President's Findings of the
IAEA International Conference on Advances in Nuclear Forensics:
Countering the Evolving Threat of Nuclear and Other Radioactive Material
out of Regulatory Control
(CN-218)

7 to 10 July 2014
Vienna, Austria

INTRODUCTION

The International Conference on Advances in Nuclear Forensics: Countering the Evolving Threat of Nuclear and Other Radioactive Material out of Regulatory Control was held at the IAEA's headquarters in Vienna from 7 to 10 July 2014. The conference was attended by more than 280 participants from 76 Member States and 8 organizations and included nuclear forensics experts, law enforcement officials, policy makers and national representatives who have interests or active roles in nuclear forensics.

The 2014 conference was the first international conference dedicated exclusively to the role of nuclear forensics within a nuclear security infrastructure. The objectives of the conference were:

(1) To review the role of nuclear forensics as an essential element of a national nuclear security infrastructure;
(2) To present recent scientific achievements and exchange experience and lessons learned related to the application of nuclear forensics;
(3) To review current practices in nuclear forensics and identify advances in analytical tools;
(4) To discuss ways of strengthening nuclear forensic capabilities and capacity building in order to ensure the implementation and sustainability of national nuclear forensic programmes;
(5) To propose and discuss mechanisms for achieving further international and regional cooperation in the area of nuclear forensics;
(6) To enhance IAEA support to States that request assistance in developing nuclear forensic capabilities.

This year's conference followed the 2002 International Conference on Advances in Destructive and Non-Destructive Analysis for Environmental Monitoring and Nuclear Forensics, organized by the IAEA and held in Karlsruhe, Germany, 21–23 October. That three day conference, attended by experts and State officials from 37 Member States, the European Union and the European Police Office, discussed the role of nuclear forensics in the prevention of acts of nuclear terrorism and in combating illicit trafficking in nuclear materials.

Based on the outcomes of the 2002 conference and through continuous cooperation with Member States, the IAEA accelerated efforts to assist States in developing nuclear forensic capabilities that could support law enforcement investigations and nuclear security vulnerability assessments. In particular, from 2003 to 2012, the IAEA prepared a number of nuclear forensic guidance documents and outreach materials. In cooperation with the Nuclear Forensics International Technical Working Group (ITWG), the IAEA published a technical manual in 2006 entitled Nuclear Forensics Support (IAEA Nuclear Security Series No. 2). The publication was recently updated and new implementing guides in the area of nuclear forensics are being prepared.

The importance of nuclear forensics as a tool to assist States in ensuring the security of nuclear and other radioactive material for which they are responsible continues to grow. Resolutions on nuclear security adopted by the IAEA General Conference emphasize the importance of nuclear forensics as a component of a Member State's nuclear security infrastructure. Recent General Conference resolutions on nuclear security have noted the IAEA's work in developing and implementing training courses and providing guidance to assist States in the conduct of nuclear forensic examinations. Nuclear forensics was also featured in the President's Summary of the International Conference on Nuclear Security: Enhancing Global Efforts, organized by the IAEA in Vienna, Austria, from 1 to 5 July 2013. That conference included a technical session on nuclear forensics.

Furthermore, the IAEA's Nuclear Security Plan 2014–2017 reflects the importance of nuclear forensics for the effectiveness and sustainability of national nuclear security measures. Recognizing the importance of international collaboration in nuclear forensics, the IAEA cooperates with the Global Initiative to Combat Nuclear Terrorism (GICNT), INTERPOL and the ITWG to develop various forms of assistance, including enhancement of awareness, guidance and training. The international community increasingly recognizes the role of nuclear forensics as a preventive measure and as a tool to support the response to nuclear security events. Through this international conference on nuclear forensics, the IAEA seeks to facilitate a comprehensive exchange of information on relevant new technologies and techniques, as well as to showcase achievements in the application of nuclear forensics.

Among some of the areas included in the programme for the conference were:

- The history of nuclear forensics in response to the increased reports of illicit trafficking in the mid-1990s;
- The relevant legal instruments that pertain to nuclear forensics;
- The role of nuclear forensics in a nuclear security infrastructure;
- Integration of existing national resources into nuclear forensic capabilities;
- The state of practice of nuclear forensics to include scientific developments;
- Related nuclear forensic data interpretation tools, capacity building, international and regional cooperation, and policy implications.

