ITWG
NUCLEAR FORENSICS UPDATE
No. 38 March 2026

CHAIRPERSONS' ADDRESS

Welcome to the 38th edition of the Nuclear Forensics International Technical Working Group (ITWG) newsletter. This informal community of nuclear forensics practitioners was originally founded to bring together two essential groups: the nuclear scientists and the law enforcement professionals. The nuclear scientists are experts in detecting and analysing radioactive materials, while the law enforcement professionals are experts in applying scientific evidence to further investigations within the limits of the justice system. The ITWG continues to strive toward closer collaboration between these communities, so that nuclear scientists can deliver the same definitive, courtroom-ready answers that investigators have long expected from the more established forensic disciplines.

This issue takes a deep dive into how the French government successfully integrated nuclear forensics into its established forensic practice, overcoming the institutional differences and scientific challenges that arise where conventional forensics—such as fingerprinting, DNA analysis and digital extraction—intersect with the handling of items contaminated by radioactive material. Although the underlying science may appear straightforward, the article demonstrates that even the simplest methods, for example using cyanoacrylate to develop fingerprints on non-porous evidence, become considerably more complex when strict radioactive contamination controls are enforced. The piece also highlights the value of the ITWG's Collaborative Materials Exercises (CMX); the carefully crafted scenarios and the rich variability of evidence they provide enable participating laboratories to refine their methods and enhance collaboration across disciplines.

Spring brings the rebirth of nature—blooming flowers, longer days and warmer temperatures—at least across the northern hemisphere. In the same spirit, the ITWG is emerging from its winter lull and preparing for the next annual meeting. We are now finalizing the last details of this year's gathering, ITWG-29, which will be graciously hosted by the German Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety in Berlin. More information will be released soon, so stay tuned and check the latest updates on our website.

With best regards,

James Blankenship and Maria Wallenius

AT THE CROSSROADS OF TRADITIONAL FORENSICS AND RADIOLOGICAL PROCEDURES

HUBERT SCHOECH

In France, radiation protection teams from the French Atomic Energy and Alternative Energies Commission (Commissariat à l'Energie Atomique et aux Energies Alternatives, CEA) have the expertise to locate, secure and remove radioactive sources or nuclear material from a crime scene. However, until recently it was not as common for the CEA to preserve traditional forensic evidence—such as DNA and fingerprints—at a radioactive crime scene.

By contrast, the national law enforcement forensic bodies—the Police Nationale (SNPS/CONSTOX Department) and the Gendarmerie Nationale (IRCGN/GRID and F2NRBC departments)—are highly experienced in collecting and preserving traditional forensic evidence but are less accustomed to working with evidence contaminated by radioactive material or removing nuclear material from a crime scene. At a radiological crime scene, both types of material must be managed.

To address this gap, French law enforcement forensic specialists and CEA radiation protection experts began working together to improve and

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coordinate their operating procedures. This process began in the lead up to ITWG Collaborative Materials Exercise 6 (CMX-6) and was honed during CMX-7 and CMX-8.[1] The collaboration between law enforcement forensic laboratories and CEA radioprotection specialists improved the traditional evidence component of nuclear forensics in France.

This article outlines the collaboration between the teams from preparations before the exercises to procedures during the exercises. It concludes by outlining lessons learned.

Preparation for the exercises

There are two sets of constraints when adapting traditional forensic techniques to radioactive evidence. First, there are the standard forensic requirements applied by law enforcement laboratories, including validated analytical methods, processing time limits, minimization of cross-contamination risks, preservation of trace evidence and maintenance of evidentiary integrity. Second, there are radiation protection constraints associated with handling evidence contaminated with radioactive materials. These include nuclear facility operating procedures, containment restrictions that limit the volume and speed of work, nuclear waste management rules, and strict requirements to prevent the spread of contamination.

To prepare for the CMX exercises, the teams developed a work plan spanning several months. As discussed below, this preparation involved joint workshops, technical training, mock-up testing and operational rehearsals conducted by law enforcement forensic teams together with CEA radiation protection specialists.

[1] The Collaborative Materials Exercises (CMX) of the Nuclear Forensics International Technical Working Group (ITWG) are recurring, scenario-based nuclear forensics exercises in which participating national laboratories receive well-characterized nuclear or other radioactive materials, as well as associated case information and other evidence, and then conduct full analyses as if responding to an actual interdiction of material out of regulatory control. Their aim is to strengthen participating states' nuclear forensics capabilities by exercising the entire analytical and interpretive chain (from laboratory measurements to communication of findings) while preserving confidentiality of individual results and publishing only aggregate lessons learned and best practices. Schwantes, J. and Marsden, O., 'Twenty years of collaborative materials exercises by the Nuclear Forensics International Technical Working Group', ITWG Nuclear Forensics Update 14, Feb. 2020.

