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Strategic plan for the establishment of a nuclear forensic capability at DRDC Ottawa

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Defence R&D Canada – Ottawa

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Abstract

As stated in the communiqué of the April 2010 Washington Nuclear Security Summit, “nuclear terrorism is one of the most challenging threats to international security”. As such, individual countries need to ensure they have strong nuclear security measures in place to prevent the illicit acquisition and use of nuclear materials. Canada’s involvement in the Nuclear Security Summit saw the commitment to strengthen nuclear security and thus reduce the threat of nuclear terrorism within Canada and abroad.

Nuclear forensics is a component of a robust nuclear security regime, supporting law enforcement in the overall attribution process from the point of view of being able to answer questions such as what is the material, who is responsible, is there more material, where was it diverted from, and what route did it take. As such, a robust nuclear forensic capability can also act as a deterrent to actors (state or non-state) considering involvement in nuclear terrorism. This paper describes a plan for developing a nuclear forensic capability in Canada, building on previous work in this area and leveraging experience and knowledge of our allies.

Résumé

Comme il est mentionné dans le communiqué du Sommet de Washington sur la sécurité nucléaire d’avril 2010, « le terrorisme nucléaire est l’une des menaces les plus lourdes qui pèsent sur la sécurité des nations ». Par conséquent, chaque pays doit s’assurer d’avoir en place des mesures solides pour prévenir l’acquisition et l’usage illicites de matières nucléaires. Lors du Sommet sur la sécurité nucléaire, le Canada s’est engagé à renforcer ses mesures de sécurité de manière à réduire la menace de terrorisme nucléaire au pays et à l’étranger.

La criminalistique nucléaire est un élément important de tout bon système de sécurité nucléaire. Elle permet, dans le cadre du processus global d’identification de la source du matériel nucléaire, de trouver des réponses à des questions d’intérêt judiciaire comme celles-ci : Quel est le matériel utilisé? Qui sont les responsables? Y a-t-il présence d’autres matières? D’où provient le matériel? Quel itinéraire a-t-on emprunté pour le transporter? Ainsi, une solide capacité en matière de criminalistique nucléaire peut avoir un effet dissuasif sur les entités étatiques et non étatiques qui envisagent de prendre part à des activités de terrorisme nucléaire. Le présent document dresse un plan en vue du développement d’une capacité de criminalistique nucléaire au Canada en tirant parti des travaux déjà réalisés dans ce domaine ainsi que de l’expérience et des connaissances de nos alliés.

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Executive summary

Strategic plan for the establishment of a nuclear forensic capability at DRDC Ottawa

Carey L. Larsson; DRDC Ottawa TM 2010-241; Defence R&D Canada – Ottawa; December 2010.

Introduction or background: Nuclear forensics is a component of a robust nuclear security regime, supporting law enforcement or military commanders in the overall attribution process from the point of view of being able to answer questions such as what is the material, who is responsible, is there more material, where was it diverted from, and what route did it take. As such, a robust nuclear forensic capability can also act as a deterrent to actors (state or non-state) considering involvement in nuclear terrorism.

Results: Canada has undergone some work in the area of nuclear forensics, but does not have a dedicated, mandated capability for analyzing radiological or nuclear material or evidence contaminated with such material. Some ad hoc contaminated traditional evidence analysis, limited to visual techniques such as fingerprint and document analysis, has been performed at DRDC Ottawa in conjunction with the RCMP. In addition, DRDC Ottawa, Health Canada's Radiation Protection Bureau, and Royal Military College collaborate in an informal nuclear forensics laboratory network for the analysis of radiological and nuclear material.

Significance: The establishment of a nationally-recognized laboratory for the forensic analysis of RN evidence at DRDC Ottawa, under the auspices of the Radiological Analysis and Defence Group, would enable Canada to perform nuclear forensics in support of law enforcement nuclear security activities. Formalization of collaborative partnerships with other government departments (mainly RCMP, RMC, Health Canada, AECL and CNSC) and international allied partners (UK, US, AUS, and others) would also be established to strengthen this capability.

