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Radiological Field Exercises for Forensic Investigators

Carey L. Larsson, Chris Clement, Diego Estan,
Carl McDiarmid and Mike Tessier

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Carey L. Larsson
DRDC Ottawa

Chris Clement
Diego Estan
Canadian Nuclear Safety Commission

Carl McDiarmid
Mike Tessier
Royal Canadian Mounted Police

Defence R&D Canada – Ottawa

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Principal Author

Original signed by Carey L. Larsson

Carey L. Larsson

Defence Scientist, Radiological Analysis & Defence Group

Approved by

Original signed by Tom Cousins

Tom Cousins

GL / RAD

Approved for release by

Original signed by Cam Boulet

Cam Boulet

Chief Scientist

Abstract

A series of tabletop and field exercises were designed and executed to test traditional forensic investigation procedures in a crime scene with radioactive material present. This allowed for specific training needs of forensic identification specialists to be identified and revised procedures to be drafted. Two scenarios were exercised, first as tabletop discussions with the Royal Canadian Mounted Police (RCMP), the Canadian Nuclear Safety Commission (CNSC), and DRDC Ottawa, and then as field exercises with the participation of the RCMP and Ottawa Police Services (OPS) forensic investigators. These exercises produced a number of lessons learned with regard to protocols for forensic investigators and led to the development of a one-page fact sheet on performing forensic identification tasks in a radiation environment.

Résumé

On a élaboré et exécuté une série de simulation d'exercices et d'exercices pratiques visant à mettre à l'essai les méthodes classiques d'examen médico-légal utilisées sur le lieu d'un crime où une substance radioactive est présente. Les résultats ont permis d'établir clairement les besoins en formation des spécialistes en identification judiciaire et de rédiger une ébauche de méthodes révisées. Deux scénarios distincts ont été étudiés, un premier à l'aide de simulation d'exercices, en collaboration avec la Gendarmerie royale du Canada (GRC), la Commission canadienne de sûreté nucléaire (CCSN) et RDDC Ottawa, et un deuxième à l'aide d'exercices pratiques auxquels ont participé des enquêteurs judiciaires du Service de police d'Ottawa (SPO) et de la GRC. Un certain nombre de leçons ont été tirées de ces exercices, notamment au chapitre des protocoles devant être suivis par les enquêteurs judiciaires, ce qui a permis d'élaborer un feuillet de renseignements d'une page traitant de l'exécution de tâches de nature médico-légale dans un milieu où une substance radioactive est présente.

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Executive summary

Radiological Field Exercises for Forensic Investigators

Larsson, C.L., Clement, C., Estan, D., McDiarmid, C., Tessier, M.; DRDC Ottawa TM 2006-118; Defence R&D Canada – Ottawa; June 2006. [D12]

Introduction or background

A series of tabletop and field exercises were designed and executed to test traditional forensic investigation procedures in a crime scene with radiological material present. This allowed for specific training needs of forensic identification specialists to be identified and revised procedures to be drafted. Two different scenarios were developed to test response capabilities. Scenarios were exercised first as tabletop discussions with the Royal Canadian Mounted Police (RCMP), the Canadian Nuclear Safety Commission (CNSC), and DRDC Ottawa, then set up as field exercises and run through with RCMP and Ottawa Police Services (OPS) forensic investigators.

Results

The tabletop exercises allowed participants to outline how each response might be carried out with all available knowledge and resources. The field scenarios then allowed pre-existing procedures to be tested by a group not involved in the tabletop discussions. Performance of the field exercise for each scenario identified several discussion points and lessons learned with respect to the forensic processing of a radiologically contaminated crime scene. Techniques for keeping responder radiation doses to a minimum were practiced, and participants concluded that all CBRN-trained responders should wear electronic personal dosimeters (EPDs).

Significance

These exercises highlighted gaps in protocols for forensic investigators and led to the development of a one-page fact sheet on performing forensic identification tasks in a radiation environment. The one-pager outlined salient points regarding safety, contamination control, fingerprints and DNA, collecting radioactive samples, and taking contaminated exhibits through a decontamination checkpoint. This work has allowed improvements to be made to the radiological and nuclear portion of the First Responder Training Program. These improvements will lead to an overall improved readiness to respond to a radiological or nuclear incident in Canada.

Future plans

To ensure an adequate level of safety when working in a radiologically contaminated environment, revised protocols for forensic specialists, including equipment and PPE recommendations, needs to be developed. These protocols will expand upon the one-pager, and will be undertaken and tested in the approved CRTI project entitled "Nuclear Forensic Response Capabilities and Interoperability" (CRTI-04-0030TD).

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Radiological Field Exercises for Forensic Investigators

Larsson, C.L., Clement, C., Estan, D., McDiarmid, C., Tessier, M.; DRDC Ottawa TM 2006-118; R & D pour la défense Canada – Ottawa; June 2006.

