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Public Security S&T Summer Symposium 2009

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CENTRE FOR SECURITY SCIENCE

Canada

Foreward

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 created in March 2006.

DRDC CSS's mission is to enhance Canada's ability to prevent, prepare for, respond to, and recover from high-consequence public safety and security events. This is accomplished by leading and administering research and development; evaluating concepts and technologies; and building a network of national and international science and technology (S&T) partners within the public safety and security communities by establishing and maintaining science clusters and communities of practice. DRDC CSS also identifies future trends and threats, and provides support 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 mission areas: Defeat the Chemical, Biological, Radiological-Nuclear and Explosives (CBRNE) Threat, the majority of which is funded through the CBRNE Research and Technology Initiative (CRTI); Critical Infrastructure Protection (CIP); Surveillance, Intelligence and Interdiction (SII); and Emergency Management and Systems Interoperability (EMSI).

DRDC CSS also leads the Major Events Coordinated Security Solutions (MECSS) project that is assisting the functional authorities in reducing the security risk associated with Vancouver 2010 Olympics through the coordinated application of 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 (CPRC), which has a mission to harness S&T knowledge to strengthen police, fire and emergency medical services in Canada.

This year's Public Security S&T Summer Symposium is taking place at the Brookstreet Hotel in Ottawa and will highlight successes for completed and on-going projects based on how they are positioned across the public safety continuum: Prepare, Prevent, Respond, and Recover.

The following abstracts outline the progress of the projects from the first seven rounds of funding. The projects will also be presented orally or in posters at the Symposium. As always, I am impressed with the breadth and quality of the work and am proud to share this knowledge with you. Many of these projects have already made tangible contributions to enhance the safety and security of Canadians, while others show great promise as they continue to evolve. I am confident that you will find these projects stimulating and I thank you for your ongoing commitment to working together to achieve these high-quality results.

Dr. Anthony Ashley
Director General, DRDC CSS

Table of Contents

CRTI 04-0004RD

Canadian Animal Health Surveillance Network

Project Lead:	Canadian Food Inspection Agency
Federal Partner:	Public Health Agency of Canada
Industry Partner:	TDV Global Incorporated
Other Partners:	Government of British Columbia, Government of Alberta, Government of Saskatchewan, Prairie Diagnostic Services Inc. – Saskatoon, Canadian Cooperative Wildlife Health Centre – University of Saskatchewan, Government of Manitoba, University of Guelph, Government of Québec, University of Montréal, Government of New Brunswick, Government of Newfoundland and Labrador, University of Prince Edward Island, Government of Nova Scotia

Objectives

The Canadian Animal Health Surveillance Network (CAHSN) is a formal network of federal, provincial, and university animal health diagnostic labs. The network will enhance Canada's ability for real-time detection of serious and infectious animal disease threats that could have zoonotic potential. It will also facilitate a response capability to minimize the human health and economic consequences to the country. CAHSN will collaborate with the Canadian Network for Public Health Intelligence (CNPHI) to allow for the rapid exchange of animal and public health intelligence. A secure web-based system will collect and process targeted surveillance data and disseminate the intelligence for rapid exchange of information and decision making to support the response framework.

Relevance

Early detection and rapid response is the most effective defence against agroterrorist incidents, which threaten livestock production and have the potential to affect the human population, as it is not possible to completely prevent the introduction of biological agents into Canada. As many bioterrorism-related risks and new animal diseases are zoonotic in nature, it is critical that human and animal health intelligence be integrated for effective disease surveillance and response. There is also a need within Canada for greater laboratory interoperability and increased surge capacity, harmonized test methodologies, and national and international networking between technical and scientific staff in order to ensure bioterrorism preparedness. By addressing these needs, CAHSN will provide the framework for animal health biosecurity, early disease detection, a national early warning system, and rapid response.

Recent Progress and Results

Project completion is scheduled for the end of September 2009. Options for long-term support as well as provincial and federal funding are being examined while models for cost sharing and governance continue to be pursued. The Canadian Food Inspection Agency is seeking funding resources to continue the CAHSN program infrastructure currently in place at the National Centre for Foreign Animal Disease in Winnipeg.

Key goals over the past year included the completion phase for laboratory interoperability, interconnectivity, and surveillance systems, and transitioning the project to program status.

Implementing laboratory interoperability within the network laboratories to achieve diagnostic capacity for foreign animal diseases (FAD) and quality assurance (QA) management has progressed extremely well; all but one participating laboratory has certified analysts for approved standardized tests. The remaining laboratory deferred participation on the capability initiatives as they are are not expected to meet biosafety requirements by project completion.

CNPHI and the surveillance team continued to concentrate on the system design and laboratory interconnectivity, putting in place a standardized information technology (IT) and management platform that connects half of the laboratory and surveillance systems across Canada. Full deployment for data interconnectivity across the network has not progressed as originally planned. Project findings revealed many challenges outside the control of the project team, disparate surveillance systems with no uniform approach to disease surveillance, systems that lack mandatory data capture, and the majority of the laboratories at varying stages of IT systems redevelopment, many of which lack programmer support. Data transmissions are being received from those provinces that have easily established interconnectivity. For those laboratories not yet linked, CNPHI can readily establish an iterim system in the event of an outbreak.

Improved surveillance and reporting for bovine spongiform encephalopathy (BSE) has been achieved with the development of the BSE Surveillance Program module. The compilation of data and analysis previously took weeks but can now be compiled by CFIA officials within hours. The CAHSN was used in the most recent outbreak of avian influenza in British Columbia (2008–2009) to capture the test results from provincial laboratories and co-related them with federal results.

A formal network known as the CAHSN Surveillance and Epidemiology Advisory Committee has also been created. Comprised of government epidemilogists and disease control experts from across Canada, the Committee's focus is to explore novel methods for prediciting, detecting, analyzing and controlling serious outbreaks of disease and provide technical guidance on surveillance issues. For the first time in Canada, national consensus has been achieved on a standardized, core minimum data set of surveillance information that can be used for any animal disease surveillance program.

The CAHSN has taken steps to address issues around sharing and reporting of animal disease and test information across jurisdictions with a Memorandum of Understanding (MOU), although the MOU relies on the willingness of participants to share routine information. Although moving slowly, a Data Sharing Agreement is also being developed for which the Department of Justice has provided an opinion on the data elements to be collected and disclosed against the application of the *Privacy Act*. Additonally, an Information Management Strategy is underway to identify and discuss CAHSN information assets and mitigation strategies to address participant concerns regarding information ownership.

The CAHSN has shown a proof of concept and has been embraced by all provincial animal health agencies as a necessary component of an animal health infrastructure. The CAHSN platform can easily be expanded beyond its original scope for FADs to include emerging endemic and zoonotic diseases.

Impact

The CAHSN provides animal health stakeholders with a national, early warning system for animal disease threats to animal and human health and the security of the food supply; a federal-provincial integrated laboratory cluster for the rapid diagnosis of serious, infectious animal diseases; and an information-sharing network linking federal and provincial agencies and departments involved with animal and human health. The network will integrate human and animal health intelligence through collaborative communication tools and a comprehensive solution set. The network will provide a beneficial impact from data exchange to analysis, as well as from surveillance to alerting and event management. Furthermore, provincial laboratories will become first responder laboratories with the capacity and capability to perform early diagnostic intervention. This function will be enabled by their accreditation and certification in FAD test methods, as well as the receipt of the necessary supports toward laboratory infrastructure, equipment, supplies, and QA management. Taken together, the project components will better prepare Canada to deal with an agro-terrorist event or zoonotic disease outbreak.

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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 will use data generated from exposure experiments and focus on the development of a generic approach to decontamination and determination of 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 will be developed using three methods. First, the project team will establish the relationship between magnitude of exposure and expected health effects. Next, by identifying individuals at risk of exposure and considering all routes of exposure (contact, inhalation, and ingestion), the team will assess the real and potential exposure risks. Finally, the team will characterize the risk to determine potential for toxicity (chemical) or infectivity (biological).

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. Available literature and pertinent laboratory data from desorption experiments and animal exposure models is used 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 personnel recently focused on the desorption of chemical agents of concern from building surfaces and in surrounding air at various temperatures. Project personnel 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 continues on those aspects of sampling that can have a large impact on assessing contamination of environmental surfaces, determining an effective means to decontaminate the surfaces, and confirming the levels of pathogen reductions achieved.

Mathematical methods for determining decontamination standards have been proposed by several partners. These continue to be evaluated and combined, maintaining the strengths of the different models. 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 will be 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 will first be established for those chemical and biological agents most likely to be used in an intentional release. Once the experimental and modelling work has been developed into standards, a broad range of personnel, from first responders to top-level decision makers, will use the standards. Special emphasis will 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 will be made available in condensed format for use in emergency response scenarios but will 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 04-0029RD

Development of an Electronic Neutron Dosimeter

Project Lead:	DRDC Ottawa
Federal Partners:	Canadian Nuclear Safety Commission, Department of National Defence – Canadian Joint Incident Response Unit
Industry Partner:	Bubble Technology Industries
Other Partner:	Los Alamos National Laboratory

Objectives

Tests of existing electronic-neutron dosimeters (ENDs) by military and civilian groups have revealed significant limitations. To meet the operational requirements of emergency response from nuclear industry personnel to radiological-nuclear (RN) incidents, Bubble Technology Industries (BTI) and Los Alamos National Laboratory collaborated to develop a new END. The size, performance, and data analysis capabilities of the END have been designed with the intention of meeting international standard IEC 61526. In this project, DRDC Ottawa provided overall project management, key experimental support, and radiological testing of the prototype. Testing of the prototype was also carried out by Los Alamos National Laboratory. The Canadian Nuclear Safety Commission (CNSC) and the Canadian Joint Incident Response Unit (CJIRU) provided valuable end-user input for the design of the prototype, which was developed by BTI. The project began in October 2005 and ended in March 2009 with the delivery of a field prototype for testing by end-user partners.

Relevance

This project addresses several of the risk scenarios identified by CRTI. These include terrorist events occurring at reactors and facilities where neutron-emitting materials are present; deployment of a nuclear weapon; and use of a radiological weapon in which a neutron-emitting source, such as plutonium–beryllium (PuBe) or americium–beryllium (AmBe), could also be involved. This project is therefore of high relevance to the counterterrorism community in general and to CRTI in particular.

Recent Progress and Results

The laboratory prototype of the END is patterned after one of BTI's commercial neutron spectral dosimeters known as the N-probe. The prototype uses a pair of small, very bright scintillators coupled to tiny photomultiplier tubes, allowing for dose determination across the entire relevant neutron energy range. Special electronics were designed to minimize power consumption to enable weeks of operation on a single charge. New algorithms to reconstruct dose allow instant evaluation of dose/dose rate, which is displayed with variable integration times from one second to several minutes. The sensitivity of the END exceeds existing commercial ENDs by at least 100 times in the range from thermal neutrons to 20 megaelectron volt (MeV). The neutron to gamma rejection factor is in the order of 1:1500. Accuracy is better than 10 percent for

neutron sources, such as PuBe, californium (Cf), AmBe, and so on. Because of its variable levels of alarm settings, which include visual, audible, and vibration alarm options for dose/dose rate, the END can be used by a person working in harsh conditions. Software for setting dose/dose rate alarm levels, health tests, and dose read-out is simple and flexible. Although the temperature stability, weight, and size of the existing laboratory prototype do not currently meet international standards, these are mainly engineering problems that will be addressed in the next version of the prototype (END-2) being developed under CRTI 07-0190TA. The new design is expected to meet essentially all specifications of international standard IEC 61526 and to provide gamma dose/dose rate as well as neutron dose/dose rate.

Impact

The main disadvantages of existing commercial neutron dosimeters are low sensitivity and, as a result, long integration time, excessive weight, and inaccurate measurements. The END project was implemented to address these technological gaps present in the market today. Many terrorist scenarios require the detection of radiation in pre- or post-event incidents. An accurate END is necessary to enable first responders to monitor instantly their own radiation exposures accurately. The new END developed by BTI with assistance from DRDC Ottawa, CNSC, and CJIRU has many applications, not just for first responder and military groups, but for the nuclear industry as a whole.

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CRTI 04-0045RD

Development of Collections, Reference/DNA Databases, and Detection Systems to Counter Bioterrorism against Agriculture and Forestry

Project Lead:	Agriculture and Agri-food Canada
Federal Partners:	Canadian Food Inspection Agency, Natural Resources Canada – Canadian Forestry Service

Objectives

This three-year project enabled the project team to assemble a biological collection of critical fungal plant pathogens of high risk to Canadian crops, forests, and the food supply, and develop a multi-gene DNA sequence database and molecular diagnostics for these fungi. A related activity involved updating an online database documenting the occurrence of all known plant pathogens in Canada.

Agriculture and Agri-food Canada (AAFC) serves as the repository for cultures and specimens through the Canadian Collection of Fungal Cultures and the Canadian National Mycological Herbarium. The Canadian Food Inspection Agency (CFIA) secured import permits and addressed biosecurity issues related to these cultures. Researchers from the AAFC and the Canadian Forestry Service (CFS) developed DNA databases, and were involved in the design and preliminary validation of molecular assays. The CFIA, the Canadian Grain Commission (CGC), and international partners such as the United States Department of Agriculture (USDA) – Animal and Plant Health Inspection Service (APHIS) undertook final validation of assays.

Relevance

Accidental introductions of exotic agricultural pathogens can cause quarantine crises and place entire ecosystems at risk. Deliberate introductions, even on a small scale, could result in loss of consumer confidence in the food system and provoke international trade embargoes, with severe economic and social consequences to Canada. To maintain open agricultural and forestry trade with partners who have already established new plant biosecurity measures, including our closest trade partners who have already implemented research programs and early detection systems, vigilance and monitoring by Canada are critical. This project resulted in improvements to the documentation of plant pathogens that occur in Canada, including close relatives of high-risk pathogens, and the development of tools for recognizing suspicious outbreaks and establishing their source of origin.

Recent Progress and Results

This final year of the project focused on the validation of previously developed assays and completion of the basic objectives for the lower priority targets. The project team was able to complete specimen collection for 21 of its 23 target pathogens and each of their five taxonomically similar relatives. In a few cases, researchers were only able to acquire DNA for the foreign target organism or one or more of the relatives. The two remaining pathogens proved impossible to obtain as a result of material transfer restrictions imposed by foreign states.

Researchers completed the sequencing of three or more gene regions for all but one of the 21 species, and were able to identify regions that differentiated the target organism from the nearest relatives in all but two of the targets. These regions have been used to design real-time (RT) polymerase chain reaction (PCR) assays; protocols were transferred to the CFIA for validation. A DNA array based on the RT-PCR probes was developed to enable parallel detection of the target pathogens.

Impact

Although the purpose for developing these assays was to detect the deliberate introduction of exotic pathogens in Canada, the immediate deployment and use of some assays for accidental introductions is helping to protect the health of oak trees and soybean, potato, and corn crops in parts of Canada. For example, although mitigation of existing outbreaks of *Phytophthora ramorum*, which causes sudden oak death and attacks many plant species, is underway in California and parts of Europe, an international blind trial found the project team's *P. ramorum* three-gene test to be the most accurate test in avoiding both false positives and false negatives. The CFIA has processed close to 58,000 putative *P. ramorum* samples since April 2007. Of these, over 16,000 were tested further by the species-specific RT-PCR assay, which detected 317 positives. A second assay based on single nucleotide polymorphisms (SNPs) to detect the origin of strains, has been implemented and a multiplex assay was developed to further increase speed, throughput and reliability. As a result of their outstanding work on *P. ramorum* detection to prevent the establishment of this disease in Canada, four team members from the AAFC, Natural Resources Canada (NRCan), CFIA, and CRTI received a Merit Award from the Deputy Minister of NRCan in June 2008. Asian soybean rust disease was first confirmed in southern North America in 2004. Rainfall and air sample collectors were deployed at 12 sites in Ontario, Saskatchewan, and Manitoba. In 2007, the first positive Canadian molecular detection of soybean rust spores occurred in samples obtained from mid-summer to early fall at multiple sites. In October of 2007, the first infected soybean plant in Canada was found in southwestern Ontario. The project team's American collaborators provided computer prediction models of spore trajectories and spore detection data that correlated with this event. This was the first detection in Canadian history of a plant pathogen in air and rain samples before a diseased plant was found. In 2009, spores were detected in Ontario and Manitoba but no diseased plants were found. The project team is looking into maintaining and expanding this network and using it to track other anticipated airborne threats such as the new potentially devastating strains of wheat stem rust called Uganda 99.

The project team also developed three RT-PCR assays for the fungus *Synchytrium endobioticum*, an obligate potato pathogen, which cannot be grown in culture and is on the US Agriculture Bioterrorism Act Select Agent List. This pathogen is known to occur in Canada, and was found again in Prince Edward Island in 2007, creating an immediate demand for the team's assays. The project team produced clean suspensions of sporangia in the 10^6/ml range to spike soil samples at various concentrations. Sufficient clean DNA was obtained from a single tuber for eventual sequencing of the whole genome. The PCR assays are being implemented at CFIA and material transfer agreements have been signed with other agencies, including the USDA–APHIS.

In 2006, the biggest epidemic in Ontario history of *Fusarium graminearum* on corn was recorded. *F. graminearum* is a mycotoxin-producing species complex of high genetic diversity, requiring molecular markers of the appropriate resolution. After screening 24 genes, it was found that the mating type (MAT) gene had the best features for the design of RT-PCR assays. This assay has since been transferred to the CGC for use in validating Canadian seed exports. The CGC, in turn, funded further development by the team's post-doctoral researcher to develop the assay. The Fusarium headblight complex is now being resolved at a resolution higher than planned.

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CRTI 04-0052RD

On-site Composting for Biocontainment and Safe Disposal of Infectious Animal Carcasses and Manure in the Event of a Bioterrorism Attack

Project Lead:	Canadian Food Inspection Agency
Federal Partner:	Agriculture and Agri-Food Canada
Other Partners:	Alberta Agriculture and Rural Development; Iowa State University – Department of Agriculture and Biosystems Engineering

Objectives

The objective of this research was to develop composting methods that could be efficiently applied on farms to assure biocontainment and inactivation of viruses during the degradation of contaminated carcasses and manure from infected animals to earth-like material.

Relevance

Current stamping out policies for managing outbreaks of avian influenza (AI) in poultry and other diseases have the potential to spread diseases and are environmentally undesirable.

Research progress and results

Scientists at CFIA's Ottawa laboratory adapted the static-pile-passive-aeration composting system for disposal of carcasses and wastes for small- and large-scale studies. With this system, compost piles could be contained in plastic and the aeration pipes installed, making it unnecessary to disturb the compost to provide aeration. Sufficient heat was produced throughout the entire mass to destroy animal disease viruses.
The project team developed methods to study the survival of the AI, Newcastle disease (ND), infectious bursal disease (IBD), foot and mouth disease (FMD), and bovine viral diarrhea (BVD) viruses through a series of composting experiments. For example, to study the IBD virus, the team treated extracts of compost with antibiotics; inoculated the extracts onto Vero cells and then detected the virus in the cell cultures by real-time reverse transcriptase (RRT) polymerase chain reaction (PCR). Although the IBD virus is non-enveloped and was the most resistant virus in these studies, it was destroyed in compost during a 10-day period when the temperature was above 50°C. Studies on the survival of the AI and ND viruses, in compost and in vitro, showed that microbial activity and temperature played a role in killing and degrading the viruses. In all cases, viruses were inactivated during the composting process before their ribonucleic acid (RNA) was fully degraded. The team therefore considered that application of RRT PCR might be useful for screening viruses in the environment and that survival of the viruses could be confirmed by virus isolation procedures.

