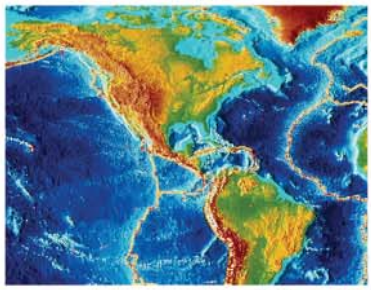
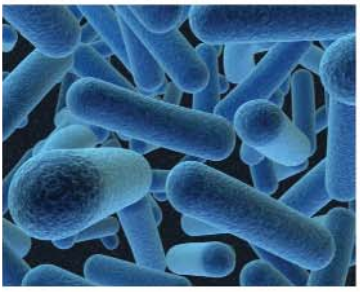
Defence Research and Development Canada
Recherche et développement pour la défense Canada

Public Security S&T Summer Symposium 2010 Proceedings

From Concept to Capability: Enhanced Public Security through Collaborative S&T





Defence Research and Development Canada - Centre for Security Science
June 14–17, 2010 Ottawa, Ontario

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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. DRDC CSS also identifies future trends and threats, and provides supports and services for all-hazards vulnerability and risk assessment, technology forecasting, and operational analysis.

Activities are undertaken through an overarching Public Security Technical Program, which is comprised of four theme areas: Defeat the Chemical, Biological, Radiological-Nuclear, and Explosives (CBRNE) Threat; Critical Infrastructure Protection and Cyber Security; Surveillance, Intelligence, and Interdiction (SII); and Emergency Management Systems and Interoperability (EMSI).

DRDC CSS also leads the Major Events Coordinated Security Solutions (MECSS) project that assisted the functional authorities in reducing the security risk associated with the Vancouver 2010 Winter Olympics (V2010) through the coordinated application of science and technology (S&T). DRDC CSS also oversees a number of international activities through agreements with the United States and the United Kingdom; and manages the Canadian Police Research Centre, which has a mission to harness S&T knowledge to strengthen police, fire, and emergency medical services in Canada.

The following abstracts outline the progress, from the first eight rounds of funding, of the projects in the domains of CBRNE, CIP, e-Security, Surveillance, and Emergency Management. These will be presented in posters at the Symposium, and also as technological demonstrations. As always, I am amazed with 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 continue to progress. 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 CSS

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CRTI 04-0018RD

Development of Standards for Decontamination of Buildings and Structures Affected by Chemical or Biological Terrorism

Project Lead:	Environment Canada
Federal Partners:	Public Health Agency of Canada, DRDC Suffield
Industry Partner:	SAIC Canada
Other Partners:	United States Environmental Protection Agency; University of Ottawa – Centre for Research on Environmental Microbiology; University of Leeds; Russian Research Institute of Hygiene, Toxicology, and Occupational Pathology

Objectives

The goal of this project is to develop clean-up standards for the decontamination of buildings after a chemical or biological attack. This work involves using data generated from exposure experiments and developing a generic approach to decontamination as well as specific guidelines for ascertaining "How clean is clean?" To this end, standards for agents that represent a real or potential risk for use in chemical or biological terrorism have been developed using three methods. First, the project team established the relationship between magnitude of exposure and expected health effects. Next, by considering primary routes of exposure (contact, inhalation, and ingestion), the team assessed the real and potential exposure risks. Finally, the team developed a methodology for identifying linkages between surface contamination of building materials and the resulting contamination by vapours of specific compounds of interest. Models are being used to incorporate previously developed algorithms.

Relevance

Decontamination of facilities following acts of biological or chemical terrorism is designed to mitigate hazards to the extent that the facilities can be recommissioned, usually to their former use. However, no suitable standards exist for determining residual levels considered safe for reoccupancy. Project members have used available literature and pertinent laboratory data from desorption experiments and animal exposure models to establish clean-up standards and to help determine whether levels necessary for rehabilitation are practically attainable. This project also established the likely cost of decontamination to acceptable levels and, if rehabitation is possible, determined whether use restrictions need to be in place based on expected inhabitants and any associated toxicological or pathogenic risks.

Recent Progress and Results

By combining laboratory results with values determined for safe concentrations in the air, for dermal contact, and for ingestion, it will be possible to determine safe concentrations on surfaces and set preliminary decontamination standards. The results of this study will then be used to develop a model that will determine "safe" surface concentrations of hazardous chemicals under various environmental conditions.

Environment Canada and SAIC Canada project members recently focused on the desorption of chemical agents of concern from building surfaces and in surrounding air at two selected temperatures. Project members generated experimental results from chemical studies involving four pesticides (lindane, carbofuran, diazinon, and malathion) and variables, such as temperature and surface materials. When compared to theoretical maximum concentrations of their respective vapours in air, results showed that, at room temperature, experimental and theoretical headspace concentrations were similar for all compounds except carbofuran. The experimental data for carbofuran were up to 500 times greater than the expected maximum concentration in vapour phase, and while headspace concentrations at 40°C were 5 to 10 times higher than at 20°C for all other compounds, carbofuran displayed similar results at 20°C and 40°C. Important material-dependent variations in vapour concentrations were also observed.

Initial costing modelling has been completed, providing a tool to estimate the value of resources needed to meet decontamination standards. Values derived from the costing model have been validated against actual clean-up costs from selected incidents. Cost scenarios were found to be conservative in nature and continue to be refined.

The University of Ottawa's Centre for Research on Environmental Microbiology (CREM) and the Public Health Agency of Canada have performed experiments on the biological side, focusing on determining the effectiveness of decontamination methods and

the use of surrogates for distinct threats. Work has been performed on those aspects of sampling that can have a large impact on assessing contamination of environmental surfaces. The results will have an impact on the selection of an effective means to decontaminate the surfaces and on the methodologies used for confirming whether the levels of pathogen reductions have been achieved.

Mathematical methods for determining decontamination standards have been proposed by several partners. Toxicological studies recently completed at the Russian Research Institute of Hygiene, Toxicology, and Occupational Pathology (RIHTOP) were based on these proposed standards. A complex set of equations was developed at RIHTOP to predict levels of concern based on hazard and toxicity indices and the physicochemical properties of a substance. Animal testing (rats and mice) of respiratory, dermal, and combined-exposure toxicity of substances was performed for the validation of the prototype method for setting decontamination limits.

Standards are being published for use by first responders and other government personnel involved in decontamination and reclamation. The information from this research will also be used to allow estimation of clean-up costs to determine whether a facility should be decontaminated and restored or simply demolished and rebuilt.

Impact

The project's interim report provided a solid foundation from which the laboratory experiments evolved. Clean-up standards methodologies have been established for those chemical and biological agents most likely to be used in an intentional release. The methodologies used in the experimental and modelling work can be developed into standards for additional compounds, enabling their use by a broad range of personnel, from first responders to top-level decision makers. Special emphasis should be placed on using standards and associated models for post-remediation clearance of facilities and for determination of potential usage of facilities following a contamination event. Consequently, standards may be made available in condensed format for use in emergency response scenarios. However, these should include more detailed analysis, including risk models, for determination of post-remediation use or for comparing the cost of remediation with that of facility destruction.

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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 of Canada, 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 objective of the project is to develop a national standard for personal protective equipment (PPE) for first responders (fire, police, and emergency medical services) in the event of a CBRN incident. The standard will provide realistic, risk-based guidance on selecting and using the appropriate level of PPE in the initial response to a CBRN incident. The standard will use a systems approach and identify the requirements for whole-body protection and protective system performance (including respiratory, ocular, and dermal), and will address integration with other equipment. A key objective of the standard is to provide guidance on the capabilities and limitations of protective equipment.

The aim of this new national standard is to enable first responders to do their jobs with greater protection and functionality.

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 the tools and information to help them do their jobs most effectively.

The new 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.

Recent Progress and Results

Members of the Canadian General Standards Board / Canadian Standards Association Standards Technical Committee for the Protection of First Responders from Chemical, Biological, Radiological and Nuclear Events have reached consensus on the standard. Committee members provided comments on the second draft, which were then reviewed at the 12th committee meeting in May 2009. Following the meeting, a first committee ballot was prepared, edited, and translated prior to distribution to members for a 30-day voting period that closed 1 February 2010. To address the comments received, resolutions were developed and the draft was revised accordingly. Consensus on the draft standard was based on the proposed resolutions.

With consensus achieved, the standard is now at the publication stage, where it is undergoing a final edit, translation, and verification. The standard should be published in August 2010.

The final version of the standard incorporates guidance on the capabilities and limitations of currently available equipment and on establishing requirements and a process for selecting recognized equipment that will provide broader capabilities. Selection principles are provided for chemical, biological, and radiological release and contagious outbreak events. The standard encourages a systems integration approach in which both the manufacturer and the user participate in qualifying appropriate equipment that will work together to protect and enable the responder to function as needed.

Impact

This is the first standard in Canada to provide 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 has brought together relevant stakeholders with world-class expertise in protective equipment development and evaluation for 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 of all groups linked together through the establishment of a national technical committee. The development of this standard will also accelerate the use of technologies.

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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
Federal Partner:	Health Canada – Health Products and Food Branch
Industry Partner:	Impfstoffwerk Dessau-Tornau GmbH
Other Partner:	University of Manitoba, 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 Health Canada's Health Products and Food Branch (HPFB), 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 and 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 GMP quality.

Impact

The deployment of these vaccines will provide Canada with a world-leading operational ability to protect the responder community from these hitherto 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 05-0108TD

National Nuclear Emergency Laboratory Network and Interoperability

Project Lead:	Health Canada – Radiation Protection Bureau
Federal Partners:	DRDC Ottawa, Royal Military College of Canada, Department of Fisheries and Oceans
Other Partners:	Ontario Ministry of Labour, Trent University

Objectives

The goal of this project is to develop a framework for the national laboratory network for radiological-nuclear (RN) emergency preparedness. Researchers in the participating laboratories will develop, test, and implement a collection of laboratory protocols and an information technology solution for laboratory results networking and reporting. Health Canada and the Ontario Ministry of Labour will develop, test, and implement gamma-ray spectra interoperability to increase capacity in the event of an emergency. In addition, the laboratory partners will conduct proficiency test and emergency readiness exercises in the network laboratories. In the final year, the partners will develop a network maintenance strategy with the goal of allowing other laboratories to join.

Relevance

Following an RN emergency, hundreds or thousands of field samples will need to be measured in a short period of time. Quality data and fast delivery of the results are essential to plan protective actions for the public and to ease concerns of the worried well. It is crucial to have well-established laboratory protocols and an efficient channel for sharing and reporting measurement results. The networking solution for laboratory results developed in this project will be implemented in the current participating laboratories and can be shared with others, thereby collectively enhancing the national response capability and capacity in an RN emergency.

Recent Progress and Results

The project partners participated in an emergency response exercise in which they analyzed spiked samples of water and air filters. Results were required within turnaround times of 24 hours, one week, and one month. The exercise provided the laboratories the opportunity to compare the results between them, as well as to identify improvements in the methodologies and reporting structure.

The development of the IT solution for data sharing between the partner laboratories is now completed. The software, LabNet, was installed in all of the laboratories and allows laboratory partners to input sample information and results of sample analysis and to share the results. Each laboratory was provided with a laptop computer with the software, allowing for portability should the need arise.

Three of the laboratories (Health Canada, Ontario Ministry of Labour, and Royal Military College of Canada) participated in the analysis of samples acquired during the nuclear emergency preparedness exercises of Environment Quebec (MDDEP). Air filters, charcoal cartridges, and water samples were sent to the laboratories from the exercise site. Participation in this exercise provided an excellent opportunity to test laboratory protocols for emergency samples. Furthermore, four of the samples (one air filter, one cartridge, and two water samples) were spiked with a traceable amount of radioactive material. This allowed for a limited intercomparison exercise.

The project team surveyed the capacity of Canadian laboratories conducting radiological analysis. The survey allowed the project team to collect emergency contact information, operating details, and sampling information for 39 facilities with radiation detection capabilities. Among them were universities, private laboratories, and federal and provincial government labs. The majority of the facilities contacted showed interest in joining the national nuclear emergency laboratory network. This offers the possibility of greatly expanding the current laboratory network capabilities, providing further support in the event of an RN emergency.

Impact

Participation in the emergency exercise in which the National Institute of Standards and Technology prepared blind spiked samples highlighted the need for exercises of this type in the future to test the capacity of the network. Such exercises provide the opportunity for further improving sample turnaround time and the precision in sample measurements, which would increase Canada's capacity to respond to an RN event.

The IT networking solution for laboratory results developed during this project will increase interoperability by enabling data exchange between laboratories using a standard format. As a result, information reported to decision makers will be simple, clear, and in a standardized form so that the results can be readily interpreted. Participation in interoperability exercises will strengthen communication and cooperation between the laboratories and will allow for continual improvement of response. The knowledge, capabilities, and applications resulting from this project will significantly enhance the national overall effectiveness and efficiency of RN emergency response operations.

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CRTI 05-0123TD
All-Hazards Sample Receiving and Storage Capability

Project Lead:	DRDC Suffield
Federal Partners:	Public Health Agency of Canada, Canadian Security Intelligence Service, Royal Canadian Mounted Police, DRDC Ottawa
Other Partners:	Toronto Police Service, Ontario Provincial Police, Toronto Emergency Management Services, Centre of Forensic Sciences, United States Department of Homeland Security, Edgewood Chemical Biological Center

Objectives

Responders are often called upon to handle samples of unknown composition. Although such samples are often subjected to on-site field screening tests, certified personnel within accredited laboratories must definitively identify the materials. To protect their facilities and personnel, gold standard laboratories will only accept certain classes of hazards. Thus, samples must be triaged. Currently, there are no triage facilities within Canada for all-hazards materials. This project will deliver the capability for an all-hazards sample receiving facility and the standard operating procedures (SOPs) and equipment to be used within it. A prototype facility will also be constructed, equipped, and demonstrated at DRDC Suffield.

The project team's work is divided into six phases: developing a list of specialized laboratory equipment and instruments for the facility; developing the technical specifications for the facility; developing SOPs for the facility; procuring specialized laboratory equipment for the facility; constructing and installing the facility; and demonstrating the facility complete with all its equipment and instrumentation. The development of the specialized equipment list and technical specifications will involve consultation with several end-user support groups (both laboratory workers and first responders) to ensure their needs are met. When the specifications for the equipment and facility are completed, work will begin on developing the SOPs for receiving samples (i.e., packaging requirements), processing samples (equipment and technique-based protocols), decontaminating samples, if necessary, and forwarding samples to the appropriate laboratory for confirmatory analysis. In parallel to the above processes, procurement of the equipment for the facility will be ongoing. Finally, the facility will be demonstrated in an international exercise involving several first responder groups. The entire project is envisioned to take approximately three years.

Relevance

This project will provide Canada with a more efficient response by ensuring that samples are quickly and properly triaged and directed to the appropriate analytical facilities, while ensuring the safety of the facilities and laboratory personnel. Establishing validated, forensically sound SOPs, using standardized equipment, and providing storage for contaminated material will ensure that the integrity of any investigation is preserved.

Recent Progress and Results

The project team has identified the type of analysis that will be performed in the facility, as well as the specialized and generic equipment required. Equipment procurement is ongoing with approximately 90 percent of this task already completed.

This past year, the project charter was successfully reprofiled to modify timelines, money, and to add partners from the United States (US). Concurrently, a cooperative activity agreement has been signed for the project under the Public Security Technical Program (PSTP) to allow for collaboration between DRDC Suffield, the US Department of Homeland Security (DHS), and the US Army's Forensic Analytical Center's Mobile Laboratory and Kits Team at Edgewood Chemical and Biological Center (ECBC) in Aberdeen, Maryland. With DHS's funding, the ECBC has recently constructed three All-Hazards Receipt Facilities (AHRFs) similar to the facility defined in this project's objective. The AHRFs are mobile and modular platforms designed to ensure safe in-processing and pre-screening, as well as accurate assessment of samples of unknown or dubious origin that may contain chemical, biological, radiological, highly-explosive residue, or toxic industrial materials. This design precludes contamination of the sample, the operator, the facility, and the environment while meeting the public health needs and the requirements of the law by protecting forensic

evidence. The system integrates primary and secondary containment (Biological Safety Level (BSL)-2 and BSL-3 along with chemical filtration) with a robust analytical methodology that provides a fail-safe system for unknown materials assessment.

Collaborative efforts have been initiated with the United Kingdom (UK) and Australia to explore the development of international standards for sample screenings. The UK has a similar capability already established in their National Network of Laboratories (NNL). Australia, through the New South Wales Police, is establishing its capability. The NNL is much more defined with five facilities in place and operational, allowing effective screening of samples and transition from the field to the downstream analytical laboratory. A similar capability is desired in Canada.

Impact

Canada does not currently have an all-hazards sample receiving and storage facility, and responders and analytical laboratories alike have identified this gap. Working closely with international partners, the project team will develop a prototype facility that will serve as the basis for the operation of similar facilities elsewhere in Canada. The development of facilities that allow samples and other hazardous materials, regardless of their nature, to be received, triaged, documented, sampled, and stored in a standardized, forensically sound fashion will have a major impact on investigations involving CBRNE materials, unknowns, and mixed threat materials.

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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 $10^{6.5}$ plaque-forming units/ml or up to 10^{10} 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 (IHC).

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
Other Partners:	McMaster University, Atomic Energy of Canada Limited, 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 priorityneeds, 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.

