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CENTRE for SECURITY SCIENCE

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ENHANCING CAPABILITY THROUGH TRANSITION AND EXPLOITATION

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Canada

Foreword

The Defence Research and Development Canada (DRDC) Centre for Security Science (CSS) is a joint endeavour between the Department of National Defence (DND) and Public Safety Canada. DRDC CSS was created in March 2006 to coordinate science and technology (S&T) that addresses national public safety and security objectives. DRDC CSS currently manages three programs: the CBRNE Research and Technology Initiative (CRTI), the Public Security Technical Program (PSTP), and the Canadian Police Research Centre (CPRC). Through these programs, investments are made in projects to address Canada's ability to prevent, prepare for, respond to, and recover from high-consequence public safety and security events.

This year's Public Security S&T Summer Symposium at the Sheraton in Edmonton, Alberta, will highlight the S&T tools and knowledge created by the CRTI project partners in the field of CBRNE research, as well as the new way forward for the PSTP and CPRC programs.

Now in its seventh year, CRTI is a unique, cross-organizational program that has invested more than $200 million in S&T projects in the CBRNE domain. Projects fall into four categories: research and technology development (RD), technology acceleration (TA), technology demonstration (TD), and technology acquisition projects. Many of the projects have gained recognition within the S&T, national security, and public safety communities, and have enhanced Canada's ability to respond to CBRNE hazards.

The following abstracts outline the progress of the projects from the first six rounds of funding. These will also be presented orally or in posters during the Symposium. All of these projects are notable for their breadth and quality, and many of them have already made tangible contributions to enhance the safety and security of Canadians. I am sure that you will find the presentations stimulating and wish you continuing success in working together to achieve these high-quality results.

Dr. Anthony Ashley

Director General, Centre for Security Science

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CRTI 0080TA

ARGOS Decision Support System for Radiological-Nuclear Hazard Preparedness and Response

PROJECT LEAD:	Health Canada – Nuclear Emergency Preparedness and Response Division
FEDERAL PARTNER:	Environment Canada – Canadian Meteorological Centre
INDUSTRY PARTNERS:	Danish Emergency Management Association, Prolog Development Centre
OTHER PARTNER:	University of Alberta

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Objectives

Through the Federal Nuclear Emergency Plan (FNEP), federal organizations prepare and respond to radiological-nuclear (RN) emergencies affecting Canadians. Information relating to the emergency and consequence assessment data is required to help FNEP managers make correct decisions. This project, commonly referred to as the Accident Reporting and Guidance Operational System (ARGOS), was undertaken in order to provide a decision support tool that can integrate data and support decisions for response measures related to an RN emergency. Software enhancements to integrate ARGOS with Canadian radiation surveillance, monitoring, and forecasting data sources are a key component of this project.

Relevance

In the event of an RN related emergency, decision makers require current and accurate information relating to the distribution, concentration, and direction of a plume. ARGOS provides a tool where real-time meteorological data, atmospheric plume trajectories, along with RN surveillance, and laboratory results are accessible. This information is made available to all necessary responders through eMap, which is the companion system to ARGOS. EMap is a web-based geographic information system (GIS) that provides the user with updated information relating to the plume, its current and projected path, and current radiation dose levels.

Recent Progress and Results

With the submission of the CRTI Project Completion Report, the ARGOS project is complete and all deliverables have been met. This project has not only met its objectives, but has remained within budget.

ARGOS has provided advances in Canadian Meteorological Centre (CMC) modelling capabilities and new methods of data delivery for emergency response operations. The software provides automatic synchronization with the CMC meteorology server for the import of current weather data. This includes Doppler radar precipitation data for every hour plus meteorological files for North America every 12 hours. Aerial surveillance data can also be imported into ARGOS.

One of the key accomplishments of ARGOS development for Canada is the ability to provide on-demand model requests from within ARGOS. The models include the Modèlle Lagrangien de Dispersion de Particules d'Ordre Zero (MLDP0) dispersion coupled to source terms and multi-level, long-range trajectory runs. The software is the official FNEP modelling information source and decision support system for Canadian RN emergencies.

The ARGOS project is affiliated with the Canadian Health Integrated Response Platform (CRTI 04-0127TD), also known as CHIRP. CHIRP will build interoperability between ARGOS and the Canadian Network for Public Health Intelligence (CNPHI). The result of this will be improvements in CBRN event detection, as well as response and preparedness throughout the RN and public health care communities.

Impact

The Government of Canada and specifically the FNEP Emergency Management System, now has an operational decision support tool. The project is now part of CRTI's RN cluster, as well as the FNEP. The ARGOS system is the link for the RN cluster incorporating information from the Fixed Point Surveillance network, Natural Resources Canada and Geological Survey Canada aerial surveys, CMC meteorology data, and data collected from field teams. Through eMap, all of this critical information is provided to the RN emergency operations centre.

ARGOS has been used with success for plume generation during CRTI exercises designed to test Canada's response to an unplanned RN emergency, such as Exercise Initial Thunder 2008 that was held in February 2008.

Operationally, the first use of ARGOS occurred during the February 2005 FERMI-2 incident involving the reactor shutdown due to a coolant leak. During this event, which involved a possible radiological gas release, Health Canada and Environment Canada used ARGOS to run weather-prediction models to track the path of any resulting plumes, both at the time of the accident and for later intervals.

CRTI 02-0093RD

An Advanced Emergency Response System for CBRN Hazard Prediction and Assessment for the Urban Environment

PROJECT LEAD: Environment Canada – Canadian Meteorological Centre

INDUSTRY PARTNERS: DRDC Suffield, Health Canada – Radiation Protection Bureau, Atomic Energy Canada Limited

OTHER PARTNER: J.D. Wilson & Associates, Waterloo CFD Engineering Consulting Inc.

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Objectives

The objective of this project, which was completed in March 2008, was to develop and validate a prototype state-of-the-science, multi-scale modelling system for prediction of the transport and dispersion of CBRN materials in the urban environment and beyond. This undertaking consisted of six major components: (1) development of a computational fluid dynamics model (urbanSTREAM) for microscale urban flow prediction; (2) incorporation of an urban parameterization in a meso-γ scale numerical weather prediction model (GEM-LAM); (3) coupling of urbanSTREAM with the "urbanized" GEM-LAM; (4) development of a Lagrangian stochastic model (urbanLS) for prediction of urban dispersion; (5) validation of the fully coupled modelling system; and (6) development of a methodology for source (event) reconstruction (work done in the context of the Public Security Technical Program).

A full prototype of the modelling system has been implemented in the computing environment of a government operations centre (Environment Canada – Environmental Emergency Response Section [EC-EERS]).

Relevance

This prototype modelling system serves as the basis of a high-fidelity predictive tool for scenario planning, forensic and post-event analysis, as well as for operational response. Incorporation of the capabilities of the proposed system in a government operations centre will result in improved emergency preparedness and management of CBRN incidents in Canadian cities. The tool can be used for planning events of national significance (e.g., G8 summit, APEC meeting, 2010 Winter Olympics). The modelling system contributes to other CRTI projects such as the ARGOS (CRTI 0080TA: Information Management and Decision Support System

for Radiological-Nuclear Hazard Preparedness and Response) and CHIRP (CRTI 04-0127RD Canadian Health Integrated Response Platform) projects, as well as to the unified interoperability concept of operations (CONOPS) framework for improving federal, provincial, and municipal coordination in a CBRN response.

Recent Progress and Results

A prototype of an operational multi-scale modelling system has been fully incorporated into the computing environment at EC-EERS, including the visualization software that allows interactive display of the complex-velocity fields in an urban environment, and of the concentration field produced by the release of a contaminant (i.e., CBRN agent) into this flow field. This prototype-modelling system, validated over Oklahoma City "Joint Urban 2003", has been executed over Ottawa, Montreal, and Vancouver in order to test, verify, and demonstrate its capabilities to provide dispersion modelling. In particular, this unique modelling system has been applied to provide city-specific dispersion modelling products for a number of hypothetical releases in Vancouver. These dispersion-modelling products have been imported successfully into a simulation engine developed under CRTI-05-0058TD "Unified Interoperability Solution Set to Support CONOPS Framework Development" with the objective of demonstrating a unified interoperability solution supporting a concept of operations framework development for the coordination of a municipal-provincial-federal collaboration to a CBRN response.

In the last year, work has been completed on a Bayesian inference approach for multiple source reconstruction. This approach was developed from a limited number of noisy concentration data obtained from an array of sensors for the difficult case where the number of sources is unknown a priori. In this approach, the posterior density function for the number of sources and the parameters (e.g., location, emission rate, time of release) for each of these unknown sources are formulated. These source reconstruction capabilities can now be further tested on experimental data sets.

A number of partners on this project participated in the annual meeting of Technical Panel 9 (TP 9) of The Technical Cooperation Program (TTCP) Chemical, Biological, and Radiological (CBR) Defense Group, which was hosted this year by the DRDC and the Canadian Meteorological Centre (CMC) in Montreal, Quebec on 4–7 February 2008. This meeting afforded the opportunity for various project partners to present the results of their work to an international panel of CBRN modelling specialists from Australia, Canada, the United Kingdom, and the United States. In addition, this interaction and collaboration with TTCP TP-9 will enable the project partners to access data from a comprehensive field experiment for Sensor Data Fusion (SDF) conducted under the auspices of TP-9; namely, the FUsing Sensor Information from Observing Networks (FUSION) Field Trial 2007 (FFT-07) with United States, United Kingdom, Canada, and Australia all participating. FFT-07 was conducted at the United States Army Dugway Proving Ground (DPG) in September 2007 for the purpose of generating a comprehensive meteorological and tracer dispersion data set suitable for testing current and future CBR SDF algorithms (source reconstruction).

Impact

The modelling system can form the basis for the automated preparation of city- and location-specific decision support products for emergency response managers and decision makers. This includes timely information on area contamination and exposed facilities from a plume of hazardous material in order to provide a coherent operational picture of the evolving CBRN hazard required for situational awareness and emergency preparedness. The modelling system is being applied to the planning of specific high-profile events such as development of CBRN counterterrorism measures for the 2010 Winter Olympics. Health Canada's operational response on nuclear hazards will benefit directly from the outputs of the system, by integrating these outputs with their ARGOS system. Funding provided under a new project CRTI 07-0196TD "Towards an Operational Urban Modelling System for CBRN Emergency Response and Preparedness" will transition this unique state-of-the-science urban flow and dispersion hazard modelling system towards the status of a prototype operational system at EC-EERS. This key-enabling technology could potentially serve as a national reach-back and support center for CBRN planning, real-time assessment, and provision of decision support products for emergency response in Canada.

CRTI 03-0005RD

Sensor Technology for the Rapid Identification of Pathogens used as Bioweapons

PROJECT LEAD:	National Research Council Canada – Industrial Materials Institute
FEDERAL PARTNERS:	National Research Council Canada – Steacie Institute for Molecular Sciences, Public Health Agency of Canada, DRDC Suffield
INDUSTRY PARTNER:	Becton, Dickinson and Company
OTHER PARTNERS:	Université Laval, Centre Hospitalier Universitaire de Québec, Centre de Recherche en Infectiologie

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Objectives

The project aimed to develop a novel technology based on luminescent polymeric transducers that would lead to a rapid and sensitive detection system for the identification of biological pathogens. The key deliverable of this project was a functional prototype able to identify fewer than 10^3 *Bacillus anthracis* cells and spores directly, either from pure culture or from spiked test samples, within one hour. In the project's third and final year, the research team tested the technology's *B. anthracis* detection. The detection process trapped differently functionalized magnetic particles as the particles diffused through a DNA sample, confining multiple different DNA targets—a capacity that could be extended in the future. This three-year project was scheduled for completion in fall 2007.

Relevance

The development of low-cost, portable devices capable of rapidly detecting and identifying nucleic acids without prior amplification could enable first responders and public health providers to rapidly detect and identify

potential biothreats on-site. Such a device would also improve the capabilities of medical triage procedures and tools used to detect and classify events as well as contribute to the efficient diagnosis of infectious diseases and genetic disorders.

Recent Progress and Results

The research team performed a final validation of the technology in the fall of 2007. Mutants from *B. subtilis* containing a perfect match sequence from the *capC* gene of *B. anthracis* and a no match sequence (from *lef* gene used here as negative control) from *B. anthracis* were used for the first step of the demonstration. The technology succeeded in detecting as low as 200 copies of DNA extracted and fragmented from a *B. subtilis capC* mutant. The protocol used included a pre-purification step and was 86 minutes long, slightly longer than the time set in the original project scope. However, this method provided a built-in dual confirmatory technique since the pre-purification and detection steps are done on totally different sequences of the organism, improving confidence in the result.

In order to lower the detection time, the research team conducted preliminary tests by attempting to directly detect the mutant without going through the pre-purification step. The total time to prepare the sample was reduced to 14 minutes. A single concentration was attempted with 10,000 cells of mutant. Although this method of detection was not optimized, the detection technology was found to be robust enough to be used with a very crude solution containing sugars and proteins. The presence of these impurities did not seem to impact the resolution of the signal.

The Public Health Agency of Canada (PHAC) provided DNA from *B. anthracis* to conduct the final validation. DNA was extracted and fragmented in the Containment Level 3 (CL3) laboratories in Winnipeg and shipped to the Centre Hospitalier Universitaire de Québec (CHUQ). At CHUQ, the DNA was submitted to the pre-purification and detection steps. The lowest cell concentration tested was 5,000 cells. The results clearly showed that detection with the real *B. anthracis* was possible and that the signal was in the same order of magnitude as the results previously obtained with the *B. subtilis capC* mutant. Moreover, the method is reproducible and robust enough to positively identify anthrax. This technology will be further demonstrated in the project "Portable Biological Agent Detection System" (CRTI 06-0187TD), where a portable device will be built and tested by a first responder in two field trials.

This project ended in fall 2007 with a technical demonstration of the technology under real conditions. The key deliverable consisted of a functional prototype able to identify fewer than 10^3 *B. anthracis* cells and spores directly, either from pure culture or from spiked test samples, within one hour.

Impact

This revolutionary technology will ensure military and civilian personnel have the fastest response time to biological threats as well as provide opportunities for Canadian biotechnology companies to develop a significant competitive edge over polymerase chain reaction (PCR) amplification technologies.

CRTI 03-0009RD

Caring About Health Care Workers as First Responders: Enhancing Capacity for Gender-based Support Mechanisms in Emergency Preparedness Planning

PROJECT LEAD: Department of National Defence – Bureau of Women's Health and Gender Analysis

OTHER PARTNERS: University of Ottawa – Institute of Population Health, Canadian Women's Health Network, Canadian Federation of Nurse Unions

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Objectives

The goal of this project is to mitigate the impact of future CBRN-contagion threats by recommending support mechanisms for health care workers as first responders and first receivers. Project researchers built on the lessons learned from the Severe Acute Respiratory Syndrome (SARS) outbreaks in 2003 in Toronto and Vancouver. The team focused on the psychosocial impact of an infectious disease outbreak and the importance of balancing work performance and family responsibilities.

This project highlighted a number of gaps and emphasized the importance of investing in Canada's health care institutions in order to ensure that they receive adequate resources for emergency planning, preparedness, response, and recovery. Recognizing that disasters affect men and women differently and that 85 percent of Canada's health care workers are women, many of whom are part-time workers with dependents, the project also highlighted the need for more family and gender-sensitive interventions, including supports to help frontline workers balance work and family responsibilities during crises.

Relevance

Health care workers are key responders to infectious disease outbreaks, caused by either the accidental or deliberate spread of micro-organisms such as bacteria and viruses. Their health and safety is critical during such events, as is their willingness to continue working during a large-scale outbreak. The population depends on the capacity and willingness of knowledgeable caregivers to provide health services and control infection. Through the identification of current gaps in supports available and by highlighting the need for more family and gender-sensitive interventions, including supports to help frontline workers balance work and family responsibilities during a crisis, this project will provide key policy and decision makers with priority areas for investment to better prepare Canada to face an infectious disease outbreak.

Recent Progress and Results

Over the project's duration, the team generated new knowledge about emergency preparedness and response in Canada's urban health care facilities. Researchers reviewed existing literature and hospital emergency plans for information about the supports

available for health care workers as first responders and first receivers. Using qualitative and quantitative research methods, the team completed national focus groups with 100 frontline nurses from hospital emergency and critical care units. In addition, the research team conducted a national survey of 1,543 nurses to discern the impact health care workers experience while working on the front line during infectious disease outbreaks.

The project findings revealed significant gaps in organizational and social support for frontline health care workers in their roles as first receivers during bioterrorism disasters. Results indicated that many of Canada's health care workers do not feel adequately prepared to respond to a large-scale infectious disease outbreak. For example, forty percent of survey respondents did not know whether their health-care institution had an emergency plan for infectious disease outbreaks in place. Health care workers also expressed concern about their lack of training as first receivers during emergencies. Coordinated efforts are needed to ensure that the concerns of frontline workers are recognized and integrated into emergency planning. Using SARS as a proxy for intentional and unintentional biological outbreaks, the team studied how emergencies impact health care workers' performance, including work and family balance. Together, the literature review and survey enabled researchers to identify gaps and to provide recommendations for improving communication, instrumental and social support mechanisms for frontline health care workers. The study revealed the need for more proactive policies and procedures to support frontline health care workers and enhance Canada's collective ability to combat future large-scale infectious disease outbreaks.

In December 2007, the project team participated in a national policy forum, the Canadian Policy Research Network (CPRN), where they presented their recommendations with regards to support mechanisms and the enhancement of personnel policies and work–family supports for first receivers. The recommendations are intended to provide decision and policy makers with information that will encourage the development of gender-sensitive support mechanisms for public health care workers. Through the policy forum and numerous media interviews with national radio, television, and the print media, the project has increased awareness of emergency preparedness in Canada's health care system.

Impact

The research findings have been disseminated to health care executives, and clinical and policy audiences at the community, provincial, and federal levels. For example, the focus group report was distributed to a national nursing conference with 600 attendees. The CPRN policy document has been posted on the CPRN website and print copies will be distributed to the Occupational Health and Safety committees at more than 1,000 health care institutions in Canada. Members of the project team have made numerous professional association presentations in Canada and abroad to organizations, including the World Association for Disaster and Emergency Medicine (WADEM), the World Conference on Disaster Management, and government departments. The project research team has also published a number of peer-review journal articles and book chapters. The discussion paper, now posted on the CPRN website, is expected to receive thousands of downloads. The project results and publications are being distributed through the networks of key organizational partners (e.g., the Canadian Federation of Nurses Unions and the Canadian Women's Health Network).

Five years following SARS, the continuing lack of preparation for infectious disease outbreaks, as evidenced in this study, is reminiscent of the SARS Commission Report by the late Justice Archie Campbell. Justice Campbell's ominous caveats should sufficiently forewarn Canadian policy and decision makers about the need to adequately prepare health care workers against future infectious disease threats. The system failures experienced during SARS in 2003 need not be repeated. There is a social imperative to prepare and protect nurses, paramedics, and others from infection at work and, in so doing, not only help them balance work and family-life responsibilities, but also ensure that Canada's surge capacity is adequately protected. The next epidemic, whether man-made or natural, will clearly demonstrate whether we have learned from history.

CRTI 03-0018RD

Experimental Characterization of Risk for Radiological Dispersal Devices

PROJECT LEAD: DRDC Ottawa
FEDERAL PARTNERS: DRDC Valcartier, Health Canada, Environment Canada
OTHER PARTNERS: Royal Military College of Canada, Carleton University, University of Ontario Institute of Technology, University of British Columbia

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Objectives

The effectiveness of radiological dispersal devices (RDDs) continues to be the subject of considerable debate. The purpose of this project was to conduct experiments to address gaps in our knowledge of the risks associated with the dispersal of radiological material by explosive and non-explosive means; to quantify the amount and physical form of the radiological aerosol generated by an RDD; and to use the results to refine the CRTI consolidated risk assessment and probabilistic risk assessment tool.

