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Nuclear Security

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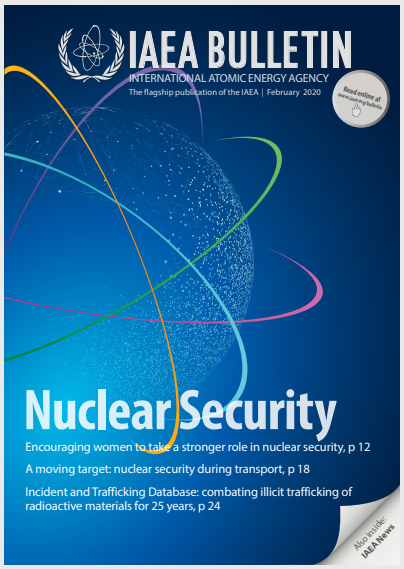

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IAEA

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.

Securing our nuclear world

By Rafael Mariano Grossi, Director General, IAEA

Nuclear technology improves the lives of millions of people worldwide in energy, health care, industry, farming and many other areas. But nuclear and other radioactive material inevitably draws malevolent interest from terrorists and other criminals. In this time of uncertainty, with conflict and tensions in many regions, it is vital that such material is protected from falling into the wrong hands. Only in this way can we ensure that the great benefits of nuclear technology for peace and development are sustainable.

The IAEA is the focal point for international cooperation in nuclear security. We help countries to provide effective physical protection for nuclear and other radioactive material and to put the necessary systems, laws and regulations in place. Our guidance helps countries to prevent, detect and respond to malicious acts involving radioactive substances and ensure that people and the environment are protected as well as humanly possible.

The IAEA's International Conference on Nuclear Security: Sustaining and Strengthening Efforts to be held from 10–14 February 2020 is an important opportunity for ministers, policymakers, senior officials and experts to discuss current approaches and priorities for nuclear security.

This edition of the *IAEA Bulletin* provides an overview of our work in this field. You can learn how Senegal worked with the IAEA to develop an Integrated Nuclear Security Support Plan to strengthen its national nuclear security regime (page 6), and how Romania made use of IAEA support in nuclear forensics against criminals who were using radioactive materials illicitly (page 20).

A strong national nuclear security regime requires well-trained and educated professionals. Graduates from the International School on Nuclear Security in Italy have returned home and strengthened national nuclear security (page 8), while training centres like the State Nuclear Security Technology Centre in China help professionals refine their skills and get experience in a range of nuclear security-related areas (page 10).

To tap into the brightest minds, the IAEA is committed to increasing the participation of women in all areas of our work and helping countries to improve gender balance in the nuclear field. Three female senior nuclear security professionals share their experiences and offer advice to those interested in working in this field (page 12).

Helping to put effective nuclear security measures in place at major public events is an important part of the IAEA's services, which also has long-term benefits for the countries concerned (page 15). As nuclear and radioactive material is most vulnerable to theft or sabotage when it is being transported, such operations are carefully choreographed to ensure maximum security (page 18).

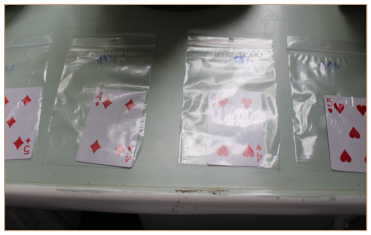
The IAEA's Incident and Trafficking Database keeps track of material that has been lost or stolen, reducing the risk that it will fall into the wrong hands and improving the chances of it being recovered (page 24). Innovative technology, such as radiation detection backpacks (page 22), plays a key role in detecting materials at risk of being used for malicious purposes.

The primary responsibility for nuclear security lies with each individual country. But the threat is global and requires a global response. By providing practical assistance and bringing together political leaders and technical experts to share experience, the IAEA makes a vital contribution to global nuclear security, helping countries to remain ahead of the curve in guarding against nuclear terrorism.

"The primary responsibility for nuclear security lies with each individual country. But the threat is global and requires a global response."

— Rafael Mariano Grossi, Director General, IAEA

(Photos: IAEA)



World View

IAEA Updates

Where can you find nuclear

Almost everywhere!

Wherever nuclear or other radioactive material is used, national authorities work to ensure that it remains secure. That means we can often find nuclear security systems and measures in industry, energy production, research and development, medicine, agriculture and even spacecraft.

These systems and measures are used by countries to prevent, detect and respond to the threat of malicious use of nuclear or other radioactive material. They can range from legislation and regulation to threat and risk assessment, and from physical protection

security systems and measures?

to nuclear security culture. Such systems and measures are an important part of a country's national nuclear security regime and play a key role in ensuring the sustainability of the peaceful uses of nuclear science and technology.

Although the nuclear security of a country rests entirely with the country itself, the IAEA works with countries, upon request, to help meet their responsibilities for maintaining effective national nuclear security regimes. As nuclear security threats recognize no borders, the IAEA serves as the focal point for coordinating national, bilateral and international efforts to strengthen nuclear security.

Enhancing nuclear security in Senegal

By Kendall Siewert

Experts discuss implementation of INSSPs at a workshop held in November 2019 in Dakar, Senegal.
(Photo: B. Battistella/IAEA)

Senegal has increased its readiness to address nuclear security threats, due in part to the country's Integrated Nuclear Security Support Plan (INSSP). Developed in collaboration with the IAEA, this plan is one of the ways Senegalese authorities are working to establish an effective and sustainable nuclear security regime.

"Before the INSSP, we did not consider nuclear security to be a problem that affected our country, as we do not have a nuclear power programme. In cooperation with the IAEA, we are working to assess our threats," said Ndèye Arame Boye Faye, Director General of Senegal's regulatory body, the Radiation Protection and Nuclear Safety Authority (ARSN). "Since working with the IAEA, we have also reassessed our priorities and capabilities and enhanced our competencies in the field of nuclear security."

Nuclear security measures focus on preventing, detecting and responding to the malicious use of radioactive materials, such as acts of nuclear terrorism. Countries can benefit from a comprehensive plan to help them identify their needs and implement measures that are effective and sustainable, with the ultimate goal of preventing potential harm from ionizing radiation if radioactive material falls into the wrong hands.

An INSSP helps a country to identify and prioritize its nuclear security needs and provides suggested actions for improvement. Upon request, an INSSP can be jointly developed by relevant national authorities and the IAEA and, when appropriate, in collaboration with other international partners.

The plan addresses all aspects related to strengthening and sustaining nuclear security. This includes a country's legislative and regulatory framework, threat and risk assessment, and physical protection regime, along with detection of and response to criminal and unauthorized acts involving material out of regulatory control. Periodic revisions are made to maintain the INSSP's relevance and sustainability over time.

114 around the world

INSSPs are tailored to fit a country's national needs, whether that involves protecting small amounts of radioactive material or larger amounts associated with a nuclear power programme. These plans help countries regardless of the maturity of their nuclear security regime.

"The value of the INSSP is recognized by many countries, whether they are just starting to establish an appropriate legislative framework for nuclear security or have been operating nuclear power plants for several decades," said Zéphirin Ouédraogo, Nuclear Security Officer at the IAEA. To date, 114 countries have drafted, finalized or approved

INSSPs. Among them, 84 countries have officially endorsed INSSPs and are in the process of their implementation.

Senegal takes a systematic approach

In 2012, Senegalese authorities requested an INSSP because the country used radioactive sources in various industries and medicine and had some sources that were out of regulatory control. Senegal began working with IAEA nuclear security experts to develop a plan, which included numerous relevant authorities, such as the regulatory body, customs, intelligence and law enforcement agencies.

Prior to the INSSP, many authorities in Senegal thought that nuclear security was exclusively a concern of the country's security forces, said Boye Faye. "The holistic approach to the INSSP helped authorities to become aware of their own and each other's responsibilities related to nuclear security, which ultimately improved their ability to work together."

During the implementation of the INSSP, which began in 2014, Senegalese authorities received equipment and training from the IAEA, such as training on regulatory inspection techniques, and hosted regional training courses on topics including transport security and human resources development. They also worked with the IAEA to develop a comprehensive nuclear law addressing security provisions, since the country's existing legislative and regulatory framework had primarily focused on safety and radiation protection.

Within the framework of the INSSP, Senegalese authorities identified the opportunity to strengthen their nuclear security regime by ratifying the Amendment to the Convention on the Physical Protection of Nuclear Material in July 2017. This key international legal instrument obliges a country to protect its nuclear facilities and material in use, storage and transport. It also requires countries without nuclear material, such as Senegal, to have in place some legal or regulatory provisions on international cooperation in order to prevent and combat acts of nuclear terrorism and other criminal offenses involving nuclear material and facilities.

As part of the regular review and update cycle for INSSPs, Senegal's INSSP was revised in 2017 to reflect the country's achievements since the plan's implementation and to review its nuclear security priorities and needs. The next update is scheduled for 2020.

Training and helping others

The INSSP has helped the country's nuclear regulator to develop the capacity to provide training to various authorities, such as customs officials, on the detection of nuclear and other radioactive material out of regulatory control at places such as border crossings and airports. Senegal has also used the plan to seek and coordinate complementary assistance from other international partners, building upon the competencies developed through IAEA support.

A key benefit of the INSSP is that it enables the country concerned, the IAEA and other entities willing to provide nuclear security assistance to plan and coordinate activities from technical and financial points of view. Such coordination optimizes the use of resources and reduces the risk of duplication.