The President's Findings are intended to reflect the presentations and discussions at the conference, and provide some observations derived from them. The findings are not intended to provide binding recommendations to the Secretariat or to Member States, but rather to help them in fulfilling their respective responsibilities.

OPENING STATEMENTS

HE Susan J. le Jeune d'Allegeershecque, the President of the Conference and Resident Representative of the United Kingdom of Great Britain and Northern Ireland to the IAEA

The conference began with an address by the President of the Conference HE Susan J. le Jeune d'Allegeershecque, the Resident Representative of the United Kingdom of Great Britain and Northern Ireland to the IAEA. The Conference President stressed the on-going threat posed by nuclear and other radioactive materials out of regulatory control. She identified that through shared technical solutions — to include nuclear forensics — there is the ability to prevent and, as required, respond to this challenge. She further highlighted that the most significant challenge for nuclear forensics is to promote cooperation between nuclear scientists, law enforcement officers and criminal prosecutors that have not closely worked together in the past.

The Conference President noted that technologies and methods during the Cold War to manufacture nuclear materials — to include mass spectrometers and X ray methods — could also be re-purposed to identify seized materials and possibly to determine where they originated. She noted that the discipline of nuclear forensics emerged and was applied to high profile seizures of high enriched uranium from 1999 to the present.

Important for consistent implementation of nuclear forensics is international guidance. To this end, the Conference President acknowledged the IAEA's effort to develop implementing guidance in nuclear forensics and to provide training on using the generalized conduct of a nuclear forensics in support of investigations. The Conference President noted that the United Kingdom is dedicated to a comprehensive national response plan focused on real time solutions to ensure a successful criminal prosecution following unauthorized acts involving nuclear and other radioactive material out of regulatory control. In addition, she stated that the United Kingdom works closely with its international nuclear forensics partners to include the Nuclear Security Summit, the GICNT and the ITWG to promote integrated approaches to nuclear forensic examinations.

IAEA Director General Yukiya Amano

IAEA Director General Yukiya Amano followed with his remarks. The Director General stressed the security of nuclear and other radioactive materials as an essential but elusive goal for Member States. From 1993 to 2013, the IAEA's Incident and Trafficking Database (ITDB) compiled 2477 confirmed incidents of nuclear and other radioactive material out of regulatory control. Of these, 424 incidents involved unauthorized possession and related criminal activities. In the same period, 16 incidents involved the unauthorized possession of high enriched uranium and plutonium. Of heightened concern, incidents as recent as 2011 point to organized networks of sellers and buyers for this material. Looking forward, the Director General noted that the international community needs to ensure harmonized approaches as the strongest possible basis for enabling effective nuclear forensic science. Through common approaches and consistent expectations, the international community benefits from robust and effective nuclear forensics. Through consistency of practice, the IAEA seeks to better establish the link between nuclear forensics and legal instruments as a way for States to fulfil their obligations under relevant international conventions. He reiterated that the 2005 Amendment to the Convention on the Physical Protection of Nuclear Materials, yet to enter into force, is a key international instrument supporting nuclear security.

HE Grigory Berdennikov, Russian Federation, on behalf of the Global Initiative to Combat Nuclear Terrorism

HE Grigory Berdennikov, of the Russian Federation spoke of how the GICNT highly appreciates the important role of the IAEA in the maintenance of nuclear security and combating nuclear terrorism. He noted that GICNT activities are undertaken in support of, and with regard to, activities of the IAEA in coordinating States' efforts to ensure nuclear security. The GICNT seeks to build upon the important work of the IAEA, as well as to develop synergies with the IAEA and other international organizations, in order to reinforce each other's efforts. The partnership raises awareness with the international policy community of the key policy challenges in implementing best practices and offers solutions to meet those challenges based on the experience of Partner States. The GICNT believes that the role of the Global Initiative is to support the activities of the relevant international organizations, notably the IAEA, through sharing experiences and conducting exercises and other practical activities, with a view to enhancing nuclear security. He expressed that the GICNT was looking forward to further active cooperation with the Agency in all major areas.

