years for IAEA activities in support of development.

Now firmly established as an important vehicle to mobilize extrabudgetary contributions to support unfunded IAEA activities, including technical cooperation projects, the PUI has greatly helped the IAEA implement its work relevant to Article IV of the NPT, which covers the peaceful use of nuclear energy.

The PUI is now also supported by 25 IAEA Member States, the European Commission, and a private corporation, and has received in total more than €200 million in contributions (as of December 2021). It has supported over 400 projects in more than 150 countries, in areas including food security, water resource management, human and animal health, nuclear power infrastructure development, and nuclear and radiation safety.

Furthermore, multi-year pledges for the PUI by several Member States have helped the IAEA sustain long-term, large-scale projects, and respond quickly and flexibly to emergencies and the evolving and emerging priorities of Member States, such as the responses to the Ebola and Zika viruses, natural disasters, and the COVID-19 pandemic.

Nuclear safety and security

Key to Moldova's success with nuclear science and technology

Nicole Jawerth

Protecting people, property and the environment is the goal of a country's nuclear safety and security infrastructure. One of the major benefits of robust safety and security systems and measures is increased and sustainable access to peaceful nuclear science and technology.

"One of the essential elements for introducing new nuclear technology or receiving a technical assistance project is the existence of a robust legal and regulatory framework for nuclear-related activities, in line with IAEA standards and guidance," said Angela Sidorencu, senior specialist in the Safeguards and Nonproliferation Department of Moldova's National Agency for Regulation of Nuclear and Radiological Activities until 2020.

"Without IAEA technical assistance projects, Moldova wouldn't, for example, have access to new technologies in radiotherapy and nuclear medicine for diagnosing and treating cancer and other diseases, and we would not have been able to improve quality assurance in all areas of radiodiagnostics and radiotherapy," Sidorencu said.

Like many countries, Moldova has radioactive material, as well as small quantities of nuclear material. It uses these materials in medical and industrial applications, as well as in science and research, and the country also has radioactive waste management facilities.

Over 15 years ago, Moldovan experts began working with the IAEA to strengthen the country's legal and regulatory infrastructure for the safety and security of radioactive and nuclear material.

"In 2006, we recognized that the existing legal and regulatory framework was not providing adequate control over activities involving radiation sources," Sidorencu said, explaining how, at the time, the assignment of responsibilities among authorities was unbalanced and split, legislation was not fully in line with IAEA safety and security documents, and there was no established inventory of radioactive sources.

The support provided to Moldova by the IAEA is related to all aspects of establishing a legal and regulatory framework for safety and security based on IAEA standards and guidance. The IAEA has provided courses to build specialists' skills and knowledge in radiation protection and nuclear security for both the regulation and operation of nuclear technologies and facilities.

There are currently three ongoing IAEA technical cooperation projects in Moldova. These include projects to improve radiotherapy services in the country's Oncology Institute, to establish capacities for isotope hydrology techniques for improved water resource management and climate change impact evaluation, and support in decommissioning a near surface radioactive waste facility and remediating the environment.

This IAEA donated vehicle has advanced features that supports Moldova in enhancing its transport security capabilities.
(Photo: D. Sirgedas/Polimaster)

Integrating nuclear security

In 2008, through its collaboration with the IAEA, Moldova became one of the first countries to establish an Integrated Nuclear Security Support Plan (INSSP). INSSPs are designed to help national authorities identify and prioritize the country's needs and establish an effective and sustainable national nuclear security regime.

"Our experts worked with the Moldovan authorities to design an INSSP that could not only help them address the physical protection of radioactive material, but could also establish comprehensive measures to ensure that material would be detected if lost or stolen," said Scott Purvis, Section Head of the Information Management Section of the IAEA's Division of Nuclear Security.

INSSPs cover all aspects of nuclear security, such as legislative and regulatory frameworks, threat and risk assessment, and physical protection regimes, along with the detection of and response to criminal and unauthorized acts involving lost or stolen material. INSSPs are periodically reviewed and updated to help the country maintain the plan's relevance and sustainability over time.

