ITWG Nuclear Forensics International Technical Working Group

ITWG NUCLEAR FORENSICS UPDATE

No. 8 September 2018

COMMENT FROM THE CO-CHAIRS

Welcome to the Nuclear Forensics International Technical Working Group's quarterly newsletter. This edition includes a brief summary of outcomes from discussions held in the picturesque mountains of Switzerland during our 23rd annual meeting in June. In addition, it includes articles on Germany's Federal Office for Radiation Protection, the US Federal Bureau of Investigation's Radiological Evidence Examination Facility, and the renewed focus on the role and work of the ITWG Nuclear Forensics Laboratories (INFL). We also are excited about the participation of so many experts in the sixth collaborative material exercise (CMX-6) that will begin later this month. We look forward to reviewing the progress of the exercise and other nuclear forensics developments at ITWG-24 next June in Romania. Other events during the second quarter of 2019 include the IAEA Technical Meeting on Nuclear Forensics and the CMX-6 Data Review meeting. We encourage you to have your suitcases (and travel budgets) ready!

With best regards,
Klaus Mayer and Michael Curry

NUCLEAR FORENSICS EXPERTS MEET IN THE SWISS MOUNTAINS

KLAUS MAYER AND MICHAEL CURRY

The 23rd meeting of the Nuclear Forensics International Technical Working Group (ITWG-23), held at Switzerland's Federal Training Centre in Schwarzenberg, marked the most recent milestone in the working group's series of annual meetings. This year's gathering of almost 100 nuclear forensics practitioners from more than 30 countries and international organizations offered many opportunities for sharing best practices and discussing nuclear forensics activities.

Scientific talks and professional development seminars

During the ITWG's Nuclear Forensics Laboratories (INFL) session, there were a variety of scientific talks on cutting-edge research and case studies where nuclear forensic techniques were applied. The professional development seminars on laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) and on lifting fingerprints from evidence contaminated with radioactive material provided useful insights. Several laboratories usefully applied LA-ICP-MS during ITWG's fifth collaborative materials exercise (CMX-5) in 2016, and others are expected to apply fingerprint-lifting techniques during the sixth collaborative material exercise (CMX-6) that will begin in September 2018. Both professional development sessions were highly informative.

ITWG-23 plenary session and task groups

During the plenary session, participants learned about ongoing activities at the International Atomic Energy Agency (IAEA), the Global Initiative to Combat Nuclear Terrorism (GICNT) and the International Criminal Police Organization (INTERPOL) including upcoming trainings, workshops and conferences, and the IAEA Technical Meeting on Nuclear Forensics in April 2019 was highlighted. The plenary talks also reviewed the ITWG's recent achievements including completion of the third Galaxy Serpent exercise (GSv3) on national nuclear forensics libraries and preparations for CMX-6. The plenary also provided opportunities to share information on the multitude of national activities that several laboratories are pursuing.

The ITWG's five task groups (Evidence, Exercise, Guidelines, Libraries and Outreach) made significant progress in their work and fostered intense discussions. New thoughts came up and each task group began preparing a strategic plan that will be available to ITWG participants before the end of 2019.

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THE FBI'S RADIOLOGICAL EVIDENCE EXAMINATION FACILITY (REEF)

JAMES BLANKENSHIP

The saying 'necessity is the mother of invention' is attributed to Plato, around 400 BC. His idea certainly applies to the challenges faced by the United States Federal Bureau of Investigation (FBI) when developing new capabilities to respond to criminal or terrorist acts involving chemical, biological, radiological and nuclear (CBRN) materials. The 1995 chemical weapon attack in the Tokyo subway was the wake-up call that prompted the FBI to develop the Hazardous Evidence Response Teams (HERTs). These forensic evidence collection teams were first comprised of professional hazardous materials officers and specialists as well as specially trained FBI agents. A few years later, the terrorist attacks on the USA of 11 September 2001, which were immediately followed by the October 2001 deadly *Bacillus anthracis* ('anthrax') mailing attacks, highlighted the necessity to not only collect CBRN evidence but to also examine it forensically. During the forensic response to the anthrax investigation, the FBI quickly realized the need for forensic examiners who were qualified to handle the dangerous CBRN materials. The FBI also recognized the need for suitable laboratory facilities to provide adequate containment of such evidence. Thus, the FBI Laboratory began to search for US Government partner laboratories where CBRN-trained staff and proper facilities were already in place.

