Defence Research and Development Canada

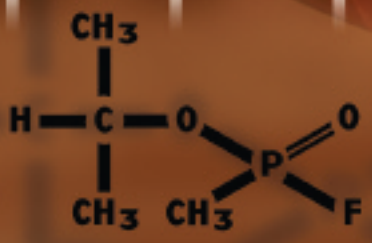
Recherche et développement pour la défense Canada

CRTI-IRTC

Technology Acquisition Projects:

Strengthening Operational Capacity

2002–2005



Canada

MESSAGE FROM THE DIRECTOR

When the Chemical, Biological, Radiological, and Nuclear (CBRN) Research and Technology Initiative (CRTI) was launched in 2002, one of its main priorities was to assess the capacities of the federal departments and agencies mandated to respond or support the Canadian government's response to a CBRN terrorism event.

The members of each CRTI laboratory cluster—groups of federal laboratories formed to discuss their needs in addressing CBRN terrorist attacks—were asked to identify immediate gaps in equipment and infrastructure and to submit project proposals to acquire the technology necessary to enhance their operational capabilities. CRTI allocated more than $21.2 million to these technology acquisition projects in the first two years alone, and has continued to invest resources on an annual basis to address the remaining gaps in Canada's CBRN preparedness.

CRTI is proud to report that it has funded a total of 71 technology acquisition projects to date. These projects represent collaborations with a variety of federal partners, including Health Canada ($7,324,100), the Canada Border Services Agency ($55,460), the Public Health Agency of Canada (PHAC) ($2,452,000), Environment Canada ($4,311,800), Natural Resources Canada ($908,300), Defence Research and Development Canada (DRDC) ($6,369,378), the Canadian Food Inspection Agency (CFIA) ($3,350,000), and the Royal Canadian Mounted Police (RCMP) ($1,231,000). The success of these partnerships not only strengthens Canada's response to potential terrorist threats; it also plays an integral role in increasing the scope of the day-to-day research and development activities of each laboratory.

Many of the projects funded over the last two years involve the purchase of existing "off-the-shelf" technology, such as microscopes, spectrometers, geographic information systems, servers, and chemical and radiation detectors. Other instruments, computer systems, and facilities have been adapted or custom-designed for the Canadian environment. One such project is the creation of a national bioterrorism agent surveillance network, which CRTI co-funded with the PHAC. Spearheaded by the National Microbiology Laboratory in Winnipeg, the project funded the acquisition of analytical equipment, reagents, and expertise to enable scientists working in provincial public health laboratories and 12 hospital facilities across the country to share and compare technical data in real time. This equipment will also enable scientists to provide early alert warnings to responders.

Increasing the capability of responders was also the goal in CRTI's funding of new chemical detection instruments for the RCMP's Forensic Laboratory Services in Edmonton. In an incident involving suspicious materials, police services, such as the RCMP, are Canada's first line of defence. The acquisition of three state-of-the-art spectrometers will enable RCMP scientists to rapidly screen and determine whether a possible biothreat is a hoax, freeing up much-needed resources and personnel for real events and helping to maintain public confidence.

Another key investment for CRTI has been the funding of a number of analytical instruments for DRDC's laboratories in Suffield. DRDC Suffield has the sole capacity to synthesize chemical warfare agents (CWAs) in Canada. Newly acquired spectrometers and a chemical vapour generator will further enhance the laboratories' internationally recognized research capability in CWA detection and identification.

CRTI's Radiological-Nuclear (RN) Laboratory Cluster has also received international attention with the recent $1.5 million acquisition of four mobile nuclear laboratories. Co-funded with DRDC, the labs are equipped with the latest radiation detection and analytical equipment and can be rapidly deployed across Canada in the event of an RN emergency. The equipment is currently being used in national field exercises, as well as in decommissioning projects. Other RN projects that have been particularly well received include Health Canada's Radiation Protection Bureau's efforts to increase the capacity of the National Dosimetry Service, and the establishment of a series of fixed-point radiation detectors across Canada.

Finally, CRTI projects co-funded with the CFIA also merit special mention, including the establishment of the Canadian Emergency Management Response System. This web-based application is designed to manage outbreaks of foreign animal diseases, such as foot-and-mouth disease. Several CFIA laboratories are also working to increase their capacity to detect chemical contaminants, pesticide residues, and other environmental toxins that could be introduced into our food supply.

This report highlights the significant contribution that these and other technology acquisitions have made to Canada's CBRN preparedness. I would like to extend my thanks to CRTI's laboratory clusters, the Project Review Committee, and the Steering Committee for their continued dedication to improving Canada's capacity to respond to CBRN terrorist threats.

Cam Boulet
Director, CRTI

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Biological Laboratories

Cabinet Safely Contains Dangerous Agents for Investigation (BIO001AP)

A new biological safety cabinet system purchased with assistance from CRTI enables scientists at the Canadian Science Centre to safely test unknown materials and new technologies in an enclosed and controlled environment. This new capability allows the Centre, particularly the National Microbiology Laboratory (NML), to enhance their ability to respond and handle unknown biological materials that are potentially contaminated with toxic gases or other hazardous chemicals.

Biological safety cabinet at the National Microbiology Laboratory

Using the cabinet, scientists can also control the temperature, humidity, and other conditions of the enclosed test environment. These features have proven useful in testing the effectiveness of personal protective equipment (PPE) that might be used by the first responder community in an emergency requiring personal protection. The Centre recently completed a study on respiratory protection devices using live organisms, and is currently evaluating advanced fumigation technologies used to treat large environments like office buildings or large rooms. With the protection provided by the cabinet, scientists can safely expose anthrax samples to a vapourized form of hydrogen peroxide, an effective decontaminant, without risk to their health. On the basis of the results of such tests, the Centre will be able in the future to advise the first responder community on the effectiveness of various types of PPE and decontaminants.

Safely testing dangerous materials in a controlled environment

The new cabinet is an integral part of the new applied biosafety research agenda of the NML.

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Charcoal Filter Provides First Responders Means to Test for Chemical Agents (BIO002AP)

Since 2002, first responders have been able to safely open and test packages suspected of containing harmful chemical agents or radionuclides at a Public Health Agency of Canada laboratory based in Ottawa because of the addition of a new filter to one of its biological safety cabinets.

A biological safety cabinet provides a clean work environment and protection for scientists working with biohazardous agents, such as viruses, bacteria, or fungi. All biological safety cabinets use high-efficiency particulate air (HEPA) filters, which are effective at trapping particulates and infectious agents, but not at capturing volatile chemicals or gases. However, modifying the design of the cabinet to enable the addition of a charcoal filter protects the environment from the potential release of toxic chemicals.

When the Royal Canadian Mounted Police and local law enforcement agencies reported that they did not have the equipment or the space in which to safely test suspicious packages, the lab was renovated to enable exhaust air to be filtered outside and the chemical agent to be absorbed by the charcoal filter. CRTI provided staff the funds needed to purchase and replace the charcoal filter on an annual basis, as needed.

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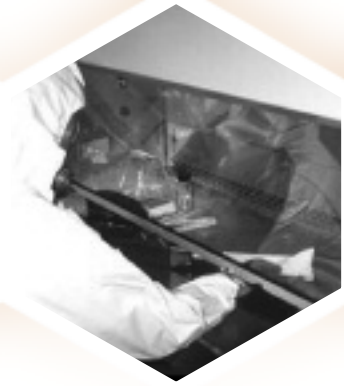

A biosafety cabinet equipped with a charcoal filter allows scientists to safely test suspicious packages

Cross-Country Surveillance Network Established to Detect Bioterrorism Agents (BIO003AP)

The National Microbiology Laboratory (NML) has created a national bioterrorism agent surveillance network through the Canadian Public Health Laboratory Network (CPHLN), and enhanced the ability of scientists working in provincial laboratories to share and compare technical data and images across the supporting computer network.

