

**The Nuclear Forensics International Technical Working Group  
(ITWG)**  
*An Overview*

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**Abstract.** The Nuclear Forensics International Technical Working Group (ITWG) is a multinational, informal association of official practitioners of nuclear forensics - laboratory scientists, law enforcement personnel, and regulatory officials - who share a common task in responding to nuclear security events involving nuclear or other radioactive materials out of regulatory control. The ITWG conducts its work through a combination of annual meetings, task group activities, and special exercises. Participation in the ITWG is open to competent and qualified Government participants from nations having, or wishing to have, a nuclear forensics capability. By coming together in an informal network, ITWG participants can fulfill the role of advancing best practices in nuclear forensic. The voluntary, informal nature of ITWG fosters cooperation and collaboration in a less restricted manner than might be possible for organizations having more formal structures.

## 1. Introduction

The Nuclear Forensics International Technical Working Group (ITWG) is a multinational, informal association of official practitioners of nuclear forensics - laboratory scientists, law enforcement personnel, and regulatory officials - who share a common task in responding to nuclear security events involving nuclear or other radioactive materials out of regulatory control. The ITWG was established in 1995-1996 as a result of an initiative of the G-8 (both the 1995 Ottawa Summit and the 1996 Moscow Nuclear Security Summit), largely through the efforts of concerned scientists from the national laboratories of the US Department of Energy and the Institute for Transuranium Elements representing the European Commission, with the encouragement of Government officials. Its establishment reflected heightened concerns over the threat posed by nuclear smuggling.

Known originally as the "Nuclear Smuggling International Technical Working Group," the ITWG changed its name in 2010 to reflect the increasing importance attached internationally to nuclear forensics. It also reflects the emphasis the ITWG is devoting to best practices for forensics - both those forensic analyses directed toward the nuclear or other radioactive material itself as well as traditional forensic procedures conducted on evidence contaminated with nuclear or other radioactive material.

Participation in the ITWG is open to competent and qualified individuals affiliated with national response organizations from states having, or wishing to have, a nuclear forensics capability. By coming together in an informal network, ITWG participants can fulfill the role of advancing best practices in nuclear forensics. The voluntary, informal nature of ITWG fosters cooperation and collaboration among scientists and allows focusing on scientific and technical issues in order to advance the discipline of nuclear forensic science.

To this end, the ITWG conducts its work primarily through task groups, which are encouraged to engage in activities on a continuous basis, and through meetings, which are intended to be conducted on an annual basis. Additional details on the task groups and annual meetings are offered in the following sections.

## 2. ITWG task groups

The ITWG organizes a portion of its work through task groups, with each group being related to an area or activity deemed critical to advancing the state-of-the-art in nuclear forensics. Presently, there are five ITWG task groups: communications out-reach and training; evidence; exercises; guidelines; and national nuclear forensic libraries.

### 2.1. *Communications, out-reach and training*

The ITWG Communications Out-reach and Training Task Group addresses the needs of ITWG participants regarding various aspects of communicating relevant information within national borders, with participants from other nations, and with other groups and organizations having interests related to nuclear forensics.

A major responsibility of the task group has been the development and maintenance of the website for the ITWG, [www.nf-itwg.org](http://www.nf-itwg.org). In this regard, the ITWG is indebted to the Commissariat à l'Énergie Atomique et aux Énergies Alternatives (CEA), France, for its financial and professional support of the website. The website affords a means of making available publications and other materials prepared by and approved for release by the ITWG, such as [1,2,3]. The website homepage is depicted in Fig 1.