"One of the key priorities of our INSSP is the security of radioactive material, as our goal is to make sure that nuclear and radioactive material does not fall into the wrong hands," Sidorencu said.

With the INSSP as a basis, Moldovan authorities have worked with the IAEA and other partners, such as counterparts in Germany, Sweden and the United States of America, both to train staff and to upgrade equipment and facilities to ensure the safety and security of radioactive sources both in use or requiring recovery, transport and storage, which is a further priority of the country's INSSP. Since 2008, Moldova has safely and securely recovered more than 8000 radioactive sources.

Adhering to international legal instruments

For a country to access the many benefits of nuclear technology, proper legal and regulatory infrastructure relating to nuclear and radioactive material needs to be in place. A robust international legal framework exists for nuclear safety and security. It is composed of treaties, conventions and agreements, which define rules and standards for the safe, secure, sustainable and peaceful use of nuclear energy.

The IAEA informs and advises countries on these relevant international legal instruments. It also coordinates workshops and meetings within the framework of the IAEA's legislative assistance programme in order to support countries in establishing and enhancing their legal frameworks.

One important nuclear security treaty is the Convention on the Physical Protection of Nuclear Material (CPPNM), along with its Amendment. The original Convention establishes measures related to the protection of nuclear material used for peaceful purposes while in international transport, as well as the prevention and detection of, and response to, offenses involving nuclear material. It further provides for international cooperation in the case of, for example, theft, robbery or any other unlawful taking of nuclear material or credible threat thereof, as well as in the design of physical protection systems.

The Amendment, which entered into force in 2016, extends the scope of the CPPNM to cover nuclear facilities and nuclear material used for peaceful purposes in domestic use, storage and transport. It also addresses criminal offenses related to illicit trafficking and sabotage of nuclear material or nuclear facilities, and strengthens international cooperation. The Convention and its Amendment are the only legally binding international undertakings in the area of the physical protection of nuclear material.

To date, 164 countries have joined the Convention and, of these countries, 127 have joined the Amendment. The Conference of the Parties to the Amendment to the Convention on the Physical Protection of Nuclear Material (A/CPPNM), planned to take place from 28 March to 1 April 2022, will mark just over five years after entry into force of the Amendment, a major milestone in the development of the international legal framework for nuclear security.

The IAEA at the NPT Review Conference
A historical overview

By Ionut Suseanu

The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) was opened for signature in 1968 and entered into force in 1970. As set out in Article VIII of the Treaty, the Parties agreed to regularly monitor the implementation of the NPT and hold a conference to review the operation of the Treaty five years after its entry into force, with further conferences every five years. The IAEA, which has a major verification role under the Treaty and facilitates international cooperation in peaceful nuclear uses, has participated in this review process, and its roles and contributions have been recognized by the Parties at all NPT Review Conferences.

Ahead of the first Review Conference, held in 1975, the IAEA prepared a technical report on its activities in connection with Article III (on safeguards), as well as working papers on its activities under Article IV (on peaceful nuclear cooperation) and Article V (on nuclear explosions for peaceful purposes).

The IAEA report on Article III dealt essentially with Agency safeguards under the NPT, made a brief comparison with non-NPT safeguards, discussed financing of safeguards and provided financial and statistical data on the situation as at 31 December 1974. Moreover, it reproduced communications received in relation to exports of nuclear material and included a brief discussion of physical protection measures. The report on Article IV described the IAEA's activities between 1964 and 1974 relating to technical assistance, the exchange of equipment and

An IAEA Safeguards Equipment exhibit at the 1975 NPT Reveiw Conference in Geneva. (Photo: IAEA)

material, the exchange of scientific and technical information and international cooperation. The report on Article V described the history of the IAEA's work on peaceful nuclear explosions, starting with the establishment of an ad hoc committee by the Board of Governors in 1969.

The IAEA continued to submit reports on its activities under Articles III and IV to each of the subsequent eight Review Conferences. As the IAEA's work on nuclear explosions for peaceful purposes was finished in 1977, a report for the years 1976–1977, updating the information presented at the first NPT Review Conference, was presented at the second Review Conference and then discontinued.

The IAEA Director General continued to address the NPT Review Conferences and refer to their outcome and possible impact on IAEA programmes and activities in statements to the IAEA's Board of Governors.