Figure 1. FBI photographer taking images of evidence within the dedicated FBI hot cells during an exercise held in 2015 at the Radiological Evidence Examination Facility, Savanah River National Laboratory

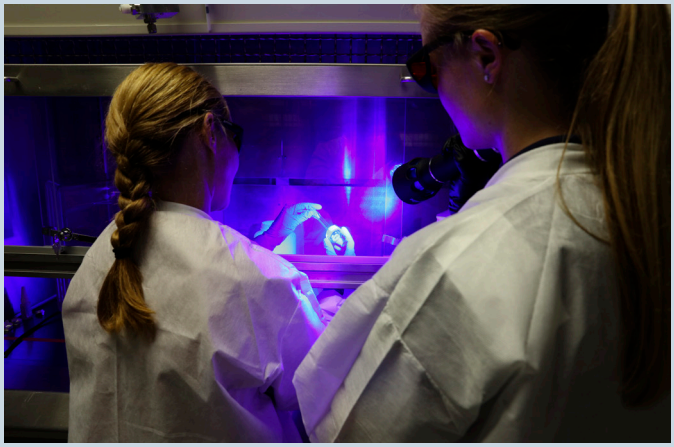

Figure 2. FBI Hazardous Evidence Analysis Team latent print examiners observing an item of evidence using a hand held light source during a drill held in 2017 at the Radiological Evidence Examination Facility, Savanah River National Laboratory

The road to REEF

The search for a partner laboratory experienced in handling radioactive materials led the FBI to the US Department of Energy's Savannah River National Laboratory (SRNL). SRNL has a long history and deep expertise in the analysis and safe handling of radioactive/nuclear materials. The next task was to find lab space where contaminated items could be examined by FBI forensic examiners, while SRNL's analytical chemists could conduct the detailed isotopic determinations. The planning team first attempted to identify existing radiological lab space where ongoing experiments could be suspended temporarily to allow the FBI to conduct its forensic examinations whenever needed. However, on closer consideration, it was obvious that—given the cross-contamination issues associated with the 50-year old research labs—it would be methodologically unsound to conduct nuclear forensic exams in the same space where radioactive materials had been handled for many years. Eventually, a set of rooms—which were previously used for electrical engineering research, but not radioisotope experiments—was selected for renovation. The planning team compiled a cost estimate to renovate the 1960s labs space and added the radioactive material containment ventilation. In 2007 the US Congress approved funding for what would become known as the Radiological Evidence Examination Facility (REEF), and the site was fully operational in June 2010.

The detailed architectural and engineering design demands for the REEF encountered several challenging dilemmas as the team attempted to include the necessary doors, locks and alarms which would satisfy both the US Department of Energy

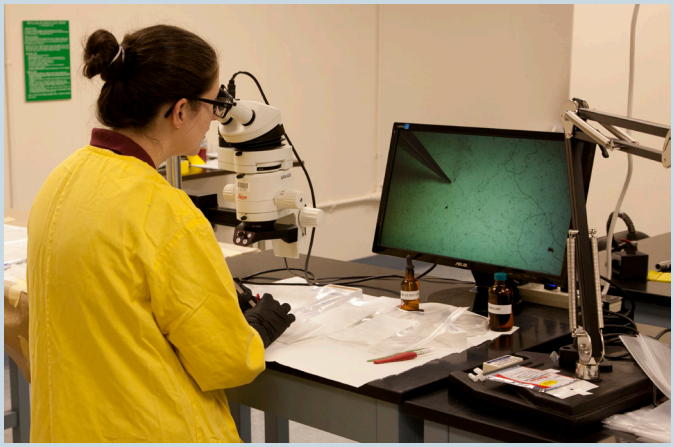

Figure 3. FBI HEAT member examining hairs and fibers recovered from an item of evidence during a drill held in 2017 at the Radiological Evidence Examination Facility, Savanah River National Laboratory