This past year, the project team conducted its annual exercise as part of Exercise Gold, the final exercise carried out in preparation for the 2010 Winter Olympics in Vancouver. Participation in the exercise provided federal, provincial, regional, and municipal organizations with the opportunity to validate their readiness to respond in a coordinated manner to any emergency occurring at the Winter Games. For the first time, two cytogenetic laboratories also took part in the exercise, scoring slides prepared at Health Canada.

To complement the existing biodosimetry capacity in cytogenetic laboratories across Canada, a training program has been developed and integrated with the course curriculum at the Clinical Genetics Technology Program at the Michener Institute, which trains 16 cytogenetic technologists each year. A training program, which provided training to eight students, was also introduced at Ste-Justine Hospital in Montreal this year. The students are 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 pilot study led by United States (US) partner Oak Ridge Institute for Science and Education. The pilot study aimed to test the feasibility of scoring chromosomes using web-based image sharing.

In May 2010, Canadian and US project partners met at a half-day biodosimetry workshop in Ottawa to discuss the current state of biodosimetry and ways to strengthen ties between the two countries.

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 06-0150TD

Integrated Blast Risk Assessment for Improved Preparedness and Response

Project Lead:	Public Works and Government Services Canada – Real Property Branch
Federal Partners:	Royal Canadian Mounted Police, Natural Resources Canada – Canadian Explosives Research Laboratory
Industry Partner:	ABSG Consulting
Other Partners:	McMaster University, University of Ottawa

Objectives

The objective of this project is to develop and demonstrate risk assessment tools for improving preparedness and response capabilities against blast threats. The objective will be achieved through the development of four tools: a screening tool; an evaluation methodology; a mitigation retrofit guideline; and a post-event on-site assessment guideline, and by the provision of two training workshops for blast emergency responders and end-users.

Public Works and Government Services Canada (PWGSC) leads and manages the project. Natural Resources Canada's Canadian Explosives Research Laboratory (CERL) is the lead in conducting field testing with test specimens supplied by McMaster University and acts as consultant to PWGSC for the screening tool development. McMaster University is responsible for the development of the evaluation and post-blast assessment tools and for providing refined P-I diagrams for the screening tool. The University of Ottawa is responsible for performing shock load tests in support of the development of the retrofit guideline. The RCMP and ABSG Consulting will provide technical advice to the team.

Relevance

This project will aid blast risk preparedness by supporting the rapid evaluation of buildings with the screening tool so that: risk ranking and prioritization can be made; high-risk buildings can be evaluated to determine mitigation needs; and the buildings can be upgraded cost-effectively with the retrofit guideline. The on-site assessment tool will be field deployable for post-blast investigations. Training sessions will be given to end-users, including first responders.

Recent Progress and Results

The project consists of five parts: development of separate guidelines for screening, evaluation, retrofit, and post-blast safety; and provision of information/training sessions for end-users.

The rapid screening tool developed by CERL, PWGSC, and DND is undergoing further development through the addition of pressure-impulse (P-I) diagrams to cover more construction types. The University of Ottawa is assisting PWGSC and CERL in refining the screening tool, which can be used to conduct preliminary risk assessments for ranking buildings according to their risk level.

Buildings identified as high-risk through screening require more detailed evaluation to determine potential needs for mitigation. The evaluation guideline provides guidance on the use of various methodologies for structural analysis, including the reliability-based approach. Development of the guidelines involves modelling, simulation, and testing. McMaster University and CERL conducted three series of field tests (two in 2008 and one in 2009) on concrete, steel, and masonry components at CFB Petawawa.

The retrofit guideline is to provide guidance on blast mitigation technologies. The University of Ottawa's shock tube, which allows scientists to test the vulnerability of building components to bomb damage, became operational in December 2008. With support from CERL, the University of Ottawa is completing a final series of tests using the shock tube on concrete and masonry components. Consideration has been given to various retrofitting technologies.

The post-blast safety evaluation guideline is to be used for on-site evaluation of a building after a bomb blast. Development of the methodology will make use of the evaluation guideline and test data.

Two information/training sessions are to be given to blast emergency responders and end-users in June 2010. The project is to be completed by September 2010.

Project work has resulted in the publication of two papers; two other papers are to be published in late 2011. Although not directly related to the project work, the project team also contributed 7 of 10 articles in a special issue on blast engineering published by the Canadian Society for Civil Engineering.

Impact

Blast risk assessment in Canada is a relatively new activity with limited knowledge and capacity. The proposed risk assessment methodology is a novel approach, which links both the preparedness (screening and evaluation) and response (post-blast assessment) requirements in an integrated manner. The integrated tool supports the establishment of national blast risk assessment tools.

The risk-based tools the project develops will provide quantitative and qualitative information on blast risk assessment. There is currently no method readily available that fulfils the requirements of reliability-based analysis for blast risk assessment. It is the purpose of this investigation to bridge this knowledge and capacity gap.

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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:	SAIC Canada, Allen-Vanguard Corporation
Other Partners:	Queen's University, United States Environmental Protection Agency, Mendeleev University – Russia

Objectives

This project is aimed at modifying the Canadian Aqueous System for Chemical and Biological Agent Decontamination (CASCADTM) to expand its area of application to radiological decontamination. This will be achieved by incorporating proven, low-cost, commercially available radionuclide sequestering agents into the current formulation.

This work is to develop the means and methods needed to decontaminate an area after an event involving radiological contamination in combination with at least one other contaminant, such as chemical or biological, or where the type of contamination is unknown.

The intent is to provide a universal surface decontamination formulation for materials exposed to radioactive isotopes of cesium, strontium, and cobalt, and that retains or enhances CASCAD's existing chemical and biological (CB) decontamination and blast suppression characteristics.

The newly developed surface decontamination formulation will be extensively evaluated on a variety of CBRN contaminants. Results of the evaluation will serve to develop guidance documents and manuals for decontamination teams.

Relevance

Inadequate decontamination capabilities are identified as a main gap for radiological risk assessment scenarios. This shortfall includes a trial-and-error approach for selecting decontamination methods that have generally low deactivation efficiency and generate a large volume of radioactive waste materials. These deficiencies seriously hinder the efforts of responders and decontamination teams. The proposed study will result in improved overall process efficiency, simplified waste treatment, reduced operation time, and lower costs.

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 strongly bound 1:1 complexes with Co^{2+} and Sr^{2+} ions. They were also stable in aqueous solutions of GCE 2000 and GPB 2100 (components of CASCAD). However, in the aqueous solutions containing GPA 2100 (third major component of CASCAD), oxidative decomposition of chelating ligands occurred to some extent. Among the four identified polycarboxylates, NTA and CA were found to be most effective in terms of solubility, biodegradability, stability to oxidation, and toxicity. For cesium, potassium hexacyanoferrate and ammonium nitrate were found most effective.

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 various surfaces, 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 in the existing formulation. The test results revealed improved effectiveness when the sequestering agents were added to the foam.

Impact

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

The modified CASCAD formulation will increase Canada's preparedness for remediation after a terrorist event or an industrial accident. The new CASCAD 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. The outcome of this project will 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:	Science Applications International Corporation Canada (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. This project will build on novel solution chemistry developed by Queen's University wherein metal ions catalyze the decomposition of OP agents through their reaction with light alcohols. Specific objectives include

- creating solid supported catalysts;
- developing appropriate low toxicity/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 its reuse;
- demonstrating a pilot-scale soil remediation system; and
- developing methodologies for building, equipment, and soil decontamination.

Environment Canada manages the project and evaluates the catalytic systems for decontamination of sensitive equipment and building materials. Queens University develops and supplies the catalysts to the partners for testing. SAIC Canada tests the catalytic systems for decontamination of soils contaminated with OP pesticides. RMC, The Research Institute of Hygiene, Occupational Pathology, and Human Ecology (RIHOPHE), and DRDC Suffield are testing the catalytic systems to destroy live OP agents on surfaces and in a liquid phase.

Relevance

OP compounds are among the most toxic agents that can be used for chemical terrorism. Their toxicity and availability as industrial chemicals also pose a threat to the environment.

Although the mechanism and the kinetics of the catalytic degradation of OP compounds have been thoroughly investigated, the decontamination of urban surfaces, sensitive equipment, or contaminated 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-product formation. Reusing the solvents reduces the environmental footprint and the quantities of solvents that are needed.

Recent Progress and Results

Queen's University scientists developed palladium (Pd)-based, solid-supported and homogeneous catalysts for decomposition of the P=S type of OP pesticides. They also improved a previously developed solid-supported La-based catalyst designed for the destruction of OP CWAs and pesticides with P=O bonds. Catalysts containing low flammable co-solvent (HFE-7100) were investigated. A liquid catalyst containing Pd-complexes in a buffered methanol solution was found to be very effective in destroying parathion. The Pd-based solid catalysts (ortho-palladated complexes immobilized on silica or polymer supports) were designed for decomposition of diazinon, fenitrothion, and coumaphos. Lanthanide metal ions were affixed to silica and polystyrene using dicarboxylic acid ligands. All matrices showed high activity in methanolysis of p-nitrophenyl methylphosphonate with the reaction half-life within seconds and high apparent second order rate constants. Of all the lanthanides, La^{3+} and Yb^{3+} with similar ligands (ethylenediamine diacetic acid) loaded into silica showed the best results. The researchers also investigated the effect of

non-polar co-solvent (HFE-7100) on reactivity of Pd- and La-based catalytic systems. Results demonstrated that the activity of the catalysts against OP agents decreases linearly with the increase in concentration of HFE-7100 in the solution. Activity remains high enough if HFE-7100 amounts are less than 40 percent (v/v) in Pd-based catalytic system and not more than 50 percent (v/v) in an La-based catalytic system.

Environment Canada addressed analytical issues and conducted decontamination tests involving Pd-based solid-supported catalyst, diazinon, and materials that represent sensitive equipment, such as plastics, painted steel, and circuit boards. A two-step decontamination process—removal of diazinon from the surfaces with methanol followed by decontamination of the solution with the Pd-based solid catalyst—was studied. More than 99 percent of diazinon was removed from surfaces by methanol extraction within 1 to 15 min. The researchers found that diazinon reacted with some of the tested plastics. The Pd-supported catalyst yielded a complete and rapid decontamination of the extract generated when diazinon was removed from the plastic materials.

SAIC Canada conducted a decontamination study on soils. Alcoholic solvents, such as methanol and isopropanol, were effective in extracting OP pesticides from soil. Up to 85 percent of malathion and 78 percent of diazinon were extracted in 30 minutes after a single pass. Polymer beads were used for the solid-phase extraction of pesticides from soils. After a single pass, up to 80 percent of diazinon was extracted in 24 hours. Up to 21 percent of the extracted pesticides were transferred to methanol in 24 hours. The solvent was then decontaminated by Pd-based, solid-supported catalyst with decontamination efficiencies ranging from 50 percent to more than 90 percent for different conditions. The catalytic system was reusable and found to be more effective in buffered media but could also be used once without buffer with a possibility of regeneration.

RIHOPHE performed decontamination tests with a live agent (Russian VX) to address analytical issues, evaluate the efficiency of La-based catalysts, identify by-product after decontamination, and evaluate toxicity of the by-products using a biochemical assay. Products of Russian VX decomposition did not inhibit the acetyl cholinesterase in the assay even at high concentrations. The results showed the complete degradation of Russian VX and the absence of highly toxic by-products in the post-decontamination solution. The efficacy of the catalyst was found to be unaffected by Russian VX decomposition products and by extractable components of plastics. The project team confirmed the high efficacy of the catalyst against Russian VX in a number of tests on different batches of Russian VX.

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. By allowing reuse of the solvents and catalysts, the decontamination methods present an enhanced environmentally and economically friendly solution for the destruction of OP compounds. The use of low-flammable, low-toxic perfluorocarbons as solvents will reduce harmful effects on the environment and responders. The possibility to reuse the reaction media will also highly reduce the amount of runoff. The rapid and complete destruction of OP agents will prevent the risk of contamination of the environment by the breakdown products.

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CRTI 06-0171TA

Explosives Storage Magazine Large Opening Door Design

Project Lead:	Natural Resources Canada – Explosives Safety and Security Branch
Federal Partners:	Natural Resources Canada – Canadian Explosives Research Laboratory, Royal Canadian Mounted Police (RCMP) – Protective Technical Services Branch
Industry Partner:	APEX Industries Inc.

Objectives

The objective of this project is to address a security shortcoming of the May 2001 revised *Storage Standards for Industrial Explosives* by designing, fabricating, and installing two distinct large-opening door prototypes for explosives-storage magazines. In the first year (2008–2009) of the project the main milestones were to conduct bullet-resistance research and sample preparation with APEX Industries; complete the bullet-resistance testing at the Canadian Explosives Research Laboratory (CERL); with APEX, come up with a preliminary design concept for the doors; and review the design with the RCMP. In the last year of the project (2009–2010), the objectives were to complete the designs, fabricate prototypes, submit them to a force attack, review and upgrade the design according to the results of the force attack, fabricate and install the prototypes in the field, and monitor them over the.winter months. These enhanced, secured, and bullet-resistant prototypes will accommodate traditional mobile materials handling equipment.

Relevance

In the interest of national security against terrorism, it is essential that the Government of Canada, through Natural Resources Canada's Explosives Regulatory Division (ERD), ensures that explosives are stored in a secured manner and will not readily find their way into the public domain.

Recent Progress and Results

The approach of the project team will be to modify a number of existing technologies, such as those associated with detention security, coupled with a number of physical security enhancements (barriers) to enable a novel application for in-service use. The novel doors will be installed and evaluated at two private, licensed explosives manufacturers and vendors offering vastly different security situations.

In the 2008–2009 fiscal year, the project team researched bullet-resistant material applicable to the project in collaboration with APEX; tested the bullet-resistant panels at CERL with APEX, developed the preliminary design concept for the two different door designs, and reviewed the design with the RCMP.

Over the 2009–2010 fiscal year, the project team fabricated two prototype door types, submitted them to a force attack test, and installed them at the site of two private, licensed explosives manufacturers/vendors. The team also completed technical drawings in both official languages.

Impact

The final door designs will contribute to hardening the target storage magazine to restrain known skill levels of adversaries who are using today's newer, more powerful, portable tools. The advanced physical attributes of the newly designed and fabricated doors, coupled with electronic security enhancements, will improve security preparedness against attempted theft by providing additional response time for the authorities.

In addition to the door prototypes, the project team will develop a national standard specification and design drawing package for all new large-opening magazine installations. This package, which will provide an economical retrofit for existing magazine sites, will be for use by approved ERD fabrication shops on a need-to-know basis. Additional leave-behinds will include the test results and recommendations regarding various bullet-resistant composite panels.

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CRTI 06-0186RD
Novel DNA-Based Radiological Dosimetry Technology

Project Lead:	National Research Council Canada – Industrial Materials Institute
Federal Partners:	Royal Military College of Canada, DRDC Ottawa, Department of National Defence – Director General Nuclear Safety
Other Partners:	Université Laval, Centre Hospitalier Universitaire de Québec – Centre de Recherche en Infectiologie

Objectives

During a CBRNE incident, the level of exposure and health threat to first responders and other operational authorities must be appropriately managed. Radiation dosimetry is used to evaluate, control, and communicate the potential health risks associated with a radiological event. However, determining dosimetry for a CBRNE event is difficult because of the unknown nature of the radiation field and the possibility of a mixed radiation field of differing quality (e.g., alpha, beta, gamma, and neutrons).

A number of dosimetry techniques are currently in use. For a complete mixed-field measurement, specialized equipment has been developed using sophisticated instruments that employ a spectroscopy method for either linear energy transfer or lineal energy. Nevertheless, all of these dosimetry techniques rely in principle on physical methods (i.e., thermoluminescent dosimetry, and electronic personal dosimeters) measuring changes in inorganic molecules.

In contrast, this project's proposed dosimeter will measure radiation-induced damage in DNA. The project will build on current research to develop a personal and wearable dosimeter using a highly innovative approach based on the specific recognition of DNA damage. The proposed dosimeter will be small, field deployable, and sensitive to detecting damage from all types of radiation.

Relevance

The proposed dosimeter will improve criminal and national investigational capabilities by diagnosing the presence of radiological-nuclear (RN) material and helping to determine the associated risks. This field-deployable technology will also enable early screening and diagnosis of individuals exposed to RN agents, which will help authorities respond more quickly and potentially reduce the number and severity of casualties.

The wearable, rapid dosimeter will be capable of detecting total damage from various radiation energies and of discriminating between threatening and non-threatening agents or doses. These capabilities will help address public health concerns, improve medical response, and increase public confidence.

Recent Progress and Results

In the last year, the project team has looked at different approaches for detecting DNA breakage by radiation. The Royal Military College of Canada developed a new approach using a dual-labelled oligonucleotide sequence that has produced the best results so far. Fluorescence measurements were conducted on the samples in collaboration with the Centre d'optique, photonique et laser of l'Université Laval. Preliminary data indicate that doses as low as 250 mGy may be detected, making this assay comparable to detection levels currently obtained with standard biodosimetry techniques. The comet assay is currently being used as a validation technique by DRDC Ottawa to compare the team's method with radiation measurement standards.