Relevance

By the time it is confirmed that an attack has been carried out using an RDD, there will likely already be casualties; all the radioactive material will be released; and the plume growth will be progressing. There will be no time left for evaluating possible countermeasures. Therefore, it is critical that strategies and decisions to protect first responders, the public, and critical infrastructure against the effects of a detonated RDD be made prior to an attack taking place. The results of the experiments conducted as part of this project have provided experimentally verified data on the effects of RDDs that can be used to develop emergency response procedures and guidelines for first responders dealing with radiological terrorism incidents.

Recent Progress and Results

The project team investigated the dispersal of radioactive material using both explosive and non-explosive means. Indoor dispersal experiments were performed to determine the aerosol properties (source term) for specific explosive RDD scenarios. Outdoor dispersal experiments were performed to investigate potential modifications to the RDD source term from a variety of phenomena. Non-explosive dispersal experiments looked at the required source preparation techniques and efficiency of dispersal using commercially available spray mechanisms. Results will be discussed in general terms due to potential security issues around the details of the experimental work.

Indoor explosive aerosol tests were performed in the DRDC Valcartier test chamber. A total of 43 explosive tests were performed over the duration of the project, using non-radioactive simulants for potential RDD materials. The majority of the experiments used ceramic simulants, including cerium oxide (CeO_2), strontium titanate oxide ($SrTiO_3$), and calcium titanate ($CaTiO_3$), supplied by the University of British Columbia. Post-detonation air sampling provided information on the total amount and the particle-size distribution of the generated aerosol. Researchers at Health Canada, Carleton University, and Acadia University chemically analyzed samples of the particles in order to determine the amount of material in each sample and the morphology of the aerosol. Determination of these properties is essential for the calculation of the health risks posed by an RDD.

Outdoor explosive trials were held at DRDC Valcartier and at Sandia National Laboratories in the United States. A total of 139 shots were performed under a variety of weather conditions and on various surfaces. Different amounts and configurations of explosives were used with and without non-radioactive tracer materials. High-speed photography and lidar (light detection and ranging) tracking of the plume was done for all shots, resulting in a wealth of information on buoyant cloud rise, dirt entrainment, fireball dynamics, and local meteorology. Researchers at the Royal Military College of Canada used the lidar results to produce a short distance-scale dispersion model based on a neural network fit to the plume evolution data. Researchers at the University of Ontario Institute of Technology studied non-explosive aerosol dispersal for CeO_2 and $SrTiO_3$.

These tests involved the characterization of spray mechanisms for both liquid and powder sources, as well as mechanical and chemical methods for source preparation. A methodology for generating dispersible powders from ceramic pellets was developed. Particle-size distributions were determined using a laser-based particle sizer, cascade impactors, and other aerosol samplers, and looked at variables such as temperature, humidity, and charge effects. In addition to the experimental work, spray nozzle modelling was performed using computational fluid dynamic (FLUENT) models to allow prediction of large-scale dispersal.

Impact

The project, which is now completed, generated a wealth of information on RDD phenomenology and risk. The results of the experiments conducted allowed researchers to determine aerosol properties and develop models for the prediction of such properties for both explosive and non-explosive RDDs. As such, the Canadian emergency response and federal science and technology communities are now able to develop improved risk assessments, and conduct more realistic training and exercises. For example, the results from this project were used to update the CRTI Consolidated Risk Assessment scenario descriptions and assessments. Internationally, the results from this project are being shared with the United States and the United Kingdom through ongoing collaborative research and a series of workshops.

CRTI 03-0019TD

Real-time Biosurveillance and Response Readiness Using an Interconnected, Electronic Information Infrastructure

PROJECT LEAD: Public Health Agency of Canada
INDUSTRY PARTNER: IBM
OTHER PARTNER: Winnipeg Regional Health Authority

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Objectives

In this project, IBM partnered with the Canadian Network for Public Health Intelligence (CNPHI) and the Winnipeg Regional Health Authority (WRHA) to deliver a comprehensive, cost-effective, real-time biosurveillance and response readiness network—Canadian Early Warning System (CEWS)—for the city of Winnipeg, Manitoba. CEWS is a secure web-based application that allows interactive trending and reporting for multiple data sources. The syndromic surveillance system also allows real-time or batch data reception using various standards. The project team also developed a detailed protocol to identify aberrations for various syndromes as reporting mechanisms.

Relevance

Recent advances in technology have made it possible to gather, integrate, and analyze large amounts of data in real time or near real time. For the most part, the traditional purposes of health surveillance have been to monitor long-term trends in disease ecology and to guide policy decisions. With the introduction of real-time capabilities, surveillance now holds the promise of facilitating early event detection and to assist in day-to-day disease management. For prompt response and mitigation, disease events must be detected early and monitored in as near real time as possible. Early detection provides the opportunity not only to implement strategies to reduce exposure and limit disease, but also to mobilize frontline response personnel and resources to meet primary care needs.

A surveillance system that allows for the early detection of a disease episode (whether intentional or natural) would enable an earlier, more rapid response. The challenge is further complicated by the lack of integrated systems to collect, store, and analyze relevant surveillance data. Once detected, disease events must be monitored and assessed accurately and in real time. Ongoing information on the prevalence, incidence, characterization, severity, and location of cases will provide health professionals with the information necessary to mobilize and allocate resources, monitor progression, and plan next steps.

Recent Progress and Results

The CEWS application is part of the Canadian Network for Public Health Intelligence (CNPHI), which is a framework developed by the Public Health Agency of Canada for disease surveillance, collaboration, response, and pan-Canadian disease-based alerting. The WRHA oversees all health care services for the city of Winnipeg and is, in essence, the owner of all relevant data sources. By negotiation with WRHA, PHAC secured access to real-time data from emergency rooms and the province-wide, 24/7 nurse call-centre system.

CEWS has been operational in Winnipeg since the fall of 2005. The application continues to evolve with the addition of new data streams and user feedback. Challenges to date have included interruptions in data flow resulting from technical complexities experienced by the data providers, user interface design and development to enable the required level of configurability and manipulation while maintaining intuitive navigation, algorithm implementation, and results management.

WRHA regularly monitors the CEWS system in collaboration with CNPHI staff to produce weekly reports identifying any unusual behaviour in the data. A protocol has been developed to identify these aberrations and report to appropriate individuals (e.g., Minister of Health) as necessary. This protocol includes analysis of a series of computerized algorithms (statistical models) that are applied to the incoming data, comparing observed and expected counts (based on baseline data) for each syndrome and by data type.

A number of activities are currently underway relating to ongoing research and development, and wider distribution. The project team is currently looking into interfacing case management data for disease-based monitoring of cases in the WRHA region. Furthermore, the system is being now piloted for laboratory-based surveillance looking at trends and statistical behaviour of multiple pathogens, including MRSA and syphilis. Moreover, the system is also being considered for laboratory test-request based syndromic surveillance for animal-health data. Finally, the program, in addition to its technology, will now be in direct supervision of the CNPHI Chief Engineer.

Impact

The challenge of real-time detection and assessment is heightened by the lack of integrated systems to collect, store, and analyze relevant surveillance data. The capability for real-time detection and event assessment will provide the opportunity to implement strategies to reduce exposure and limit disease, and to mobilize frontline response personnel and deliver resources where needed. Ultimately, the benefit to Canadians from systems like CEWS is better public health. Simply put, the primary goal of CEWS is to help frontline public health stakeholders do their jobs more effectively and efficiently.

CRTI 03-0021TD

Assay Development and Production Team for the Identification of Bioterrorism Agents: Hybridoma Development Capacity at DRDC Suffield

PROJECT LEAD: Public Health Agency of Canada – National Microbiology Laboratory

FEDERAL PARTNERS: DRDC Suffield, Canadian Food Inspection Agency – National Centre for Foreign Animal Disease

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Objectives

The focus of this project is the formation of a team of scientists—known as the Assay Development and Production Team (ADAPT)—responsible for the identification, development, and validation of reagents and assays that first responders can use to identify biothreat agents. A specific goal of this project is the establishment of a hybridoma development capacity at DRDC Suffield capable of producing monoclonal antibodies (mAbs) that can be used in novel immunoassays to detect and identify bacterial, viral, and toxin biothreat agents.

The development of this capacity involved several activities for the project team. First, it involved upgrading the DRDC Suffield hybridoma facility, which is leveraged through a previous CRTI technology acquisition project (BIO019AP: Upgrade of Hybridoma Facilities). Second, it involved cross-training DRDC scientists at the Public Health Agency of Canada's National Microbiology Laboratory (PHAC-NML) in protocols and techniques for the generation of hybridomas. Third, it involved an assessment of DRDC Suffield's existing hybridoma repertoire, which was acquired from a variety of sources including in-house and contracted research and the United States/United Kingdom/Canada/Australia Memorandum of Understanding on the Research, Development, and Acquisition of Chemical, Biological, and Radiological Defence Material (CBR MOU). And lastly, it involved the production of novel hybridomas and mAbs.

Relevance

The increasing threat of terrorist attacks involving biological agents has led to a corresponding increase in research into methods and reagents capable of identifying these agents. The ability to rapidly and effectively respond to biothreats is essential to minimizing the impact of an event on first responders and the general public. The project team is working to ensure that Canada has the capacity to quickly and adequately supply high-quality reagents and assays that allow the rapid and specific determination of the existence of a biological agent, and the scale of a related event, in a format that is field-portable and requires minimal training for military personnel and first responders.

Recent Progress and Results

All of the milestones and goals of the project have been completed with a high degree of success. Drawing upon both Canadian experts and international collaborators, the ADAPT project was highly successful in meeting its intended goals. Gaps in the Canadian diagnostic capacity to respond to bioweapons and biothreats were identified, and an inventory of Canadian immunodiagnostic resources was established, and a list of commercially available immunodiagnostic assays was assembled.

ADAPT partners successfully identified priority targets for reagent and assay development, and implemented new reagent development projects, specifically in the production of monoclonal antibodies (mAbs) targeting priority organisms, or antigens derived from those organisms. With the help of international collaborators, these mAbs were fully characterized for specificity and activity, and streamed for immunoassay development. Select reagents and assays were made ready for distribution to frontline laboratories, and standardized protocols for the operation of select immunodiagnostic platforms were developed and implemented into a training program.

Scientific and technical staff from DRDC Suffield were trained at the PHAC-NML in numerous protocols surrounding the development and characterization of hybridomas and mAbs, which has contributed to the expansion of the capabilities of the DRDC Suffield hybridoma facility.

Significant milestones for the project were all met within a reasonable timeframe with only minor delays in most cases. Timely recruitment and hiring of staff was a major reason for delays early in the project. Staff hired in the implementation of this project will continue to undertake similar roles through the creation of indeterminate positions within the federal partner agencies. Thus, the work of the activities implemented under the ADAPT project will continue well past the project funding.

Impact

Plans are in place to continue the development and use of multiple immunoreagents and immunoassays developed under this project. Project partners have already made commitments to continue both new collaborative research projects and build upon the successes of the ADAPT project. Several employees hired specifically for the ADAPT project and who were extensively trained by various partner organizations will remain as indeterminate employees. As such, the expertise and knowledge gained by this project will remain a viable Canadian resource for further bioweapon and biothreat research. Several immunoreagents and assays developed during the course of this project have excellent potential for commercial development and will be considered for such development in the future.

CRTI 03-0025TA

Defender Nuclear Detection Web

PROJECT LEAD: Health Canada

FEDERAL PARTNERS: Canada Border Services Agency, Canadian Police Research Centre, DRDC Ottawa, Transport Canada

INDUSTRY PARTNERS: Bubble Technology Industries, xwave, Raytheon Company – Integrated Defense Systems

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Objectives

The goal of this project was to develop an ultra-sensitive, low-cost nuclear detection web for the rapid and accurate detection of radiological-nuclear (RN) materials. The nuclear detection web is based on the unique Defender neutron detector, developed by Bubble Technology Industries (BTI), which provides immediate detection and measurement of neutrons emitted from RN materials.

The Defender's high neutron sensitivity and low cost enable the implementation of a broad coverage, real-time, preventative nuclear detection web. In this project, BTI equipped the Defender detectors with instruments to provide an automatic readout of the neutron exposure, global positioning system (GPS) information, user alarms, and wireless data communication. At the same time, xwave developed a flexible network application to manage and present the data to a variety of users via the Internet. Health Canada, Canada Border Services Agency (CBSA), DRDC Ottawa, Transport Canada, the Canadian Police Research Centre (CPRC), and Raytheon Company participated in the project by providing user input and conducting field tests of the Defender Nuclear Detection Web across a wide cross-section of applications.

Relevance

This project addressed the CRTI investment priority to improve operational capabilities for prevention, surveillance, and warning against CBRNE events by providing an unparalleled, low-cost neutron detection system. The system has the sensitivity and broad coverage to successfully detect illicit RN materials before they can be assembled into a weapon. Through its flexible and readily tailored network, the system improves command, control, communications, coordination and information (C4I) capabilities through managed communication of critical data between local and federal authorities and among federal agencies. The project also offers technology in support of first responders and operational authorities, by providing simple-to-use, real-time neutron detectors with low false alarm rates compared to gamma detectors and other traditional neutron detectors.

Recent Progress and Results

In February 2007, enhanced instrumented Defender detectors were delivered to the federal partners for a second round of user testing. The improvements implemented on these devices included a continuously displayed neutron dose measurement; increased ruggedization for mechanical and electromagnetic interference; improved GPS reporting; user-defined parameters for detector sensitivity, efficiency, and reporting frequency; and enhanced scalability of the server software. The new features and design improvements received positive feedback from the test users.

Through CRTI supplemental funding, the project scope was expanded to include participation in cargo monitoring trials hosted by the Canada-United States Cargo Security Project (CUSCSP). The CUSCSP is a public-private partnership of federal, provincial, state, and local American and Canadian members with the common goal of improving cargo container security. The high neutron sensitivity, low power consumption, and low cost of the Defender sensor package make the system suitable for adaptation to cargo security applications. As a result, BTI has developed the nFormant—a dual Defender reader that can be installed inside a cargo container to monitor for neutron radiation. Each nFormant system contains two Defender detectors equipped with automatic readout and recompression capabilities. Cycling between the two Defenders allows for extended, continuous monitoring.

During the past year, two prototype nFormant systems underwent integration and functional tests prior to being released for field testing. An nFormant system was then tested in a cargo container on board the DRDC Atlantic research vessel *Quest* in January 2008. The voyage—a round trip from Halifax harbour to Bermuda—lasted two weeks. As part of the testing, the nFormant measured background radiation levels (with no source present) and then took measurements when a neutron source was present in the container. Personnel from BTI gathered data on board and did not include any ship-to-shore communication. The nFormant operated continuously throughout the sometimes harsh conditions of the trial without any false alarms and successfully detected the neutron source during the sea trials. The results of the CUSCSP cargo-container trials are summarized in the project's final report.

Impact

This project has yielded the technological advancement of a unique, highly sensitive neutron detector and the development of a flexible data management network. As part of the project, the participating federal agencies will retain the instrumented Defender detectors for ongoing use. From a broader perspective, the Defender Nuclear Detection Web offers Canada the unique opportunity to deploy a radiation detection system that provides the type of mobile and extensive coverage needed to prevent and defeat a terrorist attack using RN materials.

CRTI 03-0060RD

Protective Markers for Anthrax Serodiagnosis

PROJECT LEAD: DRDC Suffield
FEDERAL PARTNERS: Public Health Agency of Canada – National Microbiology Laboratory
INDUSTRY PARTNER: Cangene Corporation
OTHER PARTNER: University of British Columbia – Department of Microbiology and Immunology

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Objectives

The focus of this project, which was completed in September 2007, was to express selected domains of *Bacillus anthracis* protective antigen (PA) in the Gram-negative bacterium *Caulobacter crescentus* in both secreted and cell-associated forms. The purified, secreted domain IV (rPA-IV) was to be used as an antigen source for the design and validation of mouse and human serum enzyme-linked immunosorbant assays (ELISA). The project team set out to test the secreted and cell-immobilised anthrax proteins as vaccine candidates in a mouse model of fully virulent anthrax. The effect of co-expression of known immunostimulatory proteins on the *Caulobacter* cell surface was also to be examined in the vaccine model.

Relevance

Domain IV of anthrax PA is widely viewed as a target of most protective antibodies against the protein. The presence of these antibodies is indicative of exposure to anthrax. In addition, vaccination against anthrax functions by generating high titres of these antibodies. A functional and fully validated ELISA assay for serum antibodies against PA domain IV will allow for the screening of individuals exposed to anthrax or given anthrax vaccine. For individuals exposed to anthrax, measuring the level of anti-PA levels will aid in identifying those requiring further treatment. Meanwhile, identifying those given the anthrax vaccine will allow screeners to confirm their immune status and evaluate their need for booster shots. Finally, successful vaccination against

anthrax using the *Caulobacter* produced proteins will promote the development of a vaccine lacking the side effects commonly experienced with the existing commercial vaccine, anthrax vaccine absorbed (AVA).

Recent Progress and Results

University of British Columbia researchers displayed the 144 amino acid rPA-IV and the 230 amino acid domain II (rPA-II) as fusions to the rsaA gene of *C. crescentus*, which encodes the crystalline surface-layer protein. Both rPA-II and IV were also co-displayed on the same bacteria. In addition, rPA-IV display was co-displayed with T-cell activating epitopes, fibronectin binding segments, mGM-CSF or IgG binding segments, to determine whether these proteins would enhance the vaccine efficacy of rPA-IV. Both PA domains were also prepared as secreted proteins by fusion to the rsaA secretion signal and purified from culture supernatants as soluble protein for use in assays or as subunit vaccine candidates.

Cangene researchers used soluble rPA-IV produced from the *Caulobacter* system to create validated ELISA assays for screening human or mouse serum for antibodies reactive to rPA-IV. Similar ELISA assays were also created for detecting antibodies against whole PA using a commercial source of PA. A validated toxin neutralization assay (TNA) for mouse serum was also developed to measure antibodies that functionally prevent anthrax lethal toxin activity. These assays were transferred to the Public Health Agency of Canada's National Microbiology Laboratory (PHAC-NML) for future experimental and clinical use.

At PHAC-NML, researchers found that serum from individuals vaccinated with the full six-dose course of AVA reacted with rPA, rPA-IV, and rPA-II when measured via ELISA. Researchers found similar results with serum from rabbits inoculated with rPA, demonstrating that two species develop serum antibodies against domains IV and II. At Cangene, rPA-IV affinity purified human antibodies were tested in the TNA assay and were found to neutralize intact rPA, validating rPA-IV as a viable vaccine target. Existing PHAC ELISA and TNA assays were adapted to this project and were effective in identifying antibodies present in serum from AVA-vaccinated individuals. Finally, researchers performed ELISA assays on mouse serum from animals given the *Caulobacter* produced rPA domains to measure the magnitude of the immune response.

Team members at DRDC Suffield successfully expressed and purified full-length PA from *Bacillus megaterium* to act as an alternative source of whole PA for comparison. They developed an intranasal virulent anthrax model for testing vaccine candidate effectiveness against inhalational anthrax. The *Caulobacter* secreted and surface-displayed rPA domains were tested in this model, with the surface-displayed proteins generating little immune response even when co-displayed with known immunostimulatory proteins. The secreted rPA-IV and rPA-II did stimulate the production of substantial antibody titres. While not as effective as AVA vaccination, these latter results indicate that the *Caulobacter* produced rPA domains might act as functional vaccines after further experimentation.

Producing rPA-II in *Caulobacter*, producing whole PA in *B. megaterium*, and testing and validating the mouse TNA assay were additional tasks beyond the original project milestones. The project team accomplished this extra work within the time and budgetary framework of the original project charter.

