EVALUATING RESULTS

Annual Report

2005-2006

CRTI - IRTC

Defence Research and Development Canada

Recherche et développement pour la défense Canada

Canada

THE **MISSION** OF CRTI IS TO STRENGTHEN CANADA'S PREPAREDNESS, PREVENTION, AND RESPONSE TO CBRN TERRORIST ATTACK THROUGH SCIENCE AND TECHNOLOGY.

OUR **VISION** IS TO BE RECOGNIZED AS THE CANADIAN AUTHORITY IN CBRN COUNTERTERRORISM KNOWLEDGE, EXPERTISE, AND SCIENCE AND TECHNOLOGY.

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LETTER FROM THE **CHAIR**

For the Chemical, Biological, Radiological, and Nuclear (CBRN) Research and Technology Initiative (CRTI), 2005–2006 was a redefining year. In addition to continuing to build and strengthen Canada's CBRN science and technology (S&T) capacity, CRTI turned its attention to developing the capabilities that are needed to deter and defend against possible CBRN threats.

A critical step in this progression involved evaluating CRTI's governance and organizational structure, as well as the projects it supports. One of the outcomes of this assessment was a change to CRTI's annual business cycle. By initiating the call for proposals in June 2005, CRTI facilitated the implementation of projects at the beginning of the fiscal year and better aligned its processes with the federal government's budget cycles.

Shifting from technology acquisition to capability acquisition was also the central theme at the Treasury Board of Canada Secretariat (TBS) Renewal Workshop in December 2005, where representatives from CRTI's partner departments met to review CRTI's submission to renew its funding for an additional five years. The submission is expected to be submitted in Fall 2006. Other objectives identified at the workshop included the need for lead federal departments to take a more active role in identifying cluster requirements and goals, as well as more targeted funding and methods of engaging the academic sector. Each of the four laboratory clusters then conducted their own renewal workshops to determine their specific goals and objectives for the coming years. They also looked for new ways to maintain and leverage what they have already accomplished, sustain their momentum, and profile their successes.

In 2005–2006, CRTI completed its fourth and fifth proposal cycles. CRTI will invest a total of $30.5 million into 27 new Research and Technology Development (RD), Technology Acceleration (TA), and Technology Demonstration (TD) projects, as well as $3.6 million in technology acquisitions for federal laboratories.

In parallel with this period of evaluation and renewal, CRTI projects continued to make some remarkable advances in CBRN preparedness. One recently completed project that produced results far surpassing original expectations was the development of medical countermeasures against ricin poisoning (CRTI 02-0007TA). The project, which successfully produced the world's first anti-ricin antibody therapy, was a collaborative effort between three different organizations—Defence Research and Development Canada (DRDC) Suffield, Twinstrand Therapeutics Inc., and Cangene Corporation—each providing its own unique, but interdependent, capabilities.

In addition to the products and technologies developed through CRTI's projects in the last year, CRTI tested the operational readiness of the radiological-nuclear (RN) community at Exercise Maritime Response (EXMR), which took place in March 2006, at Slemon Park, Prince Edward Island. The three-day exercise, which brought together RN scientific and response teams from eight federal departments and agencies, the military, and local and provincial participants from the Province of New Brunswick, was the first-ever integrated, national RN counterterrorism exercise in Canada. The rapid and effective response demonstrated by the teams during the exercise was extremely encouraging and serves a testament to the effectiveness of the CRTI cross-organizational model.

Lastly, I would like to take this opportunity to mention Dr. John Leggat, my predecessor as Assistant Deputy Minister of S&T for Department of National Defence (DND) and Chief Executive Officer of DRDC, who recently retired with over 38 years of service with the public service. I would like to thank him for his leadership in establishing CRTI, and wish him all of the best in his future endeavours. I would also like to thank all of the CRTI partners and staff who have contributed to the initiative's success over the last four years.

I am now pleased to provide you with a review of our progress in 2005–2006 through this fourth edition of the *CRTI Annual Report*.

Dr. Robert Walker

Chair CRTI Steering Committee,

Assistant Deputy Minister (Science and Technology), Department of National Defence,

Chief Executive Officer, Defence Research and Development Canada

1. INTRODUCTION

The Chemical, Biological, Radiological, and Nuclear (CBRN) Research and Technology Initiative (CRTI) is a unique, cross-organizational program mandated to strengthen Canada's preparedness for, prevention of, and response to a CBRN terrorist attack through investments in science and technology (S&T). Since its launch in 2002, CRTI partners have been awarded funding for five rounds of projects aimed at closing S&T gaps in knowledge and capabilities, amounting to approximately $149.6 million of CRTI's $170 million budget. All of these projects are notable for their breadth and quality, and many of them have already made tangible contributions to Canada's national security.

CRTI's emphasis on building and maintaining partnerships has been critical to its success. Led by Defence Research and Development Canada (DRDC), CRTI is comprised of 18 federal government departments and agencies and extends its reach to first responders, provincial governments, and international partners.[1] Work produced with the support of CRTI has gained international recognition within the S&T and security communities and has resulted in significant gains in Canada's CBRN response capabilities.

This annual report charts CRTI's progress, collaborations, and critical factors contributing to its success during its fourth fiscal year, 2005–2006. The structure and content of this report reflect the Results-based Management and Accountability Framework (RMAF), CRTI's blueprint for planning, measuring, evaluating, and reporting on the progress and results of the initiative throughout its life cycle. This report draws on the RMAF's measures and anticipated outputs to chart CRTI's activities during the last year. Corollary information, including financial data, is provided in appendices to this report.

1.1 MANDATE AND KEY ACTIVITIES

CRTI's mandate is to improve Canada's ability to respond to CBRN incidents by strengthening the coordination and collaboration of capacity, capabilities, and research and technology plans and strategies. It does this by

- creating clusters of federal laboratories as elements of a federal laboratory response network that will build S&T capacity to address high-risk terrorist attack scenarios;
- funding research and technology to build S&T capability in critical areas, particularly those identified in the scenarios that address biological and radiological attack;
- accelerating technology for the benefit of the first responder community and other operational authorities; and
- providing funds to those areas where national S&T capacity is deficient owing to obsolete equipment, dated facilities, and inadequate scientific teams.

CRTI manages six key activities:

1. *Creating laboratory clusters* and building an S&T response network for CBRN events.
2. *Building S&T capability* by funding research to build Canadian science capacity in targeted investment areas.
3. *Accelerating technology to first responders* by channelling funding into technology already under development, thereby facilitating timely adoption of new technologies by first responders.
4. *Funding national S&T capacity* by enhancing federal laboratory equipment and facilities.

[1] Member departments and agencies are listed in Annex A.

5. *Building horizontal capability* by leveraging federal government expertise and non-traditional partners, thereby enhancing S&T capacity of Canada.

6. *Building CBRN S&T expertise and knowledge* in national and international CBRN communities.

Progress in each of the six key activities is described in Section 4.

1.2 CRTI INVESTMENT PRIORITIES

CRTI's investment priorities are determined through an analysis of the risk compared with capability and capacity, and the technology requirements and response gaps of first responders and the laboratory clusters. To date, CRTI has created and funded 151 projects, 12 of which have been completed, in support of these priorities.

The table below maps the impacts of the projects against CRTI's investment priorities. The impacts are grouped according to CRTI's four portfolios: Biological, Chemical, Radiological-Nuclear (RN), and Forensic. "Pan" projects that cover multiple hazard and target areas, or address broader response dimensions, are sorted by the primary and secondary capability to be provided by the project.

Note: Because the figures in the table below reflect the number of impacts, and not the number of projects to be achieved by each portfolio, the total number of impacts exceeds the number of projects.

CRTI INVESTMENT PRIORITIES

INVESTMENT PRIORITY	PROJECT IMPACTS				TOTAL
	BIOLOGICAL	CHEMICAL	RN	FOR	
Cluster Management and Operations	4	1	4	1	10
Command, Control, Communications, Coordination, and Information (C^4I) for CBRN Planning and Response	5	4	6	5	20
S&T for Training and Equipping First Responders	9	11	7	2	29
Prevention, Surveillance, and Alert	12	4	11	1	28
Immediate Consequence Management	18	3	10	3	34
Long-Term Consequence Management	9	7	8	1	25
Criminal Investigation Capabilities	2	3	3	5	13
S&T Dimensions of Risk Assessment	2	2	4	2	10
Public Confidence and Psychosocial Factors	3	3	3	2	11

2. CRITICAL SUCCESS FACTORS

CRTI's continued success depends on its ability to recognize and address inherent challenges in fulfilling its mandate. While project partners and laboratory cluster members continue to make remarkable gains in contributing to Canada's preparedness for CBRN terrorist events, the level of engagement and commitment required to meet this objective poses an ongoing challenge. Also, the individual requirements and accountabilities of participating federal departments can sometimes overshadow common, national needs. The following two key factors contributed to CRTI's ability to address these and other challenges in 2005–2006:

- **Outreach:** Formed in February 2005, CRTI's Forensic Laboratory Cluster has strengthened CRTI's connection to first responders through a number of outreach activities targeted to this critical community. CRTI also expanded its reach to first responders, government partners, and international participants through a series of exercises, including the first integrated, national-level RN counterterrorism exercise ever conducted in Canada, Exercise Maritime Response (EXMR). Speaking engagements, workshops, publications, and the Summer Symposium promoted CRTI's mandate and achievements; established what CRTI has to offer; and helped to bring issues to the forefront of discussion. Through these activities, CRTI was able to keep current on new and emerging issues and was able to quickly adapt its approach to address them.

- **Flexibility:** Continued flexibility helps to ensure that CRTI remains a relevant and useful endeavour in which participants can see a role for themselves. To encourage greater participation in the innovation system by the university sector, adjustments to project categories will be considered to be more inclusive of university participants. Changes like these to the CRTI model demonstrate the adaptability of CRTI's approach and its commitment to staying agile, resilient, flexible, and responsive.

3. AUDIT RESULTS

3.1 CRTI INDEPENDENT FINANCIAL MANAGEMENT AUDIT

An independent financial management audit of CRTI was conducted in July and August 2004 and covered CRTI's first two fiscal years, ending 31 March 2004. The main objectives were to ensure compliance with applicable legislation and departmental policies; availability of accurate and complete information for decision-making purposes; and the existence of sound and efficient monitoring and oversight mechanisms for managing CRTI funds in other participating organizations and at the CRTI Secretariat.

The results of the review were favourable; CRTI met all of the criteria against which it was measured. The audit recommendations focused on improvements in financial oversight with respect to the information provided for in-kind contributions, project administration and reporting, and the management of rollover amounts occurring at year-end.

3.1.1 FINANCIAL OVERSIGHT OF IN-KIND CONTRIBUTIONS

In response to the audit recommendations, the CRTI Secretariat prepared a draft document that defines and offers a valuation method for in-kind contributions. It also developed a draft methodology, based on identified best practices for tracking these contributions. Once these drafts have been approved, they will be incorporated into the *Project Implementation Guidebook* (Guidebook). The importance of properly valuing and tracking in-kind contributions will be emphasized during the review of the Memorandum of Understanding (MOU). Detailed guidance on the amendments to the MOU will be provided in the Guidebook.

3.1.2 PROJECT ADMINISTRATION AND REPORTING

To improve project administration and reporting, the CRTI Secretariat invited administration personnel from other government departments to attend the Project Implementation Workshop (PIW) in May 2005, and will invite them to all future PIWs. The CRTI Steering Committee approved measures to give the Secretariat more influence to ensure the timeliness, accuracy, and completeness of quarterly reports; reporting has significantly improved since the new measures were adopted. Close-out or final reports are now being used by project managers. The Guidebook currently specifies the requirements for a final project report, which will be expanded during the next revision to the Guidebook.

3.1.3 FINANCIAL ADMINISTRATION

To improve financial administration, the CRTI Secretariat implemented quarterly finance meetings. Project Finance Officers were informed that they must strictly apply the federal government regulations regarding Payables at Year-End (PAYE) to their respective CRTI projects. Strict adherence to the regulations will greatly reduce the type of problems that were outlined in the audit report. The Secretariat also requested a report of all PAYE set up for CRTI projects at the end of fiscal year 2004–2005, and an update on the status of the PAYE. As recommended by the audit, the importance of having personnel with project management experience involved with CRTI projects has also been emphasized.

3.2 FORMATIVE EVALUATION OF CRTI

In its framework document, CRTI undertook to perform a program evaluation before requesting renewal. Department of National Defence (DND) Chief Review Services contracted Fujitsu Consulting to conduct a Formative Evaluation to assess program performance and identify areas for improvement. The evaluation was conducted over a period of 20 weeks ending on 31 May 2006.

3.2.1 ASSESSMENT

The evaluation found that CRTI is well respected in the S&T community for its innovative approach and overall leadership. It has created recognition and awareness of a critical requirement and has become a focal point for CBRN S&T.

CRTI is fulfilling its mandate in a number of areas including the effective selection, conduct, and oversight of projects; the effective building of the federal S&T network and other Canadian and international relationships; successful responses to non-CBRN events; and performance on CRTI sponsored exercises. Program activities have proceeded as planned with the expected impact in some areas although less so in others.

The evaluation attributes CRTI's success to a well-structured and tightly run program, a balanced project portfolio, and a dedicated and engaged S&T community. Successful partnership initiatives with international S&T and security communities have also expanded CRTI's influence and recognition.

Interviewees for the evaluation presented overwhelming support for CRTI as necessary and critically important. However, there is also a widespread opinion that the CRTI needs to evolve its overall approach. One approach under consideration is capability-based planning, which implies a broader response focus. It requires a more holistic approach to delivering S&T which will advance national capabilities that address assessed risks. Project selection and exploitation of results will also take into account how the capability being enabled by the project will be nurtured and sustained.

Finally, expectations regarding what CRTI can deliver have changed over time. Going forward, CRTI needs to check with stakeholders to ensure that there is consistent understanding of the CRTI mandate with clear expectations and objectives.

3.2.2 RECOMMENDATIONS

The Formative Evaluation made recommendations in five key areas:

1. CRTI is proposing a shift from its present capacity-based response planning to **capability-based response planning** to resolve strategic issues. CRTI must integrate capability-based response planning into its activities and decision-making. This initiative should be supported by the following activities:

   - Defining what capability-based response planning is and identifying the impacts it will have on CRTI's outcomes and contribution to national security objectives and outcomes;
   - Identifying the impacts of capability-based response planning on CRTI's governance and operational model, and enacting the appropriate changes; and
   - Developing and implementing an engagement model to involve provincial, territorial, and municipal jurisdictions and operational communities in both cluster and project activities.

2. **Refinement of some elements of CRTI's governance** will significantly contribute to overall effectiveness and efficiency. CRTI's governance could be refined in the following areas:

   - Build on CRTI relationships within the national level response framework and with national authorities and stakeholders;
   - Review and rationalize the laboratory clusters' objectives, roles, and responsibilities;
   - Amend the CRTI MOU to ensure the commitment of member departments and agencies to laboratory cluster activities;
   - Clarify CRTI documentation and develop consistent terminology; and
   - Introduce a formal outcomes tracking and management framework.

   The objective is to strengthen CRTI governance to meet identified challenges, provide increased effectiveness and efficiency, and position CRTI to demonstrate its overall contribution to national security strategic objectives.

3. CRTI should find ways to **exploit project results more effectively**. The objective is to establish an environment for "technology pull" from the operational communities. By understanding operational response gaps from the operational community perspective, CRTI will be better able to target its activities and meet the needs of those communities. CRTI should work to develop standards and certification of CBRN response equipment.

4. CRTI's partner departments and agencies need to **sustain the expertise, knowledge, and equipment** gathered for projects after the projects have been completed. The objective is to maintain Canada's longer-term capability and capacity to respond to CBRN events. The long-term strategies and plans of departments and operational communities must be coordinated with CRTI activities so that CRTI funding is used to increase capability, and so that new knowledge and S&T are retained.

5. CRTI should develop and implement **a broader communications strategy and plan** that targets a wider variety of audiences. The plan should set and maintain stakeholder focus and expectations regarding CRTI, raise awareness in other communities outside the federal S&T community, and support the engagement strategy to obtain the buy-in and participation of those communities.

4. CRTI KEY ACTIVITIES 2005–2006

In its fourth year, CRTI continued to deliver the capabilities developed in its third year through its six key areas of activity.

4.1 BUILDING LABORATORY CLUSTERS

CRTI's Biological, Chemical, RN, and Forensic laboratory clusters are unique fora for dialogue and discussion in the federal S&T community, focusing on the joint needs of scientific labs and the operational community with respect to addressing CBRN terrorist attacks. Through each cluster, representatives from federal departments and laboratories share their ideas, knowledge, experience, and resources, and discuss shared challenges and possible S&T solutions to issues. Such discussions benefit from the knowledge that each member brings to the collective and provides the opportunity for valuable synergies.[2]

4.1.1 OUTPUTS

Implementing the Clusters

As CRTI advanced its plans for renewal, so too did CRTI's laboratory clusters. All clusters held workshops in 2005–2006 to take stock of their achievements to date, and discuss their objectives and plans for the future.

The Biological Laboratory Cluster held its renewal workshop in March 2006 to review the mission of the Cluster, its communications and public relations goals, the impact of new technology, resource issues, gaps in representation, roles and responsibilities, and operational readiness. The Cluster intends to focus its future efforts on defining its roles and responsibilities, and developing a strategy to communicate the value of the Cluster among Cluster members, other government departments, and the general public. The focus of the Cluster is synthesized in its mission statement: To provide S&T advice and capabilities for the security of Canadians against bioterrorist threats.

The Chemical Laboratory Cluster held an exercise in November 2005 with field, sample, transportation, and laboratory components. The exercise was deemed a success, particularly because of the high level of engagement of the cluster members. A debriefing was held at the Cluster workshop in February 2006, where members also discussed the short- and long-term future of the Cluster and the development of strategies to address its sustainability, capacity, and capability. The workshop established six key focus areas on which the Cluster will concentrate its efforts between now and 2010: roles and responsibilities, intergovernmental links, funding issues, threat assessment, department-level engagement, and operational capacity. Participants developed a list of potential activities for each key area, including creating a Terms of Reference document that will be signed by Deputy Ministers, and promoting Cluster activities at venues and to audiences outside the federal government. Other suggested activities include building a portable lab for the 2010 Olympics, and developing standard methods and operating procedures for working with materials on the chemical threat list. The Cluster also intends to take a leadership role in communicating information to first responders, as well as government, academic institutions, and the public.

The RN Cluster met in September 2005 to strategize and plan for the next three years. The Cluster intends to focus its activities on integrating decision support tools, exploring a "basic research"

[2] Cluster roles and membership are provided in Annex B.

category, dealing with radiological contamination, and integrating data. The Cluster also intends to define its roles, operations, and interactions, ensure the sustainability of its capabilities, enhance RN coordination across all levels of government, and conduct exercises and training. The Cluster has developed a short-term plan for resolving identified issues and has identified actions for a longer-term cluster plan.

Given the multidisciplinary and cross-cutting nature of the Forensic Laboratory Cluster, members of this cluster participated in the renewal workshops held by the Chemical and RN laboratory clusters. The Forensic Laboratory Cluster also held its own workshop in March 2006 to review its progress on the objectives outlined in its implementation plan, reflect on the Cluster's early successes, and forge a way ahead. The Cluster identified several focus areas for its upcoming activities, including expanding its membership to more first responders and safety officers; identifying Canadian background levels of CBRN for remediation, intelligence gathering, and forensic purposes; and determining the storage stability of toxins in crime scene exhibits.

While none of the clusters experienced changes in member departments, there were changes in the individual participants representing them. Some members of the Chemical and RN Laboratory clusters also participate in the Forensic Laboratory Cluster, and joint meetings were sometimes held between the clusters to facilitate collaboration.

Supporting Operational Readiness

Cluster Exercises

CRTI exercises were held in 2005–2006 to enable the clusters to test their plans and capabilities and train participants in various aspects of CBRN response. These training opportunities enhanced cooperation and knowledge sharing between CRTI partner departments and first responder communities and highlighted areas requiring further work and collaboration.

Maritime Exercise Tests Multi-Jurisdictional Radiation Emergency Response

More than 150 RN experts took part in CRTI's three-day EXMR at Slemon Park, Prince Edward Island, in March 2006. Building on lessons learned from Exercise As Is in Chalk River, Ontario, in October 2003, and Exercise Follow On at DRDC Suffield in February 2005, the purpose of EXMR was to test the interoperability between responders and different jurisdictions during a series of simulated RN terrorist threat scenarios. The event marked the first integrated, national-level RN counterterrorism exercise ever held in Canada involving federal and provincial partners.

Participants included scientific and response teams from Health Canada, the Canadian Nuclear Safety Commission (CNSC), Atomic Energy of Canada Limited (AECL), Natural Resources Canada (NRCan), the Royal Canadian Mounted Police (RCMP), the Canadian Border Services Agency (CBSA), the Department of National Defence (DND), DRDC, Environment Canada, and the Canadian Forces' Joint Nuclear, Biological and Chemical Defence (JNBCD) Company. Provincial representatives included the director of the Emergency Measures Organization (EMO) of New Brunswick, the emergency response team from New Brunswick's Point Lepreau Nuclear Reactor, the New Brunswick joint hazardous materials (HAZMAT) team from St. John and Fredericton, and a group of international observers. *The Federal Nuclear Emergency Plan* (FNEP) Operations Centre in Ottawa

1. Mock terrorist lab used during Exercise Maritime Response.
2. Analysis of sample for the Chemical Lab Cluster exercise using a mass spectrometre.

also participated, along with national biological dosimetry labs responsible for analyzing irradiated blood samples received from the exercise field.

Over the course of the exercise, participants were presented with several scenarios: the attempted smuggling of radioactive materials through the Port of Saint John in New Brunswick; a vehicle stopped by police containing a radioactive source; a garage lab discovered to contain several radio-nuclides; a plot to contaminate fuel for a university heating plant to spread radioactive material via an exhaust plume; and a small explosion at a shopping plaza. In response to these scenarios, response teams used new radiation detection equipment developed through CRTI projects, exercised communications protocols and equipment and coordination between groups, operated an incident command structure in an multi-jurisdictional environment, and demonstrated their proficiency in traditional and RN forensics. The federal scientific teams also conducted a demonstration scenario for regional media on the day following the conclusion of the exercise.

By all accounts, the exercise was a tremendous success, proving that Canada has the capability to rapidly and effectively respond to a radiation emergency. Exercise observers also noted that in addition to good collaboration among responders from all jurisdictions, the safety of responders was protected even in the most challenging scenarios and the new technologies and equipment developed under CRTI worked well.

The results of this exercise will be used by the RN Cluster to guide their counterterrorism preparations for 2010, and to develop future exercises aimed at ensuring the readiness of regional RN emergency response capabilities in the province of British Columbia (BC).

- The Biological Laboratory Cluster continued work on its plan to conduct an exercise, tentatively scheduled for spring 2007. The exercise will be held in BC and will feature a zoonotic incident.

- The Chemical Laboratory Cluster tested the ability of its members to deal with an unknown sample in November 2005 through a mid-scale exercise. Labs located across Canada and operated by six federal departments, the RCMP, the Ontario Forensic Centre, and the Royal Military College of Canada (RMC) received samples to analyze once it was confirmed that they did not pose a radiological, nuclear, or biological hazard. When it came time to ship the samples, organizers discovered differing requirements among the labs, which presented challenges. Still, with the aim of identifying the steps needed to enable responders to ship samples to the federal labs, the difficulties encountered during shipping proved to be a valuable learning experience. Just one week after the labs received their samples, most had already reported their results. A recap meeting was held in February 2006 to review results of the exercise. The exercise demonstrated good communications and enthusiastic participation among Cluster members, and showed how far the Cluster had come towards maturity. The exercise revealed that a shared triage checklist is required and that the handling of samples must meet the requirements of the legal chain of custody. The Cluster members agreed to build on their experience with this exercise by holding another exercise in 2006.