Workshops

Joint workshops were organized to help both communities (CEA specialists and forensic investigators) better understand each other's procedures and constraints. For example, CEA specialists carried out demonstrations for law enforcement teams showing how nuclear material is collected and secured at a radiological crime scene using mock-up scenarios. In turn, CEA personnel examined in detail the steps involved in forensic DNA analysis and other evidence-processing techniques. These exchanges helped each group understand how their procedures could be adapted when working together on evidence contaminated with radionuclides.

Training

Evidence suspected of radioactive contamination must be handled inside containment systems such as gloveboxes or glove bags. Working while wearing gloves in confined spaces makes procedures slower and increases the likelihood of operational difficulties. Because the work during the CMX exercises was conducted in a CEA nuclear facility using CEA-designed glove bags, forensic specialists from the Police Nationale and the Gendarmerie Nationale were required to complete radiation protection and safety training by CEA before they were authorized to work in restricted areas.

Mock-up testing

Mock-up workshops were conducted to test how traditional forensic processes could be adapted to work inside disposable glove bags. Each analytical procedure—such as fingerprint development, photography or DNA preparation—had to be performed within the glove bag environment while accounting for constraints such as limited working space and the need to maintain airtight containment. These mock-up workshops allowed teams to identify practical adaptations before working with contaminated evidence.

Rehearsal

A full rehearsal took place the day before the start of the operational exercise. This rehearsal allowed the teams to make final adjustments to procedures and equipment. Law enforcement forensic specialists and CEA radioprotection experts prepared the tools required for evidence analysis, placed them inside glove bags in the nuclear facility, and verified that all equipment was functioning correctly before contaminated evidence was introduced.

Operational work during the exercises

During the exercises, the Police Nationale and the Gendarmerie Nationale analysed contaminated evidence during two separate two-day operational periods. Each organization worked independently on its own set of evidence. Each forensic team had access to four glove bags equipped with overhead video cameras. Approximately six forensic analysts worked with the glove bags each day, supported throughout by three or four CEA radioprotection specialists.

Figures 1–7 illustrate examples of how traditional forensic techniques were adapted for use in glove bags during the CMX-6 and CMX-7 exercises. Between the two exercises, several improvements were introduced. For example, a DNA sequencing device was added for CMX-7. CMX-6 is an exercise during which the teams receive 'evidence items' to analyse. In CMX-6 there were fewer evidence items, but the French wanted to test more of their capabilities, so they added more items to measure during the CMX-6 exercise.

Evidence processing workflow

The central point in the evidence processing workflow was a glove bag dedicated to photography. Each item of evidence was first photographed and documented in this glove bag. It was then transferred to another glove bag designed for a specific processing task (such as for porous evidence, non-porous evidence or vacuum box) and finally returned to the photography glove bag to document any developed fingerprints, writing or torn edges.

The main adaptation to adhere to it being a radioactive crime scene was to place the light source outside the glove bag. A monochromatic light generator remained outside the containment system, while a flexible optical fibre was inserted through a vinyl sleeve sealed with a special adhesive tape (see figure 1). This provided lighting without compromising containment. To reduce equipment costs and radioactive waste volume, the camera body, placed inside the glove bag, was protected with a vinyl covering (see figure 2), so only the removable lenses had to be discarded after use.

CEA radiation protection specialists used similar methods to introduce cables into glove bags via sealed sleeves or plastic pipes (see figure 3). These connections were installed, and the upgraded glove

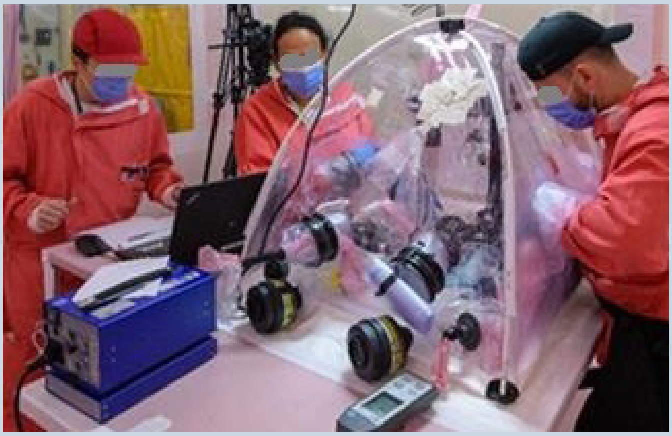

Figure 1. Photography with light sources: Fingerprint optical detection before and after (non-porous and porous surfaces, adhesive tape torn edges, notepad and sheets torn edges and indented writing)

Note: The monochromatic light generator box (in blue, left) stays outside the glove bag and the flexible optical fibre is inserted through a vinyl air tightened sleeve.