In a statement to the June 1995 Board of Governors meeting, Director General Hans Blix informed the Board that the IAEA's Secretariat had submitted reports to the 1995 NPT Review and Extension Conference on the IAEA's activities of relevance to the NPT, had described the IAEA's safeguards and technical cooperation activities to the Conference, and had made staff available to the Conference Secretariat throughout the Conference. The Director General also said that, during the Conference, the IAEA had been expressly recognized as the competent authority responsible for verifying and ensuring compliance with safeguards agreements. Additionally, the Conference had called for support for the IAEA Board of Governor's actions designed to strengthen safeguards, as well as for an increase in the IAEA's capability for detecting undeclared nuclear activities. There had also been a recommendation that nuclear material released from military use be placed under IAEA safeguards as soon as practicable.

In his statement to the June 2000 Board of Governors meeting, Director General Mohamed ElBaradei said that the 2000 NPT Review Conference had requested the IAEA to continue to identify the financial and human resources needed to effectively and efficiently meet all of its responsibilities, and had strongly urged all States to ensure that the IAEA was provided with those resources.

In his statement to the June 2005 Board of Governors meeting, Mr ElBaradei noted with regret the inability of the States party to the NPT to agree on how to strengthen the implementation of the Treaty and that, despite the outcome, challenges remained and had to be addressed. He also mentioned a need to universalize the IAEA's authority under the additional protocol, tighten control over and dissemination of proliferation sensitive aspects of the nuclear fuel cycle while ensuring supply, enhance mechanisms for dealing with non-compliance and accelerate progress towards nuclear disarmament.

In his statement to the June 2010 Board of Governors meeting, Director General Yukiya Amano welcomed the fact that the 2010 NPT Review Conference had unanimously adopted Conclusions and Recommendations for Follow-on Actions in the three areas related to IAEA's activities and that it was very encouraging that a call had been made to all States parties to the NPT to ensure that the IAEA continued to have all the political, technical and financial support it needed in order to effectively meet its responsibilities.

In 2015, Mr Amano told the Board that he welcomed the strong support expressed by NPT States Parties for the work of the IAEA during the 2015 NPT Review Conference. He also mentioned that despite the absence of a final document at the NPT Review Conference, he was confident that the States Parties would continue their work to achieve the objectives of the Treaty and that the IAEA remained ready to make its expertise available, as requested.

At the forthcoming 2020 NPT Review Conference, scheduled for 2022, Director General Rafael Mariano Grossi will deliver a statement on the IAEA's relevant work in implementing NPT Articles III and IV. Background papers submitted to the Conference, elaborate on the IAEA's efforts since the 2015 NPT Review Conference to verify States' compliance with their safeguards agreement, and IAEA support in fostering international cooperation in the peaceful uses of nuclear energy. The papers also summarize the IAEA's response to the COVID-19 pandemic, which includes the continued implementation of safeguards, and assistance to countries in the rapid detection and surveillance of the SARS-CoV-2 virus.

Verifying States' non-proliferation obligations — past, present and into the future

By Massimo Aparo, IAEA Deputy Director General and Head of the Department of Safeguards

Massimo Aparo is Deputy Director General and Head of the IAEA Department of Safeguards. Mr Aparo has worked at the IAEA since 1997, serving as Acting Director of the Office for Verification in Iran, Section Head in the Division of Technical and Scientific Services, and as Head of the Tokyo Regional Office in the Division of Operations A. Before the IAEA, he worked for an Italian company in the area of radiation detection and monitoring, in the European Space Agency and at Italy's former National Committee for Nuclear Energy.

Both 2020 and 2022 are important milestones for the global nuclear non-proliferation regime. In 2020, the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) turned 50, after decades of helping to stop nuclear proliferation. In 1963, US President Kennedy cautioned the possibility in the 1970s of a world in which up to 25 nations could have nuclear weapons. Thanks to the NPT, this never came to be.

