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Foreword

Defence Research and Development Canada - Centre for Security Science (DRDC CSS) is a joint endeavour between the Department of National Defence (DND) and Public Safety Canada.

DRDC CSS's mission is to strengthen, through investments in science and technology (S&T), Canada's ability to prevent, prepare for, respond to, and recover from accidents, natural disasters, or terrorist and criminal acts that impact the safety and security of Canadians. This is accomplished by coordinating and administering research and development; evaluating concepts and technologies; and building a network of national and international partners within the S&T and public safety and security communities.

Public security S&T activities are undertaken in four theme areas: Defeat Chemical, Biological, Radiological-Nuclear, and Explosives (CBRNE) Threat; Critical Infrastructure Protection (CIP) and e-Security; Surveillance, Intelligence, and Interdiction (SII); and Emergency Management Systems and Interoperability (EMSI).

This past year, 18 projects managed under the Canadian Police Research Centre (CPRC), CBRNE Research and Technology Initiative (CRTI), and Pubic Security Technical Program (PSTP) were completed, leading to significant advances in personal protective equipment, interoperability, surveillance, biometrics, border and maritime security, and emergency response capabilities. Many of these success stories will be represented in oral, poster, and technology demonstrations during the Public Security S&T Summer Symposium 2011.

The following abstracts describe the progress, from the first eight rounds of funding, of the projects in the domains of CBRNE, CIP, e-Security, SSI, and EMSI. As always, I am amazed at the extent and quality of the work and am proud to share this knowledge and understanding with you. Several of these projects have already made solid contributions to enhance the safety and security of Canadians, while others show great promise as they evolve. I am more than certain that you will find these projects as impressive as I have. Thank you for your unwavering commitment to working in collaboration to keep Canadians safe.

Dr. Anthony Ashley
Director General, DRDC Centre for Security Science

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CRTI 05-0016RD

Development of a Canadian Standard for Protection of First Responders from CBRN Events

Project Lead:	Public Works and Government Services Canada
Federal Partners:	Public Safety Canada, Transport Canada, Royal Military College, National Research Council, Royal Canadian Mounted Police
Other Partners:	Canadian Standards Association, Canadian Association of Fire Chiefs, Canadian Council of Health Services Accreditation, Canadian Healthcare Association, Canadian Professional Police Association, Canadian Public Health Association, International Association of Fire Fighters – Canadian Office, Paramedic Association of Canada

Objectives

The Canadian Standards Association (CSA) standard CAN/CGSB/CSA-Z1610, *Protection Of First Responders from Chemical, Biological, Radiological, And Nuclear (CBRN) Events*, specifies requirements for the selection, use and care of personal protective equipment (PPE) for first responders to a CBRN incident, including deliberate attacks/releases and contagious outbreak events. This new national standard will have a significant impact on first responder organizations in the selection, use, capabilities, and limitations of CBRN PPE, enabling them to do their jobs more safely and with greater protection and functionality.

The standard takes a systems approach to identifying the requirements for whole-body protection and system performance (respiratory, ocular, and dermal), including integration with other equipment. It also provides guidance on the capabilities and limitations of CBRN PPE, and provides information to manufacturers and test agencies on relevant performance requirements and test methods for CBRN PPE.

This ground-breaking standard was developed by a dedicated technical committee using the National Standards System, a proven, consensus-based process for standards development. The National Standards System provides that all relevant groups (manufacturers, regulators, technical specialists, test agencies, and users) are represented in a balanced manner. The committee was chaired by Eva Dickson, Royal Military College of Canada; CSA and Canadian General Standards Board (CGSB) managed the project jointly. Technical committee representatives included manufacturers of protective clothing and respiratory protection equipment; police, fire, and ambulance organizations; professional associations; hospitals and public health officials; scientists; and Public Safety Canada. In addition to representation on the committee developing the standard, public consultations were held allowing the public, including industry, to submit their comments and recommend changes.

Relevance

To protect Canadians, as well as our public and private infrastructure, it is key that first responders have access to the right equipment that combines functionality with sufficient protection, as well as tools and information to help them do their jobs most effectively.

The standard addresses protection against a multitude of CBRN risks faced by first responders through scenario development, risk assessment to exposed individuals, and the ability of first responders to plan and manage their response. The standard improves the harmonization of protective equipment used by Canadian responders and enhances consequence management capabilities resulting from the improved all-hazard protection.

While other international standards have been developed, for example, in the US by the National Fire Protection Association (NFPA) and National Institute of Occupational Safety and Health (NIOSH), the Canadian standard is unique. It is specifically designed for use by Canadian police, fire, and emergency medical services responders during an intentional CBRN incident. Other standards did not cover all types of CBRN events and a number of response groups were poorly served. Thus no existing standard delivered a combined and integrated approach to selection and performance criteria; the Canadian standard integrates all types

of events and responders into one document with common terminology and objectives.

While the Canadian standard introduces new classes of protective systems and associated requirements, where possible the American standards and the Canadian standard are interoperable. As well, there is ongoing dialogue to ensure that standards on both sides of the border are as interoperable as possible and benefit from each other's research.

Recent Progress and Results

The standard was published and available in both official languages in March 2011 after a media launch held on 25 January 2011 in Toronto. At this time CSA and CGSB announced Canada's first national standard for protective equipment for front-line fire, police, and emergency medical service workers in responding to a CBRN event. Canada's Public Safety Minister, the Honourable Vic Toews, was a key speaker at this event.

Impact

This standard is the first in Canada that provides official first responders with the critical information and guidance necessary to ensure that the appropriate suite of protective equipment and systems is selected and used in CBRN terrorism events. The development of a single recognized national standard brought together relevant stakeholders with world-class expertise in protective equipment development and evaluation of CBRN agents. The standard supports the needs of all levels of government, industry, and first responders directly and in a unique way, with the capabilities and expertise linked together through the establishment of a national technical committee. This standard is an international benchmark for an integrated and comprehensive approach to first-responder CBRN protection.

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CRTI 05-0078RD

Development of Live Replicating Viruses as Vaccines and Therapies for Viral Haemorrhagic Fever Viruses

Project Lead:	Public Health Agency of Canada
Industry Partner:	Impfstoffwerk Dessau-Tornau GmbH
Other Partner:	United States Army Medical Research Institute for Infectious Diseases

Objectives

The objective of this project is to use live, attenuated, recombinant vaccine vectors based on vesicular stomatitis virus (VSV) as innovative prophylactic and therapeutic vaccines that can be reliably produced in sufficient quantities for use in the event of a bioterrorist attack with Ebola or Marburg viruses. Partnered with the United States (US) Army Medical Research Institute of Infectious Diseases and the vaccine production company Impfstoffwerk Dessau-Tornau GmbH, the Public Health Agency of Canada (PHAC) will develop good laboratory practice stocks of the vaccines and a small, current good manufacturing practice (cGMP) stock of recombinant VSV expressing the glycoprotein of *Zaire ebolavirus* (ZEBOV). With HPFB and the US Food and Drug Administration, PHAC researchers will determine the immune correlates of protection in rodent and non-human primate models infected with ZEBOV. The project team will also show that cGMP stocks of vaccine are as effective as current experimental stocks. This data is essential for future licensing of the vaccine.

Relevance

Infection with filoviruses, in particular ZEBOV or Marburg virus (MARV), causes a highly virulent, severe haemorrhagic fever in humans and non-human primates that is often fatal. ZEBOV and MARV are considered serious threats as agents of biological warfare for a number of reasons, including: reports that the former Soviet Union produced large quantities of MARV in a formulation directed to large-scale aerosol dissemination; the simple addition of glycerine to the virus preparation makes MARV as stable as the influenza virus in aerosol phase; experiments show that ZEBOV is infectious following oral, ocular, and aerosol exposure of non-human primates; and there is no preventive vaccine or post-exposure treatment currently available for human use.

The replicating recombinant vaccines based on VSV developed in this project are currently the most effective post-exposure treatment, as well as being extremely effective vaccines. There is now a much greater potential to protect responder communities from a significant biological threat.

Recent Progress and Results

The project team developed vaccine candidates for ZEBOV and MARV based on live, attenuated, recombinant VSV vectors expressing the transmembrane glycoproteins of ZEBOV and MARV, respectively.

Single intramuscular injections of each vaccine were administered to naive non-human primates (n=4 per vaccine). Twenty-eight days later, the animals were challenged with at least 1,000 plaque-forming units of virulent EBOV or MARV. Single dose oral and intranasal immunization of mice, guinea pigs, and non-human primates were also tested for protective effect. The single dose of each vaccine was 100 percent effective at protecting the animals against each virus. Finally, the researchers tested the ability of the ZEBOV and MARV vaccines to protect animals when administered as a post-exposure vaccine at 30 minutes to 24 hours after infection with the virulent agent. None of the animals developed fever or other symptoms of illness following vaccination. Immunization elicited protective immune responses in all of the non-human primates against otherwise lethal challenges.

The ZEBOV vaccine induced strong humoral and cellular immune responses in all vaccinated monkeys while the MARV vaccine predominately induced a humoral response. Mucosal immunization resulted in protection of rodents from challenge with up to 1,000,000 LD_{50} and non-human primates from 1,000 LD_{50}. All non-human primates infected with MARV and 50 percent of the

non-human primates infected with EBOV survived when treated 30 minutes after exposure. The ZEBOV vaccine is currently being manufactured to good manufacturing practice (GMP) quality.

Impact

The deployment of these vaccines will provide Canada with a world-leading operational ability to protect the responder community from these previously untreatable threat agents. The ability to use these vaccines after exposure, rather than having to administer the vaccine months or years before, makes them more responsive to the threat environment. Viral agents that cause haemorrhagic fever are a highly significant threat because they are virtually untreatable. However, the likelihood of their use is low, so mass vaccination prior to an event is economically and medically difficult to justify.

Data suggests that these vaccine candidates are safe and highly efficacious in highly relevant animal models. Furthermore, there is an unprecedented potential for use as a post-exposure vaccine.

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CRTI 06-0138RD

Development of Canadian Diagnostic Capability for Rift Valley Fever Virus

Project Lead:	Canadian Food Inspection Agency
Federal Partner:	Public Health Agency of Canada – National Microbiology Laboratory
Other Partners:	University of Calgary, United States Department of Agriculture

Objectives

Originating in Africa, Rift Valley fever (RVF) is a mosquito-borne disease of humans and ruminants that can also spread by aerosol. The virus is considered a potentially significant biological warfare threat and a natural emerging disease threat to North America because it has the potential to spread rapidly and become endemic. Its occurrence could have a significant impact on the international trade of animals and animal products, creating serious economic as well as public health consequences. Yet Canada and the United States (US) are essentially unprepared to detect the incursion of the RVF virus in a timely manner or to control the outbreak in animals. Nor are there any commercial human or veterinary vaccines available.

This project aims to develop molecular technology-based tests and reagents for human and veterinary diagnostics for use and production outside high containment facilities. The project team will use material from the experimental infection of animals to validate veterinary tests, determine a sample collection strategy, and study pathogenesis and immune response. North American mosquito species will be inoculated to determine their potential as an RVF virus reservoir and to validate reverse transcription polymerase chain reaction (RT-PCR) for surveillance. Researchers will develop existing methods, such as real-time RT-PCR, recombinant protein technology, hybridoma development, enzyme linked immunosorbent assay (ELISA), and lateral flow assay for RVF virus.

Relevance

The RVF virus is on the “A list” of multiple international organizations. Neither the Canadian Food Inspection Agency nor the Public Health Agency of Canada have validated diagnostic tests for RVF that can be safely distributed to regional diagnostic laboratories. They also lack the capacity to handle a diagnostic surge should an outbreak occur.

Recent Progress and Results

During the past year, the project team modified the real-time RT-PCR for detection of the RVF virus RNA and evaluated samples generated through a series of experimental inoculations of calves and sheep. The assay was evaluated on over a hundred serum and tissue samples. Researchers collected sera samples for virus detection between two and seven days after inoculation, with titres reaching 106.5 plaque-forming units/ml or up to 1010 copies/ml. The virus was detected by virus isolation up to 4 days post-infection (dpi), and up to 6 dpi based on RNA detection real-time RT-PCR. Researchers observed the viral RNA in serum clearing up as development of virus-neutralizing agents began.

Two antigens are candidates for developing recombinant ELISA to detect RVF virus antibodies. Using N protein as an antigen, the assay can be used to detect both infected animals and animals vaccinated with live attenuated virus. If recombinant vaccines with disrupted NSs genes are used, the NSs protein-based ELISA can be used to distinguish between infected and vaccinated animals (DIVA). Researchers are evaluating both indirect and competitive formats.

The virus-neutralizing antibodies could be detected in the serum around 7 dpi. If any of the ELISAs detect earlier antibodies, it would be possible to detect, in combination with real-time RT-PCR, infected animals from 2 dpi based on RNA detection followed immediately by (or overlapping with) antibody detection. The project team also worked on developing reagents, expressing a number of recombinant RVF virus proteins (N, NSs, partial GP1, NSm1 and GP2, NSm1) and developing rabbit or mouse polyclonal antibody against N, NSs, and partial GP1 proteins. Positive control serum and tissue samples were developed in sheep and cattle. The US Department of Agriculture’s Arthropod-Borne Animal

Disease Research Unit was able to successfully use the polyclonal rabbit antibody for development of immunohistochemistry.

Impact

Development of high-throughput screening tests for livestock is critical to control an outbreak, minimize serious economic and public health effects, and manage longer term consequences. By developing rapid diagnostic technologies and methods that can be deployed in the field for early screening of livestock, the project will provide first responders and front-line personnel, such as veterinarians and laboratory staff, with the capability to identify, respond quickly, and contain a CBRNE event. It will also establish Canadian and American diagnostic capability for RVF virus in humans and ruminants and, as part of the high-containment animal work, address personal decontamination procedures and responder personal protective equipment.

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CRTI 06-0146RD

Rapid Identification of Radiologically Exposed Individuals for Medical Casualty Management

Project Lead:	Health Canada
Federal Partner:	DRDC Ottawa, Atomic Energy of Canada Limited
Other Partners:	McMaster University, Oak Ridge Biological Dosimetry Applications Research Calibration Laboratory, Armed Forces Radiobiology Research Institute

Objectives

In the case of a large-scale radiological-nuclear (RN) event, it is imperative to quickly identify exposed individuals for the purpose of medical intervention and to identify first responders who must be restricted from further exposure. Even for a lesser-scale event, many concerned members of the public will demand an assessment of their radiation exposure. The purpose of this project is to expand the *National Biological Dosimetry Response Plan* (NBDRP), created under CRTI 0027RD, from a proof-of-concept initiative to a formalized medical and casualty management tool. Unexploited Canadian biodosimetry capacity will be integrated into the NBDRP, which will help enhance existing biological dosimetry expertise. The NBDRP will also strengthen links to American and international partners, working towards an international biodosimetry network.

Relevance

The information provided by biological dosimetry is critical for use in medical triage and the diagnosis of casualties and first responders to reduce immediate and long-term health effects. It is also essential for mitigating the public reaction to an RN incident by distinguishing the worried-well cohort from those who have been exposed and require medical intervention. In order for biological dosimetry to be most effective, dose estimates need to be completed as quickly as possible after exposure. To expedite this process, the capacity for providing biological dosimetry in Canada is being increased and links are being developed among biodosimetry laboratories around the world. In addition, several novel, high-throughput assays are being developed. By addressing these CRTI priority needs, the NBDRP will become an essential component of an integrated national and international response plan in the event of an RN incident.

Recent Progress and Results

The NBDRP has been established to provide a national biological dosimetry response capability in the event of an RN incident. Despite the resulting increase in expertise and capacity, the NBDRP would still be incapable of responding to a mass casualty RN incident with timely dose estimates if patient numbers exceeded 500 individuals. The current project is expanding the NBDRP from the four core laboratories to include formal linkages with clinical cytogenetic laboratories across the country and with American and international counterparts.

As a strategy for increasing the scoring throughput of biological dosimetry, the QuickScan method was validated as an alternative to conventional scoring techniques. It was clearly demonstrated that the QuickScan method provides dose estimates equivalent to those determined using conventional scoring criteria while decreasing the scoring time by a factor of approximately six.

This past year, the project team also conducted its annual exercise, which included two biological dosimetry laboratories from the United States processing blood and scoring along with two hospital cytogenetic laboratories scoring slides prepared at Health Canada. Both conventional and QuickScan dicentric chromosomes assay (DCA) scoring along with the cytokinesis blocked micronucleus assay were tested in this exercise with greater than 90 percent success using the DCA.

The annual training programs, which have been developed and integrated with the course curriculum at both the Clinical Genetics Technology Program at the Michener Institute and Ste-Justine Hospital in Montreal, were delivered again. In total, 24 students were trained to conduct biodosimetry and will be hired by cytogenetic laboratories, where they can assist in

the processing of samples during an RN emergency. An agreement has also been established with the Michener Institute to develop an emergency response centre for biodosimetry.

Internationally, Health Canada is continuing to participate in a steering committee led by the World Health Organization for the development of a framework for a global biodosimetry network (BioDoseNet). This network, in cooperation with the International Atomic Energy Agency, will coordinate the biodosimetry response during an RN event in the international arena.

Project members also participated in a study led by United States (US) partner Oak Ridge Institute for Science and Education. This study aimed to test the feasibility of scoring chromosomes using web-based image sharing.

Impact

The NBDRP is one of the most advanced biodosimetry networks in existence and is often referred to as a model for other countries developing their own networks. This project's team of biodosimetrists is playing a lead role in developing an international network to facilitate emergency response and be able to assist those countries with little or no biodosimetry capacity. The project team is also partnering with the Armed Forces Radiobiology Research Institute and the Oak Ridge Institute for Science and Education to strengthen the Canada/US bi-national response capability. The development of rapid biodosimetry assays will provide critical information earlier to medical personnel and emergency response coordinators for managing the medical response to an RN mass casualty event.

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CRTI 06-0156RD

Radiological Dispersal Device Contamination Interactions with Urban Surfaces

Project Lead:	DRDC Ottawa
Federal Partners:	Environment Canada, Canadian Nuclear Safety Commission
Other Partners:	University of Ontario Institute of Technology, University of New Brunswick, US Environmental Protection Agency, Wehrwissenschaftliches Institut fur Schutztechnologien – ABC-Schutz

Objectives

The goal of this project is to understand the key interactions between radiological contaminants and urban surfaces, a necessary step prior to the development of an effective decontamination strategy. Based on the results, guidance will be formulated and submitted to policy makers for consideration. This will hopefully result in revised policies indicating appropriate actions to be taken before and after a radiological dispersal device (RDD) event.

The project partners will first exchange information on the results from previous research. Based on these results and the expertise of the project partners, an experimental plan will be finalized. This plan will include an agreement on the radiological contaminants to be tested, plans for the investigation in the deposition and migration of contaminants, and the climatic conditions to be tested.

Relevance

This project deals directly with the long-term consequence management of an urban area contaminated with radiological materials. Specifically, this project will aid in the development of effective strategies for the decontamination and remediation of a contaminated urban area following an RDD event.

The current strategy for remediation after an RDD event involves no specific methods and timelines; therefore, decontamination techniques and the responsible users will need to be identified. This current strategy could result in lengthy delays, during which environmental conditions may aggravate the contamination and result in a situation where non-destructive decontamination would be impossible.

Recent Progress and Results

Based on the project's objectives, the project partners developed an overall hypothesis and methodology, which were presented at the 2008 CRTI Summer Symposium. The hypothesis surmised that high levels of relative humidity make decontamination more difficult over time, necessitating more aggressive decontamination methods. The hypothesis suggests that greater urgency be placed on remediation so an RDD-contaminated site is not exposed to the elements (particularly rain) for long.

Experiments to determine the impact of the RDD contamination on urban surfaces have been progressing. One of the major experiments was to determine the effects of rain on different types of chemical forms of RDD contamination. This experiment was performed at the Wehrwissenschaftliches Institut fur Schutztechnologien – ABC-Schutz (WIS) facility with participation from the United States Environmental Protection Agency (EPA), the Canadian Nuclear Safety Commission (CNSC), DRDC Ottawa (as lead), and the United Kingdom's Defence Science and Technology Laboratory (Dstl). Dstl participated as an international observer out of interest in the work and brought coating technology to isolate the contaminants from the rain. The trials also included testing the different types of decontamination methods, and results have been analyzed and compared.

DRDC Ottawa has begun its experimental program and is currently looking at the effects of humidity levels. The results of the WIS rain experiments as well as previous experiments at DRDC Ottawa and elsewhere are now being combined to validate the project hypothesis and formulate a guidance document. DRDC Ottawa has also begun the standardization of its procedures and shared them with project partners and other national and international partners.

Environment Canada and EPA have continued their studies in the penetration and absorption of caesium, cobalt, and other possible RDD contaminants on a multitude of urban surfaces.

The University of New Brunswick has progressed in the development (mathematical algorithms) of a three-dimensional imaging system to study the migration of radiological contaminants within urban materials.

Impact

Based on the preliminary results, if remediation can be done swiftly, the effect of an RDD could be significantly reduced, resulting in minimal risk.

Performing remediation in a timely manner will require a change in Canadian policy on remediation after an RDD event. The primary client for this project, the CNSC, has the authority to implement the recommendations outlined in the final guidance document. To this end, the CNSC is responsible for helping to direct the project, for ensuring that the information produced is sufficient for guiding policy, and for translating the results into new policies.

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CRTI 06-0169TA

Universal Surface Decontamination Formulation

Project Lead:	Environment Canada
Federal Partners:	DRDC Ottawa, Royal Military College of Canada
Industry Partners:	Allen-Vanguard Corporation, SAIC Canada
Other Partners:	Queen's University, United States Environmental Protection Agency, Mendeleev University of Chemical Technology of Russia

Objectives

The aim of the project is to modify the Surface Decontamination Foam (SDF™), a commercial formulation used for chemical and biological decontamination, to expand its area of application to radiological decontamination. This is achieved by incorporating proven, low-cost, commercially available radionuclide sequestering agents into the current formulation.

The intent is to develop a universal surface decontamination formulation for materials contaminated by radioactive isotopes of cesium, strontium, and cobalt. The modified formulation is intended to retain its original chemical and biological decontamination features.

The newly developed formulation will be extensively evaluated on a variety of chemical, biological, radiological, and nuclear (CBRN) contaminants and tested on a large scale. Results of the evaluation will be used to develop guidance documents and manuals for decontamination teams.

Relevance

SDF is currently one of the most preferred decontamination products in the industry because of its ability to neutralize a wide variety of contaminants. SDF provides a technological solution for mitigating the effects of terrorist explosive devices containing chemical and biological (CB) agents. Since it was developed primarily for CB response, SDF is only moderately effective for radiological decontamination.

The modified SDF formulation will increase Canada's preparedness for remediation after a terrorist event or an industrial accident. The new SDF is expected to be fully compatible with application systems and auxiliary equipment deployed for the original product and will be ready for full-scale application by the end-users.

This project follows other work on CBRN decontamination (e.g., CRTI 04-0019TD, CRTI 02-0043TA, and CRTI 02-0067RD), and is a multidisciplinary effort.

Recent Progress and Results

Several readily available commercial polycarboxylic acids, including nitrilotriacetic acid (NTA), ethylenediaminetetraacetic acid, diethylenetriaminepentaacetic acid, and trisodium citratic acid (CA), were selected as chelating agents for strontium and cobalt. For cesium, several ion-exchange and precipitating agents were investigated based on their previous use in commercial processes, availability, low toxicity, and stability. These include ferric and potassium cyanoferrates and ammonium salts.

Studies were conducted to evaluate the effectiveness of the selected chelating/binding agents for target metals strontium, cobalt, and cesium in aqueous phase. All four polycarboxylates form stable 1:1 complexes with Co^{2+} and Sr^{2+} ions. These complexes were also stable in aqueous solutions containing the components of SDF: GCE 2000 (anionic surfactant) and GPB 2100 (buffer). However, in the aqueous solutions containing GPA 2100 (oxidant), some decomposition of chelating ligands was observed. Among the four identified polycarboxylates, NTA and CA were found to be most suitable in terms of solubility, biodegradability, stability to oxidation, and toxicity. For cesium, potassium hexacyanoferrate and ammonium nitrate were found to be the most effective sequestering agents.

Decontamination experiments on urban material surfaces were carried out using test coupons spiked with cesium, cobalt, and strontium. The surface decontamination efficiencies of the modified commercial decontaminants were evaluated on several construction materials, including fresh and three-year-old concrete, painted and galvanized steel, ceramic tile, drywall, marble, granite, and anodized aluminum. All the experiments were conducted using non-radioactive surrogates, and all samples were subject to ashing before analysis was performed by inductively coupled plasma mass spectroscopy. The effectiveness of the additives to remove target metals was evaluated after their incorporation into the existing formulation. The test results revealed improved effectiveness when the sequestering agents were added to the foam. A 30 percent improvement in the decontamination for cesium was observed on concrete, 11 percent on marble and 24 percent on aluminum. For cobalt, an improvement of 18.6 percent, 60.35 percent 23.56 percent and 32.82 percent was observed on concrete, marble, painted steel, and adonized aluminum respectively.

The surface decontamination efficiency of the modified SDF was evaluated using long lived isotopes (Cs-134 and Co-60) at Royal Military College (RMC). Test results confirmed a higher decontamination efficiency of the modified formulation. The formulation was more efficient at removing cobalt than cesium.Comparative studies were conducted at DRDC Suffield to determine the chemical warfare agent decontamination efficacy of the original to the modified SDF. Experiments were conducted using sulfur mustard HD and nerve agents GD, GF and VX. Marble, ceramic tile, painted steel, painted drywall, and anodized aluminum were used as surface materials. The results indicate that the modified formulation retains the chemical decontamination efficiency of the original formulation. This was observed on all surfaces except marble where the modified formulation showed a slightly lower efficiency, likely due to the material porosity.

The Mendeleev University of Chemical Technology of Russia conducted evaluations of the membrane separation to reduce the volume of the radioactive wastewater generated as a result of decontamination. Promising results were obtained using inorganic semi-permeable membranes which are highly resistant to radiation.

A large-scale testing of the formulation, using Cs-134 on concrete and aluminum, was scheduled at the Idaho National Laboratories in April 2011.

Impact

This study will result in the development of a formulation that can be used in response to CBRN incidents, whenever decontamination is required. The formulation will have a higher efficiency, simplified waste treatment, reduced operation time, and lower costs. It will help enhance the preparedness and response capabilities of first responders and technology users in a CBRN event.