Figure 4. SRNL support employee intentionally contaminating an item of evidence with the short-lived fluorine-18 isotope during a drill held in 2017 at the Radiological Evidence Examination Facility, Savanah River National Laboratory

(DOE) regulations for safe radiological containment and the FBI's regulations for evidence security. Since any amount of fire or explosion in a radiological lab could have severe consequences to worker safety as well as the integrity of the ventilation system, other design questions naturally involved the handling of radiologically contaminated flammable and/or explosives evidence. The safety authorization for the REEF now restricts the lab space to very small amounts of TNT-equivalent explosive material. To address flammable evidence, a 'facility safety board' reviews inbound evidence prior to arrival and dictates additional safety constraints that must be applied to specific items of evidence.

The HEAT comes to REEF

Prior to the completion of the REEF, the FBI Laboratory created the Hazardous Evidence Analysis Team (HEAT). HEAT comprises experienced examiners from the FBI's forensic disciplines such as questioned documents, DNA, firearms and tool marks, latent prints, digital evidence, chemistry, explosives, hair and fiber, metallurgy, and photography. In order to become qualified to handle radiological materials, the HEAT members must first complete a baseline DOE Radiological Worker-2 course at SRNL. Then they participate in exercises to examine mock evidence in the REEF. Some of the exercises include items that have been intentionally contaminated with the short-lived fluorine-18 isotope. Thus, the HEAT examiners are given experience dealing with actual radiological dose and contamination. The REEF is equipped with the same forensic instruments that the HEAT examiners use regularly at their home laboratory in Quantico, Virginia. However, some of the instruments have additional engineering controls to reduce the spread of radiological contamination. The REEF also includes a set of 'shielded cells' with remote manipulators that can be used to segregate life-threatening high-dose radiological sources from other associated evidence.

The FBI depends on the expert staff of SRNL for the maintenance and operation of the REEF. Whenever the FBI begins to consider a seizure of radiological evidence, the REEF principal scientist is alerted regarding the type of predicted evidence and the expected arrival date. On arrival at SRNL, the evidence containers are screened by SRNL radiological control officials and then the package is stored in the REEF evidence vault. Usually within one or two days, the FBI HEAT examiners arrive to conduct the full photography and examination processes. The examiners are assisted by SRNL's highly experienced radiological specialists. In many cases, a sample of the evidentiary radioactive material is submitted to SRNL for nuclear forensic analysis.

Fortunately, nuclear forensic investigations are not common occurrences. But when the cases arise, the REEF and HEAT team are critical assets in the US Government's response to radiological crimes and terrorism. •

NUCLEAR FORENSICS COOPERATION: A ROBUST AND ACTIVE GERMAN NETWORK

EMILY KROEGER

Since the reunification of Germany in 1990, several high-profile criminal investigations involving nuclear or other radioactive material out of regulatory control have been reported in the international press. Examples include the prominent 'plutonium affair' in 1994, in which approximately 360 grams of plutonium were smuggled into Munich airport; the 'WAK plutonium theft' in 2000, in which contaminated material was stolen from a reprocessing facility in Karlsruhe; and the 'Po-210 case' in 2006, in which traces of polonium-210 were discovered at different sites in and around Hamburg.

Germany is a federal system with 16 individual states ('Länder'). Each state ('Land') is directly responsible for the first response to all emergency situations, including, generally, nuclear security events. If requested, the German federal government offers support to the Länder in the form of personnel and equipment. The federal government is directly responsible for responding to some nuclear security events, in particular to suspected acts of terrorism.