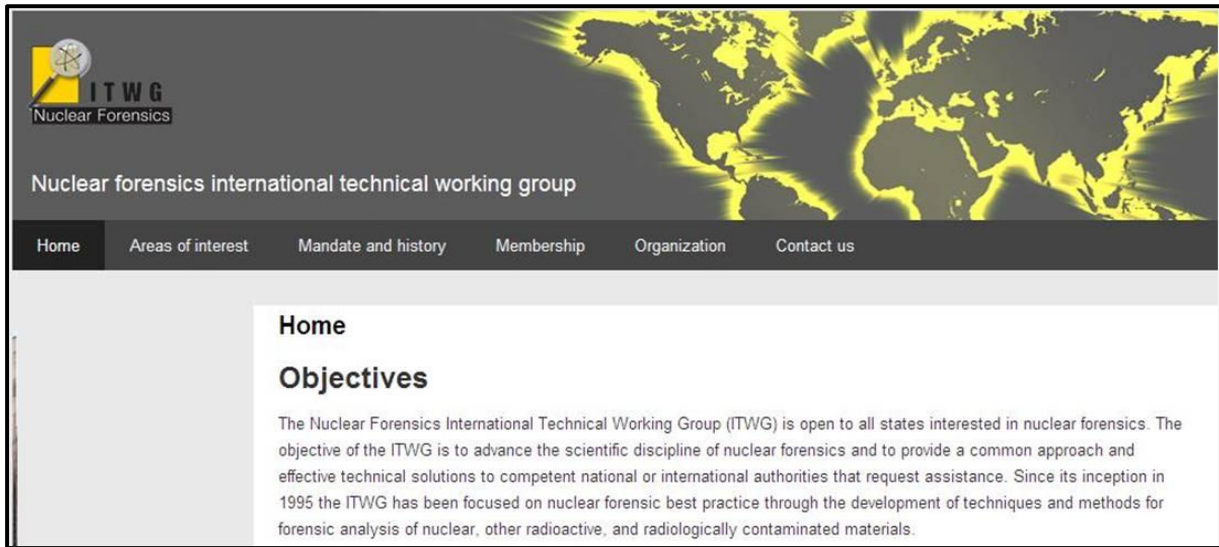


FIG 1. The ITWG website, [www.nf-itwg.org](http://www.nf-itwg.org), facilitates communication both among ITWG participants and with other individuals, groups and organizations sharing an interest in nuclear forensics.

The task group is also contributing to development and implementation of training courses related to nuclear forensic investigations. In particular training syllabi and relevant modules have been developed or are being developed related to:

- (a) Introduction to nuclear forensics. Nuclear forensics is an important element of the response to a nuclear security event. The competent authorities and organizations involved in the processing of an incident need to develop a good understanding of the benefits, limitations and requirements of nuclear forensics. This fundamental knowledge about nuclear forensics allows decision makers and regulators to develop concepts for incident response, including nuclear forensics, in an optimal way.
- (b) Radiological crime scene management. The management of a crime scene is the responsibility of law enforcement. Crime scenes with nuclear or other radioactive material present (or suspected to be present), however, pose particular challenges. Combining the different and sometimes diverging requirements of preservation and collection of evidence traditionally associated with the forensic sciences (such as trace evidence and DNA), securing the nuclear material, provision of protection from radiation hazards, and collection of nuclear forensic evidence demands the conduct of training and exercises in realistic scenarios.
- (c) Nuclear forensics methodologies. Nuclear forensic science is a discipline which makes use of and further optimizes the investigative analytical techniques often initially developed in other branches of sciences. Nuclear forensics practitioners get acquainted with the various methods used for accurately determining those characteristic parameters that provide useful hints on the history and intended use of illicit nuclear material.

Examples of groups and organizations with which the task group and its members interact include the European Atomic Energy Community (Euratom), the International Atomic Energy Agency (IAEA), INTERPOL, the United Nations Interregional Crime and Justice Research Institute (UNICRI), and the United Nations Office on Drugs and Crime (UNODC).

## 2.2. Evidence

Law enforcement personnel are well acquainted with the processes for identifying, collecting, preserving, packaging, storing and transporting evidence from conventional crime scenes and from

other areas of interest for purposes of the investigation. But operating at scenes where nuclear or other radioactive material may be present is likely to be less familiar to law enforcement personnel. Such scenes are deemed likely for nuclear security events, especially ones in which criminal acts are known to have occurred or are suspected of having occurred. The ITWG Evidence Task Group was established to address this situation.