Future plans: DRDC Ottawa will pursue the steps required to have a mandated nuclear forensic capability established at DRDC Ottawa and supported by formalized partnerships with other federal government departments.

Sommaire

Strategic plan for the establishment of a nuclear forensic capability at DRDC Ottawa

Carey L. Larsson; DRDC Ottawa TM 2010-241; R & D pour la défense Canada – Ottawa; Décembre 2010.

Introduction ou contexte : La criminalistique nucléaire est un élément important de tout bon système de sécurité nucléaire. Elle permet, dans le cadre du processus global d'identification de la source du matériel nucléaire, de trouver des réponses à des questions d'intérêt judiciaire comme celles-ci : Quel est le matériel utilisé? Qui sont les responsables? Y a-t-il présence d'autres matières? D'où provient le matériel? Quel itinéraire a-t-on emprunté pour le transporter? Ainsi, une solide capacité en matière de criminalistique nucléaire peut avoir un effet dissuasif sur les entités étatiques et non étatiques qui envisagent de prendre part à des activités de terrorisme nucléaire.

Résultats : Bien que certains travaux dans le domaine de la criminalistique nucléaire aient été réalisés au Canada, nous ne disposons d'aucune capacité spécialement conçue pour l'analyse de matières radiologiques ou nucléaires et permettant d'examiner des preuves contaminées par ce genre de matières. RDDC Ottawa, avec le soutien de la GRC, a effectué de façon ponctuelle quelques analyses traditionnelles de preuves contaminées en se limitant à des techniques visuelles telles que l'analyse d'empreintes digitales et de documents. De plus, RDDC Ottawa, le Bureau de la radioprotection de Santé Canada et le Collège militaire royal se sont concertés pour établir un réseau non officiel de laboratoires de criminalistique nucléaire.

Importance : L'établissement d'un laboratoire d'analyses des preuves nucléaires et radiologiques reconnu à l'échelle du pays à RDDC Ottawa, sous les auspices du Groupe de défense et analyse radiologique, permettrait au Canada de se doter d'une capacité en matière de criminalistique nucléaire pour soutenir les activités de sécurité nucléaire sur le plan judiciaire. L'officialisation de partenariats avec d'autres ministères gouvernementaux (en particulier la GRC, le CMR, Santé Canada, EACL et la CCSN) et avec des pays alliés (Royaume-Uni, États-Unis, Australie, etc.) permettrait de solidifier cette capacité.

Perspectives : RDDC Ottawa entreprendra les démarches nécessaires pour se doter d'une capacité de criminalistique nucléaire en bonne et due forme soutenue par un partenariat officiel avec d'autres ministères gouvernementaux.

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1 Introduction

The communiqué of the April 2010 Washington Nuclear Security Summit made the statement that "nuclear terrorism is one of the most challenging threats to international security" [1]. As such, individual countries need to ensure they have strong nuclear security measures in place to prevent the illicit acquisition and/or use of nuclear materials. Canada's involvement in the Nuclear Security Summit resulted in a commitment to strengthen nuclear security and thus reduce the threat of nuclear terrorism within Canada and abroad.

Nuclear forensics is a component of a robust nuclear security regime, supporting law enforcement or military commanders in the overall attribution process from the point of view of being able to answer questions such as what is the material, who is responsible, is there more material, where was it diverted from, and what route did it take. As such, a robust nuclear forensic capability can also act as a deterrent to actors (state or non-state) considering involvement in nuclear terrorism.

The need for a comprehensive nuclear forensic capability becomes clear after considering the actions that would follow either a radiological or nuclear terrorist attack on Canadian soil, or a nuclear detonation in a foreign State requiring Canadian military action in or near the effected area. Clear cut evidence on the origin and perpetrators of the attack, demanded from the highest levels of government, would be needed very quickly. In these circumstances, time could not be wasted on establishing the analysis framework (i.e. chain-of-custody, quality assurance and control measures, robust documentation systems, etc) necessary for obtaining irrefutable evidence to leadership. While international assistance in these matters might be sought through pre-existing agreements, some level of national capability would undoubtedly be needed to address eminent questions following an event.