Assisted by CRTI, the NML purchased real-time polymerase chain reaction (PCR) technology, enabling scientists working in regional centres within the provincial labs to decrease the amount of time it takes to detect potential bioterrorism agents from several days to just hours, if not minutes. The NML also equipped most CPHLN labs and 12 hospital labs across Canada with a BioNumerics software platform to enable the surveillance network to operate in real time, enter technical data automatically, and provide early alert warnings to first responders.

The NML also developed workshops and produced videos and CD-ROMs to train staff to use the PCR technology and the software. As staff begin conducting real-time PCR tests, the NML will develop quality assurance programs to ensure the data generated are accurate.

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Disease surveillance, prevention, and control

Capacity to Work with Non-human Primates Puts Canada's Top Lab Among World's Best Facilities (BIO004AP)

Recent upgrades to its Containment Level 3 and 4 (CL3 and CL4) laboratories have established the Public Health Agency of Canada's National Microbiology Laboratory (NML) in Winnipeg, Manitoba among the few facilities in the world to perform vaccine and antiviral development research for certain bioterrorism (BT) agents.

Animals used in research to model diseases contracted by humans, particularly non-human primates, are essential in developing and testing medical countermeasures like vaccines and antiviral treatments against BT agents, such as Marburg and Ebola virus, and Lassa virus. The existing animal facility in the CL4 lab, however, was designed to meet the normal demands of public health and research requirements—not to be prepared to respond to bioterrorism. With assistance from CRTI, structural changes were made to the animal facility, and additional equipment, including large animal cage systems, was acquired to establish the lab's capacity to work with non-human primates at the Level 4 containment level. The extended animal facility provides state-of-the-art containment space suitable for these animals and will let scientists run concurrent studies in more than one animal species. The upgrades have already had a significant impact on vaccine and antiviral development for BT agents: the lab is now working with non-human primates and has completed three experiments since the upgrade.

The tissue culture facility in the CL4 lab was also outfitted with new equipment to prepare for a large-scale diagnostic response. In the CL3 lab, the purchase of a new Class III biological safety cabinet made this facility the only one in Canada in which scientists can safely handle samples of chemical and biological hazards.

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Lab Equipment Kick-Starts New CB Forensic Laboratory (BIO005AP)

Designed to provide all the capabilities needed to identify unknown chemical and biological (CB) agents, the recently constructed Chemical/Biological Forensic Reference Laboratory at DRDC in Suffield, Alberta acquired the necessary equipment to make the laboratory functional.

The new, modular Biological Safety Level 3 lab was built with funding provided by Parliament following the terrorist attacks of September 11, 2001, but it remained empty until CRTI provided the funds to equip the lab. The purchased equipment included microscopes, refrigerators, freezers, incubators, centrifuges, a fluorometer suitable for clinical assays based on fluorescence or time-resolved fluorescence from a wide variety of plates, a microplate liquid scintillation counter and luminometer, a multi-colour fluorescence-based DNA analysis system with 16 capillaries, and an automated DNA sequencer.

With this new equipment, DRDC scientists working in the specialized lab can respond to emergency requests for sample analysis without pulling resources away from the research and development program at DRDC Suffield.

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New Instrument Improves Biological Lab's Anthrax Detection Capacity (BIO006AP)

A Public Health Agency of Canada Biological Safety Level (BSL) 3 laboratory is planning on joining Canada's network of first-response labs through the purchase of a Cepheid polymerase chain reaction (PCR) instrument—a fast, accurate, and highly sensitive DNA-based amplification and detection device used to identify anthrax. As one of the labs participating in the Canadian Public Health Laboratory Network (CPHLN), the Ottawa-based BSL 3 lab can conduct the preliminary work to detect an anthrax threat and help alleviate the workload of the National Microbiology Laboratory (NML) in Winnipeg.

Purchased with the assistance of CRTI, the new, fully automated PCR instrument identifies the presence of specific DNA sequences associated with anthrax in just two hours, instead of the 24 to 48 hours it had previously taken. The new instrument is also small enough to be taken into the field in the Agency's mobile lab. Agency scientists are using their new PCR instrument to conduct research into sampling techniques and to develop more sensitive primers—usually short, single-stranded sequences of oligonucleotides—to improve the amplification process.

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Cepheid polymerase chain reaction instrument

Multi-purpose Irradiator Makes Identification of Biological Agents Rapid and Safe (BIO007AP)

Funded by CRTI, DRDC's laboratory in Suffield, Alberta purchased a well-shielded multi-purpose research irradiator to enable scientists to rapidly and safely identify hazardous chemical and biological (CB) agents. The Gammacell 220 uses cobalt-60 sources, double encapsulated in stainless steel, to emit high-energy gamma rays and eliminate harmful microorganisms from samples containing unknown CB agents. Once the samples are rendered harmless, scientists can identify the agents using immunologic or genetic detection techniques.

Before the purchase of the Gammacell 220, scientists at DRDC Suffield had to import gamma-irradiated biological materials from the United States. Now they can grow their own microorganisms, irradiate them, and incorporate the antigens or the antibodies produced through their presence as reagents in immunological identification systems. DRDC scientists are also testing irradiated samples much more quickly than before since they are able to analyze the samples in biosafety Level 2 labs, which are much easier to work in than the Level 3 labs because they do not require the scientists to wear restrictive personal protective equipment. Their work developing the materials needed for antibody-antigen-based identification assays promises to put detection and identification tools into the hands of first responders soon.

Gammacell 220 irradiator

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New Data Standards Facilitate Exchange of Emergency Public Health Information (BIO008AP)

With funding from CRTI, Health Canada collaborated with the Canadian Food Inspection Agency (CFIA) and other partners to develop standards for sharing surveillance data related to enteric diseases during a public health emergency. These standards will greatly facilitate the flow of public health data and contribute to the development of standardized repositories of other types of surveillance and investigation data to be shared by government agencies, provincial and territorial governments, and other participating organizations.

Building on existing human surveillance data definitions and standards, Health Canada and the CFIA developed data standards, data elements, and definitions covering a number of areas, from laboratory testing to the interrelationships between people, animals, and foods. A process for the collaborative development of data standards was established using peer-to-peer collaboration tools. The results of these efforts culminated in a unique and useful data model, which serves as the foundation for data sharing about enteric diseases.

The data model has been put to extensive use and has been implemented in the Integrated Public Health System, a paperless office system for public health workers that has been implemented in British Columbia, Alberta, Saskatchewan, Manitoba, and most recently in Ontario. It will reside on the Public Health Portal maintained by the Public Health Agency of Canada (PHAC), as well as in a peer-to-peer standards development website managed by PHAC to support ongoing work on data standards.