Project team members also investigated other ways to build a dosimeter using DNA. The Industrial Materials Institute has worked on harboring DNA directly on a solid surface to measure the DNA broken by radiation. They used a proprietary cationic polymer developed at the Centre de recherche sur les matériaux avancés. For the exposure module, the Centre de recherche en infectiologie is currently investigating different synthesis techniques that could enhance the stability of oligonucleotide targets on solid support and, as a result, reduce DNA background. The project team is making sure that radiation dose levels measured by the developed technology satisfy the requirements of Director General, Nuclear Safety. The team is currently working on improving the sensitivity of the technology to reach the mGy level.

Impact

It is anticipated that this device will have broad implications in many disciplines (e.g., military, counterterrorism, aerospace, medicine, and advanced radiation protection dosimetry for the nuclear industry). This project will improve Canada's ability to prepare for and respond to a terrorist attack by addressing many priority CRTI scenarios for preparedness.

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CRTI 06-0187TD
Portable Biological Agent Detection System

Project Lead:	National Research Council Canada – Industrial Materials Institute
Federal Partners:	National Research Council Canada – Steacie Institute for Molecular Sciences, Royal Canadian Mounted Police, DRDC Suffield
Other Partners:	Université Laval – Département de Chimie, Centre de Recherche en Science et Ingénierie des Macromolécules, 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 at such low concentration levels that neither polymerase chain reaction amplification nor chemical tagging is necessary, 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

In September 2009, the RCMP tested the first instrument prototype comprising a fluidic interface developed by the Industrial Materials Institute, as well as the integrated optics for detection developed by the Centre d'optique, photonique et laser of l'Université Laval. The demonstration generated valuable information on use of the equipment and required improvements.

As a result, a second prototype is under development. Once completed, the new prototype will include automated cell lysis and fragmentation steps, and will be able to process different powdery samples. In the meantime, the Centre de recherche en infectiologie (CRI) has been actively testing different powders likely to be used in a terrorist attack. DRDC Suffield is working in collaboration with CRI to deactivate anthrax and prepare other surrogates needed for a technical demonstration.

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. 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 using FCR is currently being adapted to the method of sample preparation and fluidic manipulation of beads. The final demonstration is planned for fall 2010.

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 06-0192TD
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 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 would 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 (RMC), Sorbecon Research, and Phoenix OHC, will develop the procedures and transfer the information to RCMP and Health Canada response teams so that the capability can be demonstrated within their organizations. Capabilities are being 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, system integration, and field expedient assessment of protection.

Relevance

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

The approaches are combined to ensure that appropriate respiratory protection levels are provided to every wearer when they are required, minimizing the opportunity for equipment failure. Outcomes on best practices are also being incorporated into the draft Canadian CBRN standard CGSB-205.1-CSA Z1610: *Protection of First Responders from Chemical, Biological, Radiological and Nuclear (CBRN) Events,* as part of the CRTI project "Development of a Canadian Standard for Protection of First Responders from CBRN Events" (CRTI 05-0016RD).

Recent Progress and Results

The project covers the required ground through three different streams of activities: simulated workplace protection factor (SWPF) evaluations; individual system qualification (ISQ); and field-expedient protection (FEP) methods. All these activities involve evaluating the protective performance of a respirator when worn by measuring the leakage of a challenge (test) substance, consisting of a sub-micrometer diameter particulate such as oil or salt, into the respirator through the face seal or other components.

ISQ addresses the process of qualifying the entire system with each individual, that is, ensuring that all system components are properly sized (respirator, suit, and ancillary equipment) and appropriately integrated. After initial developmental demonstration with the technical team's assistance, these procedures have been fully implemented operationally and documented within the RCMP for several different user groups. SWPF evaluations address the proper selection and integration of the respirator into the full protective system for a specific population of first responders. In the last year, standardized methods using salt challenges have been developed to systematically identify any integration problems for APR and PAPR systems. A demonstration of protective system integration was performed with Health Canada. Performing SWPF on PAPR and SCBA respirators is technically more challenging due to background particle generation. Several different approaches have been developed, including adding a filter to the air-line or challenging with oil and using a different detection system, with qualification of these methods underway.

FEP methods assure that, when donned 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. Issues involving performance of the system at low

temperatures, and when particulate challenge concentrations are low, are being addressed. Performing FEP on SCBA is extremely challenging as the respirator cannot be modified for sampling. It has been proposed that certain tests be performed during ISQ of an SCBA system that would provide extra surety of positive pressure performance at high work rates.

Impact

The project's outputs will be transferred directly to a significant portion of the federal response community as the full RPP is implemented with five different CBRN RCMP and Health Canada responder groups. Further uptake by the response community is expected through information and resource sharing as well as implementation of the Canadian standard (planned for 2010). The project will deliver SWPF, ISQ, and FEP capabilities for powered APR, APR, and SCBA by project close-out at the end of 2010.

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CRTI 06-0202TD

Short-Range BioSpectra: A Device for the Surveillance of Bioaerosols in Large Indoor, Semi-Enclosed, and Outdoor Spaces

Project Lead:	DRDC Valcartier
Federal Partner:	DRDC Suffield
Industry Partners:	INO; MacDonald, Dettwiler and Associates Ltd.; Telops
Other Partners:	CAAM, Workplace Health and Safety Programme (WHPSP), Sûreté du Québec (SQ)

Objectives

The objective of this two-year technology demonstration (TD) project is to build a short-range light detection and ranging (LIDAR) system with command and control (C2) networking capabilities for the remote detection and classification of bioaerosols from laser-induced fluorescence. The device must be small and have low weight. SR-Biospectra will have a range from about 5 to 100 metres and more for detecting the presence of biothreats over indoor, semi-enclosed, and outdoor venues at minimal costs.

Based on work done at DRDC and INO, as well as first responder interviews conducted by INO and MacDonald, Dettwiler and Associates (MDA), an alpha model was designed, built, and tested at DRDC Valcartier in December 2008. Based on lessons learned, a beta prototype has been designed, built, and tested at DRDC Valcartier and DRDC Suffield. INO is designing and integrating the hardware; MDA is developing the C2 system; and DRDC provides the spectral exploitation algorithm and testing and evaluation facilities.

Relevance

SR-Biospectra, a short-range, compact spectrometric laser-induced fluorescence LIDAR system, will address operational deficiencies in bioterrorism prevention, surveillance, and alert capabilities. More specifically, SR-Biospectra will detect and classify biothreats in aerosol form over critical indoor, semi-enclosed, and outdoor venues. The technology will allow for continuous monitoring to detect unusual concentrations of fluorescing bioaerosols at a precise remote location, within seconds. Rapid detection of a bioaerosol release will permit timely implementation of measures to protect the public and minimize the extent of contamination.

Recent Progress and Results

This project was completed successfully by April 2010. The TD was designed in two cycles, alpha and beta, as a risk reduction measure. First, an alpha prototype was built and tested at INO and at DRDC Valcartier. Analysis of the results confirmed that the prototyped concept has sensitivity better than the minimum targeted by the TD. Based on the lessons learned from the alpha cycle, a beta demonstrator was designed and built by combining a 1 kHz, 100 µJ/pulse, eye-safe, 355 nm pulsed laser; a motorized adjustable focus collection optics of 20 cm in diameter; and a high throughput spectrograph with multi-anode linear Photo-Multiplier Tube (PMT). These components were integrated within two main modules, an optical head and an electronic enclosure, the two being linked mainly with fibre optical bundles. Measurements are done by gating the charge collection from the 32-channel PMT with small-form factor 32-channel gated integration electronics. The spectral channels span from 425 to 700 nm. Command and control software, including an automatic and manual surveillance mode as well as a signature acquisition mode, was integrated with the demonstrator. This software also includes a spectral classification program assessing the type of compound at the origin of a fluorescent signal, based on a library of spectral fluorescent signatures. The beta demonstrator was tested at DRDC Suffield with the Lidar adapted bioaerosol chamber and with well characterized challenging clouds of *Bacillus globigii* (BG), *Erwinia herbicola* (EH), Ovalbumin (OV), and bacteriophage MS2. From the data collected during these releases, an upper sensitivity limit of 40 ACPLA (BG) at a range of 100 metres was demonstrated. This result was obtained at four times the standard deviation of the noise level before generating an aerosol cloud 10-metre thick of BG spores having an average diameter of 3 µm and an ACPLA/ppl ratio of 25 percent (ppl derived from the integration of the number of particles having diameters between 1–10 µm). Following a similar procedure, the demonstrator also showed sensitivity well below 10 ACPLA for EH, less than 80 plaque forming units per litre of air (pfu/l) with MS2, and well below 0.1 µg/l for OV. Also during this trial, five runs of blind releases were performed to evaluate classification capabilities. For each of the blind releases, the demonstrator successfully classified the challenging clouds within less than a minute from the moment the cloud was generated. In addition, daytime evaluations showed the anticipated sensitivity degradation while remaining capable of detecting most challenging clouds produced during the trial.

All objectives of this TD, besides the unit size and cost, have been clearly demonstrated. Furthermore, by aligning more closely the sensitivity of the device with the needs of first responders, the targeted unit size and cost can be easily achieved through a last technical acceleration (TA) cycle.

Impact

SR-Biospectra is a novel bioaerosol detection and classification device that will significantly improve CBRNE detection, surveillance, and alerting systems over populated areas. This autonomous device will perform the remote, continuous monitoring of pre-programmed volumes having lines of sight over 360 degrees in azimuth and at ranges up to 100 m. Once networked under a C2 station, several devices can provide alert status for the presence of biothreats within seconds of an event over an area that may cover several square kilometres of varying geometric complexity. These characteristics result in a more effective and efficient response to a CBRNE event, aiding in both rapid determination of the scale of the event and evacuation planning. Additional characteristics, such as a moderate acquisition cost, small size, and eye safety, will facilitate the device's deployment over a variety of sites that attract large populations over wide areas, such as subways, stadiums, malls, airports, and harbours.

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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 will be coupled with 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 software will be compatible with the RCMP CBRNE Incident Database (CRTI 04-0047TD) currently being developed.

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 public, 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 concurrently for phases 1, 2, and 3 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 nitrate mixtures (urea, ammonium, and metal nitrates), as well as a variety of peroxide homemade explosives (HMEs). 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 metal nitrate 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 for the explosive mixtures.

A contract for the development of the software tool has been implemented with AMITA. Progress on Version 1 of the software includes completion of the system development charter; development of the methodology; development of the functional requirements (draft mode - living document); and design-development of the technical architecture (ongoing). The project team's HME investigators interact closely with the team's software developers to ensure that all data-entry modes (drop-down lists, data characteristics, methodologies) work in a tight, user-friendly fashion. Consensus among the end-users (DRDC, Canadian Explosives Research Laboratory [CERL], Public Safety Canada, 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 (US), the United Kingdom (UK), and Australia. The project

itself will deliver a database of knowledge associated with IE. In addition, the breadth of expertise associated with the project will result in a strong network of knowledge spread across Canada (DRDC Suffield, DRDC Valcartier, the CERL, Public Safety Canada, and the RCMP).

This expertise has already been used by the Canadian Forces (advice on in-theatre IED compositions), 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), and training airport security screening personnel (simulant development for Transport Canada and the US Department of Homeland Security).

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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 of Canada – Biotechnology Research Institute
Industry Partner:	The 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 to100 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 ten formulations combinations of surfactants and complex carbohydrates. Each of these improved the physical stability of the virus at -20 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-exposure treatment 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 of Canada
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 two years of the project, the project team made progress in four major tasks: developing a rapid bioassay method for Sr-90 in urine; studying the optical response of quantum dots to radiation; studying the formation of volatile P-2010 species in excreta and testing the reliability of alpha spectrometry method for Po-210 urine bioassay; and synthesizing magnetic nanoparticles for new separation chemistry.

The 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 two papers in peer-reviewed journals. The researchers studied method selectivity and summarized the results in a paper submitted for publication. In addition, a fully automated flow scintillation system has been set up to automate this method in hope 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 studied in collaboration with Oak Ridge National Laboratory. The study on the metabolism of Po-210 in rats was conducted at Atomic Energy of Canada Limited, Chalk River Laboratory. Control animals and animals that received an intravenous injection of Po-210 were housed in an airtight metabowl™ system. Everyday for five days, all animals were monitored for volatile Po-210 in their excreta. Urine samples from the rats were assayed by both alpha spectrometry method and liquid scintillation counting method. It turned out that the formation of volatile Po-210 species in vivo was low and the alpha spectrometry method is reliable for Po-210 urine bioassay. The outcomes from this study have been summarized into four papers; two of them have been accepted for publication and the other two have been submitted.

The magnetic nanoparticles were synthesized, characterized, and tested for their application in separation of Sr-90 from urine samples. The results were submitted as one paper for publication.

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:	University of Ottawa Heart Institute
Federal Partners:	National Research Council – Institute for Information Technology, Public Health Agency of Canada
Industry Partners:	AMITA Corporation, SilvaCorp, E-Privacy Management Systems Inc.
Other Partners:	University of Ottawa Heart Institute, Ottawa Public Health, The 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 is still in progress. The majority of the Phase 2 deliverables have been completed. Hospital Ethics Board Approval has been received and all hospitals participating in Phase 2 have signed an information sharing agreement. 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. Ottawa Public Health has been accessing the system since September 2009 and data feeds are being received from The Ottawa Hospital (Civic and General campuses). Work is continuing on adding data feeds from the Children's Hospital of Eastern Ontario and Queensway Carleton Hospital. A second ASSET Study/Stakeholder meeting was held at the NRC in mid November 2009 and had over 50 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 second ASSET newsletter was produced in March 2009 and featured articles on the Ottawa deployment of the ASSET-RODS system, the DRDC Public Security S&T Summer Symposium, and a profile of the NRC. An updated privacy impact assessment was also completed for the project. Phase 2 deliverables currently in progress include a public health user study and feedback on Ottawa deployment issues.

Phase 3 started in August 2008 and is still in progress. It covers the development of the new ASSET Version 1 system. Deliverables completed in this phase include a technical option evaluation, statement of requirements, and design for ASSET Version 1. Future work planned for Phase 3 includes building and deploying the ASSET Version 1 system.

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 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 will 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 was one invention that 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 the 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 06-0236TA

Improvised Explosive Device—CBRN Database Explosives Incident Expansion Project

Project Lead:	DRDC Valcartier
Federal Partner:	Royal Canadian Mounted Police – Canadian Bomb Data Centre
Industry Partner:	AMITA Corporation

Objectives

Improvised explosive devices (IEDs) are a growing threat both in Canada and internationally. As such, this project is expanding CRTI 04-0047TD "CBRN Incident Database" (CID) to include a military component. The increase in scope moves the project from being a technical demonstration to a technical acceleration project. The military component is being added to the project as the Canadian Forces have first-hand knowledge of IED design and materials in troubled areas of the world, such as Afghanistan. It is important that Canada's domestic police force have access to this knowledge base and intelligence. IED-CID will create an operational system that will align civilian sources of CBRNE threats and create a new level of interoperability. The military application will offer new geographic recording and analysis of CBRNE incidents, statistic, broadcasting, and pattern detection capability.

Relevance

IED-CID will enable responders to break the cycle of IED mobility by aligning both domestic and military sources of information. The new extension will also enable the secure recording and sharing of critical incident data among all partners—military and civilian, Canadian or international.

The IED addition will gather information on the latest techniques in areas of the world where IED attacks are prevalent, such as Iraq and Afghanistan, and share this leading information with domestic civilian forces to improve their level of knowledge on IEDs, specifically with regard to how to identify them and the proper render-safe procedures to mitigate the force of an attack.

IED-CID operates on a proven model; the initial CRTI-funded project CID transitioned seamlessly from a technology demonstration project to Socius, a commercial, global CBRNE incident database that is market ready. The RCMP has implemented Socius nationwide. In Colombia, the Colombian National Police Force has implemented Socius. IED-CID takes the principles behind Socius and adds a layer that allows for the sharing across different disciplines (e.g., civilian, military).

IED-CID will operate on two principles: aligning civilian (RCMP) and military (Department of National Defence [DND] Canadian Forces Explosive Ordinance Disposal) response capabilities by sharing relevant IED information, as well as leveraging the extensive European ATHENA interoperability project by utilizing internationally recognized data-exchange standards. At this point in time, there is no consistent set of interoperability business practices and protocol standards for the exchange of CBRNE incident information, particularly between police and military communities.

Two versions of the product will come out of this project to meet the two distinct operational needs: an enhanced interoperable version of civilian law enforcement (e.g., police) oriented CID, based upon the CID technical demonstration product; and an IED-oriented CID, based upon the CID technical demonstration product with added capabilities to function in hostile environments.

Operational partners (i.e., INTERPOL, DND, and RCMP) will provide in-depth expertise in the subject area of CBRNE incidents and the interoperability requirements. The National Research Council - Explosives Regulatory Division, the Canadian Nuclear Safety Commission, and the Canadian Food Inspection Agency will provide CBRNE-subject expertise. The Carleton University Hot laboratory will provide human machine interface expertise and design.

Recent Progress and Results

The project team was realigned in early March 2010 as the project lead transitioned to DRDC Valcartier. The RCMP remains an active partner and the team is actively reworking the Project Charter. Project work is planned to start in early October 2010.

Impact

The IED-CID project will advance Canadian expertise in CBRNE anti-terrorism efforts and deliver a system that can create a new level of interoperability between civilian and military agencies. The IED-CID will contain comprehensive incident details that can be used in the temporal and geographic tracking of CBRNE materials. Expert system capabilities will be provided through automated incident matching. Additionally, the IED-CID interoperable system will provide a comprehensive historical pool of IED and other CBRNE incident data to be used in the analysis for national and international risk assessment.