Simon Limage, United States of America, on behalf of the Global Initiative to Combat Nuclear Terrorism

The United States of America thanked the IAEA for organizing and hosting the largest international nuclear forensics conference to date, as well as including the ITWG, INTERPOL and the GICNT as cooperating entities at the international conference. Simon Limage emphasized that a theme of the week's conference is also a key element of GICNT events which seek to bring together nuclear forensic experts with a range of policy, law enforcement, technical and related backgrounds to demonstrate the critical need for these experts to collaborate: policy makers informing the technical community of their needs and technical experts sharing with policy makers the capabilities of nuclear forensics. He remarked that presentations and discussions to be provided during the international conference represented a collective next step towards strengthening nuclear forensic capabilities, capacity building and international cooperation as part of a global nuclear security community. His remarks emphasized that ongoing work through the GICNT — in partnership with the IAEA, the ITWG and INTERPOL — as well as the work done at the international conference would help sustain a robust and enduring international nuclear security architecture well into the future.

Alan King, on behalf of INTERPOL

Alan King of INTERPOL stressed that crime and terrorism require a coordinated approach involving collaboration and partnership working between many agencies to provide an effective and holistic response to the challenges from criminals that affects many communities. For this reason he stated that INTERPOL fully embraces the need for an international cooperation framework for law enforcement and sees the IAEA as its key partner in this regard. He noted that the IAEA and INTERPOL work together on a number of initiatives to include the sharing of information, the development of the IAEA's implementing guide within the Nuclear Security Series, Radiological Crime Scene Management, as well as the associated radiological crime scene management training in which INTERPOL provides the focus for the law enforcement activity. He reiterated that INTERPOL's ongoing close partnership with the IAEA, its collaborative work in training and preparing the law enforcement, scientific, health and other public sector communities, together with its long standing information sharing agreements, will go a long way to achieve the shared goals of these two international agencies in addressing the threat of nuclear terrorism.

Klaus Mayer, European Union, on behalf of the Nuclear Forensics International Technical Working Group

Klaus Mayer of the European Union explained that the ITWG is an informal group of nuclear forensics practitioners, including nuclear scientists, law enforcement and regulators, formed almost 20 years ago. He reflected that throughout these two decades, the ITWG has contributed to advancing nuclear forensics through a variety of activities, such as comparative material analysis exercises, table top exercises, guidelines and best practices. He noted that the ITWG has been working in partnership with the IAEA and has supported many of its nuclear security related activities by providing expertise in the development of the science and technology supporting law enforcement investigations and nuclear security vulnerability assessments.

Khammar Mrabit, Director of the IAEA Division of Nuclear Security

The Director of the IAEA Division of Nuclear Security, Khammar Mrabit provided his perspective of the role of nuclear forensics as a component of the IAEA's portfolio of nuclear security cooperation with, and assistance upon request, to Member States. He stated that the IAEA is committed to positioning nuclear forensics as a key piece of nuclear security infrastructure. To do this, it is necessary to understand the bridge between nuclear science, law enforcement and criminal prosecution and to make sure the same language is used. His remarks addressed that the international security community also needs to be clear that nuclear forensics is neither expensive nor complicated, but that it is about using skills and technologies already in hand and applying them to the needs of nuclear security. In this vein, he observed that nuclear forensics can be further emphasized as part of the Integrated Nuclear Security Support Plan (INSSP) and International Nuclear Security Advisory Service (INNServ) peer reviews and advisory services. The IAEA's central role in leading the coordination of international activities in nuclear security may be used to harmonize procedures and techniques through written guidance, training, as well as specialized assistance, upon request, to include the planning for a nuclear forensic laboratory. Furthermore developing analytical methods for a nuclear forensic examination, promoting quality and confidence in nuclear forensic findings, advancing the science of pathways or route identification and nuclear forensics as a preventive measure all strengthen nuclear security systems globally.