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Project Lead:	Environment Canada
Federal Partners:	Royal Military College of Canada, DRDC Suffield
Industry Partner:	SAIC Canada
Other Partners:	Queen's University, Research Institute of Hygiene, Occupational Pathology, and Human Ecology (Russia)

Objectives

The primary objective of this study is to develop an effective and rapid catalytic decontamination method to remove and destroy organophosphorus (OP) compounds, such as chemical warfare agents and pesticides, from building materials, sensitive equipment, and soils.

Specific objectives include

- creating solid supported catalysts;
- developing appropriate low toxicity and flammability solvent systems that allow catalytic decomposition of OP agents;
- investigating destruction of OP toxic substances on building materials, sensitive equipment, and in soil;
- developing and testing a solvent recovery system for solvent reuse;
- demonstrating a pilot-scale soil remediation system; and
- developing methodologies for building, equipment, and soil decontamination.

Relevance

OP compounds are among the most toxic agents that pose a threat to the environment and human health. Their toxicity and availability as industrial chemicals also makes them potential weapons of chemical terrorism. Although the mechanism and the kinetics of the catalytic degradation of OP compounds have been thoroughly studied, decontamination of urban surfaces, sensitive equipment, and soil using these catalytic processes has never been investigated.

The project results will be a base for new, non-corrosive, rapid, and environmentally friendly decontamination technologies, which involve non-aqueous reusable solvents, and provide complete destruction of OP agents without toxic by-products formation. Reusing the solvents will reduce the environmental footprint and the quantities of solvents that are needed.

Recent Progress and Results

Several types of catalysts designed for the destruction of different classes of OP compounds in methanol solutions have been applied in this study for decontamination of soils and material surfaces. Palladium (Pd)-based solid-supported and liquid catalysts were used for decomposition of the P=S type OP compounds, such as diazinon and parathion. Lanthanum (La)-based liquid and solid supported catalysts were tested for the destruction of OP chemical warfare agents (CWAs) and P=O type of compounds, like paraoxon. Both Pd-based and La-based catalysts containing the low-flammable co-solvent HFE-7100 (a mixture of methyl nonafluoroisobutyl ether and methyl nonafluorobutyl ether) were evaluated.

Different application approaches for decontamination of soils, sensitive equipment, and building materials were tested. These included

- a two-stage process,
- decontamination by immersing in a liquid catalyst, and
- spraying of liquid catalyst on surfaces.

The two-stage process comprised an extraction of OP compounds with a solvent followed by their destruction in the extract with one of the catalysts.
Methanol extraction of diazinon from soils resulted in up to 78 percent efficiency in 30 minutes. The solid phase extraction of diazinon with polymer beads provided 80 percent removal in 24 hours. Up to 21 percent of the pesticide was transferred from beads

to methanol in 24 hours. The extract was then treated using a Pd-based, solid-supported catalyst.

More than 99 percent of diazinon, malathion, and paraoxon were extracted with methanol from sensitive equipment materials within 10 minutes. The efficiency of extraction of parathion from the high-impact polystyrene (HI-PS) plastic under the same conditions was lower (95 percent). HI-PS plastic had the greatest affinity towards OP compounds among all materials tested. A penetration of OP compounds into HI-PS plastic was observed. As a result, a longer contact of OP compounds with HI-PS plastic resulted in lower extraction efficiency.

Decontamination of surfaces of sensitive equipment materials by immersing in liquid catalysts was quite effective. La-based liquid catalyst provided a complete destruction of paraoxon on the surface within 10 minutes. Pd-based catalyst decomposed more than 99 percent of parathion within 30 minutes. Paraoxon and parathion were decomposed in the runoff solution within two minutes. A complete decomposition of Russian VX agent occurred within 10 minutes. No highly toxic by-products were found after decontamination.

Decontamination of paraoxon on surfaces of building materials by spraying of liquid La-based catalyst was less effective (50 percent after 30 minutes of contact time) because of rapid solvent evaporation, and actual contact time reduction. The same reason was a factor in low effective (55 percent) destruction of live agents on surfaces after application by spraying. Treatment of live agents in a closed container improved results (95 percent efficiency) because of the decreased evaporation rate of methanol.

The following conclusions have been derived from the study:

- The developed catalysts are effective in destroying the OP compounds on surfaces of construction materials, sensitive equipment, and also in soil.
- Decontamination by immersion is effective, although some deterioration of the material's surface may occur.
- The effectiveness of decontamination by spraying is limited by a rapid evaporation of solvent. Sequential applications of the catalyst may result in a more complete decontamination.
- Based on positive results of the bench-scale study, further work is required to develop engineering solutions for effective catalyst application systems.

Impact

The newly developed methods for decontamination of sensitive equipment, building materials, and soils will have a significant impact on Canada's ability to prepare for and recover from a chemical terrorism event. The rapid and complete destruction of OP agents will prevent the risk of contamination of the environment by the breakdown products. The reuse of the solvents and catalysts will make the methods both environmentally friendly and cost effective.

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CRTI 06-0187TD

Portable Biological Agent Detection System

Project Lead:	National Research Council – Industrial Materials Institute
Federal Partners:	National Research Council – Steacie Institute for Molecular Sciences, Royal Canadian Mounted Police, DRDC Suffield
Other Partners:	Université Laval – Département de Chimie, Centre de Recherche sur les matériaux avancés, Centre d'optique, photonique et laser, Centre hospitalier universitaire de Québec – Centre de recherche en infectiologie

Objectives

This project aims to develop and validate a fully functional portable instrument for the rapid and reliable molecular detection of biological agents. This detection platform is based on a novel nucleic acid-sensing technology called fluorescence chain reaction (FCR), which gives rise to the amplification of the fluorescence signal emitted upon hybridization with a target DNA strand. This biosensor, when coupled with micron-sized carrier particles and integrated in a microfluidic device, provides rapid and species-specific detection of non-labeled nucleic acids, thereby reducing complexity and cost while improving speed of analysis.

Relevance

The project will be relevant to many CRTI priority areas, providing investigational authorities (such as the RCMP) with a robust tool to diagnose, track, and detect the source of biological agents (e.g., anthrax) in criminal or national security investigations. Based on detection technology that provides fast readout, this instrument could also support the rapid deployment of first responders to determine the existence and scale of a CBRNE event and quickly screen CBRNE exposed individuals.

Recent Progress and Results

The Centre de recherche en infectiologie (CRI) has been actively testing different powders likely to be used in a terrorist attack and has developed an appropriate treatment process that isolates bacterial spores in a rapid and efficient manner. DRDC Suffield is working in collaboration with CRI to deactivate anthrax and prepare other surrogates needed for a technical demonstration. DNA extraction and fragmentation is realized by using an ultrasonic module developed by the Industrial Materials Institute that is also intended to serve as a dunk tank to transfer the sample from a hot zone to a safe laboratory setting.

The Centre d'optique, photonique et laser has improved the versatility, performance, and user-friendliness of the detection platform. Tests with beads modified fluorescently by the Centre de recherche sur les matériaux avancés revealed proper functioning of both fluidic driving and optical detection systems. The fluidic cartridge is being fabricated from thermoplastic materials and has been optimized for mechanically trapping well-defined monolayer bead beds. Hybridization experiments performed by the team have revealed that it is possible to directly hybridize at room temperature a target DNA sequence (amplicons) of *B. anthracis* onto probe-grafted beads in a microfluidic channel in less than five minutes, allowing positive and negative control samples to be distinguished in a reliable fashion. The Steacie Institute for Molecular Sciences is currently developing a different structure of the fluorescent bead approach that might improve detection limits. The chemistry used for detection based on FCR is currently being adapted to the method of sample preparation and fluidic manipulation of beads. The final demonstration was planned for March 2011.

Impact

This project will improve Canada's immediate reaction and ability to contain and manage the consequences of a bioterrorist attack. It will also improve Canada's ability to address CRTI risk scenarios of immediate, high, and emerging preparedness priorities related to attacks on people and infrastructure.

Such an easy-to-use and reliable instrument will improve the overall effectiveness and efficiency of first responders. It will help police investigators, such as the RCMP, positively identify the presence of biologically threatening agents at the crime scene of a CBRNE event and assist the armed forces facing threats in missions abroad.

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CRTI 06-0188TA

Portable Optically Stimulated Luminescence Reader for Forensics and Retrospective Dosimetry

Project Lead:	DRDC Ottawa
Federal Partners:	DRDC Centre for Operational Research and Analysis, Canadian Nuclear Safety Commission, Royal Canadian Mounted Police, Public Safety Canada
Industry Partner:	Bubble Technology Industries
Other Partner:	International Atomic Energy Agency

Objectives

The objective of this project is to develop a portable optically stimulated luminescence (OSL) reader for three distinct, yet interrelated, radiological-nuclear (RN) terrorist applications. First, the forensics application allows tracking and positively attributing radioactive sources to suspected storage sites (and potentially to the suspected culprits). This is addressed through development of a consolidated database of OSL responses of ubiquitous materials. Second, the arms-control verification application will allow inspectors to determine prior illicit radioactive source locations. Finally, the fortuitous dosimetry application allows estimation of radiation doses to unbadged personnel (following a radiological dispersion device detonation or similar event) by examining common electronic devices such as cell phones, electronic watches, calculators, and so on.

In this project, DRDC Ottawa and DRDC Centre for Operational Research and Analysis (CORA) are providing dosimetry and OSL expertise. Bubble Technology Industries is fabricating the device and developing the associated software. The RCMP, Public Safety Canada, and the International Atomic Energy Agency (through the Canadian Nuclear Safety Commission) are providing user input, threat analysis, and scenario development, and will be testing the device in realistic exercises.

Relevance

The portable OSL detector (POD) addresses capability gaps in the areas of criminal and national security investigations, as well as consequence management capabilities. In many RN terrorist scenarios, there is potential for a radioactive source to be moved during the acquisition, transport, and storage phases in an effort to avoid detection. Measurement of retained OSL signatures will allow investigators to achieve what is currently impossible: confirmation of the previous location of a radioactive source even when no trace of radiological contamination remains. In terms of consequence management, in many envisaged RN scenarios, there could be many exposed people not wearing dosimeters. A novel method of performing rapid radiation dose estimates and triage for these individuals has also been developed by performing OSL analysis with the POD on components within their personal electronic devices.

Recent Progress and Results

A field-prototype POD has been constructed and tested. The POD consists of two parts: a base unit and a handheld unit. The former has full functionality for small samples including bleaching, sample heating, calibration with a Sr-90/Y-90 beta source, and both continuous wave and pulsed measurement of the OSL signal. The handheld unit allows the user to directly measure residual OSL signatures from surfaces such as walls and floors. The system is operated with a ruggedized personal digital assistant (PDA), which allows full control of the instrument's function, as well as archiving and analysing the data. It permits predefinition of specific measurement protocols by a subject-matter expert, as well as simplified operation by field personnel.

The base unit uses a two-inch photomultiplier tube fitted with appropriate optical filters to block the excitation light emitted by the interrogating light-emitting diodes, thereby ensuring that only the emitted OSL light is detected. Testing of the base unit has demonstrated a sensitivity of about 1 μSv in accumulated dose with Al_2O_3:C dosimetric plaque material. The handheld unit, based on a one-inch photomultiplier tube, has lower sensitivity performance because of the smaller tube. Testing has demonstrated

successful detection of signals from irradiated electronic components with the base unit, and the handheld unit has detected residual signals from concrete and other relevant materials irradiated with a variety of radiation sources.

Impact

The unique capabilities provided by the POD will impact each end-user group. The device resulting from this work will allow law enforcement end-users to positively tie a radioactive source to its previous locations, thereby assisting in the investigation and prosecution process. For arms-control verification scenarios, sites to be visited are usually given ample warning, and thus people at the site have abundant time to move RN material. Inspectors using the POD have the potential to ascertain previous storage sites from field measurements of surrounding building material. Finally, the POD provides a novel method for rapid screening and triage of potentially exposed, unbadged people following an RN event.

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CRTI 06-0192TD

Respiratory-fit Testing Program Development

Project Lead:	Royal Military College of Canada
Federal Partners:	Royal Canadian Mounted Police, Health Canada
Industry Partners:	Sorbecon Research Inc., Phoenix OHC, Inc.

Objectives

Serious deficiencies in respiratory protection programs (RPPs) for specific application to CBRN response were identified by a previous CRTI project (CRTI 0029RD: Protecting First Responders Against Chemical and Biological Threats). These deficiencies included problems with integration of the respirator into other elements of the protective ensemble, performance deficiencies, an inability to demonstrate the very high protection factors necessary for CBRN response, and concerns pertaining to the protective status of equipment when donned at the time of an incident. These problems could prevent an individual responder from obtaining adequate protection on the scene of a CBRN event.

This project will resolve these issues and develop standard operating protocols and procedures for responder organizations to aid in implementing CBRN RPPs. The technical team, consisting of experts from the Royal Military College of Canada, Sorbecon Research, and Phoenix OHC, developed the procedures and transferred the information to RCMP and Health Canada response teams. Capabilities were delivered first for air purifying respirators (APR), followed by powered air purifying respirators (PAPR), and self-contained breathing apparatus (SCBA), in the areas of individual system qualification (ISQ), system integration and performance in use (simulated workplace protection factor [SWPF] evaluations), and field expedient assessment of protection (FEPT).

Relevance

The project optimized and demonstrated the use of leading-edge approaches. It enabled routine preventative maintenance of respiratory equipment; provided on-site, fit-testing procedures to size each wearer; provided expedient methods of ensuring that equipment is correctly donned in the field; provided methods for measuring simulated workplace protection factors; and assessed equipment integration procedures to assist in selection.

The combination of these approaches was directed towards ensuring that appropriate respiratory protection levels are provided to every wearer when they are required, minimizing the opportunity for equipment failure. Outcomes on best practices have been incorporated into the Canadian Standards Association (CSA) standard, CAN/CGSB/CSA Z1610-11, *Protection of First Responders from Chemical, Biological, Radiological and Nuclear (CBRN) Events*, which was developed under the project CRTI 05-0016RD.

Recent Progress and Results

ISQ ensures that all system components — respirator, suit, and ancillary equipment — are properly sized and appropriately integrated for a given individual. After initial developmental demonstration, these procedures have been fully implemented operationally and documented within the respiratory protection programs of the RCMP and Health Canada. The methods assure their compliance with relevant portions of the Canada Labour Code, the standard on Selection, Use, and Care of Respirators (CAN/CSA Z94.4-02), and the Canadian CBRN standard. In most cases, for simple personal protective equipment (PPE) ensembles that have been appropriately qualified, protection performance in use should be close to that obtained from a quantitative fit test (QNFT). However, for more complicated PPE ensembles, such as a bomb suit system, it seems likely that a more comprehensive approach to individual fitting is required to assure that integration problems between the respirator and the remainder of the PPE do not cause protection degradation in use. This approach could include, at a minimum, some more strenuous activities performed during the QNFT.

SWPF evaluations address the proper selection and integration of the respirator into the full protective system for a specific population of first responders. A mobile capability for evaluation of respiratory protection of positive- and negative-pressure systems has been developed. This capability was used to evaluate respirator SWPF performance for a variety of Health Canada and RCMP user groups and has been used in a procurement activity. SWPF evaluations showed that positive pressure from PAPRs and SCBAs was not a guarantee of effective protection in use. One dual-mode PAPR/SCBA system that has been seriously considered for selection by the RCMP has been demonstrated to be inappropriate for use with the bomb suit or an active carbon suit because of significant integration problems that result in degradation of protection below that considered acceptable. Aside from dislodging in use, over-breathing of SCBA systems was shown in SWPF activities. Since the ISQ protection factor fit-test requirement is only 500 (compared with at least 10,000 for negative-pressure systems), when over-breathing occurs, failures in protection can be significant.

FEPT methods assure that, at the time of donning at the scene of an incident, a respirator is still providing the protection it should. For APR and PAPR systems, a commercial detection system has been automated to rapidly measure the protection factor in the field. Prototype FEPT systems have been constructed and preliminary demonstration performed by user groups in relevant environments, including screening in live agent training at Suffield by the RCMP. SCBA systems (except for dual mode PAPR/SCBA systems with drinking tube) cannot be effectively assessed by any technology currently available for FEPT without post-certification modification. It has been demonstrated that current CBRN SCBA systems can fail to provide adequate protection in simulated use. Failure is most likely to occur during high work-rate activities where dislodging and over-breathing of the respirator may occur, and is worsened by poor integration with other PPE components such as helmets, collars, hoods, and hoses. Such issues are unlikely to be caught during an FEPT even if the technology were capable and it is proposed that ISQ, using quantitative preliminary fit-testing, be used to identify and resolve many of these problems on an individual basis so that they do not occur in practice. User training should be performed to facilitate detection of large leaks in use and to provide mitigation strategies such as adjusting the PPE, reducing breathing rate, or leaving the scene.

Impact

The project's outputs have been implemented in RCMP and Health Canada RPP programs. Further uptake by the response community of the ISQ and SWPF procedures and protocols is expected through information and resource sharing, as well as through implementation of the appropriate procedures recommended in the Canadian standard. Several potential protection issues have been identified and strategies for mitigation have been proposed. Further development of the FEPT methodology for commercialization has also been proposed.

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CRTI 06-0204RD
Improvised Explosive Assessment Tool

Project Lead:	DRDC Suffield
Federal Partners:	DRDC Valcartier, Natural Resources Canada – Canadian Explosives Research Laboratory, Public Safety Canada, Royal Canadian Mounted Police
Industry Partner:	AMITA Corporation

Objectives

This project will deliver a software tool to help investigators and first responder organizations obtain rapid, evidence-based assessments of many improvised explosive (IE) formulations, compositions, and recipes. This tool contains a database with detailed, scientifically sound, physically tested, and validated data that will provide end-users with accurate information on over two dozen critical factors for a minimum of 40 IE formulations and technologies. The project will be divided into four phases: review of information sources; prioritization of formulations, compositions, or recipes to be assessed; technical assessments and software development; and database population, integration, and testing.

Relevance

Terrorists continue to use a variety of IE materials. Information on these materials, their precursors, production methods, device construction, and concept of operation has proliferated and is currently available from publicly accessible sources. The process of accurately assessing the threat associated with IE activities of a given terrorist group is time consuming, requires extensive interpretation skills, and is not immediately possible in most situations. Furthermore, the technical and scientific information upon which to base such an assessment is often non-existent. This information is critical to intelligence and law enforcement organizations and to those involved in developing credible counterterrorism threat and risk assessments. This project will address this gap by delivering a database of knowledge associated with IEs.

Recent Progress and Results

Progress has been made on the four phases of this project. The project team continues to review information sources while developing a prioritized list of formulas and compositions to add to the database.

Scientific partners investigated a series of explosive mixtures based on nitrates (urea, ammonium, and metal nitrates), chlorates and permanganates, as well as a variety of peroxide and peroxide-based IEs and homemade military explosives and analogs.

Data developed to date include the decomposition chemistry of urea nitrate, and mechanical (impact, friction, shock, electrostatic discharge) and thermal sensitivity studies of metal nitrates, peroxides, and various mixtures based on these materials. Detonation properties, including detonation velocities and blast pressures, have also been determined for a number of mixtures. This information allows for the determination of damage and lethality as a function of distance, based on estimates of the trinitrotoluene (TNT) equivalency as a function of blast and distance for the explosive mixtures. Homemade military explosives and analogs have also been synthesized, sometimes at pilot-scale, and tested.

An advanced version of the database was deployed to the project partners and is now used to enter data. Data population is done in parallel by all labs and a procedure was developed to share the updated information. The current version of the database is fully searchable. The software part is almost complete and the data population is well under way. Consensus among the end-users (DRDC, Natural Resources Canada's Canadian Explosives Research Laboratory [NRCan-CERL], Public Safety Canada, and the RCMP) indicates that this software tool and fully populated database will be significantly useful when complete.

Impact

The data generated from this project to date has been favourably received by the international community and has allowed the leveraging of a significant amount of information from the United States, the United Kingdom, and Australia. The project itself will deliver a

database of knowledge associated with IEs. In addition, the breadth of expertise associated with the project has resulted in a strong network of knowledge spread across Canada (DRDC Suffield, DRDC Valcartier, NRCan-CERL, Public Safety Canada, and the RCMP), and a significant experimental capability for work on IEs (DRDC Suffield, DRDC Valcartier, and NRCan-CERL).

This expertise has already been used by the Canadian Forces (advice on in-theatre IE device compositions, homemade explosives training), as well as by a number of national and international security partners, including use for canine detection training (RCMP, UK Metropolitan Police), law enforcement purposes (Toronto Police, RCMP), emerging threat assessments, and training of airport security screening personnel (simulant development for Transport Canada and the US Department of Homeland Security). In 2011, the expertise and the information developed under the project will be used to review the list of explosives precursor chemicals currently regulated by NRCan.

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CRTI 06-0218RD

Pre-clinical Development of a Nasal Adenovirus-based Vaccine Against Ebola Virus

Project Lead:	Public Health Agency of Canada – National Microbiology Laboratory
Federal Partner:	National Research Council – Biotechnology Research Institute
Other Partner:	University of Texas at Austin – Pharmaceutics

Objectives

The first objective of this project is to develop a formulated, pre-clinical grade, optimized, Adenovirus Human serotype 5 (AdHu5) Ebola virus vaccine. This vaccine must be substantially more efficient than the first generation Ebola vaccine following intramuscular (IM) or nasal immunization of mice, guinea pigs, and non-human primates. Enhanced efficiency will enable lower dosing requirements and thus increased safety.

The second objective is to identify more immune correlates of protection against Ebola in non-human primates. Determining vaccine efficacy in humans necessitates good knowledge of specific immune markers that can be recorded and used to interpret levels of protection. Completing these objectives will provide the necessary knowledge to initiate a Phase I clinical trial in healthy volunteers in Canada.

Relevance

The primary method of vaccine administration is by IM injection, exclusively inducing systemic immune responses. The project team has developed an optimized adenovirus-based Ebola vaccine that can stimulate both mucosal and systemic immune responses following nasal immunization. A successful nasal vaccine strategy against Ebola virus could easily be extended to other biothreat agents, such as the smallpox virus, as it offers mucosal protection and all the additional advantages provided by rapid and safe needle-free vaccination. Development of clinical-grade vaccines against biothreat agents in Canada will provide concrete countermeasures to problematic situations.

Recent Progress and Results

The research team successfully generated an improved adenovirus-based vaccine (Ad-CAG/optZGP) against Ebola virus. Overall, immunization of mice revealed that the optimized Ad-CAG/optZGP vaccine improved immune responses at doses 10 to 100 times lower than with the first generation AdHu5 vaccine currently in Phase I trial in Washington DC, sponsored by the National Institute of Health (NIH). The optimized Ad-CAG/optZGP vaccine also fully protected mice against Ebola virus at a dose 100 times lower than the minimal dose required to achieve full protection with the NIH Ad-CMV/ZGP vaccine. Unexpectedly, complete survival was also observed with the improved vaccine administered 30 minutes after the infection of mice with Ebola virus (post-exposure). The optimized Ad-CAG/optZGP vaccine stimulated a significantly faster immune response than its NIH vaccine counterpart.

The researchers evaluated 10 formulations of surfactants and complex carbohydrates. Each of these improved the physical stability of the virus at -20°C and 4°C over standard formulations in phosphate-buffered saline and 10 percent glycerol and improved transduction efficiency of the virus on Calu-3 cell monolayers. The immune response following vaccination with formulation was more robust than without formulation, indicating a correlation between neutralizing antibody levels of greater than 1:20 and activated CD8+ T cells with survival in mice. An important milestone was reached as challenge experiments in guinea pigs showed that the improved vaccine administered intranasally is fully protective in the presence of pre-existing immunity. The best performing formulation was tested in guinea pigs and the formulated vaccine demonstrated increased protective efficacy in a post-exposure challenge experiment in guinea pigs. However, it was noted that the formulation affected the quality of the vaccine preparation by increasing the ratio of infectious over total particles. As the last milestone of the project, researchers are testing the improved NML/CRTI Ad-CAG/optZGP vaccine following intramuscular and nasal immunization of non-human primates with or without pre-existing immunity. Immunologic assays are underway on animals to identify new immune correlates of protection. The project team also developed a combination therapy

resulting in 100 percent protection in guinea pigs when initiated 30 minutes and 24 hours after infection with Ebola virus. Fully curing guinea pigs infected with Ebola using a post-exposuretreatment has never been reported and is therefore extremely exciting and encouraging, especially considering the anticipated ease of getting the treatment clinically approved by regulatory agencies. The therapy is currently being tested in non-human primates.

Impact

The project is providing an optimized Ebola vaccine and the necessary data essential to support the initiation of a Phase I clinical trial in Canada. This project is on schedule with results surpassing expectations. The optimized Ad-CAG/optZGP vaccine is currently being tested in non-human primates immunized through the intramuscular or mucosal route and challenged systemically. Conclusions from this project will be compared to findings obtained from the ongoing NIH-sponsored Phase I clinical trial evaluating a first generation AdHu5-Agp vaccine.

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CRTI 06-0230RD
Rapid Methods for Emergency Radiobioassay

Project Lead:	Health Canada
Federal Partners:	DRDC Ottawa, National Research Council
Other Partner:	Carleton University

Objectives

During a radiological-nuclear (RN) emergency, first responders and civilians face the danger of contamination by radionuclides through inhalation, ingestion, or wounds. Currently, there are no rapid bioassay methods available for polonium Po-210 and strontium Sr-90, two high-risk radionuclides that can be released during an RN event. To improve RN emergency response, Health Canada has partnered with DRDC Ottawa, the National Research Council, and Carleton University to develop rapid radiobioassay methods to measure Po-210 and Sr-90 levels in urine and/or fecal samples. The project team is developing new methods by coupling rapid and automated sample preparation techniques with fast and sensitive measurement techniques.

Relevance

Rapid bioassay methods that deliver timely assessment results for internal contamination are important for managing the consequences of an RN attack, including identifying contaminated individuals for early medical intervention and addressing the worried well. Current bioassay methods for Sr-90 and Po-210 are time consuming because of tedious sample preparation and long counting times. The project team expects that the new bioassay methods can provide assessment results for possible internal contamination within the first 48 hours after the incident. This early information will enable more effective medical intervention and better decision making.

