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International Technical Working Group

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STRENGTHENING NATIONAL NUCLEAR SECURITY THROUGH NUCLEAR FORENSICS: THE ROMANIAN CASE

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The fourth Nuclear Security Summit (NSS), held in Washington, DC, in March 2016, focused on enhancing the national nuclear security capabilities of states while emphasizing that more work must be done to prevent the unauthorized possession of nuclear materials or radioactive sources by non-state actors. During NSS 2016, the President of Romania, Klaus Iohannis, announced a number of new commitments related to nuclear security that Romania stands ready to undertake. One of these commitments was to strengthen national capabilities for nuclear forensic investigations.

Against this backdrop, in October 2016 the Government of Romania in collaboration with the Global Initiative to Combat Nuclear Terrorism (GICNT) and the International Criminal Police Organization (INTERPOL) organized Exercise OLYMPUS. The event brought customs service, border guard and national police personnel together with technical experts, including nuclear forensics practitioners, from the Black Sea region. In a number of panel and scenario-based discussions, the participants identified the challenges that would be faced during a nuclear security event, as well as strategies and best practices aimed at overcoming these challenges.

Based on the results of Exercise OLYMPUS, the Romanian authorities made a comprehensive

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THE US NUCLEAR FORENSICS PROGRAMME COMBINES OPERATIONS, RESEARCH AND OUTREACH TO ENHANCE NUCLEAR SECURITY

MICHAEL J. KRISTO, LLNL, AND STEPHEN P. LAMONT, LANL

The United States has been an international leader in nuclear forensics for over 20 years, advancing US operational capabilities and the underlying science.

Beginnings of Nuclear Forensics

The USA has been a leader in nuclear forensic sample analysis for over 20 years. The alarming number of seizures of nuclear material following the break-up of the Soviet Union in the early 1990s caused the US Government to initiate a concerted to effort to develop nuclear forensics as a new mission area and a new area of scientific inquiry. The USA was instrumental in founding the International Technical Working Group (ITWG), and Lawrence Livermore National Laboratory (LLNL) hosted the initial organizational meeting (sometimes known as ITWG-0) in 1995. The USA is one of only three countries worldwide to have participated in all five of the ITWG round robin exercises to date. In addition, the USA has assisted in the analysis of numerous seized materials, including the sample of HEU oxide seized in Ruse, Bulgaria, in 1999. In 2005, three US scientists—Ken Moody, Pat Grant and Ian Hutcheon—published the first textbook on nuclear forensics, *Nuclear Forensic Analysis*.

Operational Capability

The Los Alamos National Laboratory (LANL) and the LLNL are the two laboratories designated by the US Government for operational analysis of bulk special nuclear material (SNM) for nuclear forensics. Their expertise in and historical knowledge of nuclear materials have enabled them to become the premier laboratories in the USA for nuclear forensic analysis of bulk SNM. Each laboratory is home to a unique combination of nuclear forensics facilities, instruments, and scientific and technical personnel. LANL and LLNL scientists employ a variety of

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UPCOMING TRAININGS AND MEETINGS

- IAEA Seminar on Introduction to Nuclear Forensics (Regional), Moscow, 4–8 September 2017
- IAEA General Conference, Vienna, 18–22 September 2017
- IAEA Practical Introduction to Nuclear Forensics (International), Budapest, 2–6 October 2017
- IAEA Practical Introduction to Nuclear Forensics (Regional), Sydney, Australia, 16–20 October 2017
- GIFT CBRN Forensics Workshop, Brussels, 17 October 2017
- GICNT Self-Assessment Tool Pilot Workshop, Bucharest, 7 November 2017
- IAEA Introduction to Nuclear Forensics (Regional), Pretoria, South Africa, 6–9 November 2017
- IAEA International Conference on Physical Protection of Nuclear Materials and Nuclear Facilities, Vienna, 13–17 November 2017
- IAEA Introduction to Nuclear Forensics (National), Dubai, United Arab Emirates, 20–23 November 2017

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

The US Nuclear Forensics Programme *continued*

analytical techniques for determining the isotopic, elemental, molecular and physical characteristics of a sample. Each laboratory has access to approximately 20 state-of-the-art scientific instruments for conducting nuclear forensics analyses. Their scientists continually focus on generating reliable, high-quality analytical results that will be legally defensible in a court of law. Through these efforts, the LANL and the LLNL provide the technical information and data needed by decision makers for law enforcement and nuclear security purposes.