The opening session was followed by two plenary sessions, fifteen technical sessions, two poster sessions, two panel sessions and one round table discussion, where contextual, legal, scientific, and policy topics on nuclear forensics were explored in more detail.

TECHNICAL SESSIONS

The technical sessions were designed to explore the science of nuclear forensics and state of practice of implementation to support law enforcement and nuclear security. Technical sessions also included two poster sessions on 8 and 9 July, where a majority of synopses selected for the international conference were presented. Such topics included:

- Nuclear forensics as an element of a national response plan;
- Science of nuclear forensic signatures;
- Case studies;
- Laboratory based analytical techniques;
- Data interpretation tools and methods
- Expressing confidence associated with nuclear forensic conclusions;
- Synergies with other disciplines;
- Radiochronometry (i.e. age dating);
- Raising awareness and enhancing education in nuclear forensics;
- International cooperation.

The following are brief summaries of the technical sessions:

- *Regarding nuclear forensic capabilities as an element of a national response plan* (Session 2A), the session focused on the progress of Member States in using the nuclear forensics model action plan in support of investigations of nuclear and other radioactive material out of regulatory control. National experience and lessons learned employing nuclear forensics as a means to optimize an actionable response to a nuclear security event were discussed to complement the availability of implementing guidance provided by the IAEA for the conduct of a nuclear forensic examination.
- *Regarding nuclear forensic science and the signatures of nuclear material* (Sessions 2B and 3A), the sessions highlighted the success of using analytical techniques to discern isotopic, chemical and physical data characteristics that are incorporated into nuclear or radioactive materials either geologically via feed stocks or during the nuclear fuel cycle manufacturing process to provide diagnostic information that may reveal the origin or history of these materials.
- *Regarding approaches to nuclear forensic examinations* (Session 2C), it is essential that the approach for responding to a nuclear security event be planned in advance to protect responders, the public as well as the integrity of the evidence. Validated methods and specialized facilities are required to analyse traditional forensic evidence (e.g. hair, fibres, fingerprints, DNA and digital evidence) that is contaminated with radionuclides. Strong ionizing radiation may also have an effect on the integrity of the evidence that may necessitate either analysis in-situ or application of decontamination techniques.

— *Regarding data compilation tools supporting nuclear forensics interpretation* (Sessions 2D and 3C), the sessions highlighted the advances made and national experience of several Member States in the area of developing a national nuclear forensics library to support nuclear forensic interpretation. A national nuclear forensics library is one tool that may be used to compare characteristics of materials found outside of regulatory control to determine whether seized materials are consistent with materials used, produced or stored within a State. Accessing distributed data and subject matter expertise may assist States in ensuring the security of materials for which they are responsible. Difficulties associated with the use of a national nuclear forensics library include variations in the data characteristics for individual materials originating from a common facility. Alternatives to developing a national nuclear forensics library rely upon the experience of subject matter experts to provide information pertaining to the origin of seized materials.

— *Regarding experience in laboratory analyses and data interpretation* (Session 2E), nuclear forensic capabilities need to be capable of analysing milligrams to kilograms of uranium, plutonium, transuranics, as well as sealed and unsealed radioactive materials. Both unirradiated and irradiated materials may be encountered. International cooperation can provide specialized techniques to allow measurements of bulk samples of uranium, plutonium as well as actinide microparticles. Case studies have benefited from the application of multiple measurements to build confidence in the conclusions from a nuclear forensic examination.

— *Regarding exercises and cooperation* (Session 2F), these require personnel from multiple authorities to promote collaboration, team work and operational readiness in the context of a nuclear security event. Cooperation is required to collect evidence as well as to formulate and implement a nuclear forensic examination plan that includes the use of national nuclear forensics library and associated databases. Exercises provide a means to ensure the reliability of nuclear forensics supporting a national response to include the development of a comprehensive forensic examination plan to respond to a nuclear security event, identifying appropriate roles and responsibilities of those involved in an investigation, initiation of a chain of custody as well as documented procedures and methods for traditional and nuclear forensic analysis.