Supporting countries worldwide in enhancing nuclear security is one of the key functions of the IAEA. The IAEA Nuclear Security Series publications provide countries with international consensus guidance for this purpose. The INSSP structure is based on the recommended nuclear security provisions set forth in this series, which means that all suggested actions in the INSSP are tailored to help establish, maintain and sustain the nuclear security regimes of a country.

As part of these activities, the IAEA regularly conducts regional workshops to coordinate the implementation of INSSPs, such as the workshop held in November 2019 in Dakar, Senegal. This workshop brought together participants from 38 African countries.

"The goal of this workshop was to facilitate the exchange of good practices, identify challenges and discuss opportunities, both national and regional, related to the implementation of nuclear security activities within the framework of INSSPs," said Ouédraogo. "Improving nuclear security globally begins by improving nuclear security nationally and regionally."

"The holistic approach to the INSSP helped authorities to become aware of their own and each other's responsibilities related to nuclear security, which ultimately improved their ability to work together."

—Ndèye Arame Boye Faye, Director General, Radiation Protection and Nuclear Safety Authority, Senegal

A foundation for the future

Graduates reflect on the International School on Nuclear Security

By Francesca Andrian and Inna Pletukhina

Participants of the International School on Nuclear Security learn how to use a radionuclide identification device.
(Photo: I. Pletukhina/IAEA)

Effective nuclear security requires highly skilled professionals. The International School on Nuclear Security, which takes place annually in Trieste, Italy and is supported by the IAEA and the Government of Italy, has trained over 400 students from more than 100 countries since 2011, many of whom have gone on to use this knowledge to help further nuclear security initiatives in their countries.

"I have used the knowledge I gained at the International School on Nuclear Security to help my group develop nuclear security processes and procedures," said Felix Ameyaw, from the Ghana Atomic Energy Commission, who participated in the School in 2013. "We are also working on synergies between nuclear security and safety for my country as part of our work to introduce a nuclear power programme."

The School's intensive, two-week programme, jointly run by the IAEA and the Abdus Salam International Centre for Theoretical Physics (ICTP), is designed for early career professionals from a wide range of backgrounds, including nuclear operators, regulators, law enforcement officers, academics and researchers.

It integrates theoretical lectures with practical exercises and technical visits to cover nuclear security broadly, from legal frameworks and threat assessment, to physical protection systems and nuclear security culture.

Participants also get hands-on experience in using specialized equipment to detect nuclear or other radioactive material that has gone missing or fallen out of regulatory control.

With its comprehensive curriculum, the School provides participants with a unique avenue for deepening their understanding and expertise in nuclear security so that they can help build strong national nuclear security regimes.

"This School assists countries in developing a cadre of informed and trained staff with the right knowledge, competence and skills in nuclear security," said Dmitriy Nikonov, Education Officer in the IAEA's Department of Nuclear Safety and Security, who explained how other forms of IAEA support complement the School's activities. "These types of support play an important part in helping countries address their national responsibilities in nuclear security."

Impact on participants' careers and national nuclear security

The School's impact is reflected in how participants have made use of what they have learned. More than 90% of participants surveyed after graduating said that the School has helped them advance professionally; for example, some have been assigned additional responsibilities, while others have been promoted or have moved to other organizations with specific nuclear security functions. For some, attending this course was also an important stepping stone into the field.

"I consider the knowledge acquired at this School as the very first step of my professional career in the nuclear field," said Edgar Andrés Monterroso Urrutia, who is an alumnus of the 2019 School and Head of the Secondary Dosimetry Calibration Laboratory at Guatemala's Ministry of Energy and Mines. "For us to continue reaping the benefits of radiation in medicine, industry and agriculture, nuclear security must be integrated into the daily routines of everyone working with radioactive material."

Attending the School has helped over 70% of surveyed graduates to improve nuclear security in their organizations. For some participants, this has led to implementing nuclear security good practices directly after the course.

"At the School, we practiced a complex threat assessment process for a fictitious facility containing radioactive material. I then followed the steps we learned during the exercise and facilitated, with additional help from the IAEA, the design basis threat process for Ghana's research reactor," said Ameyaw.

Other graduates have translated what they have learned into improvements such as the adoption of new regulations, enhanced monitoring procedures and physical protection upgrades.

"Through lectures, exercises and conversations with both operators and regulators, I drew on nuclear security principles from concepts to legal requirements to on-the-ground procedures of the operators," said Eltayeb Hassan from the Egyptian Atomic Energy Authority, an alumnus of the 2011 School. "As I helped draft the national regulations on nuclear security and safety, I had in mind the perspective of the operators that would be implementing these regulations at their facilities."

The School and its curriculum have also served as a model for other regional schools set up by the IAEA in a variety of languages — Arabic, English, French and Spanish — as well as for similar initiatives established by former graduates. In Tajikistan, for example, a regional training centre was set up by an alumnus of the 2015 School in cooperation with experts from nine neighbouring countries. It has since trained more than 500 professionals using a syllabus inspired by the School's programme.

Underpinning these activities are the professional relationships participants form at the School. This community has led to the creation of a wide network of nuclear security experts around the globe and opened the door to new opportunities for some former participants, helping to further bolster nuclear security worldwide.

"Collaboration towards a common vision for nuclear security is key to an effective and robust global nuclear security framework," Nikonov said. "Transferring knowledge, sharing best practices and hosting training courses are all essential activities to advancing nuclear security initiatives and continuing to cultivate leaders of today and the future."

"I consider the knowledge acquired at this School as the very first step of my professional career in the nuclear field."

— Edgar Andrés Monterroso Urrutia, 2019 alumnus, Guatemala

China's Nuclear Security Technology Centre supports international training efforts

By Miklos Gaspar

A simulator room in the SNSTC designed to generate and contain strong electromagnetic waves for testing nuclear security equipment.
(Photo: M. Gaspar/IAEA)

Accounting for mock nuclear material and its residues to confirm that nothing has been stolen, shooting laser pistols at moving human-shaped targets and climbing over wired fences. These are just a few of the training exercises performed at China's State Nuclear Security Technology Centre (SNSTC) on the outskirts of Beijing. The Centre is part of the International Network for Nuclear Security Training and Support Centres (NSSC Network), which is coordinated by the IAEA and plays a key role in international cooperation and the sharing of best practices in nuclear security.

"Protecting nuclear or other radioactive material from falling into the hands of terrorists is of growing importance in a country like China, which is expanding its nuclear power programme," said Zhenhua Xu, Deputy Director General of the SNSTC. "Nuclear security is the responsibility of every nuclear facility operator and nuclear material possessor in the sector — training is therefore a central element for strengthening nuclear security capacity."

Since the Centre of Excellence, operated by the SNSTC, opened in 2016, over 3000 participants, including 800 from abroad, have completed its national and regional training courses. The participants comprise staff from nuclear facilities, including nuclear power plants and law enforcement agencies, and the courses deal with all aspects of nuclear security, such as the prevention of terrorist attacks and sabotage, as well as how to deal with them should they occur.

The SNSTC's state-of-the-art facilities span 28 000 square metres on an 8-hectare campus, making the Centre one of the largest

of its kind in the world. In addition to a virtual shooting range and mock nuclear facility for combat training, the Centre houses a nuclear material accounting and control training facility, an emergency response simulation room and a physical protection testing field.

The facilities also house an analytical laboratory for quantifying uranium and plutonium in samples to check whether nuclear or other radioactive material has gone missing, or whether undeclared activities have taken place, as well as a laboratory for testing nuclear security equipment under extreme weather conditions.

Preparing for threats

As the amount of nuclear material in peaceful use grows worldwide, so does the need for authorities to prepare for threats. At the 2019 NSSC Network's annual meeting in Beijing, participants discussed how they can increase their cooperation in strengthening the protection of nuclear and other radioactive material against terrorism and smuggling.

There is close cooperation among national authorities, facilitated by the IAEA, in globally strengthening the nuclear security framework, and training is a key activity in this cooperation, said Raja Abdul Aziz Raja Adnan, Director of the IAEA's Division of Nuclear Security. In 2019 alone, more than 2000 participants from 145 countries took part in 101 IAEA nuclear security-related training courses and workshops — many of which were organized at various NSSCs — and developed their expertise.

"The NSSC Network and the IAEA can now provide more customized support and expand into a wider range of technical activities, in a structured, systematic and sustainable manner, in order to meet the needs of individual centres," Raja Adnan said. "We must always aim for continuous improvement to stay ahead of the threat while endeavoring to use limited resources efficiently."

For countries with smaller nuclear programmes, having facilities as large as those of the SNSTC may not be necessary. With proper planning, these countries can set up NSSCs that are suited to their national needs and can complement what countries with major nuclear power programmes can offer.

"Our Member States have asked us to play a central role with assisting in strengthening the global nuclear security framework," said Raja Adnan. "In that respect, the IAEA coordinates and implements activities through which countries can cooperate to minimize the risk of nuclear and other radioactive material being used in a malicious way."