Research and Development

The LANL and the LLNL both have active research and development programmes aimed at improving their analytical techniques and increasing the fidelity and precision of their nuclear forensics interpretation. As US Department of Energy (DOE) national laboratories, the LANL and the LLNL maintain large cadres of scientists and engineers who understand nuclear materials and the nuclear fuel cycle, but who also interact routinely with other experts throughout the US national laboratory system, in the nuclear industry and in the international community in order to interpret measurable signatures of the nuclear fuel cycle. Interaction among these experts allows the US nuclear forensics programme to advance the practice of discovering and understanding measurable signatures in nuclear material.

Promoting International Engagement

LANL and LLNL scientists are at the forefront of international collaboration on nuclear forensics and efforts to advance technical capabilities in the field. From building nuclear forensics tools 'at home' to teaching good laboratory practices abroad, they are engaged in a global undertaking to deter nuclear smuggling and identify material found outside of regulatory control.

International efforts at the LANL and the LLNL fall into three broad categories. First, they work with international organizations, such as the International Atomic Energy Agency (IAEA), to contribute to IAEA Nuclear Security Series guidance documents, and provide familiarization training in nuclear forensics for countries across the globe. Second, they work collaboratively with countries seeking to improve their nuclear forensics capabilities, by identifying and providing specialized training, conducted in the USA and in the home country, and helping them to improve their infrastructure for nuclear forensic analysis. Third, the LANL and the LLNL work with advanced countries on a peer-to-peer basis to advance the state-of-the-art in nuclear forensics and build mutual confidence in each other's nuclear forensics

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The US Nuclear Forensics Programme *continued*

capabilities. These collaborations are critical to building an international network of nuclear forensics investigators who can identify material outside of regulatory control and compare results to link seizure incidents, identify nuclear security gaps and help law enforcement disrupt attempts to traffic nuclear materials.

LANL and LLNL scientists also engage in multilateral meetings, such as the IAEA nuclear security conferences and ITWG meetings, that bring the wider international community together to share information and continue training on state-of-the-art nuclear forensics, and support US Government sponsors at the GICNT Nuclear Forensics Working Group.

Training the Next-Generation of Forensics Scientists

The US Nuclear Forensics and Attribution Act specifically tasks the US Department of Homeland Security (DHS) Domestic Nuclear Detection Office with creating a development programme to foster and maintain the US nuclear forensic workforce into the future. Efforts include establishing a clear pathway from undergraduate studies to postdoctoral study in disciplines relevant to technical nuclear forensics and providing the necessary scholarships, awards and funding opportunities for such education. The LANL and the LLNL support all these efforts from undergraduate familiarization and training to postdoctoral and early career research opportunities. For example, the Glenn T. Seaborg Institute runs an eight-week summer internship at each laboratory for students interested in nuclear forensics and related disciplines. Each laboratory routinely hosts multiple DHS graduate and postdoctoral fellows. Students can interact with premier researchers and access state-of-the-art equipment and facilities. These efforts serve to build interest and longevity into the workforce pipeline for nuclear forensics and foster prospective employment opportunities at the LANL and the LLNL. •

Figure 1. Tour of LLNL's nuclear forensics facilities during Apex Gold, a ministerial-level scenario based policy discussion held at LLNL on 27–28 January 2016

A WEEK FULL OF NUCLEAR FORENSICS EVENTS

KLAUS MAYER AND MICHAEL CURRY

The Nuclear Forensics International Technical Working Group held its 22nd annual meeting at the Konzerthaus in Karlsruhe, Germany, on 28–30 June 2017. It was hosted by the European Commission Joint Research Centre (JRC). The meeting gathered 111 nuclear forensics practitioners from some 35 countries and 4 international organizations (the IAEA, Interpol, SIPRI and GICNT) and was thus the biggest ITWG meeting yet. ITWG keeps expanding, and for the first time it attracted participants from Saudi Arabia and Serbia.