Investigators at AAFC's Lethbridge research centre studied the initial water content (WC) of manure used in construction of biocontained mortality compost. Because of its impact on overall carcass and DNA degradation, they determined that the WC should be targeted at 60 percent. Manure with 60 percent WC resulted in homogenous heating of all regions of the biocontained compost with temperatures greater than 55°C for 52 days. The copy number of a 171-base pair (bp) mitochondrial bovine DNA fragment was reduced by 86 percent after 230 days of composting. Manure with 68 percent WC resulted in inconsistent heating, pooling of moisture at the base of the compost structures, and a reduction in copy number of the171-bp fragment of only 20 percent. Compared to placing carcasses on 40 cm of straw and covering with 160 cm of manure, covering carcasses with

100 cm of manure on a base of 40 cm of straw and 60 cm of manure also contributed to improved carcass degradation. For dairy farms where solid manure is not available, biocontained mortality compost using a straw and liquid manure matrix is feasible, although would likely not be suitable for disposal of resilient infectious organisms. Maximum temperature attained in liquid manure compost was 58°C, but not all regions of the compost exceeded 55°C. Quantification of a resilient 171-bp bovine mitochondrial DNA fragment with high copy number (from 220 to 1720 copies per cell), and traditional temperature monitoring, would reliably predict carcass degradation and indicate destruction of viruses and pathogenic organisms in biocontained compost-containing cattle carcasses.

Scientists at Iowa State University monitored the performance of six emergency cover materials during warm and cool seasons. Composting was done in 2m x 2m x 1.2m (high) insulated test units that were passively aerated (10 cm diameter perforated drainage tubing installed at the base of each unit) and covered with plastic biosecurity sheeting. Decomposition of 55 to 60 kilograms swine carcasses during eight-week composting trials showed that all of the envelope materials performed similarly and adequately as support matrices for biodecomposition of soft carcass tissues. Temperature monitoring showed that some materials are better able to generate and retain heat than others. Ambient air temperatures, gas permeability, and initial moisture levels all play crucial roles in producing and sustaining elevated internal temperatures. The minimum internal oxygen (O_2) concentration for aerobic composting that is typically recommended is 5 percent, yet concentrations above 10 percent are preferred. With the exception of corn silage, average minimum O_2 concentrations in the critical bottom and middle compost layers beneath or adjacent to carcasses easily met the desired 10 percent level. A review of factors affecting chimney flow, as well as a series of indoor tests, revealed that airflow through the compost matrix is affected by external wind speed and direction, temperature differential between internal and ambient air, and the vertical elevation difference between the inlet and outlet exhaust locations in the compost pile.

The university scientists also developed a new volatile organic compound (VOC) sampling and testing method using solid phase micro-extraction and gas chromatography/mass spectrometry. The purpose was to identify and quantify marker compounds that signal initiation and completion of carcass decomposition inside biosecure compost systems. The sampling and analytical procedures were tested extensively using six different carcass envelope materials. More than 40 different VOCs were identified in composting off-gases. The highest concentrations of marker VOCs were detected in field test units with the lowest carcass decomposition and highest finished compost respiration rates.

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CRTI 04-0127TD

Canadian Health Integrated Response Platform

Project Lead:	Health Canada – Radiation Protection Bureau
Federal Partners:	Public Health Agency of Canada, Health Canada, Environment Canada – Canadian Meteorological Centre
Industry Partners:	Prolog Development Center, DBx Geomatics

Objectives

Building on past successful CRTI-funded projects, the Canadian Health Integrated Response Platform (CHIRP) integrates two decision-support platforms: the Canadian Network for Public Health Intelligence (CNPHI) and the Accident Reporting and Guiding Operational System (ARGOS) to enable bidirectional alerting, automated alerting, e-mapping, and the use of resource and decision-support tools.

CNPHI (CRTI 02-0035RD) is an integrated monitoring, alerting, data-gathering, analysis, decision-support, and information exchange system used by the public health community and the Public Health Agency of Canada (PHAC). It gathers relevant public health intelligence into a common national framework to support coordination between multi-level jurisdictions. This form of coordination and information sharing is necessary to identify risks, initiate responses, and build response capacity.

The ARGOS system (CRTI 0080TA: Information Management and Decision-Support System for Radiological-Nuclear Hazard Preparedness and Response) is currently in use for radiological-nuclear (RN) emergencies at Health Canada's Radiation Protection Bureau (RPB). It is the primary toolkit of the Federal Nuclear Emergency Plan (FNEP), which is administered by the Nuclear Emergency Preparedness and Response Division of Health Canada's RPB. ARGOS significantly improves interoperability among FNEP partners by facilitating a coordinated and rapid response to an RN incident. It also supports effective decision making and the distribution of critical information to the operational community, first responders, and ultimately, the public.

CHIRP leverages the integration of the disparate resources channelled by the CNPHI system to support the ability of decision makers—as partners in the national CBRN response framework—to react to an unexplained biological event that may be the result of a radiological agent. The project will also help these decision makers focus relevant information through the ARGOS system to the public health community in response to an RN event.

Relevance

This cross-cluster collaboration will coordinate the efforts of both the RN and biological clusters, allowing seamless interoperability between the communities while maintaining security and defined roles.

The CHIRP project makes the most of the secure infostructure of PHAC's National Microbiology Laboratory and Health Canada's RPB and strengthen partnerships with Environment Canada's Canadian Meteorological Centre. It will ultimately enhance RN event detection, response, and preparedness throughout the RN response and public health communities in Canada. It will also strengthen and preserve jurisdictional boundaries while pooling Canadian resources and infrastructure in new and innovative ways for the direct benefit of local, regional, and federal decision makers.

Recent Progress and Results

CHIRP leverages both ARGOS and CNPHI to provide an integrated response to a CBRN emergency. The ability to notify and alert the public health community in a focused, timely, and concise manner was exercised during the Canadian response to the polonuim-210 events in London, England in December of 2006. During this event, Health Canada issued focused alerts to the public health community and distributed these alerts through the CNPHI system through the CHIRP-system framework.

This project was completed 31March 2009.

Impact

The CHIRP project will provide a unified platform that will coordinate the response efforts of both the RN and biological clusters in response to a terrorist or other threat. It will assist in closing the communication gap seen in the emergency response of both clusters by allowing seamless interoperability between the communities, while maintaining security and defined roles.

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CRTI 05-0014RD

Experimental and Theoretical Development of a Resuspension Database to Assist Decision Makers during Radiological Dispersal Device Events

Project Lead:	DRDC Ottawa
Federal Partner:	Environment Canada
Other Partners:	University of Ontario Institute of Technology, Defence Science and Technology Laboratories, Wehrwissenschaftliches Institut für Schutztechnologien – ABC-Schutz, Délégation Générale pour l'Armement – Centre d'études du Bouchet

Objectives

This project will experimentally and theoretically examine the resuspension capabilities of the facilities and experts from four participating North American Treaty Organization (NATO) countries (Canada, Germany, England, and France). The project is also currently the primary focus for the team of radiological experts reporting to NATO's Radiological and Nuclear Defence Sub-Group under the Joint Capability Group for CBRN Defence.

Relevance

The main threat in almost every radiological terrorist scenario (e.g., a radiological dispersal device) is from radioactive particles distributed over a wide area. More specifically, the main biological threat is the human ingestion or inhalation of these particles. Thus, in order to fully understand the consequences of an event, radiological experts must understand the process by which deposited particles re-enter the atmosphere. This process, known as resuspension when radioactive particles are involved, is directly analogous to the re-aerosolization of particles that are biological in nature.

Particulate resuspension can be influenced by a variety of natural and man-made factors. Natural factors may include weather and the nature of surface or ground cover, and man-made factors could be vehicle and pedestrian traffic or structures. Radiological experts cannot control all of these factors nor hope to duplicate the myriad of possibilities; however, experiments conducted in controlled and contained environments can allow them to better predict, prepare, and mitigate the possible outcomes of a real radiological event.

Recent Progress and Results

Researchers continued to examine a variety of short-lived radioisotopes with different particle diameters in controlled (i.e., indoor) environments. Researchers at Wehrwissenschaftliches Institut für Schutztechnologien in Munster, Germany, hosted trials using a large wind tunnel to explore the resuspension of particles under multiple surfaces and wind conditions. Canada, the United Kingdom (UK), and Germany participated in this trial. Canadian researchers provided measurements to determine the lift-off time of the contamination. Researchers from the UK and Canada provided measurements of the particle concentration in the air in the wind tunnel. German researchers provided measurements of the contamination concentration on the test plates before and after being in the wind tunnel.

This trial proved to be a success and the project team was able to determine estimates of lift-off time, gathering enough data to further work in the modelling of particles being lifted off surfaces.

Currently, trial plans are being developed for more small-scale studies at DRDC Ottawa with a wind tunnel and large-scale proof-of-concept in Bourges, France, and DRDC Suffield for the summer of 2010.

Impact

The experiments conducted under this project will allow radiological experts to better predict, prepare for, and mitigate the possible outcomes of a radiological event, and provide guidance to field personnel (e.g., military commanders) on protective procedures and the operational constraints for work in contaminated environments.

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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 Military 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 standard will address 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 will improve the harmonization of protective equipment used by Canadian responders and will enhance consequence management capabilities resulting from the improved all-hazard protection.

Recent Progress and Results

The Canadian General Standards Board / Canadian Standards Association Standards Technical Committee for the Protection of First Responders from Chemical, Biological, Radiological and Nuclear Events was established in January 2007 and has held 12 meetings to develop the technical content of the draft standard. Stakeholders on the committee include all levels of government, first responder organizations, manufacturers, research and testing organizations, and other relevant public and private organizations.

Five sub-groups were established to develop the various sections of the standard: First Responder, Respirator, Contagious Events, Technical Specifications – Clothing and Test Methods, and Training Requirements. These sub-groups met to develop their respective sections of the draft standard, which were then reviewed and discussed by the full committee.

The scope of the standard has been expanded to provide risk-based guidance using a predictive probabilistic model for PPE selection in a contagious outbreak event. The current working draft includes sections on definitions and acronyms, the anatomy of a CBRN event, a PPE selection decision-making process and selection reference tables, information on equipment performance requirements and applicable standards, required evaluation methodologies, and guidance on the capabilities and limitations of PPE. Information is also provided on hazard and risk assessment, realistic performance assessments, and heat stress.

A draft was released for a 60-day public review in July 2008. The committee members received public comments and continued to revise and achieve consensus on the draft. The draft standard will be forwarded to committee members for vote in early summer 2009 and publication is expected in March 2010.

Impact

There is currently no comprehensive standard in Canada that provides official first responders with the critical information and guidance necessary to ensure that the appropriate suite of protective equipment and systems is selected and used in CBRN terrorism events.

The development of a single recognized national standard would bring together relevant stakeholders with world-class expertise in protective equipment development and evaluation for CBRN agents. The standard will support 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 05-0058TD

Unified Interoperability Solution Set to Support CONOPS Framework Development: Municipal, Provincial, and Federal Collaboration to CBRNE Response

Project Lead:	DRDC Ottawa – Capabilities for Asymmetric and Radiological Defence and Simulation Section
Federal Partners:	Environment Canada – Canadian Meteorological Centre, DRDC Suffield – Counter Terrorism Technology Centre, Department of National Defence – Canadian Forces Experimentation Centre, Department of National Defence – Synthetic Environment Coordination Office, Royal Canadian Mounted Police – E-Division
Industry Partners:	CAE Professional Services Inc, EmerGeo Solutions Inc, Justice Institute of British Columbia

Objectives

Complex incidents, such as those involving CBRNE threats, require a collaborative, interoperable response across municipal, provincial, and federal agencies and departments. The objectives of this project are to use a capability analysis approach to determine the effectiveness of interoperable emergency response operations. In doing so, this project will successfully produce a simulation-based, scenario-driven, capability analysis methodology that can be used to evaluate response capabilities to all-hazard types. The project team will test this methodology against real response operations at all levels of government, and geographically position the scenario to ensure a degree of likelihood resulting in a true demonstration of the value of the approach.

The project will conclude by establishing the common, shared geospatial dataset, scenarios, and experimentation methodology at each partner site to enable future collaboration and first responder training within a municipal, provincial, and federal interoperability structure.

Relevance

The realities of disaster management today, whether responding to terrorist or natural incidents, places inter-organizational collaboration at the forefront of any response, highlighting the need for a coherent and interoperable approach. Many incident responses originate at the local level with a 9-1-1 call, and, as the incident unfolds, the response may require municipal, provincial, and federal involvement. This dynamic environment demands an increased level of transparency and awareness to support the development of an integrated response capability. Broad transparency is needed for standards, processes, protocols, and capabilities to ensure a shared awareness of authority, responsibility, and competency. Therefore, the interfaces between the municipal, provincial, and federal responders must be well understood and effectively exercised.

Responding collaboratively to CBRNE challenges requires new approaches to crisis management and preparedness. This project will significantly advance municipal, provincial, and federal interoperability in responding to CBRNE events by developing a geographically specific operational architecture, instantiated in a simulation-based analysis environment that is developed within a standardized geospatial dataset, and implemented to support first responder planning, training, and operations. Additionally, the overall project execution methodology will establish an interoperability framework and concept of operations (CONOPS) development approach that is readily transferable to other geographical areas in which interagency collaboration is desirable and in which only unique features of that region's CBRNE response structure would need to be incorporated.

Recent Progress and Results

The project team has completed the development of an interoperability framework (Phase A). This involved interviewing subject-matter experts (SMEs) from the partner organizations (local, municipal, provincial, and federal responders) and integrating the resulting information into a series of architecture products. This series of products represents the different views on establishing an interoperability framework and defining a CONOPS for municipal, provincial, and federal interoperability in a CBRNE response. The project's response partners completed validating the operational architecture in Vancouver at the beginning of May 2007.

Phase B focused on developing a common, shared geospatial dataset that supports simulation-based analysis across the diverse municipal, provincial, and federal CBRNE response organizations as defined within the architecture development in Phase A. The project team acquired two-dimensional (2-D) and three-dimensional (3-D) data from the City of Vancouver and integrated the geospatial dataset into the geographic information system-based Common Operating Picture Environment (COPE) that is used by all participants in the demonstrations at the end of the project. EmerGeo Solutions developed an interface that allows for the acquisition of relevant simulation data from the simulation environment and an interface with the 3-D viewer with their software.

The development of a distributed simulation methodology (Phase C) enables the project's participants to conduct CBRNE-related scenarios within the COPE in a distributed fashion and integrate enhanced CBRNE-dispersion models and atmospheric effects. Environment Canada, in conjunction with DRDC Suffield, has developed the atmospheric models for the project.

The simulation was constructed based on the interoperability architecture (Phase D).

The project is now in its final phase and the project team successfully performed the three demonstrations as planned. Held at the Justice Institute of British Columbia (JIBC), the first demonstration focused on the experimental capability of the technology. The other demonstrations focused on the ability to use the same synthetic environment to train members of the emergency management community in CBRNE response with extended scenarios and distributed simulations. The team was invited to present the developed capability to the North Atlantic Treaty Organization Modelling and Simulation group conference in Vancouver in October 2008. It was well received by the international venue.

The project has been extended until 30 June 2009 to allow for a demonstration for the RCMP Vancouver 2010 Integrated Security Unit. The RCMP requested the demonstration to see if the developed technology will help their training. Overall, the project is almost complete with a well-developed synthetic environment training capability for JIBC to train the first responder community.

Impact

Today, the degree to which Canada can effectively respond to CBRNE events is directly related to the degree to which various responder organizations are interoperable and have a shared awareness of competency, authority, and responsibility. This project will have significant impact as it develops a scenario-based simulation environment that employs standardized geospatial data that will allow the first responder community to experiment with existing structures and explore new structures, thereby improving planning, training and, subsequently, operations.

The project will provide an enhanced simulation-based analysis and training capability for first responders at the JIBC, various Vancouver Emergency Operations Centres who work with the JIBC, DRDC Ottawa, the Canadian Forces Experimentation Centre, and Environment Canada. Additionally, the unique coupling of a common, shared, geospatial dataset—exercised through simulation-based CBRNE events but developed within an integrated architecture approach—will support interoperability assessments and analysis for municipal, provincial, and federal responses and the development of a coherent CONOPS framework for interagency CBRNE and critical incident response.

The capability methodology developed as part of this project is already being applied to analyze industry capability enhancements to emergency response procedures based on a biological incident on critical infrastructure.

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CRTI 05-0069RD

Development of Granulocyte-Macrophage Colony Stimulating Factor for Acute Radiation Syndrome

Project Lead:	Health Canada
Federal Partner:	DRDC Suffield
Industry Partner:	Cangene Corporation
Other Partner:	University of Maryland

Objectives

The objective of this project was to evaluate the efficacy of granulocyte-macrophage colony stimulating factor (GM-CSF) modified with polyethylene glycol (PEG) in the early treatment of symptoms from low lethal dose radiation exposure, to develop this product and establish exact dosing requirements. Irradiated monkeys experiencing symptoms of severe neutropenia were used as a model. Additionally, the efficacy of unpegylated GM-CSF (Leucotropin™) treatment for acute radiation syndrome was tested in a non-human primate model.

Project implementation began in May 2006. Dose frequency studies initiated in December 2006 are now complete. Efficacy confirmation and dose range studies commenced in May 2007 and are completed. Leucotropin™ studies commenced in September 2008 and were terminated in September 2008. The final study report was completed in January 2009.

Relevance

Acute radiation exposure is a potential threat to civilian and military personnel under various circumstances such as terrorist attacks or nuclear accidents. Currently, Canada has limited therapeutic tools to treat the effects of acute radiation exposure. One of the major effects of radiation exposure is neutropenia: a reduction in the number of white blood cells called neutrophils, which consequently weakens the body's defence capabilities and makes the patient vulnerable to life-threatening infections. A cytokine, GM-CSF, is the key regulator governing the functions of many white blood cells at all stages of their maturation and release from the blood-production organs such as bone marrow. A novel form of GM-CSF called PEGylated GM-CSF (PEG-GM-CSF) shows a better therapeutic profile in terms of stimulating neutrophil production and the number of injections required to alleviate neutropenia. This project was designed to confirm the efficacy of PEG-GM-CSF and unpegylated GM-CSF treatment in alleviating neutropenia and improving long-term survival of individuals exposed to acute radiation.