Introduction ou contexte

On a élaboré et exécuté une série de simulation d'exercices et d'exercices pratiques visant à mettre à l'essai les méthodes classiques d'examen médico-légal utilisées sur le lieu d'un crime où une substance radioactive est présente. Les résultats ont permis d'établir clairement les besoins en formation des spécialistes en identification judiciaire et de rédiger une ébauche de méthodes révisées. Deux scénarios distincts ont été élaborés afin de mettre à l'essai la capacité d'intervention des parties intéressées. Les scénarios ont été étudiés, un premier à l'aide des simulation d'exercices en collaboration avec la Gendarmerie royale du Canada (GRC), la Commission canadienne de sûreté nucléaire (CCSN) et RDDC Ottawa, et un deuxième à l'aide d'exercices pratiques auxquels ont participé des enquêteurs judiciaires du Service de police d'Ottawa (SPO) et de la GRC.

Résultats

Les simulations d'exercice ont permis aux participants d'établir le protocole d'exécution de chaque mesure d'intervention, en tenant compte des connaissances et des ressources disponibles. Les scénarios d'exercices pratiques ont par la suite permis à une équipe d'intervenants n'ayant pas participé aux discussions des simulations d'exercices de mettre à l'essai les méthodes existantes. Les résultats des exercices pratiques de chaque scénario ont permis d'identifier plusieurs sujets de discussion et de tirer quelques leçons au chapitre du processus médico-légal utilisé sur un lieu de crime contaminé par une substance radioactive. On a exécuté des exercices sur les techniques visant à réduire au minimum les doses de rayonnement auxquelles sont exposés les intervenants; les participants ont conclu que tous les intervenants ayant reçu une formation en CBRN doivent porter des dosimètres électroniques personnels.

Importance

Les exercices ont mis en évidence des lacunes dans les protocoles devant être suivis par les enquêteurs judiciaires et ont permis d'élaborer un feuillet de renseignements d'une page traitant de l'exécution de tâches de nature médico-légale dans un milieu où une substance radioactive est présente. Le feuillet offre des points saillants portant sur la sûreté, le contrôle de la contamination, les empreintes digitales et l'ADN, le prélèvement d'échantillons radioactifs et les mesures de décontamination de pièces à conviction contaminée. Les présents travaux ont permis d'améliorer la section relevante du programme de formation pour les premiers intervenants, qui traite des aspects radiologiques et nucléaires. Ces changements se traduiront éventuellement par une amélioration de la disponibilité opérationnelle à un incident radiologique ou nucléaire au Canada.

Perspectives

Afin d’assurer un niveau de sécurité adéquat lors de l’exécution d’activités dans un milieu contaminé par une substance radioactive, il faut élaborer des protocoles révisés pour les spécialistes judiciaires, entre autres des recommandations portant sur le matériel et l’équipement de protection individuelle (EPI). Les protocoles, basés sur le document d’une page, seront exécutés et mis à l’essai dans le cadre du projet approuvé par l’IRTC intitulé « Capacité d'intervention et interopérabilité en matière de criminalistique nucléaire » (numéro de projet IRTC 04-0030TD).

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Acknowledgements

We would like to thank Bob Kurus, Dwayne Raymond, Frank Cloake, and Shawn Rainville from the Ottawa Police Service Criminal Investigations Forensic Identification Section for their participation in the nuclear forensic field exercises. The lessons that were learned from their participation in these exercises will help to improve training for first responders in Canada.

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1. Introduction

The increased threat of unconventional weapons, such as radiological agents, being used by terrorists has required first responders around the world to begin preparing to respond to such an attack. Within Canada, a first responder training program has been established to enhance preparedness for a chemical, biological, radiological or nuclear (CBRN) event [1]. Training of all types of responders, ranging from 911 operators to forensic identification specialists, has been devised. Internationally, varying degrees of training are being offered.

Most scenarios involving the use of radiological or nuclear material, both pre- and post-event, would rely heavily on forensic evidence. That evidence may be traditional evidence (such as DNA or fingerprints) contaminated with the radioactive material, or it could be the radioactive material itself. Training of forensic investigation specialists is therefore important to ensure that collection and handling of such evidence is performed correctly.

In order to identify the specific training needs of forensic identification specialists, a series of tabletop and field exercises was designed and executed to test traditional forensic investigation procedures in a crime scene with radioactive material present. This document is a summary of these radiological forensic investigator tabletop and field exercises held in collaboration with the Royal Canadian Mounted Police (RCMP), the Canadian Nuclear Safety Commission (CNSC), DRDC Ottawa, and Ottawa Police Services (OPS). Section two presents the exercise description, section three describes the conduct of the exercise and lessons learned, section four provides some recommendations for forensic specialists, and section five outlines the conclusions of the participants.

2. Exercise Description

The forensic investigator field exercises were prepared and executed by CNSC and DRDC Ottawa. Two different scenarios were developed to test response capabilities. Scenarios were exercised first as tabletop discussions with RCMP, CNSC and DRDC Ottawa to outline how the response would be carried out. Each scenario was then set up as a field exercise and conducted with RCMP and Ottawa Police forensic investigators.

This section of the document is divided into two sub-sections, one for each of the scenarios. Each sub-section begins with the scenario description itself, and then describes the corresponding tabletop and field exercises.

