CRTI - IRTC

PART II

THE CRTI PORTFOLIO 2004–2005

CRTI ANNUAL REPORT 2004–2005

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

Canada

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The Chemical, Biological, Radiological, and Nuclear (CBRN) Research and Technology Initiative (CRTI) was announced in the December 2001 National Security Budget as one of the Government of Canada's Public Security and Anti-Terrorism (PSAT) initiatives. CRTI has a five-year mandate to manage a $170 million science and technology (S&T) fund to invest in Canadian preparedness against CBRN threats.

In 2004, a portfolio of Technology Acceleration (TA), Research and Technology Development (RD), and Technology Demonstration (TD) projects was chosen based on the following factors:

- Evaluation criteria (utilization, delivery, management, leveraging collaborations, and contributions);
- Mandatory requirements of innovation, relevance, and uniqueness;
- The funding envelope;
- CRTI investment priorities; and
- The *CRTI Framework*.

The 2004 CRTI Portfolio is presented in Part II of this annual report.

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CRTI 03-0005RD

Sensor Technology for the Rapid Detection and Identification of Pathogens Used as Bioweapons

Project Lead:

National Research Council – Industrial Materials Institute

Project Partners:

National Research Council – Steacie Institute for Molecular Sciences, Health Canada, DRDC Suffield, Université Laval, Centre Hospitalier Universitaire de Québec, Infectio Diagnostic Inc.

Current detection technologies of biothreat agent nucleic acids rely on prior amplification, a time-consuming critical step sensitive to inhibitors present in the sample. It is also prone to false positive results because of cross-contamination of reagents or laboratory infrastructures. This project aims to develop sensitive, low-cost, portable nucleic acid biosensors that will enable researchers to detect and identify pathogens such as *Bacillus anthracis* in real time without prior amplification. This project will significantly improve Canada's immediate response and near-term consequence management capabilities for a bioterrorist (BT) attack, as well as provide a key mitigation factor in addressing CRTI risk scenarios of immediate, high, and emerging priority for preparedness.

The National Research Council (NRC) will continue to develop technology that will combine minimal sample preparation, highly selective capture, and pre-concentration of the targets, as well as real-time optical detection using water-soluble, cationic, polymeric transducers. The main objective of this project is to develop a functional prototype that can directly identify fewer than 10^3 *B. anthracis* cells and spores, either from pure culture or from spiked test samples within one hour—a capacity that could be extended in the future.

The impacts of this revolutionary technology are significant. The technology will provide military and civilian personnel with the fastest response time yet to biological threats, as well as opportunities for Canadian biotechnology companies to develop a significant competitive edge over polymerase chain reaction (PCR) amplification technologies. It is expected to improve capabilities for medical triage procedures and high-performance tools used to detect and classify events. The technology will also contribute to the efficient diagnosis of infectious diseases and genetic disorders.

CRTI 03-0009RD

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

Project Lead:

Health Canada

Project Partners:

University of Ottawa, Department of National Defence, Canadian Women's Health Network, GPI Atlantic, Scarborough General Hospital, Victorian Order of Nurses, Elizabeth Bruyère Research Institute, Ontario Ministry of Community Safety and Correctional Services, University of Toronto, British Columbia Centre of Excellence for Women's Health, Canadian Federation of Nurses Unions

Traditionally, health care workers have not been included in CBRN response policy development and training. Terrorist and natural disasters such

as the attack on the World Trade Center in New York City and the Severe Acute Respiratory Syndrome (SARS) outbreak in Toronto have, however, highlighted the critical need to include this forgotten population in Canada's emergency preparedness plans.

Using the 2003 SARS epidemic as a case study, this project will investigate frontline health care worker response to, preparedness for, and resilience for coping with disaster scenarios. The results will then be used to identify gaps and make recommendations for improved support mechanisms.