Impact

Two challenges relating to possible anthrax exposures are determining which individuals have been infected and require treatment, and which previously vaccinated individuals are sufficiently protected. The validated ELISA and TNA assays created by this project and made available at Cangene will quantitatively address these challenges by measuring the serum antibody levels of anti-PA domain IV or whole PA. This approach can be applied to ensure that anthrax vaccine recipients are mounting a protective humoral immune response against anthrax. Ensuring that vaccinated military personnel and first responders are fully protected provides not only vital medical protection, but also psychological preparedness to respond to a threat as effectively as possible. The same assays can be used after a possible anthrax incident to identify exposed individuals, ensuring that adequate post-event countermeasures are provided where most needed. This project has also provided a fully virulent inhalational anthrax model for testing vaccine or therapeutic effectiveness. This model was used to assess *Caulobacter*-produced PA domains as next generation anthrax vaccines, with promising results for both rPA-IV and rPA-II. Finally, this model has also provided a national capacity to produce both PA domains and whole PA for use as antigens in validated analytical assays. Having this domestic capacity to commercially produce antigen is vital in case of interruptions to the foreign commercial supply of antigen.

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

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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 defense 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 nearly all bioterrorism-related risks and approximately 60 percent of all new 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 lab 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

Although project completion was scheduled for September 2008, the transitional funding will support the project through to September 2009. As such, a primary focus was on forecasting the completion phase and the transition of the project to program status. Options for long-term sustainability were explored, with a Strategic Plan and Roadmap drafted and submitted to CFIA. Alternative sources of funding, provincially and federally, were and continue to be explored. Meanwhile, CRTI will provide transitional funding support for an additional year. This funding is based on the original project proposal, which includes a fourth year. Negotiations on the Memorandum of Understanding reached consensus in December. A legal agreement will be required in the next phase to address certain issues, such as cost recovery for foreign animal diseases (FAD) testing, and an outline has been drafted. Also, a CD providing an overview of CAHSN was finalized and approved by Media Affairs for distribution among the animal health community.

Implementing lab interoperability within network labs to achieve testing capacity and capability for FAD, as well as Quality Assurance (QA) management was a key goal this year. This aspect of the project has progressed well, with several labs being approved as first responders for approved tests. Activities in support of this goal included the hosting of a three-day workshop by CAHSN Lab Support and QA Support, as well as focusing efforts on providing the essential program foundations, resource materials, and start-up support with site visits, training/certification, distribution of equipment, supplies and test protocols, and a diagnostic exercise for foot-and-mouth disease. The Lab Support Program began on-site analyst training. They have trained and certified 59 such analysts working in provincial and federal labs, therefore bolstering the diagnostic surge capacity across Canada.

Working in conjunction with CNPHI, the surveillance team continues to concentrate on system design and lab interconnectivity. An automated bovine spongiform encephalopathy (BSE) application and user manual was piloted at Manitoba's provincial laboratory with participation from CFIA regional staff. The query function test on the BSE pilot database was successful, and results were used for Canada's World Organisation for Animal Health (OIE) submission. Furthermore, the avian influenza (AI) application was developed and launched with live feeds from labs in Manitoba and Quebec. The developments of a minimum data set for submission information, specifically AI lab submissions, are underway. When complete, this work will enable the development of the syndromic surveillance program.

In terms of the development of surveillance applications and full deployment for data interconnectivity across the networks, the project has encountered a number of unexpected external variables that need to be overcome. These include disparate surveillance systems with no uniform approach to disease surveillance; systems that lack mandatory data capture; and varying stages of lab IT system redevelopment, many of which lack programmer support. Furthermore, as provincial and federal jurisdictions have dependencies with respect to outbreak management and require several points of data input, CAHSN will require harmonization and interconnectivity within and between systems.

A privacy impact study to investigate privacy and confidentiality issues related to the cross-jurisdictional complexities of sharing information within CAHSN is underway. This study is being undertaken through the support of CRTI as part of its capability-based planning work to derive emergency response situational information.

Impact

Upon achieving its goals, CAHSN will provide animal health stakeholders with a national, early warning system for animal disease threats to the food supply, food safety, and public health; a federal-provincial integrated lab 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 labs will become first responder labs 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 lab infrastructure, equipment and supplies, and QA management. Taken together, the project components will better prepare Canada to deal with an agroterrorist event or zoonotic disease outbreak.

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 PARTNERS: SAIC Canada
OTHER PARTNERS: United States Environmental Protection Agency; University of Ottawa; University of Leeds; Russian Research Institute of Hygiene, Toxicology, and Occupational Pathology

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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 methds. 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 levels safe for reoccupancy. Pertinent laboratory data, mainly from animal exposure models, is used to establish clean-up standards and to help determine whether levels necessary for rehabitation are practically attainable; the likely cost of decontamination to acceptable levels,

and whether the cost is justifiable; and, if rehabitable, whether use restrictions need to be in place based on expected inhabitants and any associated toxicological or pathogenic risks.

Recent Progress and Results

A method for testing the desorption of malathion from surface materials was developed at Environment Canada. SAIC Canada and Environment Canada personnel are currently evaluating the desorption of malathion from porous and non-porous surfaces at varying temperatures in order to determine the correlation to levels of malathion in air. Experimental results were compared to theoretical maximum concentrations of malathion vapours in air. Results showed that at room temperature, experimental and theoretical levels were very similar. However, at higher temperatures, experimental levels were much higher than at room temperature, though they were still much lower than maximum theoretical levels. Important material-dependent variations in vapour concentrations were also observed.

The project team also developed an analytical method using solid phase microextraction (SPME) to detect pesticide vapours. This method allowed the measurement of non-equilibrium concentrations of malathion vapours desorbed from surface materials. It is promising as a quick and simple way to evaluate quantities of contaminants desorbed from surfaces. The effects of several parameters such as surface material, temperature, humidity, gasoline vapours, and toluene vapours were studied. The reproducibility of the analysis was also evaluated. Malathion vapour is too unstable and the surface-to-volume ratio of the SPME sampling vial was too high to give reliable results at room temperature. However, trends could be observed showing the effects of some environmental factors.

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

Mathematical methods for determining decontamination standards have been proposed by several partners. These are being evaluated and combined, maintaining the strengths of the different models. Toxicological studies are underway at the Russian Research Institute of Hygiene, Toxicology, and Occupational Pathology (RIHTOP) based on these proposed standards. A complex set of equations was developed at RIHTOP in order to predict levels of concern based on hazard indices, toxicity indices, and physicochemical properties of a substance. Animal testing of respiratory, dermal, and combined-exposure toxicity of substances is ongoing for the validation of the prototype method for setting decontamination limits. At this stage, test organisms include rats and mice. Tests are ongoing 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 experiments will evolve. 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 work is completed, a broad range of personnel from first responders to top-level decision makers will use these 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.

CRTI 04-0019TD

Field Demonstration of Advanced CBRN Decontamination Technologies

PROJECT LEAD:	Environment Canada
FEDERAL PARTNERS:	DRDC Suffield, Counter Terrorism Technology Centre, DRDC Ottawa, Public Health Agency of Canada
INDUSTRY PARTNERS:	Allen-Vanguard Corporation, SAIC Canada
OTHER PARTNER:	United States Environmental Protection Agency

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Objectives

The goal of this project was to demonstrate building decontamination technologies for chemical, biological, and radiological counterterrorism. Field trials were conducted on the premises of the Counter Terrorism Technology Centre (CTTC) at DRDC Suffield. Detailed work, analytical, and health and safety plans were developed prior to trials. Three test buildings, one for each group of agents, were erected and finished with construction materials that are common in houses and office buildings. Weapon agents or their simulants were disseminated to contaminate the surfaces. The interiors of the buildings were used in chemical and biological trials and the exteriors were used in radiological trials. The buildings were then decontaminated using commercially available technologies. Concentrations of the agents or simulants on surfaces and in the air before, during, and after the decontamination were analyzed. Technology performance was evaluated for different surface materials and trial conditions. Associated costs and material and labour requirements were calculated. Data gathered will be used to develop manuals and guidelines for decontamination teams.

Relevance

The scope of this study directly addressed longer term consequence management issues, specifically CRTI's priority to improve technologies for decontamination, containment, and disposal of CBRN contaminated materials. Various tasks of the project contributed to the development of several other capabilities. These include developing a concept of operations (CONOPS) for the federal field team response to events and the way forward for inclusion of CRTI's laboratory clusters

and field teams into federal and provincial emergency response plans. The project also supports CRTI's priorities to develop test protocols to evaluate CBRN detectors, including performance and specification standards and operational guidelines, and to develop novel techniques, including instrumentation, that offer measurable advantages over existing technologies in CBRN detection, identification, and characterization.

Recent Progress and Results

CTTC designed and manufactured three test buildings finished with common surface materials such as vinyl, brick, ceramic, drywall, carpet, wood, and ceiling tiles. Overall, the decontamination methods tested were efficient on nonporous surfaces. Decontaminating porous surfaces was more challenging. The trials also allowed estimating resources needed for a real-life situation and associated costs. The chemical and biological trials were held in August 2006, and trial results were presented at last year's CRTI Summer Symposium.

In September 2007, the radiological trial was completed. The exterior of the third building was finished with vinyl and cast-concrete brick. The walls were contaminated with a solution of La-140. The concentration on walls ranged from 50 to 150 Bq/cm^2. Decontamination of the walls was performed with three commercially available products. Decontamination was efficient on vinyl, and, depending on the decontamination agent used, on windows. It was not as efficient on brick. Resources required for the decontamination were assessed, and cost and resource estimates were calculated for real-life scenarios.

Impact

The project has generated valuable field data on the efficiency of advanced full-scale decontamination technologies on different building-surface materials. Concepts of operations have been developed to deal with CBRN decontamination of buildings and structures. The effectiveness of relevant analytical instruments and methods was optimized and verified. Associated costs, including labour, material, and equipment, were calculated. The information will be used to develop manuals and set-up training for first responders and both domestic and international decontamination teams.

CRTI 04-0022RD

Rapid Separation and Identification of CBW Agents in Food and Consumer Matrices using FAIMS-MS Technology

PROJECT LEAD: National Research Council

FEDERAL PARTNERS: Canadian Food Inspection Agency, DRDC Suffield – Chemical Biological Defense Section

INDUSTRY PARTNER: Thermo Electron Corporation

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Objectives

The introduction of chemical warfare agents, toxic agrochemicals, and biotoxins into food or consumer products by a terrorist attack poses serious health threats. The goal of this project is to develop methodology based on high-field asymmetric waveform ion mobility spectrometry-mass spectrometry (FAIMS-MS) for the rapid and selective identification of chemical and biological warfare agents. The first phase of the project, in collaboration with DRDC Suffield, focused on chemical warfare agents. In collaboration with the Canadian Food Inspection Agency (CFIA), the second phase is focused on biotoxin detection.

Relevance

Sensor-based, field-deployable technologies serve as early warning systems, but due to their inherently low selectivity provide no conclusive identification of warfare agents. Conclusive identification of the chemical or biological agent requires chromatography or mass spectrometry-based methods that are slow due to the extensive sample preparation required and the low throughput of the setup. A FAIMS-based technology would provide quick, quasi-real-time separation of the relevant industrial chemicals, chemical warfare agents, their decomposition products, and selected mid-spectrum agents. In addition, due to its inherent selectivity, it may reduce the amount of sample preparation required, providing savings in time and cost.

Recent Progress and Results

The deliverables for Phase 1 of this project included a developed FAIMS separation protocol for chemical warfare agents, followed by an evaluation of the developed FAIMS protocols compared to conventional methods, and peer review and transfer to DND end-users. The deliverables for Phase 2 included a FAIMS-matrix assisted laser desorption ionisation (MALDI) interface

followed by an evaluation of the developed FAIMS protocols compared to conventional methods, and peer review and transfer to CFIA end-users. The project was successfully concluded in March 2008.

Experimental work focused on developing flow injection-atmospheric pressure ionization (APCI)-FAIMS-based methods for the separation and identification of chemical warfare hydrolysis products. Hydrolysis products considered included methylphosphonic acid (MPA), ethylphosphonic acid (EPA), thiodiglycol (TDG), ethyl methylphosphonic acid (EMPA), isopropyl methylphosphonic acid (iPrMPA), pinacolyl methylphosphonic acid (PinMPA), chemical warfare simulants triethyl phosphate acid (TEP) and tributyl phosphate (TBP), and agents such as mustard, sarin, soman, tabun, and cyclohexylsarin. The researchers evaluated three atmospheric pressure ionization methods: electrospray ionization (ESI), atmospheric-pressure-chemical ionization (APCI), and atmospheric-pressure-photo ionization (APPI). The chemical warfare simulants were used for all initial method development.

The observed detection limits by ESI-FAIMS-MS were 0.09 -0.3 µg/mL in bottled water, 0.4 10 ug/g in cornmeal (maize), and 0.2 to 180 µg/mL in canola oil.

APCI-FAIMS-MS offered the best and most universal detection of the chemical warfare agents. The observed limits of detection (LODs) were 3-15 ng/mL in bottled water, 1-33 ng/mL in oil, 1 34 ng/g in cornmeal, and 13-18 ng/g in honey for the intact agents.

A FAIMS-based method for the quantitative determination of the mycotoxin zearalenone (ZON) and its metabolites (α-zearalenol [α-ZOL], β-zearalenol [β-ZOL], and β-zearalanol [β-ZAL]), in a cornmeal matrix has been described. Detection limits achieved using the FAIMS device coupled with ESI and mass spectrometric detection were 0.4 ng mL^{-1} for ZON, and 3 ng mL^{-1} for the α ZOL+β-ZOL, and β-ZAL. This represents a significant improvement when compared to detection limits determined using ESI-MS or ESI-tandem mass spectrometry (MS/MS) analytical methods. The developed flow injection (FIA)-ESI-FAIMS-MS method was applied to reference materials ERM-BC-716 and ERM-BC-717 certified for ZON and excellent agreement with the certified values was observed

The observed detection limits were comparable to those obtained with conventional liquid chromatography mass spectrometry (LC-MS). However, the use of the flow injection-API-FAIMS-MS significantly reduced the analysis time (3 minutes per sample versus 30 minutes for the conventional method) and reduced the complexity of sample preparation (a strategy of dilute-filter-and shoot was used throughout).

Future plans for this project involve the development of API-FAIMS-based methods for the detection of biotoxins (e.g., aflatoxins, ochratoxins, and ZON) in wheat, maize, and peanut butter and peanut meal. These methods will be compared to conventional methods. A second aspect of the project involves interfacing of an atmospheric MALDI source to the FAIMS device—this may be the first report of this type of interface—and its application to the study of biotoxins and pesticides.

Impact

In a chemical or biochemical emergency, an analytical system that can screen samples and provide results in minutes rather than days or weeks is essential to rapidly assess and mitigate health, economic, and environmental impacts. The flow injection-FAIMS-MS methodology may increase the speed of analysis; more selectively identify which agent has been used; and better support medical and forensic interventions.

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

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Objectives

Currently, there are no commercially available electronic-neutron dosimeters (ENDs) that meet all military or civilian performance specifications. Past experimental evaluations of existing and prototype devices have pointed out many deficiencies relative to the desired properties of a good END. Specifically, a viable END will be a small, wearable device that has appropriate sensitivity, a wide energy response, low power requirements, good neutron and gamma (n/g) discrimination, and adequate environmental stability. In preparation for this project, a thorough assessment of existing sensor technologies and advances in technological development was performed, resulting in the conception of an alternative approach to producing a viable END. Successfully developing an END that meets all of the desired specifications is the objective of this three-year project. The project began with a conceptual design phase that included input from all project partners, followed by the current phase of constructing and testing a laboratory prototype. The last two phases of this project will focus on the fabrication and thorough testing of the final field-ready prototype.

Relevance

Neutron-emitting radioactive sources, specifically plutonium beryllium (PuBe) and americium beryllium (AmBe), commonly used in oil-well logging and density gauges, are employed globally, and often with limited security precautions. With the deliberate explosion of even a small number of these devices, for instance through a terrorist weapon such as a radiological dispersal device (RDD), large urban centres could be crippled as several square kilometres are exposed to radiation levels well in excess of regulatory limits. Such contamination is particularly serious because of the transuranic compounds involved, which are a major health threat upon entering the body. In such a scenario, any readily available commercial electronic personal dosimeter (EPD) of the type deployed with first responders will measure only the gamma ray dose, which is a small fraction (perhaps as low as 10 percent) of the total effective dose from external radiation. This project addresses CRTI's investment priority to develop science and technology in support of equipping and training first responders.

Recent Progress and Results

The past year of the project has continued in the second of four phases: constructing and testing the laboratory prototype. Following the design and testing of multiple sensor concepts during the previous year, both high energy and thermal sensors were selected and incorporated into the laboratory prototype. The high energy sensor is a solid scintillator, which has excellent n/ discrimination capability and good sensitivity, while the thermal sensor is a boron-shielded LiI (Eu) scintillator, which has good resolution and is available in the desired dimensions for the final device. The laboratory prototype was then compiled into a single enclosure approximately 40 percent larger than the planned final field prototype. This step involved fabricating the data acquisition, analog, and photomultiplier tube (PMT) boards, as well as implementing all required software, including dose calculation algorithms. The entire system has been tested with monoenergetic neutrons at the DRDC Ottawa Van de Graaff accelerator, highlighting some minor modifications required for the high voltage. Further testing following modifications is ongoing and will be followed by end-user testing at DRDC Ottawa and Los Alamos National Laboratory, New Mexico, in April and May. The project team will present the laboratory testing and end-user testing results, highlighting the ability of the detector to achieve international civilian and military specification requirements.

Impact

Many first responders currently wear alarming EPDs, and often the alarm on these dosimeters is the first indication of the presence of gamma-emitting radioactive material. In addition to providing responder communities with the ability to detect the presence of neutron sources, the END being developed for this project will also monitor their associated exposure, ultimately improving their response capability. To enable an easy transition to the new END and ensure the development of a relevant product, end-users from the responder communities are included on the project team. Completion of the project is expected for June 2008 with the delivery of two field-ready END prototypes.

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 Forest Service

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Objectives

The objective of this three-year project is to increase Canada's security against fungal bioterrorism agents. To achieve this objective, the project team set out to assemble a biological collection of critical fungal plant pathogens of high risk to Canadian crops, forests, and the food supply. The team has also worked to create multi-gene DNA sequence databases to develop molecular diagnostics for these fungi, and to build an online database documenting the distribution of all plant pathogens reported 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) is involved in securing permits and addressing biosecurity issues. The AAFC and the Canadian Forest Service (CFS) are developing DNA databases, with both laboratories involved in the designing and preliminary testing of molecular assays. The CFIA and international partners such as the United States Department of Agriculture Animal and Plant Health Inspection Service (USDA-APHIS) are validating the 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 for Canada. To maintain open agricultural and forestry trade with partners who have already established new plant

biosecurity measures including research programs and early detection systems, vigilance and monitoring by Canada are critical. This project will result in significant improvements to the documentation of plant pathogens that normally occur in Canada, including close relatives of high-risk pathogens and to the development of tools for recognizing suspicious outbreaks and establishing their non-Canadian origin.

Recent Progress and Results

The project team has assembled the collection of fungal plant pathogens and has created multi-gene DNA sequence databases to develop molecular diagnostics for these fungi. The team has also completed the online database documenting the distribution of plant pathogens reported in Canada.

To identify novel genes for diagnostic marker development, the research team validated an approach to identifying single nucleotide polymorphisms (SNPs) in microsatellite-rich regions for targeted genomes that currently lack annotation. They developed markers from available expressed sequence tag (EST) libraries for those organisms where genomic sequences were still unavailable. An SNP-based marker system was developed for *Phytophthora infestans* and was validated in three test panels (North American, worldwide, and Columbian). A similar approach is underway for other target pathogens.

