

ITWG NUCLEAR FORENSICS UPDATE

No. 33 December 2024

CHAIRPERSONS' ADDRESS

Welcome to the 33rd edition of the Nuclear Forensics International Technical Working Group (ITWG) newsletter. Riding the momentum created by the ITWG-27 meeting in Manchester, United Kingdom, the ITWG now turns its focus to the continuing good work of the task groups. For instance, the efforts behind CMX-8 are truly remarkable and will soon be readily apparent to the participants.

This edition of the newsletter has three exciting articles focused on capacity-building efforts. First, the United States Department of Energy Nuclear Smuggling Detection and Deterrence programme (DOE NSDD), which has supported the ITWG for over 20 years, showcases its robust and diverse range of nuclear forensics training, workshops and exercises. Separately, there is a fascinating report on a large-scale field exercise, demonstrating the value of forward deployed nuclear forensics capabilities linked with laboratory expertise, which was organized by the Hungarian Centre for Energy Research (HUN-REN CER), the National Bureau of Investigation of the Rapid-Response Police (KR NNI), the Counter Terrorism Centre (TEK) and the Directorate of Disaster Management (OKF) in Budapest, Hungary. Last but by no means least, the IAEA Department of Nuclear Safety and Security has produced an excellent article illustrating the breadth of its nuclear forensics training and awareness programme, which highlights two new peer-to-peer training opportunities.

As co-chairs, we continue to plan the next ITWG annual meeting. Although not yet fully confirmed, we hope to meet you all together in the summer of 2025 in Bologna, Italy to celebrate the ITWG's 30 years of existence and to continue to strengthen our collective efforts in nuclear forensics for many years to come.

With best regards,

James Blankenship and Maria Wallenius

NSDD INTERNATIONAL CAPACITY BUILDING FOR NUCLEAR FORENSICS

GREG BRENNECKA, JODI CANADAY, LIZ DALLAS, MANSIE IYER, RUTH KIPS, RICHARD PAPPAS, JON SCHWANTES, ALINA SMYSLOVA, ROB STEINER, ADAM STRATZ AND TASHIEMA ULRICH

Background

For over 20 years, the National Nuclear Security Administration (NNSA) at the US Department of Energy (DOE) has collaborated with international partners to help build their capacity to detect, disrupt and investigate the smuggling of nuclear and radiological (R/N) materials that could be used in acts of terrorism. The Office of Nuclear Smuggling Detection and Deterrence (NSDD) worked with 95 partner agencies in 66 countries in 2024. It is the largest US government programme providing detection technology and capacity building support to include nuclear forensic science.

Nuclear forensic science helps governments to investigate and prosecute illicit uses of R/N material by helping to link illicitly trafficked material to people, places and/or events, thereby supporting state obligations under relevant international conventions, national criminal codes and other security agreements. The US government departments of Energy, State, Defense, Homeland Security and Justice frame their international cooperation through four nuclear forensics capabilities end-states. First, governments should effectively integrate national (and possibly regional or international) nuclear forensics capabilities into their response plans and procedures. Second, governments should be able to categorize, collect and secure as evidence R/N materials at a crime scene. Third, governments should be able to use existing nuclear science equipment and expertise to characterize R/N materials in a laboratory to differentiate between materials that do or do not belong on their territory. Fourth, governments should know the forensic signatures of R/N materials that are

NSDD International Capacity Building... continued from page I

included in their domestic holdings and administer that competence through a national nuclear forensics library.

NSDD capacity building with partners relies on this baseline of nuclear forensics capabilities and follows practical principles. The NSDD develops and delivers training, workshops, exercises and peer-to-peer collaborations to support the technical elements associated with the investigation and prosecution of nuclear smuggling incidents. A central principle of these engagements is that the scope and technical content of activities are tailored to be commensurate with the needs and technical infrastructure of the partner. As subject matter experts and instructors in these collaborations, the NSDD engages scientists and engineers from the DOE/NNSA laboratories, notably Argonne National Laboratory (ANL), Lawrence Livermore National Laboratory (LLNL), Los Alamos National Laboratory (LANL), Oak Ridge National Laboratory (ORNL), Pacific Northwest National Laboratory (PNNL) and Sandia National Laboratories (SNL).