This paper describes a plan for developing a nuclear forensic capability in Canada, building on previous work in this area and leveraging experience and knowledge of our allies.

2 Background

Nuclear forensics is the study of radiological and nuclear materials and/or traditional forensic evidence that has been contaminated with such materials for the purpose of obtaining investigative leads and attribution indicators to further a criminal or military investigation involving their nefarious use. In addition to determining the exact form of the material and the potential hazard it could pose to the public, analysis of the radiological or nuclear material itself can lead to determination of the material's origin, age, and original intended use, which can provide investigators with information on where and how the material was diverted. Meanwhile, the analysis of contaminated traditional forensic evidence, such as fingerprints, DNA, fibres, etc., can provide crucial investigative leads resulting in attribution of an event. However, most traditional forensics laboratories do not allow (and are not licensed for) radiological and nuclear materials in their facilities, thus specialized facilities are required in order to benefit from analysis of this evidence.

There are four main aspects of nuclear forensic analysis: 1) collection of the evidence by law enforcement and/or military sampling teams; 2) analysis of contaminated traditional evidence by forensic laboratories; 3) analysis of the radiological or nuclear material in specialized radiation laboratories; and 4) interpretation of results for attribution to point of origin of the material. This process requires close cooperation between law enforcement/military and the forensic and radiological/nuclear scientific communities in the development of training programs, protocols, procedures, and dedicated facilities where these analyses can be carried out.

As mentioned above, the gathering and analysis of nuclear forensic evidence linked to a terrorist incident will be a key element of the attribution process. As with any type of forensic evidence, certain practices must be followed to ensure analysis results will stand up to legal scrutiny. Since many of the analyses involved will be performed by radiological/nuclear laboratories, it is necessary to ensure that these labs follow protocols common to traditional forensic laboratories (i.e. evidence chain-of-custody, quality assurance and control of laboratory practices, documentation, etc).

The analysis of contaminated traditional forensic evidence poses an additional challenge as forensic scientists often are not trained to work with radioactive materials and radiation scientists are not familiar with forensic analysis practices. This challenge requires close collaboration between the two communities in the development of training programs, protocols, procedures, and dedicated facilities where these analyses can be carried out. In addition, a significant amount of research and development remains to determine the effects of radioactive contamination on the evidence, the analysis equipment, and the analysis results

3 International approaches to nuclear forensics

International activities in nuclear forensics are numerous, but probably the most comprehensive of these is led by the Nuclear Forensic International Technical Working Group (ITWG). The ITWG is an informal association of nuclear forensics practitioners created in 1996 following a G8 summit in Ottawa and a subsequent International Conference on Nuclear Smuggling Forensic Analysis held in the United States [2]. The ITWG aims to provide a framework for combating the illicit trafficking of nuclear materials and other radioactive substances by establishing informal communications and cooperation among international experts, including policy makers, scientists, and law enforcement personnel. The ITWG is open to all states interested in nuclear forensics and Canada has been active in this group since 2004 via participation in annual meetings and leading a task group on evidence collection practices.

Many countries have established programs in the area of nuclear forensics, as evidenced by the 25+ countries participating in the ITWG. Programs of particular note exist in the US, UK, Australia and the EU (whose nuclear forensic laboratory is located in Germany), each of which will be described in more detail.

The US has dedicated significant personnel and resources to the establishment of a comprehensive nuclear forensic capability [3]. The Federal Bureau of Investigation has worked closely with the Department of Energy to ensure that facilities are available for the analysis of radiological and nuclear forensic evidence that are accredited to FBI evidence analysis standards and are equipped with all potentially required equipment and materials. The National Technical Nuclear Forensic Centre at Lawrence Livermore National Laboratory and the Radiological Evidence Examination Facility at Savannah River National Laboratory are two examples of this commitment. The Nuclear Forensic and Attribution Act, signed by President Obama in February 2010, strongly supports increased efforts in this area. Incidentally, from a military perspective, the US has broadened their definition of "warfighter" to include all personnel who have an armed role in the defence of the Homeland. As such, the comprehensive NF capability of the FBI could be used to support military needs. In addition, the US DOD has recently begun planning a NATO workshop on nuclear forensics, indicating the perceived military relevance of this capability within the US.