One of these activities is through the broader IAEA Collaborating Centre scheme, which, among other activities, facilitates cooperation across countries with the purpose of advancing research, development and training in the peaceful uses of nuclear science and technology, including nuclear security. In September 2019, the SNSTC, which is part of the China Atomic Energy Authority (CAEA), became an IAEA Collaborating Centre in nuclear security technologies. Under a new cooperation agreement, the IAEA and the CAEA will work together to improve the functionality of radiation detection equipment and physical protection systems, including, for example, through tests that simulate harsh environmental conditions. The agreement facilitates collaboration between the IAEA and the CAEA in research, development, testing and training related to nuclear security detection and physical protection technologies.

"Terrorism knows no borders, so counter-terrorism must also be coordinated among countries," Xu said. "As a growing power in nuclear energy, we want to play our part in that."

"Nuclear security is the responsibility of every nuclear facility operator and nuclear material possessor in the sector — training is therefore a central element for strengthening nuclear security capacity."

— Zhenhua Xu, Deputy Director General, State Nuclear Security Technology Centre, China

Using a rain simulator to test the resilience of a surveillance camera.
(Photo: M. Gaspar/IAEA)

Encouraging women to take a stronger role in nuclear security

By Kendall Siewert

Women have a growing presence in nuclear security and the nuclear field more broadly, but they continue to be underrepresented. We spoke to senior women in nuclear security to hear about their experiences, opportunities and challenges in the field.

Nataliia Klos, Chief Specialist in Physical Protection at Ukraine's Ministry of Energy and Environmental Protection

While getting her master's degree in public administration, Nataliia Klos had her first exposure to nuclear security as an intern in physical protection at Ukraine's Ministry of Fuel and Energy, which is now the Ministry of Energy and Environmental Protection.

After graduating and being hired by the Ministry, Klos' understanding of nuclear security deepened through her involvement with International Physical Protection Advisory Service (IPPAS) missions hosted by Ukraine.

"Soon after I began work, I started visiting nuclear power plants as part of IPPAS missions," Klos said. "Seeing some of these plants in person, while knowing the history of nuclear power and what could go wrong, helped me realize the essential nature of physical protection work and how it keeps people and the environment safe." She has since also served as an expert on an IPPAS mission to support other countries.

Alongside her main job, Klos is setting up a master's degree programme on physical protection in Kyiv. Her aim is to help young people acquire the necessary knowledge to work in this field and increase the number of specialists available in Ukraine, which has a large nuclear power programme.

Education and training, Klos said, can assist people with making their voices heard, which is still a challenge for women in the field. "I work with a lot of people from law enforcement. They usually listen to men first, and then later, they might listen to women. I've even been told that women shouldn't work and should stay at home. But work is a right, regardless of gender."

Klos encourages interested young professionals to pursue careers in nuclear security despite these challenges. "Times are changing, and there are more opportunities for women in nuclear security than before," she said. "My advice is to learn as much as you can, as knowledge opens doors. You never know what will be useful in the future."

Judith Rodríguez Bustamante, Deputy Administrator of International Affairs at the General Customs Administration in Mexico

When Judith Rodríguez Bustamante started working to help strengthen nuclear security at the Mexican General Customs Administration, the topics were foreign to her, and the learning curve was steep. Now, Rodríguez Bustamante has over ten years of experience as an expert and organizes workshops and training courses for customs officials and people from other agencies.

With her expertise in the prevention of illicit trafficking in nuclear and other radioactive material, Rodríguez Bustamante was invited to join the IAEA's Advisory Group on Nuclear Security (AdSec) as a senior nuclear security expert. This group, comprising IAEA and international experts, advises the IAEA Director General on nuclear security activities worldwide. "Sharing a table with other nuclear security experts from around the world has enriched my knowledge of nuclear security issues," she said.

Though she now finds herself at many tables in the field, she pointed out that there continues to be a noticeable gender imbalance. "It is a great challenge to make the voices, experiences, tenacity and knowledge of women in nuclear security heard," she said. "I am pleased to see that, at IAEA meetings, there is a parity of men and women; however, in many of the security meetings I attend through my work, there are still only two or three women at a table of thirty male participants."

To help change this, Rodríguez Bustamante said, anyone entering the field should have an open mind and a lifelong commitment to learning, and the women already in the field should remember that "in our daily work as women in the field, we are creating space for those who come after us".

Nirasha Rathnaweera, Scientific Officer in the Radiation Protection and Technical Services Division of Sri Lanka's Atomic Energy Board

If a customs officer at the Port of Colombo in Sri Lanka hears a radiation alarm go off, Nirasha Rathnaweera is one of the first people called. As part of an expert support team that assesses possible nuclear security alarms at this port, Rathnaweera uses radiation detection instruments to inspect the cargo container that sets off the alarm and verify whether it contains radioactive material. This helps the authorities determine what to do next.

"Over the last four years, our team has helped make about 14 confirmed detections," she said. "At the same time, I have conducted training courses for first responders to a nuclear security event on detection strategies for border monitoring and provided them with technical expertise." In addition to these responsibilities, Rathnaweera works as a Scientific Officer at the Sri Lanka Atomic Energy Board and is the Chief Scientific Investigator for an IAEA coordinated research project on improved assessment of initial alarms.

While Rathnaweera's work schedule is busy, sometimes requiring her to be on call around the clock, one of the main challenges she said she faces is related to her gender. "People often assume that, because I'm a woman, I don't have enough knowledge to be in the field," she said. "But once they work with me, they understand that this isn't true. They then understand what I know and what they can learn from me."

She explained that this may be because there are still too few women with the appropriate expertise and education. "We need to provide more women with the knowledge to work on radiation detection issues," she said. "Women who are interested in this topic shouldn't consider gender. If they want to be in this field, they should go for it."

Collecting and sharing these stories is part of the IAEA's ongoing efforts to change the narrative and take action to help empower women and increase their representation in nuclear security and the nuclear field more broadly.

A catalyst for change

Integrating nuclear security at major public events

By Inna Pletukhina

Protecting cheering fans, heads of state or global leaders from the threat of a dirty bomb is the aim of integrating nuclear security into the overall security arrangements for major public events. While the primary goal of these efforts is to bolster security at the event itself, they also bring long-term benefits to a country's overall nuclear security regime.

"For many countries, major public events are a catalyst that makes authorities focus on and prioritize nuclear security," said Raja Abdul Aziz Raja Adnan, Director of the IAEA's Division of Nuclear Security. "Such an event may be a target for malicious uses of nuclear or radioactive material that may have been stolen, therefore prompting countries to reassess these threats."

Nuclear security plays an important role in ensuring the success of a major public event. Measures must be taken to prevent malicious use of nuclear and other radioactive material that has gone missing. The spread of radioactive material at such an event could have a serious impact on people and the environment, including severe social, psychological, political and economic consequences.

When preparing the nuclear security arrangements for a major event, authorities must address factors such as establishing an organizational and coordination structure, threat assessment and mobilizing human and financial resources. The authorities must also ensure access to radiation detection equipment, as well as establish and strengthen relationships between, for example, scientists, security experts, first responders and law enforcement agencies. Upon request by a country, the IAEA supports these efforts.

"When going through the steps of planning and integrating nuclear security measures and systems into the overall security plan for a major event, authorities are exposed to every essential element of a robust national nuclear security regime," said Elena Paladi, Nuclear Security Officer at the IAEA. "As they identify and address nuclear security gaps and challenges when preparing for the event, they also strengthen the country's overall nuclear security efforts."

The long-term benefits of these activities include a greater awareness of nuclear security at all levels of the national security system, stronger detection and response capabilities and structures and increased interoperability between the relevant authorities.

World Youth Day 2019

In January 2019, Pope Francis, the presidents of Colombia, Costa Rica, El Salvador, Guatemala, Honduras, Panama and Portugal, and over 300 000 people gathered in Panama City for World Youth Day. In preparation for the event, authorities in Panama worked

with the IAEA to incorporate nuclear security into the overall security arrangements.

Part of these arrangements included the Panamanian authorities issuing an executive decree for a joint task force on security that provided the legal mandate to institutionalize the coordination of nuclear security between the country's relevant authorities.

"Law enforcement and customs officers; units specializing in chemical, biological, nuclear and radiological explosives; and health and other first responders all had to work as a team to prevent, detect and, if necessary, respond to a potential nuclear security event," said Lieutenant Colonel Alexis De León, Chief of the Joint Security Task Force. He explained that, before the decree, "each had their own mandate, authorities, and command and control structures".

Bringing nuclear security under one authority and one mission establishes a working relationship between the relevant branches for security arrangements. The ability to carry out operations in coordination with other branches creates a foundation for effective response to any potential nuclear security incident, both for major events and in general.

2008 Olympic Games

Complementing this foundation are skills and strategies related to radiation detection equipment and its use. Many countries preparing for big public events work with the IAEA to train staff and borrow equipment (read more about nuclear security equipment on page 22). Although the IAEA equipment out on loan is returned, the skills and experience from IAEA training events remain and are used to create a stronger framework for nuclear security detection and response activities.

"China received IAEA nuclear security assistance in relation to the Olympic Games in Beijing in 2008," said Yongde Liu, Director General of China's State Nuclear Security Technology Centre (SNSTC). "We built upon the capacity we obtained with the IAEA's assistance and experience of successfully securing many major public events, and now, in collaboration with the IAEA, we provide radiation detection training at the SNSTC." (Learn more about training at centres such as SNSTC on page 10).