The first task undertaken by this group was the development of guidelines for evidence collection in a crime scene contaminated with nuclear or other radioactive material. This guideline was approved in June 2011 and is available from the ITWG website [1]. As the task group moves forward, it will consider additional topics related to recovery of evidence. These topics might include:

- (a) Chain of custody. The chain of custody refers to those procedures and documents that account for the integrity of physical evidence by tracking its handling and storage from its point of collection to its final disposition [4]. Other terms used are chain of evidence and traceability. Establishing chain of custody at the scene and maintaining that chain of custody until ultimate disposition of the evidence minimizes the prospects that challenges might be mounted against its introduction at trial or against interpretations and conclusions drawn from examinations conducted on the evidence.
- (b) Development of an evidence collection plan. Crime scene personnel might be faced with an abundance of items that could be collected or with items that are bulky or otherwise difficult for collection, packaging, storage and transport. Furthermore, a scene involving nuclear or other radioactive material might present unique collection challenges. Developing an evidence collection plan affords an opportunity for the crime scene personnel to work with specialists in nuclear forensic sciences to ensure that critical items are collected, packaged, stored and transported in a manner consistent with the needs of the investigation and the laboratories.
- (c) Conduct of traditional forensic examinations on evidence containing nuclear or other radioactive material. These traditional forensic examinations include fingerprints (also referred to as fingermarks), genetic markers such as nuclear DNA, and toolmarks. These examinations can yield results that aid the investigation in determining whether linkages exist among people, places and things. Procedures exist for conducting such examinations on evidence that is free of detectable nuclear or other radioactive material. But procedures for evidence containing nuclear or other radioactive material are less well-developed.

The results of this task group have seen practical application in the assistance provided by ITWG participants, who have worked closely with both the IAEA and INTERPOL in developing guidance documents as well as training on radiological crime scene management.

### **2.3. Exercises**

The ITWG provides a forum for the conduct of exercises in which laboratories that elect to participate can test their ability to analyze nuclear material and can compare their results with those of the other participating laboratories. One feature of these exercises is that results are coded such that they cannot be attributed to any one of the participants. This feature affords the participants a measure of anonymity as well as protection against the misapplication of the results for purposes of grading the performance of any one laboratory or any group of laboratories.

Additionally, while the exercise results are anonymous, they can be used to inform requirements for research and development, such as enhancements in analysis techniques, availability of reference materials and improvements in instrumentation.

To date, the ITWG Exercises Task Group has overseen the development, conduct, comparative data analysis, and reporting for three collaborative material exercises, dubbed "Round Robins". The years, the materials used and the participating laboratories of Round Robin 1, 2 and 3 are given in Table I.

Important lessons have been gleaned from these exercises. These lessons include:

- (a) The participating laboratories have demonstrated their technical competence for performing analyses critical to nuclear forensic investigations.
- (b) Guidance documents such as the IAEA Nuclear Security Series publications as well as the ITWG Best Practices guidelines have proven useful. Conversely, the results of the exercises have aided in identifying areas within these guidance documents where changes are desired or where greater clarity must be sought.
- (c) Databases, historical records, and archived materials are valuable in identifying similarities and dissimilarities between materials of known provenance and samples associated with nuclear security events. Both types of results – that is, “inclusion” and “exclusion” in the terms used in forensic science – can be valuable in determining the origin of a material.
- (d) Ensuring availability of personnel, instrumentation, and equipment is challenging, perhaps reflecting the voluntary nature of these collaborative exercises.
- (e) Few participating laboratories have developed robust methods for the safe and effective conduct of conventional forensic examinations on samples containing nuclear materials. Consequently, results from these conventional forensic examinations have under-exploited.

Table I. Collaborative Material Exercises of the ITWG

Years	Material	Participating Laboratories <sup>a</sup>
1999-2000	Plutonium oxide powder	Austrian Research Centre, Seibersdorf, Austria; CEA, Valduc, France; Institute for Transuranium Elements (ITU), Karlsruhe, Germany, European Commission; Institute of Nuclear Chemistry and Technology, Warsaw, Poland; Institute of Physics, Vilnius, Lithuania; and Lawrence Livermore National Laboratory (LLNL), Livermore, California, USA
2000-2002	Highly enriched uranium (HEU) (uranium oxide powder) <sup>b</sup>	Austrian Research Centre; AWE; CEA; Cekmece Nuclear Research and Training Center, Istanbul, Turkey; ITU; Institut für Radiochemie, Munich, Germany; Institute of Isotope and Surface Chemistry, Hungarian Academy of Sciences, Budapest, Hungary; LLNL; and Nuclear Research Institute Řež (NRI Řež), Czech Republic <sup>c</sup>
2009-2010	HEU (Uranium metal) <sup>d</sup>	Australian Nuclear Science and Technology Organization (ANSTO), Menai, Australia; AWE; Comissao Nacional de Energia Nuclear (CNEN), Pocos de Caldas, Brazil; CEA; Defence R&D Canada, Ottawa, Canada; Institute of Isotopes, Hungarian Academy of Sciences, Budapest, Hungary; ITU; LLNL; and NRI Řež