The four-year study is divided into four progressive components, or modules, each building on the knowledge and resources developed in earlier modules. The first module involves a substantive review of existing literature in three distinct areas: support mechanisms for health care workers as first responders; impacts on first responder health care providers involved in SARS and other examples of undefined airborne biological agents; and mechanisms to adopt communication and organizational best practices. A summary document incorporating each of these topics will be synthesized to provide a resource for decision makers.

The second module involves the administration of a survey to public health care workers, specifically civilian and military nurses, and military physician assistants. The survey will focus on the family and health impacts on first responders resulting from their potential or actual involvement as frontline workers responding to outbreaks of infectious, airborne biological agents.

The third module for this project focuses on identification, risk assessment, and analysis of hospital employee support mechanisms during an infectious disease outbreak. This component will include an evaluation of infectious disease outbreak emergency plans for three candidate hospitals, including Scarborough General Hospital, and focus group interviews with emergency team members. The results from the analysis of the hospital emergency plans and focus group interviews will be combined with the results of the survey from Module two, and compiled into a report outlining a risk management framework for public health emergency preparedness for infectious disease outbreaks. An additional report will be prepared, examining personnel policy and work–family conflict from a gender perspective.

The fourth and final component focuses on disseminating and transferring knowledge to policy audiences. The project team, which includes researchers from governmental and non-governmental organizations (NGOs) and institutions, will host a policy workshop to provide a forum for discussion and interpretation of the implications and recommendations resulting from the study. The proceedings will later be compiled into a discussion paper. The recommendations regarding risk communication will also be developed into a document designed to influence and shape public health policy in the event of an infectious disease outbreak.

CRTI 03-0017TA

Development of a Directional Gamma Ray Probe

Project Lead:
DRDC Ottawa

Project Partner:
Bubble Technology Industries

The activation of a radiological dispersal device (RDD), sabotage of a reactor, or other potential radiological terrorist events could result in widespread contamination of a large area. Multiple fragments of radioactive material would most likely be strewn over the area in relatively close proximity to one another and would require rapid remediation. To date, however, first responders do not have the necessary technologies to isolate and identify the radioactive materials in the presence of multiple sources.

This capacity gap was recently demonstrated during the North Atlantic Treaty Organization's (NATO) Prototype Response Exercise and CRTI's Exercise As Is. Significant confusion arose among responders, including military officers and technical experts, when multiple gamma ray sources were present in a small area. The isotropic response of conventional gamma ray detectors prevented rapid isolation and identification of the individual sources. This situation led to increased time spent in close proximity to the radiation, resulting in a higher, unnecessary dose to the first responders. As a result of inadequate equipment, the isotopes present were also misidentified and the activity was incorrectly estimated. Even where there is a single, isolated radioactive source, the isotropic detector response can only indicate source location by examining dose rate trends, requiring first responders to physically move closer to the source. This again results in increased exposure of first responders.

Several solutions have been suggested to rectify these problems, but all have shortcomings. For example, the use of pancake probes to detect the associated beta emissions very close to the ground or to the source will result in even more gamma exposure to the responders. Collimated detectors demand an unacceptable mass increase. Finally, electronic methods, such as modified phoswich systems, are not suitable at higher energies owing to particle range considerations.

A simple solution that was recently proposed involves modifying the high-sensitivity S-Probe built by Bubble Technology Industries (BTI) for DRDC Ottawa. Used for high-efficiency directional gamma spectroscopy on land vehicle platforms, the probe is extremely effective at detecting very low levels of radiation. It is too large and heavy in its current form, however, to be used as a hand-held instrument.

The goal of this project is to downsize the S-Probe design into a more convenient and portable directional gamma ray probe (DGRP) for use in the field. Some relevant software already exists, such as spectral unfolding, dose calculations, peak search software, and so on, that will reduce the software development requirements. The DGRP will be packaged as a single unit, weighing approximately five kilograms, with display features that include source direction, isotope identification, and dose rate.

The final deliverable of this project will be a field-ready DGRP with sufficient sensitivity to

detect radiation levels a few times higher than those present in a normal background. The project plan has integrated both the end-user and the research and development (R&D) community into the management structure, ensuring that guidance is provided to the project as the DGRP is constructed.