- In April 2005, the Counter Terrorism and Technology Centre (CTTC) at DRDC Suffield and CRTI provided an opportunity for representatives from the CRTI laboratory clusters and other government departments to observe, first-hand, the advanced level of the Government of Canada CBRN First Responder Training Program. During this training, teams of first responders engaged in practical exercise scenarios and responded to a variety of challenges in a realistic environment

involving live threat agents. Observers witnessed responders using a variety of detection, personal protective equipment (PPE), and decontamination technologies to implement the full spectrum of their response protocols. The general consensus was that the experience was very valuable for the observers, as it exposed them to the traditional first responder operational context and how it relates to the role of federal departmental responder and laboratory operations.

Providing S&T Advice and Expertise

CRTI Secretariat and cluster members were invited to participate as spokespersons in CBRN symposia and information sessions in 2005–2006. Events included an agroterrorism workshop hosted by the United States (US) Federal Bureau of Investigations (FBI) in Kansas City, Missouri (May 2005), the Annual Arctic and Marine Oil Spills Program conference in Calgary, Alberta (July 2005), and CRTI information sessions hosted by the Public Health Agency of Canada (PHAC) in Winnipeg, Manitoba and in Ottawa, Ontario (August 2005). Presentations were also given at the Federal Food Safety and Nutrition Research Network in Ottawa, Ontario, (October 2005), the Canadian Society of Forensic Sciences (CSFS) Conference in Calgary, Alberta (October 2005), and the National Security and Public Safety conference in Toronto, Ontario (December 2005). These activities enabled CRTI members to increase the outreach of the initiative and participate in the ongoing national and international CBRN dialogue.

Developing Standards, Evaluations, and Certifications

CBRN Equipment Standards

CRTI and Public Safety and Emergency Preparedness Canada (PSEPC) have been collaborating to develop national CBRN equipment standards in Canada that would provide first responders and the operational community in Canada with direction and guidance to make informed decisions on CBRN equipment acquisitions. These standards would focus on detection and identification technology, where there is a perceived gap. CRTI has and is funding work where the purpose is to explore standards to cover the spectrum of equipment, including personal protective equipment (PPE), detection, equipment used to identify and quantify samples, and equipment used for decontamination.

Enhancing Interoperability

To enhance interoperability with the US, the Forensic Cluster disseminates subject-specific standards adopted by the US Department of Homeland Security (DHS) as they are developed. The standards are provided to Cluster members and first responders. The Cluster has already circulated a standard for sample collection of powders suspected of being biological agents and a standard for the data format to be used for data made available by radiation instruments. CRTI is acutely aware of the long-term value of interoperability within Canada and with US response groups, and continues to explore US-developed solutions for the same reason.

Evaluation Capacity
CRTI and PSEPC will provide support for the construction of a testing and evaluation capability at the CTTC in Suffield, Alberta, for use by the first responder community, governments, and industry. This facility will reside at the CTTC and will be used to evaluate equipment against live chemical and biological (CB) agent materials. Installation of the facility is anticipated for May 2008.

Standard Operating Procedures for Chemicals of Interest
Periodic and formal reviews of chemicals of interest are conducted to identify potential threats and support a broadly based consciousness of global risk. The Chemical Laboratory Cluster collected and reviewed draft standard operating procedures (SOPs) for various chemicals of interest in 2005–2006, and will continue this work into 2006–2007.

Laboratory Information Management System
Supported by CRTI funding, the Environmental Technology Centre (ETC) of Environment Canada developed a Laboratory Information Management System (LIMS) to facilitate data sharing among chemical laboratories and serve as an inventory of their capabilities. The LIMS was subsequently disseminated to members of the Chemical Laboratory Cluster to upload their data. Hosted and maintained by the ETC, the LIMS is a secure and rapid means of exchanging highly technical data and laboratory results in the event of a CBRN incident.

Developing and Managing CBRN S&T Knowledge

Some of the projects that were initiated in the first round of funding have been completed. To share the results of the projects and the knowledge gained with members of the CBRN community and with the public, CRTI published a series of success stories on the CRTI intranet portal and the CRTI website. Additional success stories will be developed as more projects are completed. CRTI also published *Technology Acquisition Projects: Strengthening Operational Capacity 2002–2005*, which describes 71 technology acquisition projects that CRTI has funded to establish or enhance the infrastructure and equipment of federal laboratories.

CRTI also sponsored the development of a 13-minute documentary in 2005–2006. The documentary showcases the CRTI community and includes profiles of CRTI leaders explaining the value the program has provided in strengthening Canada's prevention of, preparedness for, and response to CBRN terrorism.

4.1.2 ALIGNMENT WITH INTERMEDIATE OUTCOMES

Cluster exercises and plans actively engage Canada's S&T base in CBRN counterterrorism and are essential to evaluating and improving national preparedness for CBRN terrorist events. Developing CBRN counterterrorism expertise and sharing it with the S&T community and responders in various fora expands the knowledge base on CBRN countermeasures. Work to implement standards for equipment, establish shared skills and equipment inventories, and develop standard operating procedures contribute to an integrated and interoperable resource base for CBRN counterterrorism.

4.2 BUILDING S&T CAPABILITY

Research and technology development (RD) projects must close existing gaps in capabilities and capacities of the S&T and operational communities to enable an effective response to future CBRN incidents. CRTI builds S&T capability through collaboration with industry, government, and academia. RD projects require the involvement of at least two federal partners, and are usually completed within three to four years of funding approval. Typically, funding awards are in the $3 million to $10 million range.[3]

4.2.1 OUTPUTS

Completed Projects

Researchers Report Breakthroughs in Fight Against World's Deadliest Viruses

Researchers from the PHAC, with assistance from the Canadian Food Inspection Agency (CFIA), the University of Alberta, and Cangene Corporation, developed a panel of therapeutic antibodies to Ebola and Marburg viruses that could be used to protect first responders and the public in the event of a biological terrorist attack. Over the course of the project, the team used a variety of techniques, including naïve human phage display, immune non-human primate and mouse phage display, and traditional mouse hybridoma technology using novel antigens to produce more than 50 monoclonal antibodies (mAbs) against Ebola virus. Of these, eight mAbs were characterized using Western blot, isotype determinations, and enzyme-linked immunosorbant assay (ELISA) methods and all but three detected the Ebola virus glycoprotein antigen. When the mAbs' protective efficacy was further tested in vitro and in vivo, the researchers found that the mAbs neutralized Ebola infection and protected mice when given within 24 hours of infection. The team also developed more than 30 mAbs against Marburg virus antigen.

CRTI 0087RD: Therapeutic Antibodies to Ebola and Marburg Viruses
Project Lead: Public Health Agency of Canada—National Microbiology Laboratory
Federal Partner: CFIA—National Centre for Foreign Animal Disease
Industry Partner: Cangene Corporation
Academic Partner: University of Alberta

New Two-Dimensional Molecular Imprinting Techniques Bring Rapid Detection of Hazardous Chemicals Within Reach

A team of scientists led by the National Research Council (NRC) Institute for Microstructural Sciences (IMS) has developed new techniques that combine soft lithography and two-dimensional molecular imprinting to detect chemical agents. The techniques are based on the "lock and key" molecular recognition model where a molecule with a unique structure is used to create template-shaped cavities in polymer matrices with memory of the template molecules. The techniques are an important step towards the development of multi-purpose chemical detectors that will allow first responders and military personnel to quickly establish or rule out the presence of harmful chemicals used in a chemical terrorist attack or industrial accident.

CRTI 0120RD: Development of Two-Dimensional Molecular Imprinting Techniques
Project Lead: NRC—IMS
Federal Partners: DRDC Suffield
Academic Partner: Memorial University of Newfoundland

[3] The proposal selection process is described in Annex C.

New Detection Methods Will Enhance Radiological-Nuclear Emergency Response

A team of scientists from Trent University, Health Canada, the NRC, and MDS Sciex has developed new techniques to rapidly detect and analyze radioactive particles that could pose serious health risks to first responders at the scene of an RN terrorist attack. The researchers found that when they combined the capabilities of an inductively coupled plasma mass spectrometer (ICP-MS) and a high-performance liquid chromatography (HPLC) unit, they improved the detection limits and speed of analysis for plutonium, uranium, americium, and thorium in urine and air samples. The team met with further success when it measured strontium in environmental samples by coupling electrothermal vaporization, a method that combines electricity and heat to convert an element to vapour, with an ICP-MS equipped with a reaction cell. Encouraged by these successes, the researchers hope to increase the potential of the new measurement methods by conducting experiments with more samples, such as water, plants, and soil from Chernobyl and sediments from the Okhotsk Sea, Japan.

CRTI 0133RD: New Technologies for the Rapid Assessment of Radioactive Contamination
Project Lead: Health Canada—Radiation Protection Bureau
Federal Partner: NRC
Industry Partner: MDS Sciex Inc.
Academic Partner: Trent University

Researchers Make Decontamination of Public Buildings Safer and Easier

Before September 2001, scientific research had largely been focused on the decontamination of military equipment. Little information was available on how to remove or neutralize surface contaminants from the civilian targets of terrorist attacks. Assisted by CRTI, a research team led by Environment Canada tested the most promising decontamination technologies and published the results in an operating manual that includes guidelines for selecting, and protocols for using the most suitable technologies for decontaminating and restoring building exteriors and interiors following a CBRN attack. The manual covers tested and validated procedures for cleaning, neutralizing, and decontaminating surfaces and equipment, and containing and disposing of CBRN materials inside, outside, and around buildings. With the manual as a guide, first responders and others will have the information they need to safely and effectively use the multitude of decontamination technologies and equipment now available, and to make informed decisions when choosing between them. To stimulate further innovation, the research team is disseminating their analyses in research literature and through workshops and conferences.

CRTI 02-0067RD: Restoration of Facilities and Areas After a CBRN Attack
Project Lead: Environment Canada
Industry Partners: Allen-Vanguard Corporation, Science Applications International Corporation (SAIC) Canada, VLN Advanced Technologies Inc., Hytec Hydrocarbon Reclamation Ltd.
Other Partner: US Environmental Protection Agency

Outputs of Projects in Progress

The following table provides highlights of the outputs achieved in ongoing RD projects in 2005–2006.

RD PROJECT OUTPUTS 2005–2006

PROJECT	LEAD/PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 0006RD: Rapid Induction of Innate and Specific Immunity of Mucosal Surfaces	• PHAC • CFIA • Veterinary Infectious Disease Organization (VIDO), University of Saskatchewan • McMaster University	To develop novel formulations and procedures that provide short-term protection to the airways and intestines against various organisms that may be used in bioterrorism and to develop vaccines that can provide long-term immunity.	The project team found that selected CpG oligodeoxynucleotides (ODN) sequences can both stimulate an acute-phase immune response and induce the antiviral effector molecule, 2'5'-A synthetase in sheep exposed to a respiratory challenge of parainfluenza-3 virus. When the team exposed mice to Ebola virus, they found the mice showed limited protection depending on the CpG dose/virus dose and time. They also developed an inhalation challenge mouse model, which proved to be lethal following inhalation exposure with Ebola virus.
CRTI 0027RD: Biological Dosimetry and Markers of Nuclear and Radiological Exposures	• Health Canada—Radiation Protection Bureau • DRDC Suffield • DRDC Ottawa • McMaster University—Institute of Applied Radiation Sciences	To establish a National Biological Dosimetry Response Plan and develop rapid methods of radiation exposure assessment to increase throughput in large-scale events.	Work on biomarkers of radiation exposure was expanded to examine how psychological stress, in combination with radiation, affects radiation responsive markers. Saliva tests indicated that individuals who experienced higher levels of stress during a distressing event generally had changes in a number of salivary biomarkers such as salivary alpha-amylase, immunoglobulin A (IgA), and three different cytokines.

PROJECT	LEAD/PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 0029RD: Protecting the First Responder Against CB Threats	• RMC • Health Canada • DND—Directorate of Nuclear, Biological, and Chemical Defence (DNBCD) • DRDC Suffield • RCMP • 3M Canada • DuPont Canada • Med-Eng Systems Inc.	To address the issues in individual protection faced by the first responder community in planning for and responding to a CB event.	The first version of an interim guidance document on the selection and use of PPE for Canadian first responders was released. Research on the dermal toxicity of pesticides was completed, while work on developing methods for and performing realistic performance assessments of a variety of types of equipment, standardization of methods, and research on air-purifying respirators for responders is ongoing.
CRTI 0064RD: New Technologies for Surveillance of Biowarfare Agents and Identification of Engineered Virulence Genes	• PHAC • University of British Columbia (UBC) • DRDC Suffield	To rapidly identify engineered genes embedded in biowarfare strains in order to tailor therapy and develop surveillance strategies.	The research team reached its goal to successfully identify foreign deoxyribonucleic acid (DNA) in selected organisms. Foreign DNA can now be detected in seven different organisms. As a result of this work, one more Canadian lab has been certified for the use of radioisotopes.
CRTI 0072RD: Nanodosimeters Based on Optically Stimulated Luminescence (OSL)	• DRDC Ottawa • Health Canada • University of Toronto • Bubble Technology Industries (BTI)	To produce an OSL-based micro-dosimeter that provides a detailed map of contamination patterns with integrated read-out, analysis, communications, and Global Positioning System (GPS) electronics.	A prototype minidosimeter was produced based on the use of a tiny commercial photomultiplier tube (PMT). A new design for the electronics board was implemented to make the minidosimeter design compatible with the mini PMT, the commercial avalanche photodiode (APD), and the custom APD being developed by the University of Toronto.

PROJECT	LEAD/PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 0091RD: Development of Recombinant Monoclonal Antibodies for the Treatment and Detection of Bioterrorism Agents	• PHAC • CFIA • University of Toronto • DRDC Suffield	To develop mAb-based therapeutics and diagnostic reagents for biological agents and to identify candidate immunogens for vaccine development against them.	The project team created immuno-reagents that are now being used in conventional assays. New facts about the neutralization of anthrax toxins have also been discovered.
CRTI 0154RD: Rapid DNA-based Diagnostic Tests for Two Biological Agents	• DRDC Suffield • PHAC • Université Laval—Infectious Diseases Research Centre • Infectio Diagnostic Inc. (IDI)	To develop rapid molecular diagnostic assays for *Yersinia pestis* and *Francisella tularensis*. These assays will identify the agents in hours rather than days, as is the current situation.	Multiplex, liquid reagent assays for *Francisella tularensis* and *Yersinia pestis*, which allow detection of multiple amplicons using three different detection chemistries (i.e., SYBR green dye, gel electrophoresis, and TaqMan probes) have been developed. IDI has determined specification requirements for freeze-dried reagent formulations and increased their manufacturing capacity.
CRTI 02-0024RD: Probabilistic Risk Assessment Tool for Radiological Dispersal Devices (RDDs)	• DRDC Ottawa • CNSC • PSEPC • University of Ontario Institute of Technology • SAIC Canada • CBSA • Canadian Security Intelligence Service (CSIS)	A probabilistic risk assessment for the construction and use of an RDD or "dirty bomb." The risk assessment will facilitate intelligence assessments, criminal or border surveillance, and identify gaps in radioactive materials security.	The beta version of the probabilistic risk assessment tool, which permits rapid assessments of feasibility, risk, and consequence for a wide array of possible RDD attack modalities, is complete. The tool also allows users to perform sensitivity analyses on risk assessments by modifying the feasibility estimates at all stages of the RDD construction and deployment process, scenario-specific variables, or system variables that determine globally how consequences are assessed for all RDDs.

PROJECT	LEAD/PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 02-0035RD: Canadian Network for Public Health Intelligence (CNPHI)	• PHAC • CFIA • University of Guelph • TDV Global Inc.	A network to collect and process public health surveillance data, disseminate strategic intelligence related to the data, and coordinate response to biological threats, aimed at reducing human illness associated with infectious diseases.	Migration from a single-server system to a 10-server system production environment is a major enhancement in capacity that will enable a larger number of simultaneous users and a much more stable environment. The CNPHI is an operational alert, surveillance, and program and event management system that is used by 1,500 users nation-wide. A second public health training course was held for personnel from seven provinces.
CRTI 02-0041RD: Real-Time Determination of the Area of Influence of CBRN Releases	• Health Canada • AECL • McGill University • York University	A computer model that will provide real-time forecasts of the time, location, and amount of deposited CBRN material, enabling effective response to terrorist events involving an atmospheric release.	The real-time, short-term weather forecast (nowcast) algorithm was completed. North American radar composites are now operationally generated and linkages to the Advanced Research and Global Observation System (ARGOS) have been tested. Dry and wet deposition algorithms have been incorporated and tested. Test data sets involving tritium and particulates have been developed.
CRTI 02-0045RD: Forensic OSL	• DRDC Ottawa • PSEPC • BTI • RCMP	An OSL system to assist police and other officials in tracking radioactive sources and, after a CBRN event, accurately identifying locations where radioactive materials were stored.	Mechanical parts of the OSL reader were fabricated, assembled, and tested, along with the electronic printed circuit board. Hardware was verified and tested. Communication protocols between the computer and the OSL board were designed. Integration and testing of all components of the reader will begin in 2006.

PROJECT	LEAD/PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 02-0066RD: Development of Simulation Programs to Prepare for and Manage Bioterrorism of Animal Diseases	• CFIA • Environment Canada • University of Guelph • Colorado State University • US Department of Agriculture—Animal and Plant Health Inspection	A computer simulation program and atmospheric dispersion model to predict the extent and direction of the spread of a biological agent.	The first official version of the North American Animal Disease Spread Model (NAADSM) was released on 1 April, 2005. The model is currently ongoing sensitivity analysis to determine which input parameters are the most sensitive. The team has also started to collect data to define the NAADSM parameters for avian influenza (AI), and expect preliminary results by July 2006.
CRTI 02-0069RD: Molecular Epidemiology of Biothreat Agents	• PHAC • DRDC Suffield	Increased capacity of federal laboratories to subtype biothreat agents using molecular methods and develop new molecular methods for subtyping these organisms.	Multi-locus sequence typing (MLST) of *Y. pestis* and *F. tularensis* has proved to offer very limited resolving power at the biovar or subspecies level. The project team has evaluated the usefulness of single nucleotide polymorphism (SNP) genotyping for *Bacillius anthracis* and *Y. pestis* and has implemented it in their labs.
CRTI 02-0080RD: Psychosocial Risk Assessment and Management (P-RAM) Tools to Enhance Response to CBRN Attacks and Threats in Canada	• PHAC • CFIA • University of Ottawa • University of Waterloo	Tools to develop better understanding and mitigation of psychological impacts arising from stress and disruption associated with CBRN threats and attacks.	The research team formalized a P-RAM Framework, and conducted cross-country consultations on the needs for psychosocial training. The team further developed its P-RAM web tool, an accompanying prototype of a psychosocial risk manager tool, PRiMer, and expanded its database.

PROJECT	LEAD/PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 02-0093RD: Advanced Emergency Response System for CBRN Hazard Prediction and Assessment for the Urban Environment	• Environment Canada	A modeling system to forecast dispersion of CBRN materials (particularly in urban areas), predict contamination, and minimize the consequences of a CBRN attack.	The predictive capabilities of the Reynolds-averaged Navier-Stokes (RANS) equations for urban flow on the microscale (flow model is named urbanSTREAM), have been validated. The inclusion of the effects of complex urban surfaces in the sub-grid scales of a mesoscale meteorological model (the Global Environmental Multiscale Limited Area Model [GEM-LAM]) has been initiated and coupled with the urban microscale flow models.
CRTI 03-0005RD: Sensor Technology for the Rapid Detection and Identification of Pathogens used as Bioweapons	• NRC—Industrial Materials Institute • NRC—Steacie Institute for Molecular Sciences • PHAC • DRDC Suffield • Université Laval • Centre Hospitalier Universitaire de Québec • IDI	The development of a novel technology based on luminescent polymeric transducers that will lead to a rapid and sensitive detection system for the identification of biological pathogens.	A new detection process that improves the efficiency of detecting *B. anthracis* was developed and tested on synthetic oligos. Several methods to purify and fragment *B. anthracis* were tested, and fragments of different lengths were obtained. The selection of optimal capture and detection probes for *B. anthracis* was also achieved, while work on magnetic probes is still ongoing.

PROJECT	LEAD/PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 03-0009RD: Caring About Health Care Workers as First Responders: Enhancing Capacity for Gender-based Support Mechanisms in Emergency Preparedness Planning	• University of Ottawa—Institute of Population Health • DND—Bureau of Women's Health and Gender Analysis • Canadian Women's Health Network • Canadian Federation of Nurses' Unions • School of Nursing—University of Ottawa • School of Nursing—University of Toronto • Health Systems Strategies • Victorian Order of Nurses • GPI Atlantic • Ontario Ministry of Community Safety and Correctional Services • BC Centre of Excellence in Women's Health	To mitigate the impact of future CBRN contagion threats by recommending support mechanisms for health care workers as first responders, and using lessons learned from the severe acute respiratory syndrome (SARS) outbreak about the psychosocial impact and need to balance work performance and family responsibilities.	Results from a series of five focus groups suggest that front-line nurses feel unprepared, unsupported, and torn between loyalties to their profession and to their families, who may fall ill because of exposure to many different sources of infection brought home by the working nurse. The need for education and training emerged as a dominant theme in these discussions. The next step for project researchers is to complete the survey data collection and prepare a report on the survey component in the fall of 2006.
CRTI 03-0018RD: Experimental Characterization of Risk for RDDs	• DRDC Ottawa • DRDC Valcartier • Health Canada • Environment Canada • RMC • Carleton University • University of Ontario Institute of Technology • UBC	To address gaps in our knowledge of risk for both explosive and non-explosive dispersal of radiological material.	Indoor testing on the distribution of RDD-generated aerosols began in September 2005, and was followed by outdoor testing. The health effects of these aerosols are currently being assessed. The characterization of non-explosive dispersal of radiological material is also being done at the University of Ontario Institute of Technology.

PROJECT	LEAD/PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 03-0060RD: Protective Marker for Anthrax Serodiagnosis	• DRDC Suffield • PHAC—National Microbiology Laboratory • UBC • Cangene Corporation	To develop a validated serum screening assay: clinical management of individuals exposed to anthrax or in an anthrax vaccine program.	Using recombinant protein from UBC and serum from DRDC Suffield, Cangene developed and validated ELISA and toxin neutralization assays for measuring the level of anti-protective antigen antibodies in serum samples. These assays are being transitioned to the PHAC's National Microbiology Laboratory and will allow for accurate detection and measurement of these antibodies in persons given the anthrax vaccine or those who may have been exposed to anthrax. In addition, recombinant proteins from UBC will be tested at DRDC Suffield over the next year to measure their ability to act as novel anthrax vaccines.