Since the IAEA first provided assistance for the Olympic Games held in Athens in 2004, it has helped countries to carry out over 50 political, sporting, religious and cultural major public events. These activities are part of the IAEA's broader assistance for countries, upon their request, in preventing, detecting and responding to theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear or radioactive material.

Photos from World Youth Day 2019 in Panama.
(Photos: D. Calma/IAEA)

A moving target
Nuclear security during transport

By Inna Pletukhina

Experts evaluate nuclear security components related to transport.
(Photo: D. Calma/IAEA)

Nuclear and other radioactive material is hardest to protect when it is transported from point A to point B — more than half of the incidents of theft of radioactive material reported to the IAEA between 1993 and 2019 occurred while it was in transport.

"There are a lot of moving parts when transporting these materials, which makes them an appealing target for theft or sabotage," said David Ladsous, Head of the Transport Security Unit at the IAEA. "Secure transport at every step is essential to ensuring society can continue to benefit from these materials, while keeping them out of the hands of terrorists or criminals."

"Secure transport at every step is essential to ensuring society can continue to benefit from these materials, while keeping them out of the hands of terrorists or criminals."

— David Ladsous, Head, Transport Security Unit, IAEA

Around 20 million shipments of nuclear and other radioactive material are regularly transported within countries and across borders each year. These materials are used in industry, agriculture and medicine, as well as in education. Some of them are also radioactive sources that are no longer useful, known as disused sources.

The aim of nuclear security during transport is to ensure that the material is secured throughout and that it is not used for criminal or malicious purposes. While the level of security differs depending on the sensitivity of the material, the fundamental elements of secure transport include physical protection, administrative measures, training and protection of information about the transport routes and schedule. In some cases, escort personnel may also need to be armed.

Some of the major challenges with transport include the fluidity of the situation and the need to continually assess any potential threats and adjust the plans accordingly.

"At a stationary facility, it is easier to protect a radioactive source, or a disused source, through the facility's security systems and measures as well as its layers of defense. When it is in transport, there are many more variables, people involved and context changes with every mile travelled. Even an incident as small as a minor traffic collision could freeze the flow of traffic and paralyze the movement of people and goods," Ladsous said.

To prepare for all possible scenarios, the professionals involved, such as operators,

regulators, police, military and health and environmental agencies, have to use agreed operational procedures and communication methods. These coordinated efforts are guided by legislation and regulations that designate appropriate responsibilities to the relevant authorities, outline communication procedures and ensure sufficient financial support. When this coordination occurs internationally, it involves all relevant customs and transit authorities, which is often facilitated with support from the IAEA.

"During conversion of our research reactor from high enriched to low enriched uranium fuel, we had to transport highly radioactive spent reactor fuel from the site to the airport to be sent back to the original manufacturer, and we had to transport the new low enriched uranium fuel from the airport to the facility," said Yusuf A. Ahmed, Director of the Centre for Energy Research and Training in Nigeria, who was involved in the conversion project. "Although the transport time is only a few hours, there is a lot that can happen during that time, from simple traffic accidents to malicious interventions and sabotage of shipments."

Upon request, the IAEA also helps countries to draft regulations associated with transport security. In 2019, the IAEA supported more than 15 countries in drafting transport security requirements.

"As a country embarking on nuclear power, we will be transporting a significant amount of nuclear material and radioactive sources on our roads," said Sami Sulaiman, Chairman of the Egyptian Nuclear and Radiological Regulatory Authority. "In early 2020, we will have a decree, drafted with IAEA assistance, that will strictly regulate any movement of such material."

While only around 30 countries use nuclear power and therefore have significant amounts of nuclear materials to transport, almost all countries use radioactive sources. The IAEA assists countries with the security of disused sources. Such sources are beyond their useful life but can remain radioactive for a long time and frequently require transport to temporary storage facilities or permanent repositories.

"Whether it's a disused source or radioactive material that's ready for use, these materials need well-coordinated nuclear security systems and measures to minimize the vulnerabilities of transport and strengthen nuclear security overall," Ladsous said.

Overseeing the secure shipment of nuclear fuel during transport.
(Photo: G. Webb/IAEA)

The case for nuclear forensics to strengthen nuclear security internationally

By Maria Podkopaeva

Contaminated playing cards collected as evidence after being seized at a Bucharest airport.
(Photo: A. Apostol/IFIN-HH)

Romanian authorities have identified an organized crime group tied to two incidents at a Bucharest airport in 2018 involving playing cards contaminated with small amounts of radioactive material. Using their nuclear forensics skills and equipment, acquired in part through IAEA support, Romanian authorities determined that the cards were contaminated with iodine-125, which was being used to cheat at *Xoc Dia*, a popular game. This, along with information exchanged between experts facilitated by the IAEA and the Nuclear Forensics International Technical Working Group (ITWG), led to a full criminal investigation that was closed in 2019.

"When establishing the nuclear forensics programme in Romania, working with the IAEA, the ITWG and other international bodies was a natural choice."

— Andrei Apostol, Head, GamaSpec Laboratory, IFIN-HH, Romania

Initially, the two incidents were seen as isolated and considered to be misdemeanours with no legal grounds for a criminal investigation. However, information shared at an annual ITWG meeting helped link the two cases with other cases from different countries.

"Thanks to both the ITWG and the IAEA, we had ample opportunity to establish close contact with other experts who had investigated similar cases and to discuss their experiences," said Andrei Apostol, Head of the GamaSpec Laboratory at Romania's Horia Hulubei National Institute for Research and Development in Physics and Nuclear Engineering (IFIN-HH).

The initial clues and the exchanges of experience gave prosecutors key legal reasons for launching a full criminal investigation. This investigation involved using nuclear and other methods to uncover details such as how the cards were produced and how they were used for financial gain, as well as their destination and origin. The results also helped authorities in Romania find new leads and expand the scope of their investigation, including collaboration with foreign authorities.

Nuclear forensics methods were an important component of the case, said Apostol. "The main purpose of nuclear forensics is to assist a nuclear security-related criminal investigation by analyzing and providing essential information on nuclear and other radioactive material that can then be used for prosecution and trial." In this case, the results of the nuclear forensics examinations were compiled into reports used by prosecutors to prove the presence of iodine-125, an isotope mainly used for cancer treatment, which had been illicitly used to gain a financial advantage in the card game.

These reports also helped to tackle the big question of who was behind the contaminated cards. "From our experience, most of the smugglers of nuclear or other radioactive material can be considered opportunistic criminals. In the case of the contaminated cards, the people transporting them were not even aware of the presence of radioactive material on the cards," said Apostol. Using the nuclear forensics reports and other investigative means, they successfully identified the criminal group responsible for the cards and proved the group's criminal intent.

Equipped and ready

Since 2015, officials in Romania have worked with the IAEA to build the country's nuclear forensics capacities, including the knowledge and skills used in the contaminated cards case. They have also established Practical Arrangements in Nuclear Forensic Science with the IAEA, which has facilitated Romanian experts' involvement in nuclear forensic science technical advisory missions, laboratory visits and training as well as regional coordinated research projects. These activities have also been complemented by cooperation with other nuclear forensics bodies internationally.

"When establishing the nuclear forensics programme in Romania, working with the IAEA, the ITWG and other international bodies was a natural choice," Apostol said, noting how an ITWG meeting held four years ago played a key role in strengthening Romanian officials' awareness of nuclear forensics, its importance and ways to use the country's existing capacities to build a nuclear forensics programme.

A unified approach

For the last 25 years, the ITWG has offered a forum for scientists, regulators, law enforcement personnel, prosecutors and policymakers from nearly 40 countries and international organizations, including the IAEA, to discuss best practices and recent developments in nuclear forensics. It also organizes training exercises and supports the development of guidelines on nuclear forensics. The aim of the ITWG is to create a unified nuclear forensics approach to assist law enforcement authorities.

To facilitate connections for mutual nuclear forensics assistance and information sharing between the countries, ITWG affiliates are frequently involved as experts in IAEA meetings, conferences and training courses. The IAEA also assists countries that are part of the ITWG community through, among others, sharing knowledge and providing analytical services related to illicit trafficking.

"Nuclear forensics as a scientific discipline has existed since the 1990s, and the ITWG, the IAEA and the Global Initiative to Combat Nuclear Terrorism have collaborated to help grow forensics as a nuclear security tool," said Michael Curry, a senior coordinator for nuclear forensics cooperation at the US Department of State's Bureau of International Security and Nonproliferation and a co-chair of the ITWG. "As technical experts increasingly connected to policymakers, we saw tremendous growth and development of national programmes that utilize forensics as a nuclear security tool, and an important platform for those connections was the ITWG."

Since the field of nuclear forensics first emerged more than 25 years ago, the methods and technology have advanced, but so has the way criminals operate, said Klaus Mayer, Deputy Head of the Nuclear Safeguards and Forensics Unit of the European Commission's Joint Research Centre and an ITWG co-chair.

"Today, we are faced with perpetrators that act in a smarter way," Mayer said, explaining how activities can be veiled using online networks such as the 'darknet', which is anonymous and is not visible to standard search engines. "To stay ahead of the game, we not only need to continue increasing our scientific knowledge base, we also need to work in a much more information-driven manner and operate in a more integrated way with law enforcement and information services."

Countries worldwide work with the IAEA to increase their nuclear forensics capabilities. Such capabilities are a key aspect of a country's security infrastructure for the prevention, detection of and response to theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear and other radioactive material.

