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L. Koch
S. Niemeyer
N. Nikiforov
G. Mason
G.M.J. Herbillon

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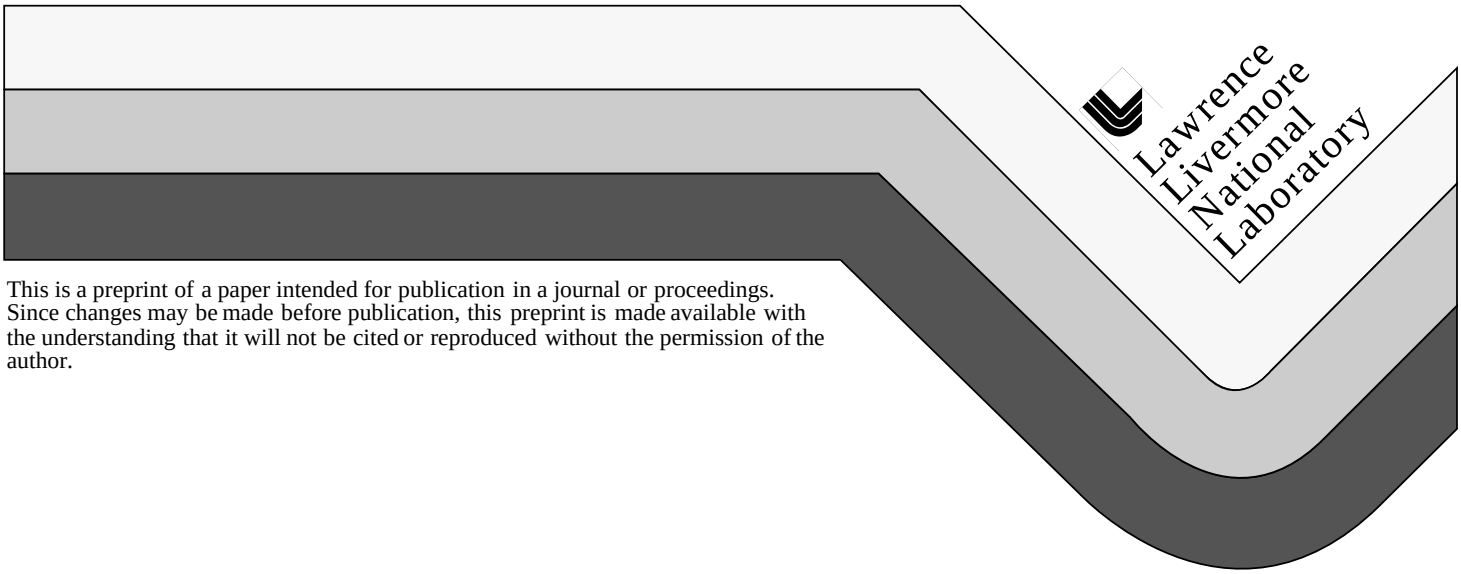

International Cooperation in Combating Illicit Trafficking of Nuclear Materials by Technical Means

L. Koch (EC, JRC, Karlsruhe, Germany), S. Niemeyer (LLNL, Livermore, CA, USA), N. Nikiforov (MINATOM, Moscow, Russia), G. Mason (Metropolitan Police of London, UK), G.M.J. Herbillon (EC, Safeguards Directorate, Luxembourg)

A consensus has been emerging during the past several years that illicit trafficking of nuclear materials is a problem that needs a more focused international response. One possible component of a program to combat illicit trafficking is nuclear forensics whereby intercepted nuclear materials are analyzed to provide clues for answering attribution questions. In this report we focus on international cooperation that is specifically addressing the development of nuclear forensics. First we will describe the role of the Nuclear Smuggling International Technical Working Group (ITWG) in developing nuclear forensics, and then we will present some specific examples of cooperative work by the Institute for Transuranium Elements of the European Commission with various European states.

Recognizing the potential importance of a nuclear forensics capability, the P-8 countries in 1995 encouraged technical experts to evaluate the role of nuclear forensics in combating nuclear smuggling and possibly developing mechanisms for international cooperation. As a result, an International Conference on Nuclear Smuggling Forensic Analysis was held in November, 1995, at Lawrence Livermore National Laboratory to investigate technical cooperation on nuclear forensics.