The UK's Atomic Weapons Establishment (under the UK Ministry of Defence) also has a comprehensive nuclear forensic capability [4] with strong links to New Scotland Yard. This capability was thoroughly and successfully tested during the relatively small scale (yet extremely taxing) radiological incident involving the poisoning of Alexander Litvenenko, a former Russian spy.

Australia has recently opened their CBRN Data Centre within the Australian Federal Police and a dedicated radiological and nuclear forensic facility is being commissioned at the Australian Nuclear Science and Technology Organization (ANSTO) [5,6]. ANSTO has performed substantial research and development work in understanding the analysis of contaminated evidence and the effects of decontamination on that evidence. They also perform responder training exercises in realistic radiation environments similar to those carried out in Canada under the First Responder Training Program.

Finally, the European Union's Institute for Transuranium Elements (ITU), situated in Germany [7], has a long-standing laboratory capability for nuclear forensic analysis. This capability has been tested numerous times following thwarted nuclear smuggling cases within EU states.

One last item of note is the nuclear forensics work being carried out by the International Atomic Energy Agency (IAEA). The IAEA funds nuclear forensic-related research internationally and has established a number of training courses on the subject, which it offers periodically in various host nations. In November 2009, Canada hosted an IAEA workshop on the Introduction to Radiological Crime Scenes and Nuclear Forensics at the Canadian Police College, with attendance from seven countries.

4 Nuclear forensics in Canada

4.1 Past Canadian activities

Canada's involvement in both the ITWG and in nuclear forensics in general began in 2003/2004 via the planning and participation in an international round robin exercise involving analysis of a seized highly enriched uranium sample [8]. This exercise, coordinated by Defence R&D Canada – Ottawa's Radiological Analysis and Defence group, involved seven different laboratories: DRDC Ottawa, DRDC Atlantic's Esquimalt laboratory, Health Canada's Radiation Protection Bureau, Canadian Nuclear Safety Commission, Royal Canadian Mounted Police, Royal Military College, and University of Alberta. This exercise was very much an "As-Is" response, resulting in a number of identified issues requiring further development, including the need to establish a dedicated contaminated evidence facility with strong links to Canada's forensic science community. Nonetheless, the analysis results from the various laboratories were in agreement and many of these labs continue to work as part of an informal national laboratory network for nuclear forensics analysis. Currently, the ITWG is in the process of executing another international round robin exercise, this time dealing with the analysis of two highly enriched uranium fuel pellets. Canada's participation, led by DRDC Ottawa in partnership with RMC, Health Canada's Radiation Protection Bureau and CNSC, is nearing completion.

Related to the ITWG involvement, DRDC Ottawa led a CRTI project (04-0030TD) entitled "Nuclear Forensic Response Capabilities and Interoperability" from 2005 until 2007 with partners from the RCMP, the Canadian Nuclear Safety Commission, Health Canada's Radiation Protection Bureau, Public Safety Canada, and Science Applications International Corporation (SAIC) Canada [9]. The US FBI and UK New Scotland Yard also contributed to the project through US-Canada and UK-Canada meetings as well as involvement in Canadian exercises. This project dealt with radiologically contaminated forensic field techniques, the establishment of protocols for forensic identification specialists to achieve attribution despite a radioactive/nuclear contaminated site, and laboratory analysis requirements and inter-comparisons.

In addition to laboratory capabilities, much work has been done to develop and deliver training to CBRN-trained forensic investigators who would be responsible for the collection of nuclear forensic evidence. These training activities, executed collaboratively with the Canadian Nuclear Safety Commission, Defence R&D Canada – Ottawa and Royal Canadian Mounted Police, involve both classroom-based lectures and practical exercises in realistic environments in an effort to highlight issues unique to working in radiologically contaminated environments [10].