The design and construction of the DGRP will occur in two stages. The first stage will involve incorporating new device requirements, as assessed by end-users, and testing the functionality of the device with these new features. In the second phase, the device will be built with reduced size, weight, and electronics specifications, and will be tested thoroughly by the end-users to ensure that it meets their requirements.

The DGRP prototype's directional and multi-source response will be tested in an operational environment using realistic simulation fields at DRDC Ottawa's T-100 compound. The final device is expected to be tested in a CRTI exercise similar to Exercise As Is.

The use of a DGRP will enable users to more rapidly and accurately locate and identify sources and determine activity in either multi- or single-source environments, thereby greatly improving Canada's response to CBRN terrorist events. Following the project, the DGRP will augment the radiation response detection suite available to the responder community. In time, the DGRP may replace current hand-held spectroscopic units that do not offer the invaluable directional information.

CRTI 03-0018RD

Experimental Characterization of Risk for Radiological Dispersal Devices

Project Lead:
DRDC Ottawa

Project Partners:
Sandia National Laboratories, University of British Columbia, DRDC Valcartier, Environment Canada – Canadian Meteorological Centre, Royal Military College of Canada, University of Ontario Institute of Technology, Health Canada, Carleton University

The efficacy of RDDs, or dirty bombs, has been a topic of considerable debate in the past few years. Opinions on RDD risks often vary wildly; some completely discount them as a risk, while others greatly overstate their impact. The purpose of this project is to address gaps in our knowledge of the risks associated with the explosive and non-explosive dispersal of radioactive material. This information is essential to properly assess the risks associated with radiological terrorism.

This project will focus on areas of RDD research that have been identified as high priorities for assessing terrorist threats but that have not been adequately explored by other research groups. Currently, the only active research project that is addressing RDD efficacy worldwide is being conducted by Sandia National Laboratories in the United States (US). The experimental plan for this project will be coordinated by DRDC Ottawa, in consultation with Sandia National Laboratories, in order to maximize effectiveness, address gaps left by the Sandia experimental program, and facilitate data sharing.

To this end, the explosive dispersal experiments will focus on ceramic materials supplied by UBCeram at the University of British Columbia. Complementary open-air explosive experiments will be conducted to verify dispersion models and study dirt entrainment in the plume. Non-explosive dispersal experiments will focus initially on the dispersal of powdered sources—a research area that has not yet been studied—and will then move to liquid dispersal using commercial nozzles.

The characterization of the explosive dispersal of radioactive material will take place at DRDC Valcartier. DRDC Valcartier has a fully enclosed aerosol test facility where the majority of the explosives tests will be performed. This facility provides complete containment of any aerosol generated in the test, enabling researchers to accurately determine the aerosol fraction and size distribution for explosive RDDs. In addition, DRDC Valcartier has an explosives test range where outdoor tests will be performed. The purpose of the outdoor tests will be to verify atmospheric dispersion models provided by Environment Canada's Canadian Meteorological Centre for RDDs using real-time light detection and ranging (LIDAR) tracking provided by DRDC Valcartier and the Royal Military College of Canada (RMC). They will also be used to study complicating factors such as dirt entrainment in the explosive-generated plume.

The characterization of the non-explosive radiological dispersal portion of the project will be completed at the University of Ontario Institute of Technology (UOIT) in Oshawa, Ontario. Work in this area was started under another CRTI project (CRTI 02-0024RD: Probabilistic Risk Assessment Tool for Radiological Dispersal Devices), and will continue in greater depth under this project. The UOIT test facilities consist of a real-time particle size measurement system based on laser scattering from aerosol particulates. This system enables the rapid and detailed characterization of spray mechanisms for both liquid and powdered sources.

The health effects of RDD-generated aerosols will also be assessed. Health Canada and Carleton University will use a wide variety of analytical techniques to determine the properties of the aerosols generated in the tests. These will include the measurement of elemental concentrations in aerosol samples, morphological characterization of particulates, determination of the fraction of the simulated radioactive material aerosolized in the RDD, measurement of aerosol solubility in lung fluid, and the calculation of health effects from aerosol inhalation.