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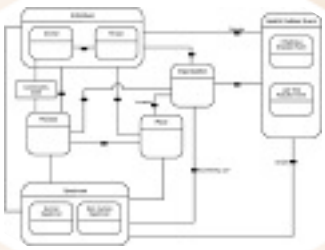
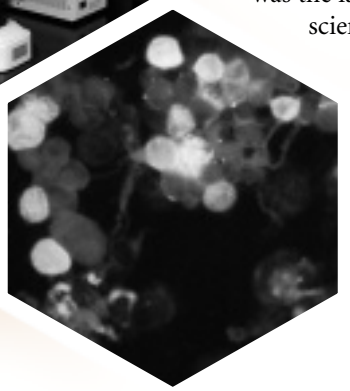


Standards for data sharing during a public health emergency

Suffield Lab Becomes Part of Lab Response Network with Fluorescent Microscopes (BIO009AP)

As part of the US Centers for Disease Control and Prevention's (CDC's) Laboratory Response Network to combat emerging infectious diseases, the DRDC laboratory in Suffield, Alberta has been developing the capacity to perform confirmatory testing for high-priority biological agents through direct fluorescent antibody (DFA) assays of bacterial preparations or infected cell cultures. The purchase of two high-performance Nikon fluorescent microscopes, assisted by CRTI, was the last step to enabling scientists to confirm the presence of anthrax, plague, tularemia, and brucellosis using assays developed by the CDC.

Nikon fluorescent microscope



Viral infected cells appear green in fluorescent antibody assays

Scientists at the Biological Safety Level (BSL) 3 lab in Suffield have been working on developing fluorescein-labelled monoclonal antibodies specific to a variety of potential biological warfare agents, including western equine encephalitis and Venezuelan equine encephalitis virus. They have also used the microscope at the BSL 2 lab to assess fluorescein-labelled human lymphocytes prior to fluorescent-activated cell sorting as the first step in cloning human monoclonal antibodies as therapeutic agents to anthrax. The next step is to transfer the CDC lab response network capacity to the new Counter Terrorism Technology Centre forensic laboratory in Suffield when it is certified sometime in 2006.

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Scientists Provide G8 Leaders Protection from Biological Threats (BIO010AP)

With the purchase of equipment to isolate and separate viruses, the DRDC laboratory in Suffield, Alberta prepared itself to analyze and identify any suspicious chemical or biological samples to support security forces for the G8 Summit held in nearby Kananaskis, Alberta. DRDC Suffield purchased a Beckman ultracentrifuge, two benchtop centrifuges, and refrigerated and non-refrigerated microfuges with the assistance of CRTI to ensure the lab developed diagnostic capabilities for detecting viruses in time to protect G8 leaders from biological threats.

The new equipment enabled scientists to isolate viral reagents to use in detecting and identifying potential biological safety Level (BSL) 3 viruses. The BSL 3 viruses were purified with the microfuge and inactivated with the centrifuge, though they require thorough safety testing before they can be released. The new equipment also enabled scientists to produce viral antigens to detect new viruses and improve their readiness to respond to virus bioterrorist attacks. The scientists are continuing to work on developing rapid, sensitive immunoassays to detect and measure eastern and western equine encephalitis viruses with the aim of replacing the virus-specific serum antibody titer that had been used for diagnosis.

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Beckman ultracentrifuge

Emergency Response Teams Receive Added Crisis Management Support (BIO011AP)

National and area emergency response teams and functional and scientific advisers at the Canadian Food Inspection Agency (CFIA) received added support to coordinate response, recovery, and mitigation activities during a CBRN emergency with the purchase of a powerful crisis–information management software application.

With funding provided by CRTI, the CFIA's Operations Coordination Team acquired and adapted Operations Management System software so that response team members can share and receive critical information instantaneously in a secure environment. Using the system, team members can track, log, and validate situational information and emergency response activities. The system collects, organizes, and presents data for decision making, including situation reports that describe the emergency incident as it develops to provide a clear picture and to facilitate coordination of activities.

Although the application is designed as a stand-alone system, the Office of Emergency Management's vision is to link it with existing databases and leverage the information contained within it for more effective emergency and routine management operations.

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Developing a Canadian Animal Disease Emergency Management System (BIO012AP)

While not traditionally viewed as a common mode for bioterrorism, the introduction of a foreign animal disease such as foot-and-mouth disease or rinderpest could effectively paralyze Canada's food supply, export trade, and financial markets.

One of the major determinants of the magnitude of an outbreak is the rapidity with which the disease is noticed and diagnosed. Canada's capacity to manage and investigate an outbreak has been substantially strengthened since CRTI provided funding to the Canadian Food Inspection Agency (CFIA) to purchase the hardware and software necessary to adapt the American Emergency Management Response System (EMRS) to the Canadian environment.

Developed by the United States Department of Agriculture (USDA), Veterinary Services, and Animal and Plant Health Inspection Services, the EMRS is a web-based application designed to automate many of the tasks routinely associated with disease outbreaks, control programs, animal health emergencies, or natural disasters involving animals. Like the American prototype, the Canadian Emergency Management Response System (CEMRS) consists of four modules for disease investigation, administration, task assignment, and reference.

CEMRS underwent a real-time pilot evaluation and further refinement during the initial Bovine Spongiform Encephalopathy (BSE) discovery in May–June 2003. It was also used to capture and disseminate information during the avian influenza (bird flu) outbreak in British Columbia in the spring of 2004.

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New Software Predicts Spread and Cost of Animal Disease Outbreaks in Canada (BIO013AP)

With funding from CRTI, the Animal Health Risk Analysis (AHRA) group of the Canadian Food Inspection Agency (CFIA) acquired US disease-modelling software to predict the spread and impact of outbreaks of animal diseases that have been identified as potential bioterrorism threats in Canada.

Originally developed by Colorado State University and the United States Department of Agriculture (USDA) to simulate foot-and-mouth disease (FMD) outbreaks in the United States, AHRA modified the SpreadModel software to accommodate different diseases, hosts, modes of transmissions, control measures, and other variables. Once the parameters for a particular disease—such as Bovine Spongiform Encephalopathy (BSE) or "mad cow disease," FMD, or hog cholera—have been identified, the software produces simulations of the epidemiological consequences of an outbreak, as well as the economic consequences, which are especially critical in highly populated areas. That information can then be shared with risk managers to aid in decisions about possible mitigation measures.

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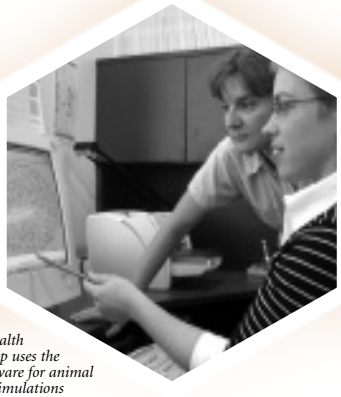

CFIA's Animal Health Risk Analysis group uses the SpreadModel software for animal disease outbreak simulations

Canada Gains Air Sampling Systems (BIO014AP)

Recognized internationally for its biological aerosol field studies, DRDC's laboratory in Suffield, Alberta was invited to apply for funding from the United States to support a follow-up risk assessment of anthrax spores in letters that the lab had been planning. The US Technical Support Working Group (TSWG) approved the Suffield lab's request and provided them with funds to purchase four state-of-the-art air-sampling systems to help them carry out their work. An agreement between the TSWG and DRDC Suffield enabled the lab to keep the air samplers after the project ended when CRTI matched the level of funding provided by the TSWG.

The high-resolution, slit-to-agar air samplers detect the presence of viable microorganisms and provide accurate counts of their concentration. Because they are portable, DRDC Suffield can respond on the scene to terrorist attacks or biological emergencies and detect airborne microorganisms. This response capability was exercised with a similar type of unit at a Toronto hospital during the Severe Acute Respiratory Syndrome (SARS) crisis and in Abbotsford, British Columbia during the avian influenza (bird flu) outbreak. The lab is currently using the air samplers in their aerosol studies to assist in the development of guidelines for responding to an intentional or naturally occurring release of bacterial spores or other microorganisms in the air.