2.1 Scenario 1: Sealed Source in the Trunk of a Car

2.1.1 Scenario Description

Mr. X has stolen a 1-Ci Americium-Beryllium (AmBe) source with the intent to irradiate his ex-wife. The source has been reported stolen. Mr. X has assembled a home-made shielding container using a coffee can and concrete mix. He has placed the stolen source in the container in the trunk of a car he has stolen, and parked the car away from his house until he's ready to use the source.

A police officer, while performing routine patrols, finds a car parked behind a dumpster in a dark alley. The officer decides to run the plates and discovers that the vehicle has been reported stolen. While peering through the passenger window, the officer notices a strange meter (Geiger counter) on the floor and decides to investigate further. Upon opening the trunk, he discovers an odd looking package (the home-made container). The local bomb squad is called.

During the bomb squad's initial reconnaissance, their electronic personal dosimeters register dose rate alarms, indicating the presence of radiation. The package was x-rayed using specialized x-ray equipment (Foxray) and the absence of any explosive hazard is confirmed. The call to the forensic identification specialists (FIS) is then made.

2.1.2 Scenario 1 Tabletop Discussion

The tabletop discussion for this exercise focused on establishing a timeline for the response and raising questions requiring further discussion or specific attention during the field exercise. This scenario dealt with a straightforward incident without radioactive contamination and thus was not expected to yield significant gaps.

The tabletop exercise began with forensic identification specialists (FIS) arriving on the scene and receiving a briefing from the incident commander and the bomb squad. FIS would then repeat the radiation survey previously performed by the bomb technicians to ensure that it is safe to approach and work in the scene. The dose rate would be measured first around the perimeter of the car, then specific measurements would be taken at both 1 metre from and on/near contact with the suspect package (provided the dose-rate isn't too large – see below). The FIS team would then proceed to document the scene via photography and videography. Also, due to the presence of radiation, they would likely contact radiation (RAD) experts to inform them of the situation (including dose rate information) and get advice on how best to proceed.

It was noted that RCMP radiation detection equipment includes the TBM-3S pancake survey meter (Technical Associates, Canoga Park, CA), and the Automess 6150AD dose rate meter (Automation und Messtechnik GmbH, Ladenburg, Germany). Furthermore, users of these instruments should be qualified and instruments should be calibrated. When a measurement is to be taken on or near contact with a suspect area, contact dose rates should be no more than 100 – 200 μSv/hr to continue working around the source. Presuming a dose-rate lower than this is measured, advice from RAD experts would be to proceed with taking swipes.

To ensure that the car is not contaminated with radioactive material, the FIS team (or the RAD experts for high contact dose rates) would then begin taking swipes of various surfaces of interest. In this scenario, the main surface of interest is the concrete-filled paint-can pig. The opening of the pig and an area around the base would be swiped with a Dacron swipe, and then measured with a RAD metre away from source. Since it is not contaminated, the swipe would be sealed in a plastic evidence bag and sent for DNA analysis. The improvised pig would then be boxed up and removed to a controlled location for further analysis, minimising contact with the pig so as to preserve evidence. The RAD survey would then be repeated to ensure no further radiation is present and the car would be processed as per usual. It is possible that the car might be removed to a secure location for further analysis.

The remainder of the discussion focused on transportation requirements and procedures. The police have exemptions to the Transportation of Dangerous Goods (TDG) act. They are able to transport forensic samples that classify as a dangerous good without following proper protocols as long as the transportation is done safely. The CNSC could also transport any material if they were called to the scene (as long as it is done in accordance with the TDG act), as their licence is broad enough to allow for it. The other, perhaps larger, issue that was discussed is where the evidence would be taken. DRDC Ottawa was suggested as one possibility since it has secure facilities capable of handling small-scale evidence. In this situation, DND chain-of-custody forms could be used for tracking purposes. For large amounts of RAD evidence, a secure facility would need to be identified. CNSC would likely need to licence a facility to store such evidence and security would need to be established.

If this situation had occurred in Ottawa or had occurred elsewhere and the evidence was brought to DRDC Ottawa, the analysis would proceed as follows. General radiation measurements would be taken (α,β, γ, n), followed by gamma spectrometry performed on the pig doubly sealed in plastic evidence bags. The glove box would be prepared (cleaned, lined with plastic), the pig would be placed inside, and the lid of the pig would be removed with tongs. A radiation identification measurement would be taken at the opening of the pig and then the source would be removed with tongs, placed on a clean surface and swiped for contamination. Since we are dealing with a sealed source, there would be no contamination. The source would then be photographed, looking for labels, serial numbers, any other identifying markings and this information would be analyzed with the CNSC in order to determine its origin. The source would then be placed into a proper pig, and the makeshift pig would be removed and handed off to a FIS officer for further traditional evidence processing at a forensic facility. Photographs would be taken throughout this process.