New Projects

A total of $16.6 million was approved for funding of new RD projects in 2005–2006. CRTI anticipates the following outcomes:

- Animal health diagnostic network that will provide real-time surveillance data from Canadian and US laboratories to enhance national and cross-border intelligence-gathering capacity to detect animal disease threats. (CRTI 04-0004RD: Proposal for the Establishment of the Canadian Animal Health Surveillance Network)
- Standards for effective chemical and biological cleanup of buildings and structures affected by terrorism. This knowledge will be captured and disseminated through various publications. (CRTI 04-0018RD: Development of Standards for Chemical and Biological Decontamination of Buildings and Structures Affected by Terrorism)
- Rapid analytical protocols based on high-field asymmetric waveform ion mobility spectrometry (FAIMS) devices mounted in front of a mass spectrometer (MS) to detect chemical warfare agents. These protocols will assist first responders in analyzing the threat and mitigate its health and economic impacts. (CRTI 04-0022RD: Rapid Separation and Identification of CB Warfare Agents in Food and Consumer Matrices Using FAIMS-MS Technology)

- Electronic neutron dosimeter prototype that meets civilian and military performance specifications for first responders to use in the event of an RN emergency. (CRTI 04-0029RD: Development of an Electronic Neutron Dosimeter)
- A database and assays for developing a DNA-based diagnostic kit to rapidly detect and monitor several exotic high-risk plant pathogens. The kit will help to mitigate severe ecological and economic impacts on Canada by promptly identifying suspicious new introductions. (CRTI 04-0045RD: Development of Collections, Reference/DNA Databases, and Detection Systems to Counter Bioterrorism Against Agriculture and Forests)
- New composting methods for the biocontainment and safe disposal of livestock and their wastes at the site of a foreign animal disease outbreak. These new protocols may also be used to prevent the spread of endemic animal diseases and to eliminate food- and water-borne pathogens threatening public health. (CRTI 04-0052RD: On-site Composting for Biocontainment and Safe Disposal of Infectious Animal Carcasses and Manure in the Event of a Bioterrorism Attack)
- Integrated electronic tools distributing critical data among CRTI decision makers and their strategic partners to rapidly identify risks, initiate response, and build response capacity in the event of a biological or radionuclear emergency. (CRTI 04-0127RD: Canadian Health Integrated Response Platform)
- A national standard that will provide guidance to first responders on the selection, use, capabilities, and limitations of CBRN PPE, thus enhancing their capabilities to prepare for and respond to CBRN events. (CRTI 05-0016RD: Development of a Canadian Standard for Protection of First Responders From CBRN Events)
- Simulations to develop a method of establishing the economic cost of events involving radiological dispersal devices, radiological exposure devices, and improvised nuclear weapons. Analysis will also integrate historical, experimental, and radiological decontamination inputs from participating agencies, with the goal of revisiting current regulatory limits. (CRTI 05-0043RD: Economic Impact of Radiological Terrorism Events)
- Evaluation, testing, and validation of a longer-acting form of granulocyte-macrophage colony-stimulating factor for mitigating neutropenia resulting from acute radiation exposure. (CRTI 05-0069RD: Development of PEGylated Granulocyte-Macrophage Colony Stimulating Factor for Acute Radiation Syndrome)
- A thorough review of information relating to improvised CB weapon technologies within the open literature and on the Internet. The review will be used to identify a set of scenarios for which there are knowledge gaps pertaining to technical feasibility and impact and for which there are also indications of terrorist interest. (CRTI 05-121RD: Evidence-based Risk Assessment of Improvised CB Technologies)

The RD projects approved in 2005–2006 are described in greater detail in Part II of this report.[4]

[4] Project partners for all CRTI projects are listed in Annex D and distribution of project funds are listed in Annex E.

4.2.2 ALIGNMENT WITH INTERMEDIATE OUTCOMES

Participation in ongoing RD projects has enhanced the expertise and knowledge of CBRN S&T performers and, upon their completion, will contribute to their capabilities. The prototypes, techniques, assays, tools, and technologies developed under RD projects in 2005–2006 are important milestones and, in some cases, have already contributed to the national response capacity.

4.3 ACCELERATING TECHNOLOGY TO FIRST RESPONDERS

Technology Acceleration (TA) projects help to accelerate the commercialization of and transition to use by first responders and other operational authorities of technologies that address key capacity gaps. TA projects involve first responders, industry, and government and are usually completed within six months to two years of funding approval. These projects are typically funded to levels between $1 million and $10 million.

Introduced in 2004–2005, the new Technology Demonstration (TD) project category enables S&T partners to demonstrate the utility and impact of new technologies to first responders in an operational setting. TD projects afford a "leave-behind" opportunity to transfer knowledge, technology, or capacity quickly to specific end-user communities. The advances in S&T resulting from the direct participation and interface with the end-user community are intended to improve the integration and interoperability of the collective response capacity. TD projects typically span three to four years.

4.3.1 OUTPUTS

Completed Projects

Quest to Develop Real-Time Biological Agent Detection System Continues

Because of the high degree of selectivity and extremely high sensitivity required, the few biological detection systems that are commercially available have limited use and are generally unaffordable. Thus CRTI has lent its support to IatroQuest to use Bio-Alloy, a highly sensitive biosensing technology that operates in real time, to develop a prototype biodetection platform and its associated fluidic biosensing cartridges. Over the course of the project, it became clear that the assumption on which the principle of Bio-Alloy's detection was based was mistaken. Unable to consistently reproduce a photoluminescent signal upon the binding of target antigens to the recognition antibodies, scientists concluded that the green photoluminescence was more likely due to the creation of a fluorophore on the chip surface. IatroQuest then launched an exhaustive review of replacement technologies, the most promising of which is the use of evanescent waves from planar optical waveguides as biosensor technology. It has vowed to acquire the rights to this technology, and has promised to return to the labs at DRDC Suffield with a working model for testing.

CRTI 0019TA: Real-Time Confirmatory **Biodetection and Identification:** Rapid Validation and Fieldable Device Prototyping
Project Lead: IatroQuest Corporation
Federal Partner: DRDC Suffield
Industry Partners: Dycor Technologies, Micralyne Inc., Fluorosense Inc.

CB^{plus} Chamber Guarantees Top Protection for First Responders

Amtech Aeronautical has developed a chamber for testing and evaluating CB protective gear using simulants rather than costly and dangerous live CB warfare agents and actual toxins. The CB^{plus} Chamber contains a mannequin that mimics human movements while wearing clothing and equipment, as well as a separate head form to test respiratory protection and the integrity of protective headwear systems. The chamber lets scientists simulate environmental conditions too dangerous to test on human subjects. It enables government and private sector clients to confirm requirements for future purchases by conducting the most comprehensive evaluation of first responder and military clothing.

CRTI 0100TA: Systems Level Simulant Test Chamber for Chemical and Biological Personal Protective Ensembles and Equipment with an Articulated Mannequin Capability—CB^{plus} Chamber
Project Lead: DRDC—Director Science and Technology Human Performance
Industry Partners: Amtech Aeronautical Limited

New Rapid, Highly Sensitive Tests to Detect Agroterrorism Threats

Teams from seven CFIA labs, as well as researchers from the NRC and the PHAC, collaborated to develop a series of antigen and antibody screening tools to prevent and rapidly detect high-threat animal viruses. The screening tools included lateral flow assays, real-time reverse transcriptase polymerase chain reaction (RRT-PCR), DNA and protein microarrays, and enzyme-linked immunosorbent assays. In all, 18 tests were developed: five for foot-and-mouth disease (FMD), five for AI, five for classical swine fever, and three for the Nipah virus. Some have been validated, while others are awaiting validation. The tests, which are mobile, robust, and suitable for use in lab networks as well as under field conditions, can be automated to handle large numbers of samples, and can accommodate electronic data collection and transmission. The project team also developed and implemented a formal first responder network laboratory training course at the CFIA in Winnipeg and produced training binders and equipment, which are now available for future first responder network training.

CRTI 0196TA: Development of Rapid Field Tests and Training Programs for Veterinary First Responders to Address Agroterrorism with Animal Pathogens
Project Lead: CFIA
Federal Partners: NRC, PHAC
Other Partners: United States Department of Agriculture—Animal and Plant Health Inspection Service, Lawrence Livermore National Laboratory, University of Manitoba, Australian National Animal Health Laboratory

Canadian Partnership Yields World's First Anti-Ricin Antibody Treatment

Researchers at DRDC Suffield collaborated with Twinstrand Therapeutics Inc. and Cangene Corporation to produce the world's first medical countermeasures against ricin. To develop antibodies that could neutralize ricin, Twinstrand Therapeutics created a harmless toxoid that could be produced in bulk, and used it to safely immunize goats and to select mAbs. Using the toxoid, Cangene produced bulk amounts of goat polyvalent antiserum against

ricin, investigated antibody purification methods to enhance ease of therapy, and developed human mAbs against the A or B chain of ricin. The antibodies were then tested by researchers at DRDC Suffield, who determined that the antibody therapy could rescue mice given 5 LD_{50} of ricin for up to 16 hours post-exposure. The project provides the first evidence that the effect of ricin, either on a group targeted by terrorists or on first responders entering the area, might be manageable with antibody therapy.

CRTI 02-0007TA: Medical Countermeasures Against Ricin
Project Lead: DRDC Suffield
Industry Partners: Twinstrand Therapeutics Inc., Cangene Corporation

Deployable Multi-purpose Sensor Network Defends Against Gamut of Terrorist Threats

Radiation experts at Health Canada and BTI completed development of a deployable detection and monitoring system that monitors, detects, and communicates the presence and location of multiple threat agents—including chemical and biological warfare agents; toxic industrial chemicals; and alpha, beta, and gamma radiation—all within a wireless network. The portable, ready-to-go system integrates information from four stand-alone CBRN point detectors and relays it to a remotely located command centre for safe and efficient monitoring of contaminated areas and high-risk terrorist targets as well as for immediate and long-term tactical response. With the network completed and performing as expected, Health Canada is working with the other government research partners to conclude final testing in field exercises designed to train participants in various aspects of CBRN response. BTI is counting on the additional feedback from the Health Canada testing to help in moving the product into the hands of first responders.

CRTI 02-0041TA: Deployable CBRN Monitoring Network
Project Lead: Health Canada
Federal Partners: CNSC, Environment Canada
Industry Partners: BTI, General Dynamics Canada

Chemical, Biological, and Radiological Decontamination Foam Made More Effective

Scientists at DRDC Suffield working with research partners from industry and government have improved the civilian version of the world-renowned CASCAD™ decontamination foam. Because this surface decontaminating foam (SDF) is a milder version of the military-strength CASCAD foam and is being used on different surfaces under different conditions, it required extensive testing to prove itself. Separate tests on various ingredients in the SDF formula led to changes in the forms of the active ingredient; some of the buffering chemicals; and the composition of the concentrates to extend its shelf life, increase the solubility of the active ingredient, and make transportation of the concentrate safer. The SDF was further modified so that it can be used in Canada's colder winter climates. Allen-Vanguard Corporation engineers then redesigned their applicator equipment to include dual tanks for storing the ingredients. First responder groups can now choose from three portable decontamination units for emergency decontamination of CB agents and removal of radioactive dusts on equipment and structural surfaces. The scientists at DRDC Suffield will

continue studying the performance of the SDF, especially to determine how it will work against toxic industrial chemicals, a source of growing concern in civilian and military circles.

CRTI 02-0043TA: Accelerated Consequences Management Capabilities
Project Lead: DRDC Suffield
Federal Partner: Environment Canada
Industry Partner: Allen-Vanguard Corporation

New High-Tech Shielding for First Responders

With CRTI funding and strategic guidance from DRDC, Canadian manufacturer AirBoss Engineered Products Inc. has developed a new polymer compound that will boost the protection offered by PPE worn by first responders and military personnel to shield them against CBRN substances. The AirBoss team used some of the CRTI funds to set up their own research facility to run toxic industrial chemical (TIC) tests and identified CRTI-116 as the polymer compound that meets all of the protective requirements. The team also discovered surface treatments of PPE materials that increase their resistance to TICs and toxic gases. AirBoss will use their findings to manufacture high-performance PPE for military and civilian emergency response personnel.

CRTI 02-0093TA: Research on Advanced Polymers for Use in the Manufacture of Individual Protective Equipment
Project Lead: AirBoss Engineering Products Inc.
Federal Partner: DRDC—Director Science and Technology Human Performance

New Portable Isolators Protect Responders and Forensic Evidence

Montréal-based manufacturer Isotech Design Inc. has developed two portable isolation devices to collect, contain, and process suspicious CB materials. The rapidly deployable lightweight isolators are more durable than their predecessors. One unit features a unique, suitcase-sized design that can be operated on battery power; the other unit is larger, yet still portable. The isolators protect first responders and investigators from CB hazards, allowing them to safely process hazardous materials on-site while maintaining the forensic integrity of evidence needed for criminal prosecution. Isotech Design will manufacture and distribute both models to public and private clients under a licence from the Government of Canada.

CRTI 03-0023TD: Portable Chemical and Biological Isolator and Collapsible Isolator Module
Project Lead: PSEPC
Industry Partner: Isotech Design Inc.

Outputs of Projects in Progress

The following table provides highlights of the outputs achieved in ongoing TA and TD projects in 2005–2006.

TA AND TD PROJECT OUTPUTS 2005–2006

PROJECT	LEAD/PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 0052TA: Rapid Carbon-14 Analysis by Accelerator Mass Spectrometry	• Health Canada • University of Toronto—IsoTrace Laboratory • Fisheries and Oceans Canada • High Voltage Engineering Europa BV (Netherlands)	To develop and test equipment for the rapid, highly sensitive measurement of carbon-14 organic samples following the environmental dispersal of nuclear material.	Following the successful operation of the transfer line between the elemental analyzer and the ion source, tests of the overall system operation in manual mode were initiated. The first radiocarbon measurement using all components of the system was carried out. An assessment of system C-14 memory will follow the tests.
CRTI 0105TA: Mobile, Real-Time Radiation Surveillance Network	• McFadden Technologies Ltd. • Health Canada —Radiation Protection Bureau • RCMP • NRCan • Mobile Detect Inc.	To integrate existing radiation sensors, GPS, telecommunication, and signal detection technologies into a mobile radiation surveillance network for use in RCMP cruisers.	A production-ready, mobile, real-time radiological surveillance system for use in the field by first responders and emergency management personnel has collected over seven million radiation measurements in the National Capital Region. Deployed radiation sensors are managed by a mobile detection unit with an onboard computer providing for GPS, telecommunications, and power management.
CRTI 0131TA: HI-6 Nerve Agent Antidote System	• DRDC • PSEPC • UGM Engineering Ltd.	To develop the essential components of a licensed, next-generation HI-6 nerve agent antidote system and establish a source of supply for the drug products in their final formulation.	A method to convert HI-6 2Cl to the required HI-6 dimethanesulfonate (DMS) salt on a small scale was identified. A small batch of HI-6 DMS for use in initial pre-clinical and possible clinical testing was purchased. The first stage of the proof of concept for the production of a small quantity of avizafone was completed.

PROJECT	LEAD/PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 02-0057TA: Canadian Radiation Alert and Expert System for Critical Infrastructure Monitoring	• Health Canada • CBSA • SAIC Canada • Ontario Power Generation	An alert system that processes and evaluates isotopic and radiation field measurements with greater sensitivity and lower rates of false alarms.	Real-time alarming software has been delivered and has been tested by Health Canada. Data distribution is generally complete; some external partners do not yet have access to the data due to institutional IT security barriers. CBSA may also request a simplified search mode for the GR460 graphical user interface in 2006.
CRTI 02-0091TA: *Clostridium botulinum* Type A Genomic DNA Microarray	• Health Canada • Institute of Food Research (Norwich, United Kingdom [UK]) • Pasteur Institut Paris • University of Helsinki	A genomic DNA microarray aimed at rapidly detecting a potential biological weapon, botulinum neurotoxin, the most poisonous known substance.	Over the past year, work on developing subtyping methods based on comparative genomics and cell surface glycans continued. Researchers examined the phenotypic and genotypic diversity of flagellar filaments from *C. botulinum* Group I and Group II strains belonging to serotypes A, B, E, and F, and sequenced the variable middle portions of these flagellin genes from 75 strains of both Group I and Group II *C. botulinum*. The results suggest that flagellar gene typing could enhance the current strain identification system based on the seven neurotoxin serotypes.
CRTI 03-0017TA: Development of a Directional Gamma Ray Probe	• DRDC Ottawa • RCMP • CNSC • DND—JNBCD Company • BTI	A field-ready directional gamma ray probe with sufficient sensitivity to detect radiation levels a few times higher to those present in a normal background.	Work to construct and refine the high field directional gamma ray probe was conducted. The final prototype is being tested in both laboratory and operational environments. The assembly of a sensitive directional gamma ray probe with revised electronic printed circuit boards and a new casing is also underway.

PROJECT	LEAD/PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 03-0025TA: Defender™ Nuclear Detection Web	• Health Canada • CBSA • Canadian Police Research Centre • DRDC Ottawa • Transport Canada • BTI • Xwave • Brookhaven National Laboratory	An ultra-sensitive, low-cost nuclear detection web for the rapid and accurate detection of RN materials.	BTI and Xwave have successfully integrated the detector package with the data management network. The project's federal partners are currently field testing the Defender Nuclear Detection Web and the technology is being adapted for use in cargo-monitoring trials with the Canada–US Cargo Security Project.
CRTI 03-0013TD: Early CBRN Attack Detection by Computerized Medical Record Surveillance	• NRC—Institute for Marine Biosciences • NRC—Institute for Information Technology • PHAC • University of Ottawa Heart Institute • AMITA Corporation • Michigan State University—National Food Safety and Toxicology Center • Carnegie Mellon University—School of Computer Science—Auton Laboratory • Performance Support Services Inc. • CAM Emergency Preparedness • e-Privacy Systems Inc. • Grey Bruce Public Health Unit • Grey Bruce Health Services • South Bruce Grey Health Centre • Hanover and District Hospital	Successful adaptation and deployment of a Real-Time Outbreak Detection and Surveillance (RODS) system developed by the University of Pittsburgh as a technology demonstration.	The Early CBRN Attack Detection by Computerized Medical Record Surveillance (ECADS) system has been successfully installed in the Grey Bruce Public Health Unit in Owen Sound, Ontario. Staff from the AMITA Corporation monitor and maintain the system daily via remote services and report that they have not yet encountered any technical difficulties. Since installation of the ECADS system, the Grey Bruce Public Health Unit has issued two alerts to area emergency departments based on data collected and analyzed by the ECADS system. The gastrointestinal alert detected through the system was confirmed by Health Canada's over-the-counter sales surveillance system.

PROJECT	LEAD/PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 03-0018TD: Airport Radiological Surveillance System	• McFadden Technologies Ltd. • Health Canada—Radiation Protection Bureau • Transport Canada • Mobile Detect Inc.	Implementation of an operational radiological security system at the Ottawa International Airport that will provide a transferable model for the protection of other airports in the national aviation system. Particular emphasis will also be placed on the safety of both first responders and on airport staff in an actual or suspected radiological incident.	A mobile, real-time radiological surveillance system is in use at the Ottawa International Airport. The system provides autonomous, round-the-clock, cost-effective, and practical radiological surveillance and radiological threat agent identification with information sharing in real-time.
CRTI 03-0019TD: Real-Time Biosurveillance and Response Readiness Using an Interconnected, Electronic Information Infrastructure	• PHAC • IBM Canada • Winnipeg Regional Health Authority	An interconnected, Internet-based network enabling the secure collection, integration, analysis, and dissemination of key health-related data and intelligence important for bioterrorism event detection and response.	The biosurveillance system is receiving real-time data from emergency rooms at all Winnipeg acute care facilities, a 24-hour, seven-days-a-week health help line, and four national pharmaceutical retailers in Winnipeg. The project team also implemented the second version of the Canadian Early Warning System, which now supports 10 analytical algorithms and seamlessly integrates with the CNPHI for role-based access.
CRTI 03-0021TD: Assay Development and Production Team	• PHAC—National Microbiology Laboratory • CFIA—National Centre for Foreign Animal Disease • DRDC Suffield	Creation of a diagnostic core group that will develop, produce, and distribute tests for the detection of bioterrorist agents.	Several proteins and mAbs specific to numerous *F. tularensis* and *Y. pestis* antigens were initially characterized. Diagnostic mAbs for *B. anthracis* toxins were fully characterized and are being assessed for development into diagnostic assays. MAbs for *C. botulinum* neurotoxin and high-throughput assays were developed.

New Projects

A total of $4 million was awarded for new TA projects in 2005–2006, while TD projects were allocated $10.3 million. CRTI anticipates the following outcomes:

- A blast protective helmet that is resistant to high-energy electronic countermeasures. The helmet will safeguard first responders engaged in tactical reaction to terrorist attacks involving radio-controlled explosive devices. (CRTI 04-0082TA: Radio Frequency- and Electronic Countermeasures-Compatible CB Blast Protective Helmet)
- A long-dwell detection in transit (LDDT) detector to monitor cargo shipments for radiological contraband will be developed; combining the technology of a passive dosimeter with the required hardware and electronics to allow the user to read the dosimeter in situ whenever the integrated radiation dose is required. (CRTI 05-0006TA: OSL Radiation Sensor for Long-Dwell Detection in Transit Applications)
- A deployable wireless network system that will address critical technology gaps in communications and information exchange for responders during a radiological or nuclear event by providing a wireless interface that connects field teams with the federal government. (CRTI 05-0053TA: Deployable RN Incident Area Network: Wireless Mesh Topology)
- NanoChip® DNA microarray technology to detect agroterrorism agents in food. The project will initially target the viruses responsible for FMD and AI. (CRTI 05-0090TA: Adaptation of Recently Developed DNA Microarrays to NanoChip Microarray Technology for Detection of Agroterrorism Agents)
- CB protective undergarments with personal cooling to mitigate heat stress when using personal protective equipment during a CBRN event. (CRTI 05-0092TA: Integrated Personal Cooling for CB Protective Undergarments)
- Assays, based on field-ready instruments, that will allow frontline personnel to quickly and accurately detect the presence of potential Category 1 and 2 biological weapons, such as Ebola virus, Marburg virus, Venezuelan equine encephalitis, SARS, influenza, and Crimean-Congo hemorrhagic fever with high sensitivity. (CRTI 05-0106TA: Development of Fieldable Nucleic Acid Detection Techniques for Category 1 and 2 Biological Agents)
- A facility with features common to a typical house that will be used for CBRN decontamination experiments testing the best-known methods and technologies. The experiments will involve first responders, allowing them to quickly adopt and directly apply the most effective decontamination methods. (CRTI 04-0019TD: Field Demonstration of Advanced CBRN Decontamination Technologies for Buildings)
- Protocols helping international forensic identification specialists and expert responders to standardize development and testing of nuclear forensic analysis methods. These procedures will help to eliminate any interference between evidence recovery and site remediation activities. (CRTI 04-0030TD: Nuclear Forensic Response Capabilities and Interoperability)

- A database capturing CBRN and explosive incidents against critical infrastructure, people, and agri-food targets. The system will provide information on threats to law enforcement and regulatory agencies facilitating effective incident response, preparedness, and prevention. (CRTI 04-0047TD: CBRN Incident Database)
- A portable intrusive sampling tool to penetrate various container types without disturbing their contents and draw a sample of potentially dangerous materials for analysis. This tool will allow first responders to effectively determine the threat and manage the consequences of an incident. (CRTI 04-0112TD: Container-Intrusive CBRN Sampling System)
- Integrated architecture focused on the CBRN aspects of municipal, provincial, and federal interoperability. The operational and system-of-systems architecture will be based on the critical incident responses of organizations to selected scenarios, as a simulated CBRN event unfolds within the selected geographical area of Vancouver and the Vancouver–Whistler corridor. (CRTI 05-0058TD: Interoperability Framework for Municipal–Provincial–Federal Collaboration)
- Interoperability protocols and information technology for a national nuclear emergency laboratory network. The network will be composed of major federal and provincial radiological and nuclear emergency operation centres and will be open to others to join in a phased approach. (CRTI 05-0108TD: National Nuclear Emergency Laboratory Network and Interoperability)
- A hand-held multi-sensor modelling system for collecting evidence at CBRN-contaminated crime scenes with minimum exposure to the first responders. The system will record and map the contamination levels of CBRN agents and make the data available to staff at safe locations, on-site and at emergency centres, for rapid attribution. (CRTI 05-0122TD: CBRN Crime Scene Modeler)
- An all-hazards facility for receipt, triage, and storage of samples. It will also deliver the recommended equipment to be used within the facility and the requisite SOPs for handling forensic samples. (CRTI 05-0123TD: All-Hazards Sample Receiving and Storage Capability)

TA and TD projects approved in 2005–2006 are described in greater detail in Part II of this report.