NSDD training, workshops and exercises

The NSDD offers training and workshop curricula that are designed in a modular fashion for easy adaptation to each partner's needs.

Gamma Spectrometry Training uses a modular curriculum that can be adapted to meet the range of gamma spectrometry needs that partners encounter. The focus is on in-field gamma spectrometry for analysing the isotopic composition of interdicted material or items at different levels of data quality and confidence—during secondary inspections, in the investigation (tertiary inspections) and in analytical laboratory settings. The NSDD considers that in-field spectrometry provides some degree of both categorization (determining health and safety risks) and characterization (determining e.g. provenance through identification of isotopic and other signatures and their interpretation). There is a particular emphasis on law enforcement aspects. In addition, the course design covers isotopic identification tools common to the programme and other relevant commercially available radiation detection equipment.

The purpose of the Applications of Existing Capabilities to a Nuclear Forensics Investigation (APPs) workshop is to explore a country's existing analytical capabilities and communication mechanisms that can be used to answer investigative questions related to N/R material found outside of regulatory control. This interactive workshop involves a review of current partner country capabilities and the context for nuclear forensics, in-field analysis, characterization and discussions on paths forward to enhance capabilities and communication pathways.

The Analytical Plan Development (APD) workshop is designed to provide partner country laboratory analysts and their management with the knowledge to perform R/N material forensics analyses in support of investigations. This workshop walks the participants through each stage of an R/N material investigation,



Figures 1 and 2. Nuclear forensics in action. Photo: Dean Calma / IAEA

highlighting the specific analytical techniques that can be used to provide useful data for law enforcement.

The National Nuclear Forensics Library (NNFL) workshop is designed to introduce the concept of an NNFL in the context of nuclear security. In this workshop, participants are guided through a series of tabletop exercises and presentations that provide them with the knowledge required to develop their own NNFL, which can be used to determine whether R/N material outside of regulatory control belongs within their own country's nuclear holdings.

As one of the follow-on activities to the NNFL workshop, the NSDD provides a field-deployable kit to help partner countries develop their own NNFL. The kit contains an SQL database backbone and an optional user interface for implementing both radiological and nuclear material library databases with query capability, NNFL guidance documents, mock sources, an artificial database for testing library implementation and guidance on implementing the kit

The NSDD has developed and administers a Monthly Spectrometry Exercise, which is a monthly round robin gamma spectrometry exercise to hone and sustain the gamma spectrometry skills of partner countries based only on their analytical skills. Participants are provided with a scenario, relevant spectra and ancillary information, and asked to provide responses to investigative questions and questions focused on response efforts, rather than give analytical answers using multivariate techniques. Topics covered have ranged from naturally occurring radioactive material to medical or industrial sources, and are drawn from real-world experiences or observations.

Peer-to-peer laboratory technical exchanges

The NSDD has more than 20 bilateral peer-to-peer collaborations advancing laboratory analysis methodologies that provide nuclear and radioactive materials signatures that can determine the origin of interdicted materials. These focus primarily on the exchange of best practices in the analysis of complex, difficult-to-handle materials such as highly enriched uranium and plutonium. However, they can also involve uranium ores, uranium ore concentrates, commercial fuel pellets, certified reference materials (CRMs) or legacy materials, as well as nuclear materials from past interdictions provided by the partner country. Although these materials are part of an exercise and not an actual nuclear forensics investigation, they are treated as 'unknown samples', and therefore offer a unique opportunity to practice

nuclear forensics coordination analyses protocols and procedures.

The outcomes of these exchanges are presented in peer-reviewed journal articles. US subject matter experts who support NSDD peer-to-peer work are typically US DOE National Laboratory scientists with decades of experience of working with such materials.