Figure 2. The main body of the camera is protected using vinyl

Figure 3. Recovery of deleted files on a USB stick

Note: The USB stick is put in the digital analysis glove bag before it is connected it to a cable. The digital analysis device stays outside the glove bag.

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Figure 4. Cyanoacrylate fumigation tools placed in a glove/fume bag

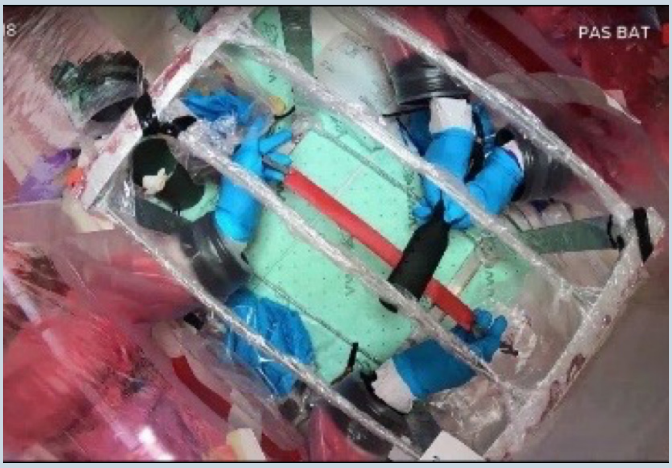

Figure 5. A porous adhesive tape is heated after being sprayed with indanedione

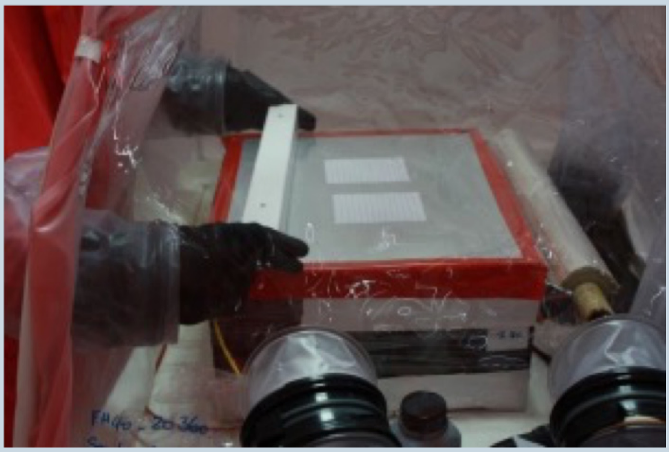

Figure 6. The use of an electrostatic toner powder to develop indented writing on pieces of paper in a vacuum box

bag was made airtight, before contaminated evidence was introduced. This approach allows the use of a wide range of digital devices within the small volume of a glove bag.

Adaptation of forensic techniques: fingerprints and writing

A range of other traditional forensic techniques was also successfully adapted to the glove bag environment.

For non-porous surfaces such as bottles, vials, and USB devices, a cyanoacrylate fumigation technique for developing latent fingerprints was performed inside the glove bag (see figure 4). The cyanoacrylate heater was placed in the middle of the glove bag; the evidence items were suspended using strings or grids, and the glove bag itself acted as the containment chamber for fumes. When many items are processed in a glove bag, it can lead to 'opacification' of the glove bag walls. This happens when cyanoacrylate fumes settle on the glove bag and obscure fingerprint details. As only a small number of items were processed during CMX-6 and CMX-7, this was not an issue.

Current laboratory practice for developing latent fingerprints on porous materials such as paper or adhesive tape commonly uses 1,2-indanedione-based reagents, which may be applied by immersion, spraying or washing, in accordance with established protocols.[2] In CMX exercises, the use of liquid chemicals had to be limited, as otherwise the exercises would generate excessive liquid radioactive waste, for which permission was not obtained. Immersion in indanedione was therefore not possible. Instead, the reagent was sprayed onto the surfaces of items of evidence, which were then suspended in the glove bag to dry before heating. Heating was performed in the same glove bag. Figure 5 shows the indanedione reaction on adhesive tape and paper sheets when heated.

There were no significant difficulties in operating the vacuum box inside the glove bag to reveal the indented writing (see figure 6). However, the glove bag volume was too small for this type of work, and handling the vacuum box while wearing gloves reduced ease of use and operator dexterity.