4.2 Capability gaps and requirements

The term nuclear forensics has led to a degree of uncertainty with respect to responsibility and mandate for carrying out this work. Traditionally, forensic analysis is carried out by law enforcement laboratories or specialized labs with strong ties to the criminal justice system. Consultants with specialized expertise can also be contracted. However, of the 106 forensic laboratories and consultants within Canada [11], none has expertise in radiological or nuclear material analysis, nor do they have facilities or capabilities for analyzing traditional forensic evidence that is contaminated with radiological or nuclear materials. The requirement for

facilities to be licensed to possess, use, transport, etc, any radiological material is one limiting factor, as are the additional hazards associated with working with such material. Establishment of a nuclear forensic capability within a laboratory or laboratories experienced in working with and analyzing radiological and nuclear materials is akin to the forensic community consulting with individuals or companies with specialized expertise in less common forensic disciplines.

Canada does not have a dedicated radiological evidence facility for analysis of either contaminated traditional evidence or radiological / nuclear material. Some ad hoc contaminated traditional evidence analysis, limited to visual techniques such as fingerprint and document analysis, has been performed at DRDC Ottawa in conjunction with the RCMP. Expansion of this capability would require a dedicated facility with strong collaboration between radiation scientists, forensic scientists, and law enforcement.

In the analysis of radiological and nuclear material (also known as technical nuclear forensics), there are currently three laboratories in Canada collaborating in an informal nuclear forensics laboratory network: Defence R&D Canada – Ottawa, Health Canada's Radiation Protection Bureau, and Royal Military College. The labs have varying, complementary capabilities and participate in regular inter-comparison exercises. The Canadian Nuclear Safety Commission has also taken part in the network, both in terms of laboratory analysis (which up to now has been very basic material characterisation) and in data interpretation.

4.3 Current Canadian situation

In Canada, response to a terrorist incident involving radiological or nuclear material is led by the National CBRN Response Team [12], which consists of RCMP forensic investigators and explosives ordinance disposal units, and supplemented with military CBRN support from the Canadian Joint Incident Response Unit. CJIRU's role is divided into several different mission areas, one of which is Sampling and Identification of Biological, Chemical and Radiological Agents (SIBCRA) [13]. SIBCRA missions consist of operational and forensic components, where the latter should provide commanders with irrefutable confirmation of use by an adversary to support timely decisions concerning the response to such actions. Canadian Forces operations in theatre may also require SIBCRA missions to be carried out, and, given the ongoing efforts in establishing nuclear weapons capabilities in several unfriendly States, future operations may include undertaking such missions.

The National CBRNE Response Team is well trained and would likely be sufficiently capable of collecting any nuclear forensic evidence needed in support of an investigation. The team may also be supplemented as necessary with scientific expertise from various government departments. The Federal Radiological Assessment Team (FRAT), an informal collaboration between Health Canada's Radiation Protection Bureau (the lead agency for the Federal Nuclear Emergency Plan), DRDC Ottawa, Director General Nuclear Safety, and Natural Resources Canada, has been established to provide radiological and nuclear expertise. Advice on what quantities of CBRN material to collect, how to appropriately package and transport this evidence, and identification of the R/N material used – both in field and via laboratory reachback – would be sought from scientific support personnel. FRAT support to the National CBRNE RT has been tested at the 2008 Summit de la Francophonie, the 2010 Vancouver Winter Olympics, and at the 2010 G8/G20 meetings in Ontario, all in a pre-deployed support-to-security role.

In response to a radiological or nuclear incident, forensic sampling and identification of radiological agents (SIRA) would be required, involving characterization of the composition of a very wide range of radioactive materials that could be involved in an incident, both to identify the source and to indicate whether the material had been deliberately or accidentally released. NATO specifies that unambiguous identification and proof of use must be obtained by using sophisticated analytical techniques in a well equipped and properly designed laboratory [13]. In the Canadian context, DRDC Ottawa's Radiological Analysis and Defence Group and the Royal Military College provide this reachback analytical capability to CJIRU and the CF. DRDC Ottawa can also provide operational SIRA support through deployment of its Mobile Nuclear Laboratory (MNL), thus providing a conduit for effective communication, situational awareness, and interoperability from field to laboratory. In addition to these operational support roles, DRDC Ottawa has provided advanced training in SIRA procedures to CJIRU and is currently involved with CANSOFCOM in the development of an advanced radiation course that includes SIRA elements in support of the new CF CBRN occupation. Given these reachback roles, placing a national nuclear forensic capability at DRDC Ottawa, expanding on existing infrastructure, equipment and capabilities of the RAD Group, with collaborative ties to RMC, is a logical choice.