The project team also developed a three-gene test for *Phytophtora ramorum*, which causes sudden oak death and can attack many plant species. In an international blind trial, the three-gene test was the most accurate available test in avoiding false positives and false negatives. CFIA processed close to 50,000 putative *P. ramorum* samples from April to December 2007. Of these, over 15,000 were tested further using a species-specific real-time polymerase chain reaction (PCR) assay and 164 positives were detected. The team's second assay, based on SNPs to detect the origin of strains, has been implemented and a multiplex assay is being developed to further increase speed, throughput, and reliability.

The project team has also developed three real-time PCR assays for the fungus *Synchytrium endobioticum*, an obligate potato pathogen on the US Agriculture Bioterrorism Act Select Agent List that cannot be grown in culture. The team produced clean suspensions of sporangia in the 106/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. CFIA is implementing the PCR assays and material transfer agreements have been arranged with other agencies. *S. endobioticum* was found again in Prince Edward Island in 2007, creating an immediate demand for these assays.

Fusarium graminearumm, which caused an epidemic on corn in Ontario in 2006, is a mycotoxin-producing species complex of high genetic diversity and, therefore, molecular markers of the appropriate resolution are required. After screening 24 genes, researchers found that acetyl citrate lyase 1 (acl1) had promising features for the design of real-time PCR assays. Oligonucleotides have been designed, and the assays are now being tested. The *Fusarium* head blight complex is now being resolved at a resolution higher than planned.

Impact

Several outputs from this project are being implemented and deployed earlier than anticipated in response to emergencies and unexpected priorities. The project team was responsible for the first molecular detection in Canadian history of a plant pathogen, *Phakopsora pachyrhizi*, before a diseased plant was found. Researchers deployed rainfall and air sample collectors at 12 sites spanning Ontario, Saskatchewan, and Manitoba. In 2007, *P. pachyrhizi* spores were detected in samples obtained from mid-summer to early fall at multiple sites. *P. pachyrhizi* causes Asian soybean rust disease, and in October, the first infected soybean plant in Canada was found in southwestern Ontario. Computer prediction models of spore trajectories as well as spore detection data from US collaborators correlated with this event.

Demand is growing for the assays developed through this project, and their application is strengthening Canada's biosecurity against fungal pathogens. CFIA fully implemented the real-time PCR assays for detecting and determining the origin of *P. ramorum* positive samples; as a result, the infested areas were circumscribed and treated appropriately, which means that Canada is still considered free of this quarantine pathogen. For the last year of the project, the team will focus on validating additional detection assays to protect Canadian agriculture and forestry. Additional practical applications are expected by the project completion date in March 2009.

CRTI 04-0047TD

CBRNE Incident Database

PROJECT LEAD:	Royal Canadian Mounted Police – Explosives Disposal and Technology Section
FEDERAL PARTNERS:	Canadian Security Intelligence Service, Canadian Food Inspection Agency, Department of National Defence – Radiological Analysis and Defence Group, Canadian Nuclear Safety Commission, Natural Resources Canada
INDUSTRY PARTNER:	AMITA Corporation
OTHER PARTNERS:	Carleton University – Human Oriented Technology Lab; Singapore Armed Forces – Chemical, Biological, Radiological and Explosive Defence Group; Australian Federal Police Bomb Data Centre

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Objectives

The CBRNE Incident Database (CID) is a Canadian and international project that captures CBRNE incidents against critical infrastructure, people, and agri-food targets. Based on the RCMP's 14 years of explosive incident experience and existing incident database, the CID has been built as a commercial off-the-shelf software system that will be used by the Canadian explosive disposal unit (EDU) community and other qualified partners to share CBRNE information in near real time. The database will improve incident preparedness, prevention, and response by sharing vital data on threats, precursors, and dissemination. Information that can be tracked includes, but is not limited to, hazardous device-making materials, incident (hoax) details, and dissemination methods. The database software will be available at no cost to collaborating countries to encourage interaction with other international police EDUs.

Relevance

CID provides the previously unavailable capability to enter and share incidents (real and hoax) among Canadian law enforcement and regulatory agencies in near real time. The effectiveness of response will be dramatically improved through 24-hour, seven-days-a-week (24/7) information availability to a broad network of first responders. This project will enhance the ability to spot patterns and make incident linkages that are not currently possible given the manual method of incident data submission. Linkages will be made as an incident is entered. Online photographs of parts and the knowledge database support better identification in the field, and the CID can also be used for training bomb technicians. Ultimately the end-user community—the first responders—will be better prepared to respond to CBRNE threats by using the CID common body of knowledge.

Recent Progress and Results

The evolution and development of the new CID included expert participation in the definition of how the CID system would be used. The system was developed based on the collective input and collaboration of expertise in the CBRNE field. The project went through a requirements-collection phase involving experienced systems analysts and field experts defining how the system would provide bomb technicians with critical incident information.

CID will provide information to users across Canada through secure web services-based network infrastructure. To meet this need, the design team ensured access and information requests to CID could run on the RCMP network. The team was supported by specialists in user design to ensure the system would be effective in assisting bomb technicians in their jobs during stressful situations and for general purpose training and information collection.

Once the system design for CID was completed, the project moved quickly into development, and CID was built as a robust and production grade system. Once completed, a comprehensive group of Canadian explosive technicians participated in the user-acceptance process to ensure it met the project requirements as planned. All of their recommendations were implemented. The project included a six-month live technology demonstration phase and the feedback was used to fine-tune the state-of-the-art production ready database system.

In anticipation of the commencement of the CID project, coupled with being on the precipice of commercialization, a rebranding initiative in search of a product name and logo was administered with the commercial name of Socius being chosen and agreed to by the RCMP. The finalized CID system was deployed onto the RCMP network in January 2008 and will be made available to all qualified users across Canada following a nationwide CID-user training plan.

Impact

The project addresses CRTI's stated initiative to develop a national and international CBRNE event database that is accessible by the Canadian forensic investigation community to track CBRNE events including hoaxes, significant threats, and events. The CID has been designed to handle each type of incident detailed in CRTI's CBRNE consolidated risk assessment guide.

CRTI 04-0052RD

On-site Composting for Biocontainment and Safe Disposal of Infectious Animal Carcases 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

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Objectives

The objective of this project is to develop composting methods that can be efficiently applied on farms or at other sites to ensure biocontainment of infected poultry or livestock carcasses and manure in the event of a bioterrorism attack employing animal disease agents.

Relevance

Current stamping-out policies for managing outbreaks of avian influenza (AI) in poultry and other diseases have the potential to spread disease and are environmentally undesirable. The composting methods developed in this project will address these shortcomings. In addition to increasing Canada's capacity to control bioterrorism outbreaks, these methods may be used in routine farm operations to prevent the spread of endemic animal diseases and to eliminate food- and water-borne pathogens threatening public health.

Recent Progress and Results

Investigators at the Canadian Food Inspection Agency (CFIA) laboratory in Ottawa studied the survival of AI and Newcastle disease (ND) viruses during composting. Specimens to be buried in compost included 20-gram samples of virus-contaminated manure or other materials that were contained within nylon mesh bags. Other specimens were whole embryonated chicken eggs (ECEs) that had been inoculated with virus and allantoic fluid from infected embryos that were contained in sealed vials. After composting, the investigators tested for the presence of viruses by detecting viral RNA using

real-time reverse transcriptase polymerase chain reaction (RT-PCR). In mesh bags and eggs, both viruses were inactivated soon after compost temperatures reached 40ºC, and in mesh bags, the RNA of the viruses was fully degraded during the 21-day composting period. In sealed vials, both viruses survived about one week longer than in bags, and the viral RNA persisted to day 21. The RNA of ND virus also persisted to day 21 in eggs with shells that remained intact during composting. This suggests that the egg shells and sealed vials served as a barrier to microbial activity capable of degrading the virus particles.

Scientists at the CFIA's Lethbridge laboratory investigated the feasibility of composting carcasses using liquid manure. Six wood-framed compost bins ($2 \times 2.5 \times 2$ m) were lined with plastic (5 mm) to a height of 50 cm. Barley straw was placed in each bin and a calf carcass (average weight was 130 kilograms) was placed on the straw. Liquid manure (9 percent dry matter) was added to duplicate bins in three levels: 95 kg, 236 kg, or 606 kg (manure wet weight). Three layers of straw and three layers of manure were added alternately, and a final layer of straw was added as a biofilter. Dry matter (DM) at construction was estimated to be 65, 50, and 35 percent for the low, medium, and high levels of manure, respectively. Over the 52-day period of composting, temperatures reached above 60°C in bins with the highest levels of manure and these temperatures were higher ($P < 0.05$) than in bins with lower amounts of manure. Carcass degradation was also visibly superior with greater amounts of manure. In conclusion, mortality composting using liquid manure is possible, and a straw matrix with 35 percent DM is recommended for dry climates such as southern Alberta. Researchers also conducted other studies to investigate the ability of the composting process to inactivate spore-forming bacteria. Team members concluded that composting does lower the viability of *Bacillus* spores, but the widespread effectiveness of this approach will depend on the achieved temperature as well as on the bacterial species in question.

Investigators at Iowa State University completed triple-replicated composting field trials using six emergency envelope materials: corn silage, ground corn stalks, oat straw, soybean straw, alfalfa hay, and wood shavings. They showed that the type of material used to envelope the carcasses and its moisture content had a significant impact on soft tissue degradation during composting. The researchers identified 55 different compounds in gas samples drawn from the core zones during field composting trials using the above six materials to envelope swine carcasses. Laboratory and field tests show that nitrogen- and sulphur-containing compounds (particularly dimethyl disulfide, dimethyl trisulfide, and pyrimidine) were reliable indicators of decaying animal tissues that could be used to monitor decomposition completion during composting regardless of envelope material, moisture content, or temperature fluctuations. Concentrations of these compounds were highest (200–6,350 ppbv) during the first three weeks, and decreased gradually to 12–43 ppbv after eight weeks.

Impact

The knowledge and technology that is being cooperatively developed in this project will give countries the capability to limit the spread of highly contagious animal diseases introduced through bioterrorism. The completion date for this project is March 31, 2009.

CRTI 04-0127RD

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

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Objectives

Building on past successful CRTI-funded projects, the Canadian Health Integrated Response Platform (CHIRP) will integrate 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 will leverage the integration of these 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 collaboration will enhance the operations of both the RN and biological clusters, allowing seamless interoperability between the communities while maintaining security and defined roles.

The CHIRP project will make the most of the secure infostructure of PHAC's National Microbiology Laboratory and Health Canada's RPB and strenghten partnerships with Environment Canada's Canadian Meteorological Centre (CMC). 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 toolbox for CBRN emergency response. 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.

In the past year, the project team has been developing the FNEP secure web interface (NucInfo) on schedule. A prototype is expected to be ready for testing at Exercise Initial Thunder (EX-IT) 2009. However, the integration of FNEP alerts into the existing CNPHI user groups as a cross-platform entity has not proceeded as planned. In response to this challenge, a separate FNEP alerting module is being created within CNPHI. This task is expected to achieve the same goals and bring this portion of the project back on track. In addition, hiring challenges at CMC have forced the realignment of CMC's deliverables in this project. To focus on the core goals of the project, the scope of CMC's deliverables have been narrowed to proceed on schedule.

In the months to come, this project will continue to build on its sucessful framework and is expected to be completed by March 31, 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.

CRTI 05-0006TA

OSL Radiation Sensor for Long-Dwell Detection in Transit Applications

PROJECT LEAD: DRDC Ottawa
FEDERAL PARTNERS: DRDC Atlantic, Canada Border Services Agency, Transport Canada
INDUSTRY PARTNER: Bubble Technology Industries

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Objectives

Smuggling nuclear weapons, components, or other illicit radiological materials represents one of the most critical terrorist threats faced today. Effectively screening the millions of cargo containers destined for North America each year requires a multi-layered defence to cut off potential terrorist pathways and push the perimeter of detection as far away from our borders as possible. The goal of this project is to develop an innovative, near-commercial radiation sensor, based on optically stimulated luminescence (OSL), which can be installed inside a cargo container to detect the presence of even low levels of radiation during shipment. By leveraging the long signal integration time provided during the container's transit, the radiation sensor can detect the presence of even shielded radioactive sources.

Relevance

The long-dwell radiation sensor under development is uniquely suited for the detection of low-activity nuclear materials and radioactive materials in shielded configurations and is, therefore, directly applicable to the prevention and interdiction of a nuclear or radiological attack. The federal partners included in this project represent the key stakeholders in preventing the smuggling of illicit nuclear-radiological materials into the country. Their participation in the program ensures that the technology developed will be highly relevant to their defence and security missions.

Recent Progress and Results

In a previous CRTI project (CRTI 01-0072RD Nanodosimeters Based on Optically Stimulated Luminescence), a prototype radiation detector was developed by DRDC Ottawa and Bubble Technology Industries (BTI) that used a passive OSL dosimeter whose radiation level could be periodically read with a tiny laser diode. The scope of this project was to further develop the prototype OSL dosimeter into a more sensitive, robust, commercially viable device specifically for Long-Dwell Detection in Transit (LDDT) applications. The radiation sensor was combined with specialized communication hardware, analysis software, and command and control software into a deployment-ready LDDT cargo monitoring system. A prototype LDDT system was fabricated and assembled by BTI and field-tested aboard the Canadian Forces Auxiliary Vessel (CFAV) *Quest* in January 2008.

Over the course of the project, significant technical advancements were achieved by BTI in modifying the original OSL sensor design. Exact positioning of the laser and thermo-luminescent dosimeter (TLD) increased total counts by 25–30 percent. Detection efficiency was improved by implementing power control of the laser, reducing the photomultiplier tube (PMT) switching time, and improving the light collection between the TLD and the PMT. Based on data collected at BTI, an algorithm for dose conversion, including temperature correction, was developed for the OSL sensor. Extensive testing of the sensor was performed at BTI to identify any requirements gaps. Measurement of temperature dependence from 0°C to 50°C gave results that varied by less than 5 percent and tests of the system in magnetic fields up to 30 Gauss showed no observable effect. Measurement of dose dependence gave a linear curve from background to beyond 8.76 mSv. In addition, the absolute dose value measured by the OSL sensor was in good agreement with the value obtained with a commercial dosimeter.

Transport Canada, the Canada Border Services Agency (CBSA), and DRDC Ottawa developed and reviewed a concept of operations. Both CBSA and Transport Canada stressed the importance of a robust mechanical design to withstand the harsh conditions within an operational cargo container. Based on this feedback, BTI developed a rugged mechanical concept for the sensor enclosure.

This ruggedized design was tested during a sea trial aboard the *CFAV Quest* in January 2008. The LDDT sensors were magnetically mounted at various locations inside a sea container on the quarter deck of the *Quest* and subjected to a variety of shielded and unshielded radioactive sources, as well as the harsh conditions on the North Atlantic in January. The sensors held up to the environmental conditions and were easily able to detect all of the sources used, most notably a 1 mCi ^{60}Co source shielded in a Type A transport container.

Impact

The LDDT system was laboratory demonstrated over the course of the project and tested at sea in January 2008, meeting design requirements. The successful development of the LDDT sensors provides a viable option for radiation detector deployment in maritime, road, and rail cargo shipments. If adopted for widespread use, these detectors have the potential to significantly increase our capability to detect, interdict, and prevent potential radiological and nuclear attacks.

CRTI 05-0014RD

Experimental and Theoretical Development of a Resuspension Database to Assist Decision Makers during RDD 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

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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 (RNDSG) under the Joint Capability Group for CBRN (JCGCBRN) Defence.

Relevance

The main threat in almost every radiological terrorist scenario (e.g., a radiological dispersal device [RDD]) 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

In the project's second year, researchers continued to examine a variety of short-lived radioisotopes with different particle diameters in both controlled (i.e., indoor) and ambient (i.e., outdoor) environments. Researchers at Wehrwissenschaftliches Institut für Schutztechnologien (WIS) in Munster, Germany, are responsible for testing indoor europium (Eu)-152 and lanthanum (La)-140, scientists at the Délégation générale pour l'armement (DGA) in Bourges, France, are responsible for examining indoor and outdoor La-140, and experts at the Colin Watson Aerosol Layout (CWAL) at DRDC Suffield are

responsible for analyzing outdoor sodium (Na)-24, potassium (K)-42 and copper (Cu)-64. In addition, the researchers at the University of Ontario Institute of Technology (UOIT) are responsible for developing a small-scale facility to perform laboratory studies with non-radioactive particles in controlled and contained environments.

DSTL and UOIT are responsible for performing calculations tailored to the experiments outlined above using a variety of Computational Fluid Dynamics (CFD) codes such as FLUENT. The DSTL and UOIT are also responsible for conducting an internal computational intercomparison to ensure that the countries have similar capabilities, given the same initial parameters, which will give confidence in the results. Environment Canada is responsible for providing its mainframe meteorological codes. The researchers will then summarize the project's outputs in a spreadsheet for field personnel.

Impact

The experiments conducted under this project will allow radiological experts to better predict, prepare, 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.

CRTI 05-0016RD

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

PROJECT LEAD: Public Works and Government Services Canada

FEDERAL PARTNERS: Public Safety Canada, Transport Canada, Royal Military College of Canada, National Research Council, Royal Canadian Mounted Police

OTHER PARTNERS: Canadian Standards Association, Canadian Association of Fire Chiefs, Canadian Council of Health Services Accreditation, Canadian Healthcare Association, Canadian Professional Police Association, Canadian Public Health Association, International Association of Fire Fighters – Canadian Office, Paramedic Association of Canada

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Objectives

The objective of the project is to develop a National Standard of Canada for personal protective equipment (PPE) for first responders (fire, police, and emergency medical services) in the event of a CBRN incident.

The aim of this new national standard is to assist first responder organizations in the selection, care, and use of such PPE, enabling them to do their jobs with greater protection and functionality. The standard will help protect our nation's first responders in addressing CBRN events by providing realistic, risk-based guidance on the appropriate level of protection required.

This new standard will take a systems approach and identify requirements for whole-body protection. It will address requirements for both respiratory protection and protective clothing and provide valuable guidance on key issues such as the interchangeability and interoperability of equipment. A key objective of the standard is to provide guidance on the capabilities and limitations of protective equipment.

Relevance

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

The standard 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 Committee for the Protection of First Responders from Chemical, Biological, Radiological and Nuclear Events was established in January 2007 and held its first meeting that month. Stakeholders on the committee include all levels of government, public safety organizations, first responders, manufacturers, research and testing organizations, public and private organizations as well as those organizations involved in the evaluation of CBRN agents.

The Committee held six meetings to develop the technical content of the draft standard. The current working draft includes sections on definitions, acronyms, response zones, a PPE selection process, a list of acceptable equipment and standards, guidance on system integration and interoperability, capabilities and limitations of PPE, and training requirements.

Five sub-groups were established to develop the various sections of the standard: First Responder, Respirator, Technical Specifications – Clothing and Test Methods, Training Requirements, and Contagious Events. At each committee meeting, the sub-groups met to develop their respective sections of the draft standard, which were then reviewed by the full committee. Protective equipment selection flowcharts were drafted to help understand the rationale in selecting the appropriate level of PPE protection for the various types of CBRN events. The sub-groups developed a number of working drafts, which committee members reviewed. A revised draft of the standard will be made available for public review and comment during the summer of 2008.

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 linked together through the establishment of a national technical committee. The development of this standard will also accelerate the use of technologies. The project team hopes to have the standard ready for publication in February 2009.

CRTI 05-0058TD

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

PROJECT LEAD: DRDC Ottawa – Future Forces Synthetic Environment 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

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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 data set, 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 data set, 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 inter-agency 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 validated the operational architecture in Vancouver from April 30 to May 1, 2007.