For the IAEA, 2022 marks the 50th anniversary of the first safeguards agreements in connection with the NPT. These agreements entrusted the IAEA with unique rights of access to States to verify their exclusively peaceful use of nuclear material and technology. The IAEA provides reassurance — at country, regional and global levels — that States are in compliance with their safeguards obligations. 2022 also marks the 25th anniversary of the adoption of the Model Additional Protocol, on which additional protocols (APs) are based. APs are vital instruments that provide the IAEA with more access to locations and information, enabling us to better detect undeclared nuclear material and activities.

These anniversaries offer a unique moment to celebrate achievements and reflect on experience gained and, perhaps most importantly, prepare for what lies ahead. The past five decades have witnessed developments with significant impacts on the nuclear non-proliferation regime and on IAEA safeguards. Adaptation has been key to success.

Nuclear verification has always evolved according to the changing operating environment, lessons learned and States' expectations. Often, changes in safeguards have come in response to — rather than anticipation of — developments, such as the discovery of undeclared nuclear material and activities, which led to the adoption of the Model Additional Protocol.

While the Model Additional Protocol's importance is often recalled in the historical context of lessons learned in the early 1990s, its strategic importance should be better understood in the current and future contexts of providing necessary transparency about nuclear-related activities. By adopting APs, States build confidence and lay a strong foundation for nuclear cooperation, which is anticipated to expand in response to climate concerns. Already in 2000, the NPT Review Conference recognized AP measures as an integral part of the IAEA's safeguards system. More than two decades later, it is now time to make that a reality for all.

More than 15 years ago, the IAEA approved the revised small quantities protocol (SQP) to address a weakness in the safeguards system. Without States' nuclear material declarations and the possibility of in-field verification activities, the IAEA's ability to draw soundly based safeguards conclusions is increasingly challenging. The old SPQs are simply no longer adequate.

Tomorrow's dynamic environment calls for the strongest possible safeguards. Everyone has a role to play, from States with a limited amount of nuclear material to those with advanced nuclear fuel cycles. Although the IAEA is often portrayed as the 'nuclear watchdog', safeguards implementation in reality is a cooperative effort. To prepare for new challenges and bridge the gap between a growing workload and limited resources, the IAEA actively monitors emerging technologies and explores innovations to stay ahead of the game.

For continued success, the IAEA needs States' political, technical and financial support. In rendering that support, States should not only consider the past and present, but also the future.

How can we achieve gender breakthroughs in nuclear negotiations and technical cooperation?

"Our power structures have evolved gradually over thousands of years. One further evolution is long overdue. The 21st century must be the century of women's equality." *— António Guterres, United Nations Secretary-General*

Today, it is undisputable that women, as well as men, have a right to participate in international security discussions and shape the decisions that will affect their lives. For a long time, however, women were often barred from holding professional positions across sectors, and foreign ministries were no exception.

For those countries that did have women in foreign service, many had formal restrictions on women's roles in diplomatic service. In certain cases, it was only in the 1970s that some countries lifted their so-called marriage bans, which required women to choose between marriage and a foreign service career.

Women have since come a long way, but despite making up 50% of the world's population, they continue to be marginalized and under-represented when it comes to dealing with international security issues. Ideas about who and what makes 'good' policy in nuclear security and non-proliferation are still strongly linked to masculinized norms, according to Still Behind the Curve, a study published in 2019 by UNIDIR.

In this study, surveys of more than 80 multilateral meetings on arms control, non-proliferation and disarmament spanning 40 years reveal patterns and trends related to gender balance in forums dealing with weapons and technology for both peaceful and military aims. Some of the findings show that:

- Women comprise only one third of diplomats accredited to arms control, non-proliferation and disarmament forums.

- In smaller, more specialized forums, the average proportion of women drops to around 20%.

- The ratio between gender composition and the size of a given meeting may correlate, in part because countries typically select men when they can only send a single representative, while women are selected as second, or more often, third or fourth members of a delegation.

- Men are over-represented as heads of delegations to a greater degree than would be expected given the overall proportion of men in a meeting. For instance, at the 2019 session of the Preparatory Committee for the Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT PrepCom), approximately 76% of heads of delegations were men and 24% were women, while overall attendees comprised 71% men and 29% women.