[2] 1,2-Indanedione is a highly sensitive forensic reagent used to detect latent fingermarks on porous surfaces (e.g. paper, cardboard) by reacting with amino acids in sweat. After indanedione treatment, developed fingermarks are viewed using a green light source and orange/red filters to record the fluorescence of the ridge detail.

DNA analysis

The greatest challenge to the teams during the exercise was the DNA analysis. For the purposes of this article, the DNA forensic analysis process can be divided into two stages: phase 1, which covers cell lysis and DNA extraction/purification, and phase 2, which covers PCR amplification and capillary electrophoresis to generate the DNA profile.[3] During the CMX exercises, phase 1 was performed inside glove bags using thermoshakers, centrifuges, and extraction-purification devices (i.e. standard instruments used for mixing, spinning, and automated DNA extraction). Figure 7 shows a centrifuge device placed in the DNA preparation glove bag.

In CMX-6, DNA swabs were contaminated with nuclear material. Previous international studies (e.g. from Australia, the Netherlands, the United Kingdom, the United States and the Joint Research Centre) have shown that the DNA extraction and purification process has a strong decontamination effect. During CMX-6, the French teams achieved a decontamination level of more than 90 per cent.

Phase 2 involved DNA amplification and electrophoresis profiling. This stage was conducted only during CMX-7 because introducing a DNA sequencing instrument (Hitachi 3500xL) into a nuclear facility required extensive preparation. This instrument is too large for a glove bag and too expensive to risk contamination (see figure 8). A number of protective measures were therefore implemented, including taking radioactivity level measurements of the samples before transferring them to the DNA sequencing device to verify that they were under the exemption values in French regulations and as low as possible; regular checks for contamination; changes of gloves and consumable parts of the device, such as pumps, capillaries, pipes, and liquid tubs; use of a tub with absorbent paper for transferring DNA samples; and protecting all potentially contaminated surfaces with vinyl, adhesive tape or removable decontamination gel. To implement these measures, an additional workstation was set up for the DNA sequencing device in the restricted area outside of the glove bags. Using these procedures during the CMX-7 exercise, the investigators were able to link the genetic profile found on one bottle to a known individual

[3] Here, 'phase 1' refers to the laboratory steps where cells in the sample are broken open and the DNA is isolated and cleaned, while 'phase 2' refers to copying selected regions of that DNA and running them through an instrument to produce the DNA profile used for comparison.

Figure 7. DNA lysis and purifiation in a glove bag

Figure 8. Protecting DNA sequencing device with decontamination gel

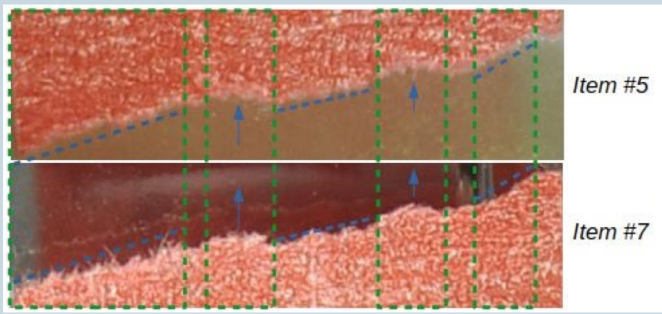

Figure 9. Two matching torn edges of adhesive tape (items #5 and #7)

Figure 10. A 'fingerprint' photographed under monochromatic light, having been revealed by cyanoacrylate fumigation

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Figure 11. Writing on paper sheets revealed using indanedione

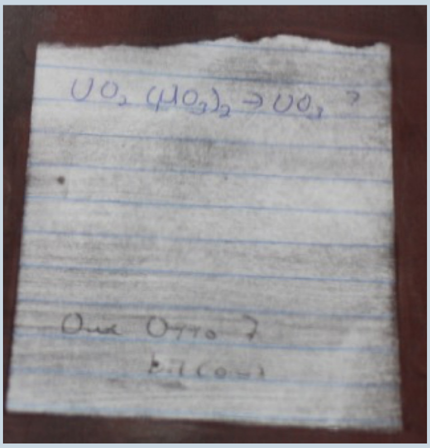

Figure 12. Optical detection of writing on a paper sheet following vacuum box and powder process

included in the exercise scenario. Some of the results from CMX-7 are shown in figures 9 to 12.

Results of the exercises

Through these adapted procedures, the teams participating in the exercise were able to analyse fingerprints, writing impressions, torn documents, digital data, and DNA under working conditions similar to those encountered in a real crime scene contaminated with radioactive material.