Recent Progress and Results

In the first three years of the project, the project team made progress in four major tasks: developing a rapid bioassay method for Sr-90 in urine and automating the process; studying the optical response of quantum dots to radiation; validating the alpha spectrometry method for Po-210 in urine using non-spiked samples; and exploring the application of magnetic nanoparticles for urine bioassay.

The Sr-90 bioassay method developed is simple and robust, with sensitivity beyond the requirement for emergency population monitoring. The performance of the method met the accuracy and repeatability requirements defined by the American National Standard (ANSI) N13.30, *Performance Criteria for Radiobioassay*. Sample turnaround time is less than one hour. When tested on a field-deployable instrument, the method demonstrated itself to be fully field-deployable. The achievements have been accepted for publication as three papers in peer-reviewed journals. A fully automated flow scintillation system has been set up to automate this method in hopes that sample throughput can be greatly improved.

In studying the optical response of quantum dots to radiation, a family of quantum dots semiconductor nanoparticles was dispersed in a solvent and irradiated with cobalt Co-60 or cesium Cs-17 at different doses (0.1 Gy to 100 Gy). Optical responses (ultraviolet, photoluminescence) were fully studied and dose-response curves were developed. This study showed that quantum dots have great potential to be used as a new generation of radiation dosimeter material. The achievements have been published as two papers in peer-reviewed journals. In addition, new quantum dots have been synthesized. They will be tested soon.

The alpha spectrometry method for Po-210 urine bioassay was validated for the first time in the past decade using non-spiked samples. Urine samples collected from rats administrated with Po-210 were measured by alpha spectrometry and liquid scintillation counting. The study showed that the alpha spectrometry method is reliable for Po-210 urine bioassay. Results were published.

The magnetic nanoparticles were synthesized, characterized, surface-modified, and tested for Sr-90 urine bioassay. The results were published as two papers. Automating the method is under way.

Impact

New knowledge and techniques were created and developed in both sample preparation chemistry and radiation measurement in the first two years of this project. The project's partners are continuing the research and development of rapid methods for Sr-90 and Po-210 bioassays, including automating the separation and measurement systems. These new techniques and methods have significantly enhanced Canada's RN emergency response capability, especially for immediate and near-term consequence management.

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CRTI 06-0234TA

Advanced Syndromic Surveillance and Emergency Triage

Project Lead:	National Research Council – Institute for Information Technology
Federal Partner:	Public Health Agency of Canada
Industry Partners:	AMITA Corporation, SilvaCorp, E-Privacy Management Systems Inc.
Other Partner:	University of Ottawa Heart Institute, Ottawa Public Health, Ottawa Hospital, Children's Hospital of Eastern Ontario, Queensway Carleton Hospital, Montfort Hospital, Michigan Department of Community Health, Queen's University Public Health Informatics, Grey Bruce Health Unit, Peel Public Health, Carnegie Mellon University – School of Computer Science, Auton Laboratory

Objectives

Syndromic surveillance uses information technology to routinely monitor existing data streams (e.g., health records) to identify disease outbreaks. In the pursuit of more efficient and effective CBRNE preparedness and response techniques, and in an effort to advance the deployment and adoption of syndromic surveillance technology, the Advanced Syndromic Surveillance and Emergency Triage (ASSET) will establish a successful and highly visible prototype deployment in Canada's capital, Ottawa. This first Canadian installation in a city at high risk will promote similar deployments in other high-risk regions. ASSET will push syndromic surveillance technology to a tipping point where widespread uptake will be possible. This will be accomplished by delivering a system that: is ready for deployment anywhere in Canada; provides methods to improve the adoption, usability, and ongoing operations of syndromic surveillance in Canada; provides response protocols suitable for Canadian cities; accepts and analyzes patient data in both English and French; and creates a strategy for interfacing locally collected syndromic surveillance data with the Public Health Agency of Canada's Canadian Network for Public Health Intelligence (CNPHI).

Relevance

By accelerating the development and deployment of syndromic surveillance technology, ASSET will provide the response community with epidemiological data to rapidly determine the existence and scale of a CBRNE event. It will also play a major role in discovering the type of event, its geographical distribution, and most likely method of spread. This capability will improve response and public safety by supporting accurate, event-specific training, countermeasures, and public information programs. It will also support immediate response requirements and hazard mitigation, including emergency room and pre-emergency room medical response. ASSET will address concerns regarding the negative impact of high false positive rates in several ways. It will improve breadth of coverage by accepting bilingual data input and allowing multiple syndrome classifications per patient using the new text classifier tool built by the National Research Council (NRC). It will also improve data accuracy by accessing the medical record in greater depth and allowing easy addition of new, more precise syndrome definitions.

Recent Progress and Results

The ASSET project kicked off in June 2007 and Phase 1 was completed in January 2008. Phase 2 started in February 2008 and all deliverables have been completed. The deployment of the existing Early CBRN Attack Detection by Computerized Medical Record Surveillance (ECADS)-real-time outbreak and disease surveillance (RODS) syndromic surveillance system in Ottawa was completed in September 2009. This system is now referred to as ASSET-RODS.

Phase 3 started in August 2008 and all deliverables (except the ASSET – CNPHI link) have been completed. The ASSET Version 1 system was deployed to Ottawa Public Health in January 2010 with updates in March 2010. The system accepts data from The Ottawa Hospital (Civic and General campuses), the Children's Hospital of Eastern Ontario, and the Queensway Carleton Hospital. Data feeds from the Montfort Hospital are expected to be completed in June 2011.

A fourth ASSET stakeholder meeting was held at the Grey Bruce Health Unit, Owen Sound, in October 2009 and had over 30 participants from various partner and other organizations. Over the two-day meeting, there were several presentations from those directly involved in the syndromic surveillance field and in the project. The meeting also included roundtable discussions and breakout sessions that covered issues of concern in the industry. A third ASSET newsletter was produced in January 2010 and featured articles on adapting ASSET for influenza-like illness surveillance, the evolution of ASSET Version1, and a profile of the ASSET hospital partners.

Phase 4 started in February 2010 and focused on adapting ASSET to the surveillance of influenza-like illness in response to the H1N1 influenza pandemic. This additional work included modifying the collection and classification of data and producing user-friendly reports for public health for the surveillance of influenza-like illness.

The ECADS system in the Grey Bruce Health Unit was upgraded to ASSET Version 1 system in April 2010. All Phase 4 deliverables are complete.

Impact

Syndromic surveillance is not yet widely deployed because there is currently no "turnkey" system that can be readily deployed in Canada, and the end-user community and other stakeholders that will promote the uptake and dissemination of this technology have yet to be fully engaged.

What makes ASSET such an ambitious and interesting project is the involvement of Ottawa Public Health (OPH) in the country's first highly visible syndromic surveillance prototype deployment. The OPH serves almost one million Ottawa residents and is responsible for delivering public health services, including health protection, disease and injury prevention, control of communicable diseases, family health services, and response to public health services.

With successful deployment in Ottawa, ASSET has become a syndromic surveillance template for national uptake across the country. The transition from project to successful and sustainable market solution is likely, given the success of the ECADS system. ECADS—the basis for ASSET—was installed in the Grey Bruce Health Unit, which was at the centre of the 2000 Walkerton, Ontario contaminated water crisis. The initial plan of the ECADS project called for a trial deployment of the surveillance system for a period of months. After the trial, the Grey Bruce Health Unit decided that the system had become a necessity for them.

ASSET builds on the investment to date by the CRTI and others in developing syndromic surveillance, and is a natural extension of the CRTI-funded ECADS (CRTI 03-0013TD) and Canadian Early Warning System ([CEWS] CRTI 03-0019TD) projects, as well as the Ontario Ministry of Health funded Queen's University Emergency Syndromic Surveillance Team (QUESST) project. The teams responsible for these projects have established highly successful local implementations of syndromic surveillance and are partners in the current project.

ASSET is also a natural extension to the CNPHI project (CRTI 02-0035RD) and complements it extremely well. CNPHI is a comprehensive monitoring, alerting, data-gathering, analysis, decision-support, and information-exchange platform to integrate public health intelligence across multiple jurisdictions into a common national framework. ASSET focuses on cities and regions, and will provide health units and regional authorities with the tools they need to collect and use syndromic information at a local level. Appropriately filtered by CNPHI, information from ASSET can then be used across jurisdictions. As partners in this project, the CNPHI team will play a major role in developing the response protocols and deployment strategies that will bring this to fruition.

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CRTI 06-0252RD

Protocols for Modelling Explosive Threats in Urban Environments

Project Lead:	Public Safety Canada
Federal Partners:	DRDC Suffield, Royal Canadian Mounted Police – Explosives Disposal Unit
Industry Partners:	Martec Limited, Waterloo CFD Engineering Consulting Inc.

Objectives

The main objective of this project is to improve Canada's preparedness to prevent and respond to an event involving improvised or emerging terrorist explosives. The project team has developed an Urban Blast tool for assessing the effects of ideal and non-ideal explosive threats in urban environments and to serve as guideline protocols for urban blast modelling. This system gives users access to a large collection of accurate, physics-based, near-field modelling results based on first principles, for a comprehensive class of fundamental urban environments and scenarios. These modelling results are provided in a form useful for agencies and analysts performing assessments of potential real-world events and also provide input for a series of quick-look tables and charts. The Urban Blast tool includes protocols that give non-specialists guidance in identifying key phenomena that must be accounted for in blast analyses to achieve an accurate prediction of the potential damage. The final Urban Blast tool will be a user-friendly computer application, with key protocols also available in the final project documentation.

The deliverables from the current project will be used in a future project to develop a rapid urban explosion analysis system. The system will use quick-running computational fluid dynamics (CFD) flow modelling to analyze user-specified explosive threat scenarios in any Canadian city and will be useful for city planners and the emergency operation and response communities.

Relevance

Protocols based on physically-accurate models and modelling solutions based on first principles are needed as guidelines for urban explosion modelling. When used effectively, modelling tools can significantly aid in predicting and preparing for catastrophic explosive threats in urban environments. Many different fast-blast analysis tools and expert systems include semi-empirical approaches that produce results in minutes. All of these tools have roles to play in risk assessments if used appropriately, but most of them are incapable of predicting the near-field effects encountered in urban environments. Because many end-users are not well-versed in either explosion physics or numerical techniques, they may use modelling tools outside the range of applicability and introduce errors in interpretation. The first-principles-based urban blast solutions will provide validated results for assessing the relative effects of threats on structures and personnel in real-world urban scenarios.

Recent Progress and Results

To develop the Urban Blast tool, the project team has built on capabilities developed over the past decade under the auspices of defence research and development programs. These capabilities include an extensive experimental database for the effects of various non-ideal explosive devices and weapon surrogates on urban structures, and the Chinook code, a first-principles-based CFD modelling software. The Urban Blast tool makes the large body of knowledge on urban explosions available to a wider audience of both experts and non-specialists.

A key feature of the Urban Blast tool is a database of urban explosive scenario results. The database includes the results from hundreds of detailed, physically accurate, near-field, urban blast calculations from the Chinook code. The database is comprised of combinations of nine fundamental urban environments and four classes of explosive threats: ideal (energy release via detonation only), afterburning, metalized, and fuel-air. While users will be able to access detailed data from individual urban scenarios, these results are also summarized in a table giving blast enhancement factors for use with different threat and environment combinations. Extensive three-dimensional (3-D) urban blast calculations have continued through the final year of the project, with specific focus on high explosive (ideal and afterburning) and metalized explosive threat formulations in a wide range of environments.

More accurate physical models were necessary to improve the predictive capability of the first-principles code used to generate the urban blast scenario database and to ensure the accuracy of the scenario results. The team conducted a comprehensive review and definition of the relevant physical models for modelling detonation, afterburning, and near-field blast of the defined classes of non-ideal explosive devices and volumetric explosive devices, and their interactions with urban structures and confined environments. The final year of the project has seen the implementation of the new physical models, with models tested at a fundamental level and validated against experiments involving reduced-scale urban environments. A consistent and physically representative set of model parameters has been developed and applied in the simulation of all threats (ideal, afterburning, metalized), with successful comparisons to experimental measurements for a range of test environments and scales.

At the highest level, the protocols consist of a procedure outlining the primary eight steps involved in an urban blast analysis. At a lower level, the protocols include guidelines to identify and classify the main blast features that influence structural damage and personnel injury (e.g., confinement, explosive height of burst, etc.), as well as guidelines on the applicability of casualty and structural damage assessment models. The lower-level guidelines required many smaller scientific studies, which continued in the final year of the project. Each of these investigations required a literature review and identification of missing information to be determined through the first-principles urban analysis. A preliminary user interface for the Urban Blast tool has been completed and improved by interactions with both expert and non-expert users. The software interface allows users to access data from specific calculations similar to their own scenarios and to interact with the guidelines, from the interpretation of their actual scenario to blast calculation and damage assessment. All project deliverables will be completed by July 2011.

Impact

The Urban Blast tool will have important impacts on preparedness for, and prevention of, explosive-related urban public security events. Existing fast modelling tools often fail in predicting the complex near-field effects from non-ideal improvised explosives. The Urban Blast tool includes a first-principles based database for urban explosive scenario solutions that can serve as an analysis tool for those charged with assessing and protecting urban structures and personnel, and as a first-principles benchmark solution for urban scenarios to validate existing modelling tools. The protocols given in the Urban Blast tool can be used as guidelines for effective urban blast modelling practices to support design, mitigation measures, operational planning, and forensics for ideal and non-ideal threats on urban infrastructures and environments. In addition, the protocols will describe appropriate analysis procedures to convert predicted values to vulnerability information for casualty and structural damage levels. Some key deliverables from this project will form the scientific basis for a subsequent project in which a rapid urban blast modeller and quick-running, physically-accurate solver will be developed for calculation of explosive threat scenarios in Canadian cities with user-defined environments and threats.

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CRTI 06-0255TA
Medical and Casualty Management Command Post

Project Lead:	DRDC Ottawa
Industry Partners:	AMITA Corporation, CAM Emergency Preparedness, Correct Solutions, E-Privacy Management Systems Inc., St. John Public Health Consulting International Inc.
Other Partners:	Grey Bruce Health Unit, Government of New Brunswick – Security and Emergencies Directorate – Department of Public Safety, University of Ottawa Heart Institute, United States Department of Health and Human Services – Office of Preparedness and Emergency Operations and the Office of the Assistant Secretary for Preparedness and Response, Carleton University – Human Oriented Technology Lab, Canada Health Infoway

Objectives

The Medical and Casualty Management Command Post (MedPost) project will develop a centralized, field-deployable, electronic medical and casualty command-post system for use during CBRNE or naturally occurring disease outbreaks with the possibility of mass causalities. The system will provide data needed by healthcare crisis management authorities at the community, provincial, federal, and international level to reduce the morbidity and mortality associated with such events.

The MedPost system is designed to present an aggregate view of essential information about casualties (e.g., the number of people affected, who they are, where they are, their condition, and with whom they have come in contact) that will be easily accessible and available through a single, central location. The secure system is designed to provide rapid cumulative or detailed data, releasing only the pre-authorized information at each level of inquiry. At each release of information, the timing and the data released will be permanently recorded.

Relevance

MedPost will improve CBRNE response capability by integrating communications between on-scene responders, hospital medical staff, and members of the response community involved in managing a CBRNE event. Having a product such as MedPost, which transcends different levels of government and crosses different disciplines (fire, paramedic, police), provides a tool that mimics the true interaction that can occur during a CBRNE event. Allowing different levels of responders to access requirements-relevant information about casualties will dramatically improve situational awareness and response. MedPost will provide an overall command and control view of a CBRNE event using data feeds from various sources including the successfully completed CRTI project, Rapid Triage Management Workbench (RTMW) (CRTI 0060TA). MedPost will fully integrate with triage software used by on-site responders, and share mission critical information among those responsible for first response, casualty care, command and control, and public communication.

Recent Progress and Results

The MedPost project was contracted in October 2008, and Phase 1 activities were completed in December 2008. Phase 2, Product Design (both functional and technical) was completed in June 2009. The project team reviewed hypothetical CBRNE scenarios to identify and detail MedPost requirements, and developed the first functional prototype released to the Grey Bruce Public Health Unit in Owen Sound, Ontario in March 2010. The initial field release provided feedback for functional enhancements for a second iteration of the functional prototype released to Grey Bruce Public Health Unit in July 2010. New Brunswick's Department of Public Safety planned and hosted a table top exercise to review and assess MedPost in August 2010. All Phase 4 (Evaluation) deliverables are complete. A formal study/stakeholder meeting was held at the Grey Bruce Health Unit in November 2010 with 30 participants from various partner and other organizations. Over the two-day meeting, there were several presentations from those directly involved in the project, as well as other professionals from the risk monitoring field of public health. The meeting also included a panel discussion that covered issues of

concern in the industry, and an information gathering workshop focused on ways and means to promote the MedPost application in communities within Canada. The product transition phase of the project will be completed at the close of fiscal 2010–2011 and the final close-out phase of the project is underway.

Impact

At the conclusion of the MedPost project, the Grey Bruce Health Unit, Grey Bruce Health Services (which encompasses 12 hospitals in the Grey Bruce area), and the Province of New Brunswick will have an operational system that will facilitate the automatic and manual collection of data using basic, aggregated data such as the number of admitted patients, number of suspected cases, and the number of persons exposed and their location. The resulting system will be scalable to also be used at the provincial or federal level should there be a large-scale event.

The near real-time, accurate situational data from existing hospitals and timely movement of data from the patient level to the medical community decision makers will significantly improve communication between hospitals, temporary or alternate treatment centres, responders, and medical decision makers (e.g., public health officials) in order to guide resource management during an emergency. By demonstrating a level of cooperation across government and first responders, the opportunities for MedPost to gain traction as a successful commercial product are enhanced.

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CRTI 06-0275TD

Integrated Two-way Radio Radiation Sensors

Project Lead:	Royal Canadian Mounted Police
Industry Partners:	Motorola Inc., Bubble Technology Industries Inc.
Other Partners:	Edmonton Police Service, Toronto Police Service, Toronto Fire Service, Service de Sécurité Incendie de Montréal, Windsor Police Service

Objectives

Currently, most police, fire, and emergency medical services (EMS) personnel carry no radiation detection equipment during their daily activities. This deficiency leaves these first responders at high risk of radiation exposure in the event of a radiological or nuclear incident. Motivated by a strong end-user push, this project integrated small radiation sensors with commonly used Motorola two-way radios to provide responders with a simple, integrated device for personal radiation safety and detection of nuclear materials.

Led by the RCMP, this project was strongly supported by police and fire services from Edmonton, Toronto, and Montréal. Motorola's development team in Florida, which is responsible for the design of Motorola's two-way radio products, led the industrial effort. Bubble Technology Industries Inc., a recognized leader in radiation detection, closely collaborated with Motorola to develop and integrate a radiation sensor package that is compact and affordable.

Relevance

The project directly addresses several key CRTI priorities, including enabling rapid determination of the existence and scale of a radiation event; aiding in responder safety and accurate public information; providing new and significantly improved detection capability and an improved communication link for detection, surveillance, and alerting systems; and supporting police and interdiction capabilities by developing technology that detects nuclear material and supports nuclear crisis and consequence management.

Recent Progress and Results

Since the contract was awarded in December 2009, progress on this project has included

- defining the requirements and architecture for a deployable integrated system that incorporates the views of the end-users;
- designing, fabricating, and testing of multiple prototype two-way radio radiation sensor units;
- optimizing the design and fabricating prototypes suitable for field testing by end-users;
- developing a training package to ensure the end-users could properly assess the functionality of the prototypes; and
- supporting field tests of the units by the multiple end-users.

In late 2010, more than 30 prototype devices were produced and distributed for testing by project end-user partners (RCMP, Edmonton Police Service, Toronto Police Service, Toronto Fire Service, Windsor Police Service, and Service de Sécurité Incendie de Montréal) to assess and demonstrate the value of these devices through field tests.

After the field tests, the end-user partners provided positive feedback about the performance and operational utility of the prototype devices. End-users expressed enthusiasm for the development of a commercial product based upon the prototype radio and radio spectrum management (RSM) system. Several requests were made regarding additional features for the commercial radio/RSM system. These requests will be considered when designing and producing a commercial product in the future.

Impact

A terrorist attack, act of war, or accident involving radioactive materials is a real and critical threat. In such a crisis, first responders will be called upon to rescue, evacuate, treat, and manage the front-line response. Ensuring the safety of first responders is a key element of effective emergency response. The high risk of a radiation-related incident drives the need for first responders to carry radiation sensors as part of their standard equipment.

This project will provide Canada's first responders with a simple and effective tool to prevent harmful radiation exposure during field duties, and to assist in detecting illicit nuclear material. It will ensure that first responders will not unknowingly operate in a contaminated area for an extended period of time, exposing themselves to radiation and possibly spreading the contamination to hospitals, command centres, and homes. Successfully implementing this technology will place Canada's first responders at the forefront of nuclear protection and response.

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CRTI 06-0301TD

Development of Nasal Spray Formulated with Antiviral Drug Against Avian Influenza Virus

Project Lead:	DRDC Suffield
Federal Partner:	Public Health Agency of Canada – National Microbiology Laboratory
Industry Partners:	CAE Professional Inc., Northern Lipids Inc., Oncovir Inc., Dalton Pharma Services

Objectives

The primary objective of this project is to advance the preclinical development of a nasal spray formulated with liposome-encapsulated poly ICLC (LE Poly ICLC) to provide non-specific, broad-spectrum protection against avian influenza (AI) H5N1 viruses. Poly ICLC is a synthetic, double-stranded polyriboinosinic-polyribocytidylic acid stabilized with poly-L-lysine and carboxymethylcellulose, and is a potent inducer of innate immunity. Successfully developing this novel drug will enhance Canada's capability to protect military, civilian, and first responder communities against AI and pandemic influenza viruses, whether caused by a natural pandemic outbreak or bioterrorism event.

Relevance

Existing drugs against AI viruses have limitations in terms of toxicity, drug resistance, and virus mutations, leaving first responders, defence personnel, and civilians vulnerable to influenza outbreaks. The prototype nasal spray device formulated with LE Poly ICLC provides a needle-free, safe, and effective means of drug self-administration conferring rapid protection against AI H5N1 viruses. In various animal studies, intranasally administered LE Poly ICLC provided effective and broad-spectrum protection against several deadly viruses including Ebola, western equine encephalitis, and AI. The project team expects that LE Poly ICLC delivered in a nasal spray will also provide broad-spectrum protection to humans against multiple viral threat agents.

Recent Progress and Results

During fiscal year 2010/2011, the first current good manufacturing practice (cGMP) batch of Poly ICLC was successfully produced by Dalton Pharma Services under sub-contract from Oncovir Inc. This batch represents the first cGMP batch of Poly ICLC ever produced in Canada. Thus, the task on the development and optimization of liposome formulation of LE Poly ICLC has been successfully completed in this project. In animal studies, this liposome formulation of Poly ICLC was found to be well tolerated in animals and was found to be efficacious in protecting mice against virus challenge with multiple lethal doses of influenza A virus. Current effort is directed at exploring feasibility for the scale-up production of liposome-encapsulated Poly ICLC (LE Poly ICLC, cGMP grade) at Dalton Pharma Services or Northern Lipids Inc. The availability of cGMP batch LE Poly ICLC would greatly facilitate clinical testing and development, and will help to advance product development for this project.

Early research on LE Poly ICLC had shown that the pre-treatment with LE Poly ICLC can be administered to experimental animals as far as three weeks in advance of a lethal virus challenge. When animals were challenged with multiple lethal doses of influenza A virus within this three-week window, the animals were highly protected against the lethal infection. However, the mechanism of action for this prolonged window of protection is unknown. Recent work using flow cytometry analysis of natural killer (NK) cells isolated from lungs of animals pretreated with LE Poly ICLC indicates these NK cells remain activated two to three weeks after drug pre-treatment. This finding is very significant because NK cell activation may represent a reliable and accurate surrogate marker of antiviral protection induced by LE Poly ICLC. The identification and validation of this surrogate marker of protection may facilitate and enhance positive regulatory review of LE Poly ICLC for clinical development.

LE Poly ICLC has consistently shown in pre-treatment studies complete (100 percent) protection in mice against a lethal influenza A (H1N1) virus challenge. More recent studies in mice have shown that LE Poly ICLC can be effective when administered post virus exposure, especially when in combination with an antisense oligonucleotide. This therapeutic drug combination results in 100 percent survival

rate compared to 0 percent survival rate in the PBS treated control group. These results suggest that LE Poly ICLC can provide excellent protection against lethal influenza A (H1N1) virus infection in experimental animals when given prophylactically as a pre-treatment, or as a post-exposure therapy.

Also in the 2010-2011 fiscal year, the project team completed a pre-Investigational New Drug (IND) document for seeking regulatory approval from the US Food and Drug Administration (FDA) for Phase I safety and tolerability study in normal human volunteers. It is expected that this document will be used to solicit guidance and direction from the US FDA, which will be extremely valuable in advancing clinical development of LE Poly ICLC, and in meeting a key objective for this project.

Impact

Influenza pandemic preparedness is necessary to control bioterrorism-related or natural outbreaks of the virus. LE Poly ICLC is a broad-spectrum antiviral agent shown to be effective in animals for prophylactic therapy of deadly viral diseases involving Al H5N1, Ebola, and alphavirus infections. LE Poly ICLC-formulated nasal spray would protect first responders, medical and security personnel, and the public against these viruses. Therefore, developing this novel drug product will significantly improve existing CBRNE preparedness and prevention capabilities.

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CRTI 06-0317TD

PROBE—Crime Scene Support Tool for Police, Hazardous Materials, and Emergency Medical Services

Project Lead:	Royal Canadian Mounted Police – Canadian Bomb Data Centre
Federal Partners:	National Research Council, DRDC Centre for Security Science, Department of National Defence – Director General Nuclear Safety
Industry Partners:	AMITA Corporation, Loraday Environmental Products Ltd., International Safety Research Inc.
Other Partners:	Toronto Police Service – CBRN Team, Carleton University – Human Oriented Technology Laboratory

Objectives

This project is designed to create awareness around the automated collection of crime scene evidence, information on triage treatment of casualties, and assistance in monitoring scene integrity with an easily portable and integrated crime scene management tool.

PROBE will leverage previous CRTI investments to close critical gaps in crime scene management capability that originated in the absence of automated, standardized, and interoperable tools. In the current environment, as the scene of a CBRNE event evolves into a criminal investigation, information becomes difficult to control and combine into a manageable format.