Recent Progress and Results

Using *in vivo* pharmacology studies, 20 kDa PEG GM-CSF molecules were successfully tested for pharmacokinetics and efficacy in additional non-irradiated and irradiated rhesus monkeys. Serum half-life was found to be significantly higher in monkeys treated with PEG-GM-CSF than in monkeys treated with unpegylated GM-CSF. This data is expected to support the use of PEG-GM-CSF at a much lower frequency than GM-CSF, which would be preferred in a nuclear terrorism event.

Using hematology assessment and in vitro clonogenic assays, it was found that PEG-GM-CSF significantly increases peripheral white blood cell counts and also increases bone marrow-derived mononuclear cell counts in a normal monkey. White blood cells, absolute neutrophil counts, and eosinophils were significantly increased over five days following administration of

approximately 300 μg/kg of PEG-GM-CSF. Also, a single administration of PEG-GM-CSF initiated a marked release of bone marrow-derived segmented neutrophils and band neutrophils. Bone marrow colony-forming cells continued to proliferate through Day 28 after the administration.

Two monkeys were total-body irradiated at 600 cGy (250 kVp x-ray) and received 300 μg/kg/day of PEG-GM-CSF on Day 1 and 7. One animal was irradiated but untreated for control. This radiation dose is $LD_{70/60}$ without supportive care in monkeys but becomes $LD_{10/60}$ with supportive care. Out of the two treated animals, one (responder) survived through Day 60 and the other (non-responder) had to be euthanized on Day 16. In the responder animal, neutrophil parameters were significantly improved over the control animal in terms of reduced duration of neutropenia and higher neutrophil nadir. The parameters for the non-responder animal were similar to those in control animal. Neutrophil counts and bone marrow clonogenic assays showed that PEG-GM-CSF induced granulopoiesis in the responder but not in the non-responder animal. Pharmacokinetics of PEG-GM-CSF were similar in both the animals.

Efficacy testing of unpegylated GM-CSF (Leucotropin) was also performed. Six male rhesus monkeys were irradiated at 710 cGy 6MV LINAC radiation source and received Leucotropin daily starting from 24 h post-irradiation. This radiation dose is equivalent to $LD_{30/60}$ with supportive care. Treatment was to continue until the neutrophil counts returned to normal levels. However, none of the animals completed the full course of treatment due to local skin reactions in the monkeys.

This project was primarily managed by personnel in Cangene's facilities in Winnipeg. Animal studies were performed at the University of Maryland, Baltimore, United States.

Impact

Products with a potential to counter harmful effects of acute radiation have been developed, manufactured, and successfully tested in preliminary studies. These medications can be deployed immediately in terrorism, war, or accidental events involving radiation exposure.

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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:	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 (EBOV) or Marburg (MARV) 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 (GP) of *Zaire ebolavirus* (ZEBOV or VSV△G/ZEBOVGP). 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 MARV, causes a highly virulent, severe haemorrhagic fever (HF) 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, which include that there have been 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; it has been shown experimentally that ZEBOV is infectious following oral, ocular, and aerosol exposure of non-human primates and, lastly, at this time there is no preventive vaccine or post-exposure treatment option 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 generated live, attenuated recombinant VSV expressing the transmembrane GPs of ZEBOV and MARV and the glycoprotein precursor (GPC) of Lassa virus (VSV△G/LASVGPC). Results showed that this attenuated recombinant VSV gave complete protection to cynomolgus macaques against lethal challenge with the corresponding filoviruses and arenavirus. The project team developed vaccine candidates for EBOV and MARV, based on live, attenuated recombinant VSV vectors expressing the relevant glycoproteins. 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.

Finally, the researchers tested the ability of the VSV Ebola and VSV Marburg vaccine 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 EBOV 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 1,000,000LD_{50} and non-human primates from 1,000LD_{50}. All non-human primates infected with MARV and 50 percent of the non-human primates infected with E BOV survived when treated 30 minutes after exposure.

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 HF agents 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. Our vaccines fill this capability gap.

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 05-0090TA

Adaptation of Recently Developed DNA Microarrays to NanoChip Microarray Technology for Detection of Agroterrorism Agents

Project Lead:	Canadian Food Inspection Agency
Industry Partner:	Nanogen, Inc.

Objectives

The objective of this project was to develop new capabilities for rapid detection and typing of the potential agroterrorism agents, avian influenza (AI) and foot-and-mouth disease (FMD) viruses. Canadian Food Inspection Agency (CFIA) and Nanogen researchers adapted DNA slide microarray technology to Nanogen's more portable NanoChip platform that can be more easily and practically used by first responders. Nanochip technology is a fully automated system with an open platform that uses electronic printing and hybridization. The researchers adapted or redesigned the existing microarray probes in the first phase of this project. Concurrent with probe redesign was assay design and layout on the NanoChip array. The second phase of the project involved optimizing electronic printing and hybridization conditions and data reporting. The third phase involved test validation using clinical samples and field testing by the end-user (i.e., CFIA's district veterinary officers).

Relevance

The NanoChip electronic arrays for FMD and AI represent novel detection and typing technology to be used at the farm site in a mobile diagnostic unit. This allows rapid testing and effective management in the event of a real outbreak, and a minimum quarantine period for the farm in the case of a suspected, but false, outbreak. The project's ultimate aim is to make this automated, portable technology available to first responders and train them to use the instrumentation.

Recent Progress and Results

The project team developed electronic microarray assays for the AI and FMD viruses using Nanogen's NanoChip 400 platform. The DNA microarray for AI virus is a hemagglutinin (H) typing assay containing 32 subtype-specific probes with redundancy for most of the 16 H subtypes, particularly for H5, an important subtype of AI. The assay contains four H5 probes, each of which detects all H5 strains tested (n=9). The H7 subtype is an equally important subtype of AI. The assay contains two probes that detect all H7 strains tested (n=5). The assay also contains two probes for the conserved matrix gene that detected all strains tested. The construction of the AI NanoChip assay was highly successful. Thirty-seven AI laboratory isolates were correctly subtyped. Four other isolates are still being investigated as to their true subtype. All AI probes showed high specificity when validated with clinical samples. The AI H-typing NanoChip assay was more sensitive than real-time (RT) polymerase chain reaction (PCR).

The DNA microarray for FMD virus is a serotyping assay with serotype-specific probes and probes for the conserved polymerase gene to ensure detection in case of new variants. Over 200 probes were examined for their use in the assay and 12 were selected for serotyping. The assay detected and correctly serotyped all 23 tested strains covering all 7 serotypes. The construction of the FMD microarray was largely successful. Two serotyping probes, however, could be improved upon as these showed some cross-reactivity during validation with clinical samples. The FMD-serotyping NanoChip assay was less sensitive than RT-PCR but can be used in conjunction with RT-PCR to serotype FMD.

First responders training and the field trial were successful. After being trained on how to use the technology, the first responders used the FMD-serotyping NanoChip assay in the field. For the field trial, a Dodge Grand Caravan was modified to carry the NanoChip and PCR instrumentation. The instrumentation was then driven for 40 km, including 10 km on gravel roads. The District Veterinary Office in Lethbridge, CFIA's Lethridge Laboratory, and Nanogen all participated in the field trial. The instrument showed robustness and the FMD NanoChip performed successfully, as expected.

The work was presented at the CRTI 2007 and 2008 summer symposiums; the Detection Technologies 2007 and 2008 conferences (San Diego and Phoenix); the Canadian Pandemic Preparedness Meeting: From Discovery to Frontlines, Winnipeg, 2008; the Canadian Animal Health Laboratorians Network meeting (2008), Ribowest; and in three seminars at CFIA, Lethbridge.

Impact

AI and FMD are highly infectious diseases that, if introduced into Canada's naive animal populations, whether inadvertently or intentionally by terrorism, could spread quickly and have catastrophic consequences to the nation's agricultural industry and a significant deleterious impact on its economy. Thus, there was 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 quarantine situations are employed for a minimal time in cases where the outbreak proves to be false. With rapid on-site testing, the quarantine period can be kept to a minimum. NanoChip electronic array technology satisfies the requirements of the portability and highly multiplexed detection needed to deal with the high genetic variability of these viruses. A unique feature of the technology is distinctly Canadian: the probes used in the NanoChip are intellectual property owned by the CFIA. The project was completed in September 2008.

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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 then 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, collectively enhancing the national response capability and capacity to an RN emergency.

Recent Progress and Results

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, 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. Furthermore, 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

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 05-0121RD

Evidence-Based Risk Assessment of Improvised Chemical and Biological Technologies

Project Lead:	Public Safety and Emergency Preparedness Canada
Federal Partners:	DRDC Suffield, Department of National Defence, Royal Canadian Mounted Police – Forensic Laboratory Services

Objectives

There are currently several well-known sources of information relating to improvised chemical and biological weapon (CBW) technologies within the open literature and on the Internet. It is possible that such information may be used as the basis for terrorist CBW production. While some of this information is easily assessed as technically unsound, much of it has not been fully assessed with respect to its technical feasibility and impact. The first objective of this project is to conduct a thorough review of this information and of information contained in classified sources that relates to terrorist interest in CBW. Project team members will then use this review to identify a set of scenarios for which there are knowledge gaps pertaining to technical feasibility and impact and for which there are also indications of terrorist interest. (Prioritization of the selected scenarios was based upon the nature of terrorist interest in the technologies identified. As many as eight candidate scenarios involving both chemical and biological agents were identified in this manner.)

The project team will experimentally assess scenarios, when necessary. This will involve constructing, testing, and thoroughly characterizing the technology in question. Issues to be addressed include (but are not limited to) factors such as the nature of technical gaps or inaccuracies in the information; level of expertise needed to recognize or overcome these gaps and successfully execute the technology; threats to the safety of those attempting to implement the recipe; availability of required material (including improvised equipment); yield, purity, toxicity, and stability of the product; efficacy of dissemination; potential for scale-up; potential signatures of activity; most appropriate target; and finally, assessment of impact.

Relevance

The knowledge generated from this work will be shared with allied counterterrorism agencies. It will represent a major contribution by Canada to collective counterterrorism activities.

Recent Progress and Results

This project is divided into five phases. The first phase of work will entail a thorough review of information contained in open and classified sources of information relating to improvised CBW technologies. The result from this review will be a list of candidate technologies. In Phase 2, the project team will prioritize the list using criteria such as the nature of the knowledge gap and indicators of terrorist interest in such technologies. In Phase 3, the technologies contained in this prioritized list will then be subjected to a thorough technical assessment. Questions relating to technical feasibility and potential impact will be addressed in this phase. Experimental assessment of the technology will be undertaken where required to bridge knowledge gaps. This assessment will include the identification of signatures that may be used for investigative purposes. In Phase 4, the project team will generate a set of training scenarios based on the technologies being assessed.

The main project deliverable will be a report detailing the full technical assessment of the technology, the rationale for its selection, the relevance of the knowledge generated to the current CRTI Consolidated Risk Assessment document, a list of relevant signatures, and a set of technically sound scenarios

that may be used for training and consequence management. This project requires three years to complete and is currently in its third year. The final report is currently being written and is expected to be delivered on schedule.

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CRTI 05-0122TD
CRTI 07-0216TA

CBRN Crime Scene Modeler — C2SM and C2SM-FAST

Project Lead:	Royal Canadian Mounted Police – Forensic Identification Operations Support Services
Federal Partners:	Canadian Police Research Centre, DRDC Ottawa – Radiological Analysis and Defence Group, RCMP – Explosives Disposal and Technology Section
Industry Partner:	MDA Space Missions
Other Partners:	Hamilton Police Service – Emergency Response Unit and Explosive Disposal Unit, Toronto Police Service – Public Safety and Emergency Management – CBRN Team and the Forensic Identification Services, Vancouver Police Department – Forensic Services Section, York University – Department of Computer Science and Engineering

Objectives

The objective of this project is to develop a system for collecting evidence at crime scenes contaminated with CBRN agents with minimum exposure to first responders. CBRN Crime Scene Modeler (C2SM) operates on board a mobile robot. C2SM increases situational awareness of the robot operator by providing registered images, CBRN data, and current robot location. The images are automatically processed to create photorealistic, three-dimensional (3-D) models of observed scenes on-site, and the models are augmented with CBRN measurements. From October 2006 to October 2008 the technology demonstration project team developed and field-tested two prototype versions and delivered three units to first responders for extended evaluation. The technology acceleration project—with an objective to develop a ruggedized, production-ready, robotic version—is expected to start in April 2009.

Relevance

First responders investigating scenes contaminated with CBRN materials rely on teleoperated mobile robotics to deliver cameras and detectors to the scene. Such robots provide mobility and remote viewing using on-board cameras, and they enable manipulation with robotic tools and use of disruptors. However, situational awareness of the robot operators is low as the existing systems are equipped only with video cameras and simple CBRN detectors. Measurements from various sensors are not registered with the workspace, robot location, camera views, or facility blueprints; the detector data may not be available in real time. This causes difficulty in interpreting such multiple data streams during and after events. C2SM offers a new solution to tasks such as detecting and locating CBRN sources, mapping contamination levels for immediate reaction and consequence management, and storing event data for on-site analysis and future reference.

Recent Progress and Results

The C2SM prototype 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, two gamma detectors, and a chemical detector. A directional gamma radiation probe (DGRP, Bubble Technology Industries) provides direction toward the radiation source, and a gamma monitor detects the radiation levels. A lightweight chemical detector (LCD, Smiths Detection) detects the presence of chemical agents and toxic chemicals. C2SM is remotely operated from a control station connected via a

wireless link. C2SM is also equipped with an optical odometer, which estimates the robot location and provides the operator with real-time display of the current location and traversed path. The complete data recorded during an event (images, models, and detector data) together with reports and annotations are geo-located, time-stamped, and stored in a multimedia event database. This database can be queried for specific conditions and results displayed in 3-D.

Two prototype versions were developed and installed on board a mobile robot (MK-2, Allen-Vanguard Corporation) and then tested during field trials in September 2007, and April, June, and September 2008. Multiple test scenarios (both indoor and outdoor) were staged and the system was used to detect and map locations of multiple gamma radiation sources. In initial tests, mostly the developers from MDA Space Missions operated the system; in the later tests, the RCMP and police responders fully operated the system. The responders were trained in operating the system and three units (modified copies of C2SM-2) were delivered for extended evaluation ("leave-behind"). The follow-up technology acceleration project, C2SM-FAST (CRTI 07-0216TA), is expected to start in April 2009 and will develop a ruggedized and production–ready mounted robot version of the system. Multiple units will be delivered to first responders participating in the project.

Impact

Using C2SM will reduce the exposure of first responders investigating crime scenes contaminated with CBRN agents by allowing them to mount and operate the C2SM system on board a mobile robot. C2SM will significantly increase situational awareness of the robot operator by providing not only current images and sensor data but also current robot location and traversed path, recent geo-located measurements, and an integrated 3-D display of the event data. C2SM will create a permanent record of the scene on-site allowing it to be used during the event for planning the operations, transferring it to command centres, and storing for future reference.

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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, 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' 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 and 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 robust analytical methodology that provides a fail-safe system for unknown materials assessment. This project is the first stage to successfully transfer money under PSTP.

In addition, 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

Currently, Canada does not 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 06-0146RD

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 into 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. In addition, the NBDRP will be strengthening links to American and international partners, working towards an international biodosimetry network.

Relevance

The information provided by biological dosimetry is critical for use in medical triage and the diagnosis of casualties and first responders to reduce immediate and long-term health effects. It is also essential for mitigating the public reaction to an RN incident by distinguishing the worried-well cohort from those who have been exposed and require medical intervention. In order for biological dosimetry to be most effective, dose estimates need to be completed as quickly as possible after exposure. To expedite this process, the capacity for providing biological dosimetry in Canada is being increased and links are being developed among biodosimetry laboratories around the world. In addition, several novel, high-throughput assays are being developed. By addressing these CRTI priority needs, the NBDRP will be 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, for the first time, the project's two American partner laboratories (Oak Ridge Biological Dosimetry Applications Research Calibration Laboratory [REAC/TS] and the Armed Forces Radiobiology Research Institute [ADFRRI]) participated in the Canadian annual exercise to test the capacity and capabilities of the biodosimetry network. Both laboratories in the United States (US) provided excellent dosimetry estimates on the samples supplied by Health Canada and demonstrated their ability to assist Canada in an emergency scenario.

To complement the existing biodosimetry capacity in cytogenetic laboratories across Canada, a training program has been developed and integrated into the course curriculum at the Clinical Genetics Technology Program at the Michener Institute, which trains 16 cytogenetic technologists each year. These students, who will be trained to conduct biodosimetry, 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.

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

In addition, new methods for biodosimetry continue to be examined, including faster analysis methods (QuickScan), higher throughput biodosimetry assays, and novel markers for radiation exposure.

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 REAC/TS and AFRRI in order to strengthen the Canada/US binational 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 the project is to develop and demonstrate risk assessment tools for improving preparedness and response capabilities against blast threats. Development of four tools—a screening tool, an evaluation methodology, a mitigation retrofit guideline, and a post-event on-site assessment guideline—will be conducted concurrently and completed by May 2010. Two training workshops for blast emergency responders and end-users are scheduled for June 2010.

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

Critical reviews of a rapid screening tool developed by PWGSC and CERL, with the relevant Federal Emergency Management Agency (FEMA) documents, have been completed. Initial evaluation reveals that to ensure the uniformity of the criteria for damage assessment, new pressure-impulse diagrams based on limits design and plastic deformations need to be developed. The software for the development of refined P-I diagrams has been developed and is being evaluated against available diagrams and test data.

Development of detailed computer programs for blast evaluation, which apply single degree of freedom (SDOF), multi-degree of freedom (MDOF) concentrated mass, and continuum elements to analyze various structural elements is complete. The objective is to compare the results of these analyses with each other and, where possible, with available

experimental data. This comparison will enable users to determine the appropriateness of each analysis method in a given situation. The software for the SDOF and MDOF is currently being evaluated against results of commercial, finite-element software.

McMaster and CERL conducted two series of field tests of masonry and steel members at Canadian Forces Base (CFB) Petawawa, in May and October-November 2008. A third series of field tests on concrete and steel members is planned for May 2009, again at CFB Petawawa.

The University of Ottawa' shock tube became operational in December 2008. With support from CERL, the university has started testing the first series of reinforced concrete members, including laboratories and columns with and without seismic detailing. Various retrofitting technologies will be considered. The aim is to develop a guideline on retrofit technologies for the blast protection of buildings.

The basic framework for a post-blast evaluation methodology has been developed, including safety classification levels and the initial development of the criteria used in the classification. Further development of the methodology awaits the evaluation of the analysis tool and the test data.

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.

The tools will be completed by May 2010 with two training workshops for blast emergency responders and end-users scheduled for June 2010. The project is expected to be completed in September after the 2010 Public Security S&T Summer Symposium.