IED-CID will provide a broader base of CBRNE incidents, including render-safe procedures for identifying successful and unsuccessful procedures related to neutralizing CBRNE devices and contaminated materials.

The project provides a business and system model of data exchange that will demonstrate international interoperability in response to CBRNE events. Improved communication between responder communities will result from the provision of this pool of national and international CBRNE incidents to be utilized for identifying trends of CBRNE incidents that could pose future threats in geographic or other areas.

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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 is developing an Urban Blast tool for assessing the effects of ideal and non-ideal explosive threats in urban environments, and serving as guideline protocols for urban blast modelling. This system will give users access to the results of a large number of accurate, physics-based, near-field modelling results based on first principles, for a comprehensive class of fundamental urban environments and scenarios. These solutions will be provided in a form useful for agencies and analysts performing assessments of potential real-world events, as well as serving as input for a series of quick-look tables and charts. The Urban Blast tool will also include protocols, providing non-specialists with 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 available in a user-friendly digital platform as well as in printed manuals for the protocols part.

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 the specifics of either explosion physics or numerical techniques, they may often inevitably 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 is building 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 computational fluid dynamics modelling software. The Urban Blast tool makes the large body of knowledge of 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 will include the results from hundreds of detailed, physically accurate, near-field, urban blast calculations from the first-principles Chinook code. The focus of the first half of the project was on classifying urban environments and threats, developing physical models, and defining a protocols framework. In the third year, nine fundamental urban environments were selected. Ideal and non-ideal explosive threats were broken down into four classes: ideal (energy release via detonation only), afterburning, metalized, and fuel-air. While users will be able to access individual urban scenarios, these results will be summarized in a table to give blast enhancement factors for use with different threat and environment class combinations. The urban blast calculations are currently underway and will continue throughout the final year of the project.

More accurate physical models are necessary to improve the predictive capability of the first-principles code used to generate the urban blast scenario database. 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. Implementation and testing of the identified models are underway. Owing to the non-ideal nature of most improvised explosive devices and the complex explosion physics in close proximity to urban structures, it will be critical to not only test the models at a fundamental level but also to validate them against experiments involving reduced-scale urban environments.

The project team created the high-level protocols framework in the first two years of the project, during which time a procedure outlining the primary eight steps involved in an urban blast analysis was identified. The protocols development was accelerated in the third year. A functional prototype has been recently completed, which leads users through the guidelines, from the interpretation of their actual scenario to blast calculation and damage assessment. To identify and classify the main blast features that influence the structural damage and personnel injury (e.g., confinement, explosive height of burst), many necessary smaller scientific studies were defined. Each of these investigations requires a literature review and identification of missing information to be determined through the first-principles urban analyses. A preliminary user interface of the Urban Blast tool is also in development and will be improved by a number of interactions with both experts and non-expert users. The interface will allow users to access data from specific calculations similar to their own scenarios, and interact with the guidelines.

The progress of the above aspects will be reported in this symposium. In the final year, all investigations and urban blast scenario simulations will be completed in parallel with the final development of the user interface. All project deliverables will be completed and delivered by July 2011.

Impact

The Urban Blast tool developed under this project will have important impacts on preparedness for, and prevention of, explosive-related urban public security events. Given that many existing fast modelling tools usually fail in predicting the complex near-field effects from non-ideal improvised explosives, this tool will include a first-principles based database for urban explosive scenario solutions that can serve as both an analysis tool for those charged with assessing and protecting urban structures and personnel, and first-principles benchmark solutions for relevant urban scenarios to validate existing modelling tools. The protocols given in the Urban Blast tool can be used as guidelines for effective modelling practices to support design, mitigation measures, operational planning, and forensics for the threats from a broad class of non-ideal explosives 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.

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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 for 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 who they have come in contact with) 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 successfucompleted CRTI project “Rapid Triage Management Workbench” (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

Phase 1 activities, including project definition and detailed project planning, have been completed. Phase 2, product design (both functional and technical) has also been completed. The project team has successfully reviewed hypothetical CBRNE scenarios to identify and detail MedPost requirements. In response to these requirements, the project team has developed a functional scope and a preliminary prototype for review by the partnering national and international medical professionals; their comments and recommendations have been considered and integrated into the first functional prototype released to the Grey Bruce Public Health Unit (Owen Sound ON) in March 2010. The initial field test is well underway and the project team continues to gather feedback for functional enhancements for a second iteration of the functional prototype.

Impact

At the conclusion of the MedPost project, the Grey Bruce Health Unit, Grey Bruce Health Services (which encompass twelve 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 06-0259TD

Psychosocial Risk Manager: Computer-based Pre-event Training

Project Lead:	University of Ottawa – Group for the Analysis of Psychosocial Health
Federal Partner:	Public Health Agency of Canada
Industry Partners:	Risk Sciences International, ihotweb inc.
Other Partners:	Netherlands Organisation for Applied Scientific Research – Defense Security and Safety, Health Protection Agency

Objectives

The Psychosocial Risk Manager (PRiMer) project builds on previous CRTI work that yielded the Psychosocial Risk Assessment and Management (P-RAM) framework (CRTI 02-0080RD), a CBRNE-adapted integrative framework combining threat characteristics with evidence-based psychosocial effects and factors involved in preparedness, response, and recovery. The goal of this technology demonstration (TD) project is to use technology and multimedia to train and transfer a knowledge base to English- and French-speaking responders and planners to assist in preparation, planning, and response to CBRNE threats or attacks.

The project team will deliver a bilingual multimedia training package (PRiMer) that will be user friendly. The team is developing a multimedia interactive session using computer-assisted teaching; designing psychosocially oriented exercises and tasks; preparing a web-based self-study guide; providing a click-on P-RAM decision-support tool; and scripting an in-class, one-day training session with a sustainable train-the-trainer component.

Relevance

The need for more psychosocial knowledge available to the responding community and to non-specialists has been loudly and clearly articulated by all types of audiences in the project team's series of consultations across Canada and across sectors. This psychosocial knowledge need spans the topics of communicating with the public, dealing with the media, coordinating between units, pre-event training, anticipating public and worker reactions, and building public confidence. The project team is providing a synthesis of the theoretical and research contributions of a recently completed research and technology development project into a user-friendly, non-specialist knowledge base. The package will implement the addition of psychosocial factors into response plans and preparation guidance, both for the public and for various types of responders. This will improve plans, ensure appropriateness of response to public demands, increase public confidence in authorities, support compliance, and augment resilience.

This project leverages the theoretical, and fundamental level work, carried out by the University of Ottawa's Group for the Analysis of Psychosocial Health (GAP-Santé) and sponsored by the Social Sciences and Humanities Research Council. In its work, GAP-Santé examines the psychosocial aspects of individual and group perception and behaviour and how these relate to inter-organizational dynamics and governance, as well as how to use these processes to increase lay public and community resiliency. The PRiMer project is of direct benefit to a concurrent DRDC-TIF initiative on *Modeling Meta-Organizational Collaboration and Decision-making*.

Recent Progress and Results

Over the past year, production of all the major elements of the PRiMer training package was completed, in French and English. These elements included a media rich, web-based self-study guide, a facilitator's guide, and participant materials for the PRiMer instructor-led workshop, workshop activities, and a web-based suite of decision support tools (a psychosocial checklist; an interactive, flash-based urban landscape-Gapville; and a community capability mapping tool). These tools are designed to support planning and implementation of psychosocial issues in emergency response plans. A suite of video vignettes was also developed to enhance the learning experience and act as lead-ins to exercises and activities. Validations of core content and workshop demonstrations took place in multiple settings. Feedback to-date has been very positive on all elements of the training program. Testing and evaluation activities of the PRiMer training program continue into 2010/2011. Plans are underway to participate in tabletop and functional exercises as field tests.

Capacity building and networks of expertise have been enhanced through relevant publications and the planning and involvement in related ongoing projects, workshops, and presentations. Articles have been published in peer-reviewed journals, including the *Journal of Emergency Management, Radiation Protection Dosimetry, Risk Analysis Health, Risk & Society, Journal of Toxicology and Environmental Health*, and *Journal of Applied Social Psychology*. Presentations at conferences or participation in workshops span a wide variety of

local, national and international organizations, including Health Canada, Public Safety Canada, European Society of Risk Analysis, World Health Organization (WHO), International Red Cross, Panel on Haiti disaster, European Commission re: Research Workshop on Mass Decontamination (ORCHIDS), Emergency Management Institute (FEMA), Canadian Nuclear Safety Commission, United Ways Community Training Workshops, and H1N1 National Emergency Psychosocial Advisory Consortium.

Impact

The TD is well-informed by the project lead's concurrent research collaborations nationally and internationally, established through the previous CRTI project. These collaborators support the need for formal training on psychosocial aspects, and many agencies have sought GAP-Santé's Canadian expertise and leadership in population, psychosocial health. Along with CBRNE incidents, GAP-Santé's knowledge base also covers other risks, such as natural disasters, food safety, and pandemics. This breadth of knowledge lends itself to an all-hazards platform.

PRiMer training is meant to impact joint civilian- and military-security missions, group behaviours, collective decisions, and shared leadership in joint operations, both domestic or foreign. Once the TD has allowed the formatting and design of an optimal package of tools and training, the project team will disseminate the package to both the public and private sectors. Training of various stakeholders will serve to enhance planning and preparedness in Canada, as well as to improve all-hazards crisis response, an area in which public demands are increasing.

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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

Objectives

Currently, most RCMP, 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 will integrate 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 is 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, leads the industrial effort. Bubble Technology Industries Inc., a recognized leader in radiation detection, will closely collaborate 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

The contract for this project was awarded in December 2009. The project team has developed the system requirements and architecture, and the engineering design is underway.

The architecture of the system involves integrating a small radiation sensor into the remote speaker microphone of the Motorola P25 XTS 5000 two-way radio. Data from the radiation sensor will be communicated to the two-way radio module and the radio will alert users if the radiation level exceeds an alarm threshold setting based on strength of the radiation field. This data will be displayed for users on the radio display and will also be transmitted via radio communication to a receiver module and laptop. The purpose of using the receiver module and laptop in this project is to demonstrate that data can be transmitted from the radio module over a two-way radio infrastructure. Through subsequent development, data from the radio module could be transmitted to a dispatch console system.

Once the design, assembly, and integration have been completed, 30 prototypes will be delivered to various end-user partners for field testing in early 2011. The project is scheduled to conclude in March 2011 with detailed reports of the field testing.

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:	Northern Lipids Inc., Oncovir Inc.
Other Partner:	CAE Professional Inc.

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 the first phase of the project, a contract was established with Oncovir Inc. to procure clinical batches of poly ICLC and components. Following United States Food and Drug Administration (FDA) guidelines, Oncovir will be able to produce good manufacturing practice-grade of liposome-encapsulated poly ICLC and liposome formulations for poly ICLC optimized for clinical development. Consequently, several pharmaceutically acceptable candidate formulations of LE Poly ICLC will be developed and evaluated. Using a widely accepted mouse influenza A virus model, project members will compare the antiviral efficacy of these formulations. The formulation with the best safety, stability, and antiviral profiles will be selected for further work in the project.

The second phase of the project focuses on stability and safety. One of the primary reasons that AI H5N1 viruses are so deadly in people is the ability of these viruses to induce "cytokine storm" in the respiratory tract. Cytokine storm is a potentially fatal immune reaction characterized by massive inflammation, apoptosis, and tissue damage, and is generally considered to be associated with an overproduction of cytokines. Because LE Poly ICLC works by eliciting protective antiviral immunity associated with cytokine induction, it is crucial to delineate and characterize the immunological effects of LE Poly ICLC in the respiratory tract. To characterize the molecular basis of immune response to LE Poly ICLC, project members treated the lung tissues of mice with Poly ICLC and LE Poly ICLC, extracted RNA from the lung tissues, and performed real-time polymerase chain reactions (RT-PCRs) that would establish cytokine and toll-like receptor (TLR) gene profiles. Preliminary results showed that treatment with the compounds up-regulates the expression of anti-inflammatory cytokines and cytokines associated with virus killing, and activates TLR-3 and TLR-9 activation pathways.

The project's third phase will involve efficacy testing. Team members will evaluate and compare various liposome formulations of LE Poly ICLC using the lethal mouse infection mode with influenza A/PR/8/34. The best formulation will then be tested using the AI H5N1 infection model. Finally, the fourth phase of the project will deal with regulatory submission.

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 AI 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 – Canadian Police Research Centre, DRDC, 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 unit and deployed to an 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 radio frequency identification) 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 (HECHMET)

Project Lead:	Royal Canadian Mounted Police – National Services and Research
Federal Partner:	Royal Military College of Canada
Industry Partner:	Vertére Inventory Manager
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 for 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, and 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 team has made significant progress in the past year. As of March 2010, all project partners have successfully completed integrating chemical inventories into their target departments and are in the process of expanding to other departments within each institution. Work is continuing on developing training packages, policies, and procedures, and on tracking lessons learned.

For the first responder community, the software now 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 now track illicit chemical inventories or materials that may exist on a restricted list for use, handling, import, or export. This tracking capability will be further enhanced by the addition later this year of a requisition module that will allow institutions to track and control chemicals from purchase to disposition. In collaboration with a number of federal partners, including Foreign Affairs, Public Works and Government Services Canada, and Environment Canada, Canadian 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. The review of the federal legislation is nearing completion; the project will then focus on the Ontario and Quebec provincial legislation.

This project has demonstrated an excellent collaborative approach between universities, the RCMP, regulatory agencies, and commercial partner Vertére Inventory Manager 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; next year HECHMET representatives will make targeted presentations to select universities across Canada regarding future expansion of the cooperative beyond 2012.

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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Project Lead:	DRDC Ottawa
Federal Partners:	DRDC Valcartier, DRDC Suffield, Royal Military College of Canada, Natural Resources Canada, Health Canada, Environment Canada
Industry Partners:	International Safety Research Inc., New England Complex Systems Institute
Other Partners:	Acadia University, Sandia National Laboratories, Atomic Weapons Establishment

Objectives

The CRTI Consolidated Risk Assessment (CRA) identifies terrorist deployment of a radiological dispersion device (RDD) as a significant threat to Canadian security. RDD response planning is currently based on valuable but incomplete experimental evidence, models, and simulations. This project improves Canada's threat intelligence and consequence management capability by developing models that more thoroughly characterize the distribution of radiological material from an RDD event.

In the experimental stream, project researchers are performing highly controlled indoor experiments with non-radioactive material, progressing to outdoor experiments using a short half-life radioisotope. These experiments will produce the most accurate simulation yet of an actual RDD detonation. In the modelling stream, the researchers are developing, refining, and verifying models of RDD detonations, and will refine and combine existing RDD algorithms or create new ones to produce the new model. The model will be verified and refined in an iterative manner using the results from the experimental stream.

Relevance

Strategies and decisions to protect responders, the public, and critical infrastructure against the effects of a detonated RDD must be made in the planning stage, not in the period after an attack. By the time it is known that an attack has occurred, there will likely have been casualties from the explosion, all the radioactive material will have been released, plume growth and particle deposition will be progressing, and there will be no time for evaluating possible countermeasures. The development of emergency response procedures and guidelines for first responders in dealing with radiological terrorism incidents requires experimentally verified data on the behaviour of RDDs, benchmarked with reliable, accurate modelling tools.

Recent Progress and Results

Following a meeting at Sandia National Laboratories with domestic and international partners, initial explosive design and composition, as well as an appropriate short-lived isotope, were chosen to replicate the project's experimental "terrorist RDD." With knowledge of the isotope to be used, the project researchers have identified several other key elements of the experimental stream. These include the isotopic activity, which, in turn, has allowed planning for isotope production, transport, and integration to begin. The researchers have written preliminary field-trial plans, an environmental assessment plan, safety plans, and a radiation management plan. Initial modelling of the plume and deposition pattern has allowed a detailed experimental plan to be assembled.

Researchers have also been proceeding with the modelling stream according to the project schedule. A 64-bit operating system has been installed on a dedicated system at DRDC Ottawa to manage and run the physics-based code. The software engineer is assessing the existing algorithms as they pertain to the disparate regimes subsumed within the RDD event framework (e.g., aerosolization, rise, transport, etc.). The researchers have decided to use the Autodyne Eulerian method, which may later be changed, and to create a bridge program to the United States (US) Defense Threat Reduction Agency's Hazard Prediction and Assessment Capability (HPAC) program. The result of this work is a physics-based modelling toolkit capable of accurately modelling each distinct regime of the event both individually and as a whole. The primary application of this toolkit is in pre-event consequence assessment.

Acadia University has staffed a laboratory capable of performing the morphological analysis that will be required once the indoor experiments are running.

Impact

By identifying the scenarios of greatest concern, and experimentally verifying data on simulated RDD behaviour (e.g., explosion, isotope fragmentation, plume formation, isotope distribution), Canada's emergency preparedness and response communities will be more able to properly prepare for such incidents. Using these data and models, first responders and decision makers will be better able to quantify the probability and impact for known and emerging RDD threats and update CRTI's CRA. The involvement of United Kingdom and US partners brings significant additional knowledge to Canada from their complementary programs and promulgates to our allies the knowledge generated by this project.

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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, 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.

Best practices and lessons learned derived from the application of foresight within the AHEM domain, and integrated with the findings of other foresight initiatives, can be disseminated to a broader community to provide guidance on how to introduce effective foresight in planning within other organizations.