As the project lead, DRDC Ottawa will oversee all aspects of the project, including the production of detailed reports summarizing the experimental findings, databases of measured aerosol properties, and models for the prediction of such properties for both explosive and non-explosive RDDs. The project will provide data on the toxicity of these aerosols and enable researchers to verify atmospheric dispersal models, which are used for assessing general CBRN threats. These data and models will allow researchers to quantify both the feasibility and impact for known and emerging RDD threats. The project is expected to last three years.

CRTI 03-0025TA

Defender Nuclear Detection Web

Project Lead:
Health Canada

Project Partners:
Canada Border Services Agency, Transport Canada, DRDC Ottawa, Canadian Police Research Centre, Brookhaven National Laboratory, Bubble Technology Industries, xwave

The International Atomic Energy Agency (IAEA) and the US Department of Homeland Security have recommended that neutron detection equipment be used to intercept illicit radiological-nuclear (RN) materials. Historically, however, it has been difficult to provide widespread neutron detection capabilities because of the high cost and technical complexity of many neutron detection systems. This project, led by Health Canada, will provide an ultra-sensitive, low-cost nuclear detection web using a unique, highly sensitive neutron detector recently developed by BTI as well as a novel, scalable data management network.

For more than 15 years, BTI's bubble detector has been used by nuclear facilities, military personnel, space agencies, national labs, and the medical community for personal neutron dosimetry and neutron field characterization. The most sensitive passive personal neutron dosimeter in the world, it consists of a clear, pocket-sized tube filled with a polymeric gel that contains tiny droplets of a superheated detector liquid. When a neutron strikes a droplet, the superheated liquid vaporizes and forms a visible gas bubble that is trapped in the gel. Since the number of bubbles is directly proportional to the neutron dose, the device provides a quantitative, real-time measurement of radiation exposure. BTI's simple design has allowed the bubble detector to be adopted readily by users with little to no training.

Using the same superheated droplet technology, BTI has recently developed an ultra-sensitive neutron detector for rapidly detecting minute amounts of RN materials. The Defender™ detector provides unparalleled sensitivity at extremely low cost and enables the implementation of a broad coverage, real-time, preventive nuclear detection web. The detectors will be equipped with electronic instruments, and a data management network for the sensor information will be developed.

Health Canada will collaborate with BTI, Brookhaven National Laboratory (BNL) in the US, xwave (a Canadian defence and aerospace information technology company), and four federal agencies (i.e., Canada Border Services Agency, Transport Canada, DRDC Ottawa, and the Canadian Police Research Centre), to develop, test, and deploy the Defender nuclear detection web.

Scalability, in both the detector size and network architecture, will be a key element in the design of the nuclear detection web. By varying the detector size, researchers can cover a full spectrum of applications, ranging from a pocket detector for continuous surveillance by authorities and a hand-held detector for personal and vehicle inspections to a fixed-installation detector for border checkpoints or rapid cargo container monitoring. Using a novel, multi-tiered architecture approach, the network will be capable of handling data from a few users to more than a few hundred thousand users. The detectors will also link to the network through an open-architecture protocol that will enable other types of detectors with the

appropriate communications protocol to be supported by the network.

This project is keenly relevant to three of the stated CRTI investment priorities. It improves Canada's prevention, surveillance, and alert capabilities by providing an unparalleled, low-cost neutron detection system with the sensitivity and broad coverage to successfully detect illicit RN materials before they can be assembled into a weapon. Through its multi-tiered network, it improves command, control, communications, coordination, and information (C^4I) capabilities by managing the communication of critical data between local and federal authorities and among federal agencies. It also provides first responders and operational authorities simple-to-use, real-time neutron detectors with very low false alarm rates compared to gamma detectors and other traditional neutron detectors.