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CRTI 06-0156RD

Radiological Dispersal Device Contamination Interactions with Urban Surfaces

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

Objectives

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

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

Relevance

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

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

Recent Progress and Results

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

Experiments to determine the impact of the RDD contamination on urban surfaces have been progressing. One of the major experiments was to determine the effects of rain on different types of chemical forms of RDD contamination. This was performed at the Wehrwissenschaftliches Institut fur Schutztechnologien – ABC-Schutz (WIS) facility with participation from the United States Environmental Protection Agency (EPA), the Canadian Nuclear Safety Commission (CNSC), DRDC Ottawa (as lead), and the United Kingdom's Defence Science and Technology Laboratory (Dstl). Dstl

participated as an international observer out of interest in the work. The trial also included testing the different types of decontamination methods, and results are being analyzed.

DRDC Ottawa has started its experimental program and is currently looking at the effects of humidity levels. The results of the WIS rain experiment as well as previous experiments at DRDC Ottawa and elsewhere are now being combined to validate the project's hypothesis and formulate a guidance document.

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

The University of New Brunswick is progressing in the development of a three-dimensional imaging system to study the migration of radiological contaminants within urban materials. Researchers have completed algorithms for the development of requirements for the detector system and are in the initial stages of testing these algorithms.

Impact

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

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

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CRTI 06-0159TA

Advanced Technical CBRNE Training Program "Operation Maple Leaf Program"

Project Lead:	Canadian Police Research Centre
Federal Partners:	Canadian Police College, DRDC Suffield – Counter Terrorism Technology Centre, Department of National Defence
Industry Partners:	Hardpoint Defence, Security and Technology Inc.
Other Partners:	Ottawa Police Service, Ontario Provincial Police, Niagara Regional Police Service

Objectives

Terrorists currently employ suicide bombs, large vehicle bombs, and radio-controlled devices as primary weapons. However, the utility of routine render-safe procedures is limited when explosives are combined with CBRN materials (explosive dissemination devices). This project will ensure that the technical skills of Canadian explosives technicians are beyond those of terrorists and that they are prepared to counter CBRNE threats. The project will provide comprehensive training that is currently unavailable in Canada by designing, developing, and presenting four new courses for explosives technicians: Advanced Electronics/Hand Dismantle Techniques (Electronics); Live Applications and Technology Transfer Exercises (LATTE); Radio Frequency-Controlled Devices and Electronic Countermeasures (ECM); and Live Agent CBRNE Training for Explosives Technicians (CBRNE LAT). Each course will be delivered twice, once in pilot form in 2008 and once as a polished training product in 2009. This approach will allow for improvements based on student feedback and international expert participation during the pilot editions.

Relevance

The project addresses several CRTI investment priorities by developing training packages directed at the science and technology and responder communities; by stimulating the development of management strategies through the analysis of large-scale exercises; and by promoting the development of advanced forensic techniques through the use of live-agent exercises that will include forensic cluster members.

Professional training documentation will include a summary of research and needs analysis, course training plans, course material packages, and evaluations relative to each course. The availability of this documentation will extend the reach of the training beyond the life of the project and maximize a strong return on investment. The project will create the training component that underlies new Canadian CBRNE response capabilities. Technicians will be enabled to use new and emerging technologies.

Recent Progress and Results

Thus far, the project has developed and delivered the three-week Electronics/Hand Dismantle Techniques Pilot Course designed for explosives technicians with little or no electronics training. The pilot course, held in March 2008, helped participants acquire skills that will enable them to construct sophisticated electronically initiated devices for training purposes and to reconstruct improvised explosive devices from

post-blast debris. The course included two days of hand dismantle exercise scenarios in the final week. Post-course feedback and testing revealed that all students had developed strong baseline skills and knowledge in the subject.

The project lead has changed from the RCMP to the Canadian Police Research Centre due to the RCMP's commitments to preparations for the 2010 Olympics. This lead change has delayed the delivery of the first Advanced Electronics/Hand Dismantle course, which will now take place from 25 May to 12 June 2009.

The LATTE course scheduled for May 2009 is being assessed to determine if it will proceed as scheduled or be delayed until October 2009. Many countries and Canadian federal government departments have expressed an interest in the course. However, several agencies have inquired if the course could be delayed since they were having difficulty acquiring funding to attend due to the economic recession. This decision will be made in April 2009.

The Advanced Electronics/Hand Dismantle course, the Remote Control/ECM, and the CBRNE LAT course may also be delayed for the same reason. However, at present sufficient numbers of agencies have indicated that they will attend and planning is going ahead to deliver the courses on schedule.

Impact

The results of the pilot course identified gaps in the training package that need to be addressed to ensure explosives technicians receive the right knowledge and tools to respond to CBRNE threats in Canada. Changes will be made to the course-training package as a result of student feedback. Modifications to the course will be made in line with the training development cycle known as the systems approach to training design and development. Professional training documentation, training plans, and course material packages will be amended to ensure maximum knowledge assimilation. The modifications will be confirmed in the final evaluation phase. The pilot course is the beginning of the development of the new Canadian CBRNE response capability. The final product will be ready for delivery to CRTI and to the Canadian Police College in May 2010.

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CRTI 06-0163TD

Real-Time Collaboration Enhancement for the ARGOS Radiological/Nuclear Risk Assessment System – GeoConference Enhancement for ARGOS

Project Lead:	Health Canada – Radiation Protection Bureau
Federal Partners:	Environment Canada – Canadian Meteorological Centre Natural Resources Canada – Geological Survey of Canada
Industry Partners:	TGIS Technologies (now PCI Geomatics), DBx Geomatics, Neolore Networks

Objectives

The *Federal Nuclear Emergency Plan* (FNEP), provides the framework for use by federal organizations to prepare for and respond to radiological-nuclear (RN) emergencies affecting Canadians. The Accident Reporting and Guidance Operational System (ARGOS), which was adapted for use by the FNEP in a previous CRTI project, provides situation information and predictive outputs to inform FNEP technical recommendations.

The GeoConference Enhancements for ARGOS (GEAR) project is demonstrating how a map-based, Internet conferencing component can be integrated into the ARGOS system to facilitate group decision making by geographically distributed FNEP members. The new component, based on PCI Geomatics' off-the-shelf *GeoConference®* product, brings outputs from ARGOS, along with other dynamic, multidisciplinary, and multi-sourced assessment information, into a discussion environment. A second objective of the GEAR project is to add traceability to map-based discussion, recommendations, and decision making.

Relevance

When an RN emergency occurs, key FNEP partners may be in a variety of locations. In fact, they may be more useful working from their laboratories or in the field rather than in the operations centre. No matter where they are working from, FNEP partners will need access to up-to-date situation information and predictive outputs as well as a way of combining their expertise during a rapidly evolving situation. The GEAR demonstration project showed that *GeoConference* could be adapted to provide secure, collaborative decision support using real-time and near-real-time access to outputs from ARGOS and other sources.

The conferencing component integrates to the existing system through ARGOS's eMAP map interface. eMAP was modified during the project to provide geographic information outputs through services based on internationally accepted (e.g., International Organization for Standardization) interoperability standards. The new component uses these interoperability standards to provide a conferencing environment based on the ARGOS layers along with other georeferenced information and base maps from multiple, dynamic sources.

Users participate in conferences with a lightweight, low-Transmission Control Protocol/Internet Protocol connections and is compatible with high-security virtual private networks. New geographic information and knowledge produced during conferences can be returned to the ARGOS eMAP components for reuse.

The geoconferencing component provides tools that users can apply to explicitly capture new geographic information, notes, and findings. In addition, all activity in a map-based Internet conference can be recorded (with time stamping) and for replay at a later time. This capability provides a means of retracing events, conference activity, and the map information that FNEP members use when producing their findings and recommendations. It provides essential information for audits and lessons learned.

Recent Progress and Results

Operational demonstration of the new component was performed during the RN segment of the Exercise Silver preparation for the 2010 Vancouver Olympics.
A map-based teleconference united four sites in Vancouver, British Columbia; Dorval, Québec; and Ottawa, Ontario. The online session was used to visualize and discuss the RN situation and potential consequences. FNEP partners from Health Canada's Radiation Protection Bureau, Environment Canada's Canadian Meteorological Centre and Natural Resources Canada's Geological Survey of Canada shared near-real-time, dynamic ARGOS outputs, using them collaboratively to guide recommendations for action.

The project is entering the final phase and, despite a late start, all of the planned technology deliveries to date have been made. Implementation of this new component for ARGOS as an operational tool of the FNEP is currently being investigated.

Impact

This project provides a new communications tool that will significantly enhance the speed and content and access to geographically related information among Canada's RN stakeholders at the federal level. It has the potential to improve the transmission of relevant information to the FNEP's provincial, non-governmental, and international partners. The tool also provides significant improvements to the traceability of decisions and recommendations based on geospatial information.

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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

Objectives

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

The goal of 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 contamination hazard 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 results of this study will aid in better target prioritization, improved overall process efficiency with a single solution, 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), ethylene diamine tetra acetic acid, diethylene triamine penta acetic acid, and citratic acid, were selected as chelating agents (CA) 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, ammonium salts, and sodium tetraphenylborate.

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, the binding efficiency for the nickel and zinc hexacyanoferrates was significantly higher than for the ferric hexacyanoferrate. Cesium in aqueous solutions not containing CASCAD was analyzed by inductively coupled plasma mass spectrometry (ICP-MS). A protocol was also developed to test additives that form insoluble complexes with Cs^{+}. The presence of surfactants in CASCAD hindered the use of ICP-MS for analysis. Neutron activation analysis was used as an alternative analytical method.

Decontamination experiments on urban material surfaces are being carried out, using test coupons spiked with cesium. The surface decontamination efficiencies of the modified commercial decontaminants are being evaluated for varying process parameters including sequestering agent concentration, exposure time, and number of applications.

Impact

CASCAD is currently one of the best 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 greatly 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 to a CBRN event.

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CRTI 06-0170RD

Organophosphorus Agent Decontamination

Project Lead:	Environment Canada
Federal Partner:	Royal Military College of Canada
Industry Partner:	SAIC Canada
Other Partners:	Queen's University; Research Institute of Hygiene, Occupational Pathology, and Human Ecology; State Research Institute of Organic Chemistry and Technology

Objectives

The primary objective of this study is to develop and evaluate a safe and rapid catalytic decontamination method designed to remove and destroy organophosphorus (OP) 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. In some applications (e.g., sensitive equipment or soils), the catalysts will be immobilized on polymers and silica-solid supports in order to be packaged in columns and used repeatedly.

Relevance

OP chemical warfare agents and toxic industrial chemicals form one of the largest groups of chemical terrorism agents. They also represent major threats in view of their extreme toxicity and availability as industrial chemicals. Existing decontamination technologies for these agents use corrosive ingredients, cannot be applied to sensitive equipment, and may be harmful to the environment. The proposed process will address these problems by developing an efficient, universal, and environmentally safe technology. It will be applicable to the chemical restoration of buildings and structures, as well as to the decontamination of sensitive equipment and soil. The resulting waste streams will be environmentally benign and will not require further waste containment or treatment operations.

The solid-supported catalytic methodology uses columns through which recovered solutions of OP contaminant are quickly neutralized. It provides an effluent that is pH neutral, is at ambient temperature, and contains no metal ions so that decontamination of sensitive equipment can be realistically accomplished. Moreover, recycling recovered neutralized solutions reduces the environmental footprint and the quantities of solvents that are needed.

Recent Progress and Results

The methanol-based catalytic system was used in preliminary experiments. These experiments were aimed at developing experimental and analytical procedures and determining key factors affecting decontamination of paraoxon in liquid phase. The decontamination efficiency was determined at various concentrations of catalyst and paraoxon and for different reaction times. This was done by quantification of residual paraoxon in the post-reaction mixture using gas chromatography/mass spectrometry (GC/MS) and ultraviolet-visible spectrometry techniques. Breakdown products were identified by GC/MS.

The researchers found that paraoxon (1 g/L) completely decomposed in 15 minutes even when the catalytic system was diluted up to 20 times of its original concentration. Diluted catalytic systems (up to 10 times) provided complete destruction of paraoxon in less than 5 minutes. Diethyl methyl phosphate and 4-nitrophenol have been identified as the main breakdown products.

The methanol-based catalytic system was effective at destroying Russian VX in liquid phase. Analytical procedures were developed and evaluated for GC/MS analysis of Russian VX and breakdown products.

The development of a solid-supported catalyst continued in two directions. The first solid matrix evaluated was lanthanides attached to terpyridine ligands, themselves attached to silica gel by amine links. The matrix was tested for the catalyzed methanolysis of paraoxon and ethyl *p*-nitrophenyl methylphosphonate. The complex showed a high to moderate reactivity. A drop in the rate constant was observed after each use of the matrix due to the leaching of metals. The value of the decrease in the rate constant depended on the metal ($Sm^{3+} \sim Eu^{3+} > Yb^{3+}$). In addition to the conventional fixation of metals to solid supports via chelating ligands, a new method based on a microencapsulation technique was employed for fixing La^{3+} and Yb^{3+} to polystyrene. In the case of Yb^{3+}, the leaching of the metal was prevented by varying the composition of the solution, which preserved the reactivity of the matrix. The rate constants were similar to the supported-terpyridine-Ln systems at around 7×10^{-4} s^{-1}.

The high fluorophilicity of lanthanides causes them to bind very strongly to the fluoride anions released from phosphonofluoridates (e.g., sarin and soman) during methanolysis, which kills the metals' reactivity. Metal additives were used to scavenge fluoride ions released into the solution. The efficiency of different metal additives, such as $Sm(OTf)_3$, $Eu(OTf)_3$, $Yb(OTf)_3$, $EtSi(OMe)_3$, $Al(OiPr)_3$, $B(OPh)_3$, $B(OBu)_3$, $MeB(OH)_2$, and p-Tol-$B(OH)_2$, was studied. $Sm(OTf)_3$ was found to be the most efficient additive and preserved 40 percent of the total activity in the presence of 4 eq. fluoride anions.

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. Now in the last year of the project (2009–2010), the objectives are 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.

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. As a measure of the biological effect of radiation, dosimetry is used to evaluate, control, and communicate the given health risk of the 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 builders have developed 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, 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 with a polymer hybrid. The biosensor will be sensitive to breaks in nucleic acid macromolecules and relevant to mixed-field radiation. The proposed dosimeter will be small, be field deployable, and sense damages for all radiation types at the DNA level.

Relevance

The proposed dosimeter will improve criminal and national investigational capabilities by diagnosing the presence of radiological-nuclear (RN) material and helping to determine its source. 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 radiation exposure to various 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

This project to build a DNA-based dosimeter relies on the development of two separate modules: a sensor module harboring DNA to be exposed to radiation, and a detection module to specifically detect fragment of DNA released upon irradiation.

A first sensor prototype was constructed using a polycyclic olefin slide containing grafted specific oligonucleotide sequences. The chemical immobilization of amino-modified oligonucleotides on these ozone-oxidized surfaces was demonstrated and the reaction conditions were optimized to ensure a high surface concentration of immobilized

oligonucleotides. Furthermore, tests were conducted to minimize or eliminate unspecific binding of DNA on the plastic surface.

The effect of gamma irradiation on the selected 70 bases oligonucleotide DNA target was demonstrated. Real-time (RT) polymerase chain reaction (PCR) analyses of free (unbound) DNA target g-irradiated at 10 Gy showed that 35 to 40 percent of the DNA is not suitable for PCR anymore when compared to non-irradiated samples.

First and second generation sensor modules are currently undergoing testing under radioactive exposure. Two RT-PCR assays have been developed to specifically detect and quantify released DNA. Those assays are also used to detect background DNA and monitor the quality of sensor modules. Results from the first generation sensor exposed under mixed-field radiation at CERN (European Organization for Nuclear Research) reference facilities showed a release of DNA from the sensor module upon irradiation.

The detection module will be based on the use of a cationic polymer via an ultra-sensitive detection technology via fluorescence chain reaction. Work has been done to design and optimize a detection platform and an optical reader. In the near future, this DNA-based detection technology will be tested under various radiation sources and compared to standard biological assays.

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 at developing and validating 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 a several thousand-fold amplification of the fluorescence signal emitted upon hybridization with a target DNA strand. This biosensor, when coupled to micron-sized carrier particles and integrated in a microfluidic device, provides rapid (less than one hour) 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

A first prototype of the instrument comprising a fluidic interface and integrated optics for detection is nearly complete. The instrument is further equipped with pumps and pressure-control units to mediate capture of beads in a fluidic cartridge. Tests with fluorescently modified beads 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 mechanical trapping of well-defined monolayer bead beds. The team has made progress towards isolation of genomic DNA from bacteria or spores in powder samples similar to those used in real case scenarios. Moreover, the team demonstrated mechanical cell lysis on a chip and evaluated the performance of the cell disruption process. The chemistry used for FCR is currently being adapted to the method of sample preparation and fluidic manipulation of beads.

Another project task involved purification and concentration of DNA in a microfluidic device using chemically modified beads. These beads are used as probes and can bind specifically to the DNA of *Bacillus anthracis*, which can be further detected using a simple optical system. The project team has described the principles of this operation and the architecture of a device that may be employed for this purpose, and has outlined efforts towards integration. While currently focused on sampling and fluid-driving automation, the team will aim long-term efforts at reliability, robustness, and user friendliness of the final instrument.

A first demonstration by a first responder is planned for late June 2009. After this demonstration, a second and final generation of the instrument will be built. The final version will include all modifications and improvements required by the first responder. 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 can 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 06-0138RD

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, Centers for Disease Control and Prevention

Objectives

Rift Valley fever (RVF), an emerging viral disease of humans and ruminants, is considered a significant biological warfare threat and a severe natural disease threat. Originating in Africa, RVF is mosquito-borne but can also spread by aerosol. Although currently absent from North America, timely detection of the virus' incursion will require diagnostic tests to be available in regional laboratories.

This project aims to extend existing human diagnostic capability and to develop veterinary diagnostic capability for the RVF virus (RVFV) in North America. The focus is on developing reagents and tests that could be safely used in low-containment facilities and in the field, as well as high-throughput assays for veterinary diagnostics, using reagents for which production does not require high containment.

Relevance

An RVFV outbreak in animals would cause serious economic consequences. Furthermore, due to its zoonotic nature, once present in North American livestock and mosquitoes, the virus could pose a serious public health problem. For these reasons, RVFV is on the "A list" of multiple national and international organizations such as the World Organisation for Animal Health, the United States (US) Centers for Disease Control, and the National Institute of Allergy and Infectious Diseases. RVFV is also on the Select Agents list of the US department of Health and Human Services and of Agriculture.

Like their counterparts in the US, the Canadian Food Inspection Agency and the Public Health Agency of Canada do not have validated diagnostic tests for RVF that can be safely distributed to regional diagnostic laboratories. North America also lacks the capacity to handle a diagnostic surge should an outbreak occur. Developing reagents and rapid detection tests based on recombinant technologies and allowing production and use of diagnostic reagents outside of biocontainment will enhance Canada's ability to respond to a potential outbreak. Diagnostic tests that are operator-safe and field-deployable will enable first responders and front-line personnel to identify, quickly respond to, and contain an RVFV-terrorist event.

Establishing high-throughput veterinary tests and creating new knowledge in the area of pathogenesis and immune response will assist with outbreak control and subsequent longer term consequence management. The ability to rapidly detect the virus will protect first responders, especially when using a pen-side test (lateral flow). These new tests and knowledge will also be critical for vaccine development.