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High-resolution slit-to-agar air sampler

Scientists to Recommend Kits for Diagnosing Infectious Diseases in Livestock (BI0016AP)

Scientists at the National Centre for Foreign Animal Diseases (NCFAD) of the Canadian Food Inspection Agency can now recommend the best diagnostic kits to use to rapidly detect highly infectious animal pathogens—such as foot-and-mouth disease, hog cholera, and avian influenza (bird flu)—on the farm, "pen-side," or in local laboratories.

Rapid and early action is needed to contain the spread of a virus. Prior to the commercial availability of diagnostic kits, all suspicious samples had to be sent to the NCFAD in Winnipeg, Manitoba for diagnosis. This is a time-consuming step that, in the face of a major outbreak, might prompt livestock producers and others affected by the disease to use a kit illegally without understanding its limitations.

Funding provided by CRTI enabled NCFAD scientists to test and evaluate the sensitivity and specificity of several commercial kits from Europe and the United States. Following an initial diagnosis at the NCFAD, scientists can now recommend to first responders and local lab which kit is best to use in the event of an outbreak.

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CFIA Emergency Operations to Incorporate GIS Technology (BI0017AP)

The Canadian Food Inspection Agency (CFIA) is modifying its data infrastructure and systems design to prepare for a web-based geographic information system (GIS) for managing, analyzing, and displaying spatial data at its national emergency operations centres. The new GIS will enable the centres to better manage the outbreak of a highly contagious disease affecting Canada's food supply or livestock sector, as well as the spread of a deadly plant disease.

Mandated to prepare for, and respond to, emergencies involving threats to food safety and plant and animal health, the CFIA's ability to respond effectively was made more difficult by the absence of one common GIS modelling and mapping system for all of the Agency's operations centres. As recently as 2003, staff was tracing the outbreak of Bovine Spongiform Encephalopathy (BSE) with Rand McNally road maps.

With funds provided by CRTI, the CFIA purchased eight Hewlett-Packard ProLiant DL580 servers to supply the geographical data to area and national centre computers in real time, and the accompanying GIS software and licence.

The next step is to implement a recently developed draft strategy for managing the data and determine the compatibility of the system with those of other federal response partners.

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Public Health Care Workers to Gain Secure Access to Health Data Mapping Application (BIO018AP)

With the help of CRTI, Health Canada acquired the necessary technology to implement the Public Health Map Generator (PHMG) for the Canadian public health community in a secure environment. A web-based application, the PHMG enables local public health workers who do not have geographic information systems (GIS) capabilities to upload their case-level data and produce useful maps of the occurrence of diseases and other important information through a secure connection to the Health Canada application and spatial data holdings.

Recognizing that jurisdictions may be reluctant to upload their data to the PHMG, Health Canada explored ways of improving security. A Privacy Impact Assessment was conducted on the PHMG, which identified areas to be addressed to comply with current privacy legislation. Health Canada also investigated the feasibility of a one-stop security pass or "single sign-on" (SSO) solution for all applications offered by Health Canada or the Public Health Agency of Canada. A proof-of-concept was achieved on the implementation of the SSO mechanism, and a threat and risk assessment was conducted. The products tested were successful for the SSO process, and licensing was obtained for the selected technology. Further work will result in a pilot implementation of the SSO solution.

While additional security will be required to use the PHMG in a CBRN event, this initiative has strengthened the national surveillance infrastructure and has created the technology environment required for CRBN surveillance and response.

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Public Health Map Generator model

Upgraded Facility Contributes to Greater Preparedness Against Biological Threats (BIO019AP)

DRDC collaborates with the United Kingdom and the United States to develop hybridoma cell lines for biological threat agents such as anthrax, ricin, brucella, and botulinum. While DRDC's laboratory in Suffield, Alberta has been working with hybridomas for some time, the limited space and equipment available hampered DRDC's ability to develop and propagate hybridoma cell lines and produce monoclonal antibodies for use in emergency preparedness and response.

With assistance from CRTI, DRDC Suffield upgraded its hybridoma facilities through the acquisition of key equipment and the installation of an enhanced security surveillance system. Among the instruments acquired was a Fluoresence Activated Cell Sorter (FACS). State-of-the-art technology, the FACS saves scientists a significant amount of time in screening hybridoma cell lines by enabling them to sort individual cells, determine which cells are secreting the antibody of interest, and deposit them separately into individual wells. A hollow-fiber bioreactor cell system for simultaneous propagation of multiple cell lines was also acquired, along with a liquid nitrogen storage system, an inverted microscope, and various laboratory support equipment.

The upgraded hybridoma facility at DRDC Suffield will enable DRDC scientists to develop new cell lines and to produce and maintain stocks of selected monoclonal antibodies for use by the Canadian Forces, the Counter Terrorism Technology Centre at DRDC Suffield, and CRTI's Biological Laboratory Cluster, and to respond to requests for surge production of monoclonal antibodies in national emergencies.

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Fluoresence Activated Cell Sorter

Hybridoma facility at DRDC Suffield

New Equipment Rapidly Diagnoses Plant Diseases (BIO020AP)

The Plant Protection Division of the Canadian Food Inspection Agency (CFIA) has acquired valuable new tools that add to its capacity to rapidly detect plant pathogens that could pose a biological threat to Canada's food supply.

With funding from CRTI, three portable Cepheid Smart Cycler polymerase chain reaction (PCR) systems, a microarray reader, and a gene sequencer were purchased for the CFIA's Plant Health laboratories in Sidney, British Columbia; Nepean, Ontario; and Charlottetown, Prince Edward Island.

Compared to some conventional diagnostic tools that can take several days to provide results, Smart Cyclers can detect nucleic acid targets from disease-causing bacteria, fungi, and viruses within 30 minutes, and can perform under rugged field conditions if necessary. CFIA scientists are also using them in the lab, along with other diagnostic instruments like the gene sequencer, to conduct further studies on the characterization and identification of potential bioagents, such as Karnal bunt, soybean rust, and Pierce's disease.

This new equipment, which has been used to support research addressing the plum pox virus outbreak in Ontario, is similar to equipment used by the United States Department of Agriculture (USDA) and other agencies of the US government with whom the CFIA may collaborate in the event of a bioterrorist event.

Cepheid Smart Cycler rapidly detects plant diseases

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Equipment Supports and Increases Access to Microorganisms with a National Culture Collection (BIO021AP)

With increasing demands for biosecurity research, the need to maintain and access strains of high-risk biological agents and their relatives has never been greater.

With support from CRTI, Agriculture and Agri-Food Canada (AAFC) and the Public Health Agency of Canada (PHAC) set out to conduct a cross-Canada inventory of current culture collections, develop and cost out a model for a national collection system network, and purchase equipment to support some of the important culture collections. Equipment such as ultra-low freezers and lyophilization instruments will help to ensure the long-term storage and security of potential biowarfare and bioterrorism agents and important human, animal, and plant pathogens.

Several federal partners, including PHAC, AAFC, DRDC Suffield, and the Canadian Food Inspection Agency laboratory in Lethbridge, Alberta have acquired equipment to date. Memoranda of Understanding concerning the roles and responsibilities of various departments have also been struck to ensure that some of the immediate needs in equipment are covered and that departments participate in the inventory and study necessary for the creation of a National Culture Collection organization.