The project will develop two generations of working prototypes capable of undergoing live field tests and evaluation by a wide-ranging community of CBRNE responders. The objective of the field tests is to develop, communicate, and publish a statement of requirements for a commercialized product.

Relevance

PROBE will provide a previously unavailable integrated crime scene management capability, allowing police, hazardous materials (HAZMAT), and emergency medical services (EMS) personnel to communicate and share CBRNE event data and information sources in real time. Responder safety and public information programs will be significantly improved through this automated support tool, which will provide a knowledge base and equipment to support rapid determination of the existence or scale of a CBRNE event and mitigate the spread of CBRNE agents. On project close, the first responder user community will be better prepared to investigate CBRNE crime scenes by utilizing the national investigation standards for the handling of CBRNE (or contaminated) forensic and long-term evidence samples.

Recent Progress and Results

Project work continued and the project team completed a Version 2 prototype that addressed findings and observations from the 2009 exercise with first responder communities. The Version 2 prototype was delivered to Toronto Police Services' Forensic Identification Section and deployed to an radio-frequency Identification (RFID) forensic evidence tracking field test.

Phase 3 of this project introduced the Version 2 Prototype to participating responder groups in the Halton region, including Halton Regional Police Services, Halton Region EMS, as well as members from Hamilton Police and Public Health; the Comité aviseur antiterrorisme de Montréal (CAAM), including Members from Service de police de la Ville de Montréal (SPVM), Sécurité incendie Montréal and Urgences-santé Québec; Saint John Fire services, including Saint John Police and Ambulance New Brunswick and participation from the RCMP Halifax; Fire Services from the cities of Coquitlam, Port Coquitlam, and Port Moody; the Animal Emergency Working Group (AEWG); and a member of Ottawa Fire Services. The Commercialization Requirements and Specifications report is underway, including requirements identified through the exercises to date. The pending exercises will provide additional input to this key project report.

Impact

Current standalone commercial and CRTI-developed software tools (Chemical Biological Response Aid [CoBRA], Palm Emergency Action for Chemical-Weapons of Mass Destruction [PEAC-WMD], Rapid Triage Management Workbench [RTMW], Socius, and RFID) provide various capabilities for managing CBRNE events. The project team will leverage these tools by integrating them into one comprehensive CBRNE crime scene support tool for police, EMS, and HAZMAT personnel.

The fact that PROBE is built on commercially viable products, such as RTMW (which is being deployed in South East Asia), Socius (which is being implemented in Canada and Colombia), CoBRA, and PEAC-WMD speaks greatly to the transition that PROBE will make from technology demonstration at the commencement of the project to a future commercial solution. PROBE will also leave behind a significant impact by creating a solution that transcends different disciplines (e.g., fire, paramedic, police) in responding to and following up on CBRNE events.

PROBE project members will leave a prototype product with each field test evaluation team member. The PROBE prototype will be portable and will provide responders with critical CBRNE information sources, standardized evidence management forms, standardized incident reporting forms and procedures, and mass casualty triage management. It will also enable interoperability and data exchange between the various responders to assist crime scene management.

The test and evaluation process will provide relevant and meaningful requirements to guide development of the next generation commercial tool over the near- and mid-term future.

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CRTI 06-0318TD

Higher Education Cooperative for Hazardous Materials and Equipment Tracking

Project Lead:	Royal Canadian Mounted Police – National Services and Research
Federal Partner:	Royal Military College of Canada
Industry Partner:	Vertére
Other Partners:	University of Ottawa, Queen's University, Concordia University

Objectives

Most universities across Canada lack accurate hazardous materials inventories and, where they do exist, the inventories are inconsistent and not always useful for administrative or regulatory purposes or easily accessible to first responders. With the ever-increasing demands of a terrorism environment, more regulations requiring reporting of chemical and hazardous materials are coming into force. Furthermore, there has recently been an increasing requirement for institutions to demonstrate to courts that all aspects of due diligence have been used in managing and handling hazardous materials. The lack of control in obtaining, recording, using, disposing of, and reporting hazardous materials presents a problem because chemicals and other materials found in universities could potentially be used in CBRNE terrorism acts.

To address these concerns the Higher Education Cooperative for Hazardous Materials and Equipment Tracking (HECHMET) project will develop a comprehensive database of hazardous materials located at four selected Canadian universities with varied academic foci, differing levels of research, and different regulatory and reporting requirements.

Relevance

This project will standardize the management of chemical inventories, resulting in wide-reaching benefits to universities, including ease of compliance with regulations, budget control, and firm demonstration of due diligence to occupational health and safety requirements. In the context of CBRNE threats and incidents, university administrators will have immediate and ongoing access to chemical inventories and will be able to identify unusual purchases of regulated chemicals and those substances that could be used as precursors for explosives, drugs, or chemical weapons. The database will also provide first responders access to information that may aid in emergency response and will help investigators by providing access to key information on the presence of, access to, and location of materials of interest.

Recent Progress and Results

The project is progressing well as universities continue to integrate chemical inventories from various departments within their institutions. Each university has also provided user access to a segment of integrated departments. Work is continuing on developing training packages, policies, and procedures, and on tracking lessons learned.

For the first responder community, the software allows remote and secure access to information required to initiate a safe and secure response to any type of HAZMAT incident at a partner university. In addition to HAZMAT response, security personnel can track illicit chemical inventories or materials that may exist on a restricted list for use, handling, import, or export. This tracking capability is further enhanced by the addition of a requisition module that will allow institutions to track and control chemicals from purchase to disposition. In collaboration with a number of regulatory agencies, Canadian federal and provincial legislation is being reviewed and the impact on Canadian universities assessed and documented. As applicable, tables containing regulated chemicals are being incorporated into the requisition module. The software will check against these tables and generate alerts/flags during the ordering and receiving processes, thereby allowing efficient tracking and control of regulated chemicals. Pre-defined reports are also being created to help universities meet their legislative reporting requirements. This project has demonstrated an excellent collaborative approach between universities, the RCMP, regulatory agencies, and commercial partner

Vertére's Inventory Manager software to develop a system that is Canadian, easy to use, flexible, yet technically robust and able to provide secure access to sensitive information across four institutions. Although the project is not scheduled for completion until 2012, the project team is currently developing a HECHMET business model with the goal of creating a sustainable model post-CRTI funding. Additional universities are already showing considerable interest. In the next year, the project team plans to conduct a test case by incorporating the chemical inventory of one department from an external university. This test case will serve to review best practices, policies and procedures, and training documents, as well as provide valuable input to the business model being developed.

Impact

Developing a comprehensive database of chemicals will allow for rapid identification of precursors and toxic materials that can be used directly or can be incorporated into explosives or improvised chemical weapons or devices. This project will have significant importance to universities and other agencies that hold large quantities of a variety of hazardous materials that have relatively unrestricted access. The impacts will include budget, inventory control, security of materials, and due diligence. Training and communication will be established between key individuals in each university and first responder communities to ensure that the needs of both academia and responders can be met.

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CRTI 07-0104TD
Detection of Radioluminescence in Air

Project Lead:	DRDC Ottawa
Federal Partners:	Director General Nuclear Safety, Canadian Nuclear Safety Commission, Health Canada, Royal Canadian Mounted Police
Industry Partner:	Bubble Technology Industries Inc.
Other Partner:	Atomic Weapons Establishment, United Kingdom

Objectives

The objective of this work is to produce a mobile prototype detector for the near-field imaging of short-range radiological contamination through the detection of radioluminescence in air. The 32-month project, begun in July 2009, encompasses all aspects of instrument development, ranging from the design of novel optical, mechanical, and electronic components to the development of data acquisition, firmware, and software subsystems. Bubble Technology Industries is performing the design and proof-of-principle testing with input from its partners. The first phase, which was completed in September 2010, demonstrated a working prototype of the imager. The second phase involves the construction of a larger focal plane detector and dedicated on-board electronics, followed by characterization studies with the partners. The final prototype will be delivered in February 2012.

Relevance

On-site detection and measurement of the activity and extent of contamination is one of the most daunting tasks radiation detection personnel can face. Because of the short range of these particles in air and other materials, conventional detection techniques involve bringing a probe (gas filled chamber or scintillator) to within a few centimeters of the suspect area. As a result, an inch by inch survey of the detection area ensues. This process is time consuming and painstaking, and can result in personnel being exposed to harmful radiation. Conventional detectors are also prone to breakage because of fragile Mylar windows located over the probes. The multispectral imager for the detection of radiological contamination (MISDORC) circumvents this problem by detecting the air scintillation surrounding the contamination. The MISDORC system uses optical imaging to isolate the origin of this scintillation in a wide field of view and rapidly detect sources equally well on flat or irregularly contoured surfaces.

Recent Progress and Results

MISDORC is comprised of three separable physical components: the imager, a motorized pan and tilt unit, and a tripod. Each component will weigh less than 20 kilograms. Custom hardware has been designed and fabricated to mount the optics and its imaging detector and electronics. This mechanical design has taken into account the need to protect the optics, keep the unit robust, and make it easy to handle and transport.

The optical design and fabrication is complete. MISDORC optically images a ±17° field of view in a narrow ultraviolet (UV) light band with very high optical efficiency. It has a large customized focal plane detector that provides single-photon imaging capability over the wide field of view. The optics are mounted on a motorized pan and tilt unit on top of a free-standing tripod and are designed to survey a scene at standoff distances between one to three meters. The optical assembly consists of six spherical lenses along with one aspherical component. Each lens has been fabricated from fused silica to provide high light transmission in the UV spectrum and coated to minimize light loss at each air-glass boundary. The final optical resolution will be limited by the granularity of the focal plane detectors and not the optics. At a distance of 1.5 metres, the detector pixel granularity will correspond to an object about 20 millimetres in diameter, which matches well the range of alpha particles in air.

Single-photon imaging is accomplished with four closely-packed 2-inch square pixilated photomultiplier tubes (PMT). Each PMT has 16 x 16 pixels for

a total of 1024 pixels. The PMTs will be covered with a customized optical filter to block visible light but transmit UV light. Proof of principle tests have shown that the specially developed data acquisition electronics are capable of quickly shuttering the PMTs as well as integrating the signals for exposure times up to 100 seconds, while maintaining the low noise features of the PMTs. The development of firmware and software algorithms is underway to control several subsystems and peripherals, such as the motorized pan and tilt unit, a laser pointer, range finder, and so on. In addition, programmers are designing a graphical user interface. First tests with the prototype indicate that it is presently capable of detecting sub-micro-Curie alpha activity at a distance of 1.5 metres. Methods have been devised for eliminating or filtering interfering room light and significantly increasing the instrument's depth of field. This instrument is scheduled to undergo challenging field tests with end users in the upcoming year.

Impact

The successful development of an instrument for the on-site detection and measurement of short-range radiological contamination will help protect emergency management personnel from exposure to radiation. The MISDORC system will give radiation detection personnel a much more rapid, accurate, and robust tool for in situ contamination measurements.

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CRTI 07-0109RD

Development and Application of Foresight and Future Visioning to Support Capability-based Planning for Animal Health Emergency Management in Canada

Project Lead:	Canadian Food Inspection Agency
Federal Partners:	Agriculture and Agri-Food Canada, Health Canada, Public Health Agency of Canada
Industry Partners:	Dairy Farmers of Canada, TDV Global Inc.
Other Partners:	Alberta Agriculture and Rural Development, Ontario Ministry of Agriculture and Rural Affairs, Canada's Veterinary Colleges

Objectives

A threat to animal health could have devastating consequences related to public health, economic security, food safety, and the environment. Canada's Animal Health Emergency Management (AHEM) system must have effective capabilities to anticipate, prevent, prepare for, and respond to animal health emergencies. Foresight, defined as a set of strategic tools that emphasize a long-term perspective to gain insight on future needs and priorities, can help chart likely futures and inform key decision making on investments in capability.

The project has been structured around three phases:

- Phase 1—Planning, Learning, and Community Building;
- Phase 2—Applying Foresight to Animal Health Emergency Management; and
- Phase 3—Developing Priorities.

Through participation from federal, provincial, academic, and industry partners, the intent of the project is to use foresight as an effective part of capability-based planning.

Relevance

Foresight offers the means to consider the long-term perspective when identifying future risks, needs, and required capabilities. Consideration of anticipated future outcomes when directing investment can form an invaluable part of the strategic planning process, particularly for organizations concerned with capital expenditures in emergency management and operating in multi-jurisdictional environments.

Recent Progress and Results

Phase 2 was completed in fall 2010 with the articulation of a collective shared vision for AHEM. Guided by the insights and outputs of the foresight process, the vision was built on a foundation of the recognized interdependence of animal health, public health, ecosystem health, and economic health. A series of key capabilities support this vision and their continued development is integral to achieve the outcomes needed for the AHEM system required in 2025 and beyond. The key capabilities underpinning the vision are organization and decision making; information and communications; expertise and personnel; science and technology; and policy, law, and regulation.

Phase 3 further developed the capability-based model, through engagement of a multi-stakeholder, multi-disciplinary community, through working groups and a dedicated workshop, held in February 2011. At the workshop, each supporting key capability area was defined in terms of a desired future outcome, as well as the guiding principles and components. Existing and pending initiatives already contributing to the achievement of the desired capability were further identified and assessed for relevance.

To catalyze achievement of the vision, the community developed and used a novel foresight approach to produce an outcomes-based roadmap, anchored in the present with existing innovative initiatives, and bridging it to the achievement of the future vision through a series of intermediate outcomes. Development of roadmaps in this manner ensures that work is not duplicated and future capability building activities are rooted in the successful outputs of activity already underway. Collective responsibility for developing priorities and achieving the articulated outcomes is strengthened through the shared vision created through foresight.

CRTI 07-0109RD

Development and Application of Foresight and Future Visioning to Support Capability-based Planning for Animal Health Emergency Management in Canada

Impact

The collaborative articulation of potential outcomes beyond the traditional strategic planning horizon offers a means to better anticipate the required future capabilities for emergency management. The application of foresight also encourages multi-jurisdictional consensus on the current gaps within the emergency management system and on potential policy and operational changes that are required to address them.

Research and development on the most effective ways to conduct foresight within public sector organizations will help increase the comfort and familiarity of planners with the concepts and methodologies, while identifying critical success factors, best practices, and lessons learned associated from its effective usage.

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CRTI 07-0121RD

Lightweight Composite Armour for Improvised Explosive Devices Protection: A Single-walled Carbon Nanotube Solution

Project Lead:	National Research Council – Steacie Institute for Molecular Sciences
Federal Partners:	National Research Council – Institute for Aerospace Research and Institute for Microstructural Sciences, Royal Canadian Mounted Police
Industry Partner:	Allen-Vanguard Corporation
Other Partners:	University of British Columbia, McGill University

Objectives

The objective of this three-year project is to mitigate explosion and ballistic hazards for first responders with armour of significantly reduced weight. The project targets a reduction of 25 percent in the weight of affected protective armour components. The objective will be achieved by improving the architecture of materials currently used and by developing lighter and higher-performance materials, all based on the use of single-walled carbon nanotubes (SWCNT), the strongest material known.

The project is divided into five work packages (WPs) with a feedback mechanism that allows material, process, and properties improvements: WP1—SWCNT Production and Quality Certification; WP2—Integration and Fabrication; WP3—Testing and Modelling; WP4—Manufacturing of Parts and Insertion into Suit; and WP5—Field Testing.

Relevance

Currently available personal protective equipment for explosive ordnance disposal (EOD) protects against improvised explosive devices (IEDs), but its weight makes it impractical for some situations, especially those requiring swift or long actions, or those involving extreme conditions. As multidimensional threats arise, such as the combination of an IED with a CBRN agent, controlling the weight of the armour becomes even more critical.

Recent Progress and Results

The SWCNT production facility at the National Research Council (NRC) is operating routinely and the current focus is on improving the yield as high as possible with a target of 80 percent to limit post-processing.

The bulk of the work is now on WP2 with the objectives of producing samples to activate WP3 and WP4 at the earliest. The project team has initiated all five proposed activities in WP2 and material selection has progressed.

For the first activity involving polyacrylic-SWCNT composites, the team successfully developed a two-step protocol to integrate SWCNT into polyacrylics and samples were fabricated and sent for testing. No significant improvements in ballistic shielding were measured and hence this work was terminated.

For the second activity involving Polycarbonate (PC)-SWCNT and ultra-high-molecular-weight polyethylene (UHMWPE)-SWCNT composites, chemical grafting methods were developed (patent pending) to integrate SWCNT into PC and UHMWPE. PC-SWCNT composites were fabricated and are currently under testing. Gel spinning was used to make fibres from UHMWPE-SWCNT. Initial tests yielded significant improvement in Young's modulus.

For the third activity involving integration of SWCNT into resins, such as vinyl ester, the project team successfully developed chemistry to anchor SWCNT to vinyl ester resins.

For the fourth activity involving SWCNT fibre, yarns, and fabrics, the team developed methods to fabricate lyotropic liquid crystals from SWCNT and the dopes were used to fabricate pristine SWCNT fibres. In addition, pristine CNT fibres were fabricated by coagulation spinning. Mechanical testing on these fibres is currently underway. A process to make SWCNT/PAN fibres using electrospinning has been developed successfully and mechanical testing is also currently underway. The team also developed a method to integrate SWCNT into Kevlar fibre

(patent pending) and initial tests yielded significant improvement in strength. The method is currently being extended to Kevlar fabrics.

For the fifth activity involving SWCNT sheets and hybrids, various forms of "bucky" papers were made and mechanical testing was performed. Samples are now being prepared for ballistic tests. Two impregnation techniques were also tested and assessed.

In WP3, the project team screened modelling algorithms for penetration and perforation and studied penetration and perforation mechanics for armor designs. In addition, they used a computational model based on fibre architecture to assist design and selection of CNT/matrix material combination and geometric orientation of the fibrils. Mechanical and ballistic tests were performed on samples with encouraging results. In WP4, hybrid systems of CNT with Kevlar at the fibril and yarn level were demonstrated with encouraging preliminary results.

Impact

Successful incorporation of SWCNT within the focus areas of protective materials can either significantly reduce weight over several armour component areas or, for the same weight, add protection where no protection currently exists. All military, law enforcement, and first responder personnel wear various levels of body armour, whether for EOD or other high-threat environments. This project will provide the first benefits of material enhanced through nanotechnology to this large group of critical personnel. There is the potential to have various levels of capability or property enhancements, or weight reductions using SWCNT, depending on the type of protective material technology, ranging from visors, helmet shells, rigid armour plates, high-density polyethylene composites, to soft armour. Breakthroughs in one or several of these areas can have wide-reaching implications for armour multi-functionality.

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CRTI 07-0132TA

Portable Electronic Microarrays for Agrobioterrorism: Detection and Typing of High-consequence Agents of Agroterrorism

Project Lead:	Canadian Food Inspection Agency
Federal Partner:	Nexogen, Inc.
Other Partner:	Institute for Animal Health

Objectives

The main objectives of the project are to provide end-users with training and assay systems for high-consequence (HC) agents in the event of agrobioterrorism. The goal is to provide assays for bovine and avian HC agents in an automated, portable, integrated instrument that combines sample preparation and ultra-fast polymerase chain reaction (PCR) with a carbon electronic microarray. The bovine assay targets agents such as rinderpest, vesicular stomatitis, and malignant catarrhal fever, while the avian assay targets avian influenza (AI) and Newcastle disease virus (NDV). The Canadian Food Inspection Agency (CFIA) and Nexogen will develop assays on the existing electronic microarray platform in the first phase of this project and transfer the assays to the new, portable "sample-to-answer" instrument in the second phase of the project. The third and fourth phases involve test validation at both CFIA and the United Kingdom's Institute for Animal Health, and field testing by the end-user, the District Veterinary Office.

Relevance

This project addresses the need for criminal and national security investigation capabilities by using an open platform able to provide highly specific typing for subtype, serotype, and strain identification of HC agents for forensic analysis. The ability to rapidly identify multiple strains during a terrorist attack allows for a more rapid criminal investigation. The portable electronic arrays for bovine and avian HC agents represent novel detection and typing technology to be used at the farm site. This ability would allow rapid testing and effective management in the event of a real attack or outbreak, and a minimum quarantine period for the farm in the case of a suspected but false outbreak.

Recent Progress and Results

The official start date of this project was January 2009. Three assays have been developed on the NanoChip 400 instrument: the bovine and avian HC assays, and the FMD strain identification assay.

For the bovine HC assay, primers for all seven target agents causing vesicular stomatitis, bovine viral diarrhea (BVD), infectious bovine rhinotracheitis (IBR), malignant catarrhal fever, rinderpest, bluetongue, and parapox complex have been incorporated into multiplex PCRs and detection probes have been designed and tested for all target viruses. Thirty-seven viral strains were successfully amplified and detected on the NanoChip instrument. The assay was also validated with clinical samples.

Screening and validation of both the AI neuraminidase (NA)-subtyping component, and the AI/NDV detection and NDV pathotyping component of the avian HC assay have been completed. For AI NA-subtyping, 42 AI strains representing all nine NA-subtypes have been successfully amplified and subtyped with the NanoChip instrument. A multiplex PCR was developed to amplify an AI-matrix (M) gene product for AIV detection and NDV-M and NDV-fusion (F) gene products for NDV detection and pathotyping, respectively. The project team successfully amplified 22 NDV and 42 AI strains using this multiplex PCR and all strains were correctly identified by detection probes, and in the case of NDV by pathotyping probes. A total of 124 clinical samples were used to validate the NA-subtyping component of the assay and 44 clinical and spiked samples were used to validate the NDV detection and pathotyping component of the assay.

For the foot-and-mouth disease (FMD) strain identification assay, 137 strain-specific probes to three or four highly variable genetic regions have been designed for selected strains representing all seven FMD serotypes. Also, 33 FMD amplicons have been tested with the strain-specific probes and all but two of the probes tested detected the target strain. Cross-reactions to non-target strains of the same serotype were occasionally observed, but the probe reactivity profiles of the strains across all sites could be used to differentiate even closely related strains.

Probes for all three assays have been tested on a new carbon electronic array that will be used with the new sample-to-answer instrumentation. Optimization of these assays on the new carbon electronic array and instrumentation is ongoing.

Impact

HC livestock pathogens are suited for terrorism because of the devastating effects both on the economy and on the public psychology in the event of an attack. If introduced into Canada's naive animal populations, these agents will have catastrophic consequences to the nation's agricultural industry. There is an urgent need for rapid on-farm testing by first responders, the District Veterinary Officers, in case of a suspected outbreak. Measures to promote vigilance among the producers themselves are needed, but cooperation of the entire community is more likely if quarantines are imposed for a minimal time in cases where the outbreak proves to be false. With on-site forensic testing, the quarantine period can be kept to a minimum. The electronic array technology developed for this project satisfies the requirements of portability and highly multiplexed detection needed to deal with the high-genetic variability of these viruses. The probes used in the assays are intellectual property owned by the CFIA.

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CRTI 07-0135RD

Building Resilience and Rural Health System Capability for Pre-disaster Planning and Preparedness

Project Lead:	Public Health Agency of Canada
Federal Partners:	Natural Resources Canada, DRDC Centre for Security Science, Agriculture and Agri-Food Canada – Rural Secretariat
Industry Partner:	Pearces 2 Consulting Corporation
Other Partners:	Justice Institute of British Columbia – Emergency Management Division, Royal Roads University

Objectives

In response to the social imperative for enhanced emergency planning in "forgotten communities," the project team, in consultation with partners and communities, will design, pre-test, and disseminate a suite of simple, user-friendly, and effective indicators, tools, and training materials for decision makers and practitioners to assess the capability and resiliency of rural health care systems and communities. The team will develop an integrated risk assessment, communication, and management framework to enhance organizational all-hazards response planning, along with a set of rural community resiliency indicators. The bilingual training curricula, tools, and web-assisted networks will provide rural, remote, and coastal communities in Canada with fully operational protocols and resources to anticipate and mitigate risks.

Relevance

In Canada and internationally, emergency planning and response investments for CBRNE and all-hazard events are generally directed to urban centres. However, intentional and unintentional attacks on humans and food and water supplies will directly impact rural, remote, and coastal communities. Additionally, CBRNE threats in urban centres will compromise rural, remote, and coastal health care infrastructure through loss of supply systems and personnel. Rural, remote, and coastal communities have a triple jeopardy: fewer professional and financial resources; less emergency measures infrastructure; and unique, long-term challenges, including "disasters in slow motion" created by geography, isolation, and demographics.

Recent Progress and Results

Using multiple primary and secondary data sources and by engaging community leaders and key partners, the research team will undertake needs assessments and pilot testing of curricula in diverse communities. Content and process will include enhancing the Gender and Disaster Network of Canada (GDNC); facilitating communication linkages among diverse networks in support of a collaborative network of networks (i.e., a virtual Community of Practice); and delivering web-assisted training, knowledge exchange, and capacity building to the five or more pilot communities.

The network of networks will include, but is not limited to, the GDNC, Ocean Management Research Network (OMRN), World Association of Disaster and Emergency Management (WADEM) International Psychosocial Task Force, Public Health Agency of Canada (PHAC) Psychosocial NEPAC Working Group, Canadian Risk and Hazard Network (CRHNet), Canadian Women's Health Network (CWHN), and will link to UN agencies, non-governmental organizations (NGOs), and government departments.

To guide the work of the Justice Institute of British Columbia (JIBC) and its partners, two expert reference committees will be convened, one on emergency management and one on knowledge translation. These committees will provide technology knowledge and will assist with quality control of educational products and internal peer review of project reports and publications. Key partners, consultants, and resource persons in this project include federal, provincial, and territorial (F/P/T) agencies; and numerous academic researchers in Canada and abroad—notably at the University of Canterbury in New Zealand, University of

Minnesota, University of Ottawa's McLaughlin Centre on Population Health Risk Assessment, and University of Ottawa's Institute of Population Health—and national and international NGOs such as GPI Atlantic and WADEM.

Deliverables achieved in the first year of project work include the literature review, project website, preliminary field data collection and coding, and inception of a steering committee, research workshops, and conference presentations at national and international events. The Literature Review Report will inform the development of a risk management framework and resiliency indices for two project deliverables, due June and September 2010. JIBC hosted the project inception meeting, including the project steering committee workshop in New Westminster in April 2009.

