

Establishing Canada's National Nuclear Forensics Laboratory Network

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Abstract. Following the 2010 Nuclear Security Summit, Canada concluded that its existing capability for nuclear forensics should be augmented by establishing a national nuclear forensics laboratory network, which would include a capability to perform forensic analysis of evidence contaminated with radioactive material. At the same time, the need for a national nuclear forensics library of signatures of nuclear and radioactive materials under Canadian regulatory control was recognized. Through the Canadian Safety and Security Program, Defence Research and Development Canada's Centre for Security Science (DRDC CSS) funds science and technology initiatives to enhance Canada's preparedness for, prevention of, and response to potential threats. DRDC CSS, with assistance from Atomic Energy of Canada Limited (AECL), is leading the Canadian National Nuclear Forensics Capability Project to develop a coordinated, comprehensive, and timely national Nuclear Forensics capability. Canada's Nuclear Forensics Laboratory Network will consist of several laboratories having complementary capabilities in areas such as radiological and physical characterization and material handling. Input from law enforcement agencies and other federal departments will ensure that the project outputs are consistent with the requirements and expectations of the user community. The process of building up this integrated laboratory network has commenced, with several tasks already underway, including the identification of requirements for laboratories within the network, cataloguing of current network laboratory capabilities, drawing up of action plans to address any identified capability gaps, and development and delivery of training plans for nuclear and classical forensic scientists. As the project progresses, it will undertake the planning and execution of both inter-laboratory comparisons and an operational exercise geared towards lab network implementation. The paper presents Canada's approach to establishing the laboratory network component of this national nuclear forensics capability, and discusses project tasks in detail, including challenges encountered during implementation of these tasks.

1. Introduction

Ensuring the safety and security of Canadians requires a national capability to respond to all credible threats. An effective response includes prevention as well as mitigation, and may require an ability to successfully interdict, investigate, prosecute, and convict the perpetrators. A gap has been identified in Canada's capability to respond to a radiological and nuclear threat; namely, a coordinated national nuclear forensics capability, such as is required for the investigation of a nuclear security event, does not exist. Such a capability would contribute not only to the safety and security of Canadian citizens, but also to those of North America and the world. The importance of developing and enhancing nuclear forensics capabilities was underscored in the 2012 Nuclear Security Summit Communiqué, fully endorsed by the Canadian government. In addition, Canada made the following statement in its National Report:

“Canada is finalizing a strategy to enhance its domestic nuclear forensics capabilities, which will include the formalization of the Canadian nuclear forensics laboratory network, the creation of a national library of nuclear and radiological signatures, and the enhancement of Canada's capacity for the forensic analysis of radiologically-contaminated evidence.”

Efforts to develop a more coordinated national nuclear forensics capability have been underway, led by Defence Research and Development Canada's Centre for Security Science (DRDC CSS). To help establish the scope and requirements of such a national nuclear forensics capability, CSS organized a workshop in September 2011 that brought together nuclear forensic stakeholders to identify how this national capability can be developed. Several areas of work were identified at that time, and formed the basis of the scope of work for the path forward.

2. The Canadian National Nuclear Forensics Capability Project

In 2012, the Centre for Security Science established the Canadian National Nuclear Forensics Capability Project under the auspices of the Canadian Safety and Security Program (CSSP), a joint initiative of DRDC and Public Safety Canada. The project, with Atomic Energy of Canada Limited (AECL) as the lead federal agency, is being implemented with a whole-of-government approach, involving several federal science and technology departments and agencies, with the active participation and guidance of the potential end users of this capability, including law enforcement and international affairs. The project will be building upon existing technology and processes, while also identifying areas where new capabilities may be needed.