Recent Progress and Results

This project is still in its infancy. The project team will be developing recombinant RVFV proteins and antibodies to produce reagents and use them in non-containment facilities. (Traditional approach for antigen production requires AgBSL3+ containment facility for virus production and inactivation, and extensive safety testing prior to release from the containment). The team will then apply these reagents to developing operator-safe and field-deployable diagnostic tests for humans and animals.

The project team will also determine a sampling strategy (timing, type of sample), based on knowledge of pathogenesis and immune response development in animals acquired during the experimental infections with wild-type RVFV, and develop positive control samples for veterinary diagnosis using results from experimental infections of animals with recombinant (less pathogenic) and wild-type RVF viruses. Furthermore, team members will establish high-throughput tests essential for outbreak control and subsequent longer term consequence management.

The project team also plans to assess, under laboratory conditions, the competence of Canadian species of mosquitoes as vectors for RVFV, and to establish a real-time polymerase chain reaction assay for surveillance in mosquitoes.

The outcomes from this project will be applicable to developing personal protective equipment and decontamination procedures for on-site farm and laboratory personnel during an outbreak.

Impact

The project will enhance Canada's preparedness, prevention, and response to a possible incursion of RVFV on the continent. An RVFV outbreak in livestock would significantly affect the international trade of animals and animal products. Developing high-throughput screening tests for livestock is critical to control an outbreak and minimize serious economic and public health consequences.

The project will build CBRN event preparedness in multiple areas, such as rapid diagnostic capability, protection of first responders, and longer term consequence management. In addition, epidemiologists can use these high-throughput, rapid, diagnostic tests along with sequence analysis of the circulating virus to trace the source of an RVFV outbreak, whether caused by natural occurrence or bioterrorist event.

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CRTI 06-0188TA

Portable Optically Stimulated Luminescence Reader for Forensics and Retrospective Dosimetry

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

Objectives

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

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

Relevance

The portable OSL detector (POD) addresses capability gaps in the areas of criminal and national security investigations, as well as consequence management capabilities. In many RN terrorist scenarios, the radioactive source is moved during the acquisition, transport, and storage phases. Measurement of retained OSL signatures will allow investigators to achieve what is currently impossible: confirmation of the previous location of a radioactive source even when no trace of radiological contamination remains. In terms of consequence management, in many envisaged RN scenarios there could be many exposed people who were not wearing dosimeters. The use of the POD on their personal electronic components will offer rapid radiation dose estimates and a triage system for these individuals.

Recent Progress and Results

A laboratory prototype for POD has been constructed and is currently undergoing testing. It consists of two parts: a base unit and a hand-held adapter. The former has full functionality for small samples including bleaching, sample heating, calibration with a $^{90}Sr/^{90}Y$ beta source, and both continuous wave and pulsed measurement of the OSL signal. The adapter unit allows the user to directly measure residual OSL signatures from surfaces such as walls and floors. The system is operated with a ruggedized personal digital assistant, which

allows full control of the instrument's function, as well as archiving and analysis of the data. It permits predefinition of specific measurement protocols by a subject-matter expert as well as simplified operation by field personnel.

The base unit uses a two-inch photomultiplier tube fitted with appropriate optical filters to block the exciting light emitted by the interrogating light-emitting diode, thereby ensuring that only the emitted OSL light is detected. Testing of the base unit has demonstrated a sensitivity of about 1 μSv in accumulated dose with Al_2O_3:C dosimetric plaque material. The adapter, based on a one-inch photomultiplier tube, has a slightly less sensitive performance because of the smaller tube. Initial testing has also demonstrated successful detection of signals from irradiated electronic components with the base unit, and the adapter has detected residual signals from concrete irradiated with a beta source.

Impact

The unique capabilities provided by the POD will impact each end-user group. The device resulting from this work will allow law enforcement end-users to positively tie a non-leaking radioactive source to a given location, thereby assisting in the prosecution process. For arms-control verification scenarios, the site to be visited is usually given ample warning, and thus people at the site have abundant time to move RN material. Inspectors using the POD would be able to ascertain previous storage sites from field measurements, and then seek explanations. Finally, the OSL reader will allow for rapid screening and triage for unbadged personnel in case of an RN event.

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CRTI 06-0192TD

Respiratory-Fit Testing Program Development

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

Objectives

Serious deficiencies in respiratory protection programs (RPPs) for specific application to CBRN response were identified by a previous CRTI project (CRTI 0029RD: Protecting First Responders Against Chemical and Biological Threats). These 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.

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, expedient methods of ensuring that equipment is correctly donned in the field, and 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.

SWPF evaluations address the proper selection and integration of the respirator into the full protective system for a specific population of first responders. Through a series of qualitative and quantitative performance evaluations, the protection factor delivered by the respirator is determined when it is worn by a representative number of individuals who are wearing full personal protective equipment (PPE) systems and performing realistic activities. The level of expertise required to remedy integration problems demands a team of technical experts on the PPE from outside the response community. Initial SWPF evaluations have been performed for project response teams using air-purifying respirator (APR) and powered APR ystems. Standardized methods are under development to allow systematic identification of any integration problems. Initial evaluations have identified a number of integration issues with in-service equipment, where PPE components such as helmets and hoods were interfering with the proper functioning of the respirator by dislodging it during various activities. The project team is developing general guidance on how to remedy these deficiencies through different fitting and sizing of equipment or selection of different PPE items.

ISQ addresses the process of qualifying the entire system with each individual—that is, ensuring that all system components (respirator, suit, and ancillary equipment) are properly sized and appropriately integrated to ensure adequate respiratory protection. As part of this activity, every individual CBRN responder will use equipment and procedures to check the performance and appropriate sizing of their respirator. The project team modified and transferred approaches originally developed for the Canadian military to the partner responder groups through laboratory stage trials at RMC and development trials performed at RCMP facilities. Initial implementation of operational-level ISQ by the RCMP for their APR systems has started, with full supporting documentation and training manuals in preparation by the entire team. Further application of the procedures to other respirator types (powered APR and self-contained breathing apparatus [SCBA]) is underway.

FEP methods assure that, when donned at the scene of an incident, a respirator is still providing the protection it should, based on it having been through ISQ and SWPF processes. Failure may result from improper handling, storage, or donning at the time of the incident. Previously, qualitative leak-test methods using an odour-producing compound have been used; however, these are not sufficiently reliable to measure what may still be significant failures in protection for many CBRN response teams. Therefore, several quantitative approaches that can be routinely used in the field are under investigation for this application. The project team is developing at least three different possible approaches for powered APR and SCBA systems. Each approach has shown some potential drawbacks that might prevent routine field implementation. Further improvements and assessments are underway to attempt to remedy these drawbacks.

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

Objectives

The objective of this 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 moveable part of the device will be small (<50x40x30 cm). SR-Biospectra will have a range of 100-plus metres 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 is being designed and built, and will be tested at DRDC Suffield by fall 2009. INO is designing and integrating the hardware; MDA is developing the C2 system; DRDC is providing the spectral exploitation algorithm and the testing and evaluation facilities; and Telops is providing commercialization feedback.

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

The project is on track, having built and tested an alpha prototype at INO and at DRDC Valcartier. Analysis of the results shows that the prototype has sensitivity better than 1000 particles per litre (ppl) of *Bacillus globigii*, having 1 µm in diameter during nighttime conditions at a 100 m standoff distance. Based on modelling of targeted requirements, the prototype incorporated a 1 kHz, 100 µJ/pulse, eye-safe, 355 nm pulsed laser; a motorized adjustable focus collection optics of 20 cm diameter; and a high throughput spectrograph with a multi-anode linear photo-multiplier tube (PMT). Gating the charge collection from the 32-channel PMT with small form-factor 32-channel-gated integration electronics enables measurements to be taken. The channels span the range of 425 to 700 nm. INO demonstrated that this configuration could support

photon counting. This first prototype is larger and heavier than the targeted final prototype, but the goal was to demonstrate that the low-cost hardware choices could provide the required sensitivity.

Testing and evaluation of the alpha prototype's performance was completed by using solid targets along with return signals from air volumes. Noise analysis from these measurements showed single photon sensitivity and the impact of Raman returns from water in the sampled air volumes. Raman returns must be filtered for maximum aerosol fluorescence sensitivity. This will be improved in the beta prototype, enhancing sensitivity for a fixed laser power.

The prototype was then moved to the obscurant chamber at DRDC Valcartier used to contain inoffensive simulants of aerosolized biological agents and clouds of aerosols of interest for the public security community (e.g., tear gases, pepper spray). The produced clouds had their concentrations refereed with an aerosol particle sizer (APS), providing the concentrations orsizes of the aerosols as a function of time. Typical spectra will be shown. Comparing spectral data produced by SR-BioSpectra with data from the APS enables sensitivity limits to be derived as a function of the ranges and probed volumes.

While testing was taking place, MDA developed a C2 system compatible with the hardware. The hardware control and data collection is done remotely and several sensors can be networked.

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—populated 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: Phase I – Review of information sources; Phase II – Prioritization of formulations, compositions, or recipes to be assessed; Phase III – Technical assessments and software development; and Phase IV – 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 I, II, and III of this project. The project team continues to review information sources (Phase I), concomitant with the development of a prioritized list of formulas and compositions for inclusion in the database (Phase II). Under Phase III, scientific partners have 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, 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.

As well, a contract for the development of the software tool has been implemented with AMITA (Phase III). 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 of significant use when complete.

Impact

Although this project only began in October 2007, the data generated to date has been very 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 that will be 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 for canine detection training (RCMP, UK Metropolitan Police); for law enforcement purposes (Toronto Police, RCMP); and for 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
Other Partner:	The University of Texas at Austin – Pharmaceutics

Objectives

The first major objective of this project is to develop a formulated pre-clinical grade optimized Adenovirus Human serotype 5 (AdHu5) Ebola virus (EBOV) vaccine. This vaccine must be substantially more efficient than the first generation EBOV vaccine following intramuscular (IM) or nasal immunization of mice, guinea pigs, and non-human primates (NHPs). This milestone is expected to be completed by mid-2009. The second major objective is to identify immune correlates of protection against EBOV in NHPs. An in-depth evaluation of different immunological markers will be performed at different time points post-immunization and challenge. This second milestone is expected to be completed at the end of the project in the summer of 2010. Completion of these two objectives will provide the necessary knowledge to support the initiation of a Phase I clinical trial in healthy volunteers in Canada and Africa.

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 secure concrete options to resolve critical situations and accelerate deployment of adequate protective countermeasures to a bioterrorist attack.

Recent Progress and Results

A long-term solution for preventing *Zaire ebolavirus* (ZEBOV) infection is the development of a safe and effective vaccine. The National Institute of Health (NIH) has initiated a Phase I clinical trial in normal adults immunized with the first-generation (AdHu5)-based vaccine containing or expressing the ZEBOV glycoprotein (ZGP). The objective is to evaluate safety and immune responses to the vaccine.

Adenovirus vectors are highly immunogenic and have become a popular tool for vaccine applications due to the well-documented clinical trials evaluating gene transfer efficacy and immune responses following administration. For this project, the ZGP antigen was codon optimized for expression in mammalian cells and inserted downstream of a modified CAG promoter (chicken-ß-actin promoter, cytomegalovirus [CMV] enhancer) in an E1/E3 deleted adenovirus-based vaccine (Ad-CAG/optZGP). In vitro evaluation of the Ad-CAG/optZGP demonstrated a 10-fold increase in the expression of the ZGP antigen when compared to the first-generation adenovirus vaccine expressing the wild-type ZGP from a CMV promoter (Ad-CMV/ZGP).

Immunization of mice revealed that the optimized Ad-CAG/optZGP vaccine resulted in improved immune responses even at a dose 10 times lower for the T cell response and 100 times lower for the B cell response than with the first-generation AdHu5 vaccine. The optimized Ad-CAG/optZGP vaccine also fully protected mice against a lethal challenge with mouse-adapted ZEBOV at a dose 100 times lower than the minimal dose required to achieve full protection with the first generation Ad-CMV/ZGP vaccine in comparable conditions. Unexpectedly, complete survival was also achieved with the improved vaccine administered 30 minutes after the infection of mice with mouse-adapted ZEBOV (post-exposure), although weight loss was observed.

New data indicate that the optimized Ad-CAG/optZGP vaccine stimulates a significantly faster immune response than its NIH vaccine counterpart. The project team has evaluated over 10 different pharmacologic formulations of the improved vaccine in mice and identified 2 formulations that improved vaccine efficacy in mice. The immune response following vaccination with formulation was more robust than without formulation, indicating a correlation between neutralizing antibody levels of greater than1:20 and activated CD8+ T cells with survival in mice.

Importantly, the team was approached by the Pan-Provincial Vaccine Enterprise (PREVENT) which has expressed an initial interest in supporting advancement of this improved vaccine to a Phase I trial in Canada (and possibly Kenya as a second site). Communication with PREVENT allowed team members to establish the basis and identify the requirements for initiating a clinical trial in Canada in 2010 to 2011 (pending funding). Project work has also resulted in one publication (2009) and contributed to another one (2008).

Impact

Conclusions from this project will be compared to findings obtained from an ongoing NIH-sponsored Phase I clinical trial evaluating a first-generation AdHu5-Agp vaccine. The completion of this project will provide an optimized Ebola vaccine and the necessary data essential to support the initiation of a Phase I clinical trial in Canada, thus assuring independent decision making. This project is ahead of schedule so far, with results surpassing expectation. The optimized Ad-CAG/optZGP vaccine is currently being tested in guinea pigs immunized through the IM or mucosal route and challenged systemically or nasally. Team members anticipate completing the project's objective as planed in the summer of 2010.

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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 wounding. Currently, there is no rapid bioassay method 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 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 year of the project, the project team made progress in four major tasks: researchers developed a rapid bioassay method for Sr-90 in urine; studied the optical response of quantum dots to radiation; conducted an animal study on the metabolism of Po-210 in rats; and synthesized 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 summarized in two papers for publication in peer-reviewed journals.

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 a great potential to be used as a new generation of radiation dosimeter material. The achievements have been summarized in two papers for publication in peer-reviewed journals. One has been accepted and the other is under review.

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. For five days all the animals were monitored daily for Po-210 in breath, urine, and fecal excretions. At the end of one week, tissues and organs were analyzed for Po-210 retention. Long-term thermal response of the animals to radiation contamination was also studied. The results are being summarized for publication.

The magnetic nanoparticles were synthesized and partially characterized. They will be used in separation and quantification of Sr-90 and Po-210 in biological samples. The project team has acquired instruments for separation.

Impact

New knowledge and techniques were created and developed in both sample preparation chemistry and radiation measurement in the first year of this project. The project's partners are continuing the research and development of rapid methods for Sr-90 and Po-210 bioassays. 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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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; providing methods to improve the adoption, usability, and ongoing operations of syndromic surveillance in Canada; providing response protocols suitable for Canadian cities; accepting and analyzing patient data in both English and French; and creating 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 to date. Hospital Ethics Board Approval has been received and all hospitals participating in Phase 2 have signed the 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 on the project. The meeting also included round-table 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 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. The third ASSET Study/Stakeholder meeting is also in planning for June 2009.

Impact

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

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

With the 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 syndromic 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, and 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:	Royal Canadian Mounted Police – Canadian Bomb Data Centre
Federal Partners:	DRDC, Canadian Nuclear Safety Commission, Natural Resources Canada, Canadian Security Intelligence Service
Industry Partner:	AMITA Corporation
Other Partners:	Carleton University – Human Oriented Technology Lab, INTERPOL

Objectives

Improvised explosive devices (IEDs) are a growing threat both internationally and in Canada. 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 regards to how to identify them and the proper render-safe procedures to mitigate the force of the 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 will follow a phased approach starting with the preparation of development and interoperability plans. This will be followed by the software engineering phase, which includes analysis and formalization of requirements, and the design and development of IED and interoperability capabilities. The evaluation phase then follows and includes involved end-user partnership. The project is concluded with the completion phase in which the results of the project will be documented. Throughout the project two phases will be run in parallel: the transition phase, which will prepare the product for production in various environments, and the commercialization phase, which ensures the application of the product will prosper past the completion of the project.

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 matching 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 as well as contaminated materials.

The project provides a business and system model of data exchange that will demonstrate international interoperability in response to CBRNE events. Improved communications 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 explosive event involving improvised or non-ideal explosives. The project team will develop protocols serving as standards and guidelines for modelling ideal and non-ideal explosive threats in urban environments. This will consist of many accurate, near-field, modelling solutions based on first principles and including pressure (static and dynamic), impulse, and temperature histories, and P-I curves on structural elements of a comprehensive class of fundamental urban environments and scenarios. It will also include multiple scaling rules for non-ideal explosives, detailed guidelines for best explosion modelling practices, and procedures for applying modelling results to predict personnel and structural vulnerability. The protocols will be available as printed manuals and a user-friendly electronic platform of guidelines, a solution database, quick-look graphs, and tables.

Relevance

When used effectively, modelling tools can significantly aid in predicting and preparing for catastrophic explosive threats in urban environments. However, the supporting documentation for modelling tools is often limited due to a lack of unique explosion solutions near urban structures and corresponding guidelines using various modelling tools. This inevitably leads to inconsistency and erroneous or inappropriate interpretations. Thus, there is a need to establish clear protocols on the application of explosion modelling tools.

Furthermore, many different fast modelling tools and expert systems often include various semi-empirical approaches producing results in minutes. All of these have roles to play in risk assessment if used appropriately, but most of them are incapable of predicting near-field solutions encountered in urban environments. Because many end-users are not well versed in the specifics of either explosion physics or numerical techniques, they will inevitably use modelling tools outside of the tools' range of applicability and introduce errors in interpretation. Therefore, protocols based on physically accurate models and modelling solutions based on first principles are needed as guidelines for explosion modelling to assess the threats on structures and personnel in real-world urban scenarios and to extend the applicability range of fast modelling tools.

Recent Progress and Results

To develop the modelling protocols, the project team will build on capabilities developed over the past decade under the auspices of defence research and development programs. These capabilities include an extensive experimental database established for the effects of various non-ideal explosive devices and weapon surrogates on field defence and urban structures, and the Chinook code, a first-principles computational fluid dynamics modelling software.

The work for this project has been divided into four phases and shared between project partners. In the first year, the team collaborated to define detailed protocols to identify classes of explosives (solid-based, liquid-based, multiphase, etc. with

effects of charge geometry, height of burst, and case confinement), classes of fundamental urban structures and scenarios, classes of physical models, classes of first-principles modelling solutions, guidelines for modelling explosion loading and effects, procedures for assessing personnel and structural vulnerability, and the framework of the protocols. To aid in the first phase of the project, the team also 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 structure and confined environments.