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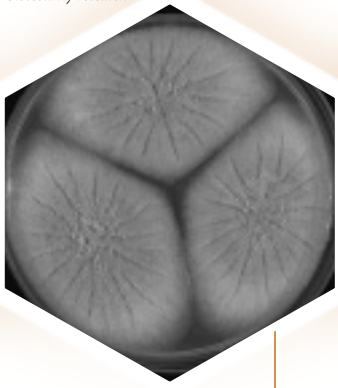
Access to high-risk microorganisms like Aspergillus flavus *(below) is necessary for biosecurity research*



Rapid Tests for Anthrax and Plague Contribute to Canada's Preparedness for an Attack on the Food Supply (BIO022AP)

Food is vulnerable to intentional contamination by bioterrorism (BT) agents such as anthrax and plague. Microbiology laboratories and public health officials need rapid, sensitive, and reliable tests to detect and characterize these agents as quickly as possible to ensure the safety of the Canadian food supply. Although rapid tests exist to detect bioterrorist agents, their ability to detect agents such as anthrax and plague in foods has not been comprehensively evaluated.

With funding from CRTI, the Canadian Food Inspection Agency (CFIA) has purchased a series of commercially available tests used by first responders in Canada and the United States to detect BT agents: the Rapid Analyte Measurement Platform (RAMP) instrument, the Ruggedized Advance Pathogen Identification Device (RAPID) kits, and the RedLine Alert kit. The CFIA is currently comparing the performance of these commercial kits and instrument to the standard bacteriological culture methods used to recover anthrax and plague agents. The results of this evaluation will enable the CFIA to make recommendations on the strengths and limitations of these technologies.

Preliminary analyses indicate that the test kits are capable of detecting anthrax and plague. The resulting report documenting the final outcomes of the study will be distributed to personnel within the CFIA, Health Canada, and DRDC to enable an informed, cohesive response to a bioterrorist attack on the Canadian food supply involving anthrax or plague.

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Testing for anthrax and plague with Rapid Analyte Measurement Platform instrument

New Sterilizer Expected to Improve Lab's Capacity to Handle Non-human Primates (BIO023AP)

While recent upgrades to its Containment Level 4 (CL4) laboratory enabled the Public Health Agency of Canada's National Microbiology Laboratory (NML) in Winnipeg, Manitoba to work with non-human primates, the recent increase in this type of work highlighted the need for a larger sterilizer (autoclave) for safely handling the cage systems.

Because the cage systems needed to accommodate non-human primates do not fit into the current sterilizers, scientists can only decontaminate, but not sterilize, the cages. Decontamination is an accepted practice worldwide; however, it is time-consuming. The complete inactivation of all microorganisms through sterilization would enable scientists to conduct new experiments with different agents faster, thus increasing the capacity for non-human primate work. It would also contribute to the overall safety of the operation.

With assistance from CRTI, the NML intends to purchase a new autoclave—a closed, airtight vessel that uses steam to sterilize materials—big enough to hold the large cage systems. The new sterilization system is anticipated to increase the lab's large animal-handling capacity, increasing its ability to work with important pathogens like Ebola virus, Marburg virus, Lassa virus, Severe Acute Respiratory Syndrome (SARS) virus, and others. A sterilizer that increases the waste disposal capacity of the CL4 facility will also improve the lab's tissue culture–handling capacity.

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World-Leading Lab to Improve Ability to Detect Airborne Threats (BIO024AP)

The purchase of three weatherproof, outdoor aerosol collectors planned for this year will significantly improve the ability of DRDC's Suffield laboratory to assess the threat of airborne particles of biological agents that are nearly impossible to detect by sight or smell.

World leaders in the collection and analysis of air samples, DRDC Suffield is regularly called on for assistance in determining the threat of dispersal into the air of bacteria such as anthrax or viruses such as Severe Acute Respiratory Syndrome (SARS) and avian influenza (bird flu). Given the possibility of terrorists deliberately releasing a biological agent through an aerosol cloud or spray, CRTI agreed with the scientists at DRDC Suffield that it was time to invest in better sampling equipment and protective gear.

The XMX-CV Aerosol Collection System, developed by Dycor Technologies Ltd. in Edmonton, Alberta, can collect 800 litres of air per minute, clean it, and concentrate particles ranging in size from 1 to 10 microns either into a millilitre of liquid or onto a dry filter. The system is easy to set up or remove and is designed to operate outdoors in weather conditions that include Canadian winters. Scientists at DRDC Suffield plan on using the system for assessments at target sites in emergencies, and in their ongoing aerosol field studies. Multiple units will greatly decrease the time for sampling different areas of a site, reduce cross-contamination, and provide new data relating to agent dispersal.

XMX-CV Aerosol Collection System

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Chemical Laboratories

Re-equipping Environment Canada's Central Response Team (CHEM001AP)

Environment Canada's Emergency Response Team is a prime contact and resource agency for incident response across Canada. As such, it is critical that Environment Canada's mobile emergency vehicle and mobile laboratory are capable of rapidly detecting, identifying, and analyzing toxic industrial chemicals and possible terrorist agents in air, water, and soil.

With several analytical instruments no longer operable, Environment Canada's Emergencies Science and Technology Division (ESTD) applied for CRTI funding to re-equip both of its mobile units. The new equipment included replacements and upgrades to gas chromatograph/mass spectrometer (GC/MS) systems, an accelerated solvent extraction system, and a multimode solid-phase extraction autosampler.

When used in combination, the new instrumentation enhances the ESTD's capacity to detect and analyze a wide variety of spilled materials with greater sensitivity, such as total petroleum hydrocarbons and chlorophenols, toxic pesticides and herbicides, and volatile organic compounds.

The acquisitions will also allow ESTD researchers to continue to develop methods for on-site analysis and to provide support and assistance to the United States Environmental Protection Agency's (US EPA's) Emergency Response Team.

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High-performance liquid chromatography/ mass spectrometer system for mobile lab

Vehicle-portable gas chromatograph/mass spectrometer system

Response Teams at Environment Canada Receive New Portable Analytical Equipment (CHEM002AP)

In the event of a major environmental emergency such as an oil spill, forest fire, or a terrorist attack involving chemical weapons, Environment Canada's Emergency Response Team is among the first federal responders to be deployed. Environment Canada also has five Regional Environmental Emergencies Teams (REETs) that can be called to the scene to provide additional support to first responders and to monitor and evaluate the environmental impacts of the incident.

To enhance this response capability, Environment Canada requested funding from CRTI to re-equip its response teams with essential portable analytical instruments and sampling kits. Among the items purchased were a Sabre 2000 ion mobility spectrometer (IMS), a Hapsite gas chromatograph/mass spectrometer (GC/MS) and sampler, and a Voyager gas chromatograph/photoionization diode/ electron capture detector (GC/PID/ECD). These portable, state-of-the-art devices allow emergency personnel to rapidly detect and identify a variety of volatile organic compounds in air, water, and soil. A portable air-monitoring system that can predict the dispersion of airborne vapours and contaminated particulate was also acquired, and regional response teams received replacement soil, water, and air test kits.

In addition to protecting the health and safety of the first responders, these new devices provide response teams with on-site and real-time analysis of many of the potential chemicals of concern to CRTI.