2.1.3 Scenario 1 Field Exercise

The field exercise for scenario one was held on March 30th, 2005 at the RCMP Technical and Protective Operational Facility in Ottawa, Ontario. Four members of the Ottawa Police Service (OPS) CBRN Forensic Investigators responded in the exercise, along with one RCMP FIS officer. The scenario was conducted as a training exercise more than a testing exercise, with the RCMP officer providing guidance. One DRDC Ottawa defence scientist also participated, providing radiological expertise.

The timeline for the field exercise is outlined here. The RCMP forensic identification trailer pulled into the area and parked about 100 m from the scene. Two forensic identification specialists (one RCMP and one OPS) suited up in full personal protective equipment (PPE) and approached the car, monitoring both the ground (with the TBM-3S pancake $\alpha\beta$ probe) and the ambient gamma field air (with the Automess 6150AD γ probe) on approach; they also wore alarming electronic personal dosimeters (EPDs). As they approached the car from the trunk-end they began to see elevated gamma readings (~0.75 μSv/h). They continued around the entire vehicle to locate hotspots, and determined that the location of highest readings was around the trunk of the vehicle. On contact with the trunk, dose rates of approximately 2 μSv/h were measured. Visual confirmation was made of something "unusual" in the trunk.

Due to the low radiation readings, the officers decided to drive the trailer closer to the vehicle, to approximately 5 meters from the car. They re-approached the vehicle with a camera, photographing the exterior of the car. The vehicle identification number (VIN) was photographed. Back at the trailer, a plastic tarp was laid on the ground on which to lay forensic equipment. A swipe was taken of the trunk lid and measured away from vehicle; it was not contaminated.

The trunk was opened and photographed. A swipe was taken of the concrete surface on top of the pig and found to be contamination-free. Neither the knob nor the chain was swiped in an attempt to preserve potential forensic evidence. The lid of the pig was removed and the dose-rate was measured to be 87 mSv/h at the opening. A swipe was taken of the inside of the pig, measured away from the area and determined to be clean.

A plastic evidence bag was placed on the ground outside the trunk and the pig was lifted out of the trunk and placed onto it. The lid was opened and the source removed (using tongs) into a more appropriate lead pig by scientific support. The lid of the evidence pig was removed and measurements were taken to ensure that no radioactive sources remained inside. The trunk and the exterior of the entire vehicle were also checked for radiation; nothing was detected. Photographs of the interior of the vehicle were taken and an Automess 6150AD radiation detector was found in the back seat. Investigators began fingerprinting the makeshift pig, the vehicle and the detector with powder. Several prints were found, photographed and lifted. The field exercise was stopped here since all further actions would be normal operating procedures for the FIS responders.

2.2 Scenario 2: Radiation Chop-Shop

2.2.1 Scenario Description

A small group of "entrepreneurs" have set up a business in the Ottawa area to process radioactive sources for illicit use. They have established a business front, and hold a valid CNSC license. They have acquired a small number of sources legitimately. They also have a number of stolen sources. The bulk of their operation consists of transforming high to low activity sealed radioactive sources into dispersible powders or liquids that they then sell to potential terrorists and/or criminals. The work has been taking place in a residential dwelling where both the storage and processing of the raw and refined sources take place.

During a routine patrol of a residential neighbourhood, an RCMP vehicle equipped with radiation detection equipment (with radio-link to the RPB at Health Canada) registers a large spike in its readings. The data, along with GPS map, is sent from the RPB to the RCMP and a nearby house is identified as the source (see Figure 1). After obtaining a search warrant, an RCMP tactical team breach the dwelling and find no occupants and what would appear to be a still active chemical lab, mechanical workshop and radioactive storage area. The call to the forensic identification specialists is then made.

Figure 1: Map of radiation readings taken from RCMP vehicle

2.2.2 Scenario 2 Tabletop Discussion

The tabletop discussion for this exercise also focused on establishing a timeline for the response and raising issues requiring further discussion or specific attention during the field exercise. This scenario dealt with a much more complicated incident with widespread radioactive contamination, including extensive contamination of potential forensic evidence.

The tabletop exercise began with the tactical team exiting the crime scene, and their boots being identified as contaminated. The boots would be removed, bagged and provided to FIS. The bomb technicians would then enter the site with the proper PPE to clear the house for explosives, meanwhile taking general radiation dose-rate measurements. When the house is confirmed to contain no explosives, a HAZMAT team would enter with proper PPE to ensure the absence of biological and chemical hazards. With the exception of some basic laboratory chemicals, the site is cleared and the forensic investigation specialists would be brought in to process the site. Due to the already recognized presence of radioactive contamination, the FIS call in radiation experts to assist.

The first task of the teams is to deal with the contaminated boots. Since three teams have already entered the scene, it was recognized that prints of the seized boots could be used to compare with boot prints within the house if this were thought to be of use. If so, the boot would be photographed, inked, an impression would be made on paper and the impression would be photographed. The boots would then be bagged and stored securely, considering the contamination.

The proper level of PPE would then need to be established for the FIS and RAD experts. Since chemical, biological and explosive hazards would already have been ruled out, PPE would consist of a C4 mask, double gloves, overboots, and a Tyvek or equivalent suit. The teams would then enter to perform a reconnaissance of the house, quickly taking dose-rate and contamination measurements of the entire house. A clean area in the house would be identified, and a Mylar sheet would be placed on the ground for the forensic equipment.