To put these numbers into context, the study included focus group discussions with diplomats in New York, Vienna and Geneva to look at the institutional culture of arms control and disarmament diplomacy. The participants shared their perception that the field has rewarded characteristics, expertise and experiences that are more commonly associated with men, such as toughness, seriousness, risk-taking and military training.

These ideas and norms could explain some of the difficulties that women face when pursuing careers in the nuclear field. They could also be part of what hinders diversity and prevents innovation. Studies indicate that diverse teams tend to be more innovative and effective in anticipating problems and finding sustainable solutions, and innovation is what the field of international security needs more of now to overcome stagnation in arms control and effectively address opportunities and challenges posed by emerging technologies.

Renata H. Dalaqua, Programme Lead for Gender & Disarmament at the United Nations Institute for Disarmament Research (UNIDIR). She is the lead author of Still Behind the Curve, a study on gender balance in arms control and disarmament published by UNIDIR in April 2019. Dalaqua holds a PhD in History and Politics from the Getulio Vargas Foundation and an MA in International Politics and Security from the University College London.

"Change isn't just about big headlines in newspapers, legal victories and international agreements; the way we plan and deliver everyday activities can create a ripple effect that benefits everyone."

— Renata H. Dalaqua, Programme Lead for Gender & Disarmament, United Nations Institute for Disarmament Research

Gender equality at NPT meetings

As State Parties look to the future of the NPT, it is important to ensure gender-balanced conferences featuring both women and men at the highest level.

Over the past few years, a growing number of NPT State Parties have stressed the importance of improving gender equality and promoting gender perspectives in the NPT review process. At the 2019 session of the NPT PrepCom, over 20 statements delivered on behalf of more than 60 State Parties addressed the relevance of gender perspectives to the NPT. Eight working papers submitted in 2019 included references to the links between nuclear affairs and gender, with three papers exclusively dedicated to this topic.

As gender mainstreaming gains momentum in the NPT, there is an opportunity to expand attention to incorporating gender perspectives into the work of NPT diplomats, as well as nuclear experts and practitioners.

At a national level, countries interested in promoting gender equality in their delegations could set objectives and directives to improve women's participation by providing more speaking roles in negotiations and promoting women in leadership positions. At a multilateral level, NPT State Parties could request the NPT secretariat to collect, track and publish gender-disaggregated data and statistics on gender balance in delegations.

Integrating gender analyses and perspectives

If gender imbalances are to be addressed, equal representation in decision-making needs to be complemented by gender analyses in nuclear policies and technical programmes. A gender analysis examines the relationships between women, men, girls and boys, including their access to and control of resources as well as the constraints they face.

Applying a gender analysis to all three pillars of the NPT could be useful for understanding how gender affects issues such as exposure to nuclear risk, the impact of ionizing radiation resulting from the use of nuclear weapons, the ability to benefit from the peaceful uses of nuclear energy, and access to education and training in the nuclear field. A sample framework proposed by a group of NPT State Parties at the 2019 session of the NPT PrepCom includes questions that could be considered during the development, implementation and review of actions related to these issues. This topic is likely to come up again at the 2020 NPT Review Conference in New York.

Further integrating gender analyses and perspectives into the IAEA's work could help to ensure that people's diverse needs are equally addressed when accessing and benefiting from nuclear technology and its products.

Change isn't just about big headlines in newspapers, legal victories and international agreements; the way we plan and deliver everyday activities can create a ripple effect that benefits everyone.

As the world enters the United Nations Decade of Action, with the aim of delivering on the United Nations Sustainable Development Goals, the IAEA's contribution to the 2030 Agenda for Sustainable Development could be further strengthened by promoting atoms for peace, development and gender equality.

Striving for gender balance in nuclear

Women are still far from being adequately represented in the nuclear field, and the IAEA is working to address this. In March 2020, the IAEA Marie Skłodowska-Curie Fellowship Programme (MSCFP) was launched to help increase the number of women in the nuclear field and support an inclusive workforce.

Named after pioneering physicist and double Nobel Prize laureate Marie Skłodowska-Curie, the programme seeks to enable and encourage highly motivated female students to pursue careers in nuclear technology, research, safety, security and other related fields.