Nuclear forensics experts analyze contaminated playing cards seized at a Bucharest airport.
(Photo: A. Apostol/IFIN-HH)

Equipped and ready to detect

Technology for nuclear security

By Joanne Liou

An expert tests a radiation detection backpack.
(Photo: D. Calma/IAEA)

Blending into the crowd, a nuclear security officer takes cues from a Bluetooth-connected earphone.

"Go left… Continue straight."

Just moments earlier, the detection system embedded in the officer's backpack was triggered by a spike on the radiation monitor. On the outside, the backpack looks generic, but, on the inside, it is outfitted with a device to detect the presence of potentially harmful radioactive elements, as well as to identify their source.

"Radiation detection equipment is used to locate nuclear and other radioactive material that is unintentionally lost or is stolen and being used for malicious purposes," said Henry Adams, a nuclear security officer at the IAEA specializing in equipment and instrumentation. "If such material turns up at a major public event, for example, it could expose people and the environment to the harmful effects of ionizing radiation and cause severe political and social consequences."

Many countries work with the IAEA to find the technology that best fits their strategic goals and national nuclear security regime. Since 2009, the IAEA has loaned authorities worldwide a range of nuclear security equipment, including personal radiation detectors and radionuclide identification devices.

This equipment complements other nuclear security systems and measures related to, among others, physical protection, legislation and regulation. These systems and measures are how countries work to prevent, detect and respond to the threat of malicious use of nuclear or other radioactive material.

High-tech backpacks

Radiation detection backpacks are one of the latest additions to the IAEA's inventory of nuclear security equipment. Introduced in 2017, these backpacks can provide a larger area of detection and identification than many other mobile tools, owing to their higher sensitivity detection system. A single backpack expands the detection footprint from centimetres to several metres.

The backpacks' scintillation detectors can categorize material as industrial, medical, naturally occurring and non-threatening radioactive material (NORM) or a special nuclear material that could be considered a threat. In under 30 seconds, the backpacks can generally identify the type of source within a one-to-two-metre distance. The

average 12-hour battery life allows for in-depth, uninterrupted activity.

Wearing the 14-kilogram backpacks, local authorities can collect data over a large area and search for any radioactive sources that may have been lost or stolen and could be used with malicious intent. Before deployment, security personnel are trained to operate and perform general maintenance of the equipment.

"Backpacks are a primary tool for radiation detection in an operational sense because of their versatility and built-in identification capability," Adams said. Given their mobility, backpacks are intended to cover a large area, he added, as opposed to stationary monitors that are utilized at ports and borders.

Experts in over 20 countries have used these backpacks for various nuclear security activities. In some cases, this has been for major public events, such as the 2019 World Youth Day held in Panama, the 2018 Asian Games held in Indonesia and the G20 Summit held in Argentina in 2018.

"With the assistance of the IAEA, we were able to augment our security arrangements by deploying detection equipment as a part of our overall security strategy around World Youth Day," said Lieutenant Colonel Jorge Gobea, Head of Panama's Joint Security Task Force formed to secure the 2019 World Youth Day. "Having access to such equipment is an invaluable and cost-efficient way of scaling up our detection capabilities whenever we need to." (Read more about nuclear security at major public events on page 15).

Refine and improve

Radiation detection backpacks come in different sizes and with various specifications. To help identify backpacks to fit various country needs, practitioners came together at an IAEA Technical Meeting in June 2019 to share their experiences of deploying, testing and maintaining radiation detection backpacks. They used data from a series of experiments designed to compare the performance of more than a dozen different backpacks with different parameters based on various national nuclear security priorities, both event-specific and overall.

"It is about balance and prioritization. Backpack technology has progressed rapidly and includes many advanced features," said Tyrone Harris, a nuclear security officer at the IAEA. "However, not all features may be necessary for all countries, and each feature can add weight to an already heavy piece of equipment."

"Having access to such equipment is an invaluable and cost-efficient way of scaling up our detection capabilities whenever we need to."

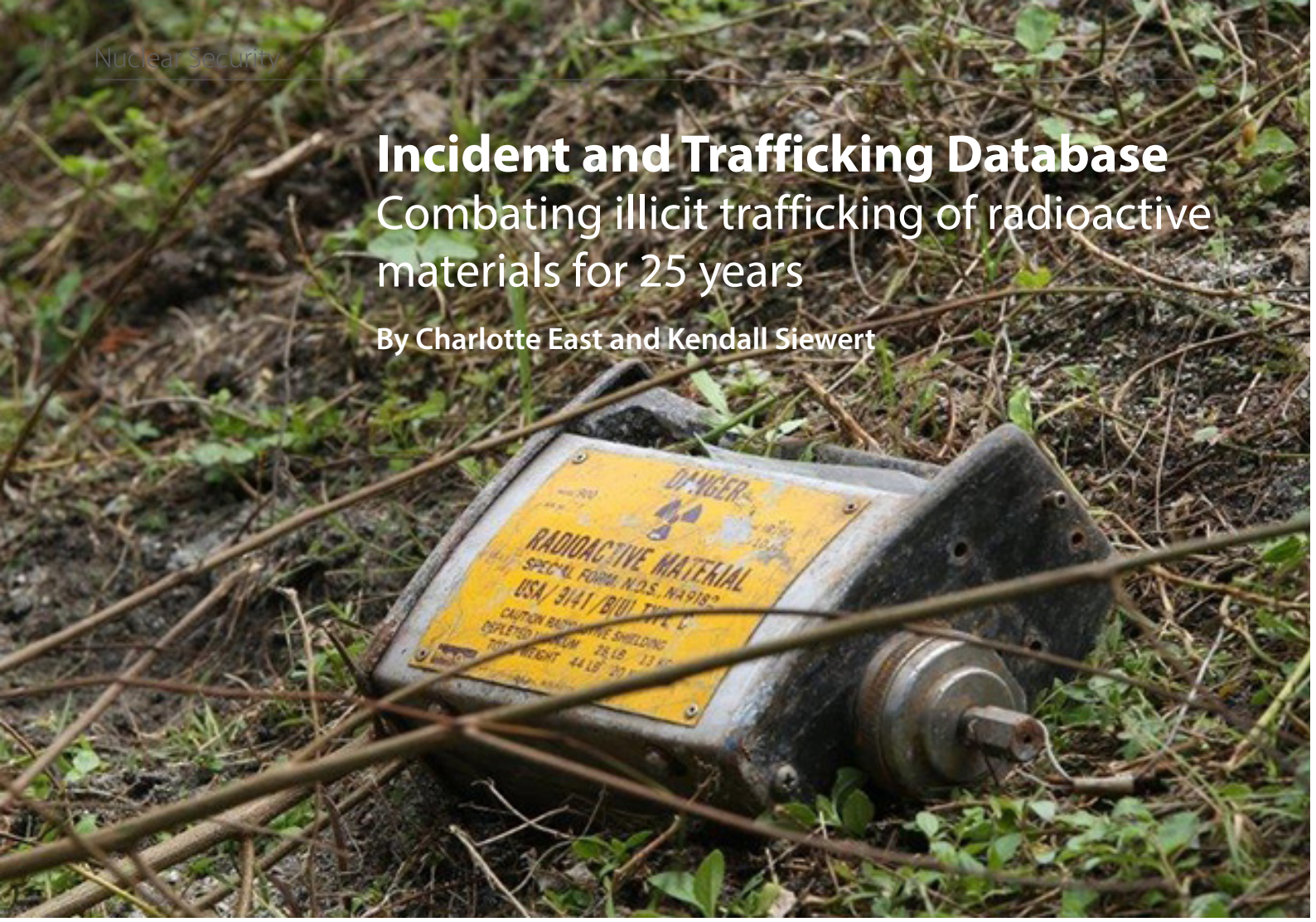
— Lieutenant Colonel Jorge Gobea, Head, Joint Security Task Force for World Youth Day 2019, Panama

A look inside a radiation detection backpack.
(Photo: D. Calma/IAEA)

Incident and Trafficking Database

Combating illicit trafficking of radioactive materials for 25 years

By Charlotte East and Kendall Siewert



An orphaned radioactive source.
(Photo: PNRI and IAEA)

If radioactive material is lost or stolen, the IAEA's Incident and Trafficking Database (ITDB) can help authorities improve the chances of the material's recovery, reducing the risk that it will fall into the wrong hands. For the past 25 years, the ITDB has played an important role in fostering international cooperation and information sharing towards enhancing nuclear security globally.

The ITDB catalogues voluntarily reported information related to lost or stolen nuclear and other radioactive material. This ranges from the smuggling and sale of nuclear material, to the unauthorized disposal and the discovery of lost radioactive sources. Incidents reported to the ITDB involve radioactive materials such as uranium, plutonium and thorium, as well as naturally occurring and artificially produced radioisotopes, and radioactively contaminated material.

Over 3500 incidents have been reported since the database's inception in 1995, around 10% of which have been confirmed as acts related to trafficking or malicious use. The rest have been incidents of undetermined intent or unconnected with trafficking or malicious use. In the past 10 years, over 250 incidents of theft of radioactive sources have been reported to the ITDB, with around one third of these sources being subsequently reported as unrecovered, with their whereabouts unknown.