The teams would re-enter to deal with collecting forensic evidence and remediating radioactive sources in an attempt to lower the dose rate in the house. The FIS would begin by documenting the entire house with video, notes, and photography. The RAD experts, having brought a pig(s), swipes, plastic bags, and labels, would secure any large sources, label each pig with what was collected, from where, and when, and would then seal (lock) and place the pig on the clean Mylar sheet. Some liquid jars are found to contain RAD material and so the RAD experts would transfer a small sample (1-2 mL) to a glass vial, seal it, and send it to a nuclear forensic laboratory for analysis. The rest of the liquid would need to be dealt with either via disposal (Chalk River Laboratory) or storage at some facility licensed to hold radioactive material. A similar process would need to be followed for contaminated filings found in the scene.

The collection of further traditional evidence would then proceed in the house, each having special procedural requirements due to the presence of radioactive contamination. For fingerprinting, surfaces could be dusted with powder, fumed with cyanoacrylate (CA), or using a chemical such as DFO (1,8-diazafluoren-9-one) or ninhydrin. If dusting a contaminated surface, the brush used to apply the powder would need to be monitored and disposed of if it became contaminated, and a photograph of the print would be taken. A lift would not be taken to prevent the removal of contamination. When using CA, only photographs would be taken of any identified prints. When looking for prints on paper, either DFO, which gives a fluorescent reaction that must be seen under a black light, or ninhydrin, which turns purple upon reaction, may be used on-scene. Documents with identified fingerprints (or without) can be double bagged and seized by police if contamination is very low, although most forensic laboratories will probably not accept any radioactive materials.

For DNA evidence contaminated with radioactive material at low levels, cooperation between the forensic laboratory and the RAD experts is required to determine if the presence of radiation will affect analysis methods. Research still needs to be performed to determine the extent of interaction between radiation and DNA, as well as establishing minimum contamination levels that might be accepted by the forensic laboratory. Most other types of contaminated forensic evidence would be photographed in the scene, such as documents or boot prints. Trace evidence such as fibres would likely not be accepted by the forensic laboratory if the material is contaminated.

2.2.3 Scenario 2 Field Exercise

The field exercise for scenario two was held on April 20th, 2005 at the RCMP Technical and Protective Operational Facility in Ottawa, Ontario. A schematic of the two-story house used for the exercise is shown in Figure 2. The ground floor layout is shown on the left, and the second floor is on the right. Only the ground floor area was used for this exercise. Four members of the Ottawa Police Service (OPS) CBRN Forensic Investigators responded in the exercise, along with one RCMP FIS officer. The scenario was conducted as a training exercise more than a testing exercise, with the RCMP officer providing guidance. One DRDC Ottawa defence scientist and one CNSC specialist also participated, providing radiological expertise to the police.

This field exercise began with the arrival of the FIS team and the RAD experts. Actions discussed during the tabletop dealing with other law enforcement teams (i.e. tactical, bomb techs, HAZMAT) were not exercised, but were assumed to have occurred. Several sealed sources of Caesium-137 of varying activity (50 mCi to 1 Ci) were placed in the laboratory and grinding rooms. Unsealed technetium-99m in liquid form was also placed throughout the house to achieve a contaminated crime scene. The timeline for the field exercise is outlined below.

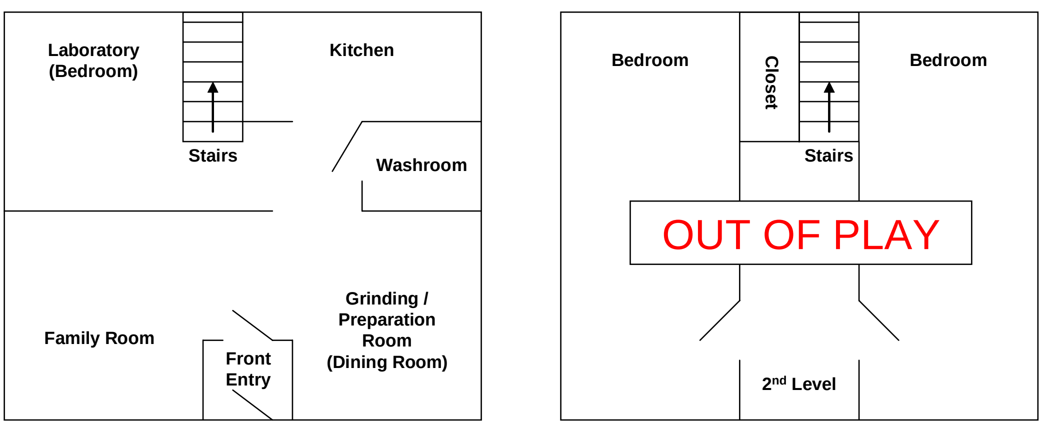

Figure 2: Schematic of the two-story house at TPOF used for the scenario two field exercise

A cordon was not set for the exercise, thus upon arrival the FIS team and RAD experts set up equipment next to the house. In a real situation, the cordon would likely have already been established and preparation would occur outside this area. The proper PPE for entering the site was established (C4 mask, double gloves, overboots, Tyvek or equivalent suit) and five FIS, two RAD experts and two exercise coordinators suited up and donned EPDs. It was decided that the FIS team would split into two groups of two and a videographer for documentation. A RAD expert and an exercise coordinator accompanied each of these teams.