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Portable low-energy germanium detectors

Hapsite gas chromatograph mass spectrometer and sampler

Relocation of Chemical Vapour Test Facility Raises Profile and Capacity (CHEM003AP)

Despite its unique capabilities, a chemical vapour penetration test facility located on the grounds of the Royal Military College of Canada (RMC) had such a low profile that it did not appear on the campus map, and site planners recommended building a much-needed parking lot in its place. Faced with the need to relocate, staff at the test facility received funds from CRTI enabling them to move the building and renovate the interior so that the facility could operate year round. The move also served to highlight the nature of the work that had been quietly going on in the modest building since 1992, and increasing since September 11, 2001.

Working with national and international manufacturers, militaries, and police services, the facility evaluates the capability of protective clothing and equipment worn by first responders to prevent or minimize the contact of chemicals against the skin. One of the first facilities in the world to perform "man-in-simulant" testing, it is equipped with a process control laboratory, an environment-controlled vapour test chamber, personnel and equipment preparation rooms, and an analytical laboratory. Since relocating, the facility has been operating all year, running three or four exposure tests per week.

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First responder protective clothing and equipment are evaluated at RMC's chemical vapour penetration test facility in Kingston, Ontario

Chemical Containment Lab in Winnipeg Passes Design Test (CHEM004AP)

With the growing need to analyze toxic agents, like ricin, or mycotoxins, such as HT2 toxin or "yellow rain," an assessment of the chemical containment laboratory at the Health Products and Food Branch (HPFB) in Winnipeg, Manitoba was recently conducted.

Constructed in 1988, the lab had not been used for 14 years when scientists at the HPFB applied for CRTI funding to assess the current state of the facility. As a first step, the design and functionality of the lab was reviewed to determine whether it had degraded over time. Private consultants conducted a thorough examination of the building, including the physical construction of the walls, floor, ceilings, and duct system, and deemed that the facility was well designed and could safely operate as a Level 3 chemical containment laboratory.

Standard operating procedures for the lab consistent with Health Canada's Biological Containment Lab guidelines were subsequently developed. After years of non-use, the building's management, administration, engineering staff, and lab personnel have refamiliarized themselves with the facility. The HPFB hopes to obtain certification for the lab in the near future.

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HPFB's chemical containment laboratory in Winnipeg, Manitoba

New Spectrometer Increases the RCMP's Capacity to Rapidly Identify Unknown Materials (CHEM005AP)

With acts of terrorism hitting closer and closer to home, the need to quickly identify and deal with suspicious materials, whether harmful or innocuous, is essential to maintaining public confidence.

The Royal Canadian Mounted Police Forensic Laboratory Services, in Edmonton, plays a leading role in the analysis of unknown substances in a possible terrorist event. Its capacity to assess substances in a timely manner has recently been enhanced with the purchase of a Raman spectrometer system.

Unlike other technologies, the Raman spectrometer can screen samples in the lab through most clear glass or plastic packaging, keeping first responders away from possible threats. Set-up time is minimal, and measurements are possible in a variety of modes including a RamanProbe mode. The probe is 10 metres in length and allows for some remote sampling capability.

The Raman spectrometer will also be used for forensic comparisons of scene materials with materials associated with a suspect, helping investigators to successfully prosecute those responsible for terrorist events.

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Confocal Raman spectrometer

New Spectrometer Screens for Unknown Powders (CHEM006AP)

With numerous anthrax scares and other white powder incidents occurring every year, it is critical that investigators are able to quickly and confidently distinguish biothreats from hoaxes so that resources can be mobilized when and where needed.

The Royal Canadian Mounted Police (RCMP) Forensic Laboratory Services in Edmonton (designated as the RCMP's major non-biological trace evidence operations and operations support site) has several analytical instruments available to identify unknown organic substances. Their capacity to conduct inorganic analyses, however, needed to be enhanced. With funding from CRTI, the lab recently purchased an X-ray fluorescence (XRF) spectrometer that allows for the rapid screening and characterization of unknown powders and materials.

Unlike scanning electron microscopy/energy dispersive X-ray spectroscopy (SEM/EDX), XRF does not generally require extensive sample preparation and can be used on samples that would deteriorate under the preparation conditions needed for SEM/EDX. The data obtained from these samples will complement other analytical tests that will be used in the investigation and subsequent prosecution of suspects associated with the incident.

This acquisition will also help the RCMP's forensics lab in the evaluation of a field-use micro-XRF unit that would be ideally suited for screening samples at the scene.

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X-ray fluorescence spectrometer

X-ray Diffractometer Aids in the Prosecution of Hoax Suspects (CHEM007AP)

When a letter containing an unknown and potentially harmful substance arrived at the prime minister's mail-clearing facility in Ottawa in October 2003, the Royal Canadian Mounted Police's (RCMP's) CBRN Response teams were called to investigate. While this incident turned out to be a hoax, the individuals involved are criminally liable under Canada's *Public Safety Act*, and it is the responsibility of the RCMP's Forensic Laboratory Services in Edmonton to analyze non-biological trace evidence, as well as provide investigational support and expert testimony during the court process.

Because physical evidence associated with such an incident is often time sensitive, it is essential that investigators have a clear idea as to the material they are dealing with when planning to move in on suspects in a case. In an effort to improve the speed at which suspicious materials are identified, RCMP Forensic Laboratory Services recently requested funding from CRTI to procure a micro X-ray diffractometer (XRD) system.

Micro X-ray diffractometer system

With its high resolution, the micro-XRD allows for the rapid identification of crystalline materials in unknown powders, particularly when used in conjunction with X-ray and other analytical techniques. Tests conducted with these analytical instruments form an important basis for subsequent criminal prosecutions and act as a deterrent for such incidents.

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World's First Buoyancy-Corrected Facility Provides Accurate Measurements of Airborne Particulate Matter (CHEM008AP)

In the event of a chemical emergency, the need to determine as quickly as possible which substances are being inhaled by first responders is critical. Until recently, however, Canada lacked the facilities to accurately measure low concentrations of airborne particulate matter like those collected on filters used in emergency air-monitoring equipment.

To address this need, CRTI co-funded a project with Health Canada to build a state-of-the-art gravimetric analysis facility on par with United States Environmental Protection Agency guidelines. It later became evident to the project's participants that there were a number of conditions, such as air density, that needed to be controlled in order to achieve the greatest degree of accuracy for samples with small particle masses (less than 50 micrograms). A special buoyancy-corrected chamber was subsequently designed that generates automatic readings of the humidity, air pressure, temperature, and mass measurements every minute to ensure that conditions remain constant between filter conditioning treatments.

The facility, which consists of two rooms and the patent-pending chamber, is housed in the basement of Health Canada's Environmental Health Sciences building. It is now fully operational and processes more than 4,000 personal, indoor and outdoor samples per year from Windsor, Ontario as part of the joint United States–Canada Border Air Quality Strategy.

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Lab technologist hard at work in gravimetric analysis facility

New Spectrometers Enhance Chemical Warfare Agent Research (CHEM009AP)

When the Canadian Forces and the Royal Canadian Mounted Police need to identify a suspected chemical warfare agent (CWA) sample, the first call they make is to DRDC's analytical research laboratories in Suffield, Alberta.

DRDC Suffield is recognized worldwide for its capacity to detect and identify CWAs, such as mustard and tabun. To enhance this capability, DRDC and CRTI co-funded the acquisition of a new nuclear magnetic resonance (NMR) spectrometer and a high-resolution quadrupole/time-of-flight (QTOF) tandem mass spectrometer to replace the lab's older spectroscopy instrumentation.

The NMR spectrometer allows researchers in the Chemical Synthesis and Characterization Group to assess the purity of CWA standards. New methods have been developed for the analysis of CWAs, their degradation products, and related compounds in aqueous samples and extracts using the tandem mass spectrometer. These new techniques have since been applied to a variety of different samples, including synthetic tabun samples and soil samples collected at a former mustard storage site.