Recent Progress and Results

With Phase 1 completed, activity over the past year was focused on Phase 2, with emphasis on applying foresight methodologies to determine the future capabilities required for an effective Animal Health Emergency Management system.

Four foresight workshops were held, each building upon the results of the previous, and producing outputs designed to identify the challenges faced by the future system, the capabilities required to provide the necessary foundation, and strategic options that could provide direction to achieve the desired vision.

The outputs from this series of workshops were then validated at two regional workshops: one in Alberta and one in Ontario. The objective was to engage stakeholders from all relevant sectors within a regional environment, deriving insight into the outputs and direction of the project thus far, and soliciting feedback and suggestions.

The key capabilities underpinning the vision for the Animal Health Emergency Management system of the future are organization and decision making; information and communications; expertise and personnel; science and technology; and policy, law, and regulation.

To support these capabilities, the project team developed principles on how these supports would function in a complex multi-jurisdictional and multi-sectoral environment, as well as suggested key priorities for activity directed at achieving them. A panel of subject-matter experts in animal health and emergency management were also engaged to supply additional clarity based on past animal health emergency experiences.

The 2nd Annual Fore-CAN Symposium, held in early May 2010, represented the transition from Phase 2 to Phase 3 of the project, which is aimed at the collaborative review and validation of priorities to achieve desired capabilities. Activity will now be directed toward engaging key partners in developing and implementing action plans, identifying and supporting parallel initiatives, and communicating project results to influence domestic and international animal health emergency communities.

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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Project Lead:	Health Canada
Federal Partners:	DRDC, Royal Canadian Mounted Police, Canadian Nuclear Safety Commission
Industry Partner:	International Safety Research Inc.
Other Partners:	Atomic Weapons Establishment, Radiation and Nuclear Safety Authority

Objectives

The objective of the Direct Alpha Spectrometry for Forensic Samples (DAAFS) project is to deliver a field-deployable alpha spectrometry system that will perform direct measurement of forensic samples for difficult-to-detect radioactive isotopes. This system is designed to rectify current gaps in pure alpha-emitting material detection. Using well-characterized sampling techniques and advanced spectral de-convolution codes, it is currently possible for first responders to identify and quantify the presence of alpha emitters to assess the risk to themselves and the public. The primary new capability introduced by the DAAFS project is the ability to perform non-destructive field-alpha analyses. The non-destructive nature of the DAAFS system means that results are available in a matter of hours rather than days.

Relevance

The requirement for this project was identified during Canada's involvement in the response to the radioactive poisoning of Alexander Litvinenko in the United Kingdom. CRTI, DRDC Ottawa, and Health Canada initiated a study to fully understand Canada's capability gaps in effectively responding to events involving difficult-to-detect isotopes, such as the polonium-210 (Po-210) used in this case. Upon completion, the DAAFS project will fully rectify this capability gap and allow an effective response.

The combination of using an appropriate sampling methodology, mobile field laboratories, and a state-of-the-art analysis software suite will provide radiological-nuclear (RN) response teams with significantly enhanced capabilities. By using non-destructive techniques, the DAAFS project achieves high-sample throughput and permits multiple forensic investigations on the same samples.

Recent Progress and Results

The DAAFS project team has accomplished almost all of its second-year goals. The team has nearly completed all software development for this project, with an imminent release of the production-ready software package. Recent achievement highlights include completing the concept of operations (ConOps), a successful field test during Exercise Gold, providing training and equipment to Atomic Weapons Establishment (AWE), developing initial sampling techniques, and conducting trials on a variety of materials.

DAAFS was deployed as a response component during Exercise Gold, the Olympic security exercise. Samples of a terrorist's clothing suspected of being contaminated with radioactive material were collected and analyzed using DAAFS. Identification of the radioisotope ^{241}Am was accomplished after approximately 10 min. spectral acquisition time. Raw spectral data was sent electronically from the field to the laboratory in Finland where the field analysis was successfully confirmed. The first field test of DAAFS was successful, but field experience indicated future software developments for the platform were necessary in the areas of data management (reach back), spectral acquisition, and analysis for general (non-research) use.

Successfully preliminary measurements and analyses of International Atomic Energy Agency (IAEA) and Mixed Analyte Performance Evaluation Program (MAPEP) intercomparison gross alpha/beta samples have been made, as well as tests on uranium yellowcake, activated charcoal (radon), and contaminated moss. Further field trials (for yellowcake, depleted uranium, low-level radioactive waste, and fresh and used nuclear fuel) are under negotiation to occur in summer 2010.

International Safety Research (ISR) and Radiation Nuclear Safety Authority (STUK) assembled a complete collection of documentation for the entire DAAFS project, covering sampling techniques, training material, various software operational manuals, and a concept of operations (ConOps). The ConOps describes the deployment, field operational requirements, and overall command and control structure.

DAAFS equipment was recently installed at AWE, and the UK team is beginning its trials. The team was successfully trained in sampling and software operation.

Impact

The DAAFS project addresses an important capability gap in the RN cluster—a field-capable alpha spectrometry system. Currently, pure alpha emitters such as Po-210 are essentially impossible to detect. The DAAFS project design will revolutionize alpha spectrometry by making it a realistic field tool.

DAAFS allows rapid assessment of crime scene boundaries and provides an accurate risk assessment to hazardous materials teams and the public. The DAAFS system will allow first responders to reach multiple remote off-site experts as necessary for a full and complete analysis of any samples collected. The non-destructive nature of the system allows for multiple measurements (alpha, beta, and gamma) using the same sample, improving response efficiency and integrating into the existing chain of custody procedures.

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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 Canada – Steacie Institute for Molecular Sciences
Federal Partners:	National Research Council Canada – 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 (WP) 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 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-SWCNT and 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 SWCNTs, 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 07-0123TA

Blast Dosimetry and CBRNE Sensors Integrated into Explosive Ordinance Device Personal Protective Equipment

Project Lead:	Royal Canadian Mounted Police – Explosives Disposal and Technology Section
Federal Partners:	DRDC Valcartier, Department of National Defence – Director Soldier Systems Program Management 10, Canadian Forces – Explosive Ordnance Disposal
Industry Partners:	Allen-Vanguard Corporation, AUG Signals, Biokinetics & Associates

Objectives

First responders involved in improvised hazardous device disposal are increasingly burdened, both operationally and physically, with having to carry diverse sensors and to deal with logistical challenges, power sources, alarm and detection signals, and so on. This project proposes to identify, assess, and consolidate commercial off-the-shelf (COTS) sensors into a unified plug-and-play system that integrates into the responder's suit and helmet, enabling real-time alert of developing hazards and remote physiological monitoring by the command post.

In addition, while a variety of disparate CBRN sensors exist, there currently exist only limited blast dosimetry sensors to quantify blast exposure and level experienced in the case of a detonation. Suitable blast intensity measurements would guide medical responders in determining the occurrence and severity of otherwise not-evident injuries (e.g., traumatic brain injury, blast lung) through correlations based on evolving blast injury knowledge.

Relevance

The proposed system will provide remote environmental and physiological monitoring through a single CBRNE response platform integrated in personal protective equipment (PPE), resulting in added practicality and improved ergonomics as compared to a number of individual devices. It will facilitate the collection of evidence with a common time stamp by personnel encumbered with highly restrictive PPE. Finally, blast dosimetry will facilitate diagnosis and emergency room triage through interpretation of the blast data, as well as post-blast scene investigation tools.

Recent Progress and Results

The sensor fusion system includes threat, physiological, blast dosimetry, and environment sensors, along with communication systems and software to monitor, record, and display appropriate data. The project team procured a suite of threat sensors, including chemical and radiation sensor devices, based on the RCMP's suggestions. Some of these devices lack the capability for real-time, remote data logging, requiring direct data download to the command centre computer after a mission. Physiological sensor systems were acquired and are being evaluated, with one having been integrated into both the suit and command centre software.

Preliminary software to relay, display, and store data on the command centre computer has also been designed and implemented. All data is time- and location-stamped based on GPS position and stored in a network-deployed database, allowing other computers access using standard web browsers. The suit-mounted computer software includes menu choices display and sensor data on both the wrist-mounted touch screen and helmet-mounted display. Additionally, a fully functional set of speaker-independent voice commands is implemented and working.

A recording device for traumatic brain injury was packaged and mounted on an EOD helmet. Blunt impact helmet sensors were designed and fabricated. Prototype flexible pressure sensors were developed to allow pressure measuring anywhere on the suit or directly on the torso. The project team has carried out preliminary blast testing with mannequins (DRDC Valcartier) and blunt impact testing. So far data is acquired through leads running from the sensors to external data acquisition instrumentation. Self-contained recording instrumentation will be developed on more advanced prototypes.

The team also procured and preliminarily tested appropriate radios, but the focus will be for a base station to facilitate data links. A coded orthogonal frequency-division multiplexed (COFDM) radio is currently being investigated, providing enough bandwidth for video at a 1 km transmission range within urban infrastructure. In the interim, the system is up and running with a Wi-Fi link to transmit data and low frame rate video.

The complete sensor fusion system includes a helmet video camera, helmet display, wrist-mounted touch screen display, GPS unit, ambient temperature sensor, battery voltage monitor, and voice command recognition software. Almost all of these subsystems have been procured and are working in the latest software revision.

Impact

Real-time detection and alarm triggers of threatening environments will allow responders to adapt their response or remove themselves from hazardous areas and permit optimum PPE use, limiting unnecessary operational burden. Select physiological monitoring, "man-down" sensors, and operator-activated "panic" buttons will provide enhanced situational awareness.

Blast event information collected at the individual level using a blast dosimeter can significantly help operational tactics and the medical community in diagnosing and treating responders who have been exposed to improvised explosive devices. Such information can also help in assessing the accumulated effect of multiple exposures to blasts, and provide indications as to when operators should be removed from duty due to otherwise difficult-to-identify symptoms. Blast dosimetry data, combined with medical data, will also be useful in improving blast protective PPE.

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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
Industry 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 (RP), vesicular stomatitis (VS), and malignant catarrhal fever (MCF), while the avian assay targets avian influenza (AI) and Newcastle disease (ND). 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 VS, bovine viral diarrhea (BVD), infectious bovine rhinotracheitis (IBR), MCF, RP, bluetongue (BT) 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 AIV neuraminidase (NA)-subtyping component, and the AIV/NDV detection and NDV pathotyping component of the avian HC assay have been completed. For AIV NA-subtyping, 42 AIV strains representing all nine NA-subtypes have been successfully amplified and subtyped with the NanoChip instrument. A multiplex PCR was developed to amplify an AIV-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 AIV 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 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:	Justice Institute of British Columbia
Federal Partners:	Public Health Agency of Canada, Natural Resources Canada, DRDC CSS, Agriculture and Agri-Food Canada – Rural Secretariat
Industry Partners:	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, pretest, 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 World Association of Disaster and Emergency Management (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 project steering committee workshop, in New Westminster, 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 B.C. 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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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 is 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.

The Rapid Triage Management Workbench (RTMW), developed under CRTI 0060TA, will be refined 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 will follow a six-phase plan to be carried out over two years. Phase 1 includes project startup activities, such as contracting and the production of the project charter and project plans. Phase 2 includes the deployment of the existing RTMW system with the British Columbia Ambulance Service and Toronto Emergency Medical Services. Phase 3 includes the technology demonstration of the RTMW system. Phase 4 includes the enhancement of RTMW to provide the unified casualty management system. Phase 5 includes the technology demonstration of the unified casualty management capability. Phase 6 concludes 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 will provide a system solution for casualty tracking and casualty management for all-hazards events involving affected and non-affected members of the public. CCC will also improve 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 will support crime scene attribution in situations where a person that caused an event is among the casualties. It will capture when and where each casualty was entered into the system, the location where they received treatment, and the facility at which an individual is located. It will also help 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 include 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 include the second issue of the project newsletter and technical demonstration exercises in Vancouver and Toronto.

Phase 4, deployment of CCC Release 2, is scheduled for completion in April 2010. Deliverables completed to date include Release 2 requirements and design, and deployment preparations.

Impact

CCC will deliver transition and sustainability after the project is completed. With such forward-thinking partners as the Toronto Emergency Medical Services and the British Columbia Ambulance Service, the transition of CCC-RTMW from technology demonstration to marketable industry product is realistic. RTMW, the basis of the CCC project, is already in the process of being deployed in southeast Asia.

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 will also develop models, methods, techniques, and training tools to assist medical responders addressing a CBRNE event, and develop 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 voice-over Internet Protocol (VoIP) for user intercommunication, and radio frequency identification technology to track casualties.

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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
Other Partners:	McMaster University, University of Ottawa

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 a new 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. 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 preventing 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/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/operators. The chair and vice-chair are members of this CRTI project team. Terms of Reference and the committee membership have been approved by CSA. Development of the standard began at the first committee meeting in September 2008. Meetings of the technical committee and executive committee continue twice a year for each committee.

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 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 building against blast effects highlights the collaboration between designers, researchers, regulatory authorities, and building owners/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 incident (building collapse) prevention.

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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, Montréal 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
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 kicked off with a meeting in December 2008 and shortly after the project team identified 11 primary isotopes of interest and selected one for the pilot animal study and MEDECOR2 validation. A literature review resulted in acquisition of the highest quality data about decorporation efficacy for various therapeutic treatments for the "11 high-risk" radioisotopes. The extracted toxicology data is providing the basis for MEDECOR2 risk assessment modelling. 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. A technical outline for the pilot animal project has been prepared for review by the Atomic Energy of Canada Limited (AECL) Scientific Merit Review Committee, and by AECL and DRDC animal care committees.

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 proposing and organizing a Medical Scan Workshop 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. In will be useful to a broad spectrum of professionals ranging from government agencies to emergency medical departments and nuclear power utilities with a resulting 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 – Director Soldier Systems Program 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 this 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 Technology Industries Inc. (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. Based on the results of this testing, input will be provided to BTI for incorporation into the design to ensure that the final END-2 prototypes perform as desired by end-users.

At the end of the project in October 2010, the team expects to have two prototypes and test results. 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 alphas, betas, gamma rays, and neutrons. The END-2 device will improve Canada's ability to respond to and recover from such attacks, which use isotopes that emit both neutrons and gamma rays. 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 07-0196TD

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. To provide additional advanced modelling capabilities by incorporating features such as thermal effects in the building-aware urban flow and dispersion models, improving the urban parameterization schemes used in the mesoscale flow models, and developing techniques for fusion of CBRN sensor data with model predictions for source reconstruction.
2. To develop the required supporting infrastructure (supporting land-cover and land-use databases, 3-D building data, and CBRN source models).
3. To demonstrate and exercise the prototype system for a number of CBRN scenarios in different Canadian cities. This includes 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. It aims to develop a key enabling technology and capability managed at a national (centralized) government operations and resource centre for CBRN planning, real-time assessment, and emergency response in Canada. The system can be used to generate unique CBRN operational dispersion modelling products and decision-support aids to decision makers and emergency response managers at all levels of government to support a wide spectrum of CBRN-related requirements.

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) flow modelling and source reconstruction components, as well as to the urbanized meteorological model, and installing and testing the prototype within EC-EERS.

The project team has completed the preliminary implementation and validation of an operational source reconstruction capability through an urbanSOURCE software model. The team has also modified urbanSOURCE for the difficult source reconstruction task of inferring the parameters of an *a priori* unknown number of sources using concentration data measured by a network of detectors. Significant progress has been made in including a thermal component in the CFD code urbanSTREAM. A module to simulate the effects of terrain or ground topography in the grid generation was developed and tested.

Work has advanced on improving the urbanized meteorological model and, in particular, the parameterizations within the Town Energy Balance (TEB) scheme of the model. The project team has almost completed the representation of snow in a non-urban environment, and has finished a major portion of the work involved in creating the effect of vegetation in the TEB canyons. Work to incorporate TEB in the latest version of the Global Environmental Multiscale Limited Area Model (GEM-LAM) is underway, while improvements to the vertical refinement of meteorological variables in the urban canopy and surface layer have been made. All of these projects will focus upcoming work on improving the coupling between the land surface schemes and surface layer.

The project team ran the prototype in quasi-operational mode during the 2010 Winter Olympics and Paralympics Games in Vancouver. About 80 integrations were launched during the entire period. Coordination with meteorologists from Vancouver's Storm Prediction Centre enabled the evaluation of some aspects of the urbanGEM modelling cascade. The team is continuing efforts to acquire building databases for other Canadian cities and apply the prototype to them.

Project members gave a presentation on the urban modelling prototype at the 90th American Meteorological Society Annual Meeting in Atlanta, Georgia.

Impact

The project aims to develop an operational prototype modelling system for use within a government operations centre. This 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. This 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 of CBRN materials that can be used to support pre-event planning and post-incident analysis, making the systems useful in both a real-time situation as well as for emergency preparedness and prevention. Impact on the user community will be demonstrated by using and testing this system in exercise planning (e.g., 2010 G8/G20 Summit), 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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Project Lead:	Royal Canadian Mounted Police – Integrated Forensic Identification Services – Specialized Forensic Services
Federal Partners:	Canadian Police Research Centre, DRDC Ottawa – Radiological Analysis and Defence Group, Royal Canadian Mounted Police – Explosives Disposal and Technology Section
Industry Partner:	MDA Space Missions
Other Partners:	Hamilton Police Services – Emergency Response Unit / Explosive Disposal Unit, Toronto Police Services – Emergency Management – Toronto CBRN Team and Forensic Identification Services, Vancouver Police Department – Forensic Services Section, York University – Department of Computer Science and Engineering

Objectives

The objective of the CBRN Crime Scene Modeller (C2SM)-FAST project is to develop technologies for investigating crime scenes contaminated with CBRNE materials using unmanned mobile robots, and to build and deploy multiple rugged prototypes with first responders.