Further justification for choosing DRDC as a locale for a national nuclear forensic capability resides in the memorandum of understanding (MOU) between DRDC and Public Safety Canada (PSC). This MOU is the mechanism through which DRDC provides scientific and technical services to PSC. In the context of nuclear forensics, this MOU enables DRDC Ottawa to provide the nuclear forensic S&T capability to PSC, or more specifically, to the RCMP. DRDC Ottawa can then take advantage of the Defence and Security Research Institute (DSRI) agreement between DRDC and RMC to establish a collaborative laboratory network and boost DRDC Ottawa's capability via on-site graduate students and post-doctoral fellows from RMC.

DRDC Ottawa is also well placed to leverage international knowledge and expertise in the area of nuclear forensics. DRDC Ottawa represents Canada on several NATO groups, providing advice on various aspects related to radiological and nuclear defence, some of which are relevant to nuclear forensics. In particular, DRDC Ottawa provides subject matter expertise on the NATO SIBCRA subgroup, thus enabling the transition of our procedures, best practice and advice into NATO doctrine. For the last six years, DRDC Ottawa has been the only Canadian representative to the Nuclear Forensic ITWG, leading the Evidence Collectors Task Group. DRDC Ottawa also takes part in the Science and Technology Intelligence Group, a unique four-eyes partnership focused on bringing together science and intelligence communities working on CBRN issues. Nuclear forensics was highlighted at this year's meeting as an area for future collaborative S&T within this community. The Global Initiative to Combat Nuclear Terrorism and the IAEA have also requested nuclear forensic expertise from DRDC Ottawa in recent months, and the Science and Technology Centre of Ukraine has met with DRDC Ottawa to discuss possibilities for collaborative nuclear forensic research. Information and expertise garnered from these involvements is irreplaceable and serves as a strong foundation upon which a robust nuclear forensic capability can be built.

5 Vision for a future Canadian nuclear forensic capability

The establishment of a nationally-recognized laboratory for the forensic analysis of RN evidence at DRDC Ottawa, under the auspices of the Radiological Analysis and Defence Group, would enable Canada to perform nuclear forensics in support of law enforcement nuclear security activities. Such a capability would have several different programs of work, namely research and development, training, and support to operations. Research and development is by far the largest component, as much work remains to be performed internationally in the field of nuclear forensics. Much of the anticipated R&D associated with this program overlaps with several on-going areas of work within the RAD Group, particularly optically stimulated luminescence, contaminated environments, and laboratory analysis. This would allow the RAD group to leverage existing knowledge from within the group and apply it to this new capability area. The training program of work would be directed at CJIRU and RCMP, and to a lesser extent, municipal police forces, with advanced radiation detection, collection and analysis techniques being taught using short-lived radioisotopes. The nuclear forensic component of this training would consider evidence collection, SIRA, packaging, and transfer of samples to a laboratory. As mentioned above, the RAD group is already involved in the development of an advanced radiation course for the CF's new CBRN occupation, thus we are well positioned for further training development. The support to operations program of a nuclear forensic capability has been described earlier in this document. Analysis of nuclear forensic evidence in support of an investigation would likely require the formalization of DRDC Ottawa's support role to CJIRU and the National CBRNE Response Team. Overall, the combination of these three program elements describes a robust capability that fits well within the purview of DRDC Ottawa's RAD Group.