From a broader perspective, the Defender nuclear detection web will offer Canada the unique ability 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 03-0013TD

Early CBRN Attack Detection by Computerized Medical Record Surveillance

Project Lead:
National Research Council

Project Partners:
University of Pittsburgh, Grey Bruce Public Health Unit, Health Canada, Carnegie Mellon Auton Laboratories

Recent scientific studies indicate that routinely monitoring specific indicator variables, such as over-the-counter drug sales of specific drug classes and the number of patients presenting to emergency rooms with symptoms and physical signs typical of specific diseases, can provide a valuable early indicator of a disease outbreak. Syndromic surveillance systems are designed to detect time- and geography-dependent abnormal occurrences (i.e., frequency or total numbers) of such indicator variables. They can be used to alert responders that an outbreak or terrorist attack may be in progress, and to track the progress of an outbreak after it has been detected. Developed by the University of Pittsburgh, Real-Time Outbreak Detection and Surveillance (RODS) is a syndromic surveillance system that is now available as open-source software to encourage its deployment and further development.

The first goal of this project, which will be led by the NRC, is to adapt RODS to the Canadian setting and deploy it successfully as a technology demonstration in conjunction with the Grey Bruce Public Health Unit in northern Ontario.

The project's next objective is to improve the specificity of syndromic surveillance. To accomplish this, the NRC will add the capability of storing free text portions of emergency room records (anonymized) to RODS. This capability will provide first responders with important information that will enable them to better characterize a potential event. The project team will work with the NRC Institute for Information Technology to improve the computerized analysis of those free text portions of the medical record. NRC will also collaborate with Carnegie Mellon Auton Laboratories in the US to optimize detection algorithms using emergency room data from past, representative outbreaks, including the 2001 *Eschericia coli* outbreak in Walkerton, Ontario.

In the third stage of the project, researchers will integrate a RODS-based syndromic surveillance system with existing and planned disease surveillance and information management systems in Canada and the US. This will be done in conjunction with Health Canada and US health institutions.

Lastly, the NRC will develop a road map for implementing syndromic surveillance in Canada. The road map will consist of a detailed implementation plan addressing technical and non-technical issues that affect future development and deployment of such a surveillance system. It will define the current state of syndromic surveillance in Canada and will identify knowledge gaps, challenges, and opportunities for routine use and collaboration with stakeholders. It will also outline the risks and barriers associated with different levels of deployment, and provide an analysis of how best to integrate syndromic surveillance with current and emerging electronic health records.

By advancing Canadian expertise in syndromic surveillance and demonstrating a system that can be readily deployed across the country, this project will address several of the highest risk scenarios identified by CRTI. In the absence of a terrorist attack, syndromic surveillance systems will also provide public health institutions with the ability to detect and manage naturally occurring outbreaks.

CRTI 03-0018TD

Airport Radiological Counterterrorism Sensor Network

Project Lead:

Health Canada – Radiation Protection Bureau

Project Partners:

Ottawa International Airport, Ottawa Police Service, Transport Canada, Health Canada – National Dosimetry Service

Airports—and the air travel and transport industries—are important components of Canada's critical infrastructure and are integral to modern economic and community life. As a consequence, the travelling public, airport facilities, and aircraft, as well as the first responders who protect them, require the most appropriate security tools available in the post-September 11, 2001 environment.

In the context of the global economy, airport and air transport security are increasingly recognized areas of concern. International and national standards for air industry security are addressing the current understanding of prevailing risks, including radiological and nuclear agents.

Significant radiological sources as well as a large number of smaller sources are widely used within Canada and around the world in medical, industrial, and scientific applications. Because of the variable security with which radiological sources are held, they are widely understood to be available for theft, diversion, or illegal acquisition. Since there is currently limited capability for radiological surveillance at Canadian airports, there is concern that illicit radioactive materials may be introduced undetected into airports and into airport passenger, baggage, or cargo systems.

To address this gap, this project will implement an operational radiological security system at the Ottawa International Airport that could provide a transferable model to protect other airports in the national aviation system. The network will provide routine radiological security for passengers and the airport, with particular emphasis on the safety of first responders and airport staff in an actual or suspected radiological incident.