The International Conference provided a unique mix of scientists, law enforcement, and intelligence experts from 14 countries and organizations. All participants were invited to make presentations, and the format of the Conference was designed to encourage open discussion and broad participation. The initial talks set the context by describing the overall nuclear smuggling problem and describing the framework for conducting nuclear forensic investigations. Nuclear forensics is the process by which intercepted materials are analyzed to provide clues for answering attribution questions, e.g. where the material came from, where legitimate control was lost, and who was involved. The forensic process begins with the detection of the incident and an on-site

evaluation; it concludes by identifying attribution indicators in the interdicted nuclear material and its associated surrounding environment. Then an attribution assessment is formed by integrating all the relevant technical and other sources of information about the incident into a consistent and meaningful interpretation. Upon establishing this general framework, presentations were then made that described real-world experience in analyzing seized nuclear materials. Law enforcement officials emphasized the importance of receiving input from technical experts, especially in developing protocols for first responders that address environmental, safety and public health concerns, as well as approaches to collecting evidence. Seven talks were given on techniques and methods for characterizing bulk samples of nuclear materials as well as associated non-nuclear signatures. These talks provided the basis for the participants to evaluate the feasibility for making forensic interpretations of technical analyses. The important of data sets was discussed at some length, including the limitations on developing and using such data sets in the international arena. Conducting international round robins was identified as a possible important means of addressing the feasibility question. It was also stressed that nuclear forensics is more complex than a straightforward characterization. Characterization alone establishes the nature of the material, but attribution identifies forensic indicators that point to relationship between material characteristics and illicit activity. The forensic approach is also cost effective. The experimental design should be adapted to each specific incident rather than executing a predescribed comprehensive analytical procedure.

The Conference culminated with plans for a Nuclear Smuggling International Technical Working Group. The Conference identified nuclear forensics as a new need, and the goal for the ITWG would be to continue the progress made at the Conference. The primary purpose of the ITWG would be at provide for technical cooperation and collaboration on the development of nuclear forensics and thus help to combat nuclear smuggling. The initial focus would be to produce a report for P-8 countries that summarized the current status of nuclear forensics.

The first ITWG meeting was hosted by the European Commission's Institute for Transuranium Elements in Karlsruhe in January, 1996. This meeting helped establish the future course for the work of the ITWG. A terms of reference was approved, and draft status reports on identifying and prioritizing techniques and methods for forensic analysis were discussed,

revised, and then approved. Future plans for ITWG activities were also laid out, with special emphasis on an international exercise. Participants at this meeting reaffirmed that the most effective means of international cooperation on developing nuclear forensics is informal communications and cooperation among cognizant experts. A key is personal interactions and experience with one another and political endorsement of these interactions. It was also again noted that nuclear forensics serves different constituencies: law enforcement, nonproliferation, and public health/safety/environment. The primary goal of the ITWG is to advance the international capability for nuclear forensics to meet the needs of all these constituencies.

Subsequent to the ITWG meeting, the Status Report was published and distributed in March, 1996 **[1]**. It still represents the most comprehensive statement of the approach and methods for conducting nuclear forensic investigations. In the following month, April, 1996, the Moscow P-8 Summit on Nuclear Security agreed on the need for international cooperation on a program to combat illicit trafficking of nuclear materials, and it specifically identified nuclear forensics as one of the elements of the program.

The second meeting of the ITWG was held in Obninsk, Russia on December 2-4, 1996. The meeting was hosted by Minatom of Russia, with support from DOE and LLNL, IPPE in Obninsk, and ITE in Karlsruhe. Participation was excellent with 57 attendees from 15 countries and 2 international organizations. The meeting agenda was designed to take the opportunity to have many Russian experts participate and give presentations. The Russian talks on policy and technical steps for addressing nuclear smuggling included the following: Minatom on MPC&A and additional security framework, VNIITF and VNIIEF on analytical capabilities for specific R&D proposals, VNIINM on the development of a forensics laboratory and a new forensic database, IPPE on their capabilities for nuclear forensics, the Khlopin Institute on detection methods, and a number of talks on policy and law enforcement roles (Customs, Internal Affairs, Procurator General).