The number of incidents involving the most serious kinds of nuclear material has significantly decreased in the last two decades, according to Scott Purvis, Head of the Information Management Section in the IAEA's Division of Nuclear Security. However, individuals continue to attempt to illegally trade a variety of other nuclear and radioactive materials. Over the past five years, an average of six such incidents per year have been reported to the ITDB, including scams that turned out to be non-radioactive material. The occurrence of these incidents demonstrates that individuals remain willing to smuggle and illicitly trade radioactive material.

Information sharing

One of the key functions of the ITDB is to encourage information sharing on relevant nuclear security events among the 139 participating countries. Details of reported incidents are shared with national points of contact and a small number of relevant staff at the IAEA and certain

international organizations such as the International Criminal Police Organization — INTERPOL. This information can then assist authorities with identifying and recovering material that is lost or stolen, strengthen national detection and response arrangements and, in some instances, help make connections between cases.

"Information exchanged through the ITDB can help authorities evaluate an incident and can open the door to identifying and establishing possible connections between incidents, whether they are local or in different countries," Purvis said. "This can then facilitate cooperation to support further investigation."

One example of such cooperation occurred in 2017, when a submission to the ITDB regarding a stolen device with a radioactive source prompted a joint investigation between two countries. As a result, an inspection team was able to locate the device on the premises of an engineering company in a different country. The device was consequently recovered, confirmed to be in good condition and then repatriated to its country of origin and to its rightful owner. Also revealed during the investigation was how the engineering company — which was charged with the criminal offense of dealing stolen goods — acquired the device.

Analyzing data

Tapping into over 25 years of information, ITDB users can review all incidents in the database with a view to identifying common threats, trends and patterns, which can shed light on criminal activities involving radioactive material and help countries identify areas for strengthening nuclear security. One such pattern identified through analysis has shown that around 50% of thefts reported to the ITDB involve material in transport. This has resulted in many countries enhancing radioactive material detection systems at their borders.

"Analyzing information in the ITDB gives us important insights, such as the types of materials being trafficked, any regions that may be particularly affected or patterns of activity. With over two and a half decades of data, we have a huge volume of information to learn from to help strengthen nuclear security in the future," Purvis said. "This can assist countries in determining the appropriate course of action to enhance detection and prevention efforts."

For example, in 2018 and 2019, a series of reports to the ITDB helped authorities identify which systems and measures to strengthen regarding radioactive sources in scrap metal; if an item containing radioactive material is improperly disposed of or erroneously sent for recycling, it may be unknowingly melted and could contaminate the scrap metal product.

In this reported case, potentially dangerous radioactive sources were found in scrap metal containers in Northern Europe. All sources were recovered and have since been stored safely at the country of origin's national radioactive waste facility. While the case is still ongoing and the details are confidential, reported information led to the conclusion that there is a serious possibility of more similar sources turning up in scrap metal containers in the future.

"The success of the ITDB is due in large part to the contributions of incident reports by participating countries over the past 25 years. With their ongoing support, the ITDB will continue to strengthen global efforts to combat the illicit trafficking of nuclear and other radioactive material through international cooperation and information exchange," Purvis said.

"With over two and a half decades of data, we have a huge volume of information to learn from to help strengthen nuclear security in the future."

— Scott Purvis, Head, Information Management Section, Division of Nuclear Security, IAEA

The ITDB catalogues information related to various types of lost or stolen nuclear and other radioactive material.

(Photo: Public Company Nuclear Facilities of Serbia)

Nuclear security: From securing one nuclear facility to securing the nation

By Yusuf Aminu Ahmed

Director of the Centre for Energy Research and Training, Nigeria Atomic Energy Commission, Ahmadu Bello University, Zaria

In recent years, Nigeria has faced a number of security challenges, from terrorism to hostage-taking for ransom. Although Nigeria's only operating research reactor — Nigeria Research Reactor-1 (NIRR-1) — has operated for more than a decade without a security incident, we remain vigilant in order to protect our nuclear and radioactive material and facilities in the face of this evolving security environment. Our commitment to nuclear security has led to improvements in security processes and procedures at NIRR-1 and at all of Nigeria's critical infrastructure facilities.

The Centre for Energy Research and Training (CERT), which operates the NIRR-1, has cooperated with international partners, including the IAEA, to strengthen nuclear security at the facility. The facility has undergone a comprehensive physical security upgrade to minimize the possibility of an outsider attack. In 2018, in cooperation with the IAEA, the reactor core was converted and refuelled with low enriched uranium fuel to make the nuclear material and facility less attractive to criminal groups.

However, security is not adversary-centric. Human factors can also lead to a breach of security. Intentional or unintentional security vulnerabilities created by facility personnel and vulnerable operating processes and procedures, commonly referred to as insider threats, are among the most serious security issues facing nuclear and other industries. There have been several security incidents at facilities containing nuclear and other radioactive material around the world involving personnel and contractors. These include the theft of nuclear and/or radioactive material, theft of sensitive nuclear design data and sabotage.

Financial issues, family problems, political or religious extremism, mental well-being or work-related issues may turn a trusted employee into a potential insider threat.

The increased concerns about the security of nuclear and other radioactive material and facilities mean that security at such facilities requires the presence, judgment

and decision-making capabilities of individuals who recognize that certain human behaviours and characteristics may have an impact on the organization's effectiveness. With the increased threat posed by terrorism, it is important to develop a programme for vetting and monitoring individuals who can be trusted with the access to and responsibilities for nuclear and other radioactive material and facilities, as well as other critical infrastructure facilities.

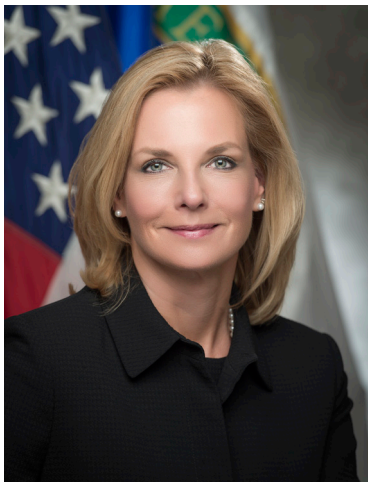
To address insider threats, within the broader context of national and international threats, CERT has implemented a human reliability programme (HRP) at its NIRR-1 facility. Its primary objective is to ensure security and safety by employing reliable and trustworthy individuals. CERT provides training for all staff, with increased training for those in critical positions, to recognize, report and mitigate risks associated with potential insider threats. NIRR-1 facility managers also follow the HRP processes and procedures in order to identify individuals who may present security and safety reliability concerns owing to physical or psychological disorders, substance abuse or other life circumstances.

Insider threats are not only a concern for nuclear facilities; insider threat mitigation programmes, such as the HRP at the NIRR-1, are applicable to all critical infrastructure facilities and industries. As a result, recognizing the utility and the successful implementation and operation of the HRP, Nigeria's Office of the National Security Adviser (ONSA) mandated the implementation of such programmes at all of Nigeria's critical infrastructure institutions.

The approach we have taken to ensure our staff have the attitudes and the best qualifications to support the success and sustainability of our nuclear science and technology programmes, including nuclear energy, has proven to be applicable across the industry and national security.

The enduring imperative of nuclear security

By Lisa E. Gordon-Hagerty



Under Secretary for Nuclear Security of the US Department of Energy and Administrator of the National Nuclear Security Administration

For more than a generation, the fear that terrorists could acquire and use a nuclear weapon has motivated a range of efforts by the Member States, in cooperation with the IAEA, to place nuclear materials beyond the reach of non-State actors. Little imagination is required to envision the disastrous consequences that would occur should these efforts fail. As former United Nations Secretary-General Kofi Annan warned, an act of nuclear terrorism "would not only cause widespread death and destruction but would stagger the world economy and thrust tens of millions of people into dire poverty."

Since the start of the new century, terrorist groups have committed acts of unspeakable barbarity in New York City, Madrid, London, Paris, Brussels, Bali, and throughout the Middle East and Africa. ISIS' use of chemical weapons in Syria and Iraq suggests it would commit violence on an even more horrifying scale if it could, and other terrorist groups have expressed the desire to obtain more destructive weapons, including nuclear capabilities. Unfortunately, this prospect is far from abstract. Al-Qaeda was thought to have pursued nuclear weapons in the 1990s, and, since that period, weapons-usable nuclear material has been interdicted outside of regulatory control in roughly two dozen actions.

Although constructing a nuclear device would require significant resources and advanced scientific and engineering skills, we cannot assume that these obstacles will hinder terrorists indefinitely. The only sure way to guarantee these malevolent actors never obtain the world's most powerful weapons is to prevent their acquisition of nuclear material.

The United States and its partners, working together with the IAEA, have made great progress over the past decade to secure or reduce the vulnerability of nuclear and radioactive material and associated facilities worldwide. Yet much work remains to be done, and because this threat recognizes no borders, efforts to counter it must be truly international in character. As the world's chief coordinator for nuclear security, the IAEA is *the* indispensable global body to assist States with improving nuclear security and enable the peaceful use of nuclear energy. The International Conference on Nuclear Security: Sustaining and Strengthening Efforts (ICONS 2020) held in February 2020 therefore presents a fitting occasion to strengthen our commitment to keeping these materials out of terrorists' hands.

Because of the IAEA's record as a venue for thoughtful deliberation and problem solving,

ICONS 2020 is an important opportunity to promote nuclear security internationally. ICONS 2020 provides a forum for senior government officials and nuclear security experts from around the world to share achievements and best practices, evaluate current approaches and propose new ones and identify future priorities for nuclear security.