— *Regarding the integration of existing national resources into nuclear forensic capabilities* (Session 2G and Panel Session 2H), highlighted that the prospect of a nuclear or radiological event presents special challenges, as many countries do not have nuclear forensic capabilities. In order to develop more capabilities to respond to nuclear or radiological incidents, it is important to identify existing facilities and capabilities that are equipped to analyse,

handle, and store radioactive materials and evidence contaminated with radionuclides. Speakers and panellists noted the importance of States outlining the goals for nuclear forensics and then identifying ways to integrate their existing resources into a national nuclear forensic capability to meet those goals. One key way is to begin integrating capabilities is to identify the personnel expertise existing within the State which can be used to help categorize and then potentially characterize material. Panellists also noted how States have begun forming relationships between the nuclear forensic experts and others in the State to build sustainability. For example, nuclear forensic experts may be used to train first responders as well as assist in related aspects of an investigation of a nuclear security event.

— *Regarding nuclear forensic science synergies with other disciplines* (Sessions 3B and 3F), the sessions emphasized how technical services and analytical capabilities, initially developed for use in the nuclear industry, can be used for the analysis of nuclear materials following a nuclear security event. The field of nuclear forensic science uses techniques, methods and tools developed over 100 years of achievements in the field of radiochemistry. New analytical instrumentation for spectrometry and spectroscopy allows for novel analysis to include bulk samples containing several compounds that need to be identified individually. Results of forensic medical evidence, drawing upon studies with fatal and non-fatal outcomes, can provide crucial information regarding the details of a nuclear security event. Often existing and proven analytical techniques from other disciplines, such as radiochemistry and traditional forensics are used to extract such information from seized materials or evidence. In addition, new approaches, applications and techniques may be developed to build confidence in nuclear forensic findings.

— *Regarding radiochronometry* (Session 3D), age dating provides information important to nuclear forensics about the time of the last chemical purification of a nuclear or other radioactive material sample. Research into using highly accurate and high precision mass spectrometry and counting techniques enables new radiochronometers to be exploited for nuclear forensic analysis — particularly for high enriched uranium. The availability of new standards and isotopic spikes affords confidence in new age dating tools to include $^{235}U–^{231}Pa$ and $^{234}U–^{214}Bi$. Age dating applicable to nuclear forensics is improved by the simultaneous application of several age dating pairs applied together on a common sample or set of samples.

— *Regarding confidence in nuclear forensic findings* (Session 3E), conclusions are based on measurements of material characteristics and the interpretation of these results. The level of confidence in these findings depends on the quality assurance system and quality control procedures of the laboratory,

including the use of validated methods, certified reference materials and demonstrated competencies. Some of the challenges include the validation of methods, the development of appropriate certified reference materials, maintaining relevant expertise and capabilities, and maintaining appropriate quality assurance management systems.

— *Regarding nuclear forensic awareness and education* (Session 3G), these comprise vital elements of a sustained nuclear forensic capability. By clearly articulating the requirements for a nuclear forensic examination, roles and responsibilities can be identified, developers of the technical capability can be appropriately oriented, and common approaches used to increase confidence in nuclear forensic findings. Education and training is essential to ensure that evidence is collected and analysed appropriately in support of law enforcement investigations and nuclear security vulnerability assessments. It is also critical to clearly identify the role of nuclear forensics in a States' nuclear security infrastructure.

— *Regarding international and regional cooperation in nuclear forensics* (Session 4A), reports to the IAEA of nuclear and other radioactive materials out of regulatory control indicate that: (i) unsecured nuclear and other radioactive materials remain available; (ii) border control measures are effective in detecting illicit trafficking, although monitoring for nuclear and other radioactive materials is not uniformly implemented at all border control points and (iii) individuals and groups are prepared to engage in trafficking of these materials. Harmonized and consistent awareness and understanding, regulation and state of practice strengthen the global nuclear security architecture. Regional approaches to include Nuclear Security Centres of Excellence are effective mechanisms to provide nuclear forensic solutions to prevent and respond to incidents of illicit trafficking. A key element in cooperative strategies is sharing experiences and lesson learned in establishing nuclear forensics as an effective component of nuclear security.