For an appropriate and timely response, a range of specialists are required, such as police, radiation protection and environmental protection from all levels of government and from other institutions such as universities and laboratories. Federal specialists are brought together on an ad hoc basis as part of the Central Federal Support Group for Serious Nuclear Threats (Zentrale Unterstützungsgruppe des Bundes für gravierende Fälle der nuklearspezifischen Gefahrenabwehr, ZUB), which is a cooperation between the Federal Criminal Police Office (Bundeskriminalamt, BKA), the Federal Police (Bundespolizei, BPOL) and the Federal Office for Radiation Protection (Bundesamt für Strahlenschutz, BfS). With 16 Länder, the federal government and many different active partners to be involved, Germany, when responding to nuclear security events, is faced with a considerable cooperation challenge. However, the advantage of such a large, active network is its natural resilience.

Coordinating an appropriate and timely response

If support from the ZUB has been requested by a Land, the ZUB will join the police investigation as a subsection, with the police commander from the Land remaining in charge of the entire operation. ZUB provides specialized personnel and equipment for the investigation of a crime scene that is contaminated with nuclear or other radioactive material. The aim is to allow normal police work to continue within a reasonable timeframe, despite the radiological hazard.

BfS advises police authorities in real time on radiation protection measures and the nuclear forensics possibilities. There are a number of practical steps that BfS implements at the scene in order to reduce the radiation dose received by the deployed personnel and to limit the spread of contamination into the environment. These include (*a*) measuring and recording the dose for all deployed personnel; (*b*) deciding on suitable personal protective equipment; (*c*) advising the decontamination facilities; (*d*) measuring airborne and other contamination levels; (*e*) providing mobile air-lock and/or contamination control points (see figure 1); (*f*) measuring an initial radiation survey as part of an all-hazards approach; (*g*) accompanying police forensic specialists into the scene (see figure 2); (*h*) removing radioactive sources from the scene; (*i*) conducting non-destructive nuclide identification and activity estimation at the scene; (*j*) advising on the transport of radioactive sources; (*k*) sealing contaminated evidence to allow removal from the scene (see figure 1), and; (*l*) assisting police experts with the handling

Box 1. The case of the contaminated playing cards

Circular pieces of playing cards and other items contaminated with Iodine-125 were found at an incinerator plant in the Land of Brandenburg, just outside of Berlin in 2014 and in 2016. As a result of these finds, the Berlin Criminal Police Office began an investigation that led to the search of a property in Berlin in 2017, where yet more contaminated playing cards and contaminated items were found. Part of the nuclear forensic analysis of the items was carried out by BfS at the incinerator plant and in the laboratory at the BfS for 'unknown' samples, as part of a cooperation between the Berlin Criminal Police Office (LKA) and the BfS.

Figure 3. Berlin police posted this picture of the radioactively contaminated playing card pieces to social media in November 2017.

Figure 1. Air-lock for people and evidence as an entrance/exit to a radiologically contaminated crime scene, showing the heat-sealing device and a mobile glovebox (during an exercise of the ZUB)

Figure 2. A mixed team of police and radiation protection specialists work together in a radiologically contaminated crime scene (during an exercise of the ZUB)

and initial analysis of evidence at the scene and in the mobile glovebox (see figure 1). Evidence contaminated with nuclear or other radioactive material can only undergo limited initial forensic analysis at the scene. Under usual circumstances, in-depth forensic analysis would take place in a police laboratory; however, police laboratories do not have the authorization or the capability to handle radioactive samples.