Although there were fewer instruments and analytical methods available than in a typical forensic laboratory, the adapted processes were sufficient to identify numerous investigative links between evidence items and the individuals involved in the CMX scenario. For CMX-7, all traditional evidence results were sent to the ITWG in the final two-month report, including a points-of-interest links diagram that the law enforcement units were able to draw up.

Lessons learned

Several important lessons emerged from the preparation and execution of the exercises.

CMX exercises accelerate progress

They encourage the rapid development of practical solutions for the collection and analysis of radiologically contaminated evidence.

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

- Hatton, C., Phathanapirom, B. and Dayman, K., 'Uncertainty quantification for nuclear forensics with population analyses', *Journal of Radioanalytical and Nuclear Chemistry*, 334/12 (2025), pp. 9385–9395.
- Shollenberger, Q. R. et al., 'Nuclear forensic analysis on uranium ore concentrates: A multi-laboratory intercomparison study', *Journal of Radioanalytical and Nuclear Chemistry*, 5 Dec. 2025.
- Kimura, Y. et al., 'Sample screening of uranium ore concentrates using portable spectrophotometers: Investigating the correlation between visible colours and chemical signatures', *Journal of Radioanalytical and Nuclear Chemistry*, 12 Dec. 2025), pp. 1–11.
- Metz, L. et al., 'Nuclear forensics: The ultimate analytical chemistry challenge', *Nuclear Science and Engineering*, 22 Dec. 2025, pp. 1–12.
- Schiferl, M. et al., 'Adapting nuclear forensics from light-water to molten salt reactors: A survey of emerging needs', *Nuclear Technology*, 2 Feb. 2026.
- Beatrice, M., Manyoba, N. and Mathuthu, M., 'Determination of lead isotopic ratios for nuclear forensic signatures from Mpumalanga Province, South Africa', *Radiation Physics and Chemistry*, 242, May 2026, art. 113659.

Joint preparation is essential

Close collaboration between forensic specialists and radiological experts is necessary to ensure successful analysis.

Specialized equipment is critical

Protective containment systems such as glove bags are essential for safe work with contaminated evidence.

Operational limitations must be understood

Constraints such as glove bag size and necessary quantity, sample transfer time between glove bags, and restricted working space affect investigative procedures.

Multiskilled personnel are valuable

In contrast to traditional forensic laboratories, where each measurement technique can be performed by a specialized team, only a limited number of forensic specialists can work in restricted radiological areas. This means that the analysts must often perform multiple types of examinations.

DNA purification plays a key role

The extraction and purification step significantly reduces contamination levels, enabling DNA analysis while protecting expensive sequencing equipment from contamination.

Mutual learning improves procedures

The joint workshops and joint work helped each team to improve its own procedures. Radiological specialists incorporated forensic evidence-preservation practices, while forensic investigators adapted their methods to work with gloves, containment systems and disposable materials.

Conclusions and outlook

The exchange of expertise between radiological specialists and forensic investigators has significantly improved the handling and analysis of radioactive-contaminated evidence. The traditional evidence component of the CMX exercises demonstrates how collaboration between the Police Nationale, the Gendarmerie Nationale and CEA radiation protection specialists can strengthen preparedness for radiological crime scenes and increase confidence in the forensic investigation of nuclear-related incidents.

The positive results achieved during CMX-6 and CMX-7 have encouraged further work on transferring decontaminated DNA evidence from nuclear facilities to standard law-enforcement laboratories once contamination levels fall below regulatory limits. Additional improvements are also being explored, including new glove bag designs and further adaptations of forensic analysis methods to containment environments. •

UPCOMING TRAINING COURSES AND MEETINGS*

- IAEA National Workshops on Radiological Crime Scene Management, 30 March–3 April 2026, Poland
- ITWG Collaborative Material Exercise (CMX) Data Review Meeting, Bucharest, Romania, 11–15 May 2026
- IAEA Regional Training Course on Basic Introduction to Nuclear Forensics, Algeria, 17–21 May 2026
- IAEA Regional Peer-to-peer Workshop on Nuclear Forensics, Bulgaria, 1–5 June 2026
- IAEA International Integrated Workshop on Radiological Crime Scene Management and Nuclear Forensics, IAEA Nuclear Security Training and Demonstration Centre (NSTDC), 8–12 June 2026
- IAEA Regional Training Course on Basic Introduction to Nuclear Forensics, Sri Lanka, 13–17 July 2026
- 26th Annual Meeting of the Nuclear Forensics International Technical Working Group (ITWG), Berlin, Germany, 14–16 July 2026

*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.

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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) 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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