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High-resolution quadrupole/time-of-flight tandem mass spectrometer

Labs Use New Microscopes to Identify Near-Invisible Compounds in Foods (CHEM010AP)

With the aid of recently acquired microscope attachments, Canadian Food Inspection Agency laboratories in Burnaby, British Columbia and Longueuil, Quebec can now analyze chemical contaminants in either powder or solid form in food samples as small as 10 microns.

Although equipped with a state-of-the-art Fourier transform infrared (FTIR) spectrometer—a powerful tool used to identify unknown chemical contaminants present in a sample—the labs were restricted by the instrument's inability to analyze a contaminant that could not be easily separated from the food matrix. However, combined with the microscope attachments purchased with the assistance of CRTI, the FTIR microscope characterizes chemical compounds on both microscopic and molecular levels and enables laboratory staff to analyze small samples of a contaminant in situ without the risk of destroying it during the extraction process. The microscope attachments enable the FTIR spectrometer to rapidly detect and identify unknown chemical compounds in suspicious powder mixtures.

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FTIR with microscope attachment in CFIA's laboratory in Longueuil, Quebec

Analyzing trace amounts of chemical contaminants in CFIA's Burnaby, British Columbia laboratory

New Tool for Detecting Food Contaminants Improves Lab Capabilities (CHEM011AP)

The ability of the Canadian Food Inspection Agency's food-testing laboratory in Dartmouth, Nova Scotia to respond to a terrorist-induced food crisis has been improved by the acquisition of a newer, more modern, and highly sensitive inductively coupled plasma/mass spectrometry (ICP/MS) instrument. Designed to analyze heavy or toxic metals and other adulterants or trace elements in food, the ICP/MS instrument will also facilitate the lab's ongoing work in monitoring Canada's food supply.

As the Agency's national centre for the analysis of toxic elements in food, the Dartmouth lab had long recognized the need to bolster the capabilities of its aging ICP/MS system. The lab needed an updated version that could detect lower levels of contamination in food, including low-level stable isotopes, and rapidly identify toxic elements. Purchased with the assistance of CRTI, food-safety specialists at the Dartmouth lab now have a powerful new tool capable of simultaneously analyzing a range of metals, such as lead, cadmium, and arsenic, at below the parts-per-billion level. Outfitted with this technique of choice, the specialists at Dartmouth can continue to provide the analysis needed to ensure that Canada's food supply is safe and that food coming into the country meets Canadian standards.

Inductively coupled plasma/mass spectrometer

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Analysis of Environmental Contaminants Simplified by New System (CHEM012AP)

Analyzing food for pesticide residues, polychlorinated biphenyls (PCBs), and other environmental contaminants was made easier with the purchase of a next-generation gas chromatography/mass selective detector (GC/MSD) system by the Canadian Food Inspection Agency's Calgary laboratory.

Limited by aging equipment requiring overhauls and repairs, the Calgary laboratory purchased this powerful, scaled-down version of a mass spectrometer coupled with a gas chromatograph with the help of CRTI. The new system enables lab staff to analyze chemical contaminants, such as organophosphorus and organosulfur pesticides, that could be used in a terrorist attack on Canada's food supply.

Quick and reliable, the GC/MSD makes an important addition to the range of analytical instruments available to the lab. Staff are already using the new system on a daily basis to monitor pesticide residues and have succeeded in identifying approximately 285 pesticides simultaneously. Plans are in the works to expand the capacity still further.

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Gas chromatography/mass selective detector system

New Technology Facilitates Rapid Analysis of Biological Toxins (CHEM013AP)

When individuals fear that they may have been exposed to toxins used in a terrorist attack, the importance of rapid analysis cannot be underestimated. With funding from CRTI, DRDC's laboratory in Suffield, Alberta has acquired new technology that will significantly reduce the time required to provide critical answers.

While immunological, antibody-based assays are a trusted means to identify biological toxins like ricin, botulinum toxins, and Staphylococcal enterotoxin B (SEB), they require scientists to conduct time-consuming individual tests. In an emergency that potentially involves four different toxins, it could take one scientist a full day to screen 12 sample unknowns and analyze the results. Using the new Luminex xMap system technology installed at DRDC Suffield, scientists will be able to conduct the tests simultaneously, significantly cutting down the test time to about two hours.

DRDC scientists are currently working to adapt existing test methods to the new technology. Once they are complete, these methods may also be applied to the development of assays to identify microbial agents like bacteria and viruses. Bead sets have been developed and assay conditions have been optimized for Brucella species, and work is underway for botulinum A toxin. The development of ricin bead sets will follow. Once the bead sets are developed, DRDC scientists will develop multiplexed assays to be used with the new technology to distinguish and identify multiple agents simultaneously.

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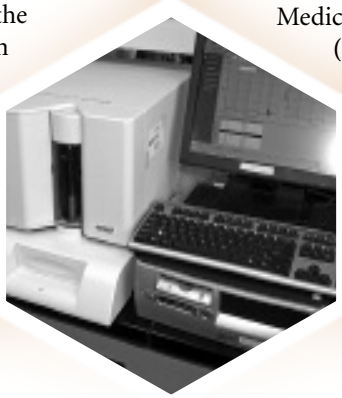

Bioplex Suspension Array System with Luminex xMap technology

New Gas Generator to Test and Evaluate Chemical Detectors (CHEM014AP)

First responders and Royal Canadian Mounted Police officers will soon be able to confidently use chemical detectors that have been tested and validated by scientists at DRDC in Suffield, Alberta. A new vapour generation system is enabling DRDC scientists to develop methods to test and evaluate the performance of commercial chemical detectors on live warfare agents, rather than chemical simulants or reference standards.

Purchased with the assistance of CRTI, the new 491M Modular Gas Standards Generator from Kin-Tek Laboratories Inc. will enable scientists to challenge chemical detector systems with standards over a range of concentrations and various matrices. The ability of the new generator to create a stable flow of chemical vapour means scientists can vary vapour densities to determine the limits of detection in current detectors, and mix the vapours of common chemicals with those of chemical warfare agents (CWAs) to determine their interference effects on detector response. Testing will begin after scientists set up sampling and analytical methods to accurately quantify the vapour produced from the 491M.

Finally, standard operating procedures for detector testing will be developed by scientists in the Chemical Detection and Identification Group and transferred to personnel in DRDC Suffield's Counter Terrorism Technology Centre for implementation.

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Kin-Tek 491M Modular Gas Standards Generator at DRDC Suffield

New Extraction Equipment Increases Mobile Lab Efficiency (CHEM015AP)

In addition to chemical warfare agents (CWAs) and biological toxins, there are many toxic industrial chemicals that pose a potential terrorist threat.

Environment Canada's Environmental Technology Centre (ETC) is responsible for rapidly detecting, identifying, and measuring a number of priority chemicals on CRTI's risk list. With funding from CRTI, the ETC recently purchased new sampling equipment that cuts down extraction times from a matter of days to a few minutes, greatly enhancing this capability.

Prior to the acquisition of an extractor and specially-configured gas chromatograph with multiple columns that can be mounted in the ETC's mobile laboratories, extraction was done by hand and samples were brought to the lab for analysis. In addition to being more efficient, the new equipment provides a greater level of confidence in the identification of unknown chemicals and has been deployed to several chemical incidents in the Ottawa area.

The instrumentation is also being used as research platforms on which to develop additional methods for other target chemicals in the lab.