In November 2009, the Office of Applied Research and Centre for Aboriginal Programs, JIBC, convened a 40-person retreat to engage project partners and rural, remote experts from universities, NGOs, and government agencies to discuss resiliency in Aboriginal communities, research ethics, and protocols for community-based research and networking with rural and remote communities. Preliminary data collection is underway in several pilot rural, remote, and coastal communities within the interior of British Columbia and on Vancouver Island.

Impact

Ongoing citizen and partner engagement has proven to be both exciting and inspirational. A Natural Resources Canada research scientist recently joined the project team to collaborate on the Integrated Risk Assessment and Communication Management Framework, Rural Community Resiliency Index, and Virtual Community of Practice, thereby bringing together two CRTI projects.

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CRTI 07-0150TD
Casualty Care Continuum

Project Lead:	DRDC Ottawa
Industry Partners:	AMITA Corporation, CAM Emergency Preparedness, Correct Solutions, E-Privacy Management Systems Inc.
Other Partners:	British Columbia Ambulance Service, Canadian Red Cross, Queen Elizabeth II Hospital, Queen's University, Toronto Emergency Medical Services, University of Ottawa Heart Institute

Objectives

The primary focus of the Casualty Care Continuum (CCC) project was to improve incident response by providing better information to responders. Current systems have proven to be deficient in tracking casualties and providing accurate and timely information for decision makers at municipal, provincial, and federal levels. CCC addresses the challenges associated with casualty management, from the incident scene to the hospital emergency department. The seamless integration of event-related data provided by this project will create a continuum of care from the event scene to the emergency department.

One of the goals of this project was to refine the Rapid Triage Management Workbench (RTMW), developed under CRTI 0060TA, into a new system for unified casualty management. The steady stream of accurate information provided by RTMW will be available throughout all levels of care and ultimately improve outcomes through increased efficiencies, better internal situational awareness, and better communication with the public.

The CCC project followed a six-phase plan over two years. Phase 1 included project startup activities, such as contracting and the production of the project charter and project plans. Phase 2 included the deployment of the existing RTMW system with the British Columbia Ambulance Service and Toronto Emergency Medical Services. Phase 3 included the technology demonstration of the RTMW system. Phase 4 included the enhancement of RTMW to provide the unified casualty management system. Phase 5 included the technology demonstration of the unified casualty management capability and Phase 6 concluded the project with an evaluation of the CCC unified casualty management system and provision of completed response protocols. Beyond the project, the vision of the project team is that the collaborations established in CCC will form the nucleus of a consortium that will support this technology and promote its uptake across Canada.

Relevance

The CCC project provides a system solution for casualty tracking and casualty management for all-hazards events involving affected and non-affected members of the public. CCC also improves communication among responders and other stakeholders by providing a common access point for collecting and distributing casualty and other critical information, such as agent protective equipment and information resources about treatment and hazards. Additionally, the CCC solution supports crime scene attribution in situations where a person that caused an event is among the casualties. It captures when and where each casualty was entered into the system, the location where treatment was received, and the facility at which an individual is located. It also helps identify caregivers and other casualties who have been exposed by contact with a contaminated individual. With this casualty tracking capability, CCC will minimize event-associated distress.

Recent Progress and Results

Phase 1, project startup, was completed in April 2009. Deliverables produced by the team include the project charter, project definition, contracting activities, project plans, project success criteria, and project functional scope.

Phase 2, which involved deployment of CCC Release 1, was completed in December 2009. Deliverables included the first issue of the project newsletter; review of medical workflows; and

development, training, and deployment of Release 1 at the British Columbia Ambulance Service and Toronto Emergency Medical Services.

Phase 3, which involved a demo CCC Release 1, was completed in March 2010. Deliverables included the second issue of the project newsletter and technical demonstration exercises in Vancouver and Toronto.

Phase 4, deployment of CCC Release 2, and Phase 5, Release 2 Technology Demonstration, were completed in September 2010.

Phase 6, project close out is scheduled for completion in March 2011.

Impact

The CCC project simultaneously addresses several CRTI priority areas. It will have an important impact on both preparedness and response and speaks to the priority of establishing pre-emergency room and emergency room triage of people affected by CBRNE events. It enables the development of tools or techniques for immediate or onsite identification, diagnosis, or monitoring of effects caused by CBRNE events. It has also developed models, methods, techniques, and training tools to assist medical responders addressing a CBRNE event, and developed intelligence gathering and forensic methods, investigational tools, and technologies that support the detection, identification, and attribution of CBRNE hazardous material to source. The CCC project additionally addresses the emerging technology priority by integrating RTMW with radio frequency identification technology to track casualties.

The transition of CCC-RTMW from technology demonstration to marketable industry product is realistic. RTMW, the basis of the CCC project, is already in southeast Asia.

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CRTI 07-0176TD

National Standard for Design and Assessment of Buildings Against Blast

Project Lead:	Public Works and Government Services Canada – Real Property Branch
Federal Partners	Royal Canadian Mounted Police, Natural Resources Canada – Canadian Explosives Research Laboratory, Department of Foreign Affairs and International Trade
Industry Partners:	Canadian Standards Association, ABSG Consulting, Canadian Wood Council
Other Partners:	McMaster University, University of Ottawa, Carleton University, University of Western Ontario

Objectives

The objective of the project is to improve Canada's preparedness and prevention capacities through the development of a national standard for the design and assessment of buildings resistant to blast effects. The new Canadian Standards Association (CSA) national standard will provide both uniform methodologies for blast design and assessment, and the criteria for determining the blast resistance adequacy of new and existing buildings. The emergency management community can use the new standard to better prepare buildings against blast effects and to better prevent buildings from being exposed to blast threats.

Public Works and Government Services Canada (PWGSC) leads and manages the project. The CSA manages the technical committee for the development of the new standard. McMaster University manages the focused research in support of the standard development. Natural Resources Canada's Canadian Explosives Research Laboratory (CERL) is PWGSC's technical consultant and supports the focused research to be carried out by McMaster and Ottawa universities. The RCMP, the Department of Foreign Affairs and International Trade (DFAIT), and ABSG Consulting provide technical advice on technical and end-user requirements.

Relevance

The project addresses the need for uniform guidelines and codes in the methodologies used for assessment, and for criteria for the required levels of building safety against blast. The new national standard will address this gap by providing guidance on design and assessment requirements, including principles for establishing appropriate threat parameters and performance criteria, analysis procedures, and test procedures. Better design of buildings prepares Canada against blast events. More accurate vulnerability assessment of existing buildings will lead to more precise improvement to a building's performance, thus ameliorating disasters in the event of a blast.

Recent Progress and Results

The project has four parts: critical review of existing standards and codes on blast design and assessment of buildings; establishment of a CSA technical committee; development of the standard with the support of focused research; and training of end-users on use of the standard.

The critical review resulted in recommendations on: (a) the adequacy, feasibility, and advantages and disadvantages of adopting existing research results, guidelines, and standards, or parts thereof, for use in the new Canadian standard; (b) a preliminary outline of the new standard; and (c) a draft plan for the focused research in support of the standard development.

A new CSA technical committee for developing the new standard was established in fall 2008. Members include a balanced matrix of researchers, practitioners, regulatory authorities, and building owners and operators. The chair and vice-chair are members of this CRTI project team. Development of the standard began at the first committee meeting in September 2008. The plan is to have the standard ready for public review in the spring of 2011, for ballot by the technical committee in the fall of 2011, and for publication in the winter of 2012.

In support of the development of the standard, focused research is being carried out by McMaster University and Ottawa University, with support from CERL,

Carleton University, University of Western Ontario, and Canadian Wood Council. Technology transfer in terms of training sessions for end-users, including the RCMP, PWGSC, and DFAIT, on the use of the standard is planned for the summer of 2011.

Impact

Recent blast events have demonstrated the urgent need to protect buildings against extreme loads (such as blast), which are generally not considered by building codes. The urgent need would also include standardizing practices in the design and assessment of buildings against blast effects to ensure uniformity of levels of safety.

Development of the new CSA standard on the design and assessment of buildings against blast effects highlights the collaboration between designers, researchers, regulatory authorities, and building owners and operators, with the aim to improve Canada's preparedness and prevention capacities. The end-user community is well represented in the CSA technical committee. The impact on the end-user community can be demonstrated through the adoption of the new standard by various jurisdictions and the use of the new standard in the building industry. The leave-behind capacity of a national standard will focus on pre-event preparedness and the prevention of building collapse incidents.

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CRTI 07-0179RD

Explosive Vapors Stand-off Detectors—Multi-option Differential Detection and Imaging Fourier Spectrometer

Project Lead:	Public Safety Canada
Federal Partners:	DRDC Valcartier, Royal Canadian Mounted Police, Canada Border Services Agency
Industry Partners:	Telops Inc., AEREX Avionics, Montréal Port Authority
Other Partners:	Ville de Montreal – HAZMAT Division, Montreal Advisory Committee on Anti-Terrorism

Objectives

This project will develop leading edge infrared (IR) hyper spectral methods and sensing technology, and optimize it for the stand-off detection of explosive vapors and precursors. This will be accomplished through the development and construction of a Multi-option Differential Detection and Imaging Fourier Spectrometer (MoDDIFS) prototype. The technology will be validated through testing of the prototype both in laboratory conditions and under realistic scenarios recommended by end-users from law enforcement, intelligence, and security organizations partnering in the project.

The methodology for this project is based on the integration of two innovative technologies: the existing and proven differential Fourier-transform infrared (FTIR) radiometry technology developed by DRDC Valcartier, and the hyper spectral imaging technology developed by TelOps in order to create a novel prototype instrument, the MoDDIFS. The project will include development of a signature investigations and characterization library, target radiance models, calibration protocols, and related algorithms, polarization technique investigations, and extensive laboratory and operational field trials. The project will also deliver technical specifications and reports, experimental results, and engineering specifications for an advanced development model.

The primary objective of the project is to develop and demonstrate leading-edge IR hyper spectral sensing technology applicable to the passive standoff detection of explosive vapors and precursors. This will be accomplished through the development of a MoDDIFS prototype.

Relevance

The passive stand-off detection of vapors from explosives and precursors emanating from a targeted building or any other pre-identified location under surveillance is a capability that does not currently exist within Canada's security arsenal. This project will fill this major gap. It will have a major impact on operational and investigational capabilities for law enforcement and security and intelligence organizations for the prevention and surveillance against explosives and other CBRN events. This capability will provide early detection and warning of a person's or group's intent and its level of readiness to mount an attack with improvised explosives.

Recent Progress and Results

The DRDC Valcartier team has completed the identification and characterization of the material signatures and the algorithm pseudo code. The critical design review was held in September 2009. The MoDDIFS sensor is currently being fabricated and integrated.

Impact

This project will have multiple applications and uses, including assistance and support to counterterrorism, intelligence, and criminal investigations with significant impacts on preparedness and prevention of explosive-related events. It will bring forth a state-of-the art methodology for stand-off detection and identification of clandestine locations handling or preparing explosives, precursors, drugs, or chemical weapons.

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CRTI 07-0186RD

Optimization of Medical DECORporation (MEDECOR2) Tool for Time and Use for Improved Bioeffects

Project Lead:	DRDC Ottawa
Federal Partners:	Atomic Energy of Canada Ltd., Department of National Defence – Director General Nuclear Safety, Health Canada – Radiation Protection Bureau, Canadian Forces Health Services Group – Operational Medicine
Industry Partners:	SAIC Canada, RadSci Research Inc.
Other Partners:	Armed Forces Radiobiology Research Institute, Czech Republic University of Defence

Objectives

In a terrorist event involving dispersion of radionuclides, first responders and the affected public face the risk of internal contamination primarily due to inhalation of aerosolized radionuclides. Alternate routes of internalization may be through ingestion and wounding. These internalized radionuclides are a significant health concern because they damage cells and thus have an impact on long-term health. Presently, there are no prediction tools that would provide medical personnel with guidance on accrued health risks from inhaled radionuclides versus benefits of treatment. Moreover, the benefits from early treatment are poorly understood and treatment strategies would gain from the development of health physics models capable of accounting for radionuclide dispersion within and excretion from the body.

The aim of this project is to develop a field-deployable medical decorporation (MEDECOR2) management tool (model) that will provide treatment strategies for the removal of internalized radionuclides by optimizing gain and minimizing risk. The tool will recommend ideal risk-aversion strategies based on treatment times and dose savings. The model developed would be useful for inhaled radionuclides, but could also be applied to cases of imbedded shrapnel or oral ingestion.

Relevance

The MEDECOR2 tool, in combination with casualty estimation models, will assist preparedness planners in determining the resources required for casualty management and establishing stockpiles. The tool is also intended for use during a response to a radiological-nuclear (RN) event where there is potential for internal contamination. It will provide a means by which first responders and receivers can manage casualties by assisting in the determination of persons who: need immediate decorporation treatment to reduce dose; are contaminated with no predicted dose aversion from decorporation therapy; have minimal risk post-intake; and are not internally contaminated but require reassurance.

Recent Progress and Results

The project team is developing easy-to-understand models and algorithms to quantify time-dependent decorporation efficacy, committed effective dose estimation, and risk reduction for both radionuclide elimination and therapeutic drug initiation and termination.

This past September, MEDECOR2 was field tested at a military exercise for the Commander of Support Forces in the Czech Republic at the invitation of the project's international partner. The exercise involved training and demonstration of the software tool, which was then field-trialled by military personnel for its abilities to triage victims and determine appropriate treatment strategies following internal contamination scenarios. MEDECOR2 was very well received by the medical personnel and several useful recommendations were made to better the development of the tool.

In addition to the software development component of the project, animal studies are being done to help validate the outputs of the tool and provide supportive data for its evolvement. A pilot animal project examining the biosolubility and biodistribution of an inhaled radionuclide (Sr-85) followed by the efficacy of various decorporation agents is now underway at Atomic Energy of Canada Limited.

In addition to promoting this project at the Health Physics Society and Health Effects of Incorporated Radionuclides meetings, the project team was instrumental in successfully organizing a Medical Scan Workshop in May 2009 with the objective to enhance and improve product development and end-user uptake.

Impact

RN casualty management, a component of medical practice that is not routine, will benefit from easy, user-friendly access to treatment strategies for internal contamination in a mass-injury event. MEDECOR2 can ameliorate the medical community's present needs by generating appropriate responses to real events as well as live and tabletop exercises. The MEDECOR2 tool will be equally useful after nuclear weapon, improvised nuclear device, radiation dispersal device, or reactor accident events and will assist medical personnel with timely triage and treatment decisions for internally contaminated persons. It will be useful to a broad spectrum of professionals ranging from government agencies to emergency medical departments and nuclear power utilities with a resulting postive impact on RN casualties.

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CRTI 07-0190TA

Extension of Electronic Neutron Dosimeter to Detect Gamma Rays

Project Lead:	Department of National Defence – Director General Nuclear Safety
Federal Partners:	DRDC Ottawa, Department of National Defence – Canadian Joint Incident Response Unit, Department of National Defence – Combat Support Equipment Management, Canadian Nuclear Safety Commission, Canada Border Services Agency, Royal Canadian Mounted Police
Industry Partner:	Bubble Technology Industries Inc.
Other Partner:	Los Alamos National Laboratory

Objectives

In a radiological dispersal device (RDD) attack, many of the ensuing radiation hazards are expected to be from both neutrons and gamma rays. Since no existing neutron electronic pocket dosimeter (EPD) can provide accurate neutron dose estimates, the CRTI project "Development of an Electron Neutron Dosimeter" (CRTI 04-0029RD) was launched to address this technological gap. However, the prospect of wearing both an electron neutron dosimeter (END) and a conventional gamma EPD was deemed undesirable by end-users. The goal of the Extension of END to Detect Gamma Rays (END-2) project is to incorporate gamma detection capabilities into the original END to provide a more accurate measurement of the radiation field the end-user has entered.

This END-2 project will produce two devices that will undergo extensive testing. End-users and other partners will be providing ongoing feedback during the development and testing phases to ensure that the final device is suitable for their needs.

Relevance

This project addresses CRTI priorities by providing a reliable tool for monitoring the mixed radiation field present in the aftermath of a CBRNE event to ensure the protection of first responders. The END-2 will provide real-time, accurate dose information for both neutrons and gamma rays to allow first responders to function with full knowledge of their radiation burden at any time. This allows them to make risk-assessment judgments in the execution of their duties, both as individuals and as members of a team. END-2 fulfills a technological gap as well as an operational need in counterterrorism activities.

Recent Progress and Results

The END-2 project began in December 2008. Leveraging the technology developed under the END-1 project (CRTI 04-0029RD: Development of an Electron Neutron Dosimeter), Bubble Technologiy Industries (BTI) designed the END-2 laboratory prototype, achieving a five-fold reduction in device size based on volume. The size reduction was achieved while still maintaining excellent detection sensitivity relative to other available EPDs.

Following a design review by end-users, fabrication and assembly began at BTI. All components and subsystems were procured and integrated to develop the END-2 laboratory prototypes. The research team extensively tested these prototypes using radiation sources at BTI, as well as the Van de Graff accelerator at DRDC Ottawa. In-house testing on neutron dose performance, gamma dose performance, and operation in mixed fields was completed and two laboratory prototypes were delivered to end-users for testing. The END-2 laboratory prototype was tested at DRDC Ottawa and underwent independent testing at Los Alamos National Laboratory. These tests confirmed the excellent dose response in neutron and gamma fields, as well as accurate dose measurements in free air scenarios and on a lucite phantom. Based on the results of these tests, input was provided to BTI for incorporation into the design to ensure that the final END-2 field prototypes would meet the needs of end-users.

In March 2011, BTI plans to deliver two field prototypes, accompanied by BTI's test results. By the completion of the project in the fall of 2011, the field prototypes will be extensively tested by

DRDC Ottawa and end-user partners and test reports will be generated. The END-2 will provide a single, compact device that measures both gamma ray and neutron doses separately, as well as the sum of the two doses.

Impact

One of the CBRNE events of main concern is the detonation of an RDD (or dirty bomb). First responders who enter the contaminated area will be faced with radiation hazards from alpha, beta, and gamma rays, and neutrons. The END-2 device, which uses isotopes that emit both neutrons and gamma rays, will improve Canada's ability to respond to and recover from such attacks. The immediate and accurate dose readings and alarm features will ensure first responders can focus their attention on resolving the threat to the public, rather than being concerned about their own radiological exposure. The separate dose readings allow first responders to understand the type of RDD that is responsible for the radiological event, and the total dose provides information to help first responders keep their doses below the recommended limits, preventing an unacceptable health detriment in the execution of their duties.

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CRTI 07-0193RD

A Compton Gamma Imager for Criminal and National Security Investigation

Project Lead:	Natural Resources Canada
Federal Partners:	National Research Council, Royal Canadian Mounted Police, Public Safety Canada, Canada Border Services Agency
Other Partners:	McGill University, Toronto Police Service

Objectives

The objectives of this project are to design, build, and demonstrate a Compton gamma imager. This instrument will be capable of displaying an image of a radiation field overlaid on an optical image of the surroundings. The imager will be made from scintillator read out by sensitive photo detectors and associated electronics.

The project began with an extensive instrument design phase to evaluate and compare various scintillation materials and readout technologies. Two designs have been chosen which optimize detector performance at large stand-off distances while respecting the operational constraints of ruggedness, portability, and cost. Once the prototype imagers are built, their performance will be characterized in terms of image resolution and sensitivity. Finally, demonstrations will take place and procedures for deployment will be developed in consultation with the end-users.

Relevance

This project addresses the need for innovative detection technologies for use in intelligence gathering prior to and following a radiological or nuclear incident.

The imager is a stand-off detector with a design goal of obtaining positional accuracy of better than a few metres at a distance of 40 metres from the subject, within a minute. The imager will be able to delineate an extended source of radiation, and will be capable of revealing directions of multiple sources, in the presence of partial shielding. The imager will be portable and concealable. It will be able to provide investigators with concrete evidence of an excess of radioactive material over expectations, or of a change in radioactive material type, amount, or location.

Recent Progress and Results

The Compton gamma imaging technique relies on tracking the energy depositions of a gamma ray as it interacts with the scintillator within the detector. The difficulty in designing a Compton imager is to find a way to record the positions of each energy deposit without introducing a lot of dead material within the sensitive volume of the detector. Through simulation and experimental validation, we have established that we can meet the design aim with two very different approaches.

In one approach, a pixellated detector is composed of small blocks of scintillator each read out with a novel light collection device known as a silicon photo-multiplier (SiPM). In contrast to traditional photo-multiplier tubes (PMTs), the SiPMs are very thin and light – they have a thickness of about 500 µm when deposited on a glass substrate. This permits the SiPMs to be embedded within the detector without a large number of gamma scatters being induced in the photo-multiplier itself.

In the other approach, the scintillating radiation detector is fashioned into long rods read out with conventional PMTs—one at each end of each rod. In this design the dead material associated with the light collection device is moved off to the side of the detector. To obtain the position of the energy deposit along the rod, the attenuation of scintillation light within the rod must be precisely tuned by a surface treatment of the rod.

The designs are complementary—the rod design is much less expensive while the pixel design is anticipated to have performance benefits. Work on both has progressed to the stage where the specification of all components has been finalized and their procurement begun. Both the rod-based and the pixel-based imagers have been partially instrumented

with the currently available components and first images from these mini-prototypes will be presented at the symposium.

Impact

The project is expected to have considerable impact in facilitating surveillance operations. The imager will be able to display the locations of radioactivity in a graphic and intuitive form. It will be able to present the locations of strong and weak sources together in the field of view, and to identify different isotopes in the field of view. By rejecting counts from regions of the field of view not attributed to the target material, signal-to-noise can be improved for high sensitivity to a shielded source. This will allow investigators to discern benign material from threat material and will contribute to successful event interdiction.

The imager will also aid in consequence management through improving responder safety by showing the location of radioactivity—including distributed sources—before a contaminated area is entered.

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CRTI 07-0196TD

Towards an Operational Urban Modelling System for CBRN Emergency Response and Preparedness

Project Lead:	Environment Canada – Canadian Meteorological Centre
Federal Partners:	DRDC Suffield, Department of National Defence – Canadian Forces Base Halifax, Health Canada
Industry Partner:	Waterloo CFD Engineering Consulting Inc.

Objectives

The objective of this project is to transition a state-of-the-science urban flow and dispersion modelling system, developed under CRTI project "An Advanced Emergency Response System for CBRN Hazard Prediction and Assessment for the Urban Environment" (CRTI 02-0093RD), toward the status of a functional prototype operational system at Environment Canada's Environmental Emergency Response Section (EC-EERS), a government operations centre.

To achieve this objective, this project implements the following three principal components:

1. Provision of additional advanced modelling capabilities by incorporating features such as thermal effects in the building-aware urban flow and dispersion models, improvement of the urban parameterization schemes used in the mesoscale flow models, and development of techniques for fusion of CBRN sensor data with model predictions for source reconstruction.
2. Development of the required supporting infrastructure, including land-cover and land-use databases, 3-D building data, and CBRN source models.
3. Demonstration and exercise of the prototype system for a number of CBRN scenarios in different Canadian cities, including modelling in support of events of national significance.

Relevance

The development of this prototype operational urban modelling system fits well within CRTI's investment priorities. The ultimate goal is to develop a key enabling technology and capability, managed at a national government operations and resource centre, for CBRN planning, real-time assessment, and emergency response in Canada. The system could be used to generate unique CBRN operational dispersion modelling products and decision-support aids to allow decision makers and emergency response managers at all levels of government to make more informed decisions. The decisions are required to support a wide spectrum of CBRN-related activities, from pre-planning support to incident response to post-incident assessment.

Recent Progress and Results

The project started in fall 2008. Work in the past year has continued to focus on making improvements to the Computational Fluid Dynamics (CFD) building-aware flow and dispersion modelling and source reconstruction components, as well as to the urbanized meteorological model, and installing and testing the prototype within EC-EERS.

The urbanEU and urbanAEU modules have been integrated into the enhanced urbanSTREAM system. This enhanced system includes modelling of the radiation component. Validation of this enhanced system was done against IOP-6 and IOP-9 data from the June 2003 experiment in Oklahoma City. The integration of urbanSOURCE into the enhanced modelling system is in progress.

Work has advanced on improving the urbanized meteorological model and, in particular, the parameterizations within the Town Energy Balance (TEB) scheme of the model. TEB will benefit from an improved snow model and from the inclusion of vegetation effects in TEB canyons. Work is underway to incorporate TEB in the latest version of the Global Environmental Multiscale Limited Area Model (GEM-LAM) model. These three improvements are almost completed. Modifications were done to improve coupling between urbanGEM and urbanSTREAM. Also, improvements to the vertical refinement of meteorological variables in the urban canopy and surface layer will allow an even better coupling.

After running the prototype urban modelling system in a quasi-operational mode during the 2010 Winter Olympic and Paralympic Games in Vancouver, the prototype was applied over Toronto to support the G8 and G20 meetings in June 2010. The prototype was run from the end of June to the end of August 2010 for a total of about 70 integrations. Modifications to the prototype following the Vancouver Games resulted in a much more stable configuration. The completion rate went from 14 percent during the Olympics to 44 percent during the Paralympics to 92 percent during the G8 and G20 meetings. Application of the system to a new city was successful, but required many modifications. A technical report describing these experiments is available. Acquisition of new building databases for other Canadian cities is on-going.

A fruitful meeting with users was held at the Canadian Meteorological Centre (CMC) in November 2010 to consider the best way forward to integrate the system into the national emergency response framework. The source of the numerical problem associated with "negative TKE" profiles at inlet planes reported by CMC has been identified and fixed.

Project members gave presentations on the urban modelling prototype at the 2011 Annual Meeting of the American Meteorological Society in Seattle, Washington, at the 9th Symposium on the Urban Environment in Keystone, Colorado, at the ITM NATO/SPS International Technical Meeting on Air Pollution Modelling and its applications in Turin, Italy, and at the Annual DND CBRN Defence Workshop in Kingston.

Impact

The project aims to develop an operational prototype modelling system for use within a government operations centre. This development will provide an integrated, multi-scale capability for the real-time prediction of the urban dispersion of CBRN materials released in a major Canadian city. The tool will improve the effectiveness and efficiency of emergency response in major Canadian cities by providing timely information on the evolution of a plume of hazardous CBRN material. The system will also allow for prediction of consequences associated with release of CBRN materials, and can be used to support pre-event planning and post-incident analysis, making it useful in both a real-time situation, as well as for emergency preparedness and prevention. Impact on the user community has been demonstrated by using and testing this system in exercise planning (e.g., 2010 G8 and G20 Summits), formulation of simulation scenarios for training purposes, and development of the capability to evaluate and execute effective real-time responses to CBRN hazards. The project team will put an increased emphasis on the user community over the coming year.