4.3.2 ALIGNMENT WITH INTERMEDIATE OUTCOMES

The development of the first anti-ricin antibody treatment is the culmination of a unique collaboration among project partners and has greatly increased Canada's response capabilities. Work to develop surveillance and containment systems, assays, prototypes, and other technologies in ongoing TA and TD projects contributed to Canadian S&T performers' knowledge of CBRN countermeasures. The knowledge, technology, and capacity developed in these ongoing projects will be transferred to first responders upon their completion.

4.4 BUILDING NATIONAL S&T CAPACITY

CRTI supports the development of national S&T capacity through the acquisition of existing technology primarily for use by science-based departments and agencies.

Technology acquisitions are intended to establish or enhance the infrastructure and equipment of the laboratory clusters, and thereby address gaps in Canada's ability to respond to CBRN threats. These acquisitions should typically be made in the year in which they are funded and be "off-the-shelf" purchases of existing technology. Priority is given to those submissions that address the most critical gaps in capacity that are consistent with cluster objectives, roles, and responsibilities.[5]

4.4.1 OUTPUTS

In 2005–2006, facilities were provided with funding to purchase acquisitions aimed at addressing identified gaps. In many cases, other organizations also gain access to the CRTI-funded acquisition, extending its reach and benefit. A total of $4.4 million was awarded for acquisitions in 2005–2006.

Technology Acquisition projects funded in 2004–2005 that were completed and began contributing to the federal laboratory response capacity in 2005–2006 are as follows:

- **Canadian Microbial Culture Collections:** Maintenance and access to microbial cultures is essential to biosecurity research. The purchase of equipment such as ultra-low freezers, lyophilization equipment, and other instruments necessary to create, maintain, and augment culture collections will improve the storage and maintenance of existing culture collections in Biological Cluster laboratories. This two-year project will continue through 2005–2006. (BIO021AP)

- **Infrared Methods for Depth-Profiling Toxin-Exposed, Solid-Phase Materials:** The installation of a desorption laser and a Fourier Transform Infrared Spectroscopy (FTIR) microscope will help DRDC to develop depth-profiling techniques that can determine the extent of contamination of solid materials and how they are affected by toxic agents. These techniques will assist in assessing the risks of off-gassing of toxic substances from contaminated materials. The rate at which toxic agents permeate through materials can also be determined, enabling scientists to judge how long materials can be expected to function as barriers to toxic agents. (CHEM023AP)

- **Enhanced Capability for Sample Clean-Up for the Analysis of Chemical Residues in Foods, Feeds, and Fertilizers:** CRTI purchased and installed the RapidTrace solid phase extraction (SPE) workstation in the CFIA's Calgary laboratory to support researchers in the analysis of chemical residues and contaminants in the food supply, especially pesticides. The powerful, high-throughput workstation automates and rigorously controls every step of the SPE process, eliminating the time-consuming manual SPE clean-up of existing analytical methods. Recently trained staff expect that a rugged, reliable SPE method that makes use of the new workstation will be fully developed and validated in the 2005–2006 year, enhancing the ability of scientific staff to analyze pesticide residues and other chemical contaminants for years to come. (CHEM024AP)

[5] A list of technology acquisitions approved in 2005–2006 is provided in Annex F.

- **Mobile Sample Reception Facility:** Re-equipping Environment Canada's Central Response Team with Gas Chromatograph/Mass Spectrometry (GC/MS) equipment and a mobile response vehicle will enable the team to conduct field analyses of chemical threats. (CHEM021AP)
- **Rapid Analyte Measurement Platform (RAMP) Detection Equipment:** This equipment enables rapid identification of bioterrorist agents from foods and agricultural products. Using this equipment, the CFIA will be able to determine the use of bioagents in a matter of minutes. (BIO022AP)
- **Federal First Responder Automated Emergency Dosimeter (FFRAED) System:** This system enables the delivery of up to 10,000 radiation dosimeters of record to federal first responders during a 24-hour period, immediately following an RN incident. (RN008AP)
- **Mobile Nuclear Laboratories:** Deployed to centres in BC, Manitoba, Ontario, and Nova Scotia, these four self-sufficient laboratories are capable of rapidly bringing state-of-the-art radiological detection and analysis equipment to the site of any RN emergency. The labs have been used in DND, provincial, and CRTI exercises. (RN009AP)
- **Robustness Package for the Fixed Point Surveillance System:** A robustness package was developed for the CRTI Fixed Point Surveillance System that includes auxiliary backup power for the fixed point sodium iodide detectors in the event of a main power failure. The package also includes auxiliary communications capability, in the event the primary communications system is lost, and increased dynamic range of the measurement system to enable operations during prolonged exposure to high dose rates. (RN010AP)
- **Field Command Centre:** A radiological field command centre was designed and procured to support the RN Incident Commander and federal field teams established under CRTI. (RN011AP)

4.4.2 ALIGNMENT WITH INTERMEDIATE OUTCOMES

The purchase of storage equipment, analysis tools, response vehicles, and other products enhanced federal laboratory capabilities in 2005–2006. Given the dual-use functions of some of this equipment, staff will have an opportunity to hone their knowledge and skills prior before applying it as a CBRN countermeasure.[6]

4.5 BUILDING HORIZONTAL CAPABILITY

"Building Horizontal Capability" refers to the ability of CRTI to encourage and nurture partnerships that leverage capability and capacity. As the field of CBRN counterterrorism is international and multidisciplinary, strong partnerships to bridge geographical borders and complementary areas of expertise are critical.

[6] The financial statement for the funding of all projects is in Annex G.

4.5.1 OUTPUTS

National and International Collaboration

Established in 2003, the Public Security Technical Program (PSTP) is a Canada–US initiative aimed at collaboratively delivering proactive S&T solutions to advance national capabilities to prevent, respond to, and recover from high-consequence public safety and security events. In July 2005, DRDC Suffield hosted a three-day workshop to discuss S&T solutions to CBRN and explosive (CBRNE) threats, one of four "mission areas" under the PSTP. The workshop specifically targeted two aspects of the CBRNE Mission Area: CBRN decontamination and restoration and volumetric explosives technology. Participants discussed various approaches and techniques for decontamination and restoration after a CBRN attack: neutralization, responders' protection, simulation, assessment and mitigation of threats and consequences, as well as the treatment and disposal of radioactive waste. The workshop also represented the first formal meeting of the PSTP explosives expert communities from both countries. These discussions focused mainly on the unique challenges presented by volumetric explosives, and included an overview of technologies and techniques to detect and neutralize explosives and the medical side of blast effects. The workshop provided participants from both countries the opportunity to exchange current knowledge and experience, and to further explore project collaborations. It generated a number of recommendations that should translate into better targeted S&T investments.

Many requests for supplemental funding from CRTI were received in 2004–2005. For a submission to be considered, it had to be a collaborative proposal that identified a participating federal department on each side of the Canada–US border, all partners, and financial contributions. All 10 projects that were approved for supplemental funding in 2005–2006 were existing CRTI projects that were also directly related to PSTP work. Such projects mark significant progress in international S&T collaboration on CBRN counterterrorism.

CRTI also joined its US counterparts at the Defence and Security Innovation Conference in Québec City in November 2005. The biennial conference focused on the PSTP and four major challenges in public security: prevention of, preparation for, and response to CBRNE threats; critical infrastructure protection; human aspects of counterterrorism and borders and territory protection; and capability integration towards emergency preparedness.

Held in Kansas City, Missouri in May 2005, the first annual International Symposium on Agroterrorism drew together 800 representatives from private industry, law enforcement, government, academia, and scientific communities from the US, Canada, Israel, Russia, the UK, and New Zealand to discuss issues surrounding threats to the food supply. Representatives from the CFIA, CSIS, PSEPC, and the RCMP attended the event. The CRTI Biological Portfolio Manager presented the Canadian position on agroterrorism in Canada, highlighting CRTI as one of the ways that Canada is addressing this threat.

In July 2005, the Leader of the Chemical Laboratory Cluster and the Chemical Portfolio Manager attended an international workshop on decontamination in Vladivostok, Russia, resulting in new relationships between CRTI and the host representatives. In November, Foreign Affairs Canada hosted a follow-up workshop to provide the Russian visitors with an opportunity to build on the relationships initiated and successes achieved in the July workshop, and

to meet with representatives from Foreign Affairs Canada and other government departments. Most recently, Environment Canada hosted a restoration workshop sponsored by CRTI and attended by participants from the federal government, the US, the UK, and Russia, in January 2006.

Following two weeks of conducting explosive dispersal testing at DRDC Valcartier in October 2005, delegates from the US, Australia, the UK, and Canada were invited to stay on site for a workshop on current and future research efforts into the characterization of RDDs. In the course of the workshop, participants from Canada and the US discussed and shared results of the work that is taking place in their countries to characterize explosive and non-explosive dispersal of radiological material. The UK representatives discussed plans for conducting trials to improve methods of assessing radiological hazards in the environment in the event of an incident.

4.5.2 ALIGNMENT WITH INTERMEDIATE OUTCOMES

CRTI's strengthened partnerships with the US, as well as new relationships forged with other provincial, national, and UK partners enabled CRTI to share and receive new knowledge for CBRN countermeasures in 2005–2006.

4.6 BUILDING CBRN EXPERTISE AND KNOWLEDGE

CRTI builds CBRN expertise and knowledge within the operational community and among national and international CBRN partners through symposia and workshops and other knowledge management activities and products.

4.6.1 OUTPUTS

Symposia and Workshops

CRTI Summer Symposium

Held in Gatineau, Quebec on 20–22 June, 2005, the third annual CRTI Summer Symposium provided an opportunity for CRTI and the broader CBRN community to learn about the progress of the projects from the first three rounds of funding and share CBRN knowledge with other experts in the field. The three-day scientific conference was followed by a two-day workshop and demonstration for first responders.

During the scientific conference, the 227 attendees learned of the results of several completed projects funded by CRTI through oral and poster presentations. These updates on new contributions to Canada's CBRN preparedness were complemented by keynote speeches from representatives from the Executive Office of the US President and from the US Army Nuclear and Chemical Agency.

During the First Responder Workshop, 129 participants were presented with five real-life radiological, chemical, and white powder incidents. In the discussion that followed, participants identified S&T gaps for CRTI to consider in future planning. One of the highlights of the workshop was a demonstration of NRCan's radiological aerial surveillance technology, which was purchased with Technology Acquisitions funding. Using an RCMP helicopter, which landed on the 18th Fairway, an NRCan representative demonstrated how the equipment could be loaded within minutes. The helicopter then flew over an adjacent area containing a temporarily placed radioactive source. Real-time data was displayed to demonstrate to the

Natural Resources Canada's radiological aerial surveillance technology was demonstrated during exercises and a workshop.

participants how this technology could be used in a real radiological terrorist event to identify the location of radiological material.

Other symposia sponsored by CRTI in full or in part included the following events:

- In September 2005, CRTI held a workshop on radiation emergency response in Ottawa, Ontario. Presenters described the ability of several federal and provincial response agencies to respond to a radiation emergency, and provided the background for an afternoon tabletop exercise. The tabletop exercise was designed to elicit ideas on how provincial and federal response teams can best work together in a radiation emergency, and to identify the ideal command structure for managing the response. The tabletop exercise identified issues likely to arise in a real incident, including the absence of a response capability to handle hundreds of contaminated people. Participants included the EMO of New Brunswick, Emergency Measures Ontario, the RCMP, the CNSC, Health Canada, and J3NBC of DND.
- Environment Canada sponsored a Technical Workshop on Restoration and Decontamination of Chemical, Biological, and Radiological Terrorist Actions in Ottawa in January 2006. Participants at the three-day workshop, which was held at the Environmental Technology Centre, exchanged technical information on all aspects of restoration, including decontamination, neutralization, and disposal of materials contaminated as a result of a CBRN attack on a facility or area. The workshop focused on research and development carried out since the first Restoration Workshop in January 2005. After analyzing the progress to date, participants identified technology gaps and challenges and developed plans of action for the next year. The workshop concluded with a special session on decontamination standards development.
- The CRTI Secretariat led a workshop in May 2005 to explore the methods, factors, and parameters on the "human dimensions" of public response to a CBRN terrorist attack. The workshop assessed the capabilities and limitations of human resilience following a CBRN event and explored the differing views among psychosocial experts. A number of psychosocial knowledge gaps for first responders, individuals, and families of those affected by CBRN events were identified. Participants included academics from the universities of Waterloo, Ottawa, BC, and Queen's; government agencies (e.g., DND, US DHS, PSEPC); practitioners and clinicians (e.g., Red Cross, Providence Health Care, and the Mount Sinai School of Medicine); as well as the Social Sciences and Humanities Research Council. The workshop results will be used as a basis to develop metrics to assist CRTI in quantifying relative psychological and societal disruption derived from CBRN scenarios for potential incorporation into the CRTI Consolidated Risk Assessment.
- Forensic specialists from CRTI and the RCMP, together with a defence scientist at DRDC Ottawa, travelled to Calgary, Alberta in October 2005 to present a workshop at the 2005 annual meeting of the CSFS. The speakers introduced the forensic science community to the challenges of collecting CBRN evidence samples and informed them about the S&T opportunities for forensic science under CRTI. Presentations provided information about CRTI and its Forensic

Laboratory Cluster, highlighted chemical incident case studies, demonstrated radiological and nuclear forensics preparedness, and reported on a sampling exercise in bioforensics. A tabletop exercise scenario, which included mock samples, identified future S&T goals for forensic capability. Workshop participants invited CRTI to return to the next CSFS annual meeting, which will be held at the University of Windsor in August 2006 and be hosted jointly with the forensic identification specialists of the Canadian Identification Society. The joint meeting will give CRTI forensics specialists the chance to take their message to an entirely new audience.

- On May 23, CRTI co-sponsored an Epidemiology and Bioterrorism workshop that included a panel of experts from five countries at the 7th International Meeting on Microbial Epidemiological Markers in Victoria, BC. At the beginning of the conference, representatives in attendance from international organizations were introduced to CRTI and its work in countering terrorism. The workshop enabled discussion on strain typing methods for bioterrorist events and the feasibility of developing an international molecular fingerprint database of existing bioterrorist agents. The workshop ended with a commitment to establish an official working group to move development of the fingerprint database forward. Held for the first time in North America, the premier international meeting on the epidemiological analysis of problem infectious agents proved an ideal venue for CRTI. Approximately 200 to 300 epidemiologists, scientists, and researchers from over 32 countries attended the four-day event, which was co-sponsored by the American Society for Microbiology and the European Society of Clinical Microbiology and Infectious Diseases.

4.6.2 ALIGNMENT WITH INTERMEDIATE OUTCOMES

Participating in national and international workshops and events enables CRTI to strengthen existing partnerships, such as those with the US, and develop new ones, such as those with Russia. As CRTI broadens its network, it raises its profile and expands its knowledge base. The summer symposium is a critical forum for knowledge sharing and for identifying the operational needs of first responders for CBRN countermeasures, and will continue to play a central role in determining CRTI's priorities.

5. OUTLOOK

The fiscal year 2006–2007 will mark the end of CRTI's original five-year mandate, and during this year CRTI will focus on renewal and repositioning. In moving forward, CRTI will take into its second mandate lessons learned from the first phase. Now part of the DRDC and PSEPC's new Centre for Security Science (Centre), CRTI will contribute to positioning the Centre, developing the Centre's domestic and international profile, and contributing to the Centre's communications program. As part of the Centre, CRTI's scope will continue to expand with the addition of an Explosives Cluster to augment the existing four laboratory clusters.

PSTP, CRTI's sister program in the Centre, works both on national security and joint Canada–US initiatives, and CRTI will participate in these initiatives, particularly as they enhance shared standards and interoperability. The goals and activities of the PSTP and CRTI will be coordinated in the interest of national security. CRTI will continue to build on its strengths in developing partnerships by participating in international conferences, seminars, and other events.

Re-energized as a result of their renewal exercises, the clusters are all planning workshops for 2006–2007. Because of its continuing success, the annual symposium will be repeated in 2007. It will again provide CRTI partners the opportunity to showcase their work and, industry a chance to learn what others are doing. It is expected that the variety of partners and the quality of their research will remain high.

During the last year of its first mandate, CRTI will continue with the transition from capacity-based response to planning and implementing capability-based response. The transition will require that CRTI define the new approach, identify its impact on operations, and integrate capability-based response into its activities and governance. This transition will be part of CRTI's renewal, as will the exploitation of technologies that are effective, not only in the fight against terrorism, but can also be positioned to assist in the prevention of and response to natural disasters.

The CRTI model has been successful and has supported exciting and relevant S&T research that is delivering valuable results. The clusters have enhanced their capability with upgraded equipment, facilities, and training. Now CRTI and the partner departments and agencies must turn to strategies for sustaining this capability and capacity. Long-term strategies need to be developed so that the expertise, knowledge, and equipment developed through projects are maintained and enhanced into the future.

There are still gaps in knowledge and capacity that need to be filled and CRTI will issue both broad and targeted calls for proposals to address these gaps. CRTI will continue to refine its Consolidated Risk Assessment process as a method of identifying priorities. Federal departments and response communities will be encouraged to take more responsibility for identifying their goals and requirements. CRTI will need to gain a fuller understanding of operational gaps to assist it in targeting its funding. It will also need to integrate the various technologies developed under it with operational applications, making the technologies more relevant to the response communities.

CRTI will strive to maintain the level of engagement of researchers with its mandate. This requirement is especially apparent in relation to its important partners in the academic community. CRTI will also develop a broader communications strategy that reaches a wider variety of audiences, both within the S&T communities and in the general public.

LIST OF **ACRONYMS** AND **INITIALISMS**

3-D: Three-dimensional

AAFC: Agriculture and Agri-Food Canada

ADM: Assistant Deputy Minister

AECL: Atomic Energy of Canada Limited

AmBe: Americium Beryllium

APD: Avalanche Photodiode

ARGOS: Advanced Research and Global Observation System

BC: British Columbia

BTI: Bubble Technology Industries

C2SM: CBRN Crime Scene Modeler

C^{4}I: Command, Control, Communications, Coordination, and Information

CAHSN: Canadian Animal Health Surveillance Network

CB: Chemical and Biological

CBRN: Chemical, Biological, Radiological, and Nuclear

CBRN/E: Chemical, Biological, Radiological, and Nuclear/Explosive

CBSA: Canada Border Services Agency

CBW: Chemical and Biological Weapon

CCHF: Crimean-Congo Hemorrhagic Fever

CFIA: Canadian Food Inspection Agency

CGSB: Canadian General Standards Board

CHIRP: Canadian Health Integrated Response Platform

CID: CBRN Incident Database

CIP: Critical Infrastructure Protection

CL4: Containment Level 4

CNPHI: Canadian Network for Public Health Intelligence

CNSC: Canadian Nuclear Safety Commission

CONOPS: Concept of Operations

COPE: Common Operating Picture Environment

CPU: Chemical Protective Undergarments

CRTI: CBRN Research and Technology Initiative

CSA: Canadian Standards Association

CSFS: Canadian Society of Forensic Sciences

CSIS: Canadian Security Intelligence Service

CTTC: Counter Terrorism Technology Centre

CWA: Chemical Warfare Agent

DHS: Department of Homeland Security (US)

DMS: Dimethanesulfonate

DNA: Deoxyribonucleic Acid

DNBCD: Directorate of Nuclear, Biological and Chemical Defence

DND: Department of National Defence

DOE: Department of Energy (US)

DRDC: Defence Research and Development Canada

DSTL: Defence Science and Technology Laboratories

DWN: Deployable Wireless Network

ECADS: Early CBRN Attack Detection by Computerized Medical Record Surveillance

ECM: Electronic Countermeasure

ELISA: Enzyme-linked Immunosorbant Assay

EMO: Emergency Measures Organization

END: Electronic Neutron Dosimeter

EOC: Emergency Operations Centre

EOD: Explosive Ordinance Disposal

ETC: Environmental Technology Centre

EXFO: Exercise Follow On

EXMR: Exercise Maritime Response

FAD: Foreign Animal Disease

FAIMS: High-field Asymmetric Waveform Ion Mobility Spectrometry

FMD: Foot-and-mouth Disease

FNEP: Federal Nuclear Emergency Plan

FNERT: Federal Nuclear Expert Response Team

FTIR: Fourier Transform Infrared Spectroscopy

GC/MS: Gas Chromatograph/Mass Spectrometry

GEM-LAM: Global Environmental Multiscale Limited Area Model

GIS: Geographical Information System

GM-CSF: Granulocyte-macrophage Colony-stimulating Factor

GPS: Global Positioning System

HAZMAT: Hazardous Materials

HPLC: High-performance Liquid Chromatography

ICP-MS: Inductively Coupled Plasma Mass Spectrometer

IDI: Infectio Diagnostic Inc.

IMS: Institute for Microstructural Sciences

iSM: Instant Scene Modeler

IT: Information Technology

JNBCD: Joint Nuclear, Biological and Chemical Defence

LANL: Los Alamos National Laboratory

LDDT: Long-dwell Detection in Transit

LIMS: Laboratory Information Management System

mAb: Monoclonal Antibody

MEMS: Micro-electromechanical Systems

MIST: Man-in-simulant Test

MLST: Multi-locus Sequence Typing

MOSL: Mini-OSL

MOU: Memorandum of Understanding

MS: Mass Spectrometer

n/g: Neutron and Gamma

NAADSM: North American Animal Disease Spread Model

NATO: North American Treaty Organization

NB EMO: New Brunswick Emergency Measures Organization

NBC: Nuclear, Biological, and Chemical

NML: National Microbiology Laboratory

NRC: National Research Council of Canada

NRCan: Natural Resources Canada

ODN: Oligodeoxynucleotides

OSL: Optically Stimulated Luminescence

PAYE: Payables at Year-End

PCR: Polymerase Chain Reaction

PCS: Personal Cooling System

PEG-GM-CSF: PEGylated GM-CSF

PHAC: Public Health Agency of Canada

PIW: Project Implementation Workshop

PMT: Photomultiplier Tube

PPE: Personal Protective Equipment

P-RAM: Psychosocial Risk Assessment and Management

PSEPC: Public Safety and Emergency Preparedness Canada

PSTP: Public Security Technical Program

PuBe: Plutonium Beryllium

RAMP: Rapid Analyte Measurement Platform

RANS: Reynolds-averaged Navier-Stokes

RCIED: Radio-controlled Improvised Explosive Device

RCMP: Royal Canadian Mounted Police

RD: Research and Technology Development

RDD: Radiological Dispersal Device

RERT: Radiological Emergency Response Team

RF: Radio Frequency

RMAF: Results-based Management and Accountability Framework

RMC: Royal Military College of Canada

RN: Radiological-Nuclear

RODS: Real-Time Outbreak Detection and Surveillance

RPB: Radiation Protection Bureau

RRT-PCR: Real-time Reverse Transcriptase Polymerase Chain Reaction

S&T: Science and Technology

SAIC: Science Applications International Corporation

SARS: Severe Acute Respiratory Syndrome

SDF: Surface Decontaminating Foam

SNP: Single Nucleotide Polymorphism

SOP: Standard Operating Procedures

SPE: Solid Phase Extraction

TA: Technology Acceleration

TBS: Treasury Board of Canada Secretariat

TD: Technology Demonstration

TIC: Toxic Industrial Chemical

UBC: University of British Columbia

UK: United Kingdom

UOIT: University of Ontario Institute of Technology

US: United States

VIDO: Veterinary Infectious Disease Organization

ANNEX A: **GOVERNANCE**

CRTI is an interdepartmental collaboration initiative. All participants have been involved in identifying the needs to improve Canada's ability to respond to CBRN threats and to select those projects that best lend themselves to meet those needs. The participating departments and agencies are as follows:

- Agriculture and Agri-Food Canada*
- Atomic Energy of Canada Limited
- Canada Border Services Agency*
- Canadian Food Inspection Agency*
- Canadian Nuclear Safety Commission*
- Canadian Security Intelligence Service*
- Department of National Defence/Defence Research and Development Canada*
- Environment Canada*
- Fisheries and Oceans Canada*
- Health Canada*
- National Research Council*
- Natural Resources Canada*
- Privy Council Office
- Royal Canadian Mounted Police*
- Public Safety and Emergency Preparedness Canada*
- Public Health Agency of Canada*
- Transport Canada*
- Treasury Board of Canada Secretariat

CRTI is coordinated by an interdepartmental Steering Committee that is chaired by the Assistant Deputy Minister (ADM) for Science and Technology, DND. Representation from the participating departments is at the ADM level. A Secretariat of 10 people, located in DRDC, manages the Initiative on behalf of the Steering Committee.