Collaboration with international organizations

Collaboration plays a large role in nuclear forensics capacity-building activities. To implement these activities, the NSDD collaborates with the European Commission Joint Research Centre (EC-JRC), the International Atomic Energy Agency (IAEA), the International Criminal Police Organization (INTERPOL), the Nuclear Forensics International Technical Working Group (ITWG), the Science and Technology Center in Ukraine (STCU) and the International Science and Technology Center (ISTC). Along with others, the NSDD is a principal contributor to the IAEA Methodologies Course and the ITWG Collaborative Materials Exercise (CMX) series. The NSDD is fully coordinated with the US government and shares relevant international capacity building activities on a regular basis through the Forensics Engagement Working Group, which is chaired by the US Department of State.

Next generation nuclear forensic scientists

The NSDD supports international pipelines for the next generation of nuclear forensic scientists. It recently conceptualized and implemented a two-year pilot programme in partnership with the STCU with the specific aim of bringing more young talent to the field of nuclear forensics in countries around the world. The pilot resulted in graduate student fellowships in Tajikistan, Moldova, Armenia and Serbia, which are putting four students through a graduate programme relevant to nuclear forensic science, providing mentorship from US nuclear forensics experts and funding travel for two conferences per year.

Summary

In 2O24, the NSDD collaborated with 95 partner agencies in 66 countries to help build their capacity to detect, disrupt and investigate the smuggling of R/N materials that could be used in acts of terrorism. NSDD capacity building in nuclear forensics relies on a baseline of nuclear forensics capabilities and follows practical principles. Specifically, the NSDD develops and delivers training, workshops, exercises and

NSDD International Capacity Building... continued from page 3

peer-to-peer technical exchanges for the purpose of supporting the technical elements associated with the investigation and prosecution of nuclear smuggling incidents.

The international community derives two distinct advantages from the building of nuclear forensics capacity worldwide. First, by encouraging all countries to develop and maintain a minimum baseline of nuclear forensics capabilities, it can enhance each country's ability to identify R/N material outside of regulatory control and support the prosecution of traffickers. Second, through peer-to-peer partnerships, countries can increase the probability that nuclear material discovered outside of regulatory control is appropriately characterized using nuclear forensics examination methods.

The cornerstone of the NSDD's work is the enduring partnerships with partner countries, international organizations and US government departments. Internationally, this involves the EC-JRC, the IAEA, the ITWG, INTERPOL, the STCU and the ISTC. Within the US government, this involves the departments of Energy, State, Defense, Homeland Security and Justice. Finally, the NSDD supports international pipelines for the next generation of nuclear forensic scientists.

HUNGARIAN FIELD EXERCISE ON COUNTERING A RADIOLOGICAL TERRORIST ATTACK AT A MAJOR PUBLIC EVENT

EVA SZELES, PETER VOLGYESI AND JANOS BAGI

The prevention or detection of and response to a radiological terrorist attack represent a global challenge. An effective response to such a nuclear security event can only be provided through strong multi-agency cooperation by the relevant competent authorities supported by scientific organizations. Hungary demonstrated these capabilities on 11 October 2024. At the request of the European Commission's Directorate-General for Migration and Home Affairs (DG HOME), a large-scale international exercise was organized by the Hungarian Research Network (HUN-REN) Centre for Energy Research (HUN-REN CER), the National Bureau of Investigation of the Rapid Response Police (KR NNI), the Counterterrorism Centre (TEK) and the Directorate of Disaster Management (OKF) in Budapest. The event was fully supported by DG HOME and the European Commission Joint Research Centre (JRC), Karlsruhe.

The overall aims of DG HOME were to assist EU member states to enhance their preparedness to combat the illicit use of nuclear or other radioactive



Figure 3. Immediate response by the operational unit of the Counterterrorism Centre (TEK).



Figure 4. Radiation Protection measurements by the Hungarian Research Network Centre for Energy Research (HUN-REN CER).



Figure 5. Dr Ákos Horváth, the Director General of the Hungarian Research Network Centre for Energy Research (HUN-REN CER) and Dr Ulla Engelmann Director for Nuclear Safety and Security of the European Commission Joint Research Centre (EC JRC).

materials, and to promote the development of a high-level nuclear security culture in the EU member states. The exercise focused on radiation detection, immediate response to a radiological event, including neutralization of the explosive device, radiological crime scene management and in-field nuclear forensics analysis. The scenario involved a radiological detection event linked to a planned radiological terrorist attack at a major public event and was located at the National Athletics Centre in Budapest. The exercise involved demonstration of the capabilities and best practices of the Hungarian authorities.