— *Regarding Poster Session I,* information was presented across six general areas: frameworks, national capabilities, material out of regulatory control, support to investigations, exercises, and training. Outcomes from this session emphasized that nuclear forensics is transitioning from an emerging to an established nuclear security discipline. The results from this session demonstrated that nuclear forensics is both designed into and implemented as part of States' national response plans. Nuclear forensic is sustained through both comprehensive exercises and training activities.

— *Regarding Poster Session II,* results were presented across three technical areas: material characterization, radiochronometry and data interpretation. Outcomes from this poster session reinforced that research in nuclear forensics is developing state of the art material characterization methods for

nuclear and other radioactive materials, which help to establish the scientific foundation for discriminating signatures to include radiochronometry. Developments and best practices in data interpretation methods also showed effective measures for organizing existing information to provide context for nuclear forensic comparisons.

PLENARY SESSIONS

Historical evolution of nuclear forensics (Plenary Session 1A)

Nuclear forensics arose in response to an increasing number of seizures of plutonium and high enriched uranium in Europe in the early 1990s. Using mass spectrometry and chemical techniques used in the manufacture of nuclear materials as well as for the purposes of safeguards, these capabilities were applied to combat the illicit trafficking of nuclear and other radioactive materials. Initially, the concern was to determine the composition of these materials, the threat they posed and their likely origin. National laws that addressed illicit trafficking needed to be strengthened.

As high profile seizures persisted with the indication of like material smuggled in separate incidents at different times, nuclear forensic capabilities grew to encompass nuclear forensics coupled with traditional forensic evidence to include hair, fibres, DNA and fingerprints that may be contaminated with radionuclides. National laws were enacted that increased the penalties for nuclear smuggling, and nuclear forensics was used to link materials to people, places and events. Nuclear forensic evidence was increasingly used by judicial systems to convict and sentence traffickers.

The IAEA has accelerated its efforts to provide implementing guidance, conduct introductory and advanced training, organize research and facilitate specialized nuclear forensic assistance to States upon request. To promote capacity building, partnerships between the IAEA and the ITWG, the GICNT, the nuclear security summits have raised the technical state of practice as well as political awareness.

Nuclear forensic resources in the legal and nuclear security context (Plenary Session 1B)

An effective nuclear security infrastructure requires a comprehensive legislative and regulatory framework that, among other things, defines as offences or violations those criminal or intentional unauthorized acts involving nuclear or other radioactive material, associated facilities or associated activities. Through determination of the origin and the history of the radioactive material, nuclear forensics can play a key role in law enforcement investigations and prosecution of offences involving the unauthorized possession of nuclear and other radioactive material. The session highlighted issues

related to the legal and regulatory framework, technical infrastructure and human capital, as well as means to achieve global awareness in nuclear forensics through capacity building and international cooperation projects. The international legal framework for strengthening nuclear security is comprised of both legally binding and non-binding international instruments and initiatives. The effectiveness of the international legal framework for nuclear security requires effective implementation at the national level, in particular criminalization of offences in national law and assignment of commensurate penalties.

The ITDB is the IAEA's information system that compiles incidents of illicit trafficking and other unauthorized activities and events involving nuclear and other radioactive material outside of regulatory control. The ITDB facilitates the exchange of authoritative information on incidents among States. The scope of the ITDB information is broad and incorporates all reported incidents in which nuclear and other radioactive material is out of regulatory control, ranging from illegal possession, attempted sale and smuggling to unauthorized disposal of material and discovery of lost radioactive sources. As of December 2013, a total of 2477 confirmed incidents had been reported to the ITDB by participating States and some non-participating States. The information reported demonstrates that the availability of unsecured nuclear and other radioactive material persists, that effective border control measures help to detect illicit trafficking, although effective control is not uniformly implemented at all international border points, and that individuals and groups are prepared to engage in trafficking this material.

Nuclear forensics has specifically been incorporated in relevant Hungarian legislation and its nuclear security regulatory system, with emphasis on the national response plan to an illicit trafficking event regulated by a new governmental decree. The national response plan is based on IAEA Nuclear Security Series No. 15, Nuclear Security Recommendations on Nuclear and Other Radioactive Materials out of Regulatory Control, and adopts a graded approach by applying different levels of response to a nuclear security event with nuclear and other radioactive material out of regulatory control, namely: the strategic level, the tactical level and the operational level.