Utilizing specialized resources

In the event that nuclear material or evidence contaminated with nuclear material is removed from the scene for further forensic investigation, the items in question are transported, based on a framework agreement with the federal government, to the Joint Research Centre (JRC) of the European Commission in Karlsruhe. JRC Karlsruhe has specialized facilities for handling nuclear material and contaminated evidence. In cooperation with BKA, JRC Karlsruhe has developed a glovebox for obtaining fingerprint analysis and DNA samples from evidence contaminated with nuclear or other radioactive material. During the analysis, the police experts direct the working steps to be carried out by JRC personnel. In addition, JRC Karlsruhe can perform nuclear forensic analysis on nuclear materials and compare the results against their extensive database.

Nuclear forensics includes not just the forensic analysis of nuclear material, or evidence contaminated with nuclear material, but also the forensic analysis of other radioactive materials and evidence contaminated with other radioactive material. BfS has a specialized laboratory for receiving and characterizing non-nuclear samples that lack a definitive nuclide identification or activity value. One recent example is the case of playing cards contaminated with I-125 (see box 1). BfS can also handle and analyze contaminated food samples. In addition, measurement in the whole body counter, biological dosimetry and the analysis of urine samples are possible if an incorporated dose is suspected. The BfS also maintains a register of highly active sealed sources.

Further cooperation on nuclear forensics exists at the federal level and between the Länder and other institutions. For instance, BfS, BKA and the Bavarian State Criminal Police Office (Bayerische Polizei) all have a strong history of cooperation with the Radiochemistry Munich (RCM) of the Technical University of Munich (TUM), which was already involved in the 'plutonium affair' case in 1994 and further incidents in Bavaria. JRC Karlsruhe has additional nuclear forensics cooperation with German authorities, for example with the Baden-Württemberg Ministry of the Environment and that Land's State Bureau of Investigation. Another example of cooperation in the field of nuclear forensics is the agreement between the research institute Helmholtz-Zentrum Berlin (HZB) and the Berlin Criminal Police Office (Berlin Landeskriminalamt, LKA) for the manipulation and analysis of radioactive sources and evidence contaminated with radioactive material linked to a police investigation.

It is evident from the extensive cooperation between police experts and radiation protection specialists in the Länder, at the federal level and internationally that Germany is very active in the field of nuclear forensics. This cooperation involves many different police experts and radiation protection specialists and is extensively tested through exercises and deployments. Training and exercises are essential for improving cooperation, capabilities and resilience! •

ITWG NUCLEAR FORENSICS LABORATORIES (INFL)

MARIA WALLENIUS AND NAOMI MARKS

The concept of the ITWG Nuclear Forensics Laboratories (INFL) was first introduced at ITWG-8 in Budapest, Hungary, in 2003. INFL's objective was to 'advance the science of nuclear forensics and to serve the need of states and law enforcement agencies that need such a capability'. At ITWG-9 in Cadarache, France, the US co-chair at the time, Sid Niemeyer, presented the organization chart of the INFL, comprising an Executive Committee and Task Groups, the latter to perform 'specific INFL functions'. The functions of the INFL included (*a*) establishing guidelines for best practices, (*b*) conducting international exercises, (*c*) promoting research and development activities, (*d*) communicating with external organizations, (*e*) providing a point-of-contact for nuclear forensics assistance, and (*f*) assisting one another in nuclear forensic investigations. The members of the INFL were scientists from laboratories who had participated in an ITWG Round Robin (now called collaborative material exercise, CMX) or were invited by the Executive Committee. The INFL was instructed to meet just prior to ITWG plenary meetings.

Increasing the INFL's visibility

Some of the INFL activities are, indeed, covered by the current five Task Groups (Evidence, Exercise, Guidelines, Libraries and Outreach). However, some other key aspects, such as 'promoting R&D activities' and 'assisting each other in nuclear forensic investigations' remain core competences of the INFL. Therefore, the Executive Committee of the ITWG decided earlier this year to give these important areas more visibility and increased attention. Similar to the Task Groups, the INFL will henceforth be supervised by two co-chairs. These are Naomi Marks (Lawrence Livermore National Laboratory, USA) and Maria Wallenius (Joint Research Center Karlsruhe, European Commission).