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CRTI 07-0234RD

Mitigating Dissemination of Bioterrorism Agents in Canadian Food Systems

Project Lead:	Agriculture and Agri-Food Canada
Federal Partners:	Canadian Food Inspection Agency, Public Health Agency of Canada, Health Canada

Objectives

The objective of this project is to demonstrate a systems-based approach for the assessment of vulnerabilities to threats directed at food commodities. The approach involves mapping the dissemination of the commodity along geographic and temporal planes, and developing appropriate mathematical tools to predict the probability of threat survival and dispersion at discrete stages and along the farm-to-fork chain. The approach will be validated through a comprehensive study of fresh-cut lettuce, a widely distributed commodity amenable to the dissemination of infectious microorganisms.

The research incorporates

- compilation of nationwide data on production, distribution, processing, and retailing chains;
- development of a geographical information systems (GIS)-based tool to enable mapping the origin, transportation routes, and ultimate destination of fresh-cut lettuce in Canada;
- design of an expert system to identify sampling strategies that accommodate a range of contamination scenarios; and
- field and pilot plant-based experimentation to enable accurate modelling of the fate of viral, bacterial, or parasitic threats along the farm-to-fork chain.

Relevance

The project will directly address gaps in food-related risk, threat, and vulnerability assessment, and in the development and validation of model systems needed to maintain the safety and security of the food supply against disruptions resulting from contamination. Hence this work will strengthen Canada's ability to anticipate, prepare for, and respond to threats to the security of the food system, and provide enhanced ability to perform systematic determination of Canada's food-system vulnerabilities and risk assessment.

Recent Progress and Results

Surrogates for four broad classes of potential microbiological threat agents were selected for the generation of models on threat behaviour, including viruses (Murine norovirus 1), parasites (*Eimeria papillata*), Gram negative bacteria (*Escherichia coli O26*), and bacterial spores (*Bacillus atrophaeus*). Methods are under development to optimize the separation and concentration of each microorganism to maximize efficiency of recovery and sensitivity of detection from bulk soil, water, plant tissue, and surface (i.e., stainless steel) samples.

A prototype expert sampling system was designed to formalize strategies and most informative analytical plans required to address the range of sampling environments under consideration. Decision-tree algorithms, built upon the inputs, variables, and databases to select and prioritize analytical methods and to predict sampling plans needed to address specific scenarios, were designed using decision-making software (i.e., Analytica™).

The process is underway for identifying lettuce production zones and quantities or volumes produced, the source and points of entry for imported raw material, the location of lettuce packing or processing plants and quantities processed, the location of produce wholesalers and distributors, the lettuce volumes distributed, the territory covered by each distributor, the time frame of lettuce distribution in each sector of the territory, and the location of points of sale. Flow charts showing the distribution of lettuce from domestic production or import sources through each stage of the farm-to-fork chains have been initiated for the various regions (i.e., British Columbia and Prairies, Ontario, Quebec, and Atlantic Canada). Several sources of data are being exploited to this end, including databases on Canadian production from Agriculture and Agri-Food Canada and the Agriculture Census conducted by Statistics Canada. Data on produce packing, processing,

wholesale, and distribution operations are obtained from Statistics Canada and the private sector, including relevant industry associations.

Impact

The enhanced risk assessment and modelling capabilities implicit to the approach will immediately benefit all stakeholders tasked with the identification and resolution of vulnerabilities across the entire food chain. It will facilitate simulation exercises by improving the accuracy of predictions concerning the dissemination of threats, information that is essential to facilitate response planning by determining appropriate points of interception and containment against complex contamination scenarios. It will also be applicable to sector-based prevention and preparedness strategies, specifically to facilitate the tracing of contaminated foodstuffs or to address disruptions in supply chains. The approach will be transferable to other commodity sectors, requiring only the assembly of needed databases and minor modifications to the predictive tools to suit specific requirements. A similar tactic can be envisaged for the development of strategies to deal with any threat agent, following modifications to the predictive tools that would take into account the level of risk, impact, and differences in threat decay rates.

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CRTI 08-0105RD

The Canadian CBRNE Recommended Equipment List

Project Lead:	DRDC Suffield
Federal Partner:	Canadian Police Research Centre
Industry Partner:	Patriot CT Services
Other Partners:	Canadian Emergency Management College, Canadian Standards Association, Canadian Association of Chiefs of Police, Canadian Association of Fire Chiefs, Emergency Medical Chiefs of Canada, Canadian Police Association, International Association of Fire Fighters — Canada, Paramedics Association of Canada, Association of Canadian CBRNE Technicians, United States InterAgency Board

Objectives

This project brings a committee of Canadian experts together to develop a CBRNE Recommended Equipment List (REL) for frontline emergency response agencies. The committee includes designates from the chiefs and membership associations of Canadian police, fire, and emergency medical services, along with representatives from standards and training institutions, and expertise relative to public safety and security S&T.

Relevance

The REL is an imperative for enabling Canadian response organizations to achieve risk reduction through the use of capability-based planning. Response organizations will be able to analyze what equipment they should have available to deal with CBRNE terrorism using the Canadian resource type criteria established by first responders as a CRTI Forensics Cluster activity. The REL cross-references training and standards related to technology and equipment so that it facilitates building both appropriate and comprehensive capabilities.

Recent Progress and Results

This project builds on CRTI investments over the last two years that have led first responder organizations towards using risk analysis and capability building as cornerstones for resource allocation and prioritizing S&T requirements. The CRTI Forensic Cluster has experimented with the National Incident Management System (NIMS), developed by the US Department of Homeland Security (DHS), and its methodology for resource typing, targeting capabilities, and building essential task lists. The Cluster has adapted 37 resource types from NIMS to Canadian conditions and refined the associated target capabilities and universal task list. This project will build on CRTI investment by developing a REL that correlates equipment, technology, training, and standards to those precise resource types and target capabilities.

The output will be new knowledge and a new knowledge product. The work of the committee and the ultimate production of the list are the key research activities. The research will be performed using recognized international standards development practices that include an inclusive approach, public review, and decision by consensus. The expert committee of approximately twenty-five people will meet 10 times over the two-year life of the project to create the REL. The Canadian list will be loosely based on the US InterAgency Board experience in producing their Standard Equipment List in 2008.

Impact

The REL is a foundational knowledge product required for all Canadian emergency first responder organizations to identify local vulnerabilities, conduct comprehensive risk assessments, identify and fill gaps in their current capabilities, and prioritize allocation of resources with a view to risk reduction. The REL will be used in planning and procurement to achieve standardization and interoperability, to enhance responder safety, to ensure compliance with standards, and to plan training cycles. The exercise of building the REL will also identify CBRNE technology that needs to be tested and evaluated professionally by the S&T community.

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CRTI 08-0112TA
Human Monoclonal Antibodies Against Ricin

Project Lead:	DRDC Suffield
Federal Partner:	Canadian Forces Health Services Group
Industry Partners:	Cangene Corporation, Canada West BioSciences Inc.

Objectives

The goal of this project is to develop and produce purified effective humanized antibodies that can protect victims of ricin exposure without ill effects.

The following milestones will be sequentially completed:

1. Mouse hybridomae will be created. Clones expressing exceptionally potent anti-ricin antibodies will be selected and developed further (DRDC Suffield);
2. The genetics of these anti-ricin antibodies will be modified from mouse to human (DRDC Suffield, Canada West BioSciences Inc.); and
3. Human anti-ricin antibodies will be produced (Cangene Corporation) and the product's efficacy confirmed (DRDC Suffield).

Relevance

Ricin is the toxin in beans of the castor plant (Ricinus communis). A single bean has enough toxin to kill 1-10 people. Worldwide, one million tonnes of castor beans are grown annually for oil lubricants and livestock feed.

Ricin is a probable terrorist threat; incidents have occurred in the USA, UK, and France. The only medical countermeasure is sheep anti-ricin antibody for UK emergency use. Animal antiserum against ricin can be made, but the literature suggests that as high as 86 percent of human casualties receiving animal proteins may experience "serum sickness." There is also the possibility that first responders receiving more than one dose of animal antibody as a preventative measure could go into anaphylactic shock.

This project will create human anti-ricin antibodies to protect first responders prior to entering an incident site, or while rescuing casualties shortly after ricin exposure.

Recent Progress and Results

The following progress has been made: A mouse anti-ricin monoclonal antibody (mMcAb) from a previous study was characterized with commercially available kits. It was unidentifiable, found not to be IgG, IgM, IgA, IgE nor IgD. When confronted with a novel threat, the body may produce novel antibodies.

Mice were vaccinated with increasing amounts of ricin and from their spleen cells monoclonal hybridomae were created.

All milestones are ahead of schedule. Intellectual Property concerns prevent disclosure of results until patents have been filed.

Contract negotiations are underway for Cangene Corporation and Canada West BioSciences Inc.

Impact

A medical therapeutic (i.e., humanized anti-ricin antibody) is being developed to protect first responders when entering a high-consequence event involving ricin toxin, and rescuing casualties shortly after exposure.

There is the possibility that, instead of moving a patient to a hospital to receive the therapeutic, a small dose could be given immediately on site. Discussions with first responders suggest that, by having access to a medical countermeasure against the toxin, they would be more willing to enter an incident site and would be less distracted or stressed in the performance of their duties. But perhaps the greatest benefit to public safety and national security may be that the availability and efficacy of the medical countermeasure discourages the terrorist from ever using ricin as a weapon.

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CRTI 08-0173TD

Nuclear Forensic Lab Interoperability and Criminal Investigation

Project Lead:	Health Canada
Federal Partners:	National Research Council, Royal Canadian Mounted Police, Royal Military College
Other Partners:	Laval University, New Brunswick Laboratories, Argonne National Laboratory, Federal Bureau of Investigation

Objectives

The primary objective of this project is to develop and validate reference materials and procedures for nuclear forensics laboratories that will ensure laboratory interoperability for the measurement of radiochronometers. The radiochronometer reference material to be investigated includes cobalt/nickel, cesium/barium, and strontium/zirconium. The methodologies and procedures developed in this project will adhere to the stringent laboratory quality requirements needed for the admissibility of scientific evidence in a court of law for criminal investigations.

The focus of the radiochronometer development will be on cobalt/nickel, which will be developed by Canadian partners, and cesium/barium, which is being led by US partners. The feasibility and initial method development of the strontium/zirconium radiochronometer will be investigated by Canadian partners.

The information and knowledge generated from the project will link into the Argonne National Laboratory's Nuclear Reactor Database, a highly relevant and important resource for nuclear forensic attribution.

Relevance

Within the nuclear forensics laboratory community, there is a lack of interoperability in terms of the consistency of analytical results produced. This has been demonstrated through a number of exercises held in the US and Canada. This gap requires specific measures in order to obtain a level of consistency and harmonization across the nuclear forensics laboratory community.

An important tool and capability for nuclear forensics science is the ability to provide data on an illicit source, such as the dates of source production, purification, or origin. Very accurate data in this area can then be coupled to other pertinent source information to allow for material attribution. The process of elucidating the date of production or purification of an interdicted illicit source is through radiochronology, or the elemental ratio determination of the radioactive component and a daughter product.

Currently, there is a lack of reference materials that specifically address nuclear forensics attribution. The nuclear forensics community needs radiochronometer reference material, which would be used to ensure measurement traceability, validation, and instrument calibration. The development of new radiochronometer reference materials would address a critical shortfall in the evaluation of measurement techniques used by the laboratories, as well as provide the tools to constrain the measurement accuracy and uncertainty. These factors play a critical role in forensic cases that are presented in a court of law.

Recent Progress and Results

Laboratory methods are being developed to accurately measure the ratio of a cobalt/nickel and cesium/nickel radiochronometer. Validation of these methods will occur through a round-robin test with participating Canadian and US laboratories. The verified protocols will be approved by the international working group for forensic analysis of radiological materials.

Impact

Nuclear forensic laboratories will be able to attribute an illicit source so that the results would be admissible in a criminal case. The production of radiochronometer test materials by a national metrology institute will allow nuclear forensic laboratories to deliver scientific evidence that meets the requirements for a criminal investigation.

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CRTI 08-0176RD

Enhancing Resilience Among High-risk Populations to Maximize Disaster Preparedness, Response, and Recovery

Project Lead:	Public Health Agency of Canada
Other Partners:	University of Ottawa, Canadian Red Cross, Government of Nova Scotia – Department of Community Services, Carleton University

Objectives

This project is developing new knowledge on essential elements of resilience-oriented intervention programs to enhance preparedness for, response to, and recovery from CBRNE events or natural disasters. EnRiCH (Enhancing Resilience and Capacity for Health) is a community-based, participatory action research project, which is using a function-based approach to design, implement, and evaluate interventions in three target communities in Canada. The project is divided into five phases: an environmental scan; development of a prototype tool for identifying strengths, assets, and vulnerabilities; implementation of interventions in three communities; evaluation; and dissemination of findings.

The environmental scan and user needs assessment, and development of the prototype tool have been completed. The design and implementation phases for the community resilience-oriented interventions will be completed in 2012. The evaluation and dissemination phases will be ongoing until the project is complete in March 2013.

Empirical evidence has already been established as part of the project to assist in evaluation of the effectiveness, appropriateness, and feasibility of community mobilization interventions designed to mitigate social risk among high-risk population groups, using a community-based participatory research design.

Relevance

Resilience is a central component influencing disaster response and recovery. It is a dynamic concept that can be enhanced with appropriate support mechanisms before, during, and following a disaster. Ideally, the supports offered during recovery enable individuals and communities to improve their pre-disaster capacity to resist the negative impacts of any future disaster.
Disasters impose disproportionate impacts on marginalized and otherwise high-risk groups. Identification of high-risk groups and their unique disaster support needs is limited when simple demographics are available (e.g., assuming all elderly people are vulnerable based on their age). It creates over-generalization by assuming all people in a given demographic are vulnerable. Instead, an emphasis on strengths, as the basis of resilience and in relation to vulnerabilities, is preferable. This is the underlying assumption of a function-based approach, where support needs are classified according to the type of functional limit experienced by an individual, rather than a label associated with a specific condition or the general term “special needs.”

Tangible tools are essential for emergency managers, first responders, and community organizations to identify strengths and vulnerabilities in their communities. Manuals and other intervention resources resulting from this project will be readily accessible to end users so they can tailor interventions, build networks, and implement them in their own communities. The comprehensive evaluation will provide detailed information about the key elements to include in resilience-building interventions, as well as the challenges and barriers end users may encounter during the process of implementation. The lessons-learned sections of the manuals and summary reports will provide stakeholders with critical information regarding the use of community-based participatory practices when implementing mobilization intervention initiatives.

Recent Progress and Results

This project began in January 2010. To date, the research team has completed an environmental scan of resilience-oriented support programs, conducted needs assessments in each of the target communities, and developed a prototype tool for identification of high-risk populations. The EnRiCH Project Advisory Panel, which consists of approximately 30 stakeholders across Canada, is preparing to meet for its second annual meeting to guide the next steps for the project and disseminate

information about the completed phases. Next steps for the EnRiCH project include design, implementation, and evaluation of the interventions.

Impact

The intervention in each target community is being designed using a community-based participatory approach, in which active consultation with representatives of the target population is a central requirement. This element of the project facilitates buy-in within the communities, and encourages ownership by stakeholders.

The interventions are being evaluated for comprehensive examination of the benefits and challenges throughout each phase of design and implementation. Significant impacts include the expansion of pre-event capability through the development of a prototype tool for emergency managers to identify high-risk groups and map community resources. The structure of the project (e.g., key-informant interviews, focus groups) has created opportunities for academic and response organizations to meet stakeholders in multiple communities and disciplines. Within communities, the interventions will provide a hub for formal and informal community leaders to network. In addition, dissemination activities will provide opportunities to meet stakeholders from multiple sectors, and establish new collaborations to implement the interventions in other communities, or develop new initiatives to further the research agenda and strategic actions toward more resilient populations.

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CRTI 08-0181TD

Detection and Identification Assay Validation Program for Biothreat Agents

Project Lead:	Public Health Agency of Canada
Federal Partners:	DRDC Suffield, Canadian Food Inspection Agency, Health Canada

Objectives

The rapid identification or exclusion of biothreat (BT) agents in a terrorist event or natural outbreak is dependent on adequate detection methods for successful consequence management. The Canadian S&T community has developed a number of detection and identification assays since 2001, but these have not been fully assessed with respect to assay performance characteristics, nor have they been adequately validated or produced with appropriate quality control and quality assurance standards. This project seeks to address these gaps so that the assays can be put into widespread use, including in public health laboratories, mobile field laboratories, and federal defence laboratories.

Relevance

The Public Health Agency of Canada (PHAC) is leading the development of the Canadian Laboratory Response Network (CLRN), a network of public health, animal health, and food safety laboratories. This project will ensure that the assays deployed in the network will be actionable: that is, a positive result in one of these tests will lead to the activation of emergency response plans, the release of medical countermeasures, and, if there is a credible terrorist threat, the instigation of a criminal investigation.

Supplying the network with high-quality assays, the production and provision of which is under domestic control, is a key aspect of the public security science response to bioterrorism. As important as positive identification, the rapid and accurate exclusion of "non threats" releases assets and infrastructure to address real issues and allows citizens to be reassured and get on with their lives. The consequence of not thoroughly validating these assays is a failure in use, which could turn a crisis into a disaster.

Recent Progress and Results

The project partners have assays for bacterial Category A BT agents developed within intramural programs and previous CRTI projects. These assays, along with other available assays, will be evaluated and validated to produce detection protocols suitable for mobile deployment and high throughput laboratory diagnostics. The project team has preliminarily identified *Bacillus anthracis* (anthrax), *Yersinia pestis* (plague), *Francisella tularensis* (tularemia) and *Clostridium botulinum* toxin (botulism) as the target BT agents. These assays will be validated for use in the CLRN and the project will also develop and test the pathway to achieve this transition with new assays in the future. At the conclusion of this project, the team will have rapid, sensitive, and specific assays of known performance in federal and provincial laboratories across the country.

Impact

A disseminated network of laboratories working with standardized protocols and using common materials of known and validated performance is a necessary component for

- the reliable identification of BT agents;
- the ability to improve the timeliness of response and quality of service to the law enforcement, public and animal health, and food safety communities; and
- successful prosecution.

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Project Lead:	National Research Council – Institute for Information Technology
Federal Partners:	DRDC Valcartier, Health Canada, Public Health Agency of Canada
Industry Partners:	AMITA Corporation, SilvaCorp, Khaled El-Emam Privacy Analytics Inc.
Other Partners:	University of Ottawa Heart Institute, Ottawa Public Health, Carnegie Mellon University – School of Computer Science, Ontario Agency for Health Protection and Promotion, Queen's University – Public Health Informatics, Michigan Department of Community Health, Grey Bruce Health Unit, Ottawa Hospital – Department of Infectious Diseases and Infection Control

Objectives

The goal of this project is to make it possible for responders to adapt existing surveillance technology to new situations. The project will develop software and adaptive process frameworks that will give responders and decision makers easy access to state-of-the-art data fusion (DF) technology, and make it possible for them to design and deploy domain-specific DF-surveillance solutions. Two prototype DF-surveillance applications will be built to detect serious in-hospital disease outbreaks, and conduct surveillance of events related to substance abuse.

Other objectives of the project are to design a proof-of-concept software framework to implement DF-surveillance applications; to develop a prototype chemical, biological, radiological, nuclear, and explosives (CBRNE) situation analysis and monitoring station and a reusable user interface with visualization; to produce privacy and confidentiality standards for DF-surveillance systems and a strategy to promote the deployment of this technology beyond the project; and to test the prototype applications with end-users and document the software frameworks to facilitate re-use. The results of this project will be incorporated into ongoing work in DF at DRDC and ongoing work on human-computer interface and text-mining at the National Research Council (NRC).

Relevance

This project combines DRDC's expertise in situation analysis monitoring and data fusion with that of the other team members to develop a service-oriented CBRNE threat detection and monitoring framework that will allow responders to implement advanced risk cataloguing, modeling, and visualization solutions that effectively address threat proliferation monitoring. Two scenarios and prototype systems are developed that address specific gaps not covered by existing systems. These systems are highly relevant to the detection of both bioterrorism and naturally occurring disease outbreaks. Technological development will focus on DF, supporting decision-making processes, allowing efficient human-system interactions, and moving electronic threat monitoring into its next stage of development.

The DF-surveillance system concepts developed in this project will allow responders to rapidly evaluate potential threats, respond appropriately to incoming alerts, and permit analysts to explore relationships between data streams, and thus enhance their ability to extract relevant features from the environment. This project leverages the knowledge of all project partners to develop a statistical threat monitoring capability applicable to multiple domains of risk. Formalizing the steps needed to combine DF-surveillance capability with risk domain expertise directly addresses DRDC CSS priorities, and will promote public confidence and trust by providing new sources of credible information relevant to CBRNE risk.

Recent Progress and Results

Project contracts were put in place in early 2010 and Phase 1 and 2 activities, including project definition and detailed project planning, were completed. Phase 3 activities including functional requirements definition and determination of the technical approach have been completed in 2010. Phase 4 is underway with the software architecture and framework completed and

data acquisition for Application #1 in process. Phase 4 is scheduled for completion during the first quarter of the 2011–2012 fiscal year. Data Acquisition has focused on accessing de-identified health information from Kingston hospitals and this is near completion. Additional data sources at University of Ottawa Heart Institute are being explored.

Impact

This project will provide evidence of a flexible and accurate surveillance technology addressing critical problems facing end-users of current systems: insufficient data; inability to integrate multiple data streams; and difficulty managing false positive signals. The goal of DF-surveillance is to process the right information, put it in the right format, and provide it to end users where and when they need it for critical decision making. The project results will include an adaptive process framework that permits the integration of multiple data sources, and its reapplication for multiple uses. This project is based on the end-user enthusiasm and "pull" generated by Ottawa Public Health, Health Canada, and infectious disease specialists at the Ottawa Hospital. The technology and capabilities this project will develop will also be incorporated into ongoing DRDC work aimed at meeting the needs of Canada's military forces.

The project will leave behind a concept, validated in a relevant environment, for a capability to provide responders with DF-surveillance systems that will allow them to more accurately monitor high-risk situations. In the event of a positive signal, responders will have the information they need to discriminate true from false positive alerts, to respond immediately and accurately to the former, and to reject the latter quickly and efficiently. At a higher level, this capability will allow decision makers to rapidly develop and deploy DF-surveillance solutions tailored to monitor high-priority threats.

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CRTI 08-0192TD

Emergency Resource Inventory Network

Project Lead:	Public Safety Canada
Federal Partners:	National Research Council, DRDC Valcartier, Environment Canada
Industry Partner:	AMITA Corporation
Other Partners:	Carleton University, New Brunswick Department of Public Safety, City of Richmond, Canadian Association of Fire Chiefs, Emergency Medical Services Chiefs of Canada

Objectives

Experience illustrates that the lack of easily accessible and comprehensive lists of emergency assets results in delays and inefficiencies during crisis. The Emergency Resource Inventory Network (ERIN) will provide expeditious access to a comprehensive inventory of response assets, such as emergency response teams, facilities, resources, training facilities, and contractors. ERIN will provide a sustainable response by assisting responders, planners, and decision makers in locating and accessing emergency equipment during surges. Real-time access is available to all resources, assisting in assessing vulnerabilities, planning, coordination, and synchronization of response and recovery. Ultimately, ERIN houses emergency "capability" and will be at the core of CRTI's future priority of capability-based planning (CBP). ERIN's inclusion of standardized resource definitions (detailing minimum levels of service, training, and equipment for different jurisdictions based on population, vulnerability, and critical infrastructure) will have positive outcomes for resource management, CRTI investment planning and priorities, and statistical audits of emergency response structures.

This project involves the production and field testing of a bilingual, open-architecture database application accommodating a national inventory of CBRNE and all-hazards emergency resources of over 50 municipal, provincial, territorial, and federal response agencies. The database will be server-based and Internet-accessible with tiered-security access. ERIN will house a complete automated directory of targeted capability lists and resource typing references that will permit "owners" to self-update as they acquire additional resources.

Relevance

The merit of an ERIN-type tool for enhancing preparedness, response, and recovery to CBRNE or all-hazards type incidents has been realized by the US Federal Emergency Management Agency (FEMA). FEMA uses a similar product called the Incident Resource Inventory System (IRIS), which has been used in the US during several natural disaster emergency responses and has been praised as having significantly strengthened the US management of resources. IRIS is not transferable to Canada and is not in both official languages, but does represent the form and function of the Canadian emergency response community.

Currently, there is no national automated system in Canada for municipal, provincial, and federal emergency response stakeholders to list, access, type, or coordinate emergency CBRNE or all-hazards response resources. The creation of ERIN will meet an urgent requirement and involve collaboration with experts in IT solution design, international responders, and multi-agency end-users and emergency management organizations at all levels of Canadian government.

ERIN will enhance the municipal, provincial, and federal inter-agency and organizational capability to identify, mobilize, and dispatch emergency resources in response. It will have positive pre-event impact as it enables the establishment of readiness metrics to measure progress in developing municipal, provincial, and federal response capacity and a system for assessing Canada's overall capability to respond to all hazards, especially acts of CBRNE terrorism.

Impact

ERIN will be a foundational piece for Canadian CBRNE response organizations, replacing current operational practices that use written records and non-interactive databases to conduct risk assessments, identify capability gaps and vulnerabilities, avoid duplication, and prioritize allocation of resources with a view to risk reduction. It will be used to plan and procure, achieve standardization and interoperability, enhance responder safety, and plan training cycles. ERIN will offer a means to activate a timely and resource-appropriate response by Public Safety Canada that is currently non-existent.

The “leave-behind” versions of ERIN and availability of the software and online training to all emergency response stakeholders will significantly improve CBRNE and all-hazards preparedness, prevention, and response in Canada. At the conclusion of a successful demonstration, ERIN may remain as production sites in Montréal and New Brunswick, along with uploaded data collected in recent local CBP projects.