To ensure relevance and practicality, the project's development team includes the Ottawa International Airport security system end-users, Ottawa Police Service first responders, and the Radiation Protection Bureau of Health Canada. Health Canada's National Dosimetry Service will also participate, implementing personal radiation detection devices to provide greater safety for workers and first responders.

In the first year of the project, radiation sensors will be selected and deployed in a network of mobile- and fixed-surveillance units. The sensors will provide a powerful security tool for deterring the illegal movement of radiological materials into the Ottawa International Airport. They will also provide the airport with effective capabilities for early detection and effective incident interdiction and management for the first time. In parallel, radiation dosimetry will be implemented for the protection of workers and first responders.

In the second year, operational experience with the network will be applied to develop the knowledge base required to transfer it to other airports. Transport Canada will also use experience with the system to address future regulatory options.

CRTI 03-0019TD

Real-Time Biosurveillance and Response Readiness Using an Interconnected, Electronic, Information Infrastructure: A Region-wide Technology Demonstration Project at the Winnipeg Regional Health Authority

Project Lead:
Health Canada

Project Partners:
IBM, Winnipeg Regional Health Authority

In the event of an intentional CBRN event in Canada, regional health authorities (RHAs) will play the key role in both frontline surveillance and response. Unusual clusters of disease are most likely to be identified at the community level, and RHA first responders will have the responsibility to provide and deliver effective response measures.

Although health information in Canada is currently captured at many "points of care," the ability to move and consolidate the information for analysis and response is primitive. Given the delays in detection and the speed at which characterization proceeds, existing systems cannot detect outbreaks of disease with the timeliness needed for an optimal response to a BT event.

In an effort to address this gap in public health preparedness, IBM will partner with Health Canada and the Winnipeg Regional Health Authority (WRHA) to deliver a comprehensive, real-time biosurveillance and response readiness network for the city of Winnipeg, Manitoba. The project, which could provide the foundation for a comprehensive national program, will target two disease syndromes: acute respiratory and gastrointestinal episodes. The implementation

of IBM's Healthcare Collaborative Network (HCN) will enable real-time, automated data collection from existing legacy systems including hospital emergency rooms and laboratories, pharmacies, and tele-triage. The HCN will provide fast, security-rich data transfer through an innovative "Publisher-Subscriber System," while encryption technology will be used to strip all personal identifying information prior to transmission.

Data will then be delivered to the surveillance arm of the Canadian Network for Public Health Intelligence (CNPHI) where it will be assessed to identify aberrations and monitor disease progression. Once data collection begins, signals detected by the biosurveillance network will be investigated and compared to traditional public health information. CNPHI analysis capabilities will include web-enabled real-time data display using graphs and maps, cluster detection in both time and space, and prediction capabilities. The intelligence generated, including any alerts, will be evaluated and made available to the respective data providers and the WRHA for further assessment through CNPHI's secure surveillance Internet portal, the Canadian Integrated Outbreak Surveillance Centre (CIOSC).

Finally, an evaluation study will assess the effectiveness of the piloted data sources, analytic interpretation, and intelligence dissemination from a CBRN perspective. The benefits and costs associated with the implementation of the network will also be determined.

CRTI 03-0021TD

Assay Development and Production Team

Project Lead:

Public Health Agency of Canada – National Microbiology Laboratory

Project Partners:

Canadian Food Inspection Agency – National Centre for Foreign Animal Disease, DRDC Suffield, Health Protection Agency (UK), Centers for Disease Control (US), Lawrence Livermore National Laboratory, California State Laboratory, Commonwealth Scientific and Industrial Research Organization

With the potential threat posed by the introduction of BT agents to the Canadian population and food supply, there is an urgent need to develop rapid and accurate tests that can be used by first responders to make initial diagnoses and to determine the extent of the attack.