* Signatories to the MOU.

ANNEX B: CLUSTER ROLES AND MEMBERSHIP

CLUSTER ROLES

Laboratory clusters are groups of federal and other government laboratories composed of S&T experts and supporting equipment and facilities. They possess S&T capabilities and capacity, and have the necessary synergy to facilitate preparation, prevention, and response to CBRN terrorist attacks in Canada.

The four laboratory clusters address CBRN threats. The roles of each of the cluster teams are as follows:

- Managing the cluster;
- Supporting operational readiness, including training;
- Providing S&T advice and services in support of operations;
- Developing and maintaining standards, and performing evaluation and certification;
- Developing and managing pertinent S&T knowledge needed in operations; and
- Conducting research and development to grow and maintain the cluster's S&T capabilities.

Cluster membership is widely dispersed among participating departments and agencies. Categories of membership are as follows:

- **Member**—labs that have a mandate or play an active role in the specific area of interest of the cluster.
- **Affiliate**—labs that have the lead on cluster-related RD projects or provide specific expertise that is of interest to the cluster.
- **Partner**—selected non-federal government labs (provincial, international, etc.) that work in the specific area of interest of the cluster.

CLUSTER MEMBERSHIP

ORGANIZATION	BIOLOGICAL LABORATORY CLUSTER	CHEMICAL LABORATORY CLUSTER	RN LABORATORY CLUSTER	FORENSIC LABORATORY CLUSTER
Agriculture and Agri-Food Canada	X	X		
Agriculture and Agri-Food Canada—Land Resources Unit			X	
Atomic Energy of Canada Limited—Chalk River Laboratory			X	
Canada Border Services Agency				A
Canada Border Services Agency—Laboratory and Scientific Services Directorate	X	X	X	
Canadian Food Inspection Agency			X	
Canadian Food Inspection Agency—Animal Lab Network	X			

X = Member A = Affiliate P = Partner

CLUSTER MEMBERSHIP (CONTINUED)

ORGANIZATION	BIOLOGICAL LABORATORY CLUSTER	CHEMICAL LABORATORY CLUSTER	RN LABORATORY CLUSTER	FORENSIC LABORATORY CLUSTER
Canadian Food Inspection Agency—Food Microbiology Lab Network	X			
Canadian Food Inspection Agency—Laboratories Directorate		X		
Canadian Food Inspection Agency—Plant Lab Network	X			
Canadian Food Inspection System International Working Group	P			
Canadian Nuclear Safety Commission				X
Canadian Nuclear Safety Commission—Directorate of Nuclear Substance Regulation			X	
Canadian Public Health Laboratory Network	P			P
Canadian Security Intelligence Service	A		A	
Centre of Forensic Sciences (Ontario)				P
Defence Research and Development Canada—Counter Terrorism Technology Centre				X
Defence Research and Development Canada—Ottawa			X	X
Defence Research and Development Canada—Public Security Technical Program				X
Defence Research and Development Canada—Suffield	X	X		X
Department of National Defence—Directorate for Strategic Intelligence	A		A	
Emergency Protection Laboratory—Ontario			P	
Environment Canada	X			
Environment Canada—Canadian Meteorological Centre		X	X	
Environment Canada—Environmental Emergencies Section		X		
Federal/Provincial/Territorial Radiation Protection Committee			P	
Fisheries and Oceans Canada	A	X		
Fisheries and Oceans Canada—Atlantic Environmental Radioactivity Laboratory			X	

X = Member A = Affiliate P = Partner

CLUSTER MEMBERSHIP (CONTINUED)

ORGANIZATION	BIOLOGICAL LABORATORY CLUSTER	CHEMICAL LABORATORY CLUSTER	RN LABORATORY CLUSTER	FORENSIC LABORATORY CLUSTER
Health Canada—Bureau of Chemical Safety Laboratories		X		
Health Canada—Bureau of Environmental Health Sciences		X		
Health Canada—Emergency Preparedness and Response, Workplace Health and Public Safety Program				A
Health Canada—Food Directorate	X			
Health Canada—Food Directorate—Bureau of Microbial Hazards	X			
Health Canada—Health Products and Food Branch				A
Health Canada—Radiation Protection Bureau			X	
Institut national de santé publique du Québec				P
Laboratoire de sciences judiciaires et de médecine légale (Quebec)				P
National Research Council—Biotechnology Research Institute	A			
National Research Council—Fuel Cell Program			A	
National Research Council—Industrial Materials Institute		A		
National Research Council—Institute of Biological Sciences	X			
National Research Council—Institute of Biotechnology Research	X			
National Research Council—Institute for Chemical Processes and Environmental Protection		X		
National Research Council—Institute for Microstructural Sciences		A		
National Research Council—Institute for Research in Construction	A	A	A	
National Research Council—Integrated Manufacturing Technologies Institute	A	A	A	
National Research Council—Ionizing Radiation			X	

X = Member A = Affiliate P = Partner

CLUSTER MEMBERSHIP (CONTINUED)

ORGANIZATION	BIOLOGICAL LABORATORY CLUSTER	CHEMICAL LABORATORY CLUSTER	RN LABORATORY CLUSTER	FORENSIC LABORATORY CLUSTER
Natural Resources Canada—Canadian Explosives Research Laboratory				A
Natural Resources Canada—Canadian Forest Service	X			
Natural Resources Canada—CANMET Energy Technology Centre		X		
Natural Resources Canada—Earth Sciences Sector—Geological Survey of Canada		X		
Natural Resources Canada—Earth Sciences Sector—Geomatics Canada		X	X	
Natural Resources Canada—Emergency Mapping Service			X	
Natural Resources Canada—Radiation Geophysics Section—National Gamma Ray Spectrometry Program			X	
Networks for Centres of Excellence—Canadian Bacterial Disease Network	P			
Networks for Centres of Excellence—Canadian Network for Vaccines and Immunotherapeutics	P			
North American Plant Protection Organization	P			
Ontario Forensic Sciences Laboratory		A		
Ontario Provincial Police				P
Provincial Emergency Management Offices (Ontario, Quebec, BC, Nova Scotia, and New Brunswick)			A	
Public Health Agency of Canada—Centre for Emergency Preparedness and Response				X, A
Public Health Agency of Canada—Centre for Infectious Disease Prevention and Control	X			
Public Health Agency of Canada—Centre for Surveillance Coordination	X			
Public Health Agency of Canada—Laboratory for Foodborne Zoonoses	A			

X = Member A = Affiliate P = Partner

CLUSTER MEMBERSHIP (CONTINUED)

ORGANIZATION	BIOLOGICAL LABORATORY CLUSTER	CHEMICAL LABORATORY CLUSTER	RN LABORATORY CLUSTER	FORENSIC LABORATORY CLUSTER
Public Health Agency of Canada—Office of Laboratory Security	X			
Public Health Agency of Canada—National Microbiology Laboratory	X			X
Public Safety and Emergency Preparedness Canada	A			X, A
Public Safety and Emergency Preparedness Canada—Canadian Emergency Preparedness College				X
Radiation Protection Bureau—British Columbia			P	
Royal Canadian Mounted Police	A	X		
Royal Canadian Mounted Police—Canadian Police Research Centre				X
Royal Canadian Mounted Police—Explosive Disposal Unit, Forensic Identification Services, and Forensic Laboratory Services			A	
Royal Canadian Mounted Police—Explosives Disposal and Technology Section				X
Royal Canadian Mounted Police—Federal Investigation Section				X
Royal Canadian Mounted Police—Forensic Laboratory Services				X
Royal Military College of Canada		X		
Standards Group—Institute for National Measurement Standards			X	
Sûreté du Québec				P
Transport Canada		A		
United States Department of Agriculture—Animal and Plant Health Inspection Service	P			
United States Department of Agriculture—Animal Research Service	P			
United States Department of Energy			P	

X = Member A = Affiliate P = Partner

ANNEX C: **PROPOSAL SELECTION PROCESS**

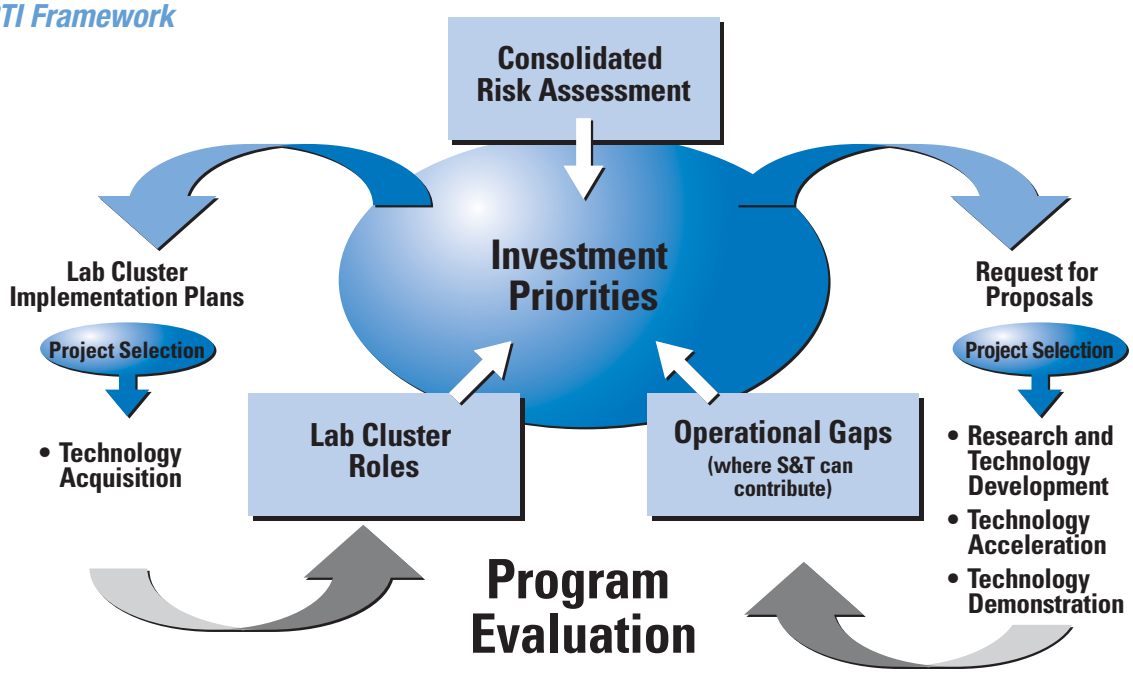
The CRTI Framework, shown below, demonstrates the dynamic aspect of CRTI planning.

For Technology Acquisition projects, the laboratory clusters identify requirements through consensus and make submissions to a Project Review Committee, chaired by the Director of CRTI and made up of the laboratory cluster leaders, before going to the Steering Committee.

For projects in the RD, TA, and TD categories, a Proposal Selection Committee composed of experts in the fields of CBRN S&T, public security, and counterterrorism evaluates the project proposals. They are supported by a number of external reviewers who provide the necessary expertise, judgment, and knowledge needed to critically assess the proposals against identified selection criteria. After proposal synopses are screened and assessed, successful applicants are invited to submit a more detailed full proposal. The full proposals are evaluated using a structured language ladder. The Proposal Selection Committee makes recommendations for the balance of the portfolio and final selection to the Steering Committee. In all cases, the Steering Committee makes the final decisions.

The Proposal Selection Committee is composed of a cross-section of subject-matter experts supported by external reviewers. The Committee members are subject to a conflict of interest and non-disclosure agreement. The Committee for 2005–2006 included the following members:

CRTI Framework



- Dr. J. Cornett, Director, Radiation Protection Bureau, Health Canada and Leader, RN Laboratory Cluster
- Dr. C. Boulet, Director, CRTI Secretariat (Chair)
- Dr. John G. Arnold, Chief Scientist, NRC, Canadian Police Research Centre
- Mr. Denis Nelson, Program Manager, CBRN Forensics, RCMP and Leader, Forensics Laboratory Cluster
- Dr. M. Fingas, Chief, Emergencies Science and Technology, Environment Canada and Leader, Chemical Laboratory Cluster
- Dr. A. Fraser, Executive Director, Science Strategies, CFIA and Co-leader, Biological Laboratory Cluster
- Mr. T. Patraboy, Senior Scientist, PSEPC
- Dr. F. Plummer, Director, National Microbiology Laboratory, PHAC and Co-leader, Biological Laboratory Cluster
- Dr. C. Tucker, Special Advisor, Science and Technology Policy, PSEPC
- Dr. B. Davidson, Vice-President, Science and Technology, MDS SCIEX
- Dr. W. Johnson, Vice-President, Research and Development, Cangene Corporation
- Dr. F. Caron, Professor, Chemistry and Biochemistry, Laurentian University
- Dr. H. Durham, Professor, Montreal Neurological Institute, McGill University

ANNEX D: **PROJECT PARTNERS BY SECTOR**

CRTI collaborated with a diversity of partners in 2005–2006.

FEDERAL GOVERNMENT PARTNERS

- Agriculture and Agri-Food Canada
- Atomic Energy of Canada Limited
- Canada Border Services Agency
- Canadian Food Inspection Agency
- Canadian Forest Service
- Canadian General Standards Board
- Canadian Nuclear Safety Commission
- Canadian Police Research Centre
- Canadian Security Intelligence Service
- Defence Research and Development Canada
- Department of National Defence
- Environment Canada
- Fisheries and Oceans Canada
- Health Canada
- Industry Canada
- National Research Council of Canada
- Natural Resources Canada
- Public Health Agency of Canada
- Public Safety and Emergency Preparedness Canada
- Public Works and Government Services Canada
- Royal Canadian Mounted Police
- Standards Council of Canada
- Transport Canada

INDUSTRY PARTNERS

- 3M Canada
- AirBoss Engineering Products Inc.
- Allen-Vanguard Corporation
- AMITA Corporation
- Amtech Aeronautical Limited
- Bubble Technology Industries
- CAE Inc.
- CAM Emergency Preparedness
- Cangene Corporation
- Carleton Quantitative Research, Ottawa
- Cepheid Incorporated
- DBx Geomatics Inc.
- Dunn Engineering
- Dupont Canada
- Dycor Technologies
- EMC Consulting
- EmerGeo Solutions Inc.
- e-Privacy Systems Inc.
- Fluorosense Inc.
- General Dynamics Canada
- GPI Atlantic
- Greenley & Associates
- Health Systems Strategies
- Hytec Hydrocarbon Reclamation Ltd.
- IatroQuest Corporation
- IBM Canada
- IDT Direct
- Infectio Diagnostic Inc.
- Innovative Micro Technology
- Ionalytics Corporation
- Isotech Design Inc.
- ITspatial Canada, Inc.
- JD Wilson & Associates
- JERA Consulting
- Kosteniuk Consulting
- MacDonald, Dettwiler + Associates Inc.
- Magellan Engineering
- McFadden Technologies Ltd.
- MDA
- MDS Sciex Inc.

- Med-Eng Systems Inc.
- MEMS Precision Technology Inc.
- Micralyne Inc.
- Mobile Detect Inc.
- Nanogen Inc.
- New Brunswick Power Corporation
- Ontario Power Generation
- Performance Support Services Inc.
- Prairie Diagnostic Services
- Science Applications International Corporation Canada
- t.e.s.t.
- TDV Global Inc.
- Twinstrand Therapeutics Inc.
- UGM Engineering Ltd.
- VLN Advanced Technologies Inc.
- Waterloo CFD Engineering Consulting, Inc.
- Xwave

PROVINCIAL PARTNERS

- Alberta Agriculture, Food and Rural Development
- British Columbia Centre for Disease Control
- Government of Alberta
- Government of British Columbia
- Government of Manitoba
- Government of New Brunswick
- Government of Newfoundland and Labrador
- Government of Nova Scotia
- Government of Québec
- Grey Bruce Health Services
- Grey Bruce Public Health Unit
- Hanover and District Hospital
- New Brunswick Emergency Measures Organization
- Ontario Centre of Forensic Sciences
- Ontario Ministry of Agriculture and Food
- Ontario Ministry of Community Safety and Correctional Services
- Ontario Ministry of Labour
- Ontario Provincial Police
- Saskatchewan Agriculture and Food
- South Bruce Grey Health Centre
- Winnipeg Regional Health Authority

CANADIAN ACADEMIC PARTNERS

- Carleton University
- Centre Hospitalier Universitaire de Québec
- McGill University
- McMaster University
- Memorial University of Newfoundland
- Queen's University
- Royal Military College of Canada
- Trent University
- Université Laval
- University of Alberta
- University of British Columbia
- University of Guelph
- University of Manitoba
- University of Montréal
- University of Ontario Institute of Technology
- University of Ottawa
- University of Prince Edward Island
- University of Saskatchewan
- University of Toronto
- University of Waterloo
- York University

FOREIGN ACADEMIC PARTNERS

- Carnegie Melon University (US)
- Colorado State University (US)
- Iowa State University (US)
- Michigan State University (US)
- University of Helsinki (Finland)
- University of Leeds (UK)

FOREIGN PARTNERS

- Animal and Plant Health Inspection Service (US)
- Australian Federal Police Bomb Data Centre (Australia)
- Australian National Animal Health Laboratory (Australia)
- Battelle Memorial Institute (US)
- Brookhaven National Laboratory (US)
- Canada–US Cargo Security Project (US)
- Centre d'études du Bouchet (France)
- Danish Emergency Management Agency (Denmark)
- Defence Science and Technology Laboratories (UK)
- Department of Agriculture, Fisheries, and Forestry (Australia)
- First Responders (US)
- High Voltage Engineering Europa BV (Netherlands)
- Infectious Disease Research Center (US)
- Institute of Food Research (UK)
- ISO Trace (New Zealand)
- ITspacial, LLC (US)
- Lawrence Livermore National Laboratory (US)
- Los Alamos National Laboratory (US)
- Netherlands Organization for Applied Scientific Research (Netherlands)
- Pacific Northwest National Laboratory (US)
- Pasteur Institut (France)
- Prolog Development Center (Denmark)
- Research Institute of Hygiene, Toxicology, and Occupational Pathology (Russia)
- Science Applications International Corporation (US)
- Scripps Institute (US)
- Singapore Armed Forces (Singapore)
- TNO Prins Maurits Laboratory (Netherlands)
- UK Ministry of Defence (UK)
- United States Department of Agriculture (US)
- United States Environmental Protection Agency (US)
- United States Medical Research Institute of Infectious Diseases (US)
- Wehrwissenschaftliches Institut für Schutztechnologien (Germany)

OTHER PARTNERS

- Canadian Centre for Human and Animal Health
- Canadian Cooperative Wildlife Health Centre
- Canadian Federation of Nurses' Unions
- Canadian First Responders
- Canadian Standards Association
- Canadian Women's Health Network
- Centre for Epidemiology and Animal Health
- Justice Institute of British Columbia
- Ottawa Airport Authority
- Ottawa Heart Institute
- Ottawa Hospital
- Ottawa Police Service
- The British Columbia Centre of Excellence in Women's Health
- Toronto Emergency Medical Services
- Toronto Police Service
- Vancouver Police Department
- Victorian Order of Nurses

ANNEX E: **DISTRIBUTION OF FUNDS BY PROJECT**

DISTRIBUTION OF FUNDS BY PROJECT

PROJECT	2002–2003	2003–2004	2004–2005	2005–2006	2006–2007	2007–2008	2008–2009	2009–2010	CRTI FUNDING
CRTI 0004TA	40,000	9,892							49,892
CRTI 0006RD	37,500	194,648	371,314	318,186	277,487				1,199,135
CRTI 0011TA	192,000	599,561							791,561
CRTI 0019TA	357,400	1,427,882	615,683						2,400,965
CRTI 0027RD	48,741	1,246,304	930,587	785,458	607,200				3,618,289
CRTI 0029RD	63,358	1,033,413	800,802	678,036	377,210				2,952,819
CRTI 0052TA	93,140	14,078	432,079	164,711	6,000				710,008
CRTI 0060TA		891,913	275,766						1,167,679
CRTI 0064RD	105,295	708,333	615,241	604,159	437,042				2,470,070
CRTI 0072RD	34,000	288,200	319,304	305,098	30,100				976,702
CRTI 0080TA	136,863	156,240	199,261						492,363
CRTI 0085TA	4,950	132,932	693,341	25,161					856,385
CRTI 0087RD	178,591	1,278,156	660,898	494,536					2,612,181
CRTI 0091RD	146,460	502,466	805,882	624,945	394,904	81,818			2,556,475
CRTI 0100TA		226,495	1,423,227						1,649,722
CRTI 0105TA	247,000	655,406	557,418	235,612	71,384				1,766,819
CRTI 0120RD	83,251	485,834	829,725	239,373					1,638,183
CRTI 0131TA	144,712	549,373	808,597	1,196,590	2,500,000				5,199,271
CRTI 0133RD	225,742	406,772	435,683	383,287					1,451,483
CRTI 0154RD	159,347	598,180	628,360	731,090	558,380				2,675,358
CRTI 0161TA		770,838	389,162						1,160,000
CRTI 0196TA	479,800	1,267,534	1,167,667	1,579,098	330,000				4,824,099
CRTI 0203RD	212,715	839,879	196,361	99,155					1,348,111
CRTI 0204RD	161,997	226,236	105,774						494,008
CRTI 02-0007TA		444,021	768,029	395,326					1,607,376
CRTI 02-0021RD		490,907	500,000	9,094					1,000,001
CRTI 02-0024RD		241,861	585,094	462,712	169,200				1,458,867

DISTRIBUTION OF FUNDS BY PROJECT (CONTINUED)

PROJECT	2002–2003	2003–2004	2004–2005	2005–2006	2006–2007	2007–2008	2008–2009	2009–2010	CRTI FUNDING
CRTI 02-0035RD		434,098	1,547,548	1,191,389	490,056				3,663,091
CRTI 02-0041RD		227,500	697,138	550,195	523,850				1,998,684
CRTI 02-0041TA		294,329	690,999	149,700					1,135,028
CRTI 02-0043TA		448,785	892,538	620,799					1,962,121
CRTI 02-0045RD		314,029	387,126	658,986					1,360,141
CRTI 02-0053TA		153,461	796,189	362,831					1,312,481
CRTI 02-0057TA			251,162	204,035	180,816				636,013
CRTI 02-0066RD		154,361	738,149	179,500	327,938				1,399,948
CRTI 02-0067RD		338,783	951,841	682,408					1,973,032
CRTI 02-0069RD		647,950	395,090	433,370	321,188				1,797,598
CRTI 02-0080RD		152,640	599,716	781,280	783,280				2,316,916
CRTI 02-0091TA			173,837	117,886	100,000				391,723
CRTI 02-0093RD		338,000	1,061,000	1,137,000	1,056,000	133,000			3,725,000
CRTI 02-0093TA		455,767	388,217	182,928					1,026,911
CRTI 03-0005RD			282,197	786,710	747,778	383,315			2,200,000
CRTI 03-0009RD			145,685	307,365	372,575	259,852			1,085,477
CRTI 03-0013TD			379,837	1,046,582	338,380				1,764,799
CRTI 03-0017TA			199,000	239,850					438,850
CRTI 03-0018RD			728,807	815,893	975,700	294,900			2,815,300
CRTI 03-0018TD			721,469	978,331	201,500				1,901,300
CRTI 03-0019TD			623,592	921,000	254,000				1,798,592
CRTI 03-0021TD			310,393	675,464	637,502	376,641			2,000,000
CRTI 03-0023TD			77,960	392,365	43,935				514,260
CRTI 03-0025TA			512,850	926,776	200,000				1,639,626
CRTI 03-0060RD			69,828	438,495	395,439	81,007			984,770
CRTI 04-0004RD				421,000	881,000	781,000	307,000		2,390,000
CRTI 04-0018RD				416,081	771,451	716,641	682,993		2,587,166

DISTRIBUTION OF FUNDS BY PROJECT (CONTINUED)

PROJECT	2002–2003	2003–2004	2004–2005	2005–2006	2006–2007	2007–2008	2008–2009	2009–2010	CRTI FUNDING
CRTI 04-0019TD				256,096	458,696				714,792
CRTI 04-0022RD				146,499	168,500	133,500			448,499
CRTI 04-0029RD				276,928	397,000	265,000	20,000		958,928
CRTI 04-0030TD				144,223	194,100				338,323
CRTI 04-0045RD				439,000	757,000	581,000	223,000		2,000,000
CRTI 04-0047TD				499,050	1,038,317	107,497			1,644,864
CRTI 04-0052RD				272,115	728,417	668,605	330,862		1,999,999
CRTI 04-0082TA				222,348	177,652				400,000
CRTI 04-0112TD				117,805	17,500				135,305
CRTI 04-0127RD				95,855	801,059	703,059	362,680		1,962,653
CRTI 05-0006TA					392,400	294,200			686,600
CRTI 05-0014RD									593,200
CRTI 05-0016RD					139,576	167,826	242,576		549,978
CRTI 05-0043RD					123,000	113,000			236,000
CRTI 05-0053TA					113,225	473,900	412,875		1,000,000
CRTI 05-0058TD					380,045	498,016	621,939		1,500,000
CRTI 05-0069RD					516,858	862,377	534,120	86,645	2,000,000
CRTI 05-0090TA					263,500	392,500	219,000		875,000
CRTI 05-0092TA					75,000	185,000			260,000
CRTI 05-0106TA					235,084	391,409	153,507		780,000
CRTI 05-0108TD					346,500	285,500	353,000		985,000
CRTI 05-0121RD				3,000	2,000	408,550	203,550	43,000	660,100
CRTI 05-0122TD					580,591	788,177	172,332		1,541,100
CRTI 05-0123TD				1,755	120,245	302,000	876,400		1,300,400

ANNEX F: **TECHNOLOGY ACQUISITIONS SELECTED IN 2005–2006**

The Technology Acquisition fund provides funds to those areas where the national S&T capacity is deficient owing to obsolete equipment, dated facilities, and inadequate scientific teams. Projects are selected through gap analysis and cluster consensus.