Phase B focused on developing a common, shared geo-spatial 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 data set into the geographic information system (GIS)-based Common Operating Picture Environment (COPE) that is used by all participants in the demonstrations at the end of the project. EmerGeo 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. In April 2008 the project team successfully performed the first of three demonstrations. Held at the Justice Institute of British Columbia (JIBC), the demonstration focused on the experimental capability of the technology. The upcoming demonstrations will focus 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 plans to schedule the second demonstration for May 2008, highlighting the distributed nature of the simulation, and the final demonstration for June 2008, emphasizing the allowance of decision control to commanders at the distributed locations.

The distributed simulation-based experiments will be executed with progressively more stress on the various responder interfaces, validating the operational architecture while providing important insights into capability gaps that can be subsequently explored and analysed in greater detail if warranted.

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 geo-spatial 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 (CF) Experimentation Centre, and Environment Canada. Additionally, the unique coupling of a common, shared, geospatial data set—exercised through simulation-based CBRNE events but developed within an integrating architecture approach—will support interoperability assessments and analysis for municipal, provincial, and federal responses and the development of a coherent CONOPS framework for inter-agency 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.

CRTI 05-0069RD

Development of PEGylated 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

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Objectives

The objective of this project is to confirm 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, as well as to develop this product and establish exact dosing requirements. Project team members will study PEGylated GM-CSF dosing requirements to alleviate severe neutropenia using irradiated monkeys as a model. This research builds on the previous CRTI project, "Evaluation of GM-CSF for Acute Radiation Syndrome" (CRTI 0085TA), and will advance Canada's ability to respond to a nuclear terrorism event.

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 a reduction in the number of white blood cells called neutrophils, consequently weakening the body's defence capabilities and making 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 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 neutrophil production and number of injections required. This project will confirm these findings and identify the optimum dose and regimen of PEG-GM-CSF treatment to effectively alleviate neutropenia and improve the long-term survival of individuals exposed to acute radiation.

Recent Progress and Results

Evidence from animal studies suggests that a victim or patient would only require one immediate treatment with PEG-GM-CSF and fewer follow-up treatments compared to the daily injections that would be necessary with GM-CSF.

Project implementation began in May 2006 and early work focused on developing conditions for PEG-GM-CSF production. Dose frequency studies began in December 2006 and are completed, while dose-finding studies commenced in May 2007 and are ongoing.

To confirm the results of preliminary animal studies, project researchers tested the pharmacokinetic parameters of three different formulations of PEG-GM-CSF (20 kDa, 30 kDa and 40 kDa) following their subcutaneous administration at dose rate of 300 µg/kg in monkeys at day one and day seven. The data indicates that with the increase in PEGylation of GM-CSF, there is an increase in the absorption of the drug from the administration site.

Project researchers also conducted efficacy studies in monkeys to test the ability of 20 kDa PEG-GM-CSF to improve neutrophil recovery when administered subcutaneously at 300 µg/kg both as two injections on days one and seven following total body irradiation. PEG-GM-CSF significantly improved all neutrophil-related parameters as compared with controls. Administering two doses of PEG-GM-CSF significantly improved neutrophil regeneration, in a manner equal to that of conventional daily divided doses of non-pegylated GM-CSF in this monkey model of severe myelosuppression. The preliminary data indicate that PEG-GM-CSF improves hematopoiesis in myelosuppressed monkeys and can effectively alleviate acute radiation-induced hematopoietic syndrome.

The final project report is due in March 2009, and deliverables will include a report on the optimal treatment regimen and a PEG-GM-CSF manufacturing protocol. This CRTI project is primarily managed by personnel in Cangene's facilities in Winnipeg, and animal studies are performed at the University of Maryland, Baltimore.

Impact

Outcomes from this project will significantly improve Canada's preparedness against radiological and nuclear threats by improving treatments for acute radiation exposure. The product being developed will be an effective and easily administrable drug that can be given to many individuals in a mass casualty situation. Given the stability of PEG-GM-CSF and lower dosing requirement of PEG-GM-CSF compared to GM-CSF, the operational community will need to stockpile less material and possibly be able to keep it longer.

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

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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 reliably be 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 Army Medical Research Institute of Infectious Diseases (USAMRIID) and the vaccine production company Impfstoffwerk Dessau-Tornau (IDT) GmbH, the Public Health Agency of Canada (PHAC) will develop good laboratory practice (GLP) 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 VSVΔG/ZEBOVGP. With HPFB and the United States Food and Drug Administration (US FDA), PHAC researchers will determine the immune correlates of protection in rodent and non-human primate models of ZEBOV infection. The project team will also show that cGMP stocks of vaccine are as effective as current experimental stocks. These data are 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 and ocular exposure of non-human primates, as well as by aerosol; 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 (VSVΔG/ZEBOVGP) and MARV (VSVΔG/MARVGP) and the glycoprotein precursor (GPC) of Lassa virus (VSVΔG/LASVGPC) and results showed that these gave complete protection to cynomolgus macaques against lethal challenge with the corresponding filoviruses and arenavirus. We 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 naïve non-human primates (n=4 per vaccine), and 28 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 no-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 1000LD_{50}. All non-human primates infected with Marburg virus and 50 percent of the non-human primates infected with Ebola virus survived when treated 30-minutes post-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 haemorrhagic fever 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. The project's 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.

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.

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Objectives

The purpose of this project is to develop new capabilities for rapid detection and typing of the potential agroterrorism agents, foot-and-mouth disease (FMD) virus and avian influenza (AI) virus. Canadian Food Inspection Agency (CFIA) and Nanogen researchers are adapting DNA slide microarray technology to the more portable NanoChip platform, which can be 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 will adapt or redesign the existing microarray probes in the first phase of this project. Concurrent with probe redesign is assay design and layout on the NanoChip array. The second phase of the project involves optimizing electronic printing and hybridization conditions and data reporting. The final phase is test validation, including 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 has developed electronic microarray assays for FMD and for AI using Nanogen's NanoChip 400 platform. The DNA microarray for the FMD virus is a serotyping assay with serotype-specific probes and probes for the conserved polymerase gene to ensure detection. 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 seven serotypes. Initial testing of clinical samples has shown a strong correlation with real-time polymerase chain reaction (PCR).

The DNA microarray for the AI virus is a hemagglutinin (H) typing assay currently containing 32 H-specific probes with redundancy for most subtypes, particularly for H5, an important subtype of AI. Over 1,000 avian H5 sequences exist in databases. The assay contains four H5 probes, each of which detect all H5 strains tested (n=9). The H7 subtype is equally important. The assay contains two probes that detect all H7 strains tested (n=5). The assay also contains two probes for the conserved matrix gene. All AI strains tested (n=32) can be detected using the conserved matrix gene and all 16 H subtypes can be typed using the subtype-specific probes. As with the FMD assay, initial testing of clinical samples with the AI NanoChip assay has shown a strong correlation with real-time PCR.

The work was presented at the CRTI 2007 summer symposium, Detection Technologies 2007, and in two seminars at CFIA Lethbridge. Validation of the FMD and AI NanoChip assays with clinical samples are ongoing.

Impact

FMD and AI are highly infectious diseases that, if introduced into Canada's naïve animal populations, inadvertently or intentionally by terrorism, can spread quickly and have catastrophic consequences to the nation's agricultural industry and a significant deleterious impact on its economy. Thus, there is an urgent need for rapid on-farm testing by first responders in case of a suspected outbreak (i.e., district veterinary officers). 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 requirement of portability and highly multiplexed detection needed to deal with the high genetic variability of these viruses. A unique feature of the technology will be distinctly Canadian: the probes to be used in the NanoChip are intellectual property owned by CFIA. The project's completion date is September 2008.

CRTI 05-0092TA

Integrated Personal Cooling for Chemical-Biological Protective Undergarments

PROJECT LEAD: Med-Eng Systems

FEDERAL PARTNERS: Royal Canadian Mounted Police, Royal Military College of Canada, DRDC Suffield

OTHER PARTNERS: University of Ottawa – School of Human Kinetics

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Objectives

Explosive ordinance disposal (EOD) first responders are often required to wear chemical protective undergarments (CPUs) beneath their EOD ensembles, resulting in additional heat stress. Personal cooling systems (PCS) are therefore often essential in addition to CPUs to mitigate heat stress. Currently, this protective equipment combination adds extra steps and time related to donning, doffing, and decontamination procedures. It also introduces additional bulk and possibly discomfort to an already burdened operator. This project set out to obtain two types of protection (chemical and cooling) out of only one layer, resulting in decreased staging time, increased mobility, reduced thermal burden, and easier decontamination procedures.

Relevance

The outcome of this project will improve the operational capabilities for the prevention and response to a CBRN event by safely extending mission time through personal cooling for the first responder equipped with CPU underneath EOD personal protective equipment (PPE). In addition, with one less layer, decontamination procedures will be simplified.

Recent Progress and Results

While the first year of the project focused on developing material swatches that were submitted to an array of tests (e.g., chemical protection against actual chemical agents and cooling performance), the second and last year focused on the design, development, and validation of final garment prototypes.

Members of the project team developed four configurations of prototype garments based on results from the swatch-level testing. Human fit trials were carried out to optimize the patterns, keeping protection requirements in mind. Researchers at Med-Eng Systems introduced moisture-management layers throughout the CPU (not only where cooling is present) for increased user comfort. They also introduced cooling in the arms of one configuration to evaluate the relevance of this added cooling area in view of added weight, reduced flexibility, and higher power requirements. Washing and durability testing took place to ensure that the quality and durability of the fabric was still maintained.

The cooling effectiveness of the various prototypes was first evaluated through the Med-Eng "thermal mannequin," which quantifies (in watts) the cooling

power provided by the cooling system in its garment configuration. This was followed by thermophysiological testing at the University of Ottawa, during which actual volunteers wore the CPU with integrated cooling together with the entire EOD and chemical-biological (CB) gear, in a controlled temperature chamber. Volunteers were asked to carry out several predetermined exercises to elicit a physiological effort.

The CPU with integrated cooling was then subjected to Man-In-Simulant Test (MIST) trials at the Royal Military College of Canada, to ensure that adding tubing for cooling purposes did not affect the chemical protection in any way. The RCMP provided overall guidance and volunteers for the MIST and fit trials that took place there. Unfortunately, the CB Plus Chamber at DRDC Suffield was not available for further chemical protection testing (using specialized mannequins).

All tests were successful and allowed the project team to determine the optimal configuration, consisting of a chemical protection layer and a moisture-management layer. Arm cooling remains as an option for users, based on their own requirements and preferences.

The concept of integrated cooling with CPUs is currently included in concepts for Med-Eng's next generation EOD ensembles compatible with CB gear.

Impact

With the project completed in March 2008, two fully functional prototypes were provided to the RCMP for immediate use. This integrated PPE is disposable and has potential for cost savings compared to having separate garments.

CRTI 05-0106TA

Development of Field-ready Nucleic Acid Detection Techniques for Category 1 and 2 Biological Agents

PROJECT LEAD: Public Health Agency of Canada – National Microbiology Laboratory
FEDERAL PARTNER: DRDC Suffield
INDUSTRY PARTNER: Cepheid Incorporated

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Objectives

The purpose of this project is to develop real-time nucleic acid detection assays for Category 1 and 2 biological weapons (viral and bacterial) in a readily available and accepted commercial format. The project team aims to identify suitable Scorpion-based primer-probe combinations for all agents; optimize the assays for use on the Smartcycler real-time polymerase chain reaction (PCR) system; and develop selected assays for the GeneXpert platform by the project's completion in August 2008. The assays will then be evaluated during CRTI-sponsored field exercises. Federal partners will provide nucleic acids, containment facilities, and assay optimization, and Cepheid researchers will provide assay design, expertise, hardware, and reagents for development.

Relevance

Assays currently available to frontline personnel are targeted to detect important biological threat agents such as *Bacillus anthracis, Francisella tularensis, Yersinia pestis*, and Variola virus. Tests for the high-consequence viral agents, such as Ebola and Lassa viruses, along with many other viral and bacterial agents of concern, are currently lacking. The development of new real-time assays for the broader scope of Category 1 and 2 viral and bacterial threat agents will allow rapid, sensitive, and accurate testing for a greater range of potential biological agents in the hands of the response and monitoring communities and, thus, greatly enhance Canada's response capacity.

Recent Progress and Results

Real-time probe-based assays have been completed and optimized for all biological agents included in this project. Identified target regions for some of these agents were unsuitable for Scorpion-probe conversion and have been left as 5' nuclease assays. All of the assays have now been evaluated in field exercises, with final completion in February 2008 during Exercise Initial Thunder (ExIT-08).

To further enhance the robustness and speed of the RNA-based assays, researchers evaluated several additional enzyme options. They found that assays based on a recombinant enzyme, Tth DNA polymerase, significantly saved time without loss to sensitivity. Consequently, the team modified the assays to use Tth DNA polymerase.

Cepheid provided training at their Sunnyvale facility on the theoretical and practical components of establishing GeneXpert assays from existing Smartcycler-based assays. The team has also started preliminary evaluation of bead formulations; the delivery of blank developmental cartridges is expected to continue soon. Assay design has been initiated for the targeted agents and implementation of the designs will commence upon receipt of the cartridges.

Impact

The tool box available to first responders and the CBRN community has grown considerably over the past few years. Real-time nucleic acid amplification and detection assays with high sensitivity, specificity, and speed are available to a limited spectrum of biological agents. The assays developed in this project will enhance the capability of responders to rapidly detect a much broader range of biological agents. At the completion of this project, assays that will complete the coverage of Category 1 and 2 biological agents will be available to the Public Health Agency of Canada's National Microbiology Laboratory (PHAC-NML) and joint national CBRNE teams.

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

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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 IT 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 a proficiency test exercise and an emergency readiness exercise 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 other laboratories, collectively enhancing the national response capability and capacity to an RN emergency.

Recent Progress and Results

The project team made significant progress in the last year on developing the IT solution for data sharing between the partner laboratories. The prototype software, LabNet, was installed in three of the laboratories in early 2008. The software allows laboratory partners to input sample information and results of sample analysis and to share the results with other laboratories. Each laboratory was provided with a laptop computer containing the software, allowing for portability should the need arise.

Four of the laboratories (i.e., Health Canada, Ontario Ministry of Labour, Royal Military College of Canada, and Department of Fisheries and Oceans) participated in the analysis of samples acquired during Exercise Initial Thunder (ExIT-08). Samples of water, vegetation, soil, and swipes were sent to the laboratories from the exercise site in British Columbia. Although the samples received during this exercise did not contain radioactive material, participation in the analysis provided an excellent opportunity to test receipt and log-in procedures for emergency samples. The laboratories performed a variety of different analyses, although they focused primarily on gamma spectroscopy. The exercise also allowed the team to test their laboratory protocols and demonstrate the LabNet software, entering data and testing the software's data-sharing feature. Lessons learned from the ExIT-08 will help improve the LabNet software and will influence the design of future exercises for the network. This project will be complete in March 2009

Impact

The IT networking solution for lab 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.

CRTI 05-122TD

CBRN Crime Scene Modeler (C2SM)

PROJECT LEAD: Royal Canadian Mounted Police – Forensic Identification Operations Support Services

FEDERAL PARTNERS: Canadian Police Research Centre – Ottawa, DRDC Ottawa – Radiological Analysis and Defence Group, Royal Canadian Mounted Police – Explosives Disposal and Technology Section

INDUSTRY PARTNER: MDA Space Missions

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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. The CBRN Crime Scene Modeler (C2SM) can be used as a hand-held device or can operate on board a mobile robot. C2SM captures images (stereo, visible, and infra-red) and data from CBRN detectors, and displays them in near real time on the operator station. The images are processed to create photorealistic 3-D models of observed scenes; and the resulting models are automatically augmented with CBRN measurements. The project began in October 2006, with the first prototype tested in September 2007. The second prototype will be tested in April 2008. Three prototypes will be delivered to first responders for evaluation before the project completion in August 2008.

Relevance

Investigating crime scenes where CBRN agents have been deployed poses great dangers to first responders. Ensuring personal protection is almost impossible in radiologically contaminated scenes. As decontamination of a crime scene may result in destruction of potentially vital evidence, it is essential to develop technologies that will reduce the need for the first responders to enter the scene and maximize their productivity. Such technologies reduce the exposure of first responders by minimizing the time spent at the scene, as well as allowing them to conduct their tasks from safer stand-off distances. C2SM provides near real-time access to detectors data, rapidly creates 3-D models of crime scenes with integrated CBRN detector data, and maps the contamination levels.

Recent Progress and Results

The current C2SM prototype operates on board a robotic platform or as a hand-held device. The sensor suite includes stereo and high-resolution cameras operating in visible spectrum, a long-wave infrared camera, two gamma detectors, and a chemical detector. A directional gamma radiation probe (DGRP) provides direction toward the strongest radiation source and a simple gamma monitor measures radiation levels (CRTI 03-0017TA: Development of a Directional Gamma Ray Probe) and a lightweight chemical detector (LCD) detects presence of chemical warfare agents and toxic industrial chemicals. C2SM is self-contained, includes a ruggedized computer, and is battery powered. In the robotic mode, it is operated from a control station connected via wireless link; in the hand-held mode, it is operated using an attached screen and input device or from a control station.

The complete data recorded during an event (images, 3D models, and detector data) together with first responder reports and annotations, and descriptions of exhibits are stored in a multi-media event database (MED). This database combines the data, location, and time when it was recorded and can be queried for specific conditions.

The first prototype, C2SM-1, was tested in field trials in September 2007, on board of a mobile robot—MK-2 from Allen-Vanguard—within an indoor environment with multiple gamma radiation sources present. The system created multi-modal 3-D models (geometry, colour, infrared, and gamma radiation) within hours, correctly identified location of radiation sources, and provided high-resolution images of these sources. The second prototype, C2SM-2, is further equipped with an interface to a chemical detector, and is able to create 3-D models faster than C2SM-1 and is fully automatic. C2SM-2 was tested in field trials in April 2008.

Impact

C2SM will reduce the exposure of first responders investigating crime scenes contaminated with CBRN agents by allowing them to operate the system on board a mobile robot. When used in the hand-held mode, C2SM will reduce the time spent in contaminated environments collecting images and detector data, and performing measurements. C2SM systems will enable automatic creation of 3-D models and registration of CBRN-detector data, annotations, and linking in additional data, 3-D visualization, and interactive measurements and storage in the complete event data. The permanent record of the scene will be created on-site allowing it to be used during the event for planning operations, transferring it to command centres, and storing for future reference.

The three prototypes developed in the project will be delivered to the first responders participating in the project for evaluation and field trials in June 2008. The project will be completed in August 2008.

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: Metro Toronto Police, Ontario Provincial Police, Toronto Emergency Management Services, Centre for Forensic Sciences, Department of Homeland Security, Edgewood Chemical Biological Center

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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, the 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 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 75 percent of this task already completed.

This past year, the project charter was successfully reprofiled to modify timelines and money, and to add partners from the US. Concurrently, a cooperative activity agreement (CAA) 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 (ML&K) 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 (BSL-2 and BSL-3 along with chemical filtration) with robust analytical methodology that provides a fail-safe system for unknown materials assessment.

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 and five facilities are 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.

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

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Objectives

Rift Valley fever, an emerging viral disease of humans and ruminants, is considered a significant biological warfare threat and a severe natural disease threat. Originating in Africa, Rift Valley fever 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 Rift Valley fever 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 lists" of multiple national and international organizations such as the World Organisation for Animal Health (OIE), Centers for Disease Control and Prevention (CDC), and the National Institute of Allergy and Infectious Diseases (NIAID). RVFV is also on the United States Departments of Health and Human Services (HHS) and Agriculture (USDA) Select Agents list.