The nuclear forensic laboratory would consist of state-of-the-art radiological detection equipment (much of which is extant within the RAD group) augmented by specialized equipment to be procured largely through anticipated, future CRTI funding. RAD staff would manage the laboratory, establish a comprehensive research and development program focused on contaminated evidence analysis and radiological and special nuclear material characterization, and maintain it in readiness for a terrorist event involving such materials. Formalization of collaborative partnerships with other government departments (mainly RCMP, RMC, Health Canada, AECL and CNSC) and international allied partners (UK, US, AUS, and others) would also be established to strengthen this capability.

Using the existing nuclear forensic laboratory network as a starting point, the major investment would be focused on small infrastructure modifications and personnel. A single receiving facility with the necessary security and associated requirements for dealing with evidence, as well as detection capabilities for radiological and special nuclear material characterization (already in place) and facilities for working with contaminated evidence (as exists at DRDC Ottawa) would be the starting point. Links to other laboratories mentioned above would be established for more specialized analyses. The main receiving and analysis facility could effectively operate with a staff of 2 DSs (1 already in place), 1 senior EG (already on staff), 1 junior EG, and 1 chemist, supplemented with graduate students. The large amount of R&D needed in the area of nuclear forensics would keep this group busy.

The anticipated outcomes of carrying out this vision include the following:

- The laboratory would strengthen Canadian public security capabilities by providing an accredited – and needed – previously non-existent capability.
- Input and participation from internal (CF/CJIRU) and external (RCMP) partners will ensure the establishment of a relevant facility that meets end user requirements, thereby furthering DRDC Ottawa's capacity to respond to operations.
- The centre would reduce risk in CF equipment acquisition by determining whether field equipment being considered for purchase is adequate to support the requirement for sampling.
- The capability would provide a more robust means to test current best practices, thus better enabling transition into NATO doctrine.

Overall, the nuclear forensics facility and associated program of work will better position DRDC Ottawa's RAD group to meet the needs of CJIRU and the RCMP for long term operational support while establishing an R&D program directly linked to ongoing work within the group.

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List of symbols/abbreviations/acronyms/initialisms

ANSTO	Australian Nuclear Science and Technology Organization
AUS	Australia
CANSOFCOM	Canadian Special Operations Forces Command
CBRN(E)	Chemical, Biological, Radiological, Nuclear(, Explosives)
CF	Canadian Forces
CJIRU	Canadian Joint Incident Response Unit
CNSC	Canadian Nuclear Safety Commission
CRTI	CBRNE Research and Technology Initiative
DNA	Deoxyribonucleic Acid
DND	Department of National Defence
DRDC	Defence Research & Development Canada
DSRI	Defence and Security Research Institute
EU	European Union
FBI	Federal Bureau of Investigation
IAEA	International Atomic Energy Agency
ITU	Institute for Transuranium Elements
ITWG	International Technical Working Group
MNL	Mobile Nuclear Laboratory
MOU	Memorandum of Understanding
NATO	North Atlantic Treaty Organization
PSC	Public Safety Canada
R&D	Research & Development
RAD	Radiological Analysis and Defence
RCMP	Royal Canadian Mounted Police
RMC	Royal Military College
S&T	Science and Technology
SIBCRA	Sampling and Identification of Biological, Chemical, and Radiological Agents
SIRA	Sampling and Identification of Radiological Agents
US	United States
UK	United Kingdom

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As stated in the communiqué of the April 2010 Washington Nuclear Security Summit, "nuclear terrorism is one of the most challenging threats to international security". As such, individual countries need to ensure they have strong nuclear security measures in place to prevent the illicit acquisition and use of nuclear materials. Canada's involvement in the Nuclear Security Summit saw the commitment to strengthen nuclear security and thus reduce the threat of nuclear terrorism within Canada and abroad.

Nuclear forensics is a component of a robust nuclear security regime, supporting law enforcement in the overall attribution process from the point of view of being able to answer questions such as what is the material, who is responsible, is there more material, where was it diverted from, and what route did it take. As such, a robust nuclear forensic capability can also act as a deterrent to actors (state or non-state) considering involvement in nuclear terrorism. This paper describes a plan for developing a nuclear forensic capability in Canada, building on previous work in this area and leveraging experience and knowledge of our allies.

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Nuclear forensics, contaminated evidence analysis, radiological analysis laboratory

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