Currently, there is insufficient commercial attraction to developing and marketing diagnostic kits for diseases that, although serious in humans or animals, are not present in Europe or North America, and would therefore generate little income. As well, the requirement to work at Biocontainment Level 3 or 4 facilities greatly increases the associated development costs of kits, further reducing any industrial interest. Globally, there are very few high-level containment laboratories working with potential BT agents. In Canada, for example, only the National Microbiology Laboratory (NML), the National Centre for Foreign Animal Disease (NCFAD) at the Canadian Science Centre for Human and Animal Health (CSCHAH) in Winnipeg, and DRDC Suffield have the capabilities to work with these reagents.

Since none of the developed countries have been faced with a BT attack, the response to diseases caused by viruses—such as Nipah, Marburg, Ebola, and SARS—has been limited to the rapid development of diagnostic tests that can satisfy a limited demand. These tests would not, however, likely survive close scrutiny in terms of specificity, sensitivity, and reliability. The reagents for these tests are usually in limited supply, and are often different for each laboratory. The tests used by each laboratory are also often particular to that laboratory, and have not been compared between laboratories using panels of standard sera or antigen.

To date, there are large numbers of potential reagents that have been produced, but not characterized or assessed as being diagnostically useful. This project, led by Health Canada, aims to create a diagnostic core group that will develop, produce, and distribute tests for the detection of BT agents.

Research partners and collaborating laboratories, including the Health Protection Agency in Porton Down, United Kingdom (UK); the Centers for Disease Control (CDC), Lawrence Livermore National Laboratory, and California State Laboratory in the US; and the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Australia will meet to document the existing diagnostic protocols for the major BT agents. The supply of corresponding reagents, the sensitivity and specificity of the tests available, the test platforms, their ease of use, and their likely performance in the hands of first responders in a BT attack will be subsequently assessed. A gap analysis will identify which current BT agent diagnostic technology would not meet international standards for validation, and which quality reagents are unavailable to Canadian laboratories.

Project plans also include stockpiling reagents, producing protocols for the diagnosis of the selected BT agents, and establishing a distribution chain for use by frontline laboratories in the event of a BT attack. Lastly, through cross-training, a hybridoma development capacity will be established at DRDC Suffield.

It is not anticipated that all gaps will be filled within the scope of this project; it will be necessary to select certain BT agents for further test development and validation.

CRTI 03-0023TD

Portable and Collapsible Chemical/ Biological Isolators

Project Lead:

Public Safety and Emergency Preparedness Canada

Project Partners:

DRDC Suffield, DRDC Ottawa, Royal Canadian Mounted Police – Office of Laboratory Security, Health Canada, Canadian Food Inspection Agency – Emergencies Science Division, Environment Canada

First responders from all disciplines are routinely called upon to deal with suspicious packages and their contents. Regardless of whether these packages contain hoax materials or hazardous substances, they must all be treated as legitimate chemical or biological (CB) threats and processed according to the perceived threat. The materials must also receive preliminary processing on site to reduce the risks associated with transporting potentially hazardous materials.

In the case of a major CB incident, certain agencies are mandated to assist with real-time, on-site analysis of suspect materials. These procedures involve opening the container or package, performing preliminary tests on the contents, sampling the contents, packaging any samples, and resealing the container. It is essential that these procedures be conducted in a manner that safely contains suspect materials and that does not affect the health and safety of responders or the public.

A working group made up of technical experts and operational personnel from Public Safety and Emergency Preparedness Canada, DRDC Suffield, DRDC Ottawa, the Royal Canadian Mounted Police, Health Canada, the Canadian Food Inspection Agency, and Environment Canada met in June 2003 to identify the procedures and equipment to be used in investigations of items that may contain or be contaminated with CB materials. The group identified the need for portable and rapidly deployable containment devices that would permit the safe handling of suspect materials, both at the collection and analysis phases of the process. Equipment currently exists that will safely contain either CB materials; however, there are no isolators that can safely contain both types of materials, nor are there any that are well-suited—that is, small enough or light enough—to enable rapid deployment.