According to the hypothetical scenario, a terrorist group smuggled nuclear and other radioactive materials across the Hungarian border in order to carry out a radiological terrorist attack at one or more major public events in Budapest. Based on information provided by the intelligence services, Hungary elevated the terror threat level and enhanced nuclear security measures at major public events. A person paid by the terrorists was given the task of driving a van into the National Athletics Centre, placing a backpack in the stadium and phoning the terrorists.

During the first part of the exercise, the mobile portal monitors of the TEK detected radiation (Cs-137 and special nuclear material) as the van entered the stadium and sent a silent alarm to the command post located at the scene. In response, the operations unit of the TEK arrested the driver and police patrols began to evacuate the stadium, which was simulated by volunteer students from the National University for Public Service (NKE). At the same time, the TEK's bomb disposal experts started work on neutralizing the explosive device in the van. The TEK Chemical, Biological, Radiological and Nuclear (CBRN) unit first took remote dose rate measurements using robots, then located the radioactive material in the vehicle and, with the support of the radiation protection expert at the HUN-REN CER at the command post, calculated the length of time that the bomb disposal expert could spend at the scene. The TEK also demonstrated decontamination of the bomb disposal expert.

In the second part of the exercise, the National Bureau of Investigation together with radiological experts from the HUN-REN CER worked as a combined expert team to collect and examine the RN materials and the forensics evidence contaminated with radionuclides at the scene. The special Hungarian protocol for radiological crime scene management had been developed by the KR NNI Criminal Forensics Department in cooperation with the HUN-REN CER within the framework of a joint project supported by the Ministry of the Interior in 2019. In-field forensics examination of a contaminated mobile phone (digital data and fingerprints) in a glove bag, in situ measurement of collected DNA samples using a portable DNA analyser, and in-field gammaspectrometry analysis of nuclear material were also demonstrated in connection with the radiological crime scene management (RCSM) activities. The National Directorate General of Disaster Management (OKF) provided technical assistance with ensuring the mass decontamination of civilians.

The event was opened by Mónika Herczeg, Head of the European Internal Affairs Cooperation Department at the Ministry of the Interior, Ulla Engelmann, Director for Nuclear Safety and Security at the JRC, and Valerio Liberatori, DG HOME. In all, 40 international CBRN and radiological experts from 18 EU member states and 45 Hungarian representatives of the various authorities participated in the event. The participants had an opportunity to observe and evaluate Hungarian multi-agency response capabilities for countering a radiological terrorist attack.

The exercise was closed with high-level speeches from Áron Jeney, Director of the KR NNI, Klaus Mayer, Head of the Nuclear Safeguards and Nuclear Security Unit at the JRC, and Ákos Horváth, Director General of HUN-REN CER. A press release and a short video can be found at https://www.ek.hun-ren. hu/en/2024/10/28/national-radiological-exercise-atthe-national-athletics-centre/

IAEA DEBUTS TWO NEW NUCLEAR FORENSICS WORKSHOPS IN 2024 CHELSEA WILLETT

The International Atomic Energy Agency (IAEA) launched two new week-long workshops in 2O24 as part of its wide-ranging training programme and continuous support to its member states to establish and develop national nuclear forensics capabilities. These workshops will complement existing IAEA courses, which range from awareness-building in a classroom to laboratory-based technical training.

Peer-to-peer workshop on nuclear forensics

The Peer-to-Peer Workshop on Nuclear Forensics (P2P Workshop) has been designed for states with existing knowledge and practice in nuclear forensics that are prepared to enhance and deepen their capabilities and collaborate with partner states. The P2P Workshop is designed for delivery at the regional level to promote cooperation, collaboration and training in nuclear forensics within a specified region, with an emphasis on sharing good practices and solutions to common challenges.