PANEL SESSIONS AND ROUND TABLE DISCUSSION

Nuclear forensic capabilities within a national nuclear security infrastructure: the role of nuclear forensics (Panel Session 1C)

Each State carries the full responsibility for nuclear security. Specifically, each State has the responsibility to provide for the security of nuclear material and other radioactive material and their associated facilities and activities; to ensure the security of such material in use, storage or transport; to combat illicit trafficking and the inadvertent movement of such material; and to be prepared to respond to a nuclear security event. However, terrorists and criminals work across international borders, therefore a coordinated international response is crucial. States also recognize that nuclear security in one State may depend on the effectiveness of the nuclear security regimes in other States. Therefore, there is an increasing need for appropriate international cooperation to enhance nuclear security worldwide. In this respect, the IAEA plays a central role in leading the coordination of international cooperation in nuclear security and in helping States, upon request, to ensure that nuclear and other radioactive materials do not fall into the wrong hands.

It is also important to address the interfaces and coordination between nuclear forensics and all elements of an effective and sustainable nuclear security infrastructure that governs: (i) prevention (ii) detection of and (iii) response to criminal or intentional unauthorized acts involving or directed at nuclear or other radioactive material, associated facilities, or associated activities. In this way, nuclear forensics is just one piece of the nuclear security continuum. States may need to ensure their national legislation allows for these interfaces and coordination a well as outlines how information may be shared between relevant parties. Additionally, ensuring that nuclear forensic evidence can be utilized in the courtroom is essential. This continuum is captured in IAEA Nuclear Security Series No. 15, Nuclear Security Recommendations on Nuclear and Other Radioactive Material out of Regulatory Control, which refers to nuclear forensics as part of preventive measures, or deterrence, to enable response and to foster international cooperation to bring an elevated state of practice.

Nuclear forensics as part of a nuclear security infrastructure needs to able to provide information relevant to whether national legal statutes have been violated and enable law enforcement to conduct their investigations, conduct preliminary assessments about the characteristics of the seized nuclear and other radioactive materials to determine the conduct of further examination, strengthen nuclear security controls, and best position the State to receive international assistance, as requested. Essential is the integration of nuclear forensics within a national response plan and nuclear security infrastructure to include on-scene categorization to identify the threat and develop an appropriate forensics examination plan as well as to protect the public and responders at the scene of a nuclear security event.

Exercising nuclear forensics to verify that roles and responsibilities are identified and implemented appropriately is essential as well as the provision of shared experience and lessons learned from the actual response to a nuclear security event.

Cooperation and coordination of all involved ministries, agencies and nuclear security event responders is essential, including the appropriate subject matter experts, to ensure they are identified and fully represented a priori in the conduct of a nuclear forensic examination.

Nuclear forensics science: the next five years (Panel Session 3H)

Nuclear forensics as a tool for law enforcement investigations and to support nuclear security vulnerability assessments requires continual innovation. As the threat associated with the continuing reports of nuclear and radioactive material out of regulatory control persists, the science needs to advance as well. Nuclear forensic science ensures that new tools are always available to aid States in preventing and responding to a nuclear security event. Through peer review, nuclear forensic science allows new methods to be verified before they are used in support of an actual law enforcement investigation or potential criminal prosecution. Nuclear forensic science benefits from the widest intersection of all branches of science and engineering. Companion disciplines — to include geochemistry, materials science, nuclear engineering and environmental science — exploit new frontiers of nuclear forensic signatures and interpretation as well as access to new subject matter experts to build confidence in nuclear forensic findings. By building in synergies with other fields of science and engineering, the credibility of nuclear forensics can be best sustained for use in an examination. As synergies are developed, States can build a sustainable nuclear forensic capability through training the next generation in the companion disciplines and educating them in the intersections with nuclear forensics. Additionally, the international community should continue to share best practices and methods for nuclear forensics.

During the international conference an interactive exercise further demonstrated the States need to optimize the best use of existing resources and capabilities, while bridging to companion disciplines, to best advance nuclear forensics.