The C2SM operates on a mobile robot, feeding live video and time-stamped and geo-located data from on-board cameras and detectors to remote robot operators. The C2SM's photorealistic three-dimensional (3-D) models of scenes of interest, and its two-dimensional (2-D) maps of the robot's path and location, improve situational awareness and enable on-site operation planning and post-event analysis. On-board sensors support the C2SM's autonomous exploration of a crime scene by enabling it to localize itself and operate in the absence of global positioning system (GPS) signals. The current prototype uses chemical and radiation detectors; the project team plans to integrate an explosive vapour detector as well.

Relevance

First responders investigating scenes contaminated with CBRNE materials rely on teleoperated mobile robots to safely deliver cameras and detectors to the scene. Such robots enable responders to view the scene remotely through on-board cameras and manipulate hazardous materials with robotic tools and disruptors. However, the responder's situational awareness is low because existing systems are equipped only with video cameras and simple CBRNE detectors. Measurements from various sensors are not registered with the work space, robot location, camera views, or facility blueprints, and the detector data may not be available in real time, all of which makes interpreting such multiple data streams difficult, both during and after events.

The C2SM offers a new solution for detecting and locating CBRNE sources, mapping contamination levels for immediate reaction, and managing consequences after the event. Responders using the C2SM are presented with a multi-faceted view of the event that includes live display of images and data, a 3-D photorealistic view of the scene augmented with measurements from interfaced detectors, and a floor map with the robot's current location and path.

Recent Progress and Results

The ongoing C2SM-FAST Technology Acceleration project was started in June 2009. Ruggedised production-ready prototypes are expected in summer 2010. The project is building on a Technology Demonstration project (CRTI 05-0122TD, "CBRN Crime Scene Modeller,") that developed and field tested early prototypes in 2006 to 2008.

The C2SM is a self-contained system that operates on-board a teleoperated robotic platform. The sensor suite includes stereo and high-resolution cameras, an infrared (thermal) camera, and a laser range finder. The CBRNE detector suite includes a Bubble Technology Industries directional gamma radiation probe that provides direction towards the radiation source, radiation dose, and spectrum; a Lightweight Chemical Detector from Smiths Detection that detects the presence of chemical agents and toxic chemicals; and a MultiRAE air quality monitor from RAE Systems that measures levels of airborne hazardous substances. C2SM is remotely operated from a control station connected by a wireless link.

A prototype version was fully integrated and tested in field trials in December 2009. The trials focused on detecting chemicals, evaluating the operation concept / user interfaces, and site mapping. The next field trials are planned for May 2010 and will focus on radiation mapping.

The C2SM is equipped with an integrated power source and can be operated on different mobile platforms. The current prototype operates on-board the Vanguard MK2 Remotely Operated Vehicle; the next generation prototype will support the MK1 Caliber Scout.

The project also includes development of the C2SM and robot simulator, a virtual environment like a video game for training robot operators and C2SM first responders to use unmanned mobile robots.

Impact

Operating the C2SM on-board a mobile robot will reduce first responders' exposure to CBRNE agents because it will allow them to investigate contaminated crimes scenes from a distance. The C2SM will significantly increase responders' situational awareness in the field by providing an integrated 3-D view of the event data as well as a 2-D map of the robot's current location and traversed path. Time-stamped and geo-located data stored in a database serves as a permanent record of the scene and operations, which can be used during the event for operational planning, transferred to a command centre, and stored for post-event analysis. The C2SM training simulator will enable more efficient and extensive training of responders.

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Project Lead:	Public Health Agency of Canada – National Microbiology Laboratory
Federal Partners:	Canadian Food Inspection Agency – Lethbridge Laboratory, National Research Council – Institutes for Biological Sciences, DRDC Suffield, Health Canada – Health Products and Food Branch

Objectives

The lack of capability and capacity within Canada related to microbial forensics is a critical gap. The federal government must be able to rapidly assess bio-crime and be able to establish a thorough criminal case to bring perpetrators of a bio-crime to justice. Any such case must be able to stand up to intense legal scrutiny and meet international standards due to the nature and global importance of successful prosecution of crimes of this nature. This project will address this critical gap by establishing forensic sample processing protocols that will withstand legal scrutiny and by initiating the complete characterization of category-A list bacteria currently in federal laboratory collections. Thus, this project will initiate the creation of a Microbial Forensics Centre within Canada. Development of robust, forensically valid protocols and databases will enhance Canada's criminal and national security investigation capabilities. It is anticipated that a Microbial Forensics Centre will be able to perform forensic analysis of samples for law enforcement in response to a bio-crime.

Relevance

This project has direct relevance to the Criminal and National Security Investigation Capabilities priorities set forth by CRTI. It will develop Canada's capacity for bio-crime attribution and robust bio-forensics capability while at the same time establishing a Canadian Microbial Forensics Centre capable of maintaining strict protocols and policies to ensure allocation of attribution. Scientists will be cross-trained in relevant areas of genetics, strain-relatedness comparisons using different methods, attribution legalities, bio-crime investigation techniques, and data and evidence security. Exercises and protocols developed within the project will directly create data and experience that may be used in post-event scenarios for possible geographical source linkage of an agent.

Recent Progress and Results

The creation of a federal Microbial Forensics Centre at the Public Health Agency of Canada involves the characterization, storage, and traceability of reference select agents held in-house. The project team is currently characterizing a multitude of select agent strains, which have a variety of older data associated with them (e.g., biochemical, cellular fatty acid, or sequence results), through molecular methods, such as full genome sequencing, single nucleotide polymorphisms (SNPs), and multi-locus variable-number tandem repeat analysis (MLVA). In order to fully track strain movement and house all the data in one place, a customized LabWare Laboratory Information Management System (LIMS) database is being developed to manage forensics samples.

Although there are systems in place to manage and track current in-house strains, they are antiquated, cumbersome to use, and subject to error. The LIMS database will identify where stocks are located and when they are removed for testing. All testing data is associated with the parent stock. Tests for the parent isolate (stock) include plating for growth and DNA extraction. LIMS traces where that DNA is stored, as well as any DNA sub-branches that are identified from tests such as SNP, MLVA, sequencing, and so on.

Use of the Labware LIMS software is a major step towards complete traceability and accountability, meeting ISO 17025 requirements by providing full sample tracking, instrument and calibration management, standards and reagents management, full auditing, bar coding, and a multitude of other fully customizable functions. One of the LIMS more useful features is the ability to trace multiple stocks generated from a parent sample or multiple aliquots from a single DNA extraction. All samples and storage locations are bar coded, and staff are provided with individual log-ins to ensure chain-of-custody accountability. In addition, the software provides audit logs and an approval management system so no one can alter results without approval by a manager.

The project team's next step toward creation of the Microbial Forensics Centre is to develop a bioinformatics pipeline or algorithm for the complete genetic characterization of these reference strains.

Impact

Establishment of a Microbial Forensics Centre will have considerable impact for forensic response to a bio-crime event. Creation of datasets and algorithms provides a wealth of information that can be used for multiple purposes. The LIMS database manages the possession, use, and transfer of select agents in the laboratory, providing accountability and traceability of select agent isolates. The LIMS database can be (and has been) used in the field during a security incident to document, ensure chain of custody accountability, test, and report on a suspect biological specimen. The outcome of this project will be a forensic unit capable of supporting the national counterterrorism activities of the RCMP, Canadian Security Intelligence Service, Canada Border Services Agency, and other defence-related agencies and departments. As well, the new centre will be able to support non-terrorist criminal investigations where air, water, or food supplies have been contaminated with a biological agent through negligence or accident.

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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 08-001SXT
Detection and Elimination of Bioweapons in Forensic Samples

Project Lead:	University of Ottawa
Federal Partner:	Royal Canadian Mounted Police

Objectives

This project has three main objectives: first, since bioagents might have an effect on DNA extraction, to compare an automated extraction method using a small-format robotic system-the Qiagen company's EZ1® Advanced BioRobot workstation-to manual extraction using the RCMP's protocols and the DNA IQ™ System by the Promega Corporation; second, to confirm whether a preliminary protocol developed to remove all infectious bacteria from the biological samples during extraction eliminates all infectious material and still yields sufficient quantities of quality DNA while ensuring that toxins are eliminated or denatured during the extraction process; and, third, to determine whether prolonged exposure of biological samples to live bacteria or toxins affects DNA yield.

Relevance

Bioterrorism requires police and security agencies to act as quickly as possible to obtain biological evidence that will identify the biological agent and, in the case of human DNA, assist in identifying the culprits. It is also important that the forensic officers are able to maintain a safe working environment and contain the samples to reduce the risk of spread to the population. For these reasons, this project was designed to provide forensic personnel with an alternative method for rapid, safe, and efficient on-site DNA extraction whenever bioweapons are believed to be present.

Recent Progress and Results

This project focuses on handling samples contaminated with three types of biological agents that could compromise DNA extraction and render the field situation dangerous: vegetative bacteria, bacterial spores, and bacterial toxins. Before proceeding with DNA quantification, amplification, and analysis, the contaminated sample needs to be rendered safe for the environment and the laboratory technician. Results from comparisons of the automated and manual extraction methods demonstrated that the automated system consistently yielded DNA of good integrity for successful sequencing and in amounts over the threshold required for sequence analysis (0.250 ng).

To confirm whether DNA extraction protocols eliminated infectivity of infectious agents, the project team seeded blood and saliva samples with Risk Group 2 (RG2) bacteria as surrogates for Risk Group 3 (RG3) vegetative bacteria. The team demonstrated that an overnight heat treatment at 56°C was enough to eliminate infectivity of vegetative bacteria, and concluded that the first step of DNA isolation, which is a heat treatment in the presence of detergents and enzymes, is sufficient to sterilize vegetative bacteria samples. However, the extraction protocols did not inactivate anthrax spores, and a filtration step (0.22μ) was required to remove the infectivity from the samples. Experiments with toxins showed that Staphylococcal enterotoxin B was removed from samples during overnight incubation at 56°C in the presence of detergent and proteinase K. The fate of Botulinum toxin and a ricin toxoid are currently being examined. Work to determine the effect of prolonged exposures of human DNA samples to bacteria, spores, or toxins on DNA isolation is in progress.

Impact

Once complete, the project will improve the response and recovery of samples during a bioterrorism attack. The data acquired through the project team's experiments will encourage the development of a standard operating protocol for extracting DNA from samples contaminated with biological agents in the field. Results will demonstrate which method should be used to extract DNA in a timely and safe fashion. To date, results appear to demonstrate that the protocols used during extraction produce safe DNA samples that forensic laboratory personnel can then process for quantification and amplification. The remaining work will enable the CBRNE response team to plan a crime scene approach based on an understanding of how the integrity of the DNA may be compromised by exposure time.

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CRTI 08-0112TA
Human Monoclonal Antibodies against Ricin

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

Objectives

It is possible to make antiserum derived from an animal for use against ricin, but the literature suggests that 10 to 86 percent of patients receiving foreign proteins may experience an immune system reaction known as serum sickness. To avoid losing casualties due to such a countermeasure, the project team will carry out the following sequential milestones:

- Create mouse hybridomae-secreting anti-ricin antibodies;
- Use the ricin poisoning method to select for clones that produce neutralizing rather than binding antibodies;
- Genetically alter the clones so that mouse antibodies are converted to human;
- Commercially produce human anti-ricin antibodies in bulk under good manufacturing practice (GMP) conditions; and
- Test and evaluate the human anti-ricin antibodies in animal models.

Relevance

Ricin is the toxin found in beans of the castor plant (*Ricinus communis*). Although a single bean has enough toxin to kill 1 to 10 people, the plant has many uses. About one million tons of castor beans are grown around the world for use as oil lubricant and livestock feed. However, ricin's potential as a terrorist weapon is high. Poisoning by ricin has already occurred in the United States, United Kingdom, and France and yet no medical countermeasure is available. The project team will create human anti-ricin antibodies that can be used either to protect first responders entering an incident site or to rescue casualties shortly after toxin exposure.

Recent Progress and Results

The project builds on the success of a previous project, CRTI 02-007TA, which exceeded expectations. During that project, project team members acquired beans from India because ricin was not commercially available, renovated and equipped facilities, and, with the approval of the Department of Foreign Affairs and International Trade, produced enough toxin at DRDC Suffield's high-security, small-scale facility to meet requirements for several years. It was thought that no therapeutic would be effective 30 minutes after ricin poisoning. However, following development of an animal model, researchers learned that high-titre goat anti-ricin antiserum could rescue mice 16 hours after poisoning.

Although this project has just begun, project team members are already demonstrating successful results. Usually monoclonal antibodies (which bind to a single site on the toxin) are about 10-fold less effective than polyclonal antibodies (which bind to many sites). The team has found that by vaccinating the mice with the toxin using a novel procedure, using the lymphocytes of the mice to create anti-ricin antibody-secreting hybridomae, and then screening the hybridomae with proprietary methods, monoclonal antibodies are 10 to 50 times more effective than polyclonal antibodies for neutralizing the toxin.

One of the questions the team sought to address is what occurs in the body when a casualty (which, in this case, was represented by the mouse model) is exposed to ricin and then rescued with antibody therapy, such as goat anti-ricin antibody. They have discovered that while some vaccines take several weeks or months to induce immunity, the vaccinated mice cleared the goat antibodies and replaced these with their own high-titre, anti-ricin IgG antibody. Mice were immune and protected from 5 LD_{50} of ricin 2 weeks or 5 months after vaccination. These results suggest that ricin-exposed casualties receiving antibody therapy may subsequently develop long-term immunity to the toxin, a value-added benefit to antibody therapy.

Impact

This project will result in a medical therapeutic (i.e., human anti-ricin antibody) that can be made available to protect first responders entering a high-consequence public safety and security event involving ricin toxin, or to treat and rescue casualties shortly after exposure.

Discussions with first responders suggest that having a medical countermeasure against the toxin would make it easier to focus on the requirements of the situation because it would reduce any apprehension they might experience on entering an incident site, as well as any stress they would feel in the performance of their duties.

However, the greatest benefit to public safety and national security would be if the therapeutic is never used because knowledge of its availability and efficacy discourages terrorists from ever using ricin as a weapon.

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CRTI 08-0122TD

Validation of Decontamination Processes in the Agri-Food Context

Project Lead:	Canadian Food Inspection Agency
Federal Partner:	Public Heath Agency of Canada, Department of National Defence – Canadian Forces Fire and CBRN Academy
Industry Partner:	Allen-Vanguard Corporation
Other Partners:	Ottawa Fire Services, United States Department of Agriculture, United States Environmental Protection Agency

Objectives

This project will address knowledge and technology gaps in decontamination capabilities for bioterrorist events affecting the meat production system. The project's objectives will be carried out through three phases.

In Phase One, the project team will work in the lab to evaluate disinfectants, such as surface decontaminant foam technology (which is used by CBRN first responders and militaries around the world), household bleach, Virkon™, and so on, against foreign animal disease and potential bioterrorism agents at varying temperatures and in soil and manure.

In Phase Two, the team will adapt decontamination procedures and application technology used by military and first responders to agri-sector machinery, equipment, and response needs. The new protocols will be tested in two vehicle and equipment decontamination trials.

In Phase Three, the team will carry out two disease-response exercises in stockyards or slaughter/production facilities. The trials will be held either in late fall or early spring because these seasons present more challenges to procedure and efficacy verification. The exercises will simulate a full response to the discovery of a biological threat in a facility, including decontamination of selected facility surfaces as well as equipment and vehicles used in the response.

Relevance

Standards for evaluating disinfectants are based on health-care needs, so, for example, efficacy testing is conducted at room temperature, on stainless steel surfaces, and with serum on organic matter. As a result, the effect of normal field conditions, including temperature variation or soil and manure contamination, is unknown. The technical challenges in decontamination under field conditions addressed by this project are of interest to a number of agencies involved in bioterrorism response, as demonstrated by the list of partners involved in this project.

Recent Progress and Results

The project team has so far carried out studies to evaluate the effect of 2 percent Virkon and 10 percent bleach against Newcastle disease virus (NDV) using embryonated chicken eggs to assay for virus inactivation. Results demonstrated that the virus titre dropped in the presence of 5 percent chicken manure as compared to a control with virus only. After a contact time of 5 minutes, both bleach and Virkon were generally effective ($\geq$ 4-6 log10 reduction) at inactivating NDV in the absence or presence of manure when at room temperature and also at 4°C. After a contact time of 15 minutes and with the addition of 40 percent propylene glycol, both disinfectants were effective at inactivating NDV in the absence or presence of manure when at -25°C. To completely reduce the NDV titre to zero at -25°C, both bleach and Virkon required a contact time of 15 minutes in the absence of manure and a contact time exceeding 2 hours in the presence of manure.

The team has also carried out bacterial agent experiments, testing the efficacy of 2 percent Virkon and 10 percent bleach against *Bacillus anthracis* spores, *Francisella tularensis*, and *Yersinia pestis* at room temperature. Final results show that, after 5 minutes, 10 percent bleach achieves an average 6-log reduction of *B. anthracis* and a 6.6-log reduction of *Y. pestis*, and after 2 minutes, a 6.7-log reduction of *F. tularensis*. On the other hand, testing completed with 2 percent Virkon against *B. anthracis* spores shows minimal activity, averaging just 1.1-log reduction after 30 minutes. Virkon was also only able to achieve a 3.3-log reduction of *F. tularensis* after 30 minutes. However, preliminary results of Virkon against *Y. pestis* have shown 6-log reductions after 1 minute.