With an overall goal of developing a coordinated, comprehensive, and timely national Nuclear Forensics capability within Canada, the areas of work identified during the 2011 workshop were separated into two separate but inter-related project streams:

- (1) Stream 1 (Laboratory Network), led by Atomic Energy of Canada Limited (AECL), was mandated to establish a national nuclear forensics laboratory network capable of undertaking comprehensive nuclear forensic analysis of nuclear and other radioactive material, as well as forensic analysis on evidence contaminated with radioactive material as part of the investigation of a nuclear security event.
- (2) Stream 2 (Library), led by the Canadian Nuclear Safety Commission (CNSC), was tasked with establishing a national nuclear forensic library (NNFL) consisting of comprehensive descriptions of nuclear and other radioactive materials produced, used, or held in Canada, which will provide the basis for conducting comparative assessments with material encountered outside of regulatory control.

These two streams will proceed in parallel, with the following partner organizations lending their expertise to one or both streams: DRDC's Ottawa Research Centre, the Royal Canadian Mounted Police (forensics and operations), the Royal Military College of Canada, the National Research Council, Health Canada, Public Safety Canada, the Department of National Defence, and the Department of Foreign Affairs, Trade and Development. Over the course of the project, the library stream will identify materials for analysis by the network labs, providing samples where possible, and the labs will carry out analysis in order to help populate and validate the NNFL. The work of the two streams will culminate in a trial exploitation of this capability at the end of the project. The project is envisioned to take approximately three years to complete, from April 2013 to January 2016. The total commitment of resources to this project, including CSSP funding and partner in-kind contributions, is close to \$5 M.

3. National Nuclear Forensics Laboratory Network

A robust nuclear forensics program requires a wide range of expertise found across several government agencies, making it necessary to formalize a network of these organizations, providing a framework for collaboration. Canada's Nuclear Forensics Laboratory Network (the lab network) will consist of several laboratories with complementary capabilities in the fields of radioactive measurements, analytical chemistry (both isotopic and elemental compositions), physical characterization, optical and electronic microscopy, and surface and particle analysis. The laboratories are also expected to have radioactive and nuclear material handling and storage facilities. In addition, law enforcement agencies will work with laboratories in the network to develop procedures for the forensic analysis of evidence contaminated with radioactive material. Partners in law enforcement and

international affairs are also providing advice and guidance on the overall direction of the development effort, in order to ensure that the project outputs are consistent with the requirements and expectations of the user community.

The establishment of the lab network has been broken down into a number of key tasks:

- (1) Establish requirements for nuclear forensics labs
- (2) Catalogue current analytical capabilities in the federal S&T sector
- (3) Identify gaps in the lab network capability and determine appropriate actions to close the gaps
- (4) Implement appropriate actions to develop technology and standards to address the identified gaps
- (5) Develop training plan for nuclear and traditional forensics specialists, and begin delivery of training
- (6) Develop protocols for collection, packaging and transportation of RN materials to the labs
- (7) Develop appropriate protocols and procedures for the handling of evidence at the RN labs
- (8) Plan operational exercise details and establish assessment procedure to test NF capability
- (9) Execute operational exercise geared towards lab network implementation

2.1 *Nuclear Forensics Laboratory Requirements*

Nuclear forensics laboratories must be capable of providing timely, scientifically valid data in a manner that is legally defensible. Access to appropriate resources, and the skills and experience to exploit these resources, is essential to the provision of nuclear forensic data. While resources and expertise are prerequisites to legal defensibility, the operation of a nuclear forensics laboratory according to a defined and documented structure also represents a cornerstone of the nuclear forensics process.

The goal of this task is to produce a document that provides guidance for the minimum quality assurance requirements for facilities conducting nuclear forensics analysis and/or traditional forensics on evidence contaminated with RN material as part of the national nuclear forensics laboratory network. The requirements are to be drawn from those associated with established standards (e.g., ISO 17025), published literature (e.g., guideline documents from the IAEA), and forensics practitioners, including Canadian and international forensic laboratory best practices. Elements of the lab requirements will include laboratory organization and management, sample control (particularly in terms of chain of custody considerations), document and data control, personnel qualifications and training, and analytical methodology.