The future of nuclear forensics will be driven by world events that continue to include reports of nuclear and other radioactive materials out of regulatory control. The science needs to be in place to provide the best answers to question the origin and history of nuclear and other radioactive materials out of regulatory control in support of law enforcement investigations and nuclear security vulnerability assessments. This international conference highlighted key scientific developments that promise nuclear forensics will continue to be able to meet requirements asked by the scientific, law enforcement and policy constituencies.

Nuclear forensics: where science meets policy (Round Table Session 4B)

Nuclear forensic science is a technical discipline supporting law enforcement investigations and nuclear security vulnerability assessments. However, nuclear forensics is not implemented in isolation. Understanding the requirements posed by the policy community is essential to ensure that — as a part of a nuclear security infrastructure — nuclear forensics answers key questions, such as what the materials are, how, when and where the materials were produced, and what their intended use could be. Effective implementation of nuclear forensic capabilities include coordination and expectation management between policy makers and practitioners, international cooperation to advance and mature nuclear forensic capabilities as a keystone of nuclear security, and provisions to enhance and evolve the technical foundations of nuclear forensics.

The needs of the policy community have to be clearly articulated to practitioners such that appropriate nuclear forensic capabilities can be developed and sustained relative to national needs. Not all States need to have elaborate capabilities for nuclear forensics; determining the scale and scope of nuclear forensic capabilities within the State involves coordination between the policy and technical communities. At a minimum, the policy community must understand what capabilities currently exist within the State to support nuclear forensic examinations — national laws, a national response plan, coordination between law enforcement, and measurement and analysis laboratories. From the national perspective, establishing clearly understood roles and responsibilities to support a nuclear forensic examination and being fully prepared to implement them is essential.

Nuclear forensics awareness and understanding is crucial for policy makers. It is important for the policy community to understand what shapes confidence in nuclear forensic findings such as demonstrated competencies, quality assurance and control, written procedures and the use of calibrated equipment and standards. The most sophisticated instrumentation or nuclear forensic laboratories in the world are of little value if it is not used to return the most defensible scientific data in support of an investigation.

Nuclear forensics need not be expensive or unnecessarily bureaucratic. Existing capabilities already maintained by the State may be used for a nuclear forensic examination consistent with the generalized conduct of a nuclear forensic examination specified in IAEA Nuclear Security Series No. 2, Nuclear Forensics Support (2006) and its forthcoming revision within the IAEA Nuclear Security Series. These existing capabilities for analysis of nuclear and other radioactive materials may be found at nuclear research institutes, universities, maintained by nuclear operators or producers, or used by environmental monitors or regulators. It is not the instrumentation only, but rather how it is used that determines the resulting strength of nuclear forensic findings.

Once developed, the infrastructure supporting nuclear forensics must be fostered and sustained. This involves regular exercises of all facets of a nuclear forensic examination – from evidence collection to analysis to interpretation and reporting. Learning through education and training needs to be in place to ensure an enduring nuclear forensic capability is implemented and that expertise is available — from analytical science, to nuclear engineering, to forensic science disciplines — to ensure the next generation of practitioners is properly prepared and research can be sustained to enable innovation and advances, such as the science of signatures. As its technical foundations mature through advances in technology and improvements in methodologies, nuclear forensics also needs to evolve to ensure that the most discriminating and credible findings support investigations of nuclear security events.

Systematic, comprehensive and harmonized approaches are critical and will enable the international community to rely on the consistency of a nuclear forensic examination. In this regard, the IAEA can play an important role through the development of guidance, supporting provision for their voluntary application and use through education and training, coordinated research projects, peer reviews and advisory services. It can also assist States, upon request, to develop a national nuclear forensic library to include an administrative association of databases as one way to assist States in meeting their national nuclear security responsibilities and international obligations. Strategies for the IAEA to better assist Member States, upon request, in nuclear forensics include harmonized guidance on relevant analytical measurements, assistance to nuclear forensic laboratories, regional approaches that use nuclear security support centers as well as assistance, upon request, through IAEA Integrated Nuclear Security Support Plans.