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CRTI 08-0203RD

Science and Technology Solutions to Mitigate Vulnerabilities in Canada's Food Supply

Project Lead:	Canadian Food Inspection Agency
Federal Partners:	Public Health Agency of Canada, Health Canada
Other Partners:	University of Guelph, Michigan State University, US Homeland Security – National Center for Food Protection and Defense, US Food and Drug Administration

Objectives

This project has three main objectives: 1) develop novel improved sample preparation methods for concentrating *Bacillus anthracis* (anthrax) and *Clostridium botulinum* (botulinum toxin) in food matrices such as milk, juice, bagged salads, processed meat, and bottled water; 2) assess different technologies (SmartCycler, LightCycler480, PyroMark, and EzyBot) as rapid, improved, detection and identification systems; and 3) deliver standard operating procedures (SOPs) and validated protocols.

The Canadian Food Inspection Agency (CFIA), Health Canada, and the University of Guelph, in collaboration with Michigan State University, will work to develop improved methods for sample preparation and concentration of anthrax spores and toxins from food matrices to enhance the sensitivity of down-stream detection technologies. CFIA, Health Canada, and the Public Health Agency of Canada will assess the detection platforms for the specific detection and identification of anthrax and toxins in food. The US Food and Drug Administration and US Homeland Security National Center for Food Protection and Defense will provide expert advice on food security.

Relevance

This project is relevant to the CRTI priority of safety of the food system and will lead to the development of detection technology platforms for rapid and accurate identification of anthrax spores and botulinum toxin. These tools will allow for the rapid, specific, and sensitive screening of biothreat agents in food. The ability to rapidly identify an agent during a terrorist attack may reduce response time and minimize the impact on public health.

Addressing the science and technology (S&T) gaps will enhance Canada's capability to respond to natural, accidental, or deliberate contamination of the food supply involving these biothreat agents.

Recent Progress and Results

Work has been successfully completed on the development and optimization of the tangential flow filtration system for the recovery of *B. anthracis* spores in artificially contaminated bottled water, juice, and hot dogs. Work is ongoing to optimize fabrication of electrospun polymer fibers and to immobilize aptamers and antibodies on the fibers for the efficient capture of botulinum toxins. Additionally, work is underway to develop a method to capture and detect *B. anthracis* spores using immobilized phage specific for *B. anthracis*. Monoclonal antibodies to botulinum toxin were used to coat magnetic beads and have been successfully used to capture, concentrate, and detect botulinum toxin in fruit juices, carrot juice, and bottled water.

The use of nano immuno-magnetic capture methods for concentrating *B. anthracis* spores from food has been successfully demonstrated. The development of a pyrosequencing assay using the PyroMark to detect and identify *B. anthracis* through single nucleotide repeats sequence analysis is ongoing. Some of these preliminary results have been or will be presented at upcoming international conferences.

Impact

The project will lead to the development of tools that will enhance Canada's preparedness in the event of natural, accidental, or deliberate contamination of the food supply involving anthrax spores or botulinum toxin. The potential application of the detection tools at food processing sites could provide a capability for enhanced surveillance and an early warning system of contamination involving biothreat agents. The methods developed will provide a rapid response

system to identify acts of malicious biocontamination of food products. The development of robust detection tools, such as the SmartCycler and EzyBot systems, will provide field deployable detection capabilities. The detection technology platforms could aid in the recovery from contamination events affecting food processing and distribution establishments after decontamination of affected sites. These detection tools may have an added potential application for the detection of biothreat agents from environmental and clinical samples during a terrorist event.

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CRTI 08-0214RD

Cosmic Ray Inspection and Passive Tomography for Special Nuclear Material Detection

Project Lead:	DRDC Ottawa
Federal Partners:	Canadian Border Services Agency, Atomic Energy of Canada Limited, Health Canada
Industry Partners:	Advanced Applied Physics Solutions, International Safety Research
Other Partner:	Carleton University

Objectives

The goal of the Cosmic Ray Inspection and Passive Tomography (CRIPT) project is to design, construct, and test cost-effective muon tracking and spectrometer systems that are capable of detecting, in a practical length of time (less than one minute per container), special nuclear material (SNM) or dense shielding for radiological sources concealed in large cargo containers. This technology can also be used to image actinides in nuclear waste containers and account for spent nuclear fuel. Small-scale muon tracking prototypes were built and tested in 2010; the full-scale prototype system (consisting of approximately 64 m^2 of muon detectors) will be tested in late 2012. Partners are carrying out the following roles:

- DRDC Ottawa is leading the project and performing simulation studies;
- Carleton University and Advanced Applied Physics Solutions (AAPS) are building the muon tracking and spectrometer systems;
- Atomic Energy of Canada Limited (AECL) is developing the SNM detection and tomographic imaging algorithms;
- Canada Border Services Agency (CBSA) is benchmarking existing radiation detection systems and determining the muon system's operational constraints;
- Health Canada is investigating machine learning techniques to improve the system's sensitivity; and
- International Safety Research (ISR) is providing project management support and studied the feasibility of a complementary, passive neutron detection system to improve SNM detection rates.

Relevance

The smuggling of illicit SNM and radiological material into Canada and allied countries is a major security concern. While radiation detection systems for cargo exist that are sensitive to low levels of gamma or neutron radiation, SNM, such as uranium (U) and plutonium (Pu), and well-shielded radiation sources are difficult to detect by conventional means. A solution to this problem might be provided by highly penetrating, cosmic ray muons. Dense chemical elements with a high atomic number of protons in the nucleus (high-Z materials), like U, Pu, and lead (Pb), scatter muons at larger angles than lower-Z materials. Charged particle tracking detectors placed around an object of interest such as a shipping container can be used to measure the deflection of the muon trajectories and consequently image the contents of an object.

Recent Progress and Results

CRIPT has made significant progress since project approval in April 2009. Computer simulations of the performance of different detector designs have been carried out at Carleton University, AAPS, AECL, and DRDC Ottawa. Carleton University has performed detailed simulations of the response of different drift chamber designs to cosmic ray muons. These simulations led to a novel cathode-pad design for the drift chambers. AAPS simulated the response of scintillators to cosmic ray muons; these simulations determined the optimal size and geometry for the scintillator detectors that will be used for CRIPT's full-scale prototype. AECL has developed and tested different image reconstruction algorithms to perform 3-D reconstructions of the contents of different volumes (e.g., cargo containers, spent nuclear fuel containers, nuclear waste containers, etc.). These simulations have determined the muon tracking

and spectrometer requirements. DRDC Ottawa also performed simulations to determine the specifications of the muon spectrometer design.

The simulations informed the designs of two small-scale muon tracking prototypes: gas-filled drift chambers built by Carleton University and scintillator-based trackers built by AAPS. Each prototype consisted of four layers of muon detectors with total active areas of approximately four square metres each. The prototype systems performed well with two millimetre position resolution for muons and greater than 99.5% efficiency. The muon detection performances and construction costs of these small prototypes were used as criteria to determine the design for the large-scale prototype. Scintillator detectors have been chosen for the full-scale prototype, to be completed in 2012.

ISR simulated the signal of neutrons produced by highly enriched uranium (HEU) to determine if it is feasible to detect its “passive” neutron signal. Unfortunately, the small signal is unlikely to be detected due to the much larger and variable cosmic ray neutron background.

Impact

This project will deliver a prototype muon tomography system capable of detecting SNM or dense shielding in air-cargo sized containers. The system will be tested by AECL to characterize the ability of the system to identify the content of nuclear waste. The deployment of effective muon tomography technology at Canada’s ports of entry would improve our ability to detect contraband SNM and shielded radiological sources, both of which pose a very serious threat to Canada’s security and that of our allies. The consequences of not detecting a smuggled improvised nuclear device (IND) or radiological dispersal device (RDD) when it enters Canada could be catastrophic.

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CRTI 08-0225TD

Radiological/Nuclear Response Criteria

Project Lead:	Health Canada - Radiation Protection Bureau
Federal Partners:	Public Safety Canada, Department of National Defence, Canadian Nuclear Safety Commission
Industry Partner:	International Safety Research

Objectives

Capability analyses of radiological/nuclear (RN) events have demonstrated that large-scale terrorist-based events (i.e., those events that require the capabilities of multiple response agencies) require enhanced organizational interoperability. Many agencies that may be called to respond to an RN incident have independently developed various response criteria, plans, and procedures. Although these have been developed based on national, international, and expert guidance, there may be differences in the response concept of operations or response criteria (e.g., safety distances, dose rate alarms, and turn-back levels). This project collectively refers to these aspects of response as RN Response Criteria (RNRC). Recent exercises have demonstrated that response inefficiencies arise when some of the agencies that respond do not have established criteria or they are unaware of the criteria established by the other groups.

The goal of this project is to educate all stakeholders regarding RN criteria and components to optimize the interoperability and effectiveness of these organizations during an RN event (i.e., first responders, municipal, provincial, and federal organizations). This will be achieved by conducting research on the current international, national, provincial, and municipal RN response criteria protocols to encourage open discussion on current RNRC practices. The information will be available to all stakeholders. The project objectives will be accomplished through four phases: stakeholder survey and literature research, a two-day conference, a workshop, and RNRC documentation.

Relevance

This project is a direct response to the need for RN criteria, which has been identified in several previous and current CRTI projects, exercises, and workshops (MEDNEREX, Exercise Initial Thunder, Exercise Integrated Response, an RN contamination workshop in 2007, PROBE [06-0317TD]). A CRTI RN Contamination workshop held in 2007, for example, showed that, although Canada has a vast array of national resources and capabilities, their effectiveness may be reduced by inconsistent use or understanding of response protocols and criteria. In the case of a radiological dispersal device, emergency response capabilities will be enhanced by a coordinated effort. In the case of mass contamination, clearly defined boundaries and consistency in dealing with the exposed are of critical importance to responder effectiveness and public safety.

Recent Progress and Results

Phase 1 of the project involves a stakeholder survey and literature research. Health Canada's Radiation Protection Bureau and the Canadian Nuclear Safety Commission (CNSC) will distribute a letter to all stakeholders discussing the project and soliciting interest in a possible conference and their willingness to exchange RNRC information. If the response is favorable, then a questionnaire will be distributed to organizations with established RNRC. This questionnaire will solicit information regarding established criteria, protocols, procedures, and concept of operations. Research findings from various jurisdictions (from local to international) and questionnaire responses will be summarized in a RNRC synopsis report to be presented at a stakeholder conference during Phase 2.

Phase 2 of the project will involve a two-day conference, where stakeholders will be encouraged to present their RNRC approaches. There will also be an opportunity for participants to exchange information regarding RNRC. This interactive approach will promote open discussion and educate organizations about various approaches to RNRC. Following the conference, the RNRC synopsis report will be updated with information from the conference and distributed. Topics of global interest may be explored further in Phases 3 and 4.

During Phase 3, a working group will be established, co-chaired by Health Canada and CNSC, with representatives from federal, provincial, regional, and municipal partners. The objective of the working group will be to develop a draft RNRC document for distribution to all stakeholders including those organizations that do not currently have RNRC.

The final project phase will involve incorporating the comments and feedback on the draft RNRC document from all stakeholders and distributing a final RNRC version. This document will only be released on agreement of Health Canada and CNSC.

Impact

This project will significantly improve Canada's preparedness and response capability for RN incidents. Awareness and understanding of guidelines and criteria for RN incident response will increase the interoperability of all responding agencies, thereby increasing response safety and effectiveness.

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CRTI 08-0233TD

An HI-6-based Intravenous Product for Nerve Agent Post-treatment

Project Lead:	DRDC Suffield
Federal Partners:	Canadian Forces Health Services, Royal Canadian Mounted Police
Industry Partner:	UGM Engineering Ltd.
Other Partner:	Ottawa Hospital

Objectives

The objective of this project is to develop and demonstrate an HI-6-based intravenous (IV) product for continuous IV treatment of nerve agent poisoning. A formulation and manufacturing process will be developed by April 2011; initial animal research and Good Laboratory Practice (GLP) non-clinical safety studies will be performed by May 2012; and a nominal number of formulated packaged units will be produced and demonstrated at DRDC Suffield via the CBRN First Responder Training Program by June 2012. UGM Engineering Ltd. will provide general contractor services by managing the formulation process for the IV product and overseeing the development of an industrial process at contract manufacturing organizations. DRDC Suffield will conduct GLP non-clinical safety studies and the final product demonstration in the swine model. Military partner Canadian Forces Health Services and first responder partners (RCMP and Ottawa Hospital) will provide clinical expertise that includes highlighting end-user scenarios that may affect the final product configuration as well as providing recommendations for appropriate formulation and dosing specifications.

Relevance

Neither the military nor the National Emergency Stockpile System has a stock of IV oxime product specific to the treatment of nerve agent exposure. Efforts conducted to date to restock Canada's supply of nerve agent antidote have focused on intramuscular (IM) therapy. Current auto injector therapy limits the ability of the treating physician to titrate the dose of oxime to a patient's need. In addition, multiple IM injections may not sustain therapeutic plasma at levels required for effective treatment, possibly resulting in local adverse effects. This leaves a gap in the capability to treat nerve agent exposure. Development of an intravenous HI-6 formulation will provide a more flexible and effective treatment regime for nerve agent poisoning, including topical exposures.

Recent Progress and Results

An IV HI-6 Health Canada Scientific Advisory Meeting was held 7 October 2010. Proposed pilot and animal efficacy studies intended to support a submission under the Special Access Program were presented for feedback; the plan was well received. A full partners meeting was conducted to help frame and formalize the IV HI-6 concept of use for treatment of nerve agent poisoning; parameters such as treatment initiation, dose justification, and patient monitoring were discussed. DRDC Suffield has initiated the procedure for becoming Good Laboratory Practice Certified by the Standards Council of Canada (SCC); a facility inspection is pending.

Formulation (lyophilization) testing and optimization has also been conducted. Optimized HI-6 formulation test batches are undergoing stability testing to ensure they meet stability requirements. An analytical method to detect and quantify ethyl methanesulfonate (EMS), a mutagen that may be a potential impurity produced during the HI-6 production process, has been developed and the method is currently being validated.

Putative impurities in HI-6 DMS production have been identified. These impurities have been synthesized for use as reference material during impurity analysis of future HI-6 manufactured lots.

Impact

To date, HI-6 has been unavailable for civilian use in Canada. Extensive research shows that HI-6 is significantly more effective against a broad range of nerve agents than the treatment that can currently be used for treating civilian casualties. Development of a flexible parenteral formulation of HI-6 will provide significantly greater treatment options for first responders in the event of an incident. For example, Japanese first responders at the Tokyo subway incident found that large numbers of exposed victims required higher than expected doses of oxime, which could not be practically addressed using multiple 500 mg auto injectors. The ability to specifically titrate doses will not only improve the efficacy of therapy, but will also increase first responder and physician efficiency resulting in the ability for larger numbers of casualties to receive treatment. This will bring Canada one step closer to providing its military and first responder community with a complete nerve agent exposure treatment regime.

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CRTI 08-0234TD

Modelling the Effects of Public and Animal Health Emergencies on Laboratories

Project Lead:	Public Health Agency of Canada
Federal Partners:	Health Canada, Canadian Food Inspection Agency
Other Partners:	University of Guelph, Michigan State University, US Homeland Security National National Center for Food Protection and Defence at the University of Minnesota, US Department of Agriculture

Objectives

This project proposes to develop modelling capabilities to scientifically assess surge-related needs within Canadian provincial and federal public and animal health laboratories during a biothreat emergency. The project researchers adopt statistical and simulation modelling techniques used by the United States (US) Centers for Disease Control and Prevention (CDC) and the Association of Public Health Laboratories (APHL).

To forecast the capacity of public health laboratories, the CDC projects pandemic workloads, resource use, and sample through-put capabilities. The quantifiable results from these studies can be used to forecast the need and timing for tactics such as reducing sample workloads, increasing resources, and changing processes to improve the overall specimen throughput and to assist decision making in real-time.

Relevance

The problem to be addressed has three aspects:

1. There is no laboratory modelling tool in Canada that predicts the capacity required to prepare for a laboratory surge in response to a specific biological threat;
2. Laboratories across Canada have individually prepared for public or animal health events in ways that are not necessarily consistent; and
3. Laboratories are stockpiling with no evidence-based data to accurately determine their stockpiling requirements.

The modelling tool to be developed by this project will be completely new to Canada. The data provided by current models are limited to supporting laboratory pre-event surge response planning. This tool will highlight gaps in the surge response capabilities of laboratories based on specific biological agents. Because this model will be generic for laboratories and pathogens, it can be applied to both federal and provincial jurisdictions, and to both public and animal health laboratories. This modelling will allow laboratories to more completely assess risks and address surge capacity, thus decreasing the impact of a biological threat.

Recent Progress and Results

The CDC modelling tool has helped efforts for US state and federal laboratories to prepare for public health threats. The tool would enable Canada to assess laboratory surge capacity in response to various biological threats through multiple avenues (i.e., public and animal health threats), thus mitigating the impacts of multiple threats. The modelling will help to coordinate and standardize cross-border strategies between the US and Canada by standardizing assessment criteria, language associated with assessment, and response preparedness solutions.

The CDC and APHL modelling techniques, along with the expertise from Canadian public health laboratories and animal laboratories, will shape a biological agent-specific tool that can predict the necessary resource requirements for laboratories during a response. This prediction will allow laboratories to implement strategies to improve capacity prior to a bioterrorist event.

The project examines modelling the outcomes of five biothreat agents with the greatest impact on humans and animals in terms of mortality rates and biothreat potential. The project team selected the human pathogens *Bacillus anthracis* (anthrax), *Yersinia pestis* (plague), and *Clostridium botulinum* (botulism) and the animal pathogens *Aphtae epizooticae* (foot-and-mouth disease) and Rift Valley fever. The animal pathogens would also have a high detrimental effect on the animal industry because of massive culling.

Impact

The outcome of this project will be a modelling tool that can be used by laboratories to identify resource gaps and process vulnerabilities incumbent on the expected testing influx during a public or animal health biothreat. The tool will enable the prediction and optimization of the resource requirements tied to diagnostic testing during an outbreak on top of an existing workload. In addition, the model may address how changes to testing protocols such as pooling samples, automating processes, or eliminating steps affect testing output. These models will identify ways to mitigate the surge-related impacts of a public or animal health emergency on laboratories and their stakeholders.

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CRTI 08-0241TD

Field-deployable Techniques for Emergency Radiobioassay

Project Lead:	Health Canada
Federal Partners:	DRDC Ottawa, Canadian Forces
Other Partner:	Atomic Energy of Canada Limited

Objectives

Following a radiological/nuclear (RN) emergency, first responders and the affected public may be internally contaminated by radionuclides. In such cases, rapid bioassay is very important for immediate and near-term consequence management (i.e., identifying the contaminated individuals and providing dose information to physicians). Previous CRTI projects, CRTI 02-0133RD and CRTI 06-230RD, focussed on the development of rapid methods for laboratory-based bioassay, but they leave an important gap in terms of field applications. This project addresses that gap with the objective of developing radiobioassay techniques that can be used in the field. The techniques will be based on, but not limited to, the knowledge and technologies developed by the previous projects identified above. In addition, this project will develop field techniques for the urinalysis of the top ten radionuclides identified by the latest version of Consolidated Risk Assessment and demonstrate the techniques as a "bioassay module."

Relevance

This project will develop non-invasive bioassay techniques (in vitro) that can be used in the field for screening individuals exposed to internal radiation, identifying contaminated persons, and providing dose information to physicians for necessary medical intervention. It will also develop methods for identifying and monitoring human exposures to radionuclides that are delivered either directly in the field or later at identified reach-back laboratories. Both are important since methods are needed to triage casualties following an incident and to analyze the hundreds or thousands of bioassay samples that even a small-scale incident may generate. This project will develop bioassay techniques that offer high sample throughput coupled with high sensitivity and precision. These techniques are expected to be robust and easy to use by first responders.

Recent Progress and Results

In the first year of the project, the following progress has been made:

- Requirements for radiological emergency bioassay have been published. A revision is going to be submitted soon to echo the recently published international guidelines.
- A rapid bioassay method for Am-241 in urine was developed. The method is simple, robust, and sensitive enough for emergency bioassay. The performance of the method met the accuracy and repeatability requirements defined by ANSI N13.30. Sample turnaround time is about one hour. This method has been compared with a gamma spectrometry method and an ICP-MS method. Results have been published as two papers.
- Rapid alpha spectrometry methods were developed to measure alpha emitters, such as Pu-239 and Am-241, in urine samples. Results have been submitted for publication.
- Methods (creatinine-based and specific gravity-based) for normalizing urine output have been developed. Results have been submitted for publication as two papers.
- Urine bioassay of gamma emitters (Cs-137, Co-60, Ir-192) have been developed. Results have been published.

Impact

New knowledge and techniques will be developed throughout the course of this project in both sample preparation chemistry and radiation measurement. These new techniques and methods will significantly enhance Canada's RN emergency response capability, especially for immediate and near-term consequence management.

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PSTP 02-0300BTS

Sensor Interaction for Small Ship Tracking and Awareness in Harbour

Project Lead:	DRDC Atlantic
Industry Partner:	Ultra Electronics Maritime Systems
Other Partners:	Dalhousie University, Halifax Port Authority

Objectives

The objective of the study was to investigate the utility of employing overlapping sensors to work in concert to identify and track non-AIS vessels within harbour environments, principally through anomaly detection. It also sought to understand the processes and approaches to security currently practiced by Canadian port authorities and to investigate the role of the operator and how this role is impacted by automated processes.

The specific objectives of the study were as follows:

- Develop an understanding of how grouped, persistent sensors address the tracking of small ships in port environments;
- Identify the incremental improvements in detection that layered sensors create;
- Help understand how human operators process data and whether automated functions can help them conduct their jobs; and
- Understand if anomaly detection can consistently be addressed by automated sensors or if it is best for an operator to identify anomalous behaviour.

Relevance

An understanding of the current state of security planning practices has been achieved through interactions with the Halifax Port Authority, as well as survey feedback from three other Canadian ports. Port authorities employ little automation for port security, with the human eye primarily responsible for processing data. Authorities also believe that the greater the number of sensors employed, the greater the level of surveillance and tracking capability. The study focussed on small boat tracking, which is a necessary requirement for maintaining a vigilant security regime in a port.

Recent Progress and Results

The study was managed by DRDC — Atlantic, which was responsible for ensuring that the study remained within scope, coordinating the team members, chairing progress review meetings, and ensuring that the project time lines were realized. Ultra Electronics Maritime Systems was the technical authority and provided expertise on current port security operations and how they affect technological considerations. Ultra provided a Command and Control system to the Halifax Port Authority and understood the challenges of tracking small vessels and the trade-offs that are involved in sensor selection. Dalhousie University was the anomaly detection expert and helped gather data for the study. The Halifax Port Authority was an advisor, providing direction and input as the project proceeded and ensuring that the study remained relevant to the port community. The team produced an interim report in March 2011.

The study leveraged data that was generated through a trial held in Halifax in October 2010. The trial involved tracking small vessels without automatic identification systems (AIS) by using AIS-directed cameras, radar, and bottom-mounted arrays, both acoustic and electromagnetic. The sensor data was integrated into a Google Earth graphical user interface (GUI) to observe how different sensors track the same object, where they overlap, and where there are gaps. Sample data from bottom-mounted arrays and the AIS camera system has been integrated into sample video clips. The data sample was then increased by incorporating radar data.

The team conducted a literature search to develop an understanding of what is known about sensor interactions. While extensive, it cannot be considered complete because of the vast number of sources available. It should be treated as a snapshot into the current state of knowledge. The team viewed and interviewed security operators in their work

environment in the Halifax Port Authority security control room. No system can be completely automated and there must be at least minimal human interaction with it.

Impact

The study helps to understand how sensor deployment —type and placement—can address small ship, non-AIS tracking. It revealed which processes can be automated and which ones need to be addressed by human operators. It developed an understanding of the incremental detection capabilities to be gained by using sensors in concert and will allow port authorities to get the most financial value from trade-offs that are inherent within any security planning paradigm.

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PSTP 02-0302EMSI
Canada-US Border Radio Coverage

Project Lead:	DRDC Atlantic
Federal Partners:	Industry Canada, Communications Research Centre, Canada Border Services Agency, Canadian Coast Guard
Industry Partners:	Martello Defence Security Consultants Inc., Fiorel Systems, VE2DBE
Other Partner:	Réseau québécois de calculs de haute performance

Objectives

The project will provide a method and a baseline radio coverage report that can be used as a standard and repeatable model to follow and reuse. The project will also include work for 700 MHz broadband data for public safety. It will create a common information source and community of interest enabling live and end-user validated information and a foundation for training and continuous improvement.

Relevance

The final recommendations of this study will influence three cross-domains: the political domain through proposed new changes in licensing policy like enhancing the metadata for searchability; the operational domain through the conduct of field-testing and validation of the predictions with end-user cooperation; and the technological domain by identifying emerging research and development subjects that have a high potential of solving the current inconsistencies in public safety radio system interconnectivity.

Recent Progress and Results

The study produced the following technologies and knowledge:

- Comprehensive data mining Structured Query Language (SQL) scripts to identify first responder agency radio system records in radio license databases;
- A modified robust radio propagation software that can be used as a batch program to run on a 1000+CPU core supercomputer, allowing a continent-wide radio coverage plot at 100m/pixel resolution;
- Radio propagation model results that were validated through field testing and high-fidelity fine-tuning measures were identified;
- 700 MHz wireless broadband spectrum data usage needs for first responders and LTE network capacity models for first responders; and
- New technology solutions options were identified and presented as a technology roadmap including a Technology Readiness Level (TRL) rating.

The high-resolution coverage plots and associated tools and training will allow for first reponders to maintain and update their “radio situation awareness,” while the technology road map produced will help first responder and public safety agencies to plan and optimize their new system procurement with a common national approach.

Impact

Should a significant incident occur in the border region, the radio coverage plots can be used as a repository to identify “who can talk to who” at the scene. This is a key enabler for interoperability of multi-agency on-scene response.