The new arrangement was instituted at the ITWG-23 meeting held on 4–8 June 2018 in Switzerland. The agenda of the INFL comprised 11 presentations and 2 'professional development seminars' (PDS) covering a full day of the three-day meeting. The first PDS was about laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS), which was co-organized by the JRC Karlsruhe (European Commission) and the Canadian Nuclear Safety Commission (CNSC). The second PDS addressed the lifting of fingerprints from contaminated evidence. This PDS was co-organized by PNNL (USA), FBI (USA), AWE (UK) and NFI (the Netherlands). The professional development seminars gave participants the possibility to learn about these techniques and methods in more detail and to become familiar with their applications as well as limitations.

Technical presentations pack a punch

The presentations given at this year's INFL session touched on various topics related to nuclear forensics research and development. They included several topics of broad interest to the INFL, including age determination of plutonium (Pu), highly enriched uranium (HEU) analysis by gamma spectrometry, isotopic measurements of oxygen in low-enriched uranium (LEU), new reference materials for nuclear forensics and chemometrics for uranium ore concentrate (UOC). Also several case studies (e.g. Iodine-125—see an article by Emily Kroeger in this issue—and depleted uranium) were presented. In the feedback questionnaire, about 75 per cent of the participants marked the technical presentations as 'highly valuable'—a clear message from the community to continue in this direction.

In summary, the INFL remains a key component of the annual ITWG meeting, and the increased emphasis on scientific developments and case studies will be an important component of future ITWG meetings. •

UPCOMING TRAININGS AND MEETINGS

- ITWG 6th Collaborative Material Exercise (CMX-6), begins September 2018
- Australia–New Zealand Forensic Science Without Borders Conference, Perth, Australia, 9–13 September 2018
- IAEA Regional Training Course on Introduction to Nuclear Forensics (Spanish speaking), Buenos Aires, Argentina, 10–13 September 2018
- IAEA General Conference, Vienna, Austria, 17–21 September 2018
- JRC Nuclear Forensics Awareness and National Response Plan Training (Phase I), Tanzania, 24–27 September 2018
- IAEA International Training Course on Practical Introduction to Nuclear Forensics, Budapest, Hungary, 1–5 October 2018
- 3rd KINAC–SIPRI Nuclear Non-Proliferation and Security Seminar: State Implementation of the National Nuclear Forensic Libraries, Daejeon, South Korea, 23–24 October 2018
- IAEA Regional Introduction to Nuclear Forensics (French Speaking), Dakar, Senegal, 13–16 November 2018
- IAEA Conference on Global Radioactive Materials Security, Vienna, Austria, 3–7 December 2018
- IAEA Technical Meeting on Nuclear Forensics, Vienna, Austria, 1–4 April 2019

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.

Nuclear Forensics Experts Meet in the Swiss Mountains *continued*

Participant feedback

The 'clicker session', which was facilitated by the IAEA and designed to register participants' anonymous responses to multiple-choice questions, helped to establish a robust picture of trends within and preferences of the nuclear forensics community. It was found that more than 60 per cent of ITWG-23 participants came from Europe, nearly 25 per cent came from North America, and more than 10 per cent came from Africa or Asia. With regard to sector affiliation, more than 70 per cent of ITWG-23 participants identified themselves as scientists, nearly 20 per cent identified as law enforcement or security service personnel, and 10 per cent as regulators or other professions.

Gracious hosts, both past and future

The Swiss authorities at SPIEZ Laboratory—including Mario Burger, Franziska Mala and Lisa Brüggeman—hosted ITWG-23 and provided perfect organization. Our colleagues from Romania's Horia Hulubei National Institute of Physics and Nuclear Engineering have graciously offered to host ITWG-24 next summer in Bucharest.

Presentations from ITWG-23 are now available to ITWG participants on the restricted website. •

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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/

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