The agenda included plenary presentations reviewing ITWG activities over the past year and an outlook on future directions presented by Michael Curry. The IAEA, Interpol and GICNT provided briefings on nuclear forensics-related activities. Ed Fei (NNSA) reported on the Nuclear Forensics Simulation Exercise (NUFORSE), which is a radically different, highly interactive scenario-based exercise. Jovana Nikolov, a first-time participant, reported on Serbia's interest in and efforts on nuclear forensics. The presentation by Andrei Apostol and Kathleen Schoofs on attracting the next generation of nuclear forensic scientists generated an interesting discussion. In the ITWG Nuclear Forensic Laboratories (INFL) session, technical presentations illustrated ongoing research activities (a readout of CMX-5, reference materials, ongoing research at the JRC and the IAEC, and the IAEA's coordinated research programme) and casework (playing card contaminated with I-125). Vladimir Stebelkov addressed the issue of the use of information during nuclear forensic examinations,

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A Week Full of Nuclear Forensics Events *continued*

a contribution that feeds into the discussion on the concept of national nuclear forensic libraries and which deserves to be followed up. Vitaly Fedchenko shared his thoughts on the use of methodologies developed for nuclear forensics in other areas, such as the possible verification of a fissile material cut-off treaty (FMCT). A session was dedicated to reviewing and prioritizing the R&D needs identified at last year's meeting, where an impressive list of some 100 research topics was established. In an interactive session, participants identified their respective priorities. It is hoped that the guiding questions provided in this session will provoke a similar discussion at the national level. The five Task Groups of the ITWG (Evidence, Guidelines, Outreach, Libraries and Exercises) held individual working sessions. On the last day, Paul Thompson ran a table-top exercise to illustrate the challenges associated with linking operational issues with scientific aspects.

Overall, this year's ITWG meeting offered a broad spectrum of nuclear forensics-related presentations, discussions and breakout group sessions and thus contributed to advancing the science, the networking of experts and the exchange of experience. ITWG-23 will be hosted by Switzerland on 5–7 June 2018. This year's ITWG gathering was preceded by a meeting of the GICNT Nuclear Forensics Working Group (NFWG) on 26 June and on 27 June by a JRC hosted meeting open to ITWG and NFWG participants on 'presenting nuclear forensics evidence in Court'. •

Figure 1. ITWG-22 kicks off with a plenary session

Figure 2. Klaus Mayer, the ITWG Co-chair and the host of the event addresses the audience

Figure 3. Attendees commemorate ITWG-22 with a group photo

Figure 4. Kaitlyn Toole of ANSTO comments on a presentation

Figure 1. Participants in the training course on nuclear forensics methodologies join for a group photo

Figure 2. Training course participants ready to enter the nuclear forensics laboratory