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PSTP 02-0305eSEC

Study of Software Defined Radio for Spectrum Sensing in a Wireless Common Operating Picture

Project Lead:	Department of National Defence
Federal Partners:	DRDC Ottawa, Communications Research Centre Canada – Communications Signal Processing
Industry Partner:	ThinkRF

Objectives

The purpose of this study is to investigate combinations of persistent sensors, suitable both to the harbour setting and to the task of tracking small ships, with a view to identify those with the greatest potential to enhance situational awareness, principally through anomaly detection. The study will report on the current state of sensor interaction capability for all pairs of sensor types in current use in harbours around the world. It will also explore sensor interactions that will be possible with additional research and development. Moreover, the study will explore the value of areas with overlapping sensor coverage in a harbour and examine the tradeoffs and hurdles involved in realizing interaction capability in those areas. Sensor combinations with the greatest potential to enhance situational awareness will be examined for their usefulness in communicating actionable intelligence to human operators. In looking at these sensor combinations, the study will explore the processes, algorithms, and interface needed to make the interactions take place.

Relevance

Currently, there are no market solutions available that will address the price or performance requirements for large-scale deployment of general purpose, reliable signal detection. This study will examine the combination and evolution of proven technology developed by the partners, thereby minimizing technological risks, to identify those with the greatest potential to enhance situational awareness. Improving the detection of illegal activity in and around Canadian harbours contributes directly to the Border and Transportation Security Community of Practice's goal of enhancing Canada's ability to undertake surveillance along its borders.

Impact

The resulting system will provide the basis for real-time wireless signal intrusion detection, technical security counter measures, and real-time detection of signal initiated radio-controlled improvised explosive devices. Upon system verification, the partners will strive to work with inter-departmental cyber security working groups to define and develop the system software applications.

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PSTP 02-0327EMSI

National Common Alerting and Notification Protocol

Project Lead:	Public Safety Canada
Federal Partners:	Environment Canada, Industry Canada, Natural Resources Canada, Statistics Canada
Industry Partners:	Allport Group, NetAlerts, Healy Consulting
Other Partners:	Canadian Association for Public Alerting and Notification, Province of Alberta Emergency Management, Province of New Brunswick Emergency Services, Organization for the Advancement of Structured Information Standards, University of New Brunswick, Univeristy of Alberta, Canadian General Standards Board, Canadian Health Infoway

Objectives

The Canadian Profile of the Common Alerting Protocol (CAP-CP) is a collection of three documents (Canadian implementation rules, Canadian event references, Canadian location references) that define Canada's national emergency messaging technical format for alerting; between emergency management officials and to the Canadian public. The Canadian Profile is compliant with the Common Alerting Protocol (CAP) reference standard, which is an international standard of the Organization for the Advancement of Structured Information Standards (OASIS).

The CAP-CP is currently managed by an informal group of public and private stakeholders (CAP-CP Working Group). They have carried out activities in support of CAP-CP without the benefit of formal governance, a formal change management process, or sustained funding. A few of the members also voluntarily support international efforts associated with the CAP reference standard.

The study team set out to define a formal governance structure, change management process, compliance program, and sustainable support program for the CAP-CP. Additionally, this project included targeted investments to fill known implementation gaps with the CAP-CP.

Relevance

The CAP-CP is in use today, in the Canadian Multi-Agency Situational Awareness Systems (MASAS) initiative and the National (public) Alert Aggregation and Dissemination (NAAD) system. Both of these systems are supported by the Senior Officials Responsible for Emergency Management (SOREM), and interoperability between them is dependent on conformance with the CAP-CP. The CAP-CP is also used in provincial and private alerting systems. Further, the CAP reference standard is used in the new United States Integrated Public Alert and Warning System (IPAWS). Interoperability between MASAS and IPAWS is dependent on conformance with CAP.

Recent Progress and Results

The study team, which included all of the members of the CAP-CP Working Group, were involved in every step of this study from research, analysis, and debate, to consultation, consensus, and the development of the final and ancillary products. Additionally, subject matter experts were consulted and leveraged to achieve the study objectives. After considerable research, analysis, debate, and consultation, the study team envisioned committees of subject matter experts volunteering their time to manage many emergency management specifications, of which CAP-CP is but one. These specifications would be identified in the *Communications Interoperability Action Plan for Canada*, and governed in accordance with the *Communications Interoperability Strategy for Canada*. The management of these specifications would follow a common change management process, which will preferably become a Standard of Canada. In this way, volunteers involved in the development of a new specification, or Canadian implementation of an international standard, will consistently follow

one efficient process. The debate over process and specification requirements will therefore be separately addressed. A draft change management process was developed in support of next steps.

The study team also envisions the development of a Canadian strategy to support and influence international emergency communications standards of interest, as is done in other sectors (e.g., the Canadian Health Infoway Standards Collaborative). Doing so can reduce, if not eliminate, the need to manage Canadian implementations, while supporting interoperability across our borders with international stakeholders.

In parallel to the study efforts, investments were made to fill known gaps. Ancillary products developed through this study included generalized CAP-CP location boundary files (Statistics Canada), marine boundary files and geocodes for use in CAP-CP (Environment Canada), a CAP-CP validation tool (NetAlerts), a comprehensive reference implementation guide (Healy Consulting in collaboration with Environment Canada), and improved CAP-CP web communications (CAPAN).

Fortuitously, the *Communications Interoperability Strategy for Canada*, which was published late in the study, aligns well with the team's vision and recommendations.

Impact

This study presents an effective, efficient path forward for the change management of CAP-CP, and other emergency communications specifications of interest, which are governed in accordance with the *Communications Interoperability Strategy for Canada*. It also offers recommendations on how to effectively and efficiently support the adoption of them, from lessons learned with the CAP-CP.

Additionally, recognized gaps for current users of the CAP-CP have and are being filled; in support of interoperability within the emergency management community, and private distributors of public alerts, in support of public safety.

Equally important in this time of fiscal restraint, the path proposed offers significant financial savings, when compared with a path initially proposed for the CAP-CP, which this study was to evaluate.

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PSTP 02-0336BIOM

Assessing Vulnerability of Biometric Technologies for Identity Management Applications

Project Lead:	Communications Security Establishment Canada
Federal Partners:	Canadian Border Services Agency, Department of Foreign Affairs and International Trade, DRDC Toronto, Office of the Privy Council, Royal Canadian Mounted Police, Transport Canada
Industry Partners:	IBG Canada, GenKey, priv-ID, Reboot Communications
Other Partner:	University of Toronto — Identity, Privacy and Security Institute

Objectives

The first objective of the project is to evaluate the potential vulnerability and utility of biometric technologies for government use in controlling access to information technology (IT) systems and in e-government services. This objective addresses the goal of the biometric community of practice to evaluate, analyze, and support biometric technology implementations that enhance national capabilities.

The second objective is to improve the ability of Canadian government departments and agencies to identify and mitigate security vulnerabilities and privacy risks, and preserve interoperability in identity management systems. The project will achieve this objective by producing guidance for decision makers on how to deploy biometric technology as a method for single-factor authentication.

Relevance

The project produced a framework for evaluating vulnerabilities in biometric technology options for IT system access control applications and e-government services. By incorporating existing frameworks and policy documents, the framework provides straightforward guidance for decision makers deploying authentication and identity management solutions. The framework addresses technical considerations such as vulnerabilities and interoperability, as well as other factors related to deployment such as cost, usability, technology readiness level, privacy, and other legal, ethical, and cultural issues. The project also compares the use of biometrics and traditional means of single-factor authentication by executing a small-scale evaluation of fingerprint biometrics versus passwords for logging on to desktop applications.

Recent Progress and Results

Building upon the report by the Communications Security Establishment Canada (CSEC) on *Biometrics for Authentication for Enterprise Security Architectures*, the project team compared the use of biometrics against other authentication methods such as passwords and cryptographic tokens. The team conducted a survey of existing biometric assessment frameworks, as well as recent privacy policy documents, familiarizing itself with common IT frameworks and identifying gaps. The team synthesized a practical framework, then developed case study analyses by researching deployed operational biometric systems in Canadian and international settings and applying the new framework.

For the comparative evaluation, the project team developed a test methodology and plan for directly comparing the use of biometric authentication to password authentication through an experimental test using a small set of test subjects and trials. The team built a test platform that simulates the user login experience using a representative fingerprint biometric system and a username-password authentication system, while collecting measurable criteria such as the following information:

- Whether access was granted;
- Number of attempts before gaining access; and
- Length of time to authenticate.

Additional metrics such as ease-of-use and user acceptance were collected through a user survey conducted after the tests.

Impact

The project facilitates the assessment of potential solutions by identifying gaps in existing security evaluation methodologies and synthesizing a best-of-breed evaluation framework that incorporates privacy issues. Study results will inform IT security and privacy policy development, and facilitate deployment of biometric technologies as standalone authentication methods and in conjunction with other mechanisms for multi-factor authentication systems. Results from the comparative evaluation portion of the project provide a baseline of data comparing biometrics and passwords using experimental research trials, opening the door for more comprehensive evaluation scenarios beyond the project.

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PSTP 02-0341BTS

Asymmetric Threat Mitigation in the Great Lakes, St. Lawrence Seaway, and Maritime Ports and Inshore Waters

Project Lead:	Communications Research Centre Canada
Industry Partners:	Airborne Underwater Geophysical Signals Ltd., Blue Force Global Special Services Group Ltd., CFN Consultants, AKW Global Enterprises

Objectives

This study employs a systematic and interdisciplinary analysis to better understand the current and arising capability gaps relating to maritime and the Great Lakes St. Lawrence Seaway (GLSLS) border regions persistent small vessel surveillance, and to evaluate potential technological solutions that will address these gaps. The approach taken includes a review of technical literature and a qualitative survey of stakeholders from technological, policy, and operational perspectives. The study, which will be concluded by June 2011, will provide a roadmap to designing a Surveillance, Intelligence, and Interdiction (SII) solution aimed at countering asymmetric threats and improving border management in the maritime and GLSLS inshore regions.

The lead federal department is Communications Research Centre Canada (CRC). Airborne Underwater Geophysical (AUG) Signals assumes the day-to-day management of the project and spearheads the technology assessment portion of the study; CFN heads the operational and strategic policy analysis; AKW coordinates liaison with stakeholders; and Blue Force assesses current operational capabilities in contrast with current and developing modus operandi of threat groups.

Relevance

The study aims to scope solutions for manageable persistent surveillance of maritime border areas with special attention to the mitigation of the small vessel threat, while fully acknowledging the need to balance border security measures and sustaining free flow of trade and traffic. The study will output an architecture and capability road map of a multi-sensor system that will increase the tempo of threat detection and emergency response, improve domain awareness in the border regions and decision making quality, and provide the necessary insight for officials to ensure the integrity and efficient functioning of the border, thus making an important contribution to border and transportation security.

Recent Progress and Results

During the first phase of the project, the existing and emerging threats from small vessels facing the Great Lakes St. Lawrence Seaway (GLSLS) and maritime borders were determined via reviews of the open literature and discussions with stakeholders, including both military and civilian from all levels of government, thereby better defining the current and arising capability gaps. The challenges associated with small boat surveillance and insights as to what Canada must do to deal with the task of preventing illegal activities carried out using this kind of craft were investigated, and an inventory of persistent surveillance requirements for the maritime and GLSLS border regions was created, taking into account the identified threats and constraints. Current technologies, including ground-based, space-based, underwater, and airborne sensors, as well as signal processing and information fusion software that could enhance persistent surveillance and small vessel detection, identification, and tracking were identified, reviewed, and categorized based on their ability to mitigate the small vessel threat in the context of specific target environments.

During the next project phase, emerging technologies that could improve our national ability to mitigate the small vessel threat will be identified. Technology Readiness Levels assessment and impact analysis will be conducted for the identified technologies vis-à-vis legal, cultural, privacy, and ethical concerns. An outline of a multi-sensor persistent surveillance system, including both sensor and processing components that will support border enforcement and surveillance/response mechanisms, will be developed for each of the relevant target environments. The steps and timeframe needed to operationalize study outputs will also be determined. Border management and law enforcement agencies, as well as the Department of National Defence and non-law enforcement stakeholders, will be briefed on study findings and key conclusions relevant to their mandates. Final

report capturing all findings from the study, including a Strategic Advisory Note and a Capability Road map will be delivered in June 2011.

Impact

With the emergence of asymmetric threats characterized by unpredictable military or paramilitary operations aimed at carrying out attacks on a superior opponent while trying to avoid direct confrontation, smaller vessels often serve as the medium of choice for adversaries consisting of non-state actors and groups. This transition requires the adaptation of current SII capabilities to enable efficient detection, identification, and tracking of small craft before they can breach the defensive layers of ships, ports, or shore facilities.

The evaluation of a variety of potential technologies and techniques that could be employed to enhance the security of Canada's border, while allowing the efficient and seamless passage of people and goods in a manner consistent with the Government of Canada's priorities on sovereignty, prosperity, and security will result in a roadmap design for an SII solution that will allow persistent surveillance and the accurate, robust, and timely identification of small vessels—compliant and non-compliant.

Author

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PSTP 02-0359eSEC

Advanced Analytics and Darknet Space Analysis for Predictive Indicators of Cyber Threat Activity

Project Lead:	Communications Security Establishment Canada
Industry Partner:	Bell Canada
Federal Partners:	Royal Canadian Mounted Police, Department of National Defence, Canada Revenue Agency, Industry Canada

Objectives

The primary objective of the study was to support the e-Security community of practice through an S&T initiative that provides research and development recommendations to advance the state of the art in cyber threat intelligence prediction technologies. It used advanced analysis techniques to identify and trace malicious activities that are undetectable by traditional means, and to steer the deployment of actions against such perceived threats. It proposed an advanced reference network security architecture.

Some specific objectives were as follows:

- Investigate darknet/darkport traffic analysis tools and techniques, and assess the state of the research in the area;
- Design an advanced reference network security architecture to predict attacks to critical networks at a national level;
- Propose a system design to automate the extraction of the threat metrics; and
- Identify and discuss areas that require research, estimate time horizons, and evaluate technology readiness levels.

Relevance

Advanced tradecraft combined with dark space analysis has been shown to represent an effective means for detecting zero-day attacks (attacks that exploit unknown application vulnerabilities) and mounting an effective proactive defence against cyber attacks. Near-real-time cyber threat intelligence can facilitate the implementation of a proactive defence of critical cyber infrastructure to counter the rapid evolution of cyber threats. The fusion of metrics from the Internet core in Canada with global threat intelligence is an effective means for achieving cyber situational awareness. However, to use such sophisticated analytical techniques to detect and monitor dark space activities, operatives require breath of coverage, depth-of-access, and fidelity of analysis.

The study addressed the health of broadband networks and advanced persistent threats in tandem with the security of rapidly evolving networks and the ever expanding Internet protocol universe. The study also addressed critical dependencies with important control planes such as domain name system (DNS) security and trusted internet connectivity (TIC) in the manner recognized through the close integration of the Comprehensive National Cyber Security Initiative.

Recent Progress and Results

The study used advanced investigative research, scientific evidence, and diagnostics, including a review of techniques, tradecraft, and lessons learned, which validated the threat assessment and security architectures. The study

- established a common operating picture of the science available for cyber security and proactive defence;
- synthesized global threat intelligence and provided a threat and risk assessment for the national information infrastructure;
- addressed the legal and ethical dimensions of cyber threat and defence;
- established a reference architecture for a national cyber security strategy; and
- considered the future of cyber threats and defence.

Impact

Through core intelligence, steered by dark space analysis, the team designed and demonstrated a solution that was orders of magnitude more cost-effective than traditional security solutions. The study provided important information to enhance Canada's ability to prepare for, prevent, respond to, and recover from a high-consequence cyber security event.

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PSTP 08-0100CIP

Integrated Evaluation of Critical Infrastructure Interdependencies for Major Event Planning

Project Lead:	Public Safety Canada
Other Partner:	École Polytechnique de Montréal – Centre risque et performance

Objectives

This study will explore how the Centre risque et performance (CRP) can adapt and apply its critical infrastructure interdependency evaluation methodology for major event planning.

Relevance

During major events, critical infrastructure is put to the test. Over a short period, the sites designated for those events must receive political and security personnel and thousands of journalists and protesters. Furthermore, since 2001, major event planning has taken on a highly safety-conscious focus, and the selected locations are often isolated with very tight security. That was the case in 2007 at the North American Leaders' Summit in Montebello, Quebec. During the event, the controlling forces tried to impede the flow of protesters by enclosing them in a restricted location where critical telecommunications equipment was situated. That type of situation is at the heart of the problem of critical infrastructure interdependencies during major event planning.

Over the last 10 years, the CRP has developed expertise in the field of network interdependencies through its research projects in Montreal and Quebec, Quebec. It has brought together a dozen public and private partners from among the most important critical infrastructure managers in Quebec. This work has facilitated the evaluation, modelling, and prevention of the domino effects associated with functional and geographic critical infrastructure interdependencies. Concrete operational tools have been designed in order to respond to partner needs while respecting the confidentiality of their data. The results of the work are undeniable: modification of internal network management rules, better understanding of vulnerabilities related to the use of alternative resources, and the extension of warning times allowing more significant critical infrastructure resiliency.

Recent Progress and Results

Following preliminary meetings with the managers of essential services who had participated in major events, two main findings were made:

- Every event planning process responds to the specific issues related to the event and although there is a certain amount of overlap among issues, they can vary greatly from one event to another.
- Unlike location-based critical infrastructures in municipalities, when events are being organized, the acquisition of knowledge concerning technical constraints and the location of infrastructures is constantly changing.

On that basis, the approach developed by the CRP for municipalities was adapted to identify critical infrastructures for an event as a function of its issues. Moreover, the approach was developed such that it can be integrated into the planning of a wide range of different events. The approach was then evaluated by 40 representatives of 25 organizations that had taken part in major events at 11 meetings organized for that purpose. Following these meetings, adjustments were made to produce the final tools that will allow users to define the territory, issues, organizations involved, functional dependencies, and geographic interdependencies related to a particular event.

The tools developed are now ready to be used in planning a major or large-scale event. Two organizations have already shown an interest in using them.

Impact

During the evaluation meetings, we received confirmation that an event's dependency on critical infrastructures and its impact on those critical infrastructures are not taken into consideration based on an overall vision. The approach developed during this study mitigates this deficiency.

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PSTP 08-0103BTS

Evaluation of Wide-area, Covert, Radar Networks for Improved Surveillance, Intelligence, and Interdiction against Watercraft and Low-flying Aircraft

Project Lead:	Royal Canadian Mounted Police – Border Integrity
Federal Partner:	Great Lakes and St. Lawrence Seaway Marine Security Operations Centre
Industry Partner:	Accipiter Radar Technologies Inc.

Objectives

The purpose of this study is to examine the feasibility of deploying radar networks for surveillance on the St. Lawrence River and the Great Lakes to improve security along the US–Canada border. This study will assess the operational performance of Accipiter Radar Technologies Inc.'s radar system, a persistent, wide-area surveillance sensor network that delivers relevant real-time and historical information about surface and air movements during extended deployments.

The study will also address the current gap in persistent, covert surveillance capability with the following key objectives:

- To provide border enforcement officers with experience in radar surveillance under operational conditions over a significant period of time.
- To establish, using empirical methods under operational conditions, performance measures for radar installations against marine vessels and low-flying aircraft.
- To understand the parameters for full-scale deployment that provide the most effective coverage at the lowest cost and with the most efficient use of human resources.
- To obtain user feedback and recommendations on the utility of information products.
- To consolidate the learning from all of the above objectives into an informed roadmap for future full-scale deployment.

Relevance

At present, there is virtually no persistent or deployable wide-area surveillance capability in the Great Lakes and St. Lawrence Seaway border region that can provide real-time or historical situational awareness of vessel or aircraft movements related to border crime. Drawing on its experience with border enforcement agencies in Canada and the US, Accipiter has developed such a system, which has been tested for technical performance but not for operational performance characteristics and benefits during extended deployments.

This study will address the core operational requirement determined by the RCMP Border Integrity Technical Working Group to "predict, record, and observe to effectively reduce and prevent border crime between the ports of entry." Further gaps and requirements will be identified by establishing performance measures and capabilities for tracking both large and small uncooperative marine and airborne targets. This will allow for future deployment planning.

Recent Progress and Results

The project is in the initial stages of refinement and procurement.

Impact

This study will significantly enhance Maritime Domain Awareness in the Great Lakes area. It will allow RCMP Border Integrity and the Marine Security Operations Centre to track, understand, and predict movement in the Lake Ontario region. It will facilitate an operational capability to respond to illegal crossings and, using an intelligence-led planning dynamic, to plan significant marine interdiction operations. The study will also expand and intensify existing cooperative relationships (the community of practice) to deliver improved surveillance capabilities for border enforcement.

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PSTP 08-0115eSEC
Automated Risk Management System

Project Lead:	DRDC Ottawa
Industry Partner:	Bell Canada
Other Partner:	University of Ottawa

Objectives

This study established the requirements and design for an automated risk management system (ARMS) capable of comprehending information technology (IT) systems in critical infrastructure sectors, recommending courses of action, and providing metrics to enable comparison among solutions, thereby helping planners to make informed decisions pertaining to risk. One requirement is that the system be able to identify and represent the interconnections and dependencies between systemic components and the potential cascading effects that may expand beyond the initial impact of a triggering security incident. Working towards the common ARMS design, this project was conducted as a series of research tasks that cover the areas of automatic systemic dependency discovery, mapping dependencies to risk management methodologies, identifying criticality metrics, and calculating cascading risk impact.

Relevance

Modern IT systems have evolved to the state where it is not possible for a single entity to be completely aware of the inter- and intra-system dependencies that exist in its environment. Hidden points of vulnerability may exist that are only apparent in retrospect, after a security incident has brought them to light. Additionally, when responding to such an event, the new risk posture is not well known. It is not clear where efforts should be expended to bolster the current security status to prevent cascading risk impacts. The ARMS study has addressed these issues, providing information that can be used to build a tool for decision makers that would help them make informed decisions about how best to predict, contain, and respond to security incidents in a timely manner.

Recent Progress and Results

The project has conducted research into each of the areas of investigation needed to formulate a design for the ARMS. The effort used a bi-directional view of dependency modeling to identify methods for the automated detection of inter- and intra-system dependencies. A top-down view of the organization is necessary to define the relative value of a process or component; however, a bottom-up view is needed to provide implementation details of how organizational objectives are met. This dual view of dependency modeling enabled the categorization of the nature of systemic dependencies themselves and how they would be represented within the ARMS.

The modeling of dependencies is enhanced by including the physical location of components and operational constraints. The location of systemic components is a relevant factor in the impact of a physical security event. Methods for incorporating physical location, including that of mobile and connectivity-based components, were reviewed. Mechanisms by which these components could dynamically provide their location were examined as well as software packages capable of managing the location information of systemic assets. Similarly, pattern recognition and classification techniques were applied to the problem of classifying low-level information traffic as supporting specific organizational-level business practices, thus providing context and relative value for systemic connections.

The effort to model systemic risk culminated in a review and selection of a mechanism for representing the nature of inter- and intra-systemic risk and supports the calculation of risk metrics that can be used in the course of action activities. The chosen method, predictive criticality metrics (PCM), was deemed to be an applicable approach for defining criticality metrics across a dynamic system. In so far as its purpose is to coordinate a team of agents in a dynamic, uncertain, non-linear environment to achieve a team reward in response to emergency events, PCM shares many characteristics with systemic risk management. PCM supports a rich modeling language that is able to capture the complex nature of dependencies in addition to the impact of non-

local effects. It also enables the establishment of a risk-oriented criticality metric that can be used to determine appropriate courses of action to mitigate the effect of cascading risk events.

Impact

A system based on the design of the ARMS will enable those responsible for the safety of Canadian IT networks to monitor the risk posture of the current system configuration. The ARMS will support analysis to identify potentially unseen critical dependencies, flaws, and weaknesses within the environment. It will support proactive protection by allowing administrators to select a range of options for configuration changes that result in the most robust risk posture. Under conditions of an occurring security event, ARMS will support reactive analysis, identifying the impact to critical processes and identifying where mitigations should be deployed to contain the incident and stabilize the new security posture.

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The Impact of Emerging Maritime Information and Sensor Systems on Northern Situational Awareness

Project Lead:	DRDC Atlantic
Federal Partners:	Transport Canada, Canadian Coast Guard
Other Partners:	C-Core, International Communications and Navigation, Rutter Technologies

Objectives

The objective of this study is to provide a comprehensive report on the current state of technology and state of implementation for a number of new maritime information and sensor systems, and to investigate the integrated application of these systems for northern situational awareness. Three companies have been selected to study the following areas: new and emerging maritime information systems, new and emerging shore-based and ship-based sensor systems, and new and emerging space-based sensor systems. DRDC Atlantic will integrate the study results and determine cross linkages to improve northern situational awareness. A major workshop will be held following the completion of the study, and results will be provided to national and international communities of interest.

Relevance

In recent years, new maritime information and sensor systems have had a dramatic impact on global and regional maritime situational awareness and on communication connectivity in remote maritime areas. RADARSAT-2 was launched in December 2007, the Automatic Identification System (AIS) became fully operational the same year, and Long-Range Identification and Tracking (LRIT) became fully operational in January 2009. There are at least as many emerging information systems and sensors that promise to impact situational awareness over the next three to five years. Automatic Dependent Surveillance — Broadcast (ADS-B) on aircraft will become more prevalent in that time frame, Class-B Automatic Identification Systems (AIS) will likely be carried on many more small vessels worldwide, and high-resolution radar will become more common in shore-based, ship-based, and airborne applications. Taken together, these new and emerging technologies hold promise for dramatically improving situational awareness in northerly maritime regions and in the Arctic.

Recent Progress and Results

This study commenced in the second quarter of 2009. The DRDC Atlantic project team met with each company in St. John's, Newfoundland, to discuss the scope of the study and the timeline for the project deliverables.

Impact

In all regions of sovereign and strategic interest to Canada, situational awareness is a key component of effective decision making for security, safety, and efficiency of movement. Situational awareness is built on accurate and timely knowledge of the vessels, vehicles, aircraft, people, and goods present in those regions. Developing and maintaining situational awareness in urban areas is a major challenge. However, for remote, sparsely populated areas of Canada, such as the Canadian North, adverse climate, lack of power, and lack of communication connectivity lead to even greater challenges. These challenges are particularly evident in the huge maritime areas of Canadian responsibility, which include northern waters and the Arctic Archipelago that accounts for 30 percent of Canada's land mass. Because of the increasing interest in northern regions in resource exploitation and the growing interest in northern maritime trade routes for global shipping, Canada must address the challenges of northern situational awareness. The approach taken by DRDC Atlantic to address these challenges is to document the current state of existing and emerging maritime information and sensor systems for use in northern environments, and to explore how these systems can be cross-linked to increase the level of northern situational awareness.

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