The P2P Workshop combines conventional lectures with in-depth, hands-on activities to empower participants to learn from each other, share experience and collaborate. The workshop is structured around a week-long scenario that comprises four practical exercises that follow the steps of a nuclear forensics investigation: physical characterization, interpretation of gamma spectra, scanning electron microscopy (SEM) image analysis, and isotopic analysis data interpretation.

The P2P Workshop was successfully piloted in Yogyakarta, Indonesia, in August 2024. Workshop participants from eight states from the Association of Southeast Asian Nations (ASEAN) worked collaboratively to engage with the scenario material. Each participating state also presented a poster on national nuclear forensics capabilities, allowing all attendees to learn about the state-of-practice in Cambodia, Indonesia, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Viet Nam.



Figure 6. Participants from the Peer-to-Peer Workshop on Nuclear Forensics interpret SEM images in teams. Photo: IAEA

NOTABLE PUBLICATIONS ON THE WORK OF THE ITWG, NUCLEAR FORENSICS AND RELATED DISCIPLINES

- Wang, L. et. al., 'Nuclear forensic analysis of rare earth elements in uranium ore concentrates', *Yankuang Ceshi (Rock and Mineral Testing)*, vol. 43, no. 4 (2024), pp. 622–31.
- Tóbi, C. et. al., 'Applicability of atomic force microscopy for nuclear forensic examination', *Journal of Radioanalytical and Nuclear Chemistry*, 4 Oct. 2024.
- Edwards, M. A. et al., 'Updated uranium reference material 231Pa/235U consensus model ages for nuclear forensics', *Journal of Radioanalytical and Nuclear Chemistry*, 19 Oct. 2024.
- Pointurier, F., Berthy, F. and Marie, O., 'Correlative morphological, elemental and chemical phase analyses at the micrometric scale of powdered materials: Application to nuclear forensics', *Vibrational Spectroscopy*, vol. 134 (Sep. 2024), 103729.
- Topyła, E. et al., 'Fast separation and determination of 55Fe and 63Ni using chelating resin Chelex 100 for activated parts of nuclear reactors and nuclear forensics', *Journal of Radioanalytical and Nuclear Chemistry*, 27 Sep. 2024.

Participants expressed great enthusiasm for the P2P Workshop and found the collaborative activities and regional exchanges of capabilities and experiences particularly beneficial. This workshop was supported by the National Research and Innovation Agency in Indonesia and the US DOE. The IAEA will continue to offer the regional P2P Workshop approximately once per year.

Integrated workshop on radiological crime scene management and nuclear forensics

The IAEA also developed and launched an Integrated Workshop on Radiological Crime Scene Management and Nuclear Forensics (IW), which is to be offered exclusively at the newly established Nuclear Security Training and Demonstration Centre (NSTDC) in Seibersdorf, Austria. The workshop has been designed to establish and build participants' awareness of the key techniques and approaches commonly used in radiological crime scene management and nuclear forensics, and to highlight the importance of effective communication and collaboration between these two areas.

The IW balances lectures with hands-on radiological crime scene activities and nuclear forensics data interpretation, thereby engaging participants in many of the activities important to radiological crime scene response and nuclear forensics examinations. The IW is structured around a week-long scenario and a mock radiological crime scene, an in-field categorization space and a demonstration laboratory. In addition, participants are given the opportunity to use portable detection equipment and develop a nuclear forensics analytical plan.



Figure 7. Participants from the Integrated Workshop on Radiological Crime Scene Management and Nuclear Forensics handle and document mock evidence in a portable glove tent. Photo: IAEA

The IW was piloted at two sessions in Q2 and Q3 of 2O24 to participants representing Armenia, Burundi, Costa Rica, Georgia, Indonesia, Kenya, Malaysia, Nigeria, Oman, Paraguay, Senegal and Ukraine. Participants enjoyed the interactive elements, such as demonstrations, videos, practical exercises and live play exercises, throughout the week and gained a greater awareness and appreciation of the importance of radiological crime scene management and nuclear forensics.