Impact

Information produced by this project will enable responders to select a valid disinfectant and contact time given field conditions (temperature, degree of organic material contamination). The project will also result in validated, national standard operating

procedures developed by the Canadian Food Inspection Agency for the decontamination of equipment and vehicles used in agricultural disease emergencies and in events involving the food production system. As well, the creation of new partnerships between previously unrelated sectors of emergency response workers will enable synergies in response, knowledge, and equipment sharing.

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CRTI 08-0176RD

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

Project Lead:	University of Ottawa
Federal Partners:	Public Health Agency of Canada – Division of Aging and Seniors, Human Resources and Social Development Canada – Office of Disability Issues
Other Partners:	Canadian Red Cross, Government of Nova Scotia – Department of Community Services, Carleton University

Objectives

Enhancing Resilience and Capacity for Health (EnRiCH), is a community-based, participatory action research project, utilizing a function-based approach to design, implement, and evaluate resilience-oriented 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/vulnerabilities; implementation of interventions in three communities; evaluation; and dissemination of findings.

The environmental scan and prototype tool will be completed in 2010. The design and implementation of the interventions will be completed in 2011 and 2012, respectively. Evaluation and dissemination will be ongoing until the project is complete in March 2013.

This project will develop new knowledge on essential elements of resilience-oriented intervention programs to enhance preparedness, response, and recovery for CBRNE events or natural disasters. It will also provide empirical evidence on 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 to plan, implement, and evaluate resilience-oriented interventions in three communities.

Relevance

Disasters are characterized by disproportionate impacts on marginalized and otherwise high-risk groups. Events such as the earthquakes in Haiti, terrorist attacks in Moscow and Mumbai, and Hurricane Katrina are salient reminders of how social networks, community capacity and emergency preparedness influence the transformation of an emergency into a disaster, particularly in demands for services and community response capacity. 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 (Berry & Hutton, 2009).

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 (Kailes & Enders, 2007), 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.”

While there is substantial literature on the needs of different populations during community crises and disasters, there is little empirical evidence regarding the effectiveness, feasibility, and appropriateness of interventions designed to assist people with functional limitations during disasters. This project will move the research agenda forward to focus on the evaluation of specific interventions to enhance resilience and preparedness for people who are considered to be at higher risk for negative impacts from a community emergency or disaster.

Tangible tools are essential for emergency managers, first responders, and community organizations to identify strengths/vulnerabilities in their communities. Manuals and other intervention resources resulting from this project will be readily accessible to end users so they can tailor the interventions, build networks, and implement them in their own communities. The comprehensive evaluation will provide detailed information about the key elements to be included in resilience-building interventions, as well as the challenges and barriers end users may encounter as they go through the process of implementing interventions in their communities. 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 commenced at the end of January 2010. To date, two milestones have been reached:

- The stakeholder advisory panel, made up of 18 representatives of stakeholder groups from across Canada, was recruited. The advisory panel will consult with the research team and project partners regularly throughout the life of the project. The inaugural meeting of the project advisory group was held in May 2010.
- The first deliverable, a report of the findings from the Canadian portion of the environmental scan, was delivered. Researchers found numerous programs across 42 communities in Canada that offer supports to assist those with functional limitations in everyday activities, especially in emergency preparedness.

Data collection for the international environmental scan and key informant interview components of Phase 1 are complete, and reports will be submitted in June and August 2010. Next steps for the project include needs assessments in each of the target communities in fall 2010 and the development of the prototype tool for identifying high-risk populations.

Impact

The intervention in each target community will be 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 will be 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 prototype tools for emergency managers to assess resiliency among high-risk groups, which can be integrated into existing response frameworks. Creation of social networks, empirical evidence, and practice guidelines will inform policy and investment in community support initiatives and preparedness programs in Canada.

The structure of the project—including key-informant interviews, focus groups, and interventions—naturally creates 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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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; develop a prototype chemical, biological, radio-nuclear, and explosives (CBRNE) situation analysis and monitoring station and a re-usable user interface with visualization; produce privacy and confidentiality standards for DF-surveillance systems and a strategy to promote the deployment of this technology beyond the project; 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 Defence Research and Development Canada (DRDC) and ongoing work on human-computer interface (HCI) 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 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 activities, including project definition and detailed project planning, have been completed. Phase 2 activities are underway with certain key deliverables, including functional requirements definition and determination of the technical approach, in process and scheduled for completion during the first quarter of the 2010–2011 fiscal year. In addition, the first of two project newsletters has been published.

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 Montreal, CBRNE Committee, Canadian Association of Fire Chiefs, Emergency Medical Services Chiefs of Canada

Objectives

Experience illustrates 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 United States (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 a production site 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 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, Santé 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 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

A contract has been prepared, signed, and awarded to the University of Guelph, and work is due to start in April 2010. Equipment purchase and installation for the project has been completed and hiring of staff will be completed in April 2010.

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 08-0208TA

Special Nuclear Materials and Radiological Detection, Locating, and Tracking

Project Lead:	Health Canada – Radiation Protection Bureau
Federal Partners:	Transport Canada, Canadian Police Research Centre, Atomic Energy of Canada Ltd., Royal Military College of Canada, Canadian Nuclear Safety Commission, Department of Foreign Affairs and International Trade
Industry Partners:	Mobile Detect Inc., Ottawa International Airport, General Electric Research, McFadden Technologies Ltd.

Objectives

The objective of this project is to advance and integrate detection technologies for special nuclear materials (SNM) and radiological threat agents (RTA) in the areas of radiation detection, radioactive isotope identification, radioactive source locating and tracking, identification of a suspect object or person by video imaging, and first responder capabilities.

The detection technology advances developed by General Electric Global Research will be integrated into a real-time distributed network of radiation sensors already deployed at the Ottawa International Airport. The networked operation of these new detection capabilities will be assessed through an end-user pilot of the system operating routinely in the public areas of the airport.

RadWatch, a legacy CRTI-funded radiation sensor network operating at the Ottawa International Airport, will provide a platform for the integration and operation of new SNM and RTA static and handheld technologies. RadWatch will undergo further development to manage the new spectroscopic, tracking, and video data. The resulting extended-capability RadWatch system will incorporate new mission critical information about SNM and RTA radioisotope identification as well as information about location and associated suspect information.

Relevance

The advanced RadWatch will greatly expand the scope of actionable information for airport security operations decision makers and responders. This expanded actionable information will be available through Graphical User Interfaces (GUIs) designed with end-users. These GUIs will reside on responder handheld PDAs or phones, and on Security Operations Centre computers. These GUIs will be based on the expanded concept of operations (CONOPS) and standard operating procedures (SOPs) developed by project partners and on the new detection capabilities of the project.

Recent Progress and Results

The project is in its early stages, beginning in 2010 and scheduled for completion in 2012. Project deliverables will include both stationary and portable handheld networked SNM and RTA detectors with isotope identification capabilities, configurable alarm sensitivity and a data stream supporting rapid data analysis, and the real-time actionable information over the RadWatch network. The surveillance provided by the project system will be non-profiling and covert. The handheld radiation detectors will be concealable and will permit first responders to confirm findings at the location of the suspected threat. These capabilities for the Security Operations Centre and for responders will provide important new tools for threat detection and resolution. Directly involving end-users of the system throughout the project will help it succeed. Involving expert end-users during early phases will lead to development of relevant and usable technology. Likewise, assessment of the project deliverables by expert end-user partners will lead to market acceptability.

Impact

The project outcomes will be applicable to a wide range of transportation modalities, public venues, and critical infrastructures by providing a system for the autonomous radiological and SNM surveillance of the movements of people and objects with alerting and situational awareness provided to security operations.

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CRTI 08-0214RD

Cosmic Ray Inspection and Passive Tomography (CRIPT) for Special Nuclear Material (SNM) 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 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 will be tested in summer 2010; the full-scale prototype system (consisting of approximately 50 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 developing a complementary 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 (U, Pu) exist, 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, high-Z materials like U, Pu, and Pb scatter muons at larger angles than "normal" (i.e., lower-Z) material. Charged particle tracking detectors placed around an object of interest (e.g., 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 begun at Carleton University, AAPS, AECL, and DRDC Ottawa. Optimizing the design of the muon tracking and spectrometer systems, these simulations have studied details of the performance of different muon tracking technologies and various SNM detection and tomographic image reconstruction algorithms.

Carleton University has performed detailed simulations of the response of different drift chamber designs to cosmic ray muons. These simulations have led to a novel cathode-pad design for the drift chambers. AAPS is simulating the signal produced in scintillators by cosmic ray muons; these simulations will determine the optimal size and geometry for the scintillator detectors. AECL has been testing different image reconstruction algorithms (point of closest approach, maximum likelihood/expectation maximization) that use information from the multiple scattering of muons (i.e., scattering angle, horizontal displacement, and momentum) to perform 3-D reconstructions of the contents of different volumes (e.g., cargo containers, spent nuclear fuel containers, nuclear waste containers). DRDC Ottawa is performing simulations to determine the performance of different muon spectrometer designs.

Simulation results have helped to set the performance requirements for the muon tracking and spectrometer systems. These requirements have informed the designs of two small-scale muon tracking prototypes: gas-filled drift chambers (Carleton University) and scintillator-based trackers (AAPS). Each of these prototypes will consist of three or four layers of muon detectors with total active areas of approximately 3 m^2. The measured muon detection performance of these small prototypes will be incorporated into refined computer simulations to determine the optimal design for the large-scale prototype.

In addition to this technical progress, an operational analysis has been performed by CBSA and DRDC Ottawa to understand the operational constraints to which a muon tomography system would be subjected at a Canadian port. CBSA is also in the process of quantifying the sensitivities of current radiation scanning systems to different types of SNM in different cargo configurations.

ISR has begun simulations of the production of neutrons in lead and SNM due to cosmic ray (muon and neutron) interactions. The detection of "spontaneous," high multiplicity neutron events would complement muon tomography measurements.

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 would be catastrophic.

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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 product for continuous intravenous (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 the DRDC Suffield via the CBRN First Responder Training Program (by June 2012). Partners will carry out the following roles:

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 autoinjector 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 events. 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

This project is early in development. Before any progress can be made a Public Works and Government Services Canada contract must be awarded to UGM Engineering Ltd. for general contracting services to commence. Upon award of the contract, UGM will subcontract pre-formulation research to contract research organizations.

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 autoinjectors. 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 08-0241TD

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 the physicians). Previous CRTI projects, CRTI 02-0133RD and CRTI 06-230RD, focus on the development of rapid methods for laboratory-based rapid 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 the 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 were drafted for emergency radiobioassay. The requirements from medical end-users have been addressed, a dose threshold has been defined, required sensitivities for bioassay techniques have been derived, and gaps and priorities for method development have been identified. A paper has been submitted for publication in a peer-reviewed journal.
- 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 submitted (two papers) for publication in a peer-reviewed journal.
- Rapid alpha spectrometry methods were developed to measure alpha emitters such as Pu-239 and Am-241 in urine samples. Results have been summarized in a paper for publication in a peer-reviewed journal.

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 08-0107ESEC
Combating Robot Networks and Their Controllers

Project Lead: Bell Canada

Federal Partner: Royal Canadian Mounted Police

Objectives

This project introduced a methodology for risk-based analysis and correlation of multiple, carrier-grade sources of threat information. By applying scientific methods, it aimed to enhance the eSecurity Cluster's capability to predict and interdict cyber attacks against Canada. The project represented a departure from relying on anecdote, doctrine, and security policies as the common means of managing risk from things as dangerous as botnets in the hands of sophisticated threat agents. It made progress towards a quantitative assessment that allows precision and predictability in risk management.

This work required in-depth investigation and real-time analysis to design systematic surveillance of threat networks to provide a greater understanding of stealth technologies. Particular scrutiny was given to sophisticated and evolving tradecraft amongst dangerous threat agents.

Relevance

Botnet metrics were collected and consumed in carrier operations at exceptionally high data rates. It was possible to interdict threats on a global scale; however, historical incident reporting, compliance audits, and qualitative surveys indicated that the Government of Canada's level of exposure to botnets remained unknown. There is little in current security standards or policy that addresses this threat, and very little is detectable through compliance audits of management of information technology security (MITS) or threat and risk assessments (TRAs).

It is imperative that Canada be able to defend itself against a distributed denial of service (DDOS) attack like the one that hit Estonia in 2007, incapacitating that country's computer networks. Proactive, sophisticated cyber defence will enable surveillance, intelligence, and interdiction of an emerging cyber threat. Excellent results are expected with little risk, since much of this knowledge has already been made operational in the carrier's network "cloud," the public or semi-public space on transmission lines. The project will produce pragmatic and explicit designs to provide more network assurance for the Government of Canada while reducing overall IT security costs.

Recent Progress and Results

The project examined all aspects of botnet and other cyber attacks, as well as associated concerns, including economic drivers, the technology of botnets and malicious software, and trends in technology crime.

The problem space was defined on the basis of open-source published reports and academic research. Using near real-time threat metrics, a statistically valid national picture was developed of the cyber threat involving botnets. The current threat to Canada's—and specifically the government's—critical infrastructure was scrutinized.

In addition, a high-level architecture for global, national, and Government of Canada solutions to botnets is under development. It includes commentary on reactive-to-proactive operations, facilitation, threat shaping, and domestic and foreign undercover operations.

Also under development are the current and future roles, capability gaps, opportunities, and a road map to make enforcement in cyberspace possible. A model will support law enforcement agencies in intelligence collection and analysis of the criminal use of botnets, including their dual-use applications.

Impact

Sophisticated, large-scale botnet quarantine tradecraft and mitigation capabilities have existed in telecom networks since the 1990s. Malicious code analysis and treatment centres provide a safe virtual environment to block or scrub the majority of threat traffic from cyberspace. This project has blazed a path from the cloud to an enterprise-level capability for the Government of Canada where none existed. It demonstrated how the Government can greatly reduce its cyber exposure while saving on operating costs.

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PSTP 08-0109BIO

Comprehensive Evaluation of Stand-off Biometrics Techniques for Enhanced Surveillance during Major Events

Project Lead:	International Biometric Group
Federal Partners:	Canada Border Services Agency, Royal Canadian Mounted Police, DRDC Toronto, Foreign Affairs and International Trade Canada, IPC
Other Partner:	University of Toronto

Objectives

The objective of this project was to evaluate biometric techniques that can be used to enhance the identification and verification of persons of interest seeking entrance to Canada through various border environments. The project included a detailed survey of the capabilities, limitations, and future direction of stand-off biometric systems, such as iris recognition and face recognition. Stand-off biometric systems are those capable of identifying subjects (cooperative or non-cooperative) at distances of up to several meters. The project also included a pilot of stand-off iris recognition and face recognition technology deployed in a DRDC facility.

Federal partners and IPC contributed domain expertise related to the Government of Canada's dual prosperity and security mandates. The University of Toronto contributed expertise in privacy policy and system design. The project commenced in August 2009, with delivery of the project's final report on 31 May 2010.

Relevance

The project addresses the investment category by providing a framework for evaluating stand-off biometric technologies and systems for applications that include security at major events, border control, and law enforcement. This framework is highly relevant to decision making for investment in emerging technologies that may be capable of high-confidence identification of individuals against watch lists.

The framework includes technical considerations, such as range of operations, resistance to environmental conditions, interoperability with traditional biometric access control and identification systems, configuration and customization alternatives, and resistance to circumvention. The framework also addresses factors such as cost, usability, technology lifecycle, and privacy impact.

Recent Progress and Results

Recent scientific progress and results have focused on two areas: the development of a Subject Acquisition Profile (SAP) for stand-off systems; and an in situ evaluation of the performance of stand-off iris and face recognition systems in a controlled environment at DRDC.

SAPs are used to define levels of technology robustness and interoperability for a specific biometric domain. The development of a stand-off SAP provides agencies that are researching, procuring, and deploying stand-off systems with a common taxonomy for comparing the capabilities and limitations of commercial and prototype stand-off offerings. Topics addressed in the stand-off iris recognition SAP include the following:

- Capture volume, standoff distance, range of motion, subject speed;
- Throughput, capture speed, capture rates;
- Iris diameter (non-upsampled), number of simultaneously captured eyes;
- Exposure time, image quality feedback;
- Imaging wavelength/spectral spread, scan type;
- Image margins in pixels around the iris border;
- Maximum average irradiance, sensor signal-to-noise ratio; and
- Pixel depth in the 700–900 nm range, data format.

In the stand-off pilot, the performance and usability data that was collected includes the following:

- Accuracy and throughput;
- Usability and level of effort;
- System calibration and configuration;
- Capture and matching thresholds;
- Range of operations (height, distance, volume); and
- Image quality (based on ISO 19794-6 specifications).

Specific figures of merit were collected for the following elements:

- Detection of a subject in the imaging area based on successful location/encoding;
- Identification of subject(s) based on score(s) above the system's match threshold; and
- Failure to identify subject(s) based on comparison score(s) below the system's match threshold.