2.2 *Catalogue of Current Analytical Capabilities*

To establish the national lab network, there is a need to know the current analytical capabilities of each of the labs. Using IAEA's Nuclear Security Series No. 2, *Nuclear Forensics Support*, as a guide [1], several categories of capability were identified, including on-scene capabilities, radiation detection, imaging (both portable and non-portable), powder characterization, surface analysis, elemental and isotopic analysis, and specialized facilities such as fume hoods, glove boxes, and shielded cells. Input from each of the labs will be consolidated into one catalogue of analytical capabilities. Since the contents of the catalogue are expected to change with time, as new capabilities are developed and established, and old, obsolete ones discarded, the intent is to update this catalogue on a regular basis.

2.3 *Analytical Capabilities Gap Assessment*

An assessment of current capabilities will be performed to identify gaps in current knowledge and capabilities. During this task, it is necessary to consider the minimum acceptable capability as opposed to the ideal set of capabilities. Part of this assessment is to determine actions to close the identified gaps. A literature review of previous work in Canada and internationally will be conducted to aid in drawing up options for closing these gaps. Another approach that will be adopted is participation in international nuclear forensics meetings and workshops to leverage what is being developed in Canada with other international partners.

2.4 Training of Nuclear and Traditional Forensics Specialists

This task will involve identifying training requirements and potential sources of training for both nuclear forensics and traditional forensics specialists. Effectively, this task will develop a cross-training program, promoting forensic awareness training for RN lab scientists, with an emphasis on chain-of-custody aspects of evidence handling, and RN awareness training for traditional forensic scientists.

2.5 Development of Protocols

Protocols developed under this task will include those for the collection, packaging, and domestic transportation of RN materials to the laboratories, as well as those for the handling of evidentiary material at the labs. Development of these protocols will take into consideration best practices and existing procedures that have been developed for first responders and field personnel. These protocols, intended to be non-prescriptive, will serve as guidelines for each lab to develop their own standard operating procedures.

2.6 Operational Exercise

The coordinated nuclear forensics capability developed under this project will ultimately be demonstrated in an operational exercise geared towards lab network implementation; time and resources permitting, the operational exercise will be preceded by a lab intercomparison study focused on validating the technical aspects of the network's analysis capabilities. Planning of the operational exercise will involve the identification of test objectives and assessment criteria as input to designing the exercise. The exercise will involve the end user community, and will cover the entire "life cycle" of an event, from the incident itself to evidence collection, analysis, and presentation of evidence in a court of law.

3. Project Status

The project charter was signed by all partners in September 2013, and a kick-off meeting for the lab network was held shortly thereafter to initiate work on the first two tasks: the requirements for nuclear forensics laboratories in the network, and the catalogue of current NF analytical capabilities. One major lesson being learned during the early days of the project is that frequent project communication is essential to coordinate a multi-organizational effort such as this. Thus, the lab network has a regularly scheduled teleconference to discuss status of ongoing work and action items from previous meetings and teleconferences, and a document sharing site has been set up to facilitate collaboration. Realizing the importance of face-to-face interactions to discuss major milestones and resolve any serious issues, project meetings are held quarterly on a rotating basis, where each meeting is hosted by a different lab.

4. Conclusion

Canada has initiated the National Nuclear Forensics Capability Project, taking a two-stream approach to develop a formalized Nuclear Forensics Laboratory Network and a National Nuclear Forensics Library. The Lab Network as a whole will be capable of comprehensive NF analysis, as well as classical forensic analysis on evidence contaminated with radioactive material. Canada's approach to building up the Lab Network is to mobilize and coordinate several federal S&T agencies with complementary capabilities. As active partners in the project, law enforcement agencies and other government departments ensure that the outputs meet the needs of the end user community. The project builds upon existing knowledge, expertise, and facilities in order to provide the greatest possible return on investment.

To succeed, the project requires strong collaboration among nuclear scientists, forensic experts, law enforcement, policy makers, and operational support specialists, and much progress has already been made towards achieving this goal. The ultimate result of this strong collaboration will be the development of a national nuclear forensics capability, which will ensure that Canada is capable of

analyzing both seized materials and contaminated evidence in a manner that supports the successful prosecution of crimes involving the misappropriation or misuse of RN materials.

5. Acknowledgements

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REFERENCES

- [1] INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Forensics Support: Reference Manual, Security Series No. 2, IAEA, Vienna (2006).