A proposed new draft of the terms of reference sparked a spirited debate at the third ITWG meeting which was held in Como, Italy, in June, 1997 (the meeting was fully hosted by the Landau Network-Centro Volta and Unione Scienziati per il Disarmo). The comments were then incorporated

into a new version that was produced after the meeting. These newly adopted terms of reference more fully describes the ITWG's purpose, the need to avoid duplication, its general activities, and a "reporting relationship" to the P-8. The general activities of the ITWG include evaluating present capabilities for combating nuclear smuggling, identifying technical needs, recommending to participating countries steps for future improvements, and recommending new cooperative measures. A major objective for the ITWG is to make recommendations and conduct studies that may lead to new agreements between governments and organizations. An overall goal is to provide for a more effective and uniform approach to combating nuclear smuggling. The terms of reference also specify the rights and responsibilities of the ITWG participants. For example, participants should receive the support of their national government or organization to attend the ITWG meetings. The work of the ITWG is expressly for the benefit and use of the participating governments and organization, and accordingly, participants are responsible to ensure that ITWG discussions are not shared with the general public.

The terms of reference includes a specific delineation of the technical elements of nuclear forensics. The following comprises the section on "Technical Elements for Nuclear Forensics":

The primary goal for nuclear forensics is to develop a preferred approach to nuclear forensic investigations that is widely understood and accepted as credible. The preferred approach should continue to evolve and improve based on further experience and developments. The description of the preferred approach should include a listing of technologies along with a specified approach to interpretation of the data. Success in meeting this goal would provide the basis for the international community speaking with one voice regarding the technical evaluation of illicit trafficking cases.

The technical elements for the ITWG's work on nuclear forensics include:

- Development of protocols for collection and preservation of evidence that meets the requirements of specialized laboratory measurements; in addition, also develop protocols for laboratory investigation

- Evaluations and recommendations regarding technical equipment for initial hazard evaluation and on-site assessment of nuclear material composition

- Prioritize techniques and methods for forensic analyses of nuclear and non-nuclear materials associated with illicit nuclear materials trafficking in order to answer questions regarding source attribution, route attribution, and intended use of the nuclear materials.

- Development of forensic databanks to assist in the interpretation of analytical results

- Formulate and execute interlaboratory exercises to evaluate and improve the effectiveness of forensic techniques and methods

- Facilitate technical assistance to countries (including non-P-8 countries) in response to specific requests; requests for assistance may also be accomplished using other bi-lateral or multi-lateral agreements

An opportunity to expand participation in the ITWG was presented at an NPEG (Non-Proliferation Expert Group) meeting held in Vienna in November, 1997. This meeting was held to kick off a new development for the NPEG in which the original P-8 countries expanded to include new adherents. Several suggestions by the NPEG for future ITWG tasks could significantly broaden its technical agenda. As a result, at the next ITWG meeting (held in London in July, 1998), a number of new countries attended and a large part of the agenda was devoted to overviews by these new participants on their efforts to combat illicit trafficking of nuclear materials in their country. A task group on developing a model action plan for nuclear smuggling forensics. This work arose from a task that was identified at the previous ITWG meeting. Nine general elements were proposed as necessary. It was emphasized that each country would need to develop the specific approach to implementing each of these elements. The nine elements are: incident response, crime scene analysis, radioactive evidence collection, traditional evidence collection, transportation to laboratory facility, in-laboratory evidence collection and distribution, laboratory analysis of radioactive material and evidence processing, laboratory analysis using traditional forensics and evidence processing, and case development. The London Metropolitan Police also gave a series of talks to illustrate their approach to forensics for cases

with high levels of national importance. A general theme is that when the case is important, an incredible amount of time and effort will be spent in order to recover every possible print.

The next meeting of the ITWG will be held in Helsinki in June, 1999. A particular emphasis at this meeting will be to discuss the results of an international exercise in which a sample of Pu was analyzed by a number of countries. A variety of questions regarding the sample will be answered using the techniques and approach that each country chooses to use. Countries that do not participate in the forensic analyses are encouraged to be full participants in the discussion of the results in order for them to gain insights regarding the effectiveness of various approaches.

The Institute for Transuranium Elements has been prominent in the application of nuclear forensics to specific cases, and it has also been engaged in a number of cooperative ventures to further develop the capabilities. Since 1992 the Institute of Transuranium Elements has been requested by the European Commission Safeguards Directorate and German authorities to characterise more than 20 different seized nuclear materials to such an extent that their origin and intended use could be traced. In the previous 20 years there were only a few cases where we had to analyse nuclear material of unknown origin. Now - in the new situation we had to develop a methodological approach to: 1) come up with more specific nuclear forensic analytical methods, 2) establish - in co-operation with international partners - a databank from archive information, 3) support - in the framework of TACIS/PHARE - middle and east European states in their endeavour to set up own nuclear forensic capabilities, and 4) participate - last but not least - in the ITWG.