INTERPOL and numerous radiological crime scene management and nuclear forensics experts in the field provided invaluable contributions to curriculum development leading up to the successful debut of the IW. The IW will be delivered three times in 2025 to up to 30 member states.

UPCOMING TRAINING COURSES AND MEETINGS*

- IAEA Regional Workshop on Radiological Crime Scene Management, Gaborone, Botswana, 9–13 December 2024
- American Nuclear Society Mid-America Regulatory Conference (MARC) XIII, Kailua-Kona, Hawaii, 23–28 March, 2025
- IAEA International Integrated Workshop on Radiological Crime Scene Management and Nuclear Forensics, Seibersdorf, Austria, 7–11 April 2025

*Please check directly with the event organizer on the status and dates for implementation of the individual events listed above.

Dates and locations of IAEA training courses and meetings will be officially confirmed with host member states; participation in IAEA training courses and meetings is by nomination and in accordance with established IAEA procedures.

CONTENTS

Chairpersons' Address	1 1 4 6 6	
NSDD International Capacity Building for Nuclear Forensics		
Hungarian Field Exercise on Countering a Radiological Terrorist Attack at a Major Public Event IAEA Debuts Two New Nuclear Forensics Workshops in 2024 Notable Publications on the Work of the ITWG, Nuclear Forensics and Related Disciplines Upcoming Training Courses and Meetings		
		7

NUCLEAR FORENSICS

Nuclear forensics is an essential component of national and international nuclear security response plans to events involving radioactive materials diverted outside of regulatory control. The ability to collect and preserve radiological and associated evidence as material is interdicted and to conduct nuclear forensics analysis provides insights to the history and origin of nuclear material, the point of diversion, and the identity of the perpetrators.

THE NUCLEAR FORENSICS INTERNATIONAL TECHNICAL WORKING GROUP

Since its inception in 1995, the Nuclear Forensics International Technical Working Group (ITWG) has been focused on nuclear forensic best practice through the development of techniques and methods for forensic analysis of nuclear, other radioactive, and radiologically contaminated materials. The objective of the ITWG is to advance the scientific discipline of nuclear forensics and to provide a common approach and effective technical solutions to competent national or international authorities that request assistance.

ITWG PRIORITIES AND ACTIVITIES

As a technical working group, the priorities for the ITWG include identifying requirements for nuclear forensic applications, evaluating present nuclear forensic capabilities, and recommending cooperative measures that ensure all states can respond to acts involving illicit trafficking and unauthorized possession of nuclear or other radioactive materials. An objective of the working group is to encourage technical peer-review of the nuclear forensic discipline. These goals are met through annual meetings, exercises, and informal and formal publications.

Outreach is a primary goal of the ITWG. The working group disseminates recent progress in nuclear forensic analysis and interpretation with the broader community of technical and security professionals who can benefit from these advancements. Affiliated international partner organizations include the International Atomic Energy Agency (IAEA), the European Commission, the European Police Office (EUROPOL), the International Criminal Police Organization (INTERPOL), the Global Initiative to Combat Nuclear Terrorism (GICNT) and the United Nations Interregional Crime and Justice Research Institute (UNICRI).

ITWG MEMBERSHIP

Nuclear forensics is both a technical capability as well as an investigatory process. For this reason the ITWG is a working group of experts including scientists, law enforcement officers, first responders, and nuclear regulators assigned by competent national authorities, affiliated contractors, and international organizations. The ITWG is open to all states interested in nuclear forensics.

ITWG participating states and organizations recognize that radiological crimes deserve thorough investigation and, when warranted, criminal prosecution. The ITWG encourages all states to possess the basic capability to categorize nuclear or other radioactive materials to assess their threat. As an international group, the ITWG shares its expertise through its membership to advance the science of nuclear forensics as well as its application to nuclear security objectives.

http://www.nf-itwg.org/



The 'ITWG Nuclear Forensics Update' is produced by the Stockholm International Peace Research Institute (SIPRI) on behalf of the Nuclear Forensics International Technical Working Group and with the financial support provided by the United States Department of Energy, National Nuclear Security Administration. The content and the views expressed here belong to the authors.