The second phase of the project, expected to span a year, will focus on developing physical models. Owing to the non-ideal nature of most improvised explosive devices and the complex explosion physics in close proximity of urban structures, it will be critical to choose and develop the corresponding physical models and validate them against experiments. Physical models have been developed and validated with experiments, coordinating with the definition of their requirements. The models developed and enhanced include detonation in condensed matter, reaction and phase changes of combustible particles, the equations of state for the afterburning of detonation products of explosives, and detonation compression momentum and heat transfer in heterogeneous explosives. It also includes models for wall or street reflection interactions from explosives and combustible powders in urban environments; near-field mixing mechanisms including collision, jetting, turbulence and wake flow; and casing effects and fragmentation. Relevant aspects of the protocol framework have also been in development.

In the third phase, expected to begin in April 2009 and also span a year, models will be implemented in the Chinook code to obtain extensive solutions in the near-field of urban structures and environments. Team members will establish modelling guidelines and vulnerability assessment procedures on the basis of these first-principles solutions. Finally, in the fourth phase, the team will demonstrate the final protocols. The protocols will be completed and delivered by July 2011.

Impact

The protocols from this project will have important impacts on preparedness for and prevention of explosive-related urban public security events. They will be used as standards and guidelines for effective modelling practices to support design, mitigation measures, operational planning, and forensics for the threats from an extensive class of non-ideal explosives on urban infrastructures and environments. Furthermore, given that many existing fast modelling tools usually fail in predicting the complex near-field effects from non-ideal improvised explosives, these protocols will also provide first-principles benchmark solutions for relevant urban scenarios to validate these modelling tools. In addition, these 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 health care 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. Grey Bruce Health Unit in Ontario and British Columbia Ambulance Services in British Columbia will test the MedPost prototype release in time for the 2010 Vancouver Olympics.

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 (federal, provincial, municipal) and crosses different disciplines (fire, paramedic, police), provides a tool that mimics the true interaction that can occur during a CBRNE event. Allowing different levels of responders to access requirements-relevant information about casualties will dramatically improve situational awareness and response. MedPost will provide an overall command and control view of a CBRNE event using data feeds from various sources including the successfully completed CRTI project "Rapid Triage Management Workbench" (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

Contracting closed in late October 2008 and Phase 1 activities, including project definition and detailed project planning, have been completed. Phase 2, product design (both functional and technical), is well underway. 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 privacy impact assessment. Based on this information, a prototype model has been developed and is under review by the partnering national and international medical professionals. Their comments and recommendations will be considered for integration into the first functional prototype scheduled for release in January 2010.

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. Additionally, having a product such as the Rapid Triage Management Workbench, which has been successfully commercially deployed in South East Asia as a basis for MedPost, bodes well for the commercial success of the by-products created as the end result of the project.

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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, Praxcim, ihotweb inc.
Other Partners:	Justice Institute of British Columbia, 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.

Over the past year, content profiling, concept and detailed design specifications, and prototyping of some PRiMer elements have been undertaken. Production, validation, and demonstration activities are planned within the forthcoming year.

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, insure 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.

Recent Progress and Results

Significant progress has been achieved in the creation of PRiMer. In development of the *Content Profile*, a literature database was created that is being continuously updated as new evidence becomes available. The concept and design specifications for all the major elements of PRiMer (i.e., web-based self-study guide, interactive training session, and decision-support tool) have been developed. In addition, a prototype version of the *Self-Study Guide* has been created, soon to be pilot tested.

The project team has integrated research evidence into the web-based *Self-Study Guide* in the form of five psychosocial principles and three planning challenges to improve planning and preparedness. The *Self-Study Guide* incorporates a rich array of multimedia elements including video clips, photos, audio, graphics, animations, interactive quizzes, and downloadable files. The *Interactive Training Session* focuses on three planning challenges. These challenges are examined in relation to emergent behaviours, particularly at the group level. Psychosocial lessons are brought out by using a digital cityscape. The *Decision Support Tool* includes geographic information software that allows planners to access a map of their community with resources to "psychosocialize" emergency response efforts.

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 *International Journal of Risk Assessment and Management, Journal of Health Psychology, Journal of Toxicology and Environmental Health, International Journal of Global Environmental Issues–Special Issue on Risk Perception and Social Trust,* and *Journal of Applied Social Psychology*. Presentations at conferences or participation in workshops span a wide variety of local, national, and international organizations, including the Department of Homeland Security, Pan American Health Organization, World Health Organization, United States Army Corps of Engineers, Health Canada, Public Safety Canada, Society of Risk Analysis, Canadian Emergency Management College, and the Society for Community Research and Action. International, ongoing collaborations have also been maintained with the Australian Research Council Centre for Excellence in Policing and Security, and with European Union members such as the Netherlands Organisation for Applied Scientific Research – Defense Security and Safety, and the King's Centre for Military Health Research, United Kingdom.

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 expertise lends itself to an all-hazard platform.

PRiMer training is also meant to impact joint civilian- and military-security missions, group behaviours, collective decisions, and shared leadership in joint operations—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-hazard crisis response, an area in which public demands are increasing.

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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., Dalton Pharma Services

Objectives

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

Relevance

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

Recent Progress and Results

During 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

Objective

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 that 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 this reporting period and Phase 2 activities, including Functional Scope Definition, Technical Approach, Architecture, Design and Build, have been completed. A Version 1 Prototype has been delivered to Toronto Police Service for field testing in an exercise with the Toronto Police Service, Toronto Fire Services, Toronto Emergency Medical Services, Explosive Disposal Unit (EDU) CBRN Technicians, and Toronto Police Service 52 Division Priority Response Unit.

The Medical Emergency Treatment for Exposures to Radiation (METER) sub-project within PROBE has been successfully completed, having delivered training and exercises in Halifax, Nova-Scotia; Quebec City, Quebec; Ottawa and Toronto, Ontario; and Vancouver, British Columbia. METER also leaves behind a radiation assessment tool, training course materials for medical responders and receivers, concept of operations for a radiological-nuclear medical response tabletop emergency exercise, and a capability survey. The project is planned for completion in June 2010.

Impact

Current stand-alone 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

Project Lead:	Royal Canadian Mounted Police – National Services and Research
Federal Partner:	Royal Military College of Canada
Industry Partner:	Vertére Inventory Management Software
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 are not always useful for administrative or regulatory purposes. 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.

The goal of this project is to "Canadianize" a world-leading inventory software product and build a comprehensive database of chemicals 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 aid investigators by providing access to key information on the presence and location of materials of interest.

The results of this project will complement the information gathered and the work conducted in CRTI 05-0121RTD: "Evidence-based Risk Assessment of Improvised Chemical and Biological Weapons."

Recent Progress and Results

The project team has made significant progress in the past year focusing on data preparation, continued development of the software, and establishment of the server environment with security firewalls and access controls. The University of Ottawa is the "host" university, which means the database servers and software are located on its campus.

The four university partners spent a great deal of time preparing their chemical inventories for conversion to the new system to ensure the data was accurate. The University of Ottawa was the first to have its chemical inventory converted in the fall of 2008. As of January 2009, the University of Ottawa was able to add new chemicals to the database. Concordia University converted their data in March 2009, followed by Queen's University and the Royal Military College of Canada in April 2009.

An important aspect of the project is the integration of Canadian regulatory and legislative requirements. Work has begun on the Chemical Weapons Convention, Controlled Goods Program, and Designated Substances (Ontario). Tables containing regulated chemicals have been incorporated into the software. These tables will be used to generate alerts during the ordering and receiving processes, allowing efficient tracking and control of regulated chemicals. Work on these and several other regulations will be ongoing for the length of the project.

The project team decided to adopt the use of the web version of Chemwatch, allowing efficient management of Material Safety Data Sheets information. Chemwatch can be accessed directly through the Vertére software giving users quick access to emergency response, health and safety, and detailed chemical properties information for research purposes. Chemwatch is available in 25 languages.

Work has begun on the French translation of the *Vertére User Guide*. By the end of the project, the software as well as all documentation will be available in both official languages.

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 and which 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.

Additional universities are already showing considerable interest. The project is scheduled for completion in 2012.

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CRTI 06-0319TD

Guidelines for Combined Air Demand and Heat Strain Management of First Responders

Project Lead:	Canadian Police Research Centre
Federal Partners:	DRDC Toronto
Industry Partner:	Moroz Biomeasurement Systems Inc.
Other Partners:	University of Waterloo, Loughborough University, Toronto Fire Service, Toronto Police Service, Royal Canadian Mounted Police – Toronto Detachment, Canadian Joint Incident Response Unit

Objectives

Incident commanders need to be able to assess the potential risks of the environment to their personnel in order to define the level of personal protective equipment (PPE) required to handle the incident. However, once the level of protection is defined, commanders also need to understand and safely plan for the potential life-threatening and functional limitations of the PPE on the first responder. Currently, guidelines are not available that define safe exposure durations for first responders functioning in Level A or B ensembles. This project will develop standards and guidelines that will assist incident commanders in ensuring that their personnel are safe and not at risk of becoming a casualty due to heat injury from an excessive rise in core temperature while wearing their PPE or asphyxiation due to exhausted air supply from their self-contained breathing apparatus (SCBA).

Relevance

Protective clothing and SCBA are designed to allow the first responder to function in a contaminated environment; however, the risk assessment must also consider the potential for heat injury (e.g., heat exhaustion and heat stroke) and asphyxiation with the use of PPE and SCBA. Presently no laboratory- and field-validated standards exist that safely manage these two factors, which limit the duration of PPE functionality for first responders. The outcomes from this project, therefore, will enable CRTI to establish safe work standards. By establishing these safe-exposure-time guidelines, incident commanders can focus on carrying out hazard identification and forensic evidence gathering without concerns for placing their personnel at increased risk of heat injury or asphyxiation with the use of the required protective clothing and equipment.

Recent Progress and Results

The project, which has just begun, will be carried out over the next three years. Management of thermal strain and options for cooling will be investigated in the climatic facilities at DRDC Toronto. Loughborough University in the United kingdom (UK) will determine the intrinsic clothing insulation and water vapour permeability of the ensembles at different wind speeds using an articulating thermal mannequin. The University of Waterloo will lead the air management component of the project by providing real-time measurements of metabolic rates and air demand of activities conducted in the Level A and B ensembles. In addition, the University of Waterloo will assist with the validation of heat-strain models and clothing-adjustment factors that will ultimately allow work guidelines to be constructed for different environmental conditions, clothing configurations, and metabolic rates. The final product, after field confirmation with end-users, will provide incident commanders with an electronic tool to determine time limit guidelines that ensure safe management of air supply and heat stress for levels of PPE requiring the use of SCBA.

Impact

Incident commanders must deal with the uncertainty of the hazards within the environment in which they ask their personnel to gather forensic samples and conduct criminal investigations. These initial uncertainties require the use of PPE that are impermeable to the transfer of environmental contaminants and require that a clean and safe air supply is provided through the use of SCBA. The requirement for this protection, however, places the first responder at risk of death from heat injury because of the restriction of heat transfer from the body through the clothing, and asphyxiation if proper work and rest guidelines are not followed. The outcome from this project will be an electronic tool that allows incident commanders to prescribe appropriate work and rest strategies to safely manage the risk of heat injury and asphyxiation. By ensuring the safety of their personnel, the incident commander can then focus on the requirements of the scenario for criminal investigation and gathering of forensic evidence.

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CRTI 06-0317TD-METER

Medical Emergency Treatment for Exposure to Radiation

Project Lead:	Department of National Defence – Director General Nuclear Safety
Federal Partners:	DRDC Ottawa, Department of National Defence – Canadian Forces Health Service Group, Health Canada – Radiation Protection Bureau, Canadian Nuclear Safety Commission, Public Health Agency of Canada
Industry Partner:	International Safety Research Inc.
Other Partner:	Queen Elizabeth II Hospital

Objectives

The Medical Emergency Treatment for Exposures to Radiation (METER) project aims to improve the ability of medical first responders and first receivers to assess and treat individuals who may have received high ionizing radiation doses. The METER project is a sub-project of PROBE—Crime Scene Support Tool for Police, Hazardous Materials, and Emergency Medical Services (CRTI 06-0317TD (PROBE). The objectives of this project, which was started in April 2008 and completed in April 2009, were to showcase and improve the Radiological Casualty Assessment Tool, deliver medical emergency response training courses and tabletop exercises in five locations in Canada, and assess the current medical radiological-nuclear (RN) response gaps and develop a plan to close these gaps.

Personnel from project partners have participated in the further development, improvement, and delivery of training courses and tabletop exercises and in the improvement of the Radiological Casualty Assessment Tool. International Safety Research personnel performed the assessment of the current medical RN response gaps and development of a plan to address them. Personnel from the Public Health Agency of Canada reviewed the training material and provided comments.

Relevance

The project directly addressed some of CRTI's identified priority areas. It supplied an improved Radiological Casualty Assessment Tool that can be used by medical practitioners in the field and in emergency rooms for rapid triage and management of casualties exposed to radiation or contaminated with radioactive material. The training courses and tabletop exercises provided knowledge and abilities to assist medical first responders and first receivers to assess and treat casualties.

Recent Progress and Results

The project further developed, reviewed, and improved the Radiation Casualty Assessment Tool, training course material for medical first responders and first receivers, and tabletop exercise material for the medical response to an RN emergency. Training courses and tabletop exercises were provided to first responders and first receivers, hospital administrators and radiation safety officers in Quebec City, Quebec; Toronto and Ottawa, Ontario; Halifax, Nova Scotia; and Vancouver, British Columbia.

The project developed a concept of operations for the medical response to an RN emergency that provides strategies for the management of RN casualties and for the preparation of plans. The project also hosted a capability survey for the current medical response to an RN emergency in the five cities mentioned above and proposed a plan to deal with the identified gaps.

Impact

The project improved the knowledge and awareness of participants and demonstrated that a comprehensive training program is needed across Canada. Interaction between medical first responders and first receivers throughout the tabletop exercises brought a better understanding and appreciation by participants of their colleagues' preparedness, skills, knowledge, and resources.

A direct impact of the project is a recommendation from Emergency Health Services in Halifax to change their policy to allow the transportation of casualties contaminated with radioactive material. The project team has been requested to conduct additional training courses and tabletop exercises in Vancouver prior to the Olympics. Ontario, Quebec, and Nova Scotia have also expressed interest in the conduct of additional courses and exercises. Health Canada's Radiation Protection Bureau may champion the continuity of the course and exercise after the completion of this project.

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CRTI 07-0103RD

Full-Scale Radiological Dispersal Devices Experiments and Models

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 short half-life radioisotopes. 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. They 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. An initial modelling attempt is needed to proceed with these plans.

Researchers have also been proceeding with the modelling stream according to the project schedule. DRDC Ottawa has retained a software engineer to assess 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 program. The result of this work is a physics-based modelling toolkit capable of accurately modelling each distinct regime of the event individually and together 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. The New England Complex Systems Institute is also ready to begin an agent-based modelling approach that will supplement the physics-based model described above. The agent-based modelling toolkit will be able to run in (near) real-time during an actual event. The benchmarking of the simulated RDD event will give confidence to the predictions of the consequences of employing different isotopes, chemical composition, device yield, location, and so on.

Impact

By identifying the scenarios of greatest concern, and experimentally verifying data on simulated RDD behaviour (i.e., explosion, isotope fragmentation, plume formation, isotope distribution, etc.), 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

As a part of the CRTI capability-based planning model, 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. 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

Phase 1 has been completed, culminating in an introductory workshop in January 2009 that involved over 80 participants representing government, academia, industry, and non-governmental organizations. The workshop introduced the concepts and methodologies of foresight to be employed in the project. International speakers provided lessons learned from their own experiences in the application of foresight to both the public health and animal health domains.

Phase 2 is organized around four foresight modules, the first of which is an exercise challenging workshop participants to identify the key issues and driving forces that have an impact on AHEM. Foresight work undertaken in subsequent months has built upon the outputs of the first activity.

The second foresight module, conducted in April, involved a smaller group of participants participating in facilitated scenario development. The gathered experts were asked to

articulate four divergent visions of the future given the uncertainty of identified driving forces. This range of future outcomes provides a framework for identifying key risks and testing the robustness of different strategic options.

The third foresight module, conducted in May, challenged a group of participants to engage in facilitated systems mapping. This process involves developing a common perspective across organizations and disciplines to increase understanding of the current AHEM system. Analysis of the map of relevant elements and key relationships allows for the identification of key leverage points in the system, which are areas where activity should be focused to enact effective change.

The fourth foresight module, to be conducted in October, will integrate the current and future perspectives together. The objective is to initiate identification of anticipated gaps in capability given the range of future outcomes, and begin to develop the associated recommended actions to be undertaken given the key leverage points in the system.

Given the challenges of engaging a broad range of project participants distributed across the country and representing numerous organizations, the project has employed innovative information technology measures to encourage the evolution of a virtual community. A social networking website, <www.forecan-precan.ca>, offers project participants the means to actively participate in dialogue, provide commentary and validation on foresight-driven deliverables, and inform themselves on other foresight initiatives currently underway in Canada and internationally. In addition, electronic surveys have been administered to project participants both before and after events to chart the performance of the project and, specifically, to ascertain knowledge transferred and confidence in the methods employed, and solicit feedback on an ongoing basis.

Impact

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

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

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CRTI 07-0113TD

Direct Alpha Spectrometry for Forensic Samples

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 has accomplished nearly all of its first year goals. Progress has been made on the development of the software, the sampling technique, the concept of operations, and the related training materials.

The software component of DAAFS has undergone the most development to date. Operational beta versions of nearly all necessary software have been delivered by the Finnish Radiation and Nuclear Safety Authority. Health Canada is beginning tests and trials of the software with some new sampling techniques. Currently, the alpha spectral simulator (AASI) and the fitting routine (AASIFIT) are fully functional. The spectral analysis, identification, and de-convolution software package has been delivered. Further work is needed to fully integrate the system by developing the necessary automation and reach-back capabilities.

Preliminary investigations conducted by the Radiation and Nuclear Safety Authority using various sampling techniques have determined that fluoropore membrane filters have the best performance of the techniques tested thus far. Collected particles do not penetrate the filter matrix and thus give a high-quality spectrum. The DAAFS team has identified two successful sampling techniques to date. Vacuum sampling has proven to be most effective when used to collect samples from soft surfaces, such as textiles, while a surface swipe is effective with hard surfaces. Additionally, the hardware and techniques used for vacuum sampling will allow first responders to perform airborne sampling for the presence of airborne radiation contaminants. Further testing at Health Canada will test adhesive materials, such as various tapes, and the use of particle size-selection techniques on various samples and sample types.

Finally, the research team has established a preliminary framework for the concept of operations in consultation with first responders. The team has been documenting its results effectively so that training materials are being developed as the project progresses. Further development on these aspects of DAAFS will occur as the system matures.

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

The project addresses "responder requirements" under the CRTI's investment priority of "Explosive – Threat and Capabilities." 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

Since the project began in September 2008, the focus has been on literature reviews for WP1 and WP2, screening models and readying equipment for WP3, and beginning fabrication for WP4. The SWCNT production facility at the National Research Council has been commissioned, the instrument has been calibrated, and the production of SWCNT is now being carried out routinely. Technicians are improving the yield of the production equipment to limit post-processing, with a target yield of 80 percent.