Results were analyzed to generate the following metrics:

- Percentage of events in which a subject was detected in the imaging area;
- Percentage of subject detections in which an enrolled subject was not identified (false negative ID rate);
- Percentage of subject detections in which an enrolled subject was identified as another subject; and
- Percentage of subject detections in which a not-enrolled subject was identified as another subject.

Impact

Results from this study will improve the Government of Canada's ability to specify, procure, test, configure, deploy, and operate stand-off biometric systems. This will result in improved security through high-confidence verification of identities and through detection of individuals at a distance and on the move. Results will also support development and implementation of interoperable systems, such that data collected through stand-off systems will be interoperable with data collected through controlled systems, such as border control systems.

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PSTP 08-0110BIO

Comprehensive Evaluation of Biometric Techniques for Multi-Domain Use Supporting National Security

Project Lead:	International Biometric Group
Federal Partners:	Canada Border Services Agency, Royal Canadian Mounted Police, DRDC Toronto, Foreign Affairs and International Trade Canada, IPC
Other Partner:	University of Toronto

Objectives

The objective of this project was to evaluate biometric techniques that can be used to enhance the identification and verification of persons of interest seeking entrance to Canada through various border environments. In addition to a detailed survey of biometric technologies deployed for border applications, the project included a scientific evaluation of the performance of face recognition technology in a simulated surveillance application.

IPC and federal partners contributed domain expertise related to the Government of Canada's dual prosperity and security mandates. The University of Toronto contributed expertise in privacy policy and system design. The project commenced in August 2009, with delivery of the project's final report on 29 March 2010.

Relevance

The project addresses the investment category by providing a framework for evaluating stand-off biometric technologies and systems for applications that include security at major events, border control, and law enforcement. This framework is highly relevant to decision making for deployment of biometrics in border applications, as the collection and use of biometrics in border environments has an impact on policies and systems for law enforcement, defence, document issuance, and immigration.

The framework includes technical considerations such as accuracy, throughput, and interoperability. It addresses issues related to informational and personal privacy, as well as considerations related to costs, integration, and lifecycle management. In addition, specific findings related to face recognition accuracy and performance can be used to support decision making on the use of face recognition for surveillance applications.

Recent Progress and Results

Recent scientific progress and results have focused on the performance of face recognition in surveillance applications. The project examines different techniques used to measure face recognition surveillance performance, including:

- Rank-based results, based on the strongest 1:N match from a given search, regardless of comparison score. Genuine and impostor matches may occur at Rank 1-N (the number of results that an agency can investigate is a business decision based on risk vs. resources). Results are often presented as CMC (cumulative match characteristic) plots. This type of analysis is most useful when comparing the relative strength of two algorithms in the absence of a target application.
- Threshold-based results presentation using a match threshold as a determinant of whether to return results from a search. Results may include no matches exceeding the threshold, or that one or more are genuine or that impostor results exceed the threshold. Threshold-based results presentation is appropriate for open-set applications, such as surveillance.
- Emerging techniques for evaluating 1:N results. These include what can be referred to as "Order-3" analysis, which is based on the relationship between match scores obtained by the system for a sample. This includes generated plots showing the probability distribution for the difference between the best and second-best match scores or all scores lower than a given threshold. Order-3 analysis can be associated with the confidence level of match scores.

In addition to the analysis perspectives listed above, several parameters relevant to surveillance system operations were involved in the study:

- 3 cameras (CCTV, HD-CCTV, and webcam);
- 3 heights (5.0 ft, 6.5 ft, and 8.0 ft);
- 3 matchers (Cognitec, VeriLook 3.2, and VeriLook 4.0);
- 2 watchlist image formats (controlled CCTV and web cam); and
- 2 genuine target image formats (emulated passport and HD-CCTV).

For illustration, using rank-based results analysis, nearly 60 percent of probes matched at Rank-1 when compared against a webcam-collected gallery with a noisy background. This is compared to slightly less than 30 percent of probes that matched at Rank-1 when compared against a CCTV-collected gallery with a controlled background. Using threshold-based results, taking all probes into consideration, 7 emulated passport genuines scored above the optimal threshold, 4 uncontrolled impostors scored above the optimal threshold, and 10 controlled impostors scored above the optimal threshold. These results are consistent with rank-based results in that they underscore the impact of gallery composition on identification rates.

Impact

Results from this study will improve the Government of Canada's ability to specify, procure, test, configure, deploy, and operate biometric technologies for border applications. This will result in improved security through high-confidence verification of identities and through detection of individuals with multiple identities in a given system. Results will also support development and implementation of interoperable systems, so that data such as fingerprints, face images, and iris images collected for border applications can be exchanged with other systems implemented and operated by the Canadian government.

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PSTP 08-0120CIP

A Scenario-based Approach to Protecting Telecommunications Critical Infrastructure in British Columbia: Ensuring Business Continuity during a Major Hazardous Materials Event

Project Lead:	CAE Professional Services Inc.
Federal Partner:	Industry Canada Pacific Region
Industry Partners:	TELUS, Bell Canada, BC Hazmat Management Ltd.

Objectives

This project involved conducting a live hazardous materials (HAZMAT) simulation to meet two main objectives: evaluate the response capability when pairing technical telecom expertise with trained HAZMAT expertise, and evaluate the Command and Control (C2) capability of Bell and TELUS when jointly managing the HAZMAT incident under advisement from BC Hazmat Management Ltd. Two complementary objectives were developing an implementation plan and a *HAZMAT Incident Response Handbook*.

Industry Canada provided expertise regarding federal government support to emergency telecommunications business continuity. Bell and TELUS are national service providers with responsibility to ensure communications and business continuity in British Columbia (BC) and BC Hazmat Management Ltd. has extensive training, equipment, and experience in responding to HAZMAT events. CAE Professional Services has demonstrated expertise in the use of Capability-Based Planning (CBP) to design, conduct, and measure the effects of scenario-based exercises, the definition of "As Is" and "To Be" architecture products, implementation plans, and the development of guidebooks. The scenario and architecture products were developed with subject-matter expertise from Industry Canada, TELUS, Bell, and BC Hazmat Management Ltd.

Relevance

The project findings will be transitioned to operational communities through a *Capability Roadmap* (outlining an implementation plan) and a *HAZMAT Incident Response Handbook*. Both documents will be provided to telecommunications critical infrastructure (CI) emergency planners responsible for ensuring business continuity during a HAZMAT incident in BC. However, the CBP methodology in both documents will be presented in a format that can be easily adapted to meet the unique needs of other CI sectors and Canadian regions to further reinforce the overall resiliency of Canada's CI.

Recent Progress and Results

The full mock-up simulation exercise took place at a secure CI site over 10 hours. During the simulation, quantitative ratings and qualitative data was gathered using tailored human factors and CBP tools, including information collected by observers and participants during a post-exercise debriefing session. The entire exercise was recorded by video camera.

Data collected during and after the exercise was used to analyze the capability for Persistence, Agility, Reach, Range and Information (PARRI framework); the data revealed close agreement between observers and exercise participants (responders and C2 participants), particularly with respect to the need to improve information exchange.

Data collected from stakeholders indicated that the main capability development challenges were training and funding. In addition, several interoperability issues became apparent. (Interoperability is the ability of people, processes, and tools to enable entities—such as organizations or units—to provide and accept services from each other; in other words, to enable entities to operate effectively together.) The interoperability issues identified included the following:

- Responder hot zone pre-entry awareness level;
- Resource management (human resources and equipment);
- Training;
- Health and safety;
- Telecom-HAZMAT response capability standard operation procedures (SOPs);
- Communications; and
- Command and control.

The capability development challenges and interoperability issues that were identified provided the foundation for developing the *Capability Roadmap*. Vision architecture articulated the implementation of the proposed capability and included the following phases:

- Industry buy-in;
- Further evaluation of the capability with respect to a wider range of repair tasks that require finer manipulations and placement of equipment within restricted spaces;
- Preparing a business case;
- Developing a governance model and cost-sharing formula;
- Developing SOPs;
- Communications; and
- Developing a team selection and training program

The results support the conclusion that the paired Telecom-HAZMAT response capability is a safe and effective option that can be deployed to repair telecom CI in a HAZMAT environment. Further, the project team noted that improvements to C2

communications are required for optimal performance of such teams. Given the overall performance of the capability, it represents a viable and plausible implementation, pending cost-benefit analyses, for the Canadian telecommunications industry at national and regional levels. The project team suggested that industry move forward with implementation mindful of the requirements for buy-in from telecom providers, the identification of funding sources, and the requirement for careful team selection and continuous training, including exercises.

Impact

The current study applied a scientifically rigorous and replicable methodology for evaluating capability within the telecommunications CI sector of British Columbia. This methodology is scalable to regional and national levels within the telecommunications industry as well as other CI sectors. These findings reinforced the need for involving all levels of government, operational first responder and technical expert communities, and regional representatives from private industry owners of the CI in the emergency planning initiatives for HAZMAT events so that policy-makers and industrial decision makers can be informed about unique regional issues within BC that affect the capability to ensure business continuity. Further, this study produced "To Be" and "As Is" architecture products that can be applied to major events within BC, thereby establishing enduring relationships between these critical emergency planning partners.

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PSTP 08-0130EMSI

Emergency Management System Interoperability Framework (EMSIF)

Project Lead:	Public Safety Canada
Federal Partners:	Department of National Defence, DRDC Atlantic, DRDC Capacity Engineering
Industry Partner:	Advanced Systems Management Group

Objectives

Public safety and emergency managers and government decision makers require timely access to relevant and accurate information to exercise their mandates and responsibilities. Improving the quality of information, and making that information accessible and understandable, has long been the target of the public safety and emergency management (EM) communities, decision makers, and stakeholders. The ability to share and access information across a number of heterogeneous organizations, systems, and services, commonly referred to as interoperability, has been difficult to achieve.

With the objective of delivering voice and information interoperability, the project team initiated the development of the Emergency Management Systems Interoperability Framework (EMSIF). The EMSIF will provide a foundation of architectural and engineering concepts and practices that will enable participating agencies to develop and acquire capabilities, systems, and services that can better interoperate with the broader emergency and public security communities. Additionally, these well-established practices could assist agencies with their internal needs for enhanced information sharing and interoperability. The primary objectives for this study were to

- provide an inventory of current emergency management, Geographic Information System (GIS), other data dissemination solutions, and the technologies deployed;
- summarize via gap analysis the EM cluster members' technology infrastructure requirements and their information exchange and data dissemination needs;
- identify information required to design an ideal information exchange and data dissemination architecture matching the needs of the EM cluster;
- draft a road map proposing architecture conformance to an Open standards, web-based, and GIS-enabled secure emergency management/incidence response system of systems.
- propose a charter for an Emergency Management Common Interest Group (EM CIG) to foster open standards for the sector, and solicit Object Management Group's (OMG) support, as the requisite standards body, to ensure there is a standards setting vehicle in place for enabling the vision and road map identified by EM stakeholders; and
- identify Canadian federal government leads and their assigned mandates in relation to establishing standards and an architecture for EM interoperability.

Relevance

Gaps exist in the ability of organizations to share information and represent that information in a GIS and web-enabled manner with peers within the EM community. Environments and solutions exist to capture and display tracking of vehicles, vessels, and other targets of interest, and that provide their GIS representation. The extent to which information assurance capabilities are achieved across the EM cluster, and whether an integrated interoperability framework exists for or within the EM cluster, is unknown.

This project will contribute directly to addressing the ability to integrate diverse emergency systems, both semantic and GIS-based, with regard for privacy, caveat separation, security, and purpose of data collection. The intent is to identify how applying open standards can address these gaps by using an adaptive approach that can directly support operational information exchange environments.

Recent Progress and Results

The project team completed the industry scan that involved searching the web to identify frameworks used in activities relating to EM and homeland security and entering the information in a database.

The Advanced Systems Management Group (ASMG) completed the framework, which includes recommendations to adopt the National Information Exchange Model (NIEM), The Open Group Architecture Framework (TOGAF), Department of Defense Architecture Framework (DoDAF), and the Unified Profile for DoDAF/MODAF (UPDM) as base standards for EMSIF.

Through a series of presentations and workshops, the project team finalized the framework and reached consensus to develop the continuum approach as a major element of the strategy, as outlined in the Vision document. The project team also completed the road map document on March 31, 2010.

Impact

By identifying the interoperability gaps in the current information delivery offerings, and a vision for an interoperability framework, the EM cluster will have a set of recommendations (a road map) to implement. The objective is to offer guidance on how to design, install, and maintain the system-of-systems solution. Conceptually, a systems-of-systems interoperability framework and road map will provide the EM cluster with a community-wide, open standards, and best practices mechanism to enable interoperability. Defining this standards-based, best practices solution will also build upon architecture advances that are model driven, while facilitating the achievement of seamless, timely, and secure data integration and data exchange services, irrespective of whether that information exchange addresses situational awareness, collaborative planning, or decision support (including GIS) outcomes. The objective is also to identify whether available solutions provide an adaptive environment to meet changing operational needs and conditions experienced during an emergency-response incident.

This study will attempt to demonstrate that the EM cluster's information sharing goals for shared situational awareness, collaborative planning and decision support, and better outcomes, lie within reach of EM stakeholders.

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Project Lead: CAE Professional Services (Canada) Inc.

Federal Partners: Agriculture and Agri-Food Canada, Canadian Food Inspection Agency, Department of National Defence – Enterprise Information Security Environment

Objectives

Responsibility for emergency management (EM) spans organizational structures. The federal government created the Government Operations Centre (GOC) to maintain federal situational awareness of events in real-time. The GOC maintains communication with federal departments through the Emergency Operations Centres (EOCs), which have a critical role in coordinated command and control (C2). Effective incident response requires the ability to share planning assumptions and develop shared situational awareness using voice and electronic communications horizontally between EOCs. In short, reliable Horizontal Information Exchange (HIE) underpins the collaboration and communication required between federal EOCs during a crisis.

C2 information systems rely on information exchange practices and protocols for consistency. Bridging embedded routines and the legacy systems have proved to be a challenge to interoperability despite the evolution toward open standards and migration toward common data. To date, the Canadian EM community has not accepted such standards.

The objective of this study was to evaluate the impact of HIE at the federal EOC level on the EOC management capability. The current focus on HIE was derived from earlier research (Forbes et al., 2008), which exercised the documented EM processes within the Agriculture and Agri-Food Canada (AAFC) National Emergency Operations Centre (NEOC), and identified persistence and information elements as important opportunities that should be pursued to facilitate EOC communications requirements (Forbes et al., 2008).

Relevance

The table-top exercise highlighted the critical importance of effective HIE in orchestrating a whole-of-government response to a federal-level emergency that necessitates actions from multiple government departments. The study results indicate that, despite the comprehensive understanding of documented EM processes held by federal EOC stakeholders, capability gaps persist and significant opportunities exist to enhance information dissemination between key departments and agencies. Improvement plans and activities defined within the capability roadmap are centred on the challenges to facilitating HIE and provide important “as is” and “to be” architectural baselines for future work in this area.

Recent Progress and Results

This study used a Capability-Based Planning (CBP) approach to investigate the impact of HIE at the federal EOC level on the EOC management capability. A table-top exercise was designed to guide discussions through a pandemic-based scenario that exercised the EM response to incidents requiring simultaneous actions from each of the multiple federal EOCs.

The table-top exercise was executed in three sessions that were held at two-week intervals. The exercise included the following components:

- Preparation day to establish the start state for the exercise;
- Table-top exercise day during which a set of six scenario segments was used to exercise federal EOC response and departmental actions focussing on HIE between federal EOCs; and
- Hotwash day to debrief federal stakeholders on the findings from the exercise.

The project team used the United States Department of Homeland Security Target Capability List as the baseline for identifying EOC management capabilities and the metrics that were tailored to evaluate critical aspects of information exchange.

The current findings demonstrated, through an investigation of six unique aspects of information (precision, quality, security, sharing, survivability, and timeliness), that all elements could be considered as methods for facilitating HIE between EOCs. However, the elements associated with precision and survivability represented the most important opportunities for facilitating HIE between federal EOCs due to the emphasis that is placed upon traceable decisions during EM responses.

The project team identified seven capability gaps:

- Ability of EOCs to share data;
- Ability of EOCs to discover relevant activities or information in supporting departments;
- Ability to manage information using email and email devices (e.g., BlackBerry) (with emphasis on their use by EOC managers and senior officials);
- Ability to understand EOC activation protocols (consistency);
- Ability to adhere to protocol and standards (information precision);

- Ability to maintain relevance (information precision); and
- Ability to withstand future enquiry (information survivability).

The capability development challenges that were identified provided the foundation for developing the capability roadmap. The project team identified a series of implementation issues to address interoperability issues and constraints relevant for each of the three phases as they relate to people, processes, and tools. The project team developed a vision architecture comprised of capability views and project views using the US Department of Defense Architecture Framework (DoDAF) Version 2.0. This vision architecture articulated the implementation of the proposed capability against a timeline that depicts activities within three chronological phases.

Impact

The project findings support federal decision makers to improve HIE requirements by providing a comprehensive capability roadmap with targeted improvement activities and an extensive reference baseline for future architecture-driven modelling initiatives. In doing so, this study will augment Canada's ability to respond to high-consequence public safety and security events by facilitating the exchange of the critical information that is required between multiple federal departments to effectively manage emergency responses. The project has resulted in recommendations for monitoring and future applications of the baseline architecture products, generated with a view to the progressive adoption of open standards and data models that depict sophisticated EM tools equipped to manage large-scale emergency responses that require simultaneous information transmission from multiple government departments.

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