Like their counterparts in the US, the Canadian Food Inspection Agency (CFIA) and the Public Health Agency of Canada (PHAC) do not have validated diagnostic tests for Rift Valley fever 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 frontline 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). They will then apply these reagents to developing operator-safe and field-deployable diagnostic tests for humans and animals.

The 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, they will establish high-throughput tests essential for outbreak control and subsequent longer term consequence management.

The project teams 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 (RT-PCR) assay for surveillance in mosquitoes.

The outcomes from this project will be applicable to developing personal protective equipment (PPE) 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.

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 Limite

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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 brought within the NBDRP and existing biological dosimetry expertise will be enhanced via the Response Plan.

Relevance

The information provided by biological dosimetry is critical for use in medical triage and the diagnosis of casualties, in order 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. The NBDRP will also assist in consequence management for concerned first responders. However, 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, several novel, high-throughput assays are being developed for use in a mass casualty RN scenario. These assays may also be useful for assessing human exposure to chemicals. By addressing these CRTI priority needs, the NBDRP will be an essential component of an integrated national response plan in the event of an RN incident.

Recent Progress and Results

The previous project established the NBDRP 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 US counterparts. This expansion will greatly enhance emergency triage biodosimetry capacity.

Impact

The NBDRP is one of the few biodosimetry networks in existence and is being used as a model by other countries. With the development of biodosimetry programs around the world, an international network is developing to facilitate emergency response on an international level. The project team is partnering with US counterparts at Oak Ridge Institute for Science and Education (ORISE) Biological Dosimetry Laboratory (REAC/TS) and the Armed Forces Radiobiology Research Institute (AFRRI) in order to strengthen international integration and response capability. The development of rapid biodosimetry assays will provide critical information to medical personnel and emergency response coordinators for managing the medical response to an RN mass casualty event.

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 PARTNERS:	ABSG Consulting
OTHER PARTNERS:	McMaster University, University of Ottawa

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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 screening, evaluation, and post-blast assessment tools. 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, such that risk ranking and prioritization can be made; the evaluation of high risk buildings to determine mitigation needs; and the cost-effective upgrading of buildings 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 (RST) developed by PWGSC and CERL and the relevant Federal Emergency Management Agency (FEMA) documents have been completed. Initial evaluation reveals that in order 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.

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, are under development. The objective is to compare the results of these analyses with each other and, where possible, with available experimental data. This will enable users to determine the appropriateness of each analysis method in a given situation. The SDOF models have been completed, and significant progress has been made with respect to both the MDOF spring and continuum elements. Other available commercial finite element software will be used for 2-D and 3-D analyses to compare the results with the SDOF and MDOF models.

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. It is recommended that entire buildings or certain areas within a building be classified as unsafe, area unsafe, no restriction on use, and so on.

A literature review on structural retrofit methodologies for blast has also been conducted. Previous research can be grouped into two categories: techniques involving system retrofits and techniques involving individual member retrofits. The objective of the system retrofit techniques is to provide secondary load paths to prevent progressive collapse, while individual member retrofits are often limited to the elements located on the exposed surface of the building or nearby locations.

A literature review on blast load effects on structural elements indicates that much of the information on blast retrofitting is based on lessons learned from seismic retrofitting, and that the majority of the field trials on columns have been conducted in the US.

Design of the reinforced concrete, steel, and masonry specimens (i.e., columns, beams, and walls) is in progress. Construction of the specimens for both the field and laboratory (shock-tube) testing will commence in May 2008. Theoretical analyses are being conducted and testing procedures are being developed for the testing program.

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 developed by the project 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 being scheduled for June 2010. The completion of the project is September after the 2010 Public Security S&T Summer Symposium.

CRTI 06-156RD

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

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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

The project is still in its infancy, thus experimental results are limited. The results provided are from earlier experiments.

One of the first experiments to indicate that environmental conditions may play a large role in the effectiveness of decontamination performance was an experiment performed by DRDC Ottawa and Wehrwissenschaftliches Institut fur Schutztechnologien (WIS). During this trial, urban materials were contaminated with either an aqueous solution of radioactive sodium (^{24}Na) iodine or with dry non-soluble radioactive europium (^{152m}Eu) oxide. The decontamination was approximately 40 percent effective on the material contaminated with the radioactive solution, while the same decontamination techniques were approximately 90 percent effective on the dry insoluble contaminants.

A similar trial was performed at DRDC Ottawa using radioactive sodium (^{24}Na) carbonate applied to a concrete block as a dry powder and as an aqueous solution. The results showed that one could achieve over 90 percent decontamination by vacuuming the dry particles compared to approximately 20 percent decontamination using a chemical solution on the aqueous solution, showing again that surfaces contaminated with dry particles are easily decontaminated.

During this trial, one of the plates with dry contaminant became wet due to condensation from the detector (this result was omitted from the above results). Vacuum decontamination was applied and resulted in a 20 percent decontamination efficiency. This demonstrates the effect of environmental conditions on decontamination efficiency and the importance of employing the correct strategy for radiological decontamination.

The Environmental Protection Agency's (EPA) contribution to the project consisted of assessing three aspects of the impact of RDD contaminations on urban materials: distribution coefficients for cesium, assessing cesium penetration depth and pathway in two dimensions, and the development of a laboratory-scale deposition to mimic the deposition of RDD contaminants.

Still in progress is the development of a common list of threat isotopes, testing methodologies, and challenge levels. In addition, efforts are underway by DRDC Ottawa and the Canadian Nuclear Safety Commission (CNSC) to characterize and develop procedures for the use of strontium-82 for this project.

The University of New Brunswick has started the development of a three-dimensional imaging system to study the migration of radiological contaminants within urban materials. Work is also in progress on a large trial to be conducted at the WIS facility in December 2008. This trial will study how rain affects contaminant migration and decontamination efficiency.

Impact

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

For remediation to be performed in a timely manner, a change in Canadian policy on remediation after an RDD needs to be implemented. CNSC is the primary client for this project and has the authority to implement the recommendations outlined in the final guidance document. To this end, 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.

CRTI 06-0159TA

Advanced Technical CBRNE Training Program "Operation Maple Leaf Program"

PROJECT LEAD:	RCMP Explosives Disposal and Technology Section
FEDERAL PARTNERS:	Canadian Police College, DRDC Suffield, Counter Terrorism Technology Centre, Department of National Defence
INDUSTRY PARTNER:	Allen-Vanguard Corporation
OTHER PARTNERS:	Ottawa Police Service, Niagara Regional Police Service

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Objectives

Terrorists currently employ suicide bombs, large vehicle bombs, and radio-controlled devices as primary weapons. In addition, 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 Counter Measures (ECM); 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

The project's first milestone is the development of the Electronics for Explosives Technicians/Hand Dismantle Techniques Pilot Course. The three-week pilot course is designed for explosives technicians with little or no electronics training. The course emphasizes hands-on practical exercises and minimizes the time dedicated to theory. The delivery of the course is approximately 85 percent hands-on and 15 percent theory. The aim is to build skills and knowledge that will be valuable to operational technicians in responding to Category A, hand dismantle, and CBRN situations. In addition, this training will be valuable for technicians during post-blast investigations and when conducting routine equipment maintenance.

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 (IEDs) from post-blast debris. The course included two days of hand dismantle exercise scenarios in the final week.

The March course was attended by senior explosives technicians from several countries. Each technician was trained by an internationally recognized explosive devices disposal school. Observation and testing revealed that the attending technicians, although all qualified explosives technicians, possessed varying levels of knowledge and skill in electronics and hand dismantle techniques. Feedback revealed that few countries had instituted specific courses to cover these subjects. As Canadian police and military explosives technicians often work internationally alongside their counterparts, a baseline skill level common to the international community is required. Even though operating techniques and protocols may vary, the basic operational skills and knowledge remain the same.

Post-course feedback and testing revealed that all students had developed strong baseline skills and knowledge in the subjects taught. The first two weeks covered four categories of IEDs. These skills will be used by the international technicians to analyze, in detail, actual incidents involving victim-initiated booby traps, various types of timers, radio frequency devices, and combination devices. Participants developed a basic knowledge of electronics within Category A IEDs; advanced hand dismantle techniques and hazards Category A tool kits; component identification for post-blast investigation; assessment and evaluation of the adversary's electronic skills; determination of indicators and signatures; and IED construction using off-the-shelf items.

To round out the first two weeks of electronics training, students received training in advanced hand dismantle techniques and developed skills working with Category A devices, such as how to render safe body bombs and booby trap devices.

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 (SATDD). 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 the Canadian Police College in May 2010.

CRTI 06-0163TD

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

PROJECT LEAD: Health Canada – Radiation Protection Bureau
FEDERAL PARTNER: Environment Canada – Canadian Meteorological Centre
INDUSTRY PARTNERS: TGIS Technologies, DBX Geomatics, Neolore Networks

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Objectives

The Federal Nuclear Emergency Plan (FNEP) provides the framework for coordinating and conducting the multi-departmental federal response to a radiological or nuclear emergency affecting Canadians domestically and abroad. The Accident Reporting and Guidance Operational System (ARGOS) supports all aspects of radiological-nuclear (RN) emergency preparedness and response associated with the FNEP.

In this project, Health Canada's Nuclear Emergency Preparedness and Response Division (NEPRD), in collaboration with Environment Canada's Canadian Meteorological Centre (CMC), will integrate real-time geocollaboration components with ARGOS. The new subsystem will be based on GeoConference, commercial off-the-shelf software from TGIS Technologies.

Relevance

The capabilities provided by this customized and enhanced addition to the ARGOS system will enable the Canadian nuclear emergency response structure to facilitate large quantities of dynamic multi-disciplinary, multi-sourced geographically referenced assessment information in real time, allowing for improved decision making.

Recent Progress and Results

This project is in the initial phases: the contracts for all industry partners are expected to be completed in the first quarter of the 2008–2009 fiscal year.

The new subsystem will be based on GeoConference, commercial off-the-shelf software that provides easy-to-use, low-bandwidth, map-based Internet conferencing. It will present geographically referenced eMap information to conference participants through connections to standardized web mapping services and vector data.

Traceability is an important part of the FNEP requirement. GeoConference already has features that assist decision recording. Additional features will be added to allow reuse of georeferenced features created in map-based Internet meetings and for comprehensive recording and replay of map-conferencing sessions. Software integration and development is being funded by CRTI.

Impact

This project is expected to enhance communication among nuclear emergency stakeholders and decision makers that may be dispersed geographically during a radiological or nuclear event by providing a shared online tool box for collaborating on geographically based information in real time. This new tool box will be a significant enhancement to the current FNEP ARGOS/eMap system.

CRTI 06-0169TA

Universal Surface Decontamination Formulation

PROJECT LEAD: Environment Canada
FEDERAL PARTNERS: DRDC Ottawa
INDUSTRY PARTNERS: SAIC Canada, Allen-Vanguard Corporation
ACADEMIC PARTNER: Queen's University
OTHER PARTNERS: Environmental Protection Agency, Research and Development
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Objectives

The aim of this project is to modify CASCAD, a broad-spectrum aqueous decontaminant, to make it much more effective for radiological decontamination. CASCAD in its present form is effective for decontamination after biological and chemical events but does not have the required properties to treat radiological releases.

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

Relevance

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

The project team has all the expertise and facilities required to significantly advance CBRNE response capabilities. 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 based on the results of previous studies. As such, it will attempt to bring together a combination of recent technological advances. This project will also address gaps in radiological risk assessment, decontamination, and urban dispersion modelling.

Recent Progress and Results

The CASCAD modification will be achieved by incorporating proven radionuclide sequestering agents into the current formulation. The agents to be used are novel, yet commercially available, isotope-selective compounds. Studies of compatibility between sequestering agents and CASCAD components will

be a major part of the project. The project team will systematically evaluate and optimize properties of the formulations they develop with regard to the existing capabilities in chemical, biological, and radiological decontamination, as well as blast suppression.

Impact

When added to a blast suppressant developed by the RCMP and Canadian industry, CASCAD components provide a technological solution for mitigating the effects of terrorist explosive devices containing chemical and biological (CB) agents. CASCAD is now used by the military, first responders, and decontamination teams across Canada and a number of other countries. Since it was developed primarily for CB response, CASCAD is only moderately effective for radiological decontamination. The new formulation will improve upon existing CB decontamination and blast suppression characteristics.

A new CASCAD formulation will greatly increase our preparedness for remediation after a terrorist event or an industrial accident that involves a radiological release. CASCAD is currently the best decontamination product in the industry, based on its ability to neutralize a wide variety of contaminants and because it is relatively safe for the application and clean-up personnel. The new CASCAD will 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 greatly impact the preparedness and response of first responders and technology users to a CBRNE event.

CRTI 06-0170RD

Organophosphorus Agent Decontamination

PROJECT LEAD:	Environment Canada
FEDERAL PARTNER:	Royal Military College of Canada
ACADEMIC PARTNER:	Queen's University
INDUSTRY PARTNER:	SAIC Canada
OTHER PARTNERS:	Research Institute of Hygiene, Occupational Pathology and Human Ecology, State Research Institute of Organic Chemistry and Technology

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Objectives

The primary objective of the study is to develop and evaluate a safe and rapid catalytic decontamination method designed to remove and destroy organophosphorus 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 organophosphorus 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

Organophosphorus 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. The 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 they will require no further waste containment or treatment operations.

The solid-supported catalytic methodology uses columns through which recovered solutions of organophosphorus 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

Over the course of this three-year study, the project team will create viable solid-supported catalysts; develop appropriate low toxicity and flammability solvent systems that solubilise the organophosphorus agents and allow catalytic decomposition; investigate the destruction of organophosphorus toxic substances on building materials, on sensitive equipment, and in soil; develop and optimize a solvent recovery system; demonstrate a pilot-scale soil remediation system; and develop methodologies for building, equipment, and soil decontamination.

Impact

The new technologies developed through this project will contribute to current contamination countermeasure strategies. They will be applicable to buildings, equipment (including sensitive equipment), contaminated soil, and sediments, and will be a valuable asset for equipping and training response personnel. The new technologies will likely find broad application, both domestically and internationally, in response to chemical emergencies, decommissioning of industrial facilities, and environmental remediation.

It is expected that the newly developed technologies will also be applicable to biological and combined chemical-biological decontamination. This is due to the disinfection action of the alcohols used in the process.

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 – Protective Technical Services Branch

INDUSTRY PARTNERS: APEX Industries Inc.

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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. 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/vendors offering vastly different security situations.

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.

Impact

The ultimate door designs will contribute to hardening the target in order to restrain known skill levels of adversaries who are using today's newer, more powerful, portable tools. These advanced physical attributes, coupled with electronic security enhancements, will improve security preparedness against attempted theft by providing additional response time for the authorities having jurisdiction.

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, Director General Nuclear Safety

OTHER PARTNERS: Université Laval, Centre Hospitalier Universitaire de Québec, Centre de Recherche en Infectiologie

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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. Relatively large instruments have been used for area monitoring of neutrons; however, these powered instruments are not well suited for personal dosimetry. The "neutron bubble detector" has been introduced as a small, passive device for individual neutron-dose assessment. For a complete mixed-field measurement, specialized equipment builders have developed sophisticated instruments that employ a spectroscopy method for either linear energy transfer (LET) 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

Chemical methods were developed for surface modification of a particular commercial grade of polycyclic olefin, which has a high glass-transition temperature and excellent optical and micromachining properties. 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. Calculations determined the amount of DNA released by various radiation doses. The amount of DNA functionalized on the surface will take into consideration these numbers so as to optimize the detection of released DNA using a cationic polymer. Furthermore, tests were conducted in order to minimize or eliminate unspecific binding of DNA on the plastic surface.

A first sensor prototype was constructed using a polydimethylsiloxane (PDMS)-based microfluidic device and a polycyclic olefin slide containing grafted specific oligonucleotide sequences. This sensor module is currently undergoing testing under radioactive exposure. Initial detection and quantification of fragmented DNA after radiation exposure was carried out with standard polymerase chain reaction (PCR) techniques. The device will eventually incorporate functionalized beads for detecting the released DNA with a cationic polymer coupled with ultra-sensitive detection via fluorescence chain reaction (FCR). An optical reader is currently being built that will enable the reading of the polymer-based devices. Finally, the 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 therefore improve Canada's ability to prepare for and respond to a terrorist attack and address many CRTI scenarios of preparedness priority.

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, Centre Hospitalier Universitaire de Québec, Centre de Recherche en Infectiologie

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Objectives

The proposed project will build on previous expertise acquired through the CRTI program and move the technology from an RD project (CRTI 03-0005RD: Sensor Technology for the Rapid Identification of Pathogens Used as Bioweapons) to a fully validated device (technology demonstration). The main goal is to build a prototype of a novel biosensor and have it tested by a first responder to improve on the design and functionality of the device. The instrument will be able to positively identify the presence of *Bacillus anthracis* (anthrax)—pass or fail—in solid powder within 90 minutes and will be tested by the RCMP.

Relevance

The project will be relevant to many CRTI priority areas, providing investigational authorities such as the RCMP with a tool to diagnose, track, and detect the source of biological agents such as 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 version of the prototype is nearly complete. Aspects of its design, fabrication, and functionality were defined in consultation with the first responder. Specifically, the project team outlined the overall analytical procedure with a particular emphasis on *B. anthracis* spores and detailed how they envisage implementing all the steps on a chip. The team first focused on the choice of plastics suitable for making the chip, screening a number of commercially available hard thermoplastic materials compatible with microfabrication for their thermal, mechanical, and optical properties. Lysis of *B. anthracis* spores was also attempted by both mechanical and magnetic actuation, and the project team evaluated the performance of the two methods.

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 *B. 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 also 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 the first responder is planned in early 2009, after which 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 to, 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 priority 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.

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, Public Safety Canada, Royal Canadian Mounted Police
INDUSTRY PARTNER:	Bubble Technology Industries
INTERNATIONAL CONTRIBUTOR:	International Atomic Energy Agency

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Objectives

Optically stimulated luminescence (OSL), a technique capable of measuring a radiation-induced signal from many common materials, is a rapidly expanding area of study. OSL has many well-established applications in technical fields such as geoarchaeological dating and medical dosimetry, as well as several emerging security-related applications. This project seeks to build upon the success of the recently completed project, "Forensic Optically Stimulated Luminescence" (CRTI 02-0045RD), by developing and field-testing a single instrument, the portable OSL detector (POD). The POD is capable of applying OSL techniques to forensic investigations, arms control verification, and retrospective accident dosimetry.

Relevance

The POD is designed with three distinct end-user communities in mind, and thus has applications across several priority areas. Many radiological-nuclear (RN) terrorist scenarios involve the acquisition, transport, and storage of a radioactive source. Because many ubiquitous materials retain an OSL signature long after irradiation, an instrument capable of measuring this signal in the field will allow investigators to confirm the previous location of a radioactive source even when no trace of radiological contamination or other evidence remains. This capability will prove invaluable in the tracking of radiological materials both for forensic investigations and arms control inspections.

The retrospective dosimetry function of the POD would prove equally invaluable following an RN attack, such as the dispersal of a radioactive substance in a radiological dispersal device (RDD) event, where it is certain that the majority of those potentially exposed will not be wearing dosimeters. The enhancements to the POD relative to the original forensic OSL prototype will permit first responders to accurately estimate the external radiation dose of such individuals by analyzing personal electronic devices, such as cellular phones, PDAs, and laptop computers in their possession at the time of exposure. This "fortuitous dosimetry" approach will allow for a more rapid and accurate dose estimate than is currently available for unmonitored individuals, enabling triage and consequence management.

Recent Progress and Results

The inaugural meeting of the project team was held on 14 March 2008. The primary goal of this meeting was to obtain input on end-user requirements from the project partners to inform the development of a preliminary design, to be presented for approval in May 2008. Technical development is well underway, with significant progress made in identifying new technologies and components that will improve the system's performance relative to its predecessor. Once the preliminary design has been approved, the project will proceed through iterative construction and testing of laboratory and field systems, with end-user feedback driving development at all stages.