<sup>a</sup> The name of the laboratory shown in the table is the one that was in use at the time of the exercise.

<sup>b</sup> 90+% <sup>235</sup>U, provided by Nuclear Research Institute Řež, Czech Republic.

<sup>c</sup> In addition, Defence R&D Canada, Ottawa, Canada, participated on a delayed basis, submitting its report in November 2004.

<sup>d</sup> 90+% <sup>235</sup>U, provided by a US government facility, Oak Ridge, Tennessee.

The results of and lessons learned from the most recent exercise, Round Robin 3, have been published [2]. A copy is available from the ITWG website.

Currently, a fourth collaborative material exercise (CMX-4), involving low enriched uranium (LEU), is in the final phase of preparation. Shipment of the samples is scheduled to be conducted in the fourth quarter of calendar year 2014. After completion of the material analysis and reporting of the findings to the organizers of CMX-4, a data review meeting will be held for discussing the results.

Moreover, the group has offered table top exercises in which the procedural and conceptual aspects related to nuclear forensic investigations were elucidated. Such table-top exercises are typically held during annual meetings of the ITWG and offer a scenario-based learning exercise.

#### **2.4. Guidelines**

Publication of peer-reviewed reports, journal articles and related materials is an important aspect to fostering the growth of nuclear forensics as a forensic science discipline. Such publications aid in meeting the objective of placing nuclear forensics on a sounder and more readily defensible scientific basis. The ITWG Guidelines Task Group is engaged in work supportive of this objective. In particular, the task group oversees the development and adoption of consensus-driven best practices guideline documents. These documents are intended to be general rather than prescriptive. That is, they describe in broad terms what is to be accomplished and how it might be accomplished, but they lack the specificity one might associate with a standard operating procedure.

To date, the task group has overseen the publication and adoption of [1,3]. It is also overseeing the preparing of guidelines on various topics, including a graded framework for comparing and evaluating results from nuclear forensic-related analyses. This framework was tested during Round Robin 3 and is described further in [2].

Additional guidelines are expected to be developed, adopted and published, reflecting the level of interest in the work of the ITWG.

#### **2.5. National Nuclear Forensics Libraries**

The results of the ITWG material exercises highlighted the need for databases and historical materials that might be used to allow comparisons to be made between materials and processes of known provenance and evidence and other samples associated with a nuclear security event. These results and other discussions prompted the ITWG to establish a task group devoted to the topic of national nuclear forensics libraries, which are viewed as a tool that might prove useful in addressing the need for databases and historical materials. Consequently, the ITWG National Nuclear Forensics Libraries Task Group was established in 2009.

A national nuclear forensic library is a collection of information, relevant to nuclear forensic investigations, about nuclear or other radioactive material that either resides in, or was manufactured by a particular country. A national nuclear forensic library may hold such information in electronic form (a single database or several databases) or in the form of a physical sample archive, or any combination thereof [3].

A national library contains information on certain characteristics that help distinguish one nuclear or other radioactive material from another. In the view of the task group, such national-level libraries should be organized in a manner that allows a government to easily search its data using these characteristics and information to answer queries that stem from the illicit use of nuclear and other radioactive materials or other events associated with nuclear smuggling or some other nuclear security event. For the purposes of nuclear forensics, it is envisaged that materials from throughout the nuclear fuel cycle will be considered for potential inclusion in the library contingent on the requirements of individual states. Such a library also identifies the facility where the nuclear or other radioactive

material is stored and, as information is available, would contain information on how the material was made and a history of its use [3].