IAEA/EC/NNSA INTERNATIONAL TRAINING COURSE ON NUCLEAR FORENSICS METHODOLOGIES: THE HOST'S PERSPECTIVE

MARIA WALLENIUS

On 17–28 October 2016, the European Commission's Joint Research Centre (JRC) in Karlsruhe, Germany, hosted the IAEA's International Training Course on Nuclear Forensics Methodologies. The 22 experts participating in the IAEA flagship training course came from nine countries: Germany, Indonesia, Malaysia, the Philippines, Romania, Serbia, South Africa, Switzerland and Ukraine. For the fourth time, this training course was organized, prepared and conducted in a partnership between the IAEA, the JRC and the US National Nuclear Security Administration. Building on the experience gained from previous courses held at the Pacific Northwest National Laboratory (PNNL) in Richland, WA, USA in February 2012, November 2013 and May 2015, this 10-day training event focused on practical, hands-on training in the controlled setting of a nuclear forensics laboratory. Based on a fictitious scenario of an illicit trafficking incident involving uranium and plutonium, on the first day participants observed demonstrations of radiation portal monitors and hand-held radiation detectors, and learned how evidence is prepared for nuclear transport. In the following days, the participants used the nuclear forensic laboratory to practice working in a glove-box environment and to prepare samples for destructive analysis. In addition to that, they spent two days on gamma spectrometry measurements. During the second week, the participants observed and, most importantly, conducted various advanced analytical measurements. These included a half-day each on understanding the principles—and nuclear forensic usefulness of—alpha spectrometry, thermal ionization mass spectrometry, inductively coupled mass spectrometry as well as scanning electron microscopy. These techniques allowed the participants to determine the isotopic composition, element content, chemical impurities, age and morphology of the uranium and plutonium samples being investigated. The participants were also familiarized with procedures for developing fingerprints on radioactively contaminated items collected at a crime scene. After obtaining the analytical results, the participants consulted the nuclear forensics library to compare the evidence samples with 'domestic' holdings. The training course was supported by international experts from PNNL, Los Alamos National Laboratory and Lawrence Livermore National Laboratory, USA, as well as the United Kingdom's Atomic Weapons Establishment and the Swedish Defence Research Agency. •

THE FIFTH ITWG COLLABORATIVE MATERIALS EXERCISE

JON SCHWANTES, OLIVIA MARSDEN AND FIONA TAYLOR

The ITWG serves as a platform for advancing best practices and protocols in nuclear forensics. The ITWG's Exercise Task Group contributes to that work by organizing voluntary, inter-laboratory collaborative materials exercises (CMXs) aimed at analysing, identifying and prioritizing techniques and methods for forensic analyses of seized nuclear materials as well as classical forensic evidence contaminated or comingled with nuclear and radiological materials.[1] The fifth and largest collaborative materials exercise (CMX-5) began in September 2016. The official end of the exercise was marked by the participants gathering in Bucharest to attend a Data Review Meeting. For CMX-5, two low-enriched uranium oxide pellets were shipped to participating laboratories for analysis as part of an elaborate mock-illicit trafficking scenario. Analytical results from a third virtual-swipe sample was also provided to participants for them to attempt to establish or exclude linkages between the samples based on their materials characteristics. The exercise facilitator, acting as the 'lead investigator' of the fictitious nuclear forensic investigation, requested laboratory assistance from the exercise participants in an attempt to spur basic and advanced nuclear forensic analyses. Laboratories shared their results with the lead investigator following IAEA guidance in the form of preliminary reports after 24 hours and one week, as well as a final report after two months. The design features of CMX-5 successfully targeted the use of:

- morphological features as nuclear forensic evidence;
- analytical results that support law enforcement group inclusion / exclusion decisions
- a chain of custody for managing nuclear forensic evidence; and
- formalized analytical plans for communicating and documenting law enforcement requests for analysis.

The three-day Data Review Meeting in Bucharest provided an opportunity for participants to discuss lessons learned, share experiences and exchange best practices, and was graciously hosted by a newcomer to the ITWG CMX series, the Horia Hulubei National Institute of Physics and Nuclear Engineering. Participants reported on and discussed results from 38 separate analyses used to characterize exercise samples, the results of which it is planned to summarize and publish in several journal articles in the coming year. While still preliminary, one major lesson learned during CMX-5 was the importance of being aware of the limitations of assigning confidence to decisions based on a single material characteristic. CMX-5 also highlighted the necessity to engage with subject matter experts to weigh the importance of multiple measurements when combined results are used to make decisions. •