"Equipping women with scientific education and work experience will promote equal representation in the application of nuclear technologies to meet our shared global challenges such as climate change, growing populations and food insecurity," said IAEA Director General Rafael Mariano Grossi, who initiated the MSCFP.

Annually, more than 100 female graduate students are awarded MSCFP scholarships for master's programmes in nuclear-related fields at accredited universities, along with the opportunity to pursue internships facilitated by the IAEA. When awarding MSCFP scholars, diversity of both geographic location and field of study is taken into consideration.

The importance of women in science

Scientific breakthroughs in nuclear-related fields have given the world previously unimaginable benefits. Marie Skłodowska-Curie's groundbreaking work on radioactivity in the late 1800s enabled us to harness the power of the atom and develop countless applications in medicine, engineering and science.

As the world faces pressures from a changing climate, growing populations, food insecurity and increased energy demand, maintaining a qualified workforce to drive innovation and productivity is crucial. Nuclear-related studies can help countries tackle several of these challenges, and the high demand for qualified professionals in nuclear-related fields will continue to grow.

With its unique mandate to accelerate and increase the peaceful uses of nuclear energy, the IAEA is at the forefront of research and technology transfer and depends on a stable pool of qualified technical professionals to fulfil its mission. This workforce does and must include women.

Women, however, often face barriers in entering and progressing in the fields of science, technology, engineering and mathematics. The MSCFP seeks to enable more women from around the world to pursue careers in the nuclear field and is building up gender-balanced capacities relevant to nuclear energy and other nuclear applications, nuclear safety and security, and non-proliferation.

More information about the IAEA Marie Skłodowska-Curie Fellowship Programme can be found at www.iaea.org/mscfp.

IAEA launches groundbreaking programme on methods for radiological and environmental impact assessment

The IAEA has launched a new programme to help countries further build their capacities for carrying out radiological environmental impact assessments. The programme — Methods for Radiological and Environmental Impact Assessment (MEREIA) — was launched in October 2021 and will run through to 2025. It aims to help countries apply assessment approaches, conceptual models, mathematical models and data within the broader context of environmental impact assessment.

"We are delighted to have launched the MEREIA programme to improve the quality and accessibility of the guidance we provide to countries in assessing the impact of radionuclides released into the environment," said Anna Clark, Head of the IAEA's Waste and Environmental Safety Section. "Increasing capability in this area will enable countries to make informed decisions about whether and how the impact of radionuclide releases should be controlled."

Environmental assessment models are used by operating organizations and regulators to simulate the release of radionuclides into the environment from facilities such as nuclear power plants and hospitals with nuclear medicine departments. These models are essential tools for understanding the potential impacts of such releases, including those of authorized discharges. Assessments also consider impacts on both people and wildlife, as well as other environmental, social and economic factors, including natural resources and food production.

The IAEA began supporting environmental assessment activities in the 1980s and has since run a series of programmes, the most recent being the Modelling and Data for Radiological Impact Assessments (MODARIA) programme, which ran from 2012 to 2019. MODARIA aimed to enhance the capabilities of countries to simulate the release of radionuclides into the environment and assess exposures to the public and wildlife. MODARIA had the direct participation of some 140 specialists from more than 40 countries.

MEREIA further develops the environmental assessment models and methodologies initiated by the MODARIA programme and aims to build international consensus on good practice in this area, under the umbrella of the IAEA safety standards. MEREIA also improves the resources within countries, not only through its modelling capacity, but also through a mentoring approach to enhance knowledge management. The MEREIA programme is intended for professionals from regulatory bodies, operating organizations and technical support organizations, as well as scientists, researchers, decision makers and others with responsibilities for carrying out radiological environmental impact assessments.

"MEREIA's aim is to provide an international forum to bring experienced and less experienced individuals together from countries in different regions," said Joanne Brown, Head of the IAEA's Assessment and Management of Environmental Releases Unit. "The MEREIA programme will provide a unique interactive setting to strengthen the development of young professionals through a series of workshops and opportunities for writing technical papers and presenting scientific results at the MEREIA meetings."