The bulk of the work has been on WP2 to produce samples to activate WP3 and WP4. Four of the five activities for WP2 have been initiated: (1) A two-step protocol to integrate SWCNT into polyacrylics has been successfully developed and samples have been fabricated and sent for testing. Several approaches to integrate SWCNT into polycarbonates are currently being examined. (2) The chemistry to anchor SWCNT to vinyl ester resins has been developed successfully. (3) A method to fabricate lyotropic liquid crystal from SWCNT has been developed and the dope has been used to fabricate pristine SWCNT fibres. Raman spectroscopy has been used to characterize the alignment. In addition, pristine carbon nanotube (CNT) fibres have been fabricated by coagulation spinning. Mechanical testing on these fibres is currently underway. (4) A process to make SWCNT-polyacrylonitrile fibres using electrospinning has been developed successfully. Mechanical testing is currently underway. (5) Various forms of "buckytube" papers have been made and mechanical testing has been performed. In addition, two impregnation techniques have been tested and assessed.

In WP3, researchers have screened modelling algorithms for penetration and perforation, and studied penetration and perforation mechanics for armour designs. In addition, they have used a fibre architecture-based computational model to assist in the design and selection of the CNT-matrix material combination and the geometric orientation of the fibrils. In WP4, hybrid systems of CNT with Kevlar at the fibril and yarn level have been 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:	AUG Signals, Biokinetics & Associates, Allen-Vanguard Corporation
Other Partner:	Ottawa Police Service

Objectives

First responders involved in improvised hazardous device disposal are increasingly burdened, operationally and physically, with having to carry diverse detectors and sensors, and to deal with individual 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, compatible 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 determine and quantify the 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

COTS detectors, sensors, and radio equipment currently in use by RCMP responders have been identified to ensure that the integrated system will be compatible with the RCMP. A number of such devices have been acquired for the electronics integration activities that will be initiated shortly. Devices acquired so far include chemical detectors as well as physiological monitoring systems. Specialized computers have also been acquired.

While previous blast dosimetry efforts have focused on the collection of helmet acceleration data, the team is currently working on blast overpressure collection devices to be worn on the body and investigating the possibility of including a few such sensors to determine blast amplitude, as well as blast direction, for better characterization of the blast threat. A number of candidate pressure sensors have been identified.

Allen-Vanguard Corporation is working with a subcontractor that will optimize an innovative sensor based on specifications for this project. Initial blast testing of early blast dosimetry prototypes is planned for May–June 2009 at DRDC Valcartier. DRDC scientists have started collecting information from their own organization, as well as Department of National Defence medical groups, on blast dosimetry requirements and applicability in the field.

In parallel, blunt-impact testing on anthropomorphic mannequins is in the planning process to investigate how forces transmitted between the helmet and the head could be measured by small and inexpensive helmet-mounted force sensors. A number of force-sensor candidate samples have been acquired and preliminarily tested for their electronics response.

Impact

Real-time detection and alarm triggers of threatening environments will allow responders to adapt their response or remove themselves from hazardous areas, and can permit optimum PPE use, limiting unnecessary operational burden. Select physiological monitoring, "man-down" sensors, as well as 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 first 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:	Nanogen, 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 assays target foot-and-mouth disease (FMD) and other bovine HC agents, such as Rinderpest and the avian diseases, avian influenza (AI) and Newcastle disease. The Canadian Food Inspection Agency (CFIA) and Nanogen 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 are currently being developed on the NanoChip 400 instrument: the bovine and avian HC assays, and the FMD strain identification assay. Animal inoculations and sample collections for assay validation are 80 percent completed.

For the bovine HC agent assay, the project team designed and tested detection probes for vesicular stomatitis (VS) virus and two differential diseases (bovine viral diarrhea [BVD] and infectious bovine rhinotracheitis [IBR]). All 14 strains of VS virus, six strains of BVD virus, and two strains of IBR virus were successfully detected on the NanoChip instrument.

For the avian HC agent assay, the project team developed a PCR to amplify neurocanthocytosis (NA) gene sequences from all AI virus strains (n=42) in the CFIA collection. Sequencing of this region for all strains is nearly complete. Probes (n=33) designed to discriminate between the nine NA types of AI virus have been tested. Strains of subtypes N4 (n=1) and N9 (n=4) were all specifically detected with a single probe per subtype. Detection and discrimination of 5/5 N1, 7/9 N2, 4/5 N3, 1/2 N5, 1/2 N6, 2/3 N7, and 2/6 N8 strains have also been observed. Five additional N1 and N2 strains remain to be tested. Further probe design and testing is underway.

For the FMD strain identification assay, the project team designed strain-specific probes to three genetic regions. The team tested probes for serotypes A and C, which successfully identified the laboratory strains they were designed to detect. Cross-reactions to other strains within the serotype were minimal.

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 NanoChip are intellectual property owned by 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, Public Safety Canada – Rural Secretariat
Other Partners:	GPI Atlantic, National Aboriginal Health Organization, Canadian Women's Health Network, World Association of Disaster and Emergency Management

Objectives

In response to the social imperative for enhanced emergency planning in "forgotten communities," the Justice Institute of British Columbia (JIBC), in consultation with project partners and communities, will design, pretest, and disseminate a suite of simple 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 JIBC 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. In terms of outcomes, the project will foster and build disaster preparedness, planning, response, and recovery capacity in a minimum of five pilot rural, remote, and coastal communities in Canada.

Relevance

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. Federal government partners, notably the Public Health Agency of Canada (PHAC) – Rural Secretariat, Agriculture and Agri-Food Canada, and Public Safety Canada, will undertake to integrate the tools, curricula, virtual community of practice, and related deliverables into existing program and projects, thereby extending the reach and saturation of the dissemination process.

To guide the work of JIBC and its partners, two expert reference committees will be convened: an Expert Reference Committee on Emergency Management and an Expert Reference Committee 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.

Recent Progress and Results

The official start date of this project was April 2009, too recent to report any project results.

Impact

Using multiple primary and secondary data sources, engaged collaboration with key partners, needs assessments, and pilot testing of curricula in five diverse communities, the JIBC will develop a set of accessible, web-assisted, user-friendly tools and training materials to build capacity in rural, remote, and coastal communities in Canada. Content and process will include support to and enhancement of the Gender and Disaster Network of Canada, the facilitation of communication linkages among diverse networks in support of a "network of networks," and the provision and delivery of web-assisted training, knowledge exchange, and capacity building to the five pilot communities of practice. The members of the network of networks will include, but are not limited to, the Gender and

Disaster Network of Canada, the Ocean Management Research Network, the World Association of Disaster and Emergency Management – Psychosocial Task Force, PHAC, the Psychosocial Interagency Working Group, the Canadian Risk and Hazard Network, and the Canadian Women's Health Network, and will link with the Pan American Health Organization and United Nations disaster management units.

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CRTI 07-0150TD

Casualty Care Continuum

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

Objectives

The primary focus of the Casualty Care Continuum (CCC) project is to improve incident response by providing better information to responders. Present 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 via 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 the 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-hazard events involving affected and non-affected members of the public. CCC will also improve communication amongst 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 when 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 which facility an individual is presently located at. 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

The CCC project began in March 2008, and the team has made progress in the first two phases. Phase 1, project startup, was completed in April 2009. Deliverables produced by the team included the project charter, project definition, contracting activities, project plans, project success criteria, and project functional scope.

Phase 2, release 1 of CCC, started in January 2009 and is in progress. The Phase 2 deliverables completed by the team to date include the first issue of the project newsletter, CCC-RTMW, Release 1, specifications and design. Deployment of CCC-RTMW, Release 1, is scheduled for the British Columbia Ambulance Service in April 2009 and deployment to the Toronto Emergency Medical Services will follow shortly after.

Phase 3, demonstration of CCC, Release 1, is scheduled to start in May 2009.

Impact

CCC will deliver transition and sustainability after the project is completed. The implementation of CCC-RTMW with the British Columbia Ambulance Service may result in the use of this product for the Vancouver 2010 Olympics. 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 a 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: CCC 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 effected by CBRNE events and enabling 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 07-0153RD

Consolidated Assessment of Threats for the Transport of Combustible Liquid/Gaseous Fuels

Project Lead:	DRDC Suffield
Federal Partners:	Public Safety Canada, Royal Canadian Mounted Police, Natural Resources Canada – Canadian Explosives Research Laboratory, Transport Canada
Industry Partners:	AMITA Corporation, CAM Emergency Preparedness, E-Privacy Management Systems Inc.
Other Partners:	Timescales Scientific Ltd., Martec Ltd.

Objectives

Discussions on Internet chat boards, and the recent attacks in London and Manchester involving sedans fitted with compressed gas cylinders and tanks containing motor fuels, are confirmation that terrorists are assessing the merits of fuel-air explosives (FAE) as a new weapon in their arsenal. While these attacks were small in scale and poorly executed, it is probably only a matter of time before terrorists acquire the know-how to stage a significant FAE event. The aim of the current project is to assess the feasibility of terrorists converting tanker trucks or rail cars into mobile FAE bombs. The project will determine the requirements for a successful attack and quantify the effects of such an attack on people and urban infrastructure. The researchers will propose countermeasures and recommendations for follow-on work.

The researchers will begin with a survey to identify fuels that are most frequently transported in bulk. They will rank these fuels in terms of their detonability. Researchers can produce an initial ranking of the fuels based on flammability data (e.g., the minimum explosive safety gap, [MESG]) available in the open literature. They will also perform chemical kinetics calculations to group fuels having similar detonability.

Once the researchers have identified the high priority fuels, they will quantify the detonability of the fuels experimentally in cases where no data exists. In the case of gaseous fuels, where the detonability is controlled by chemistry alone, the researchers will determine the detonation cell size (a measure of the thickness of the detonation front) in detonation tube tests using the smoke-foil technique. In the case of dispersed liquid fuels, where the detonability is controlled primarily by physical processes (e.g., droplet breakup and vaporization), the researchers will directly measure the minimum charge mass and cloud size in field experiments. They will investigate two basic attack scenarios during the project.

Relevance

This project contributes to the CRTI priority, "Explosives – Threat and Capabilities." In particular, the project will contribute to the analysis and understanding of threats based on explosives. It will also produce a consolidated list of combustible liquids that could be used in a large-scale attack. This project also addresses two gaps in the CRTI priority, "Access to Explosives and Positive Control of Material," in that materials will be identified during the project that are not presently considered to be a threat to public safety and security.

Recent Progress and Results

The start of the project has been delayed because of delays encountered in obtaining all memoranda of understanding and subsequent charter signatures. The vast majority of required fieldwork must be conducted during spring-summer-fall months. Recently emerging staffing issues now preclude the completion of field trials during the summer of 2009 at Suffield. Acceptance of a modified project schedule to account for these slippages will be sought at the first peer-review committee for the project. Laboratory screening is to take place at Canadian Explosives Research Laboratory (CERL) in a recently assembled 20-litre sphere. Three gases have been tested with acceptable results, but improvements are being made to the test methodology. Liquid fuels have not yet been evaluated.

Impact

The project will identify the prerequisites for a successful attack, information that will lead to increased coordination of efforts between DRDC, Transport Canada, law enforcement, security, and intelligence agencies. The project may lead to more stringent physical controls over certain materials, or the development of new security procedures and technologies. Earlier surveillance or interdiction of a planned attack might also become possible knowing the prerequisites for such an attack. The deliverables will include a consolidated risk assessment and recommendations in the form of interim and final reports.

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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 (TC) 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 consists of four main parts: (1) a critical review of existing standards and codes on blast design and assessment of buildings; (2) establishment of a CSA TC; (3) development of the standard with the support of focused research; and (4) training of end-users on the use of the standard.

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

The CSA TC for developing the standard was established in the fall of 2008. Members of the TC include a balanced matrix of researchers, practitioners, regulatory authorities, and building owners and operators. Chair and vice-chair of the TC are members of the project team. Terms of Reference and the TC membership have been approved by the CSA.

Project members began developing the standard at the first TC meeting in September 2008. They drafted the Table of Contents for the standard and established subcommittees (SCs) for developing the contents of the standard. The second meeting was held through a teleconference in January 2009. The next meeting took place on 16–17 April 2009, at the CSA office in Toronto to go through the contents developed by the SCs.

In support of the development of the standard, focused research will be carried out such that defined knowledge gaps are filled and technical issues raised during the standard development are resolved by analytical or experimental investigations or both. The next TC meeting will examine the recommendations proposed by the review report and by the SCs. A work plan for the focused research is to be developed at the next TC meeting. It is expected that the focused research will commence in the spring of 2009.

The project team is planning to transfer the technology in the summer of 2011 through training sessions for end-users, including personnel from the RCMP, PWGSC, and DFAIT, on the use of the standard.

Impact

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

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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

The 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, development of 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 advanced significantly on the identification and characterization of the material signatures. The writing of the pseudo-code for the processing algorithm is also practically completed.

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 Tool for Time and Use for Improved Bioeffects

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

Objectives

The terrorist threat of radionuclide dispersal via explosive or non-explosive energetic release is of great health concern. First responders and the affected public face the risk of internal contamination primarily due to the potential inhalation of aerosolized radionuclides. Alternate routes of internalization may be through ingestion and wounding. These internalized radionuclides are a significant health concern because they release energies that 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 versus the 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 (MEDECOR) 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 MEDECOR 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 a 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 (1) need immediate decorporation treatment to reduce dose, (2) are contaminated with no predicted dose aversion from decorporation therapy, (3) have minimal risk post-intake, and (4) are not internally contaminated but require reassurance.

Recent Progress and Results

A formal meeting was held in December 2008 at DRDC Ottawa to officially launch the project. The partner organizations reviewed the project background and set expectations for participation and future work. Contracting activities were completed in early April 2009. Since then, the Phase 1 activities, including the project definition and detailed project planning, have been completed, and team members are now working on Phase 2 activities such as software tool design and risk model development.

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. MEDECOR can ameliorate the medical community's present needs by generating appropriate responses to real events as well as live and tabletop exercises. The MEDECOR 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 Partners:	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 electronic neutron dosimeter (END) project (CRTI 04-0029RD) was to address this technological gap. However, the prospect of wearing both the END and a conventional gamma EPD was deemed undesirable by end-users. The goal of the END-2 project is to incorporate gamma detection capabilities into the original END. Furthermore, the measurement of both doses in a single END-2 allows them to be summed to give a single total dose value. This attribute is extremely important to ensure first responders know their total accumulated dose in the course of their duties and can ensure they do not exceed the recommended limits.

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, 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 aim of the project is to add gamma-ray dosimetric capabilities to the END, as well as to ruggedize the design for first responder use. The END uses a ^{6}LiI(Eu) scintillator crystal to measure thermal neutrons and a plastic scintillator for fast neutrons. The gamma ray signals are currently separated from the fast neutron signals and rejected. The use of these rejected signals would allow the measurement of gamma rays as well as neutrons in the END-2.

The END-2 project began in December 2008. The first phase of the END-2 project generated a preliminary conceptual design for the device. End-user feedback is essential at all stages of development to ensure the project succeeds at meeting the needs of first responders. The meeting to end Phase 1 in March 2009 ensured that end-user input was incorporated into the final conceptual END-2 design. Improvements based on the lessons learned from the END project will be also incorporated into the END-2 device to improve the performance of the final instrument for both neutrons and gamma rays.

At the end of the project, the team expects to have a field prototype of an END that also measures gamma dose. 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. The final deliverables are two prototypes and the test results. End-users and other partners will evaluate the prototype in field trials to ensure that the product is suitable for their own needs.

Impact

One of the CBRNE events of main concern is the detonation of an RDD (or dirty bomb). First responders who enter the contaminated area will be faced with radiation hazards from alpha and beta particles, 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 unacceptable health detriments in the execution of their duties.

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CRTI 07-0193RD

A Compton Gamma Imager for Criminal and National Security Investigation

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

Objectives

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

The project will begin with an extensive instrument design phase to evaluate and compare various scintillation materials and readout technologies. A design will be chosen that optimizes detector performance at large stand-off distances while respecting the operational constraints of ruggedness, portability, and cost. Once the prototype imager is built, its performance will be characterized in terms of image resolution and sensitivity. Finally, demonstrations will take place and procedures for deployment will be developed in consultation with the end-users.

Relevance

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

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

Recent Progress and Results

The Compton gamma imaging technique relies on tracking the energy depositions of a gamma ray as it interacts with the scintillator within the detector. In the simplest case, an incoming gamma ray scatters from an atomic electron in a layer of scintillator. The position and energy of the recoiling electron are recorded in this "scatter detector" and the outgoing gamma ray undergoes a photo-electric absorption process, depositing energy at some position in an "absorber detector." The direction of the incoming gamma ray (up to an azimuthal angle) can be computed from this data. Combining data from several such events eliminates the degeneracy and provides a unique estimate of the position of the source of radiation.

Detailed Compton imager simulations have been made using the EGSnrc radiation transport package. The simulations model the energy depositions in the imager caused by a source of gamma radiation. They include interactions in the sensitive volume of the detector, in the intervening air, and in dead material corresponding to readout components. A representative contribution from naturally occurring radioactive material was also included. Reconstruction of the source image from the energy depositions was accomplished using an iterative minimization procedure.

The main conclusion from this work has been that a detector of dimension of approximately 30 cm x 30 cm x 30 cm and weighing on the order of 20 kg can resolve the location of a 10 mCi Cs-137 source, 40 m distant, to within a few degrees in a field of view of 90° x 90°, in under a minute.

Further conclusions from these investigations concern the scintillator material for the scatter detector. Plastic, CaF_2, NaI and $LaBr_3$ are all potentially capable of providing the desired performance characteristics, provided that scatter detector dimensions are optimized for the chosen material.

A comparison of predictions obtained using the EGSnrc (standard in medical physics) and the Geant4 (standard in high energy physics) simulation packages found agreement to within a few percent in observables relevant to Compton scatter imaging.

The research has now turned to validating the simulations with test-stand data. At McGill, the performance characteristics of an imager built from bar-shaped scintillating elements crossed with wavelength-shifting strips is being studied. At the National Research Council, research is concentrated on understanding the potential performance of an imager based on 1 cm^3 pixels of scintillator. The effectiveness of various readout schemes, ranging from conventional photomultiplier tubes to novel silicon multi-pixel photon counters, is being investigated at Natural Resources Canada.

Impact

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

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

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CRTI 07-0196TD

Towards an Operational Urban Modeling 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.

Objective

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:

- 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;
- To develop the required supporting infrastructure (supporting land cover and land-use databases, 3-D building data, CBRN source models); and
- 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 (e.g., 2010 Olympic Winter Games in Vancouver).

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:

Work on this project commenced in the fall of 2008. Work focused on three main fronts over the first six months of the project: improvements to the Computational Fluid Dynamics (CFD) flow modelling and source reconstruction components as well as on the urbanized meteorological model, and the installation of the prototype within EC-EERS.

A general methodology based on a Bayesian probabilistic inference scheme has been developed. This methodology addresses the difficult case of multiple source reconstruction when even the number of sources is unknown. The methodology was successfully tested with synthetic concentration data for various scenarios involving multiple source releases.