At the ITWG Annual Meeting in 2012, the task group developed and successfully conducted a web-based, virtual tabletop exercise” (TTX) on national nuclear forensics libraries. This virtual TTX has been given the name “Galaxy Serpent” and has two over-arching objectives. First, participants are to compile a national nuclear forensic library using spent fuel characteristics provided by the TTX coordinators. Second, participants are to use this library to determine if a nationalized (that is, hypothetical) seizure of spent fuel is consistent with or is inconsistent with the fuels represented in the exercise library.

Interest in “Galaxy Serpent” has been keen. The first iteration was launched in January 2013, with participating teams from four nations, with results due during the second quarter of the calendar year. A second iteration was launched shortly thereafter, with participating teams from a different group of four nations. A third and fourth iteration were completed later in 2013 and in early 2014, respectively. Most of the participating labs were prepared to describe their methodological approach and the findings in a scientific article. The compilation of these papers is being published as a special issue of the "Journal of Nuclear Materials Management" and should become available in the course of summer 2014 on the INMM web-site.

### 3. ITWG Annual Meetings

From its beginnings in 1995, the participants in ITWG recognized the value of getting together annually on an informal and annual basis to share best practices, report results from relevant case studies in the field of nuclear forensics, and consider the needs for the nuclear forensics community. The hosts and locations for the meetings held to date are given in Table II.

Table II. Meetings of the ITWG

Year	Host Organization	Location
1995	LLNL	Livermore, California, USA
1996	Joint Research Centre – Institute for Transuranium Elements (ITU)	Karlsruhe, Germany
1996	MINATOM	Obninsk, Russia
1997	Landau Network	Como, Italy
1998	Metropolitan Police	London, England
1999	Säteilyturvakeskus (STUK)	Helsinki, Finland
2000	IAEA	Vienna, Austria
2002	Euratom	Luxembourg
2003	Hungarian Atomic Energy Agency (HAEA)	Budapest, Hungary
2004	CEA	Cadarache, France
2005	NRI Řež	Prague, Czech Republic
2006	ITU	Speyer, Germany
2007	Totalförsvarets forskningsinstitut (FOI)	Umeå, Sweden
2008	Institute for Nuclear Research and Nuclear Energy (INRNE)	Sofia, Bulgaria
2009	IAEA	Vienna, Austria
2010	AWE	Oxford, England
2011	Kiev Institute for Nuclear Research (KINR)	Kyiv, Ukraine
2012	Netherlands Forensics Institute (NFI)	The Hague, The Netherlands
2013	Rosatom	St. Petersburg, Russia

The organizers of the ITWG also recognized that meeting on an informal basis afforded an opportunity for more candid discussions than might have been possible for events associated with governments, industries or international organizations.

ITWG annual meetings have followed a similar format. Each meeting has a host organization that is involved in some aspect of nuclear forensics, and the ITWG is deeply appreciative of the support given by these host organizations. The 2014 annual meeting will be held immediately following the IAEA Nuclear Forensics Conference in July 2014 in Vienna.

The meeting itself is conducted over a period of 3 to 3.5 days. The format of the meeting has involved a mixture of plenary sessions, task group meetings, and other break-out sessions on special topics. The plenary sessions are a mixture of reports from groups and organizations involved in nuclear forensics, such as the IAEA, INTERPOL, the Nuclear Security Summit, and the Nuclear Forensics Working Group of the Global Initiative to Combat Nuclear Terrorism (GICNT), and technical papers.

Interest in the ITWG annual meetings has been gratifying. For example, the annual meetings in 2010, 2011 and 2012 were each attended by representatives from more than 30 nations and 5 international intergovernmental organizations. In total, these three meetings reached an audience of nearly 280, demonstrating the extent to which interest in nuclear forensics has grown since the founding of ITWG in 1995.

#### **4. Summary**

The ITWG offers the international community an informal means of sharing information and ideas regarding best practices for the conduct of nuclear forensics, spanning the scope of activities from evidence collection through reporting of results. It also provides a means for collaborating to identify these same best practices and to conduct exercises that demonstrate where such practices satisfy expectations and where improvements are needed. The ITWG welcomes broadened participation in its activities on the part of competent and qualified practitioners of nuclear forensics.

#### **REFERENCES**

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