CRTI TECHNOLOGY ACQUISITIONS 2005–2006

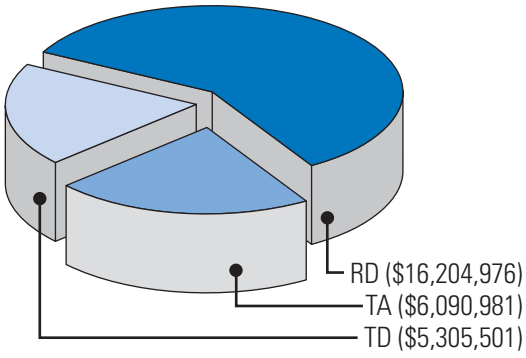
PROJECT NUMBER	CRTI FUNDING ($000S)	CAPABILITY DESCRIPTION	DEPARTMENT/ FACILITY
BIO023AP	450	Upgrade of Containment Level 4 (CL4) to Increase Sterilization Capacity	PHAC
BIO024AP	97	Emergency Response—Large Volume Aerosol Collection	DRDC Suffield
CHEM026AP	85	HPLC Analysis of Chemical Warfare Agents in Samples Collected in Support of Counterterrorism	DRDC Suffield
CHEM027AP	55.46	Vapor Generation System	CBSA
CHEM028AP	140	A Versatile High Throughput Microplate Reader for Multiple Applications in Health Risk Characterization of Chemical Hazards	Health Canada
CHEM029AP	120	Field Analysis of Chemicals with New Technology	Environment Canada
CHEM030AP	320	Analysis of Chemicals by Inductively Coupled Plasma	Environment Canada
CHEM031AP	90	Refurbishment of Atomic Emission Detector	Environment Canada
FOR001AP	345	GC/MS/MS Analysis of Chemical Warfare Agent Products in Forensic Samples Collected in Support of Counterterrorism	RCMP
FOR002AP	161	Equipment and Forensic Identification Protocols for the Handling of Evidence Potentially Contaminated by CBRN Materials	RCMP

CRTI TECHNOLOGY ACQUISITIONS 2005–2006 (CONTINUED)

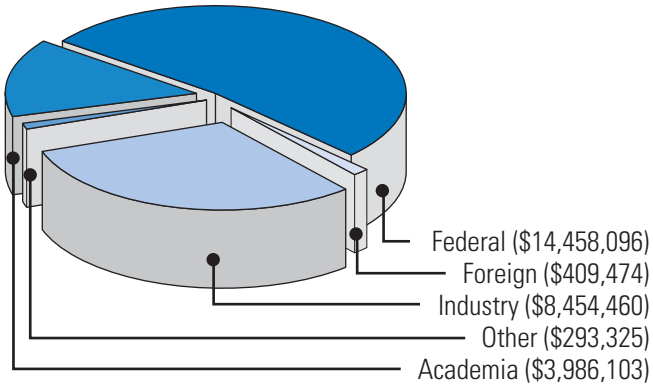
PROJECT NUMBER	CRTI FUNDING ($000S)	CAPABILITY DESCRIPTION	DEPARTMENT/ FACILITY
RN012AP	25	Update to Airborne and Ground Base Surveillance System	NRCan
RN013AP	210	Fixed Point Surveillance Network Upgrade	Health Canada
RN014AP	92	Single Grain OSL Attachment for the Automated TL/IRSL/Blue OSL Dosimetry System Model Riso TL/OSL-DA-15C/D	DRDC Ottawa
RN015AP	100	Roll Out of Cluster Data Management System—Phase 1	Health Canada
RN016AP	100	Integrating RN S&T Capacity	Health Canada

CRTI FINANCIAL OVERVIEW 2005–2006

DISTRIBUTION OF FUNDS BY PROJECT CATEGORY



DISTRIBUTION OF FUNDS BY SECTOR



CRTI FUNDING TO FEDERAL GOVERNMENT PARTNERS 2005–2006

DEPARTMENT/AGENCY	FUNDING
Agriculture and Agri-Food Canada	$ 439,000.00
Environment Canada	$ 3,445,901.93
Health Canada	$ 5,752,092.32
Royal Canadian Mounted Police	$ 1,250,087.21
National Research Council of Canada	$ 2,219,164.90
Natural Resources Canada	$ 43,582.00
Canada Border Services Agency	$ 49,835.21
Canadian Security Intelligence Service	$ 395,365.00
Canadian Food Inspection Agency	$ 2,451,713.00
Public Health Agency of Canada	$ 6,081,135.07
DND – Royal Military College	$ 678,035.99
DRDC Ottawa	$ 4,831,849.94
DRDC Suffield	$ 2,382,549.39
Total	**$ 30,020,311.96**

PART II: **CRTI PORTFOLIO**

PART II: THE CRTI **PORTFOLIO**

In 2005–2006, two rounds of CRTI project selection were completed. In both rounds, 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 CRTI Portfolio for 2005–2006 is presented in Part II of this annual report.

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CRTI 04-0004RD

PROPOSAL FOR THE ESTABLISHMENT OF THE CANADIAN ANIMAL HEALTH SURVEILLANCE NETWORK

Project Lead:

Canadian Food Inspection Agency

Federal Partner:

Public Health Agency of Canada

Industry Partners:

TDV Global Inc., Prairie Diagnostic Services

Other Partners:

Government of Nova Scotia, Government of Alberta, University of Prince Edward Island, University of Guelph, University of Montréal, Government of Quebec, Government of New Brunswick, Government of British Columbia, Government of Manitoba, Government of Newfoundland and Labrador, Canadian Cooperative Wildlife Health Centre, Saskatchewan Agriculture and Food

As the recent outbreaks of bovine spongiform encephalopathy and avian influenza (AI) have illustrated, the threat of a major animal disease epidemic can have devastating impacts on Canadian agriculture and, by association, the Canadian public. The early detection of foreign animal diseases (FADs) or the emergence of a new disease syndrome is critical to mitigate the economic consequences and reduce the potential risk to human health from any zoonotic agent. Currently, however, Canada lacks a comprehensive surveillance infrastructure that can rapidly alert animal health authorities about the potential emergence of a disease outbreak.

This project aims to establish the Canadian Animal Health Surveillance Network (CAHSN), a network of federal, provincial, and university animal health diagnostic laboratories that will provide real-time surveillance data on the status of Canadian livestock. The system will integrate ongoing targeted surveillance with syndromic and rumour surveillance techniques to provide a national intelligence-gathering capacity for animal disease threats. Veterinary epidemiologists will monitor the information to detect any emerging disease or syndrome events that require urgent investigation, and recommend further action to decision makers responsible for disease control.

The CAHSN will also increase the surge capacity of federal and provincial laboratories to rapidly diagnose serious and infectious animal diseases. It will establish interoperability between laboratories by using common protocols and reagents, and providing a framework within which technical and scientific staff may be easily exchanged to participate in training and to share expertise.

The network will collaborate with the Canadian Network for Public Health Intelligence (see CRTI 02-0035RD) to allow for the rapid interchange of animal and public health intelligence, such as the first appearance of anthrax or AI in animals, or the first appearance of West Nile virus in humans. It will also link to the animal health laboratory network in the United States (US) through the Canadian Food Inspection Agency's (CFIA's) National Centre for Foreign Animal Disease. This important link to the US will facilitate information exchange on the occurrence of FAD events that could potentially spread across the borders between the two countries.

CRTI 04-0018RD

DEVELOPMENT OF STANDARDS FOR CHEMICAL AND BIOLOGICAL DECONTAMINATION OF BUILDINGS AND STRUCTURES AFFECTED BY TERRORISM

Project Lead:

Environment Canada

Federal Partners:

Public Health Agency of Canada, DRDC Suffield

Other Partners:

University of Ottawa, Russian Institute of Hygiene, Toxicology, and Occupational Pathology, Science Applications International Corporation, Lawrence Livermore National Laboratory, University of Leeds

In addition to mitigating the immediate impacts of a chemical and biological (CB) attack, an effective emergency response plan must include standards that will direct procedures for effective site remediation. Worldwide, however, only a few standards exist for chemical warfare agents (CWAs), even fewer for toxic industrial chemicals (TICs), and none for biological agents.

The goal of this project, led by Environment Canada, is to develop cleanup targets or standards for decontaminating buildings and construction materials after a CB emergency, using experimental data and models. The first step in the project involves a literature survey to locate any existing standards and procedures, as well as data on residual quantities, the dissipation of aerosols or chemicals from surfaces over time, and exposures to surfaces and airborne targets.

Once the literature review is complete, project partners at the University of Ottawa, the Public Health Agency of Canada (PHAC), the Russian Institute of Hygiene, Toxicology, and Occupational Pathology, Defence and Research Development Canada (DRDC) Suffield, and Environment Canada laboratories will generate data to develop algorithms. The algorithms will then be used to develop CB cleanup standards. Methodologies for this phase of the project include measuring exposure from residual material and comparing this to toxicological data.

Finally, the algorithms and standards will be subjected to a wide range of verification tests, including measurements using surrogate CB agents, and readjusted as necessary. The algorithms produced can be used in the future to evaluate other CB agents.

The outcomes from this project will be critical for cleanup personnel and first responders. The standards will be linked to cleanup methods so that the response community will be able to gauge whether a proposed method achieves the desired result. An emergency response manual, developed under a previous CRTI project, will be updated with any information obtained during this study.

CRTI 04-0019TD

FIELD DEMONSTRATION OF ADVANCED CBRN DECONTAMINATION TECHNOLOGIES FOR BUILDINGS

Project Lead:

Environment Canada

Federal Partners:

DRDC Suffield, DRDC Ottawa, Public Health Agency of Canada – Office of Laboratory Security, Health Canada – Canadian Centre for Human and Animal Health

Industry Partners:

Science Applications International Corporation, Allen-Vanguard Corporation, United States Environmental Protection Agency

For Canadian military personnel; hazardous materials (HAZMAT) teams; and researchers developing chemical, biological, radiological, and nuclear (CBRN) decontamination technologies, testing equipment and response capacity under realistic conditions is critical.

The purpose of this project, led by Environment Canada, is to address this gap by constructing a special building or buildings at the Counter Terrorism Technology Centre at DRDC Suffield that will be used specifically for a CBRN decontamination demonstration. The facility will include features common to a typical house or office building, and will contain standard construction elements such as concrete, painted steel, wood panel, laminated plastic, and drywall. One level will be dedicated to demonstrating chemical restoration technology, another to biological decontamination, and a third to radiological-nuclear exercises. Each level will be isolated from the others using airtight barriers to enable independent work and reduce cross-contamination.

Once the facility is constructed, it will be contaminated with selected CB agents and short-lived radionuclides. The agents will be applied on the test surfaces using an explosive dissemination device developed at DRDC Suffield or, in some cases, using a spray device.

Restoration teams consisting of trained military personnel, along with HAZMAT teams and research personnel from participating project partner organizations, will then conduct decontamination experiments on the facility. These experiments will be conducted using the best-known technologies for each test type, for example, surface decontamination foam for the chemical decontamination demonstration, vaporized hydrogen peroxide for the biological agent exercises, and zeolite slurry for the radiological restoration tests. The information collected will include the performance of the contaminant and decontamination products; the effectiveness of the restoration method; the cost and duration of the decontamination, cleaning, or neutralization material; and the contamination resulting from the cleanup.

Each trial will continue until a pre-set level of residual contamination is achieved. If such a level is not achieved, CASCAD™, a stronger decontamination formulation, will be used for a complete cleanup of CB trials. For radiological decontamination, researchers will wait until the level of radioactivity is safe before using the contaminated facility.

The project will be driven by the needs of first responders, who will be directly involved in planning and executing the demonstration. Because of this direct involvement, they will be able to quickly adopt and directly apply the test methods.

CRTI 04-0022RD

RAPID SEPARATION AND IDENTIFICATION OF CHEMICAL AND BIOLOGICAL WARFARE AGENTS IN FOOD AND CONSUMER MATRICES USING FAIMS-MS TECHNOLOGY

Project Lead:

National Research Council of Canada

Federal Partners:

Canadian Food Inspection Agency, DRDC Suffield

Industry Partner:

Ionalytics Corporation

Following a chemical or biochemical terrorist attack, it is essential that first responders know the nature of the threat as quickly as possible to mitigate its health and economic impacts. Current analytical systems, however, can take days or even weeks to screen samples and provide results.

Led by the National Research Council of Canada (NRC), this project aims to improve this capability using high-field asymmetric waveform ion mobility spectrometry (FAIMS). FAIMS is a novel, continuous chemical separation method that has already proven successful in clinical, proteomics, and environmental analytical applications. The separation of ions in FAIMS results from differences in ion mobility in strong and weak electric fields. When driven by strong electric fields, the collision between an ion and a molecule of the bath gas is more energetic than the thermal energy collisions that result when the ion is stationary. This change in the energy of collision has subtle effects on ion mobility and enables the separation of ions.

Mounted in front of a mass spectrometer (MS), the FAIMS device can separate ionized chemicals in seconds, rather than minutes or hours as in the case of conventional chromatography-based separation systems. Working with Ionalytics Corporation, the company commercializing FAIMS technology, the project team will design, test, and implement rapid analytical protocols based on FAIMS-MS and evaluate this new technology to detect known and potential chemical warfare agents (CWAs).

Three federal government agencies will collaborate on this project. The NRC's Institute for National Measurement Standards, which is renowned for developing innovative MS methods and technologies, has been actively involved in FAIMS research in the early stages of development. DRDC Suffield will provide technical expertise on CWAs and toxins, and the CFIA will provide expertise on food-related chemicals. The CFIA and DRDC Suffield will also provide input into the design and testing of these methodologies from the perspective of the end user.

CRTI 04-0029RD

DEVELOPMENT OF AN ELECTRONIC NEUTRON DOSIMETER

Project Lead:

DRDC Ottawa

Federal Partners:

Canadian Nuclear Safety Commission, Standards Council of Canada, Department of National Defence – Joint Nuclear, Biological and Chemical Defence Company

Industry Partner:

Bubble Technology Industries

Other Partner:

Los Alamos National Laboratory

The threat of a deliberate explosion or dissemination of even a small number of neutron-emitting sources, such as plutonium beryllium (PuBe) and americium beryllium (AmBe), could cripple a large urban infrastructure, contaminating many square kilometres with radiation levels far exceeding regulatory limits. Such contamination is particularly serious because of the transuranic compounds involved, which are a major health threat once they enter the body. Currently, however, there are no electronic neutron dosimeters (ENDs) commercially available for first responders to use in the event of such a radiological-nuclear (RN) emergency.

The purpose of this project is to develop an END that meets civilian and military performance specifications. Evaluations of existing and prototype devices have identified many deficiencies relative to the desired properties of a viable END. These include appropriate sensitivity, a wide energy response, low power requirements, total neutron and gamma (n/g) discrimination, and adequate environmental stability. Among the most significant technological challenges in developing a usable END are minimizing its power requirements, electronics, size, and weight.

The project will occur in three stages—conceptual design, construction of a laboratory prototype, and construction of a field prototype—over a three-year period. The conceptual design will focus on the size, sensitivity, energy response, power requirements, n/g discrimination capability, and environmental suitability. During this phase, the necessary components of the device will be identified and procured, and subsystems of the device will be designed, constructed, and tested.

In the second year of the project, Bubble Technology Industries (BTI) will construct a laboratory prototype, taking into account the lessons learned from the conceptual design phase. DRDC Ottawa and the Los Alamos National Laboratory (LANL) will subsequently test the laboratory prototype to determine the device's sensitivity and energy response in a variety of neutron and mixed radiation fields.

In the third stage of the project, BTI will build two field-ready END prototypes. The prototypes will then be sent to DRDC Ottawa and the LANL for a thorough assessment, followed by operational testing in a variety of scenarios by the Canadian Nuclear Safety Commission (CNSC), the Standards Council of Canada, the Joint Nuclear, Biological and Chemical Defence Company, and DRDC Ottawa.

Due to the recognized deficiency in neutron dosimetry, the potential application of a viable END is widespread. End-user groups will include federal government departments that are involved in responding to radiological terrorist events, first responders, nuclear personnel, and other radiation personnel working in neutron-rich fields.

CRTI 04-0030TD

NUCLEAR FORENSIC RESPONSE CAPABILITIES AND INTEROPERABILITY

Project Lead:

DRDC Ottawa

Federal Partners:

Canadian Nuclear Safety Commission, Royal Canadian Mounted Police, Health Canada, Canadian Security Intelligence Service

Industry Partner:

Science Applications International Corporation

While traditional forensic science has made significant advances in the past few decades, there are several gaps in current knowledge and techniques available to forensic investigators to deal with the emerging threat of RN terrorism. Attribution capabilities, for example, will likely be challenged by widespread radiological contamination. Another area of concern is the need for links between forensic specialists and expert responders to ensure that important forensic evidence is not disturbed during site remediation and sampling. This concern was highlighted during recent RN exercise scenarios, including the International Technical Working Group's nuclear smuggling exercise and DRDC's Exercise Follow On (EXFO), which tested the federal nuclear expert response team (FNERT) in several RN scenarios.

This project, led by DRDC Ottawa, will address these gaps by establishing protocols for forensic identification specialists, developing and testing nuclear forensic analysis methods, and creating links between expert responders and forensic identification specialists.

The project will address first-responder methodologies, evidentiary and legal issues, and issues related to working in an RN-contaminated environment. The project team will also collaborate with the US Federal Bureau of Investigation (FBI) and New Scotland Yard in the United Kingdom to compare international techniques and ensure interoperability. Based on these findings, procedures for forensic specialists will be developed, with special emphasis on on-site evidence recovery techniques that account for RN hazards, on-site analysis techniques using glove box or other containment methods, and traditional forensic techniques for analyzing RN-contaminated material.

The second objective of this project is to develop and test the nuclear forensic laboratory analysis methods to expand attribution capabilities. This work will focus mainly on exercises aimed at comparing techniques used by various laboratories to analyze standardized swipe samples. Two such exercises will be held: the first will enable labs to identify issues requiring further development, and the second will test the techniques developed in response to the first exercise. Methods will be assessed for determining processing history, interpreting signatures and trace elements for attribution, verifying and comparing analysis methods (e.g., high-resolution gamma spectroscopy and thermal infrared multispectral scanner), and conducting interlaboratory comparisons using various samples to ensure interoperability of analysis capabilities among laboratories.

The final objective is to create links between expert responders, such as the FNERT, and forensic identification specialists, to pave the way for information sharing in the field. These links will help to eliminate any interference between evidence recovery and site remediation activities. Recommendations

on suggested field procedures and interactions between these groups are expected.

The knowledge and techniques required to meet these objectives will be derived from tabletop and small-scale field exercises with forensic specialists and scientific experts. These exercises will include sample collection in the field, transportation to several qualified labs, and the subsequent nuclear analysis. Potential attribution indicators and interpretation methods will be considered.

All knowledge products and capabilities developed from this project will be incorporated into end-user systems. Procedures for working in a radiologically contaminated environment will be incorporated into the RN portion of the CBRN First Responder Training Program, and will be adopted by the Royal Canadian Mounted Police (RCMP)and FNERT.

CRTI 04-0045RD

DEVELOPMENT OF COLLECTIONS, REFERENCE/DNA DATABASES, AND DETECTION SYSTEMS TO COUNTER BIOTERRORISM AGAINST AGRICULTURE AND FORESTS

Project Lead:

Agriculture and Agri-Food Canada

Federal Partners:

Canadian Food Inspection Agency, Canadian Forest Service, Natural Resources Canada

The accidental introduction of exotic plant pathogens continues to have tremendous ecological and economic impacts on many countries, including Canada. Potato late blight, potato wart, karnal bunt, chestnut blight, and white pine blister rust are only a few examples of diseases with severe impacts in North America. Deliberate introductions, even on a small scale, could result in severe economic and social consequences to Canada. Rapid, accurate detection and identification of microorganisms, especially fungi, which represent 80 percent of plant pathogens, is critical to minimize risk, ensure rapid responses, and organize appropriate remedial measures.

This project, led by Agriculture and Agri-Food Canada (AAFC), will generate data and assays that can be used to develop a deoxyribonucleic acid (DNA)-based diagnostic kit to rapidly detect and monitor several high-risk plant pathogens. The first step in the project involves updating the Canadian phytopathogen and host database, which will form the foundation for recognizing vulnerable crops or forests and identifying associated native pathogens. The updated database will serve as the basis for the further development of fungi reference collections, which will complement existing culture and specimen collections at the AAFC. The acquisition of new reference material will facilitate the identification of suspicious new introductions by morphological means. The database will provide access to information extracted from the literature, and will have a broad-based clientele from federal, provincial, and international agencies.

When a pathogen is introduced, high-resolution genetic profiles are used in forensic analysis to identify the sources of the outbreak and the potential spread from first infection, and to assist with its eradication. Using a novel bioinformatics approach, AAFC will identify universal, highly variable genes to be used for genotyping by single nucleotide polymorphisms (SNPs).