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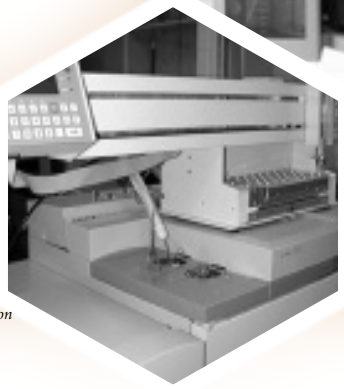
Accelerated solvent extraction system



Solid-phase microextraction sampler

New System Boosts Lab Capability to Analyze Chemical Contaminants in Food (CHEM016AP)

The Canadian Food Inspection Agency's laboratory in Calgary, Alberta added a new system to its arsenal of analytical instruments, expanding the range of pesticide residues and other chemical contaminants it can analyze in emergency situations threatening the safety of Canada's food supply, and during routine monitoring programs. For compounds not sufficiently volatile for analysis by gas chromatography, the high-performance liquid chromatograph/mass selective detection (HPLC/MSD) system is very efficient, separating fragile organic and inorganic compounds in a short time.

Purchased with the assistance of CRTI, the new hybrid system has already been used to analyze chloramphenicol in honey and other foods of animal origin. Chloramphenicol is an antibiotic used by veterinarians but banned in Canada for treatment of food-producing animals because of its threat to human health. The trace levels of this compound and the complexity of the honey and beeswax matrix require very sensitive methods of determination, a requirement met by the HPLC/MSD system.

Lab staff have also used the HPLC/MSD system to develop an analytical method sensitive enough to confirm the presence of nitrofurans. Like chloramphenicol, nitrofurans are antibiotics banned for treatment of food-producing animals. Low levels of chloramphenicol and nitrofurans have been found in honey and other foods of animal origin from other countries. The addition of the HPLC/MSD to the Calgary lab makes the task of identifying these antibiotics and unknown chemical contaminants easier.

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High-performance liquid chromatograph-mass selective detection system

Study of Health Canada's Chemical Containment Lab in Winnipeg Complete (CHEM017AP)

Following an initial assessment of the design and functionality of the Chemical Containment Laboratory at the Health Products and Food Branch (HPFB) in Winnipeg, Manitoba, CRTI funded an additional project to determine the extent of remedial work that needs to be done and to develop a commissioning plan for certification.

The Chemical Containment Laboratory was constructed in 1988, but was never certified. It is one of two Health Canada Level 3 labs in Western Canada and is an integral part of CRTI's Chemical Laboratory Cluster, particularly with respect to mycotoxin research and analysis. As such, it is important that all steps are taken to ensure that remediation and certification are completed.

Private consultants provided the HPFB with detailed plans, diagrams, and specifications for the remedial work that was recommended, along with a plan for certifying or commissioning the lab once those remediations were completed. HPFB also obtained an order-of-magnitude cost estimate for the suggested construction and renovations, allowing the HPFB to prioritize funding as it becomes available.

The HPFB anticipates using the facility to develop its capability and capacity to analyze ricin, staphylococcal enterotoxin B, botulinum toxin, and mycotoxins.

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New Instrument Assesses Marine Biotoxins in Canadian Waters (CHEM018AP)

Using a newly acquired liquid chromatography/mass spectrometry/mass spectrometry (LC/MS/MS) instrument, the Canadian Food Inspection Agency's laboratory in Dartmouth, Nova Scotia discovered and confirmed the presence of yessotoxin, a potent biotoxin commonly found in New Zealand shellfish, in Canadian waters. The lab, which regularly tests for paralytic, amnesic, and diarrhetic poisoning toxins in shellfish harvesting areas, was the first to report the presence of yessotoxin in North America.

The new LC/MS/MS instrument was purchased with the help of CRTI to enable lab staff at Dartmouth to detect and identify saxitoxin, a powerful neurotoxin secreted by a type of blue-green bacteria, which is included in the list of toxic chemicals covered under the Chemical Weapons Convention. With greater sensitivity and specificity than any single-stage instrument, the LC/MS/MS instrument combines the separation power of chromatography with a mass spectrometry analytical technique capable of identifying and quantifying chemical materials in a sample. Shellfish monitoring with the new instrument has given the Dartmouth lab the ability to defend against this type of bioterrorist attack. The instrument has also demonstrated an added advantage in enabling the lab to discover a number of previously unidentified toxins in Canadian waters, thereby helping to protect Canadians against naturally occurring outbreaks of marine biotoxins.

Liquid chromatography/mass spectrometry/mass spectrometer

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New Decontamination Facility Built for Chemical Incident Response Personnel (CHEM019AP)

Scientists with Environment Canada's Environmental Technology Centre (ETC) are deployed to an average of 30 hazardous material releases and oil spills each year. Once on the scene, they are the primary resource for detecting and measuring chemical contamination levels, and determining the most effective countermeasures to control and minimize the damage to the environment.

As first responders to pollution emergencies and possible chemical terrorist incidents, ETC staff can be exposed to known or unknown hazardous materials. In the past, ETC had its own decontamination unit; because it was too large to maintain, however, it was passed on to Ottawa's HAZMAT unit.

With funding from CRTI, researchers at the ETC recently designed and built a new decontamination facility for its field personnel. The self-contained unit consists of a six metre trailer with heaters, air filters, generators, water, and a power supply that can be rapidly deployed to the scene of a chemical emergency in the Ottawa region.

Small decontamination kits for Environment Canada's regional offices were also acquired with CRTI's financial assistance. These units will improve response capability and could be used to test other decontamination methods.

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ETC's custom-designed decontamination facility for field personnel

Centralized Computer Management System Created for Chemical Labs (CHEM020AP)

With funding from CRTI, experts at Environment Canada's National Laboratory for Environmental Testing, in collaboration with partners from the private sector, recently created a centralized computer management system to facilitate information sharing between federal laboratories in the event of a chemical emergency.

CRTI's Chemical Laboratory Cluster includes facilities across the country and in several different federal departments and agencies, such as Environment Canada, the Canadian Food Inspection Agency, the Royal Canadian Mounted Police, DRDC, and Health Canada. Using the new data management system, each lab will report their analyses to a central server, allowing for better coordination between partners. Custom-designed software makes the database user-friendly and secure.

Now that the system is in place, the next step is for each lab to populate the database with their specific capabilities and to test possible scenarios to ensure that the system functions as planned.

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New data management system for CRTI's Chemical Laboratory Cluster is user-friendly

Mobile Sample Reception Facility Reduces the Risk of Chemical Contamination (CHEM021AP)

Environment Canada's Environmental Technology Centre (ETC) receives dozens of unknown samples each year for chemical identification. While safety procedures and protocol are always strictly followed, a mobile chemical containment facility that could be used to initially assess and triage suspect samples would further reduce any potential risk to handlers and the receiving lab.

With no off-the-lot units to choose from, researchers at the ETC applied for CRTI funding to design and build a facility that would fulfil their needs. A small fifth-wheel trailer was equipped with a biological and chemical Level 3 isolation chamber and three attached glove-box units to enable researchers to manipulate the samples and bring portable analyzers into proximity. The unit also allows staff to package and remove sub-samples from the main sample without any potential exposure. The self-powered and heated facility can be used year-round and can be driven to sites in the surrounding Eastern Ontario area, or transported by air when necessary.

The facility is now fully functional and its success has generated interest from other federal agencies with similar requirements.

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Infrared Spectroscopy Determines Toxic Agent Penetration in