Yet, as important as ICONS 2020 will be for global nuclear security, it is one element of a broader, ongoing effort. In 2021, the IAEA will also host the 2021 Conference of the Parties to the Amendment to the Convention on the Physical Protection of Nuclear Material, or the 2021 A/CPPNM Conference. An Amendment to broaden the scope of the 1979 CPPNM was adopted in 2005, including by significantly expanding the original requirements for protecting nuclear material used for peaceful purposes during international transport to include protections for such material in domestic use, storage and transport. The A/CPPNM entered into force in 2016 and serves as the foundation of the international nuclear security regime. It is the only legally binding undertaking covering the physical protection of nuclear materials and facilities. As of late 2019, there are still nearly 40 States Parties to the CPPNM that have yet to ratify the Amendment, and I encourage all States that have not yet done so to ratify the CPPNM and its Amendment prior to ICONS 2020, as the United States has proudly done.

Finally, I urge the Parties to the A/CPPNM to ensure they are implementing its provisions. In particular, States Parties must ensure they have enacted the necessary legal frameworks to support robust physical protection of nuclear materials and to criminalize certain acts, such as theft or smuggling of nuclear material. Doing so is crucial to international cooperation covered by the A/CPPNM, including the exchange of information on nuclear security threats and the prosecution or extradition of suspects believed to have committed offenses within the A/CPPNM's scope.

Those of us who are responsible for preventing nuclear terrorism often ask ourselves a haunting question: if such an attack were to occur, what would we wish we had done differently to prevent it? The priorities developed at ICONS 2020 and other international fora provide clear guideposts for improving nuclear security and making the world a safer place. What is needed now is the will to see these goals through to fruition and uphold our responsibility to future generations.

IAEA's Grossi at COP 25: More nuclear power needed for clean energy transition

(Photo: J. Donovan/IAEA)

IAEA Director General Rafael Mariano Grossi, speaking at the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP25) on 11 December in Madrid, Spain, said greater use of low carbon nuclear power is needed to ensure the global transition to clean energy, including to back up variable renewables such as solar and wind.

The world is currently well off the mark from reaching the climate goals of the Paris Agreement. With around two thirds of the world's electricity still generated through the burning of fossil fuels, and despite growing investment in renewable energy sources, global emissions of greenhouse gases reached a record high last year.

Mr Grossi said greater deployment of a diverse mix of low carbon sources, such as hydro, wind and solar, as well as nuclear power and battery storage, will be needed to reverse that trend and put the world on track to meet climate goals.

"We should not see nuclear energy and renewables as being in competition with one another," he said at a side event on Sustainable Development Goal 7 (SDG 7), on ensuring access to affordable and reliable energy. "We need to make use of all available sources of clean energy."

Nuclear power plants produce virtually no greenhouse gas emissions or air pollutants during operation. They are also able to operate around the clock at near full capacity, while variable renewables require back-up power during their output gaps.

"Nuclear power offers a steady, reliable supply of electricity," Mr Grossi stated. "It can provide continuous, low carbon power to back up the increasing use of renewables. It can be the key that unlocks their potential by providing flexible support — day or night, rain or shine."

He also spoke of the role of nuclear applications that help countries adapt to the consequences of climate change that are already apparent. "Our scientists help countries to develop new varieties of rice and barley that are tolerant of drought, extreme temperatures and salinity," he said. "We support the use of nuclear techniques to identify and manage limited water resources."

The United Nations side event, entitled "Accelerating the energy transformation in support of sustainable development and the Paris Agreement", focused on initiatives that could have a significant impact towards achieving the SDG 7 goals, helping to close the energy access gap in a sustainable way and promoting climate action by transitioning towards zero-carbon energy solutions.

The event was opened by remarks from Liu Zhenmin, Under-Secretary-General of the United Nations Department of Economic and Social Affairs (UNDESA), Damilola Ogunbiyi, Chief Executive Officer of Sustainable Energy for All and Li Yong, Director General of the United Nations Industrial Organization (UNIDO).

Mr Grossi said nuclear power needs a place at the table where the world's energy future is decided, and that he was encouraged by his talks with other international organizations and their willingness to work with the IAEA towards a cleaner climate.

He underscored the symbolism of attending COP25 just one week after taking office.

"This reflects the importance of the issue and my firm belief that nuclear science and technology have an important role to play in helping the world to address the climate emergency," he said. "That view is shared by many of the IAEA's 171 Member States."

— By Jeffrey Donovan

Sudan looks to nuclear technology to double farmers' income and grow peanut exports

Sudanese farmers in areas prone to drought now have a drought-tolerant peanut variety that will improve their livelihoods and increase the country's peanut exports. This new variety has shown up to 27% improvement in yields while needing less water and has the potential to double farmers' income. It was developed using nuclear techniques with the support of the IAEA, in cooperation with the Food and Agriculture Organization of the United Nations (FAO).

"Farmers in the rainfed areas of North Kordofan State used to grow fewer peanut crops, as they generally believed the environment was unsuitable," said Elgailani Adam Abdalla, Director of the El-Obeid Agricultural Research Station in the west of Sudan, adding that instead they had to rely on less lucrative produce, such as watermelons. "With this new variety, they have seen for the first time that peanut crops can grow and produce high yields even in harsh conditions."

Peanuts, also known as groundnuts, are commonly pressed into oil or used in various local dishes, including salads, soups and stews. Their leaves and stems, as well as cakes pressed from peanuts, are popular for livestock feed.

Sudan used to be one of the world's top exporters of peanuts, but its ranking has fallen in recent years. Traditional, small-scale farming in Sudan's western states produces 70% of the country's peanut supply. Since peanuts depend on rainfall to survive, devastating droughts in these regions have significantly affected farmers' ability to produce high yields.

The government is now looking to regain its footing as a top exporter while improving the livelihoods of subsistence farmers. Achieving this goal requires a crop variety that can produce high yields in these drought-prone areas. After a decade of research at the El-Obeid Agricultural Research Station, Sudan's Ministry of Agriculture and Forestry released a variety named Tafra-1 in 2018 and is now in the process of multiplying its seeds for large-scale distribution to farmers.

Developing the variety

Scientists used irradiation as an initial step in plant breeding to develop this


(Photo: IAEA)


(Photo: IAEA)

new variety. Irradiation accelerates changes in the genetic make-up of crops, so scientists can select lines with desired traits, such as drought resistance, and eventually obtain the best variety. While crops can take several centuries to adapt to changes in the environment through spontaneous mutation and natural selection, irradiation speeds up this process. This is also how this variety got its name: 'Tafra' means mutant in Arabic.

The IAEA, in cooperation with the FAO, supports countries, including Sudan, in adapting their agricultural practices to climate change. "Climate change causes increasingly significant damage to agriculture, putting food production at risk in various parts of the world, including Sudan," said Fatma Sarsu, a plant breeder and geneticist at the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. "Increasing agricultural production and productivity, in addition to adapting crops to variations in climate, is critical to ensuring food and nutrition security. Our collaborative work has contributed to crop adaptation to climate change in Sudan through the development of a new peanut variety."

Support, delivered through the IAEA's technical cooperation programme, included fellowships, training courses and equipment, such as a rainout shelter and a sprinkler irrigation system. The IAEA also supported Sudan by dispatching international experts to assist with the development, evaluation and selection of an improved peanut variety.

A participatory approach

Researchers were in charge of developing several potential varieties, but it was up to farmers to decide which ones worked best in their fields.

"We included farmers from the early stages of the research process so they could actually select the variety that best fits their needs," said Abdalla. This demand-driven research process also leads to a better chance of farmers adopting and using the variety once it's been developed, he added.

Farmers tested several peanut varieties across seven villages in North Kordofan State, one of the most vulnerable to drought in Sudan, monitoring them with researchers over four years to assess the outcome.

They were looking for certain desirable traits such as high and stable yields under various climate conditions and tolerance to terminal drought, the most common type of drought in the region, where dry spells coincide with the end of the growing season when the peanut plants are nearly mature.

In the end, the farmers and researchers came to the same conclusion: Tafra-1 was the clear winner, favoured for its tolerance to drought and ability to produce high yields with little rain.

Benefitting farmers and the economy

The new variety can grow with less than 250 mm of rain per year compared to the 350 mm needed for the traditional one, Abadalla said. It also produces yields that are 11% higher on average than the traditional variety — 1024 kg/hectare versus 926 kg/hectare — and, in some locations, yields have risen by as much as 27% in tests during the last three years.

Higher yields mean higher incomes for Sudan's small-scale farmers, who make up around 12% of the country's total population. Yield estimates across multiple growing seasons and locations indicate that, by using the new variety, peanut farmers could make up to US $28 more per hectare

per harvest. This is a significant increase given that a farmer's average income from a single season of peanut crops is roughly US $26 per hectare.

Eight hectares of the variety have been planted at present, and the Ministry of Agriculture and Forestry is working to multiply the seeds for large-scale use, Abdalla said. Meanwhile, the variety's high performance has prompted farmers to start multiplying seeds on their own.

But it won't be long before there are plenty of these seeds to go around.

"In 2020, we will give seeds to 100 farmers," Abdalla said. "But, in only three years, we expect to have multiplied enough seeds to supply all 230 000 potential groundnut farmers in North Kordofan State. We will then be able to produce enough for domestic consumption and the external market."