Using the enhanced genetic resource collections, researchers will develop multi-gene DNA sequence databases to fill gaps for high-risk fungi, allowing unambiguous identifications, genotyping, and the development of diagnostic tools. The inclusion of related species will minimize unanticipated false positives or negatives in final assays. Robust, worldwide pre-crisis sampling of target species will enable phylogenetic and geographic characterization of high-risk fungi, which will assist with forensic localization of inoculum sources in suspicious outbreaks. The sequence database will provide immediate diagnostic capability, allowing unambiguous identification by Basic Local Alignment Search Tool comparison of DNA sequences from pure cultures or clean specimens.

In the final phase of the project, DNA arrays will be generated to detect and identify all target fungi in a single assay using the DNA sequence database and custom-designed oligonucleotide selection software developed at the AAFC. The arrays will be validated using test samples spiked with pathogens or related native species in blind test scenarios. The development of diagnostic oligonucleotide probes will allow rapid identification of plant pathogens from field materials using off-the-shelf technology available to most plant pathology laboratories and to federal and provincial inspection agencies.

With a legislative mandate for plant and animal disease control and eradication, the CFIA will be the primary end-user of this technology. Other end-users include AAFC, the Canadian Forest Service of NRCan, provincial governments, and university plant pathology laboratories. The resultant databases and technologies will also play a critical role in the creation of a national Plant Protection Network, and facilitate exchanges and interactions with the National Plant Diagnostic Network in the US.

CRTI 04-0047TD

CBRN INCIDENT DATABASE

Project Lead:

Royal Canadian Mounted Police – Explosives Division & Technology Section

Federal Partners:

Canadian Food Inspection Agency, Canadian Nuclear Safety Commission, Canadian Security Intelligence Service, DRDC Ottawa – Radiological Analysis and Defence Group, Natural Resources Canada

Industry Partner:

AMITA Corporation

Other Partners:

Carleton University – Human Oriented Technology Lab, Singapore Armed Forces – Chemical, Biological, Radiological and Explosives Defence Group, Australian Federal Police Bomb Data Centre

In the event of a real or suspected CBRN event, Canada's emergency response capability greatly depends of the speed, detail, and accuracy of data received by first responders. Having an incident database accessible to law enforcement and regulatory agencies would not only dramatically improve the effectiveness of Canada's response, it could also facilitate incident preparedness and prevention by sharing vital information on threats, precursors, and dissemination.

The purpose of this project is to design and demonstrate a CBRN and explosive incident database that will capture CBRN incidents against critical infrastructure, people, and agri-food targets. The CBRN

incident database (CID) will be built as a commercial-off-the-shelf CBRN incident system that will be accessible to municipal, provincial, national, and international law enforcement and regulatory agencies. Led by the RCMP, the project will involve collaboration from the Canadian Security Intelligence Service (CSIS), the CFIA, DRDC Ottawa, the CNSC, NRC, AMITA Corporation, and Carleton University's Human Oriented Technology Lab. The project will also involve international partners, namely the Chemical, Biological, Radiological, and Explosive Defence Group of Singapore's Armed Forces and the Australian Federal Police Bomb Data Centre.

The CID will be based on the technical knowledge acquired from the RCMP's 10 years of experience in explosive incidents and their existing incident database. In the initial phases of the project, experienced systems analysts and field experts will define the system requirements and how the system will provide critical incident information to bomb technicians.

The database will provide information to users through a secure, web-based network infrastructure. To meet this need, the design team will ensure that access and information requests can be processed through the RCMP network. The CID will enable end-users to track information such as hazardous device-making materials, incident details, and dissemination methods, and make incident linkages in a matter of minutes or hours through real-time, 24/7 incident submission. Real-time incident submission marks a significant advance compared to the present system of manually inputting mail or fax incident reports, which can result in delays of days or even weeks.

Online photographs from the RCMP's parts and knowledge database will support better identification in the field and the system will facilitate training of bomb technicians. Specialists will support the team in designing the user interface to ensure the system is effective in assisting bomb technicians during stressful situations and also for general purpose training and information collection.

Once the system design for the CID is complete, the CID will be built as a robust and production grade system. A select group of users will assist in testing the system to ensure it meets the project requirements as planned. The finalized CID will then be deployed onto the RCMP network and made available to all users and police forces, estimated at more than 500 locations, across Canada.

A four-month, live technology demonstration will conclude the project. The user feedback resulting from the demonstration will be used to fine-tune the database.

CRTI 04-0052RD

ON-SITE COMPOSTING FOR BIOCONTAINMENT AND SAFE DISPOSAL OF INFECTIOUS ANIMAL CARCASSES AND MANURE IN THE EVENT OF A BIOTERRORISM ATTACK

Project Lead:

Canadian Food Inspection Agency

Federal Partners:

Agriculture and Agri-Food Canada

Other Partners:

Iowa State University, Alberta Agriculture, Food and Rural Development

Livestock raised under intensive management practices are vulnerable to highly contagious FADs. Policies for managing disease outbreak in major livestock-producing countries usually involve slaughtering infected animals and transporting the contaminated carcasses away from the site of the outbreak for incineration and burial. These practices, however, have the potential to spread disease and are environmentally undesirable. Also, the removal of carcasses does not eliminate the virus from the premises, and the manure from infected animals can be a major source of the virus.

The goal of this project is to develop new composting methods for the biocontainment and safe disposal of cattle, swine, and other species of livestock and their wastes at the site of a FAD outbreak. The project, which will build on methods successfully used for composting poultry carcasses and manure during the 2004 outbreak of AI in Fraser Valley, British Columbia, will focus on evaluating and reducing environmental impacts, and improving engineering design to accelerate destruction of viruses and the degradation of carcasses to earth-like material.

AAFC, Lethbridge, will collaborate with Alberta Agriculture, Food and Rural Development on the development of methods suitable for composting cattle carcasses and manure in bins in cold or warm seasons. Experiments will establish the influence of bin structure (e.g., insulation, dimensions, coverings, and location of aeration pipes) on heat production throughout the mass. To assess the environmental impacts of composting, specimens from compost piles will be analyzed for microbial content, chemical content, and greenhouse gas production. Since the level of virus in the mass to be composted may be very low, studies will also be conducted to determine whether measuring the degradation of selected animal genes by molecular methods can be used to predict destruction of viruses throughout the entire mass.

The research at Iowa State University in Ames, Iowa, will focus on biosecure methods for composting swine following a disease outbreak. Through replicated compost engineering studies, researchers will evaluate the performance of low-cost agricultural residues, such as ground straw, cornstalks, and silage, which are capable of maintaining composting conditions that are sufficiently hot, aerobic, and moist to promote rapid carcass decomposition and pathogen destruction. The tests will be replicated during warm and cold seasons. Resulting performance data will be used to develop engineering design recommendations for the thickness of cover material, and the size and placement of passive aeration tubes and gas vents.

To develop standards for emergency composting operations, the CFIA will investigate the destruction of selected model viruses (viruses closely related to

viruses causing FAD) during composting using virus isolation methods, real-time reverse transcriptase polymerase chain reaction (RRT-PCR) assays, and bioassays. Based on results of these studies, similar composting studies will be carried out on the viruses that cause AI, Newcastle disease, foot-and-mouth disease, and classical swine fever in the CFIA's Level 3 biocontainment facilities in Winnipeg. This information, along with studies on the degradation of animal DNA and the production of heat and gases during composting, will assist in establishing criteria for predicting the destruction of virus throughout the entire compost mass.

In addition to potential bioterrorism applications, the results of this study 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.

CRTI 04-0082TA

RADIO FREQUENCY- AND ELECTRONIC COUNTERMEASURES-COMPATIBLE CHEMICAL AND BIOLOGICAL BLAST PROTECTIVE HELMET

Project Lead:

Royal Canadian Mounted Police

Federal Partner:

DRDC Suffield

Industry Partners:

Med-Eng Systems Inc., EMC Consulting, Dunn Engineering

Other Partners:

Royal Military College of Canada

Recent world events, such as the commuter train bombings in Madrid, Spain, and the day-to-day bomb disposal operations in Iraq and Afghanistan, highlight the increasing trend toward the deployment of command-initiated, radio-controlled, improvised explosive devices (RCIEDs) by terrorist groups. These devices are easy to make, inexpensive, and can be easily acquired in almost any country due to the wide abundance of available components and the proliferation of knowledge on the Internet. Canada's capacity to deal with this emerging threat requires technological adaptations to equipment, such as blast protective helmets, and operating procedures to ensure the safety of first responders.

The primary means of mitigating this threat is through the use of high-energy electronic countermeasures (ECMs). ECM equipment jams or blocks radio frequency (RF) signals in a localized area to prevent terrorists from using a remote transmitter to activate an RCIED. However, current ECM signals can also block communication frequencies used by first responders and induce electric current signals in any non-RF-shielded electrical component in its radius.

Existing blast protective helmet designs do not offer the level of RF shielding required to function adequately in an event of an RCIED emergency. In particular, RF compliance was not included in the project scope of the recently fielded CB blast protective helmet (see CRTI 0161TA). Moreover, irrespective of the use of ECM equipment, it is

possible that the electronic functions (i.e., communication, ventilation, lighting, and power) of the existing CB blast protective helmet allow for short-range induction into other electrical components. This induction could inadvertently detonate an IED with an overly sensitive, electrically driven initiation system.

The goal of this project, led by the RCMP, is to develop an RF/ECM-compatible helmet using the existing CB blast protective helmet as the mechanical platform for RF-shielded electronics. Design changes will include the reconfiguration of components and systems to address the RF shielding and emission challenges. The electronics will be redesigned, the mechanical enclosure revamped, and the entire system tested to ensure compatibility with RF/ECM standards, namely MIL-STD-461E and DEF-STAN-59-41.

In addition to the electronics tests, the RCMP will collaborate with project partners to validate the RF/ECM-compatible CB blast protective helmet in actual threat environments. These trials will include man-in-simulant tests (MISTs) using chemical simulants at the Royal Military College (RMC) of Canada, biological simulant tests, and blast tests at DRDC Suffield, and a variety of other user trials to ensure the helmets are accepted in the field and offer optimal functionality. The project is expected to be completed by July 2006.

CRTI 04-0112TD

CONTAINER-INTRUSIVE CBRN SAMPLING SYSTEM

Project Lead:

Royal Canadian Mounted Police

Federal Partner:

DRDC Suffield

Industry Partner:

Magellan Engineering

In certain circumstances, first responders may be required to identify dangerous materials in a container that may not be identifiable. This can be due to the container shielding, deception, the first responder's lack of experience with particular agents, or a number of other factors. Yet identifying the contents of a container is vital in threat assessment and response. By accurately identifying suspected agents in a package or container prior to transmission or dispersion, first responders can determine whether the material constitutes a genuine threat and more effectively respond to and manage the consequences of an incident.

To assist first responders in identifying dangerous materials, smart methods need to be developed to distinguish between the uncommon presence of non-threatening substances and the presence of dangerous chemical and biological materials. In particular, first responders need special tools, such as intrusive sample tools, and handling procedures to help them deal with packages that could contain

CBRN agents. This project aims to adapt available intrusive tool technology and develop handling procedures to use in "render safe operations," where intrusive sampling could improve response efforts and contribute significantly to overall risk mitigation.

There are already intrusive and non-intrusive tools available for identifying potential agents within a container, but they have significant deficiencies in terms of cost, availability, field deployment capability, and applicability. To overcome these shortcomings, the intrusive sampling tool will be portable, mountable, cost-effective, and dual-purpose. Its primary function will be to gain entry to the container while not disturbing the contents; its secondary function will be to draw a sample for in situ or ex situ analysis. Since it will be designed to pierce various container types, the tool and the sampling tool platform will be robust.

The interdisciplinary project team, which comprises first responders, security and response personnel, and engineering research and development experts, will use a live agent test session at DRDC Suffield to verify its robustness. Following testing and acceptance of a marketable design, the project team will develop handling procedures based on best practices and lessons learned during the tool concept, development, and experimentation phases of the project.

CRTI 04-0127RD

CANADIAN HEALTH INTEGRATED RESPONSE PLATFORM

Project Lead:

Health Canada – Radiation Protection Bureau

Federal Partners:

Public Health Agency of Canada, Environment Canada – Canadian Meteorological Centre

Industry Partners:

Prolog Development Center, DBx Geomatics Inc.

Responding to the needs of first responder communities, the Canadian Health Integrated Response Platform (CHIRP) project aims to integrate several electronic tools to enable decision makers to make rapid assessments during and after a biological or RN event by distributing critical data to CRTI's RN and Biological Laboratory clusters, federal, provincial, and territorial partners, and others. The electronic tools include two decision-support platforms already used by the biological and RN communities: the Canadian Network for Public Health Intelligence (CNPHI) and the Accident Reporting and Guiding Operational System (ARGOS).

The CNPHI is a comprehensive monitoring, alerting, data-gathering, analysis, decision-support, and information-exchange platform used by the biomedical community. It integrates public health intelligence, such as data that have been interpreted or have strategic value, into a common national framework. The integration of these data supports coordination between multi-level jurisdictions and enables users to use the data to identify risks, initiate response, and build response capacity. Major progress has been made over the last two years in

improving the CNPHI's capacity for public health surveillance, alerting, and response through the development of comprehensive tools with best-of-breed alerting modules and program watch modules. By building on and leveraging the CNPHI's resources, the CHIRP will support the ability of local, regional, and national decision makers to react to any biological event and work as a partner in the national CBRN response framework.

Since its adoption as the decision-support tool used to implement the *Federal Nuclear Emergency Plan* (FNEP), the ARGOS has improved coordination and interoperability between FNEP partners. It facilitates a rapid, coordinated response to a radiological or nuclear incident, effective decision making, and the provision of critical information to first responders, the operational community, and ultimately, the public. Including the ARGOS in the CHIRP will add one more tool to the integrated tool box that will be provided to the RN and public health communities for emergency response.

Integration of the ARGOS and the CNHPI into one platfrom will enable the CHIRP to capitalize on their respective strengths and greatly enhance the capacity for CBRN preparedness and event detection and response in Canada. The CHIRP will take advantage of the resources and infrastructure of each tool, while maintaining and respecting current jurisdictional boundaries. These resources include several CRTI-funded projects, the secure infostructure at the PHAC's National Microbiology Laboratory (NML) and Health Canada's Radiation Protection Bureau (RPB), and the emergency operations centres at the NML and the RPB. Development of this integrated approach also has the potential to evolve into a comprehensive platform across the CRTI laboratory clusters and to promote collaboration with international partners.

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

CBRN experts recognize the need for radiation sensors that can be used over a long period of time to detect the presence of low levels of radiation, such as those emitted by heavily shielded radioactive materials. These levels may be difficult to detect with existing hand-survey instruments but may be easily detected over a longer period of signal integration. The goal of this project is to develop a long-dwell detection in transit (LDDT) detector that combines the technology of a passive dosimeter with the required hardware and electronics to allow the user to read the dosimeter in situ whenever the integrated radiation dose is required.

Researchers at DRDC Ottawa and BTI developed a miniature prototype of an optically stimulated luminescence (OSL) dosimeter during a previous CRTI project (CRTI 01-0072RD: Nanodosimeters Based on Optically Stimulated Luminescence) that is well suited for use as an LDDT detector. The mini-OSL dosimeter (MOSL) measures 15.5cm × 15.5cm × 8.75cm (6.25" × 6.25" × 3.5") and is a construction of several standard components linked together to demonstrate its functionality rather than a commercial device aimed at an identified market. BTI engineers will reduce the size of

the prototype MOSL dosimeter and package it in robust enclosure with appropriate readout and operational control for long-term monitoring applications. The MOSL was originally designed for continuous readout, which is not required for its use as an LDDT detector. BTI can therefore also simplify the heat dissipation system and reduce the onboard power requirements. They will replace the wireless communications in the MOSL prototype with smaller and newer units, and make the device compatible with typical communication protocols for shipping applications. The project team will then test the entire system under the conditions that may be faced during the deployment of the LDDTs, for example, in cargo containers both on land and at sea.

At the end of the project, the team expects to have a complete prototype system that will be deployed at desired locations in a suite of individual units, such as within a ship, train, truck, and plane. These individual units will transmit data through a local gateway node that will communicate bi-directionally with a remote central command post. This will demonstrate the capability of the LDDT system to perform long-term radiation monitoring of containers on a cargo conveyance.

CRTI 05-0014RD

EXPERIMENTAL AND THEORETICAL DEVELOPMENT OF A RESUSPENSION DATABASE TO ASSIST DECISION MAKERS DURING RDD EVENTS

Project Lead:

DRDC Ottawa

Federal Partners:

Environment Canada, DRDC Suffield

Other Partners:

University of Ontario Institute of Technology, Defence Science and Technology Laboratories, Wehrwissenschaftliches Institut für Schutztechnologien – ABC-Schutz, Centre d'études du Bouchet de la Délégation générale pour l'armement

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.

This project will experimentally and theoretically examine the resuspension capabilities of the facilities and experts from four participating North American Treaty Organization (NATO) countries (Canada, Germany, England, and France). The project is also currently the primary focus for the team of radiological experts reporting to NATO's Radiological and Nuclear Defence Sub-Group under the Joint Capability Group for CBRN Defence. The goal of the project is to provide guidance to field personnel (e.g., military commanders) on protective procedures and the operational constraints for work in contaminated environments.

The project partners will 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 in Munster, Germany, will test indoor europium-152 (Eu-152) and lanthanum-140 (La-140), scientists at the Délégation générale pour l'armement in Bourges, France, will examine indoor and outdoor La-140, and experts at the Colin Watson Aerosol Layout at DRDC Suffield will analyse outdoor sodium-24 (Na-24), potassium-42 (K-42) and copper-64 (Cu-64). (Note that since the CRTI award, indoor facilities at the Defence Science and Technology Laboratories [DSTL], Porton Down, in Wiltshire, England have been developed.) The facilities in Germany, France, and Canada have committed to hosting at least one experiment over the course of the project. In addition, the researchers at the University of Ontario Institute of Technology (UOIT) are developing a small-scale facility to perform laboratory studies with non-radioactive particles in controlled and contained environments.

DSTL and UOIT will perform calculations tailored to the experiments outlined above using a variety of Computational Fluid Dynamics codes such as FLUENT®. In the early stages of the project, the DSTL and UOIT (and possibly the Centre d'études du Bouchet in France) will conduct an internal computational intercomparison to ensure that the countries have similar capabilities, given the same initial parameters, which will give confidence in the results. As the project develops, Environment Canada will be responsible for providing its mainframe meteorological codes. The researchers will then summarize the project's outputs in a spreadsheet for field personnel.

CRTI 05-0016RD

DEVELOPMENT OF A CANADIAN STANDARD FOR PROTECTING FIRST RESPONDERS FROM CHEMICAL, BIOLOGICAL, RADIOLOGICAL, AND NUCLEAR EVENTS

Project Lead:

Public Works and Government Services Canada

Federal Partner:

Canadian General Standards Board

Other Partner:

Canadian Standards Association

To perform their job of protecting Canadians, first responders, such as police, fire fighters, and

emergency medical services, must have functional equipment that provides them with adequate protection from a CBRN terrorism event. They also require information that will enable them to prepare and respond effectively. However, there currently are no standards in Canada that provide first responders with the critical information and guidance they need to select and use the most appropriate protective equipment.

Public Works and Government Services Canada is therefore leading a project to develop and maintain a national standard on the selection, use, capabilities, and limitations of CBRN personal protective equipment (PPE). To help ensure the standard becomes a national standard of Canada, development includes specifying the requirements for CBRN PPE (e.g., respiratory protection and whole-body protection clothing) used by first responders; and providing valuable guidance on such key issues as the interchangeability and interoperability of equipment to enhance the capacity of first responders to work across jurisdictions. Development will also address the differences between a conventional HAZMAT incident and a CBRN terrorism incident to improve understanding of how CBRN terrorism response guidelines may differ.

The work of developing the standard will use the strengths and expertise of the Canadian General Standards Board (CGSB) and the Canadian Standards Association (CSA), both of which are recognized nationally and internationally for developing leading-edge, world-class protective equipment standards. As part of their accredited standards development process, the two standards bodies will bring together relevant stakeholders, including first responder organizations, various levels of government, manufacturers, and research and testing organizations with expertise in the development and evaluation of PPE.

The project will also involve the establishment of a national Technical Committee to assess and evaluate applicable hazards and emerging technologies as well as the capabilities and limitations of PPE. To determine potential exposures to the first responder, and the level of protection that will be required, the Technical Committee will consider representative worst-case scenarios and agents in each CBRN category based on research completed under a separate CRTI project. (CRTI 0029RD: Protecting the First Responder Against Chemical and Biological Threats)

A national standard developed jointly by CSA and CGSB will assist organizations in planning equipment acquisitions and will significantly improve the ability of first responders to evaluate and mitigate the risks associated with available equipment, thereby enhancing their ability to prepare for and respond to CBRN events. By providing key information, currently not available, to assist first responders in identifying and categorizing an event as early as possible and in identifying the level of protection required, it will also be of interest to public and private sector organizations directly or indirectly involved in the management of a CBRN event.

CRTI 05-0043RD

ECONOMIC IMPACT OF RADIOLOGICAL TERRORISM EVENTS

Project Lead:

DRDC Ottawa

Federal Partners:

Canadian Nuclear Safety Commission, Canadian Security Intelligence Service, Atomic Energy of Canada Limited

Industry Partner:

Battelle Memorial Institute, Pacific Northwest National Laboratory

A radiological terrorist event, such as the detonation of an RDD, could result in widespread contamination of large tracts of infrastructure (i.e., buildings and roads), which would require extensive processing or reconstruction before they could be returned to public use. While it is known that radiological decontamination is difficult and expensive, and that the chronic health effects of radiation strain the public system, no prior study has been conducted to quantify the associated economic costs of RDD-related events.

This project will involve conducting simulations to develop a method of establishing the economic cost of events involving RDDs, radiological exposure devices, and improvised nuclear weapons. The researchers will glean data from two other CRTI projects: Probabilistic Risk Assessment of Radiological Devices (CRTI 02-0024RD) and Experimental Characterization of Risk from RDDs (CRTI 03-0018RD), as well as from US nuclear weapon cost studies conducted by the Battelle Memorial Institute. The project members will reframe the calculations in terms of the Canadian construct and integrate them with assessments from the most recent CSIS and *Public Records Act* data. In anticipation of the upcoming 2010 Olympics, the key project simulation sites will include the host city of Vancouver, as well as other major Canadian urban centres, and a few rural sites. The analysis will also integrate historical, experimental, and radiological decontamination inputs from participating agencies, with the goal of revisiting current regulatory limits.

The project will commence in June 2006 and the final report will be issued by March 2008. It is anticipated that the findings of this study will improve the effectiveness of RN emergency response plans by generating tangible data for a more accurate evaluation of risk in RDD events.

CRTI 05-0053TA

DEPLOYABLE RADIOLOGICAL AND NUCLEAR INCIDENT AREA NETWORK: WIRELESS MESH TOPOLOGY

Project Lead:

Health Canada

Federal Partner:

DRDC Ottawa

Other Government Partner:

New Brunswick Emergency Measures Organization

Industry Partners

t.e.s.t., New Brunswick Power Corporation

Canada's Radiological Emergency Response Team (RERT) involves resources at all levels of government and uses a variety of RN systems and processes. The evolution and progress of the RERT to date has resulted in the identification of a critical technology gap in communications and information exchange: the streaming of real-time field measurements from the site of an incident to federal government resources such as Health Canada's ARGOS, a client-server database application that stores measurement data collected from a variety of disparate sources. Experience from past exercises and first responder feedback confirms that this is a major factor limiting the overall performance of the radiological team. Without it, the efficiency and effectiveness of the RERT decision makers and the deployment of field personnel are adversely affected.