Dose-rate measurements were taken on the stairs up to the entry and FIS equipment was brought to the base of the stairs. One FIS team, the FIS videographer, two RAD experts and one exercise coordinator entered the residence with both a gamma survey meter and an alpha/beta probe to perform an initial reconnaissance. This was comprised of quick dose-rate measurements of the house and localization of large radioactive sources requiring remediation by the RAD experts. The second FIS team and an exercise coordinator took a radiation survey around the exterior of the house to identify hot areas. They then entered the house to join the other teams in conducting the reconnaissance. The second FIS team communicated their findings to the team already inside. High dose-rate locations were marked with a piece of paper with an evidence identifier and the dose-rate reading written on it, however, no distance at which the reading was taken was noted.

The survey of the house was completed and large sources were identified. Several radiation pigs were in the house already as part of the scene and these were used to remediate the large sources by the RAD experts. Once the large sources were secured the dose-rate in the house was reduced to a reasonable working level. A Mylar sheet was placed down and FIS equipment was brought inside. The FIS teams then proceeded to gather evidence including fingerprints, DNA, documents, photography/videography, and some material samples. The pigs were dusted for prints and swabbed for DNA around the handle; one of the pigs was then taken outside and a RAD expert performed gamma spectrometry using a BTI Microspec 2, identifying Cs-137 (see Figure 3).

Figure 3: Forensic (left) and radiological (right) analysis of pig containing seized Cs-137 source

Figure 4: Evidence collection in a contaminated crime scene. Clockwise from top left: dusting a bottle for fingerprints; measuring brush for contamination; fingerprints found on a document; collection of contaminated grindings.

Forensic investigation in the contaminated crime scene included collection of fingerprints, DNA, documents, and samples of a variety of other unusual materials present (see Figure 4). Each team had a clean and a dirty man for evidence collection to prevent cross-contamination of the samples. The majority of the fingerprinting was performed by dusting with powder. Cyanoacrylate fuming was attempted, however the material (glue) proved unusable. While the search for fingerprints on paper is best performed with either DFO (to get a fluorescent reaction that must be seen under a black light) or ninhydrin (turns purple upon reaction), in this exercise documents were dusted with powder. Documents with prints were double bagged and checked for contamination. Documents without prints were photographed. Several swabs of various areas were taken for DNA samples, but any contaminated swabs were instead given to the nuclear forensic laboratory for analysis. Miscellaneous sample collection included materials such as metal filings, white powder, and liquid in a chemical jar. These were sampled and all were found to be contaminated. Samples were all double bagged and were to be sent to a nuclear forensic laboratory for analysis.

Once these steps were complete, the exercise was terminated. A quick contamination check was performed on all participants and equipment in the scene before exiting. No contamination control-point had been established for the exercise, but this brief contamination check identified only the bottom of the Tyvek boot-covers as contaminated. These were removed and disposed of and the house was locked up for three days to allow for decay of the technetium-99m to background levels.

3. Lessons Learned

Performance of the field exercise for each scenario identified several discussion points and lessons learned with respect to the forensic processing of a radiologically contaminated crime scene. These points were noted by the exercise coordinators both during the exercise and in the hot-wash held immediately following each scenario. This section discusses the salient points.

3.1 Scenario 1 Lessons Learned

As mentioned in the previous section, this scenario was a straight-forward test of a forensic response to a radiological incident involving sealed sources. Nonetheless, there were some significant items and questions raised regarding the response.

First and foremost, it was noted that the Ottawa Police forensic investigators do not wear/own EPDs, although both the Tactical Team and HAZMAT do. FIS depend on EPDs worn by firefighters or others on the scene for radiation detection. They also do not have radiation detectors, and thus would require some assistance from the RCMP or scientific support such as CNSC or DRDC Ottawa. However, there is currently no official mechanism in place outlining a means for acquiring such support if required in a real situation. From a radiation safety perspective and, to a lesser extent, due to the small incremental cost of doing so, it is strongly recommended that the OPS CBRN FIS officers purchase EPDs.

Several procedural questions were raised regarding the ideal locations for performing radiation contamination swipes, keeping in mind the need to preserve fingerprints and other traditional forensic evidence. In this scenario, elevated radiation readings were detected around the trunk of the car and thus this vicinity should be swiped for contamination. Effectively any rough surface would be ideal for taking contamination swipes because these would be poor surfaces for retrieving fingerprints. Once the trunk was opened, the makeshift pig was identified as a likely location for possible contamination. The pig consisted of a paint can filled with concrete, with an inner diameter to hold the radioactive source, a small lid to cover this opening with a metal knob at its top, and a chain-link handle. During the exercise, the concrete surface of the pig was swiped but the knob and the chain were not. The chain could have been swiped, due to its uneven surface, and if the swipe of the chain were found to be clean (as it was), it could have been used for DNA evidence.