Impact

The POD has attracted a great deal of interest from the forensics and intelligence communities, as well as from organizations such as the International Atomic Energy Agency (IAEA), who seek to detect undeclared nuclear activities. Previous work has demonstrated that the device will be capable of detecting radiation exposure in a wide range of ubiquitous materials, including cement, concrete, ceramic tile, table salt, and the ceramic substrates of electronic components—one or more of these materials is sure to be present in any conceivable scenario involving illicit RN activities or radiation exposure to the unmonitored public. At the conclusion of this project, the POD will be ready for commercial production and adoption by the law enforcement, arms control verification, and medical responder communities, providing capabilities to each group that are not currently available by other means. Following testing of the finished detector in realistic field trials, to be designed with the input of end-users, the project is scheduled to conclude at the end of 2009.

CRTI 06-0192TD

CBRN 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.

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Objectives

Serious deficiencies in respiratory protection programs (RPPs) for specific application to CBRN response were identified on a previous CRTI project (CRTI 0029RD: Protecting the First Responder Against CB 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 (i.e., orders of magnitude higher than traditionally considered for occupational applications), and concerns pertaining to the protective status of equipment when donned at the time of an incident. This project will implement a number of recommendations from the previous CRTI project to resolve these issues, which would otherwise prevent an individual responder from obtaining adequate protection on the scene of an event.

Relevance

The project will provide training packages for first responders and support immediate response requirements, while assisting the federal partners with regulatory compliance. The technology and leave-behind capability to be developed will be used as a platform for program development and training of other first responder groups.

Recent Progress and Results

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

The project team will evaluate three categories of respirators—the air purifying respirator (APR), powered-air purifying respirator (PAPR), and self-contained breathing apparatus (SCBA)—using individual system qualifications (ISQ), simulated-workplace-protection evaluations (SWPF), and field-expedient protection evaluations (FEP). Each combination of respirator and application (ISQ, SWPF, and FEP) will be considered and demonstrated as the project progresses through laboratory trials and refinements, developmental testing (DT), and operational testing (OT). Assessment technologies that may potentially be investigated and optimized for one or more applications include condensation nucleus counter (i.e., Portacount), controlled negative pressure (i.e., OHD3000 and corn oil), and differential pressure methods (P). The interaction of each respirator with other protective equipment, clothing, and gear will be considered, along with the anticipated responder activities of the five different CBRN responder groups within the RCMP and Health Canada.

Impact

The capabilities, including test equipment, training, and written procedures, attained by the RCMP and Health Canada through this project (with similar capabilities maintained at the Royal Military College of Canada (RMC) will constitute the leave-behind capability of the project. The successful protocols and test procedures will also be published, such that other first responder groups will be able to duplicate the outcomes of the project within their own respiratory protection programs.

The capability for determination of the workplace protection factor for responder groups will be maintained and contracted by RMC, consistent with previous successful efforts in this area (i.e., for the Canadian Forces and a variety of responder groups, governments, and industry worldwide over the last 15 years). The project team led by RMC will be available for consultation to any group wishing to implement these components of a respiratory protection program.

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

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Objectives

The objective of this project is to build a short-range (SR) lidar (light detection and ranging) system with command and control (C2) networking capabilities for the remote detection and classification of laser-induced fluorescence from bioaerosols. The device will be small—the size of a shoe box—with minimal costs for maintenance and acquisition (less than $50,000). SR Biospectra will have a range out to 100 metres for detecting the presence of biothreats over indoor, semi-enclosed, and outdoor venues.

Based on previous work done at DRDC, an alpha model will be designed, built, and tested by October 2008. Then, based on lessons learned and interviews with first responders, a beta prototype will be designed, built, and tested by fall 2009. INO (National Optics Institute) will integrate, fabricate, calibrate, and compliance-verify the system hardware, while MacDonald, Dettwiler and Associates Ltd. (MDA) will develop the C2 system. DRDC will develop the spectral exploitation algorithm and provide the testing and evaluation facilities. Telops will provide commercialization feedback at the design as well as the testing and evaluation phase.

Relevance

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

Recent Progress and Results

This project is in the initial stages of development with contract structures put in place in February 2008. Calculations and modelling based on scaling factors from the lidar equation and sensitivity data from a previous DRDC technical investigation project (Stand-off Integrated Bioaerosol Active Hyperspectral Detection), have predicted a sensitivity of 1,000 CFU/Litre under low/medium ambient radiance at a range of 100 metres and

with collecting optics of 15 centimetres in diameter. This modelling work has formed the basis for the alpha model currently being designed.

Concurrently, INO has developed a software simulator for the device to permit MDA to develop a C2 system compatible with the hardware. To reduce false positive alarms to a rate compatible with most operational requirements, DRDC is developing a multivariate spectral exploitation strategy. This exploitation strategy, once coded by MDA in SR-BioSpectra, will permit the evolution of a spectral library alongside the evolving operational capability needs.

Plans for testing and evaluating the alpha prototype are underway. First, well-calibrated solid targets scatterers will be deployed to quantitatively evaluate the optical performance of the prototype for subsequent comparison with the model's predictions. Second, the lidar adapted obscurant chamber at DRDC Valcartier, having a clear corridor of 2.4 metres $\times$ 2.4 metres $\times$ 22 metres, and equipped with remotely controlled garage-type doors, will be used to contain inoffensive simulants of aerosolized biological agents (e.g., *Bacillus globigii*) and clouds of aerosols of interest for the public security community (e.g., tear gases, pepper spray, and obscurants). The produced clouds will have their concentrations refereed with an aerosol particle sizer (APS) providing the concentrations and sizes of the aerosols challenging the alpha model as a function of time. By analyzing the spectral data produced by SR-BioSpectra in comparison with those from the APS, limits of sensitivity in particles per litre (ppl) as a function of the ranges and probed volumes will be derived. This analysis and the first responders' feedback from the testing and evaluation done at Valcartier will direct the design of the beta model.

Impact

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

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

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Objectives

This project will deliver a database to help investigators and first responder organizations obtain rapid, evidence-based assessments of many improvised explosive (IE) formulations, compositions, and recipes. This database—populated with detailed, scientifically sound, and physically tested and validated data—will provide end users with accurate information on over two dozen critical factors for a minimum of 40 IE formulations and technologies. The database 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 database 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 is reviewing information sources and prioritizing formulas and compositions. Under Phase III, scientific partners have been investigating a series of explosive mixtures based on urea nitrate (UNi), including the chemistry of UNi, coupled with mechanical (impact, friction, electrostatic discharge) and thermal sensitivity studies of UNi and selected mixtures. Partners also investigated detonation properties of the UNi and mixtures, determining detonation velocity and air-blast properties for both free-field and fully confined (chamber) situations. This information allows for the determination of damage and lethality as a function of distance, based on estimates of the TNT equivalency as a function of blast for the explosive mixtures.

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) and the United Kingdom (UK). 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 Canadian Explosives Research Laboratory, Public Safety Canada, and the RCMP).

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: University of Texas at Austin – Pharmaceutics

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Objectives

The first objective of this project is to develop a formulated pre-clinical grade optimized Adenovirus Human serotype 5 (AdHu5) Ebola virus vaccine. This vaccine must be substantially more efficient than the first generation Ebola virus 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 objective is to identify immune correlates of protection against Ebola virus in NHPs by the end of the project (summer 2010). The project team will perform an in-depth evaluation of different immunological markers at different time points post-immunization and challenge. The completion of these objectives will provide the necessary knowledge to support a Phase I clinical trial in healthy volunteers in Canada and Africa.

Relevance

The primary method of vaccination is by IM injection, exclusively inducing systemic immune responses. The researchers have developed an optimized adenovirus-based Ebola vaccine that can be delivered intranasally, and therefore stimulate both mucosal and systemic immune responses. A successful nasal vaccine strategy against Ebola virus could easily be extended to other biothreat agents, such as the smallpox virus. It would offer mucosal protection and all the additional advantages provided by rapid and safe, needle-free vaccination. The development of clinical grade vaccines against biothreats 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

Zaire ebolavirus (ZEBOV), one of the four subtypes of Ebola virus identified to date, is associated with mortality rates of up to 90 percent. Currently, it is impossible to predict the re-emergence and spread of Ebola virus. A safe and effective vaccine would provide a long-term solution by preventing the spread of infection. Recently, vaccines based on virus-like particles, vesicular stomatitis virus, human parainfluenza virus type 3, or adenovirus—containing or expressing the ZEBOV glycoprotein (ZGP)—have successfully protected NHPs against a lethal dose of Ebola virus. The National Institute of Health (NIH) has initiated a Phase I clinical trial in normal adults immunized with the first generation AdHu5-ZGP to evaluate safety and immune responses to the vaccine.

Adenovirus vectors are highly immunogenic and have become a popular tool for vaccination due to the well-documented clinical trials evaluating gene transfer efficacy and immune responses following administration. The ZGP antigen was codon optimized for expression in mammalian cells and inserted downstream of a modified CAG promoter (chicken-β-actin promoter, cytomegalovirus 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. These results support future development and pre-clinical testing of the optimized Ad-CAG/optZGP vaccine.

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 now ahead of schedule with results surpassing expectations. The optimized Ad CAG/optZGP vaccine will soon be tested in guinea pigs immunized through the IM or mucosal route and challenged systemically or nasally. The researchers anticipate completing the project's objective as planned in the summer of 2010.

CRTI 06-0230 RD

Rapid Methods for Emergency Radiobioassay

PROJECT LEAD: Health Canada
FEDERAL PARTNERS: DRDC Ottawa, National Research Council of Canada
OTHER PARTNER: Carleton University, University of Western Ontario, Atomic Energy of Canada Limited – Chalk River Laboratories

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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 and Carleton University to develop rapid radiobioassay methods to measure Po-210 and Sr-90 levels in urine and fecal samples. The project team will develop the radiobioassay methods by coupling rapid and automated sample preparation techniques with fast and sensitive measurement techniques.

Relevance

Rapid bioassays 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 will provide assessment results for possible internal contamination within the first 48 hours after the incident to better assist in medical intervention decision making.

Recent Progress and Results

The project has been divided into two main tasks: rapid and automated sample preparation, including effective matrix removal and effective analyte extraction; and fast and sensitive measurement, including combined Cerenkov counting with liquid scintillation counting (LSC) for Sr-90 and liquid scintillation alpha spectrometry for Po-210. New scintillation systems, especially new scintillants such as quantum dots (nanoparticles with great potential for use in radiation detection), will be developed to improve energy resolution and signal/background ratio, and to reduce quenching. In addition, new techniques and methods developed for laboratory reach-back will be tested and applied in a field-deployable instrument.

The project officially began in December 2007 and the project team has been working on the plans for each task. Carleton University and Health Canada are studying the separation of Sr and Yttrium radionuclides from urine samples; DRDC Ottawa, Health Canada, the National Research Council, and the University of Western Ontario are conducting experiments on the response of quantum dots to radiation; and Health Canada, DRDC Ottawa, and Atomic Energy of Canada Limited (AECL) Chalk River Laboratories are planning an animal study on Po-210.

Impact

A wealth of new knowledge will be created during the project, in both sample preparation chemistry and radiation measurement. The project partners will deliver new techniques and methods for rapid measurement of these two radionuclides in bioassay samples, including integrated instrument systems. These new techniques and methods will significantly enhance Canada's RN emergency response capability, especially for immediate and near-term consequence management.

CRTI 06-0234TA

Advanced Syndromic Surveillance and Emergency Triage

PROJECT LEAD:	National Research Council – Institute for Information Technology
FEDERAL PARTNER:	Public Health Agency of Canada
INDUSTRY PARTNERS:	AMITA Corporation, SilvaCorp, E-Privacy Management Systems Inc.
OTHER PARTNERS:	University of Ottawa Heart Institute, Ottawa Public Health, Ottawa Hospital, Children's Hospital of Eastern Ontario, Queensway Carleton Hospital, Montfort Hospital, Michigan Department of Community Health, Queen's University Emergency Syndromic Surveillance Team, Grey Bruce Health Unit, Peel Public Health, Carnegie Mellon University – School of Computer Science – Auton Laboratory, Canadian Institute for Health Information

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Objectives

This project aims to enhance CBRNE preparedness and response techniques by advancing the deployment and adoption of syndromic surveillance technology. Syndromic surveillance uses IT to routinely monitor existing data streams, such as health records, to identify disease outbreaks. The Advanced Syndromic Surveillance and Emergency Triage (ASSET) project will establish a successful and highly visible prototype deployment of syndromic surveillance in Canada's capital, Ottawa. This first Canadian installation in a city at high risk will promote similar deployments in other high-risk regions.

Relevance

Currently, syndromic surveillance is limited in Canada because there is no turnkey system that can be readily deployed throughout the country, and the end-user community and other stakeholders that will promote the uptake and dissemination of this technology have yet to be fully engaged. Also, there remains concern that syndromic surveillance may generate too many false positive alerts, and that deployments directed solely at counterterrorism will be neither cost-effective nor sustainable.

ASSET will push syndromic surveillance technology to a tipping point where widespread uptake will be possible. It will do this by delivering a system that is ready for deployment anywhere in Canada; by providing methods to improve the adoption, usability, and ongoing operations of syndromic surveillance in Canada; and by providing response protocols suitable for Canadian cities. To address concerns regarding high false-positive rates, ASSET will improve breadth of coverage by accepting and analyzing bilingual data input and allowing multiple syndrome classifications per patient; improve data accuracy by accessing medical records in greater depth

and allowing easy addition of new, more precise syndrome definitions; and will use the best available outbreak detection algorithms such as Bayesian spatial cluster detection.

The ASSET system will be able to detect natural and terrorism-related disease outbreaks by building on the investment to date by CRTI and others in developing syndromic surveillance. ASSET is a natural extension of the Early CBRN Attack Detection by Computerized Medical Record Surveillance (ECADS: CRTI 03-0013TD) and Canadian Early Warning System (CEWS: CRTI 03-0019TD) projects, as well as 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 also complements the Canadian Network for Public Health Intelligence (CNPHI) project (CRTI 02-0035RD), which is a comprehensive monitoring, alerting, data-gathering, analysis, decision-support, and information-exchange platform to integrate public health intelligence across multiple jurisdictions into a common national framework. ASSET focuses on cities and regions, and will provide health units and regional authorities with the tools they need to collect and use syndromic information at a local level. Appropriately filtered by CNPHI, information from ASSET can then be applied nationally. 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 project to fruition.

Recent Progress and Results

The ASSET project kicked off in June 2007. Phase 1 was completed in January 2008 and included project start-up activities such as contracting and the production of the project charter and project plans. Phase 2 will run for seven months and covers the deployment of the existing ECADS-RODS (real-time outbreak and disease surveillance) syndromic surveillance system in Ottawa.

Over 50 participants from various organizations attended the first ASSET Study/Stakeholder meeting, which was held at The University of Ottawa Heart Institute in January 2008. 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 roundtable discussions and breakout sessions that covered issues of concern to the industry. The first ASSET newsletter was produced in March 2008 and featured articles on syndromic surveillance, the January meeting, and a profile of Ottawa Public Health.

The project team has completed several Phase 2 tasks including establishing the syndromic surveillance system development environment, determining the Ottawa ECADS-RODS deployment infrastructure, and producing a draft deployment plan. A Preliminary Privacy Impact Assessment was also completed for the project. Tasks currently in progress include obtaining ethics board approval for syndromic surveillance; preparing a memorandum of understanding (MOU) or data sharing agreement between the hospitals; conducting a public health user study; and integrating Ottawa region maps into the syndromic surveillance system. Future work planned for Phase 2 includes building the data feeds from the hospitals, collecting historical data from hospitals, and deploying the ECADS-RODS system in Ottawa. The project ends July 2009.

Impact

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 discerning the type of event, its geographical distribution, and the 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.

In addition, ASSET and its United States (US) partners will support and promote binational interoperability. This will be achieved by working with the Public Health Agency of Canada (PHAC) and CNPHI to develop protocols and algorithms that will establish and strengthen the collaboration of Canadian public health units and other stakeholders with their US counterparts.

CRTI 06-0236TA

IED-CID Explosives Incident Expansion Project

PROJECT LEAD:	Royal Canadian Mounted Police – Canadian Bomb Data Centre
FEDERAL PARTNERS:	Department of National Defence, Defence Research and Development Canada, Canada Nuclear Safety Commission, Natural Resources Canada, Canadian Security Intelligence Service, Canadian Food Inspection Agency
INDUSTRY PARTNERS:	AMITA Corporation
OTHER PARTNERS:	Carleton University – Human Oriented Technology Lab, INTERPOL

AUTHORS:

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Objectives

Improvised explosive devices (IEDs) are a growing threat both internationally and in Canada. As such, this project is expanding CRTI-04-0047TD "CBRNE 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.

IED-CID will operate on two principles: aligning civilian (RCMP) and military (Department of Defence Canada Forces Explosive Ordinance Disposal [EOD]) 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.

Recent Progress and Results

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 (NRC-ERD), the Canadian Nuclear Safety Commission (CNSC), and the Canadian Food Inspection Agency (CFIA) will provide CBRNE-subject expertise. The Carleton University Human Oriented Technology (HOT) Lab will provide human machine interface expertise and design.

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. Throughout the project, two phases will be run in parallel: the transition phase, which will prepare the system for production in various environments, and the commercialization phase, which ensures the application of the product will thrive past the completion of the project. The evaluation phase and project completion phase—in which the results of the project are documented—close out 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 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 (RSP) for identifying successful and unsuccessful procedures related to neutralizing CBRNE devices, including 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.

CRTI 06-0252RD

Protocols for Modelling Explosives 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.

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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 near 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 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 first-principles modelling solutions 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 (R&D) 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 (CFD) 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 third 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. Some preliminary aspects of the physical models have been developed and compared with experiments, coordinating with the definition of their requirements. This includes models for reaction of combustible particles; the equation of state for the afterburning of detonation products of explosives; shock and detonation compression momentum; and heat transfer to accelerate and heat particles in heterogeneous explosives. It also includes models for wall or street reflection from explosives and combustible powders in urban environments; near-field mixing mechanisms including collision, jetting, turbulence and wake flow; and casing effects and fragmentation.

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 standards and modelling guidelines 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.

CRTI 06-0255TA

Medical and Casualty Management Command Post (MedPost)

PROJECT LEAD: DRDC Ottawa

INDUSTRY PARTNERS: AMITA Corporation, CAM Emergency Preparedness, Correct Solutions, E-Privacy Management Systems Inc., NORMECA, St. John Public Health Consulting International Inc.

OTHER PARTNERS: Grey Bruce Health Unit, Government of New Brunswick – Department of Public Safety – Security and Emergencies Directorate, University of Ottawa Heart Institute, United States Department of Health and Human Services, Office of Preparedness and Emergency Operations, Office of the Assistant Secretary for Preparedness and Response, Carleton University – Human Oriented Technology Lab, Canada Health Infoway

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Objectives

The 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, and federal level to reduce the morbidity and mortality associated with such events.

The 2003 SARS outbreak brought to light capability gaps in the Canadian health care information management system. Taking into consideration the gaps identified and lessons learned from that outbreak, the MedPost system will be 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.

Relevance

MedPost will improve CBRNE preparedness and response capability by integrating communications between on-scene responders, hospital medical staff, and members of the response community involved in managing a CBRNE event. 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). Allowing different levels of responders to view medical information about casualties will dramatically improve situational awareness of CBRNE events. 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 activities were completed in early May 2007. 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. A formal meeting was held in February 11, 2008, at the AMITA Corporation in Ottawa to officially launch the project. The nine partner organizations present at the meeting reviewed the project background and set expectations for participation and cooperation. By the end of the first quarter of the 2008/09 fiscal year, the project team will have completed several more key deliverables, including the Requirements and Functional Scope Definition and the Preliminary Privacy Impact Assessment.