The Deployable Wireless Network (DWN) system satisfies this critical gap by providing a wireless interface that connects field teams with the federal government. This is achieved by integrating the following components:

- Custom RN algorithms to perform field measurements while in motion;
- Communication interface to realize the near real-time streaming of RN measurements to the incident command centre; and
- Communication of all field measurements from the incident command centre to the federal government (e.g., ARGOS software program).

The wireless mesh topology completes the communication gap through an automated interface to the instrument or instruments, and a link back to the on-site centre and the federal mobile broadcast satellite. The information transmitted to CRTI's RN Laboratory Cluster is in a format that enables programs such as ARGOS and E-MAP, a web-based mapping system, to use the data to present current status and historic measurements at the incident site.

The ability to provide constant real-time monitoring assists in the potential for the detection and location of a dirty bomb before it is deployed. The simple and easy measurement process enables an area to be inspected faster and, in turn, more frequently. In the event that an RN incident occurs, the plan is to have resources at the location perform the initial measurements; as additional resources from federal, provincial, and other sources arrive, they can be integrated into the team.

Exercises to determine response capability to an RN incident are planned in incremental stages with the following partners: Health Canada, DRDC Ottawa, the New Brunswick Emergency Measures Organization (NB EMO), and the Point Lepreau Generating Station in New Brunswick. Based on performance results and objectives, additional training scenarios will be developed to achieve the desired or defined performance at all stages of the RN response team.

Evaluations and verification of the project's functionality will be performed at DRDC Ottawa and at the Point Lepreau Generating Station as well as at the NB EMO. Research scientists at DRDC Ottawa will confirm the project's functionality for a dirty bomb scenario, performing field measurements of radiation sources and integrating them with a dispersal model, while at the Point Lepreau Generating Station and the NB EMO scientists will confirm the project functionality for tracking a radioactive plume. The actual measurements of the plume in the field will be made using simulated values and reported using the DWN.

CRTI 05-0058TD

INTEROPERABILITY FRAMEWORK FOR MUNICIPAL-PROVINCIAL-FEDERAL COLLABORATION

Project Lead:

Greenley & Associates

Federal Partners:

DRDC Ottawa, DRDC Suffield, Royal Canadian Mounted Police – E-Division, Environment Canada – Canadian Meteorological Centre, Department of National Defence – Canadian Forces Experimentation Centre

Industry Partners:

CAE Inc., EmerGeo Solutions Inc.

Other Partners:

Justice Institute of British Columbia, Vancouver Police Department

Complex situations resulting from CBRN threats demand a collaborative response from diverse municipal, provincial, and federal stakeholders. The lack of a formal structure within which to capture and exercise joint municipal–provincial–federal CBRN response compromises public safety in Canada. Multi-jurisdictional first responders require clear standards, processes, protocols and capabilities to ensure a shared awareness of authority, responsibility, and competency and achieve operational interoperability.

This project will employ the Capability Engineering and Design Approach (CEDA™) to develop an integrated architecture focused on the CBRN aspects of municipal–provincial–federal interoperability. The project team will build an operational and system-of-systems architecture based on the critical incident responses of organizations to selected scenarios, as a simulated CBRN event unfolds within the selected geographical area of Vancouver and the Vancouver–Whistler corridor.

To develop the simulation environment, the team will develop a standardized, high-resolution geospatial dataset of selected incident sites (e.g., public facilities and transportation hubs) and the surrounding urban areas. The team will then integrate the dataset into a Common Operating Picture Environment (COPE), which will be shared among project participants for simulation-based analysis. They will incorporate these enhancements into existing CBRN models used at DRDC Suffield and include Environment Canada's "urban canyon" dispersion algorithms into the Geographical Information System (GIS)-based COPE.

Federal first responders will analyze the three simulation-based scenarios to test the municipal–provincial–federal responder interfaces in terms of command, control, shared awareness, and the extent to which operational interoperability can be achieved. The simulation-based analysis will be used to validate the operational architecture, investigate potential challenges, and establish a platform to enhance municipal–provincial–federal interoperability.

The project will augment simulation-based analysis and training capabilities for first responders at the Justice Institute of British Columbia, various Vancouver-based emergency operations centres who work with DRDC Ottawa, the Canadian Forces Experimentation Centre, and Environment Canada. It will also support interoperability assessments and analysis for municipal–provincial–federal responses and the development of a coherent Concept of Operations (CONOPS) framework for inter-agency CBRN and critical incident response.

CRTI 05-0069RD

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

Project Lead:

Health Canada

Industry Partner:

Cangene Corporation

Radiation overexposure is a potential threat to both civilian and military personnel in various circumstances. Radiation exposure has been reported in a number of civilian and medical accidents, including accidental X-ray exposure and nuclear plant accidents such as the Chernobyl disaster, and in at least one military training accident that occurred in 2000. Moreover, the proliferation of global nuclear capacity and the increased traffic in spent nuclear fuels makes the deliberate exposure of personnel involved in a military or terrorist situation a reasonably high probability. These risks make the search for a new treatment for countering acute radiation syndrome a necessary undertaking.

Scientists at the Cangene Corporation recognized that the use of cytokine therapy in humans exposed to radiation has not been systematically evaluated. However, based on the body of knowledge derived from laboratory, animal, and clinical studies, it is possible to deduce a role for hematopoietic stem cell modulators in radiation exposure. For example, animal studies have demonstrated that granulocyte-macrophage colony-stimulating factor (GM-CSF) is useful in ameliorating the effects of sub-lethal radiation exposure where some viable early stem cells remain. All currently available cytokines have proved ineffective where the dose of radiation is such that all stem cells are eliminated.

The primary scientific objective of this study is to conduct a systematic evaluation of the role of a longer acting form of GM-CSF in the mitigation of neutropenia resulting from acute radiation exposure. The longer acting form will consist of GM-CSF chemically attached to polyethylene glycol, resulting in a PEGylated GM-CSF (PEG-GM-CSF) molecule that would require less frequent dosing than the parent GM-CSF molecule. It is possible that the drug will also be useful for protecting individuals, such as rescue and other workers, who are likely to be exposed to radiation.

PEGylation has become a well-recognized method of increasing the utility and efficacy of injectable drugs. Because radiation studies by deliberate exposure may not be ethically conducted in humans, and capture of subjects accidentally exposed to radiation is not feasible in a systematic, controlled manner, the study requires the use of animal testing. Cangene's previously completed CRTI project (CRTI 0085TA) demonstrated the production and characterization of various forms of PEGylated GM-CSF. These purified PEG-GM-CSF molecules were subsequently used in rat and monkey studies. Pharmacokinetic studies in rats showed significantly longer half-life for PEG-GM-CSF than non-PEGylated GM-CSF (i.e., longer residence time in the bloodstream). In the irradiated monkey model, recovery from neutropenia was shown using PEG-GM-CSF (dosing on days 1 and 7 after irradiation). The recovery between days 8 to 11 after irradiation corresponded to the period in which PEG-GM-CSF levels were elevated in the bloodstream after injection at day 7.

The proposed three-year plan includes a strategy for animal testing for efficacy, production of PEG-GM-CSF at pilot scale, development of a stable product formulation, animal testing for safety and toxicology, and development of validated tests

(assays) for eventual product commercialization. It is believed that work to determine optimal dosing amount and frequency, which is in addition to that outlined in this project, would help to develop a therapeutic regime to accelerate recovery from radiation-induced neutropenia. The details of such work would include, for example, dosing at different time points after irradiation to keep a concentration of PEG-GM-CSF elevated to therapeutic levels over the entire course of therapy. If this dosing schedule is effective at one concentration, the dosing amount may then be varied. Other investigations may include determination of PEG-GM-CSF efficacy as a function of initial treatment time post-exposure, and PEG-GM-CSF efficacy as a function of varying amounts of total radiation exposure. The inclusion of these activities will depend on the animals used to achieve the primary objectives of the project.

If data from the initial experiments warrant it, the scope of the study may be adjusted in consultation with the Project Review Committee and Project Champion.

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.

Emerging infectious diseases and the threat of bioterrorism, agroterrorism, and biological warfare make it imperative that sensitive and rapid methods are available to quickly and accurately identify a wide variety of disease agents. Ideally, these methods should also be able to identify engineered variants of those agents, which may have been modified to make them more efficient as biological agents of terrorism or warfare.

Current methods for detecting multiple agroterrorism agents and all of their possible different strains rely on time-consuming methodology and do not ensure a rapid or complete response. DNA microarrays offer a very plausible, accurate, and efficient approach to rapidly identify a wide variety of microbial agents in a multiplexing fashion. The microarrays can be designed to include nucleic acid sequences that will bind to core sequences of microbial pathogens, even if these pathogens have been modified for terrorism or biowarfare purposes.

This project brings together DNA microarrays already developed by CFIA scientists with a new, rapid, electronic DNA microarray system—the NanoChip® technology commercialized by Nanogen Incorporated. The project team will initially target the viruses responsible for foot-and-mouth disease and AI.

The current DNA microarrays are relatively complex, requiring manual array set-up, and nucleic acid capture and analysis. Using an electric, field-assisted DNA microarray design and the corresponding capture of nucleic acids extracted from biological agents or the samples containing them, the two technologies combined should enable consistently faster detection of multiple agents. The researchers will validate the new diagnostic technology using clinical samples, and will demonstrate its application by the end-user in a field trial. Their goal is to bring this unique technology into the hands of first responders for use in the field.

In the longer term, the project team hopes that the NanoChip microarray technology can be used to develop a miniaturized, hand-held, portable system that will integrate both sample preparation and DNA-based electronic microarray detection of microbial pathogens. In addition, the potential of this technology to integrate a wide variety of human, animal, and plant pathogens into the same system will enhance Canada's ability to maintain effective surveillance against these threats, supporting effective federal and provincial disease surveillance and networking.

CRTI 05-0092TA

INTEGRATED PERSONAL COOLING FOR CHEMICAL-BIOLOGICAL PROTECTIVE UNDERGARMENTS

Project Lead:

Royal Canadian Mounted Police

Federal Partners:

DRDC Suffield, Royal Military College

Industry Partner:

Med-Eng Systems Inc.

Other Partners:

University of Ottawa – School of Human Kinetics, Netherlands Organization for Applied Scientific Research

Explosive ordnance disposal (EOD) first responders are often required to wear chemical protective undergarments (CPUs) underneath their EOD PPE. With polymerically encapsulated activated carbon in the fabric, the CPU provides uniform carbon distribution for protection against specified chemical and cutaneous biological agents. A number of end-user groups, including military, law enforcement, fire departments, government contractors, HAZMAT response teams, and expert laboratories, have validated the effectiveness of CPUs. As a result, the CPU technology has been successfully used for a number of years.

However, when worn with PPE, CPUs add to the heat stress of individual operators, potentially compromising their operating time or putting them in danger should they be overcome by heat while working in a "hot zone," a chemically or biologically contaminated area. Personal cooling systems (PCSs) are therefore often essential to mitigate the possible effects of overexposure to excess heat or overexertion. But the combination of a PCS with the CPU adds extra steps and time to put on, take off, and undergo decontamination procedures, and introduces additional bulk and possibly discomfort to an already burdened operator.

For the benefit of the end-user, a preferred solution is to combine CB and cooling protection with only one layer of fabric. This project therefore proposes to integrate CB protection with personal cooling systems to reduce equipment weight and bulk, facilitate the effort to put on and take off the protective equipment, and simplify decontamination procedures. Work will focus on integrating cooling capabilities with two to three different types of material technologies used in the construction of CPUs. Toward this end, Med-Eng Systems contacted well-known manufacturers of chemical protective fabric, including Blücher GmbH, the maker of SARATOGA™ protective technology, and LANX Fabric Systems, to discuss the viability of, and interest in, integrating CB protection with PCS and to ensure that the proposed solution can be implemented with the CPU protection currently in use.

The project aims to optimize cooling conduits for maximum benefit to the operator, while removing the weight, cost, and discomfort associated with low-value cooling areas. Conduits will be centered around the torso by affixing tubing via stitching onto the CPU fabric or by capturing the tubing between CPU layers via different processes of lamination, using thinner, less insulating material with enhanced moisture-wicking properties (possibly anti-microbial) on the inside to optimize cooling efficiency. The resulting integrated cooling CPU will be compatible with multiple types of cooling sources (e.g., ice-based or vapor compression cooling systems).

Testing and validating the integrated cooling CPU, using appropriate standards for CB protection, will be conducted at the RMC in Kingston, Ontario, based on MIST; at the CB*Plus* Chamber at the DRDC facility in Suffield, Alberta; and at the Organization for Applied Scientific Research in the Netherlands using live-agent testing. The effectiveness of physiological cooling will also be tested and validated at the University of Ottawa's School of Human Kinetics. Because they involve representative movements in the type of harsh environment typical of a CBRN scenario, the tests carried out at RMC and the University of Ottawa are ideally suited to become part of the training for first responders.

As the lead federal partner, the RCMP will guide elements of the CPU design with integrated optimized cooling and provide leadership in the development of CBRN test protocols, render-safe procedures, and volunteers for system user trials. At the end of the project, the RCMP will receive three to four fully functional prototypes, three of which will be based on sewn tubes, if feasible, and one on lamination. First responders will be able to extend safe mission time by wearing CPUs equipped with personal cooling. The result for Canada will be improved response capability to a number of high-risk CBRN scenarios.

CRTI 05-0106TA

DEVELOPMENT OF FIELDABLE 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

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. However, frontline personnel are not able to test for many other agents, especially viral pathogens, which may be used as biological weapons. The purpose of this project is to develop assays, based on field-ready instruments, that will allow frontline personnel to quickly and accurately detect the presence of potential Category 1 and 2 biological weapons (bacterial and viral) with high sensitivity.

The project team will develop an inventory of Scorpion-based primer-probe sets and establish real-time polymerase chain reaction (PCR) assays for use on the Smartcycler for 15 classes of potential bioterrorism agents. These agents include Ebola; Marburg; Lassa; alphaviruses such as Venezuelan equine encephalitis; New World arenaviruses such as Junin, Machupo, and Guanarito viruses; severe acute respiratory syndrome (SARS); influenza; Brucella; Chlamydia; Burkholderia; human pathogenic hantaviruses; Crimean-Congo hemorrhagic fever (CCHF); Henipah viruses such as Nipah and Hendra viruses; Coxiella; and rickettsia. The assays will then be evaluated in a CRTI-sponsored field exercise in 2007–2008.

The team will further develop the assays for Ebola, Marburg, Lassa, CCHF, and the Venezuelan equine encephalitis virus for the GeneXpert platform. The GeneXpert technology is a hands-off, automatic system composed of a mini-fluidic cartridge for sample processing, and an instrument that drives the cartridge fluidics and performs real-time PCR. This development step will include freeze drying reagent mixtures in bead form and testing for retention of activity and sensitivity, as well as optimizing extraction and purification schemes for the GeneXpert system. Once the results are satisfactory, the team will produce trial amounts of the assays in GeneXpert cartridges. The team will evaluate the assays in-house, as well as during a second CRTI-sponsored field exercise in 2007–2008.

When this project is completed, the team hopes to have developed assays for all the remaining biological agents of concern so that first responders will have complete detection coverage in the event of a bioterrorism attack. Such rapid and reliable on-site detection techniques will enhance the safety of first responders, military personnel, and the public. They will also allow appropriate countermeasures to be implemented earlier, thereby preventing pathogen transmission and reducing panic in the population.

CRTI 05-0108TD

NATIONAL NUCLEAR EMERGENCY LABORATORY NETWORK AND INTEROPERABILITY

Project Lead:

Health Canada

Federal Partners:

DRDC Ottawa, Fisheries and Oceans Canada, Royal Military College

Other Partners:

Ontario Ministry of Labour, British Columbia Centre for Disease Control, Trent University

Following an RN attack, effective consequence management relies heavily on sound scientific evidence and timely decision making. Laboratory reach-back capability plays an important role in meeting such requirements. Reach-back includes the capability of a laboratory to measure radionuclides in field samples of various matrices, the capacity to measure hundreds or thousands of samples in a very short period of time, and an effective solution to exchange data between laboratories and report laboratory results to the decision makers. In an RN emergency, many laboratories (e.g., federal, provincial) may be called upon to analyze the large volume of field samples. In this situation, interoperability between laboratories becomes an important issue.

The goal of this project is to create a national nuclear emergency laboratory network by developing a complete package of standard laboratory protocols for measuring field samples from typical RN scenarios and for different purposes (e.g., screening, monitoring, and forensics), an information technology (IT) solution for data exchange and reporting, a series of training sessions and exercises to test preparedness and interoperability, and a management strategy to sustain the future development of the network. The network will be composed of major federal and provincial RN emergency operation centres and will be open to others to join in a phased approach.

By standardizing protocols and reporting tools, results from different laboratories can be easily amalgamated and assimilated into models and decision support tools, such as the ARGOS. In an emergency and during some of the exercises planned for this project, data gathered through the national laboratory network will be reported to federal technical advisors and modellers in Health Canada's Emergency Operations Centre (EOC) for the FNEP, where it will be made available to provincial EOCs.

Upon the completion of this project, laboratories in this network will employ a package of standard protocols—subject to minor modification to fit specific laboratory needs—for RN emergency response. The IT solution will enable data exchange between laboratories that share the standard format to allow interoperability. Results reported to the decision makers will be simple, clear, and in a standardized form so that they can be readily interpreted. In addition, a network management strategy will be in place to provide a management framework for the development of this network, including attracting more laboratories to join.

This project will deliver a CONOPS between federal and provincial RN EOCs in an RN event, in addition to helping improve CRTI lab cluster management and operations. The project will also help improve immediate reaction, near-term consequence management, and forensic investigation capabilities.

CRTI 05-0121RD

EVIDENCE-BASED RISK ASSESSMENT OF IMPROVISED CBW TECHNOLOGIES

Project Lead:

Public Safety and Emergency Preparedness Canada

Federal Partners:

DRDC Suffield, Royal Canadian Mounted Police – Forensic Laboratory Services

There are currently several well-known sources of information relating to improvised chemical and biological weapon (CBW) technologies, within the open literature and on the Internet, that may be used as the basis for terrorist CBWs. While some of this information is easily assessed as technically unsound, much of it has not been fully assessed with respect to technical feasibility and impact. The goal of this project is to conduct a review of this information and of information contained in classified sources that relate to terrorist interest in CBWs. The review will then be used to identify a set of scenarios for which there are knowledge gaps pertaining to technical feasibility and impact, and for which there are also indications of terrorist interest. Scenarios will be selected and prioritized based on the nature of the terrorist interest in the technologies identified. It is anticipated that up to eight candidate scenarios involving both chemical and biological agents will be identified in this manner.

The project will be divided into five phases. The first phase will entail a thorough review of all the information available relating to improvised CBW technologies. The result from this review will be a list of candidate technologies. In the second phase, the list will be prioritized using criteria such as the nature of the knowledge gap and indicators of terrorist interest in such technologies. The next step will involve thoroughly assessing the technologies contained in the prioritized list, which will include addressing questions relating to technical feasibility and potential impact.

The fourth phase will be generating a set of training scenarios to assess the technology experimentally where required to bridge knowledge gaps. This will involve constructing, testing, and thoroughly characterizing the technology in question. The technology will be assessed based on several important factors, including the nature of technical gaps or inaccuracies in the information; the level of expertise needed to recognize or overcome these gaps and successfully execute the technology; threats to the safety of those attempting to implement the technology; the availability of required material (including improvised equipment); yield, purity, toxicity, and stability of the product; efficacy of dissemination; potential for scale-up; potential signatures of activity; and the most appropriate target and assessment of impact.

The final deliverable of this three-year project will be a report detailing the full technical assessment of the technology, the rationale for its selection, the relevance of the knowledge generated to the current CRTI *Consolidated Risk Assessment* document, a list of relevant signatures, and a set of technically sound scenarios that may be used for training or consequence management. The knowledge generated from this work will then be shared with allied counterterrorism agencies.

CRTI 05-0122TD

CBRN CRIME SCENE MODELER (C2SM)

Project Lead:

Royal Canadian Mounted Police – Forensic Identification Research Services

Federal Partners:

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

Industry Partner:

MDA

Other Partners:

Toronto Police Service – CBRN Team and Forensic Identification Services – Emergency Management, Vancouver Police Department – Department of Forensic Services Station, York University – Department of Computer Science and Engineering

Investigating crime scenes where CBRN agents have been deployed poses great dangers to first responders. Radiologically contaminated crime scenes present the most difficult challenges of all. Personal protection is next to impossible to achieve, as any prior decontamination of a crime scene may result in destruction of potentially vital evidence. It is therefore essential to develop technologies that will reduce the need for first responders to enter the scene, maximize their productivity to reduce their exposure, and allow them to conduct their tasks from the relative safety of longer stand-off distances or by using mobile platforms.

The objective of this project is to develop a multi-sensor modelling system for collecting evidence at CBRN-contaminated crime scenes with minimum exposure to the first responders. The CBRN Crime Scene Modeler (C2SM) will be designed to rapidly record the CBRN scene in three dimensions (3-D), as it existed when the first responders arrived. It will record and map the contamination levels of CBRN agents and make the data available to staff at safe locations on-site and at emergency centres for rapid attribution. The C2SM will thus allow investigators and courts to view the scene and evidence in its "pure" state.

The C2SM will be based on the instant Scene Modeler (iSM), a 3-D modelling system under development at MDA. It will be used either in a hand-held mode or in an automatic mode on-board a mobile platform. The iSM automatically processes image sequences from a moving stereo camera and creates calibrated, photorealistic 3 D models of environments and objects. The project team will also augment the C2SM to read the threat level and distribution of contaminants using three CBRN detectors (chemical, infrared, and directional gamma ray probe).

First responders from the RCMP, Toronto Police Services, and the Vancouver Police Department will develop operational procedures and test scenarios for the C2SM, and operate it during field trials. DRDC Ottawa will provide expertise in detection and threat assessment of RDDs, novel RN detectors, and operational procedures. The Canadian Police Research Centre will evaluate the C2SM system for use in CBRN events and investigations. MDA will build two versions of prototypes, integrate novel visualization algorithms from York University, and will provide technical support to the team.

The project team will develop two prototypes, one at the end of the first year and another at the end of the project, which will be tested in two field trials. The first responders will receive three copies of the second prototype and will be trained to operate it. Experience gained through the use of these systems by first responders in the field and their feedback will be invaluable in commercializing the technology.

CRTI 05-0123TD

ALL-HAZARDS SAMPLE RECEIVING AND STORAGE CAPABILITY

Project Lead:

DRDC Suffield

Federal Partners:

Public Safety and Emergency Preparedness Canada, Public Health Agency of Canada – Office of Laboratory Security, Royal Canadian Mounted Police – Forensics Laboratory Services, DRDC Ottawa

Provincial Partners:

Ontario Centre of Forensic Sciences, Ontario Provincial Police – Provincial Emergency Response Team, Toronto Police Service – CBRN Team, Toronto Emergency Medical Services – Critical Care Transport Unit

Responders to a potential CBRN event must often handle samples of unknown composition and threat. While these samples may be subjected to on-site field screening tests, trained personnel within accredited laboratories must definitively identify them. To protect their facilities and personnel, qualified laboratories will accept only selected classes of hazards into their facilities. As a result, the samples must be triaged for their inherent hazards before being submitted to traditional analytical laboratories. However, there are presently no facilities in Canada capable of sorting materials containing mixed, multiple, or unknown hazards.

This project will deliver an all-hazards facility for receipt, triage, and storage of samples. It will also deliver the recommended equipment to be used within the facility and the requisite standard operating procedures for handling forensic samples. Within three years, a prototype facility will be constructed, equipped, and assessed at DRDC Suffield. The completed facility will be demonstrated to responders and laboratory personnel during an international exercise.

The deliverables of this project will augment investigations involving unknown or mixed CBRN threat materials, enabling effective national response to a CBRN event.