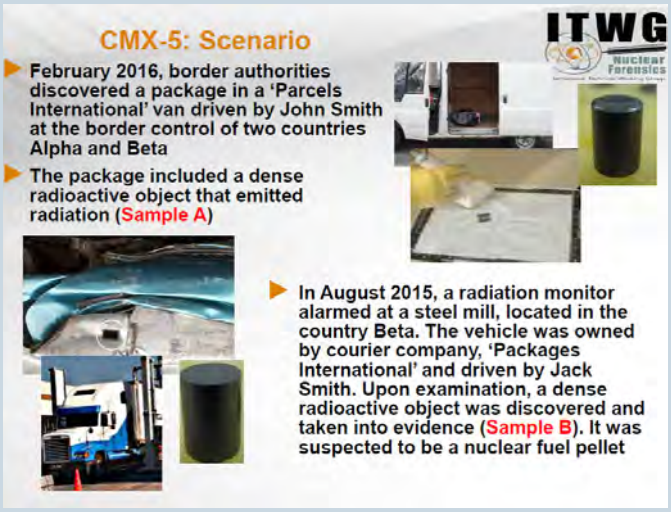

Figure 1. An overview of the CMX-5 scenario

Figure 2. Participants in the CMX-5 Data Review Meeting in Bucharest stand for a group photo

[1] For more information on CMXs, see Schwantes, J. and Marsden, O., 'The ITWG Exercise Task Group', *ITWG Nuclear Forensics Update*, no. 1 (Dec. 2016), <http://www.nf-itwg.org/newsletters/ITWG_Update_no_1.pdf>, p. 6.

Strengthening National Nuclear Security through Nuclear Forensics: Romania *continued*

evaluation of the national nuclear security architecture. These efforts were led by the Ministry of Foreign Affairs and included contributions from all the key national players with responsibilities in the field of nuclear security: law enforcement, nuclear forensics experts, intelligence agencies and the regulatory body. In a series of inter-institutional meetings, experts made three proposals to further consolidate the national nuclear security system. These were officially endorsed by the President and the Prime Minister of Romania.

The first proposal was to strengthen the national legal framework by elaborating a National Response Plan to Incidents of Illicit Trafficking of Nuclear or Other Radioactive Materials. To this end, the Presidential Administration mandated the Ministry of Foreign Affairs to establish an expert working group to elaborate a first draft of the Plan, which would then be finalized by a decision-making group under the direct coordination of the administration.

The second proposal was to strengthen Romania's nuclear forensics capabilities by ensuring the official recognition of the National Nuclear Forensics Laboratory, which is being established by IFIN-HH as a unique institution offering nuclear forensics support to national law enforcement authorities in the course of an investigation. This proposal will develop information support to investigations, referred to as a National Nuclear Forensics Library. Both projects are in the process of implementation.

The third proposal was to keep the topic of nuclear security high on the national agenda by creating a Working Group under the direct leadership of the Presidential Administration to focus on the current issues related to nuclear security, as well as on enhancing collaboration between law enforcement and technical support organizations, including nuclear forensics experts.

Building on the success of Exercise OLYMPUS, Romania will organize a new regional event in November 2017, in collaboration with GICNT. Exercise OLYMPUS RELOADED will be a common effort of the Ministry of Foreign Affairs and IFIN-HH, which will combine the practical aspects of nuclear forensics with a table-top exercise focused on the investigation of a case of the illicit trafficking of nuclear materials. The key objective is to strengthen collaboration between prosecutors and nuclear forensics experts by establishing direct channels of communication, common lexicons and complementary responsibilities.

In preparation for Exercise OLYMPUS RELOADED, in July 2017 the Ministry of Foreign Affairs hosted a meeting between prosecutors and nuclear forensics experts—the first event of this kind to take place at the national level. Both sides took stock of each other's contribution to the investigation of a case of illicit trafficking of nuclear and other radioactive materials, and agreed to maintain close collaboration not only in view of the upcoming GICNT exercise, but also to help ensure a robust national nuclear security framework. •

CONTENTS

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/