Impact

At the conclusion of the MedPost project, the Grey Bruce Health Unit and Grey Bruce Health Services (which encompasses twelve hospitals in the Grey Bruce area) will have an operational prototype of a 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 prototype will be flexible enough 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.

CRTI 06-0259TD

Psychosocial Risk Manager (PriMer): 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
OTHER PARTNERS:	Justice Institute of British Columbia, Netherlands Organisation for Applied Scientific Research, Health Protection Agency

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Objectives

Research data indicates that psychological, behavioural, and social impacts are the most enduring and costly consequences of terrorism threats and actual events. CBRNE and natural disaster events, as well as the threat of these events, disrupt public trust, economy, social fabric, and well-being—affecting victims, responders, decision-makers, and the general public. To deliver more effective rescue efforts and assistance in long-term recovery, Canada needs better preparation, planning, knowledge, and understanding of psychosocial factors.

This project builds on previous CRTI work that yielded the Psychosocial Risk Assessment and Management (P-RAM) framework (CRTI 02-0080RD), a CBRN-adapted integrative framework combining threat characteristics with evidence-based documentation of psychosocial effects or factors. The goal of this TD project is to use technology and multimedia to 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 multimedia training package (PriMer) that will be bilingual and user-friendly. The team will develop a multimedia interactive session using computer-assisted teaching; design psychosocially oriented exercises and tasks; prepare a web-based, self-study guide; provide a click-on P-RAM decision support tool; and script an in-class, two-day training session with a sustainable Train-the-Trainer component.

Relevance

The need for more psychosocial knowledge available to the responding community and to non-specialists has been loudly and clearly articulated by all types of audiences in the project team's series of consultations across Canada and across sectors. This psychosocial-knowledge need spans the topics of communicating with the public, dealing with the media, coordinating between units, pre-event training, anticipating public and worker reactions, and building public confidence.

The project team will package the theoretical and research contributions of the recently completed RD 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 various types of responders. This will improve plans, improve appropriateness of response to public demands, increase public confidence in authorities, and augment resilience as well as compliance.

This research stems from the Group for the Analysis of Psychological Health's (GAP-Santé's) more theoretical and fundamental level work, sponsored by The Social Sciences and Humanities Research Council (SSHRC), in which GAP-Santé examines the psychosocial aspects of individual's and group's perception and behaviour and how they 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

The psychosocial content identified in GAP-Santé's research and development program has been structured in learning units and skills of relevance, for which GAP-Santé will design an appealing user-friendly training concept to be delivered in multimedia mode. Experts and field workers will validate the products for content and usability, and responders, planners, and decision makers will test the products in training demonstrations. The product will also be tested, in French and English, through a field exercise.

The core partnership of the project evolves from an already well-established relationship between the University of Ottawa group and the Public Health Agency of Canada, and will extend to the Justice Institute of British Columbia (JIBC), and private sector multimedia production professionals from Praxcim, a firm specialized in multimedia training for large operation, multi-site, complex organizations. GAP-Santé's network of responders and planners include the federal health and security agencies, the provincial emergency medical services, and social services, and some municipal pilot groups. The project team aims to integrate military operations with DRDC and Canada Command, especially in the context of preparation for the Olympics. With GAP-Santé's concurrent work on pandemics and their TD partners, GAP-Santé is accessing the private sector. This project will also foster GAP-Santé's links with the United Kingdom Emergency Training Centre, the Netherlands' TNO group that leads many counterterrorism initiatives within the European Union, the United States Department of Homeland Security sociobehavioural group, and the Australia panel on population mental health and disasters.

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, allowing them to build from an all-hazard platform and to relate back to it.

PRiMer training is meant to also 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 it through commercialization to both the public and private sectors. Training of various stakeholders will serve to enhance planning and preparedness, as well as improve all-hazard crisis response, an area in which the public demands great reassurance.

CRTI 06-0275TD

Integrated Two-Way Radio Radiation Sensors

PROJECT LEAD: Royal Canadian Mounted Police
INDUSTRY PARTNERS: Motorola, Bubble Technology Industries
OTHER PARTNERS: Edmonton Police Service, Montreal Fire Service, Ottawa Police Service, Toronto Fire Service, Toronto Police Service

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Objectives

Currently, most RCMP, police, fire, and emergency medical services (EMS) personnel do not carry radiation detection equipment during their daily activities. This deficiency leaves these responders at a high risk of radiation exposure in the event of a radiological or nuclear incident. For example, first responders converging on the site of an explosion have no warning to indicate whether the bomb contained radioactive material, and could work in a contaminated area for hours, exposing themselves to radiation and unknowingly spreading the contamination to hospitals, command centres, and homes.

Motivated by a strong end-user push, this project will integrate small radiation sensors with commonly used Motorola two-way radios in order to provide responders with a simple, integrated device for personal radiation safety and detection of nuclear materials.

Relevance

The project directly addresses several key CRTI priorities: it enables rapid determination of the existence and scale of a radiation event, aiding in responder safety and accurate public information; it provides a novel and significantly improved detection capability and an improved communication link for detection, surveillance, and alerting systems; and it supports police and interdiction capabilities through the development of a technology that identifies the presence of nuclear material and supports nuclear crisis and consequence management. Successful implementation of the technology will place Canada's responders at the forefront of nuclear protection and response.

Recent Progress and Results

Led by the RCMP, this project is strongly supported by police and fire services from Edmonton, Toronto, Ottawa, and Montreal. Motorola's development team in Florida, which is responsible for the design of Motorola's two-way radio products and accessories, is leading the industrial effort. Bubble Technology Industries will closely collaborate with Motorola to develop and integrate a compact, affordable, radiation sensor package.

There will be four key outcomes of this 18-month project: developing and integrating a compact, reliable radiation sensor with a standard two-way Motorola radio product for the purposes of first responder personal radiation safety and detection of nuclear materials; producing and distributing prototype devices to end-user partners in order to assess and demonstrate the utility of these devices through field tests; utilizing the input from the end-user partners to define and accelerate the transition of the technology to a suitable commercial product; and creating a network of partners with synergistic technical expertise and operational experience that will continue to drive innovations in first-responder communication and sensor systems.

This project is currently scheduled to commence in June 2008.

Impact

A terrorist attack, act of war, or accident involving radioactive materials is a real and critical threat. In such a crisis, our first responders will be called upon to rescue, evacuate, treat, and manage the front line response. In many cases, they will converge on the scene before any clear characterization of the magnitude of the event can be formed. It is, therefore, imperative that our officers, firefighters, and EMS personnel arrive at the incident equipped with sufficient gear to immediately identify serious threats to personal safety. The high risk of a radiation-related incident (such as a dirty bomb), coupled with the inability to detect radiation through ordinary senses, drives the need for first responders to carry radiation sensors as part of their standard equipment.

The project will utilize a proven three-phased, systems engineering approach to rapidly define, develop, and test the technology. Successful completion of this project will yield a compact prototype radiation sensor, which is conveniently and affordably integrated with a common two-way radio. The device will equip the operational community with sensors that will alert personnel to radiation safety hazards, enabling them to minimize their radiation exposure. Through subsequent development, the alarm status of the sensor can also be tagged with the identity and location of the user and transmitted to nearby radios and the dispatch centre, allowing other responders to identify a responder in need. Use of the device during routine operations will also provide the capability to detect radioactive sources in the vicinity and assist in the prevention of an incident involving radioactive materials. Approximately thirty prototypes will be distributed to the end-users for a comprehensive test phase that will accelerate the transition of the technology to the operational community.

CRTI 06-0301TD

Development of a Nasal Spray Formulated with Antiviral Drug against Avian Influenza Virus

PROJECT LEAD: DRDC Suffield
FEDERAL PARTNERS: Public Health Agency of Canada – National Microbiology Laboratory
INDUSTRY PARTNERS: Northern Lipids Inc., Oncovir Inc.

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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 avian 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 viruses. 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 US Food and Drug Administration (FDA) guidelines, Oncovir will be able to produce GMP-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 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 Toll-like receptor 3 (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, and 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.

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, Department of National Defence – Defence Research and Development Canada, Department of National Defence – Director General Nuclear Safety, Canadian Police Research Centre
INDUSTRY PARTNERS:	AMITA Corporation, Loraday Environmental Products Ltd.
OTHER PARTNERS:	Toronto Police – CBRN Team, Carleton University – Human Oriented Technology Lab

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Objectives

The goal of this project is to provide police, emergency medical services (EMS), and hazardous materials (HAZMAT) personnel with a tool to manage the crime scene of a CBRNE event or subsequent criminal investigation. PROBE combines commercial software with CRTI-developed software products to create an integrated, expandable, and easily portable crime scene-management tool. PROBE will leverage previous CRTI investments to close critical gaps in crime scene-management capability originating in the current void of automated, standardized, and interoperable tools.

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. This project is designed to create awareness around automated collection of crime-scene evidence, information on triage of casualties, and monitoring scene integrity.

Relevance

As the scene of a CBRNE event evolves into a criminal investigation, information becomes difficult to control and combine into a manageable format. PROBE will provide a previously unavailable, integrated, crime scene-management capability allowing police, HAZMAT, and EMS personnel to communicate and share CBRNE-event data and other information in real time. Responder safety and public information programs will be significantly improved through this automated support tool. PROBE will provide equipment and a knowledge base 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 community will be better prepared to investigate CBRNE crime scenes by using national investigation standards for the handling of CBRNE (or contaminated) forensic and long-term evidence samples.

Recent Progress and Results

Project contracting closed in late March 2007 and Phase 1 activities, including project definition and detailed project planning, are complete. Phase 2 activities, focusing on product development, are well underway with certain key deliverables, including the functional scope definition and determination of the technical approach, in process and scheduled for completion during the first quarter of 2008/2009. In addition, the first of three project newsletters was published.

Once the product is developed, trained police, EMS, and HAZMAT personnel will test and evaluate PROBE through a series of live field exercises. The test and evaluation process will provide relevant and meaningful requirements to guide the development of the next generation commercial tool over the near- and mid-term future. The PROBE project team will leave a fully functional prototype product with each field test evaluation member. The project is planned for completion in September 2010.

Impact

Current stand-alone commercial and CRTI-developed software tools (Chemical Biological Response Aide [CoBRA], Palm Emergency Action for Chemical – Weapons of Mass Destruction [PEAC-WMD], Rapid Medical Triage Workbench [RTMW], Socius, RFID) provide various capabilities for managing CBRNE events. The project team will leverage these tools by integrating them into one comprehensive and interoperable suite of tools.

PROBE will be portable and will provide responders with critical CBRNE-information sources, standardized incident-reporting forms and procedures, mass casualty triage management, and evidence tagging using RFID. It will also provide interoperability and data exchange between the various responders to assist crime scene management.

CRTI 06-0318TD

Higher Education Cooperative for Hazardous Materials and Equipment Tracking

PROJECT LEAD:	Royal Canadian Mounted Police – National Services and Research Branch
FEDERAL PARTNER:	Royal Military College of Canada
INDUSTRY PARTNER:	Vertére Inventory Control Systems
OTHER PARTNERS:	University of Ottawa, Queen's University, Concordia University

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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 needed. 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 develop and "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 due-diligence reporting relationships and requirements. This project will commence with chemical inventories with subsequent work incorporating radiological, biological, and other controlled materials.

Relevance

This project will standardize the management of chemical inventories, resulting in wide-reaching benefits. Benefits to universities include compliance to 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 provide first responders with access to information that may aid in emergency response. In addition, the database 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 05-0121RD: Evidence-based Risk Assessment of Improvised Chemical and Biological Weapons.

Recent Progress and Results

Contracts between Public Works and Government Services Canada (PWGSC) and the University of Ottawa, Concordia University, and Queen's University were signed into effect only during the last days of fiscal year 2007/08. Irrespective of these delays, the universities started pre-contractual work and purchased the appropriate licenses, servers, barcode readers, and associated merchandise to start the project.

The University of Ottawa hosted a workshop in February to identify regulatory reporting requirements for several federal departments and Acts (e.g., Chemical Weapons Convention, *Transportation of Dangerous Goods Act*, *Chemical Management Plan*).

A sub-set of the chemical inventory at the University of Ottawa has been provided to Vertére Inventory Control Systems for conversion to their database format.

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 the 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.

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 PARTNERS:	Moroz Biomeasurement Systems Inc.
OTHER PARTNERS:	University of Waterloo, Loughborough University, Toronto Fire Service, Toronto Police Service, RCMP Toronto Detachment, Canadian Joint Incident Response Unit

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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 casualties 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 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 that 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.

Computerized Explosives Validation Tools (CEVT)

PROJECT LEAD: DRDC Valcartier

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Abstract

THz spectroscopy is one of the most promising technologies to detect concealed explosives non-invasively without the health threats of ionizing radiation. The THz spectroscopy has the potential to revolutionize security scanning by seeing inside bags and containers to provide a 3-D model of their contents as well as their various chemical compositions. Its unique strength to detect explosives and precursors via its unique THz molecular signature perfectly fits to one of CRTI priorities on pre-events of CBRNE.

The project aims to facilitate the use of THz spectroscopy for C, B, E threat-material detection by creating an intelligent computerized THz spectroscopy and imaging system to enhance THz radiation signal of explosives and relevant barrier materials, remove atmosphere and barrier materials noise, and reduce false alarm rates for standoff detection. The key objectives include (a) to create an experimental THz radiation database of explosives and relevant barrier materials; and (b) to develop efficient and accurate quantum chemistry calculations on THz spectroscopy of explosives using novel quantum chemistry algorithms and high-performance multi-core hardware computing.

Radiation Detection Modelling and Operational Analysis for Detection Architecture Studies

PROJECT LEAD: Department of Homeland Security, USA

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Abstract

A primary mission of the Domestic Nuclear Detection Office (DNDO) is to develop an enhanced Global Nuclear Detection Architecture (GNDA) by analyzing current detection capabilities, identifying gaps and solutions, and investigating new areas for further research and development. A "nuclear detection architecture" in this context is a strategy to reduce the risk of nuclear terrorism by encountering, detecting, and interdicting nuclear threats before they reach their intended targets.

Quantitative, physics-based models and mathematical analysis can often identify, at an early stage, the proper priorities and technical barriers for detector research and acquisition, operational planning, detection architecture, and laboratory and field testing. Modelling can also aid data analysis by providing metrics and predictions for comparison to data. As fundamental building blocks for architecture analysis, detection modelling and operational analysis are essential tools for DNDO to quantify the performance of detection technologies and concepts of operation (CONOPS) that are being considered for possible deployment in the domestic and global nuclear detection architecture.

In support of this broad analysis task, DNDO is supporting a detection modelling effort aimed at developing and applying an overall modelling framework, including supporting models and databases. The DNDO modelling team consists of Lawrence Livermore National Laboratory, Pacific Northwest National Laboratory, Sandia National Laboratory, and Science Applications International Corporation. For any given analysis, the choice of a particular model will depend on the specific question or decision at hand. For example, an "end-to-end" model of a multi-layered defence is useful for assessing the overall risk posed by RN threats. By contrast, an evaluation of the performance of a single detection system in a specific deployment concept would draw on more detailed models describing the relevant contributing factors. This evaluation would need models that characterize the following basic elements: radiation sources, including threat sources, ambient background, benign "nuisance" sources such as NORM, industrial and medical sources; detector and detector system hardware and software; and operational scenarios involving realistic source-detector encounters and the impact on normal activity of alarm resolution protocols. In addition, the modelling framework must include appropriate data for model calibration and validation.

The focus of this presentation will be on modelling approaches and needs for assessing single detector performance in operational environments. The project team will present examples of results, insights, and recommendations that have emerged from their modelling efforts since the establishment of DNDO in 2005. The team will address the topics of radiation sources; detector models for passive, active, and radiographic detection; operational scenarios and response protocols for alarm resolution and interdiction; and databases for model validation and effectiveness studies.

ECADS–RECORD
Early CBRN Attack Detection by Computerized Medical Record Surveillance—Retrospective ElectroCompilation of Emergency Room Data

PROJECT LEAD:	National Research Council – Canada Institute for Information Technology
FEDERAL PARTNER:	Public Health Agency of Canada
INDUSTRY PARTNERS:	AMITA Corporation
OTHER PARTNERS:	University of Ottawa Heart Institute, Carnegie Mellon University – School of Computer Science, Grey Bruce Public Health Unit, South Bruce Grey Health Centre, Grey Bruce Health Services, Hanover and District Hospital

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Objectives

Syndromic surveillance systems detect abnormal disease occurrences that are time and geographically dependent for outbreak detection and tracking. Early CBRN Attack Detection by Computerized Medical Record Surveillance (ECADS) demonstrated the retrospective ability to detect the gastroenteritis outbreak in Walkerton, Ontario in May 2000. At the completion of the ECADS project (CRTI 03-0013TD), the Grey Bruce Health Unit (GBHU) chose to adopt the system. GBHU began monitoring live data feeds from 12 emergency departments on a daily basis for infectious disease alerting using the system in 2005. The system has since provided alerts on norovirus, influenza, *Cryptosporidium* and scarlet fever.

ECADS–RECORD is a protocol that follows ECADS, which will be used to extract and analyze a closed, de-identified data set from December 2005 to March 2008 from the GBHU. The University of Ottawa Heart Institute and Carnegie Mellon University will conduct a retrospective analysis of the alerts provided to GBHU, write a scientific paper describing the GBHU experience with syndromic surveillance for the purpose of publication, and develop improved detection algorithms to reduce false-positive alerts.

Relevance

ECADS–RECORD will highlight, in a scientific paper, several of the highest-risk scenarios identified by CRTI and describe methods to mitigate risks by early detection and investigation of infectious disease outbreaks. In the

absence of a terrorist attack, syndromic surveillance systems provide public health institutions with the ability to detect and manage naturally occurring outbreaks. By providing evidence of the value of automated data extraction and analysis of the data contained in health care records in a real-world setting, this data analysis will provide further impetus for the development and deployment of this technology. Syndromic surveillance has the potential to provide a source of high-quality health care data on large populations not only for disease surveillance but for improved health care management, health services research, and epidemiological research.

Recent Progress and Results

The ECADS–RECORD project team has held four teleconferences to plan the methodology for data transfer and analysis and to outline the content for the scientific paper. The team has reviewed the disease outbreaks that were detected and tracked by the GBHU using ECADS. Earlier detection and better situational awareness, as a result of ECADS, were confirmed and will be highlighted in the analysis. The team has explored incorporating complementary sources of information for surveillance such as school absenteeism in the analysis. The GBHU response protocols have been reviewed and will be included in the analysis.

Submissions to hospital ethics boards for project review are complete and approvals are pending. A data accumulation plan has been devised and contact has been made with the participating hospitals and respective privacy officers. A plan for transferring and storing the data securely has been completed. A data sharing agreement to address all privacy and security issues between the participating hospitals, the GBHU, and the University of Ottawa Heart Institute is being drafted. Quick progress on this agreement is anticipated as it is similar to the one used for ECADS.

Carnegie Mellon University is making preliminary adjustments to their detection algorithms in anticipation of analyzing the data set. The detection algorithms will be described in the methods section of the analysis.

Impact

Syndromic surveillance improves the responder community's ability to determine the existence and scope of a disease outbreak. This project will provide evidence from an actual syndromic surveillance deployment in Grey Bruce, demonstrating improved infectious disease detection and situational awareness by the health unit and the community. The team will conduct a descriptive analysis of the technical issues and factors affecting the usability and acceptability of the system by local users. The analysis will be formatted into a paper for publication in scientific journals. Receptors of these deliverables are municipal, provincial, and federal public health and safety communities; first responders; and military.