To fill this capacity, this project will develop two modular and portable isolation devices. The first device will be a rapidly deployable, lightweight isolator that will allow for on-site collection, containment, and processing of suspect materials. The second unit will be a larger, though still portable, biological Level IV isolator, which will enable safe handling of suspect materials. A set of prototypes will be produced for use in testing and a further four sets of production units will be subsequently delivered to the federal project partners.

It is anticipated that this project will require two years to complete and will be conducted in three phases. The first phase, which will take about six months, will be devoted to identifying suitable materials, designing test plans, establishing specifications, and developing the engineering design and review process for the isolators. The second phase of the project, estimated at about seven months, will involve constructing and testing a prototype. Eventually, testing will involve live agents and will be performed at DRDC Suffield. The third and final phase of the project will involve the construction of four sets of isolators, which will be delivered to end-users for training, evaluation, testing, and demonstration of capability in actual field-use conditions.

The delivered product from this project will be fundamentally important to, and will greatly facilitate, the on-site recovery and processing of evidence recognizing CB hazards. It will also facilitate forensic investigations in contaminated environments.

CRTI 03-0060RD

Protective Markers for Anthrax Serodiagnosis

Project Lead:
DRDC Suffield

Project Partner:
University of British Columbia

The 2001 anthrax attacks in the US, in which 23 people were infected with the disease through the aerosolization of spores from contaminated posted letters, have pushed improvements in

B. anthracis diagnoses and treatments to the forefront of biodefence and medical microbiology efforts.

B. anthracis causes disease via two major virulence factors: a glutamic acid capsule and anthrax toxin. Anthrax toxin is a tripartite protein exotoxin comprised of edema factor (EF), lethal factor (LF), and protective antigen (PA). Because of its central role in the delivery and action of anthrax toxin, PA is an ideal target for the immune response, and a PA-based vaccine can provide protection against an anthrax infection.

The present anthrax vaccines produced in the US and the UK are composed of filtrates from attenuated *B. anthracis* strains that are mainly PA but also contain dozens of other co-isolated factors. The vaccines are expensive to produce and have side effects associated with the co-isolated microbial factors and the formaldehyde that is used to ensure the preparations contain no viable *B. anthracis*. In addition, it takes several immunizations with either vaccine over a prolonged period of time—18 months—before protection is established. With access to these vaccines also being an issue in Canada, the CRTI Biological Laboratory Cluster has identified the need to establish a national anthrax vaccine source and DRDC Suffield is leading efforts to fill this capacity. Assays to monitor the immune status of vaccinated individuals and to determine whether a person has been exposed to anthrax are also needed.

To this end, the primary objectives of this project are to develop a validated serum-screening assay using protective antigen Domain IV (rPA-IV) vaccine, define domains on the PA to identify subjects exposed to or infected with *B. anthracis*, develop an aerosol challenge model for anthrax, and examine novel vaccine leads for rapid immunization.

The development of an aerosol challenge model to anthrax will allow researchers to accurately determine the efficacy of biologicals—drugs, antibodies, and vaccines—to anthrax in a route encountered in a BT agent incident. The project will also offer a potential new recombinant rPA-IV vaccine that could be delivered as an aerosol. The rPA-IV has the potential to provide a vaccine that is cheaper to produce, has fewer side effects, and results in superior protection against the disease with fewer injections. A quicker acting vaccine would not only benefit first responders, but would also reduce the concurrent antibiotic and vaccination treatment time for individuals potentially exposed to inhalation anthrax.

A successful vaccine can also be used to immunize donors for the development of anthrax hyperimmune sera for post-exposure treatment. There is also the potential to immunize via aerosolization of the harmless *Caulobacter crescentus* strain, engineered by the University of British Columbia, to produce rPA-IV displayed on the cell surface. Delivery of the rPA-IV by this method is similar to the route of infection by which inhalation anthrax is established. Aerosol delivery may selectively stimulate the immunoglobulin A-dominated mucosal immune response, which may provide greater protection against the disease than the humoral immune response, generated through the standard subcutaneous delivery of the current vaccines.