Work has begun to validate the methodology against a purpose-designed, real-dispersion experiment involving various combinations of multiple source releases conducted under a multinational cooperative Fusing Sensor Information from Observing Networks (FUSION) field trial, held at the United States Army Dugway Proving Ground in September 2007. This field experiment was designed and sponsored by the Technical Cooperation Program Chemical, Biological and Radiological (CBR) Defense Group Technical Panel 9.

Work is also proceeding on the inclusion of a thermal component in urbanSTREAM, the CFD flow model. Once the thermal component is fully implemented, urbanSTREAM will be tested against data obtained through the Joint Urban 2003 experiment conducted in Oklahoma City.

Work has advanced on improving the urbanized meteorological model and, in particular, the parameterizations within the Town Energy Balance (TEB) scheme of the model. Several modifications were done to the land surface scheme related to treatment of snow. The most important of these changes concerns separate calculations of the surface budgets over bare soil, vegetation, and snow portions of computational grid points. Good coordination was pursued with the Environmental Prediction in Canadian Cities (EPiCC) project and the associated collaborations with Meteo-France about the improvements of TEB.

The project team has also started work on improving the coupling of an urban mesoscale meteorological model with the microscale flow models. To help in this task, a building-resolving extension (referred to as the "micromet" model) of the mesoscale prototype was developed. Comparisons with published literature on this subject (both observational and CFD modelling) indicated very good performance of the "micromet" model.

Impact

The operational prototype modelling system will be functional 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 Olympics), formulation of simulation scenarios for training purposes, and development of the capability to evaluate and execute effective real-time responses to CBRN hazards.

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CRTI 07-0219RD

Microbial Forensics

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

Objective

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 whole genome sequencing 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. This project 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

This project will involve the genomic analyses of category-A list bacterial pathogens currently held within Canadian Federal Laboratories. Databases of whole genomic sequences and alternative molecular genetic typing schemes (for example, multiple-locus variable-number tandem repeat analysis [MLVA] or single nucleotide polymorphism [SNP] analysis) will be established. The work in this project is being planned and will be conducted so that all procedures used will eventually be subjected to validation as per forensic standards. The aim is to establish procedures that enable the generation of high-quality data that is able to withstand legal scrutiny. Furthermore, we will utilize our pre-existing relationship with the RCMP and the training course "Scientific Evidence in Courts" to train scientific staff in the area of crime attribution.

Impact

Establishment of a Microbial Forensics Centre will have considerable impact for forensic response to a bio-crime event. The outcomes of this project will be a forensic unit capable of supporting the national counter terrorism activities of the RCMP, Canadian Security Intelligence Service, Canada Border Services Agency, and others. Additionally, it will be able to support non-terrorist criminal investigations where air, water, or food supplies have been contaminated with biological agents through negligence or accident. The experience and expertise of the post-9/11 forensic anthrax investigations will be accessed to ensure the assays meet evidentiary requirements. The project team will be working with other federal institutions to develop a genetic database for the molecular characterization of strains. This molecular database will be available to law enforcement when required. In short, the project team will develop a needed capability for Canada and make it available to support criminal investigations. Furthermore, the genetic information generated within this project may supplement the corporate records of the governing agency submitting the sample genome. Indeed, this data can be used to corroborate and validate bacterial strain information currently within Canadian government culture collections, as the total genomic sequence blueprints provide unequivocal information for discerning strains.

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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 the 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 of 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 is underway. 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 (e.g. 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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PSTP 08-0100CIP

Integrated Evaluation of Critical Infrastructure Interdependencies for Major Event Planning

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

Objectives

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

Relevance

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

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

Recent Results and Progress

Work on this study will begin in June 2009. The Centre will integrate its current research to develop an interdependency evaluation methodology for major events that are occasional and of short duration. Therefore, it is an issue of integrating temporary measures with existing systems while modifying organizers' management and decision-making processes to prevent unforeseen and debilitating domino effects.

A concrete case will be used to validate the developed methodology: the planning of the G-8 summit in Ontario in 2010. Based on the resources used and provided by the critical infrastructure involved in the planning of that event, the Centre risque et performance will evaluate vulnerable interdependency relations and prevent domino effects.

Impact

The Centre risque et performance will work in concert with Public Safety Canada to ensure the greater resiliency of the critical infrastructure involved in the organization of important national and international events. The developed methodology will then be used for the planning of other major events in the country. At the same time, feedback on the planning of recent major events that have taken place in Canada will be produced. That feedback will facilitate the advantageous use of event organizers' experiences and lessons learned about critical infrastructure interdependency management.

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PSTP 08-0103BTS

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

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

Objectives

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

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

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

Relevance

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

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

Recent Progress and Results

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

Impact

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

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PSTP 08-0107ESEC

Combating Robot Networks and Their Controllers

Project Lead:	Bell Canada
Federal Partner:	Royal Canadian Mounted Police

Objectives

This project introduces a methodology for risk-based analysis and correlation of multiple, carrier-grade sources of threat information. By applying scientific methods, it aims to enhance the eSecurity Cluster's capability to predict and interdict cyber attacks against Canada. The project represents an essential 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.

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

Relevance

Botnet metrics are collected and consumed in carrier operations at exceptionally high data rates. It is possible to interdict threats on a global scale; however, historical incident reporting, compliance audits, and qualitative surveys indicate that the Government of Canada's level of exposure to botnets remains 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

Currently, the project is examining 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 has been defined on the basis of open-source published reports and academic research. Using near real-time threat metrics, a statistically valid national picture has been developed of the cyber threat involving botnets. The current threat to Canada's—and specifically the government's—critical infrastructure is being 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 telecoms 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 will blaze a path from the cloud to an enterprise-level capability for the Government of Canada where none exists today. It will demonstrate how the government can greatly reduce its cyber exposure while saving on operating costs.

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PSTP 08-0115ESEC

Automated Risk Management System

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

Objectives

National preparedness requires foresight of the system-wide cascading impacts of a security event and the effect on operations. Such cascading effects will not only significantly broaden the impact of a single event, they will also potentially trigger new events involving other infrastructure services. The Automated Risk Management System (ARMS) project examines artificial intelligence (AI) techniques and solutions, and risk models, analysis tools, and mitigation techniques to compute quantitative metrics that determine the risk exposure of information technology (IT) assets (information, components, etc.) that are based upon dynamically changing IT infrastructure and operational priorities without prior knowledge of the infrastructure. Furthermore, the technologies examined will be evaluated based on their ability to model cascading risk impacts to information, networks, systems, and operations caused by security event scenarios.

This study will examine the following challenges: automated system interdependency discovery; mapping of operational requirements onto a core risk model; modelling of complex systems, infrastructures, and interactions via autonomous, semi-intelligent risk management engines; computable quantitative criticality metrics; and cascading impact of infrastructure loss and the associated risk.

Relevance

Communications and information technology is one of the ten critical infrastructure (CI) sectors identified by Public Safety Canada. Moreover, the remaining sectors heavily depend upon communications and IT. The ARMS study addresses Public Security Technical Program's (PSTP's) requirement to enhance capabilities to allow government and the private sector to adequately inform, assess, and address threats and risks from source to target, thereby reducing the impact of threats.

Thus, the ARMS study will examine the problem of automating risk management so as to determine whether semi-intelligently and autonomously evaluating vulnerabilities of infrastructure systems to determine and address threats is feasible. The study will also enumerate the benefits such a capability would present and provide a framework on how such a system could be developed.

Recent Progress and Results

The ARMS project will commence in the second quarter of 2009.

Impact

ARMS will deliver a study examining and contrasting existing and emerging techniques that can be applied to solve these problems. The result will be an openly published research report that defines the elements necessary to proceed toward a proof-of-concept demonstrator. The methodology combines original research with leveraging of expertise, prior research, and off-the-shelf technology. The participating organizations will collaboratively deliver work in the study area.

This work will be of significant value in determining directions of research for reducing risk from security events. For example, when planners are aware of assets whose loss would cause the largest disruption to the infrastructure they could reduce their exposure by modifying the infrastructure and ensuring adequate safeguards are in place; for example, by replicating critical infrastructure components. ARMS will specifically address how to automate risk management so as to handle security events in a fully automated and automatic manner.

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PSTP 08-0119BTS

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

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

Objectives

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

Relevance

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

Recent Progress and Results

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

Impact

In all regions of sovereign and strategic interest to Canada, situational awareness is a key component of effective decision making related to security, safety, and efficiency of movement. Situational awareness is built on accurate and timely knowledge of the vessels, vehicles, aircraft, people, and goods present in those regions. Developing and maintaining situational awareness in urban areas is a major challenge. However, for remote, sparsely populated areas of Canada, such as the Canadian North, adverse climate, lack of power, and lack of communication connectivity lead to even greater challenges. These challenges are particularly evident in the huge maritime areas of Canadian responsibility that include northern waters and the Arctic Archipelago that accounts for

30 percent of Canada's land mass. Because of the increasing interest in northern regions for resource exploitation and growing interest in northern maritime trade routes for global shipping, Canada must address the challenges of northern situational awareness. The approach taken by DRDC Atlantic to address these challenges is to document the current state of existing and emerging maritime information and sensor systems for use in northern environments, and to explore how these systems can be cross-linked to increase the level of northern situational awareness.

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PSTP 08-0120CIP

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

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

Objectives

This study will use a scenario-based approach to protecting telecommunications critical infrastructure (TCI) in British Columbia (BC) in order to ensure business continuity during a major incident involving chemical or biological hazardous materials (HAZMAT). The simulation will evaluate a cost effective and innovative capability which pairs telecom technical experts with trained, experienced and certified HAZMAT responders to conduct maintenance and recovery operations in a HAZMAT environment.

The primary objectives of this study are to conduct a live HAZMAT simulation that will (a) evaluate a response capability that pairs technical telecom expertise with trained HAZMAT expertise and (b) evaluate the command and control capability of a Bell and TELUS virtual Joint Operations Centre remotely managing the HAZMAT incident under advisement from BC Hazmat Management Ltd. personnel. This exercise will assist Bell and TELUS in their preparedness planning during HAZMAT incidents. Two complementary objectives are (c) the development of an implementation plan and (d) a BC HAZMAT incident response handbook for Industry Canada. The implementation plan will describe the road map and requirements for enabling the paired response capability that was evaluated during the exercise. The BC HAZMAT incident response handbook will describe responsibilities, processes, and tools that are needed to ensure business continuity within the BC region if a major HAZMAT incident occurs there.

Relevance

TCI is the cornerstone that enables most critical infrastructure (CI) sectors to conduct their daily business transactions and to ensure public safety and security for Canadians. Most TCI is owned by private sector service providers who work to ensure reliable business continuity both within the telecommunications sector and externally to other CI sectors. Business continuity within the telecom sector is ensured, at least in part, through the conduct of technical physical maintenance at CI sites that is performed by experienced technical teams.

Several factors led to the selection of BC as the site for this study. As TCI owners, Bell and TELUS are working together under a Memorandum of Understanding (MOU) to maintain business continuity for specific facilities in BC. As well, the province has proactive plans in place for the management of emergencies including CBRNE incidents.

The findings from this study will be transitioned to the operational communities through the development and communication of a BC HAZMAT Incident Response Handbook. This handbook will be provided through Industry Canada to emergency planners regarding responsibilities, processes and tools need to ensure business continuity. The BC HAZMAT Incident Response Handbook can be adapted to meet the unique needs of other CI sectors and other Canadian regions to further reinforce the overall resiliency of Canada's CI. Results will be leveraged within modelling and simulation synthetic environment to facilitate testing and validation of the proposed implementation plans and the effectiveness of any resultant complex system behaviors.

Recent Progress and Results

A recent study conducted by The Public Security Technical Program (PSTP) in partnership with Industry Canada and Bell Canada documented the results of a simulation-based assessment of the emergency response capability to a CBRN threat at a CI location in Canada.

Subsequent research leveraged a recommendation from this study and identified the operational requirements for establishing a rapid, telecom-centric HAZMAT response capability that would be equipped to respond to a CBRN-type event that could threaten the physical infrastructure associated with the Canadian telecommunications industry. A prioritized option (Option A) for establishing this rapid, response capability within Canada was identified from the research. A recommendation, based on input from the Canadian Telecommunications Emergency Planners Association (CTEPA) and Verizon Business Major Emergency Response Incident Team (MERIT℠), was made to investigate the implementation of this prioritized option that would ultimately lead to the establishment of the rapid, response capability within Canada.

Impact

The study findings are expected to reinforce the need for involving all levels of government, the operational first responder and technical expert communities, and regional representatives from the 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 issues within BC that affect business continuity. The impact of this study will be to produce an architecture framework that can be applied to major BC events (e.g., 2010 Olympics), thereby establishing enduring relationships between these critical emergency-planning partners.

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PSTP 08-0130EMSI

Emerging Public Safety Interoperability Frameworks, Standards, and Architectures

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

Gaps currently exist in the ability of organizations to share information with peers within the emergency management and systems interoperability (EMSI) community of practice (CoP). There are environments and solutions in place to capture and display much of the information needed by the community during an emergency. The extent to which this information can be shared across the EMSI CoP, and whether a common integrated interoperability framework and information sharing exchange model exists for or within the EMSI CoP is unknown.

This study will explore and assess new and evolving standards-based approaches for controlled and adaptive information sharing, including open standards, and web-based and service-oriented approaches that will support the diverse set of communities assisting in emergency operations at varying stages of an incident. The study will identify existing and emerging standards that appear to enable network-enabled information exchange for emergency management and public safety interoperability.

Objectives

The project will describe a standards-based capability framework to guide the development and deployment of a shared information environment balancing information sharing and information protection in a multi-agency operation. The framework will address the full scope of interoperability requirements, including areas such as information sharing, information protection, information assurance, information quality, context, and so on, with due regard for privacy and security considerations. Integrating open standards will provide opportunities for individual agencies to employ commercial off-the-shelf (COTS), open source, or custom-developed solutions and better manage their life-cycle costs.

Relevance

The PSTP Emerging Public Safety Interoperability Frameworks (EPSIF) study is of significant interest because of its analysis of multiple ontological, data, and technical standards that can apply to information sharing. Conceptually, this study will benefit the Public Safety Community of Interest (CoI) by identifying a framework to organize existing and evolving standards into a coherent framework, helping evolve current thinking on the use and promotion of standards across the public safety community. This will provide a reference target for alignment of studies and initiatives aimed at leveraging open-standards bodies in promoting cost-effective situation awareness for the Public Safety CoI.

Recent Progress and Results

The project charter has been recently completed and the study contract should be released in the same timeframe as this Symposium. Although in its very early stages, the study proponents have already shared information on existing initiatives, and the collaboration with other interested parties has been initiated. The stated coordination with the Object Management Group (OMG) has been initiated by the Advanced Systems Management Group (ASMG) and Enterprise Information Security Environment (EISE). Other interested parties can obtain additional information from Public Safety Canada, EISE, or ASMG.

EISE and ASMG have initiated work with the OMG to participate in the ECMEM effort, and are working within the scope of the PSTP EPSIF study to establish a forum to identify ongoing activities related to frameworks and architecture standards. OMG has chartered the Emergency, Crisis and Major Event Domain Special Interest Group (DSIG) to align the efforts of other special interest groups and taskforces, internal to OMG and in cooperation with other standards groups, with regard to the Information Exchange Framework, Shared Operational Picture Exchange Services, E-Government, Healthcare, and others. DSIG members have expressed a desire to share information with the ECMEM effort.

Impact

The results of this study will provide a roadmap for cooperation and functional direction at a top-of-government level, through standards endorsed by the Public Safety CoI, which will form the basis for more interoperability for Canadian systems of systems. While not intended to be prescriptive, this will provide both a mechanism for influencing setting of cross-border standards for information sharing through one or more open standards groups. This study is expected to establish a framework for establishing adaptive and flexible approaches to the development of systems and products that support open standards.

Standardization of interfaces across systems boundaries and assurance that multiple producers adopt those standards will ensure that the various participants in a high-consequence public safety or security event will be able to use systems at hand. These systems will effectively communicate with one another, and allow organizations to prepare and simulate information exchanges through supported ontologies and policy frameworks.

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PSTP 08-0135EMSI

New Approaches to Enhancing Interoperability for Horizontal Information Exchange Across Crisis Support Organizations

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 spans organizational structures. Effective incident response requires an ability to share planning assumptions and develop pooled situational awareness using both voice and electronic communications. In short, reliable horizontal information exchanges underpin collaboration. Command and control information systems rely on information exchange protocols and bridging legacy systems has proved a challenge. The evolution toward open standards and a common data model that is based on other recognized data models (e.g., HL7, CPSIN, JC3IEDM, NIEM) offers a potential solution to this challenge. No such standards have yet been accepted within the Canadian emergency management community.

The objective of this 18-month project is to evaluate horizontal information exchanges at the Emergency Operations Centre (EOC) level and define interoperability requirements. EOCs play a critical role in coordinated command and coherent control through implementation of Incident Command System/Unified Command, and facilitating interoperability and activation of Federal Emergency Response Plan Emergency Support Functions. A case scenario will be used to illustrate these advantages.

Relevance

The outcomes will address interoperability and security constraints to facilitate improved communication during public safety and emergency management responses. The project will also serve to support federal decision makers in directing the use of available technology. The deliverables for this project include conducting a capability-based planning exercise and analyzing horizontal information exchanges within the Canadian Food Inspection Agency and Agriculture and Agri-Food Canada (AAFC) National Emergency Operations Centres (NEOCs) with insight into the requirements for the handling and housing of secure information, options analysis, the generation of architecture products, and the preparation of a final report.

Recent Progress and Results

In 2008, a live command post exercise (CPX) involving the AAFC NEOC was conducted, in partnership between The Public Security Technical Program (PSTP) and AAFC. The intent of the CPX was to validate the documented AAFC NEOC emergency management processes that could be implemented during an internally focused event within the organization. The exercise engaged decision makers from within the AAFC's Office of Emergency Management Business Continuity Branch in response to a flu pandemic scenario. The scenario contained injects that reflected a range of possible incidents that could affect the application of internal EM

processes. The CPX captured key processes using capability-based planning, architecture tools and views, and a metrics-based evaluation (PARRI framework). The results reinforced the need for building EOC team experience under realistic and controlled circumstances.

The results of the CPX, particularly those findings related to EOC communications requirements, formed the basis for this project's case study. Many of the same partners have joined the project team with a view to identifying the full range of interoperability requirements.

The first phase of this project, requirements identification and capability analysis, is set to be completed by the end of June, with the capability-based planning exercise taking place in late fall 2009.

Impact

The current project will leverage the important findings from the 2008 CPX and will focus on improving information exchange efficiencies using an architecture-driven modelling approach to examine communications requirements ("as is" and "to be" depictions) that will incorporate open standards, information exchange models, and service-oriented architecture elements. These findings are expected to augment Canada's ability to respond to high-consequence public safety and security events through facilitating the exchange of critical information that is required between multiple federal departments to manage emergency responses effectively.

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