In the meantime, the IAEA is continuing to support projects in the country to help further improve crop productivity and the livelihoods of small-scale farmers in drought-prone areas. "We are very pleased with the success of this new groundnut variety, but further multiplying the variety and expanding outreach is vitally important to scale up the impact on livelihoods," said Solomon Haile, the IAEA Programme Management Officer responsible for projects in Sudan.

— By Kendall Siewert

Second shipment of low enriched uranium completes IAEA LEU Bank

The IAEA on 10 December 2019 received the second and final shipment of low enriched uranium (LEU) at a purpose-built facility in Kazakhstan housing the IAEA LEU Bank, which was established to provide assurance to countries about the supply of nuclear fuel. The delivery completes the planned stock of the material that the IAEA LEU Bank will hold, following the first shipment in October.

Kazakhstan's JSC National Atomic Company Kazatomprom — the world's largest producer of natural uranium — delivered 28 cylinders of LEU to the facility at the Ulba Metallurgical Plant (UMP) in the city of Ust-Kamenogorsk. The uranium originated from Kazakhstan and was enriched at a facility in the neighbouring Russian Federation before the LEU was transported by train to the site in eastern Kazakhstan, where it was checked and officially accepted by IAEA experts.

Owned by the IAEA and hosted by Kazakhstan, the IAEA LEU Bank is one of the IAEA's most ambitious undertakings since it was founded in 1957.

"With the arrival of the second shipment, the IAEA LEU Bank stock is now complete," IAEA Director General Rafael Mariano Grossi said.

(Photo: IAEA)

(Photo: K.Laffan/IAEA)

"I remember when the project was discussed and agreed by the IAEA Board of Governors in 2010, and I am very pleased that the Agency met the challenge and delivered on what the international community requested."

Marta Ferrari, the IAEA's Acting Project Executive for the IAEA LEU Bank, was at the site to inspect the consignment and sign the delivery documents. "With the arrival of the second shipment of LEU from Kazatomprom, the IAEA LEU Bank now has a sufficient amount of material for approximately one complete core for a 1000 MW(e) pressurized water reactor."

The establishment and operation of the IAEA LEU Bank are fully funded by voluntary contributions from IAEA Member States and other donors totalling US $150 million, covering estimated costs for at least 20 years of operation. Donors include the Nuclear Threat Initiative, the United States of America, the European Union, the United Arab Emirates, Kuwait, Norway and Kazakhstan. Kazakhstan also contributed in kind by hosting the IAEA LEU Bank.

"We would like to thank the donors for their generous contributions and the very helpful cooperation offered by Kazakhstan, China and the Russian Federation," Director General Grossi added.

Background

In December 2010, the IAEA Board of Governors authorized the Director General to establish the IAEA LEU Bank to serve as an assurance of supply mechanism of last resort for Member States that experience a supply disruption due to exceptional circumstances and are unable to secure nuclear power fuel from the commercial market, State-to-State arrangements or by any other means. It is a physical reserve of 90 tonnes of LEU, the basic ingredient to fabricate fuel for nuclear power plants.

More information on the history of the IAEA LEU Bank project and the first shipment of 32 cylinders of LEU from France's Orano Cycle is available on the IAEA's website.

The UMP, as the facility operator, has the prime responsibility for the safety and security of the IAEA LEU Bank and shall apply the IAEA safety standards and nuclear security guidance documents. The IAEA will perform review missions periodically to ensure that the UMP continues to operate the facility in accordance with such guidance.

Other assurance of supply mechanisms established with IAEA 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.

Globally, there are around 450 nuclear power reactors in operation today, supplying about 10 percent of the world's electricity and one third of all low carbon electricity. In addition, 52 nuclear power reactors are currently under construction.

New collaborative portal provides one-stop-shop access to isotope hydrology resources

A new information portal, launched in December 2019, will help water scientists expand their access to data from all over the world and increase collaboration possibilities to advance scientific research using isotope hydrology for better assessment of the quantity, quality and sustainability of the world's water supplies.

"We created this one-stop-shop Isotope Hydrology Collaboration Site platform to help streamline how isotope hydrologists access the information we offer," said Leonard Wassenaar, Head of the IAEA's Isotope Hydrology Section. "Before, we were receiving many requests for information and data via email, but now experts can instead get the relevant isotope hydrology details they are looking for all in one place, whenever they need it."

Water molecules have a unique set of 'fingerprints' that can be tracked throughout the entire water cycle, from evaporation to their return to a water source. By measuring different isotopes in water molecules, it is possible to determine the age and origin of water. Policymakers can use this information to gauge the vulnerability of water resources to pollution and determine the rate of replenishment.

Featuring an interactive portal for water scientists and collaborative partners who use isotope hydrology technologies and applications, the new system provides all the relevant information concerning IAEA isotope hydrology activities to aid them in their work.

The portal is available following registration for the IAEA's NUCLEUS platform and gives users access to a wide range of water-related resources, including an archive of all IAEA isotope hydrology publications, technical documents and newsletters, as well as to laboratory software and participation in laboratory proficiency testing.

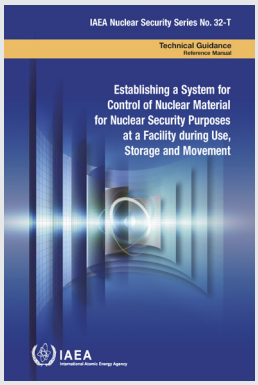
Also accessible are two of the IAEA's flagship collaborative networks: GNIP, the Global Network of Isotopes in Precipitation, and GNIR, the Global Network for Isotopes in Rivers. These networks are used in a variety of areas, such as climate change studies, environmental research and forensics.

The portal includes e-learning pages and reference materials to facilitate education and training. The e-learning component of the portal provides easy-to-understand educational videos on isotope hydrology, such as a step-by-step overview of tritium sample processing and analysis. For those wishing to participate in training courses, a dedicated web page showcases all available courses. A list of upcoming events and announcements allows experts to keep up to date with the latest water-related activities, such as workshops and conferences.

Registered users can also access the IAEA coordinated research projects they are participating in and collaborate with other users. Discussion boards have been set up to foster dialogue between scientists.

Some experts are already engaging with the portal to support their work. "I am really interested in staying in contact with the network. Let me know what we can do to collaborate further," said Emilia Jiménez Hernández, Research Assistant at the Applied Isotope Laboratory of the Research and Experimental Centre for Public Works (CEDEX) in Madrid, Spain.

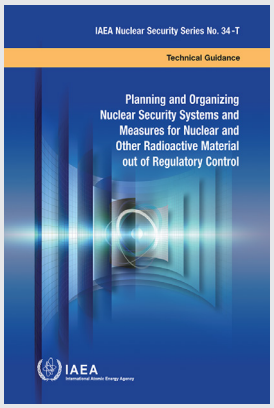
— Ismini Dimidis



Establishing a System for Control of Nuclear Material for Nuclear Security Purposes at a Facility during Use, Storage and Movement

focuses on the control of nuclear material during storage, use and movement using a facility's nuclear material accounting and control (NMAC) system. It describes practical measures for controlling nuclear material for nuclear security purposes during all activities at a facility, including movements, and how to use a graded approach in applying such measures. The technical guidance provided is targeted at States and their competent authorities on how to use individual elements of the NMAC system, but it will also be useful for persons responsible for designing, operating and assessing nuclear security systems, physical protection of nuclear facilities, nuclear security management, operators and managers of NMAC systems; as well as for those preparing associated regulations; and persons responsible for computer security at nuclear facilities.

IAEA Nuclear Security Series No. 32-T; ISBN: 978-92-0-103017-7;
English Edition; 38.00 euro; 2019



Planning and Organizing Nuclear Security Systems and Measures for Nuclear and Other Radioactive Material out of Regulatory Control

provides guidance on the planning and organization of nuclear security systems and measures for the detection of criminal or intentional unauthorized acts involving nuclear and other radioactive material out of regulatory control and for the response to potential nuclear security events (the response framework). The guidance includes processes for reviewing the adequacy of existing nuclear security systems and measures, identifying gaps in capabilities and resources, and designing new systems and measures to address identified gaps.

IAEA Nuclear Security Series No. 34-T; ISBN: 978-92-0-100119-1;
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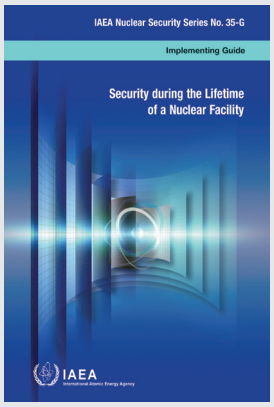

Security during the Lifetime of a Nuclear Facility

provides guidance to States, competent authorities and operators on appropriate nuclear security measures during each stage in the lifetime of a nuclear facility, from initial planning of the facility through to its final decommissioning. The publication addresses effective nuclear security in the transition between stages and applies to the nuclear security of nuclear material and nuclear facilities throughout the lifetime of all types of nuclear facilities. Although focused on nuclear power, the guidance contained in this publication may be useful for States developing nuclear programmes with other types of facilities, including those for research and development.

IAEA Nuclear Security Series No. 35-G; ISBN: 978-92-0-101119-0;
English Edition; 24.00 euro; 2019

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