During the exercise, the radioactive source was removed, using tongs, into an appropriate (safer) pig by scientific support. This task is one that would likely be performed by scientific support personnel and the source would then be either identified on scene (i.e. using equipment from the Mobile Nuclear Laboratory (MNL)) or taken to a nuclear forensic laboratory for analysis. This again raises the need for a mechanism to acquire such support by all levels of law enforcement.

Several issues were not dealt with in the context of the exercise, but were discussed during the hot-wash. Specifically, how seized sources or other radioactive material would be transported, and where they would be taken were discussed. Transportation of any recovered sources or radioactively-contaminated forensic evidence could be performed by the CNSC, if they are present. It is also possible that the RCMP, Ottawa Police, and other law enforcement agencies could transport contaminated evidence under exclusion from the TDG act for the transport of forensic samples. This means that police could transport the samples without needing to follow general packaging requirements as long as the transport is performed safely. As mentioned above, material would be transferred to a laboratory associated with scientific support on scene (i.e. DRDC Ottawa or CNSC), who could contact other laboratories within the nuclear forensic lab network if necessary. Radioactively-contaminated traditional evidence will not be accepted at a forensic laboratory and a lot of research remains to be performed to determine interactions between radioactive contamination and various traditional forensic analysis procedures.

3.2 Scenario 2 Lessons Learned

The second scenario was a much more complex test of a forensic response to a radiological incident involving a multitude of both sealed and unsealed sources. Some of the same items were raised during the conduct of this scenario, however there were several new issues raised.

Upon arrival at the exercise site, another exercise was going on in the same vicinity, so the team needed to park close to the area without interfering with the other groups. The team decided to park their vehicle directly next to the house used for this scenario, and suited up in PPE on both sides of the vehicle. Unfortunately, the dose rate around the chosen setup area was around 5μSv/hr and the outside walls of the house had areas with dose rates as high as 100μSv/hr. Even in an exercise situation, this was not the most appropriate location from which to stage. In this situation, it would have been better to prepare on the far side of the car, putting both distance and shielding between the responders and the house.

It was assumed that tactical, explosives disposal, and HAZMAT had already entered the crime scene and would have likely already established a cordon, entered the house and possibly taken some dose-rate measurements. None of this was offered to the FIS team before entering by the exercise coordinators. During the hot-wash afterwards, a question was raised regarding the type of cordon that would have been established - a 10μSv/h cordon versus a general police cordon around the building. Responders that have taken the National CBRN First Responder Training have been taught that a 10μSv/h cordon should be established around the building before entering. If this information hasn't been clearly communicated to the new team preparing to enter, then a proper radiation cordon should be established before entering the building. Furthermore, measurement of dose rates around the exterior of the building before entering is a good protocol to follow in order to identify possible hotspots within the house.

When dealing with a radiological scene, especially if loose contamination has not yet been ruled out, all surfaces should be considered contaminated until they are found not to be and equipment should be placed on Mylar or plastic anywhere within the cordon. It is very plausible that contamination could have been tracked out of the house and the FIS equipment could have been set down in this contamination. This was performed inside the house, but not outside. Radiation detection equipment (gamma metre, EPDs) might also be bagged to prevent contamination. Furthermore, when samples/exhibits are taken in a contaminated area, the outside of the evidence bag (and everything else leaving the scene for that matter) should be swabbed before taking it out of the scene. The swabs should be checked for contamination in a low background area within the scene.

An important consideration for FIS personnel, and in fact all first responders in a radiation scene, is in regards to taking dose-rate measurements of identified sources. It was noticed that, when taking dose-rate measurements, the radiation meter was placed as close as possible to the source, and the measured value was recorded on a small card, along with an identifier, and placed near the source. There is really no need to take measurements on contact with the source, particularly for large sources. Furthermore, it is extremely important to record both a dose-rate and a distance measurement in order for the reading to have any meaning after the fact.

Remediation of larger sources would usually be performed by the RAD team, but there has been a degree of hesitation with regards to this from an evidence stand point. It is typically felt that making the scene safe is of high importance and that as long as the scene is not disturbed too much, this practice should be followed. In this instance, fingerprinting and DNA swabbing was still performed on the pigs. DRDC Ottawa did have pigs on site, which could have been used, leaving the "evidence" pigs for the investigators.

Determination needs to be made with regards to what will be done with the pigs following the processing of a scene. In practice, the large sources would be secured, and the pigs labelled, sealed (locked), and placed on a clean sheet until someone is available to transfer them to a storage site. Police have an exemption under the TDG act to transport forensic material, including anything classified as dangerous goods. The transport conditions should be safe, but do not need to meet normal requirements (i.e. signage, packaging, etc.). So, either the police or CNSC could transport the material to a laboratory or storage site (such as CNSC facilities or DRDC Ottawa).