Despite stringent physical protection measures nuclear material has been diverted from plants, laboratories or during transport. So far, border control by customs failed to prevent smuggling. If nuclear material was seized by law enforcement, it was found by chance or when offered to undercover agents. For such cases we got only hints where the material might have originated, which had to be substantiated by in depth investigation at the Institute.

The seized materials ranged from easily identifiable nuclear fuel pellets to oxide or metal powders of varying U-235 enrichment and Pu content (see

table 1) [2]. In order to verify the identity of nuclear materials we have developed several analytical techniques in the past. They formed the basis of the nuclear forensic methodology that was applied in the above mentioned instance [1]. The investigations followed the principle of diagnosis, by which the progress of the examination is guided by the results of the proceeding analyses. For the interpretation of analytical results one needs access to archive information in order to compare the results with material or nuclear properties of former known productions except for self explaining results such as age, enrichment, neutron hardness, etc.

Table 1, Types of seized nuclear materials

Physical Form	**Fissile Material**	**Quantity (g)**	**Intended use**
UO_2 pellets	~ 2 % U-235	40	RBMK fuel
UO_2 pellets	~ 2,4 % U-235	900	RBMK fuel
UO_2 pellets	~ 2,5 % U-235	1100	RBMK fuel (recycled)
U metal rod	U-nat	4300	fuel for Pu-production
UO_2 pellets	U-nat	330	CANDU fuel
Powder	U-nat	2000	Yellow cake
Powder	U-nat	5000	U_3O_8
UO_2 pellets	~ 3,6 % U-235	20	VVER 440 fuel
UO_2 pellets	~ 4,4 % U-235	900	VVER 1000 fuel
Ceramic Pins	88,9 % Pu-239	0,2	Ionisation sources
UO_2 granulate	87,8 % U-235	0,8 (2000)	FBR-test fuel
Pu/Ga metal powder	99,75 % Pu-239	6	weapon
PuO_2 / UO_2 powder	87 % Pu-239	560	MOX-test

Investigations on nuclear material illicit trafficking across borders demands international cooperation. Most of the material analysed by the Institute had been produced in the former Soviet Union but was not

necessarily diverted inside Russia. From the beginning we therefore had a close co-operation with Russian authorities, which resulted into two main ongoing projects: 1) setting up of a databank, and 2) upgrading of the forensic laboratories at the Bochvar Institute. Both activities are financed under the TACIS programme.

The common databank of the Bochvar and the Transuranium Institute [3] is further expanding. Since the type of archive data available differ according to the specification used at that time, we will organise a workshop to recall the underlying corresponding analytical techniques. For a current case one has to determine such parameters of a nuclear material that are filed in a database and hence one has to use the appropriate analytical techniques. For this reason the two laboratories in Moscow and Karlsruhe have to be upgraded.

In its FONSAFE programme the Institute for Transuranium Elements is setting up support programmes to upgrade the technical capabilities in identifying unknown nuclear material in Bulgaria, Czech Republic, Hungary and Ukraine. Other countries have expressed their interest and will be included. The projects foresee upgrading of equipment, training, joint exercises within the country and between the state laboratory and the Transuranium Institute. The use of the Transuranium Institute laboratories and the database for joint analyses of seized material is provided.

We conclude by emphasizing that the scope of nuclear forensics is much wider than indicated in these specific examples of cooperation. In the ITWG several deficiencies were quickly recognised, which, however, are common for classical forensics [4, 5, 6]: a) analytical techniques for smuggling route forensics and geolocation, and b) protocols for seizure to preserve evidence.To bring the quality of nuclear forensics to a comparable status in different states, we need especially to update an inventory on analytical techniques that can be applied for nuclear material characterization, and to demonstrate through round robins the status of nuclear forensic capabilities. We stress the need for continued development of a model action plan for nuclear forensics which integrates different law enforcement services who operate under the legal requirements of their particular state. Finally, we will continue recent work on identifying and evaluating instrumentation for the detection of nuclear material.

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