— By Margherita Gallucci

Addressing drought in Zimbabwe

Applying nuclear science to understand groundwater and river dynamics

In the local Lozi language, they call it 'Mosi-oa-Tunya', or 'the Smoke that Thunders', but, by the end of 2019, Victoria Falls' thunder was more like a dripping trickle. Africa's largest waterfall has been a victim of the region's droughts, and Zimbabwe, which borders its banks, is also suffering.

More frequent, intense and unpredictable droughts have robbed the country's residents and farmers of sufficient clean and fresh water, impacting food security and threatening the livelihoods of 45 per cent of the rural population. Urban areas have been affected too. Heavily reliant on hydropower as a source of electricity, Zimbabwe's energy grids have been crippled by prolonged droughts, leaving towns and cities with frequent power shortages and cuts.

Finding solutions to Zimbabwe's chronic water problems includes looking to nuclear techniques for developing groundwater abstraction guidelines — a task which requires a good understanding of surface water–groundwater interaction and the country's water resources.

Through its technical cooperation programme, the IAEA, in collaboration with the University of Zimbabwe, Zimbabwe National Water Authority, the Environmental Management Agency and the Helmholtz Centre for Environmental Research is seeking to reveal, through the use of isotope hydrology, how groundwater and river systems within the country interact. Their findings will help the country better manage its freshwater resources, cope with water pollution and ensure safe water supply to the country's population.

"Most of Zimbabwe's rain falls between November and March; the rest of the year is a very long dry season. And, recently, good rains have only come in two out of every five years," said Alexander Mhizha, former Chairman of the Department of Construction and Civil Engineering at the University of Zimbabwe. "Therefore, we increasingly have to rely on groundwater, but there is limited knowledge on aquifer recharge areas and rates. Training our scientists and strengthening laboratories are key to better managing our water supplies."

The IAEA's regional and national projects focus on training and supporting partnerships within the country, said Anna Grigoryan, the IAEA's Programme Management Officer for Zimbabwe. "Through coordinating drought response between water stakeholders, Zimbabwean decision makers can make knowledgeable choices and promote sustainable management of the country's water supply."

The need for quality water

Water shortages from droughts are not the only problem; a lack of clean water is a growing issue.

River water is susceptible to contamination and is open to many types of pollutants. "If a river is contaminated, the contamination will automatically flow through to the groundwater. As these two water bodies are not isolated from each other, it is extremely important to understand how they interact, not only in terms of water amounts but also in terms of water quality," said Ioannis Matiatos, isotope hydrologist at the IAEA.

"By using stable isotopes of oxygen and hydrogen and naturally occurring radioactive isotopes such as tritium and radon-222 to trace water, we can better understand the complex dynamics of river and groundwater systems," he said. This allows scientists to understand which water body is contaminated and how to replenish it.

Both river water and groundwater are important in providing clean water for drinking, as well as for urban and agricultural use, within the Save catchment — the focus area of the IAEA project. Located in the eastern part of Zimbabwe, the catchment receives limited rainfall during its dry season, leaving it prone to drought. With a growing population and an economy reliant on agriculture, the demand for water in the catchment area is growing.

Training scientists on isotopic techniques

To better understand the relationship between river water and groundwater, in 2018 counterparts from the University of Zimbabwe received training at Addis Ababa University in Ethiopia, and, at the end of that year, at the IAEA's laboratories in Vienna, Alexander Mhizha learned how to evaluate geological, hydrochemical and hydrological data, as well as to design a field sampling campaign for the study sites.

In June 2021, experts from the Helmholtz Centre for Environmental Research in Leipzig, Germany, conducted a five-day virtual training course for experts from Zimbabwe. The participants were instructed in the basic principles of isotope hydrology, with special emphasis on the use of stable and radioactive tracers as tools to investigate surface water–groundwater interactions, groundwater dating techniques and the vulnerability of aquifers to contamination.

"The isotopic results found by local researchers will help identify the challenges Zimbabwe's national groundwater management system needs to tackle and, in turn, enable more sustainable management of the country's water supply," said Michael Schubert, a mineralogist at the Helmholtz Centre in Leipzig and one of the trainers of the course.

— By Puja Daya

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