Finally, when discussing this scenario during the tabletop exercise, it was suggested that the boots from tactical teams, bomb technicians, and HAZMAT would be presented to FIS for comparison with boot prints within the house. During the hot wash, a procedure for doing this was discussed as follows: (a) Photograph boot, ink boot and take an impression, photograph impression (b) Bag and store securely, considering contamination. It was thought that these boots could be used either to eliminate boot prints in the scene made by the early entry team if boot prints were thought to be "good evidence" in this type of scenario, or if not useful to FIS, they could be passed on to a nuclear forensic laboratory as a preliminary sample for analysis. This aspect was not tested during the exercise.

4. Recommendations

These field exercises for forensic investigators were extremely useful in highlighting areas requiring further work, as evidenced by the long list of lessons learned. In fact, even the most simplistic of radiation scenarios resulted in questions regarding the transport, analysis, and storage of seized radioactive material. As a result of these exercises, a one-page “hot tips” document was put together as a refresher for FIS personnel in the midst of an incident [2]. The contents of the refresher, with five main topic headings, are discussed in detail below.

The first heading of the one-pager was Safety First. This section gives basic advice on establishing permissible doses, turn-back dose-rates, and PPE before entry. It recommends that any information from previous entry teams be considered, and that in the case where no information exists, perform a quick gamma survey of the exterior of the building to establish hot-spots. Within the scene, this section advises teams to minimize ambient dose rates by first locating sealed sources, photographing them and documenting the dose rates measured at one metre, then to shield the sources with whatever is available in the scene. Finally, this section reminds responders to use the principles of time, distance and shielding to reduce dose.

The second heading is Contamination Control, which advises responders to consider all surfaces contaminated until proven otherwise. Any swipes taken should be measured in the area of lowest background to assess for contamination, and plastic sheeting should be used to protect any equipment brought into the scene. PPE is extremely important in a contaminated area, and clean-person/dirty-person protocols should be practised. Also, all personnel, equipment and exhibits should be measured for contamination at a control point before exiting the scene.

The next section was focused on taking traditional forensic evidence in a contaminated crime scene, entitled Fingerprints and DNA. It is noted that the act of swiping surfaces to check for contamination could destroy fingerprint and DNA evidence, and that contamination swipes can be taken on surfaces that are poor for finding fingerprints. Furthermore, any swipe found not to have contamination could be sent for DNA analysis. Fingerprints discovered in the crime scene can be photographed in lieu of lifting and removing contaminated prints.

The last two sections are somewhat connected, those being Collecting Radioactive Samples and Taking Contaminated Exhibits through Decon. These sections state that samples can be any of a large number of different matrices, and should not contain other hazards (such as biological agents or explosives, for instance). Generally small samples are sufficient for analysis, with readings of approximately 10 to 100 times background, and all samples should be double-bagged to prevent cross-contamination. Continuity of evidence should be maintained through the clean-dirty line and exhibits should be locked up and transported to the appropriate laboratory.

5. Conclusions

First responder training is essential to ensure that an attack utilizing unconventional CBRN weapons is dealt with in the most efficient way possible. These exercises were able to highlight some necessary improvements to the Canadian CBRN First Responder Training Program, and identified the need for the development of protocols for Forensic Identification Specialists in a radiologically contaminated environment. Furthermore, the need for responders with a CBRN mandate to possess and wear alarming electronic personal dosimeters as a first step in identifying the presence of radiation was highlighted during the response.

References

[1] http://www.ocipep.gc.ca/ep/college/cepc_broch_e.asp#cbm, August 2005.

[2] CNSC and RCMP, Performing Forensic Identification Tasks in a Radiation Environment, April 2005.

List of symbols/abbreviations/acronyms/initialisms

[Enter list here, if applicable. If not, delete the page.]

AmBe	Americium-Beryllium
CBRN	Chemical Biological Radiological and Nuclear
CNSC	Canadian Nuclear Safety Commission
DNA	Deoxyribonucleic Acid
DND	Department of National Defence
DRDC Ottawa	Defence Research and Development Canada – Ottawa
EPD	Electronic Personal Dosimeter
FIS	Forensic Identification Specialists
HAZMAT	Hazardous Material
OPS	Ottawa Police Service
PPE	Personal Protective Equipment
RAD	Radiation
RCMP	Royal Canadian Mounted Police
RPB	Radiation Protection Bureau
TDG	Transportation of Dangerous Goods

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A series of tabletop and field exercises were designed and executed to test traditional forensic investigation procedures in a crime scene with radioactive material present. This allowed for specific training needs of forensic identification specialists to be identified and revised procedures to be drafted. Two scenarios were exercised, first as tabletop discussions with the Royal Canadian Mounted Police (RCMP), the Canadian Nuclear Safety Commission (CNSC), and DRDC Ottawa, and then as field exercises with the participation of the RCMP and Ottawa Police Services (OPS) forensic investigators. These exercises produced a number of lessons learned with regard to protocols for forensic investigators and led to the development of a one-page fact sheet on performing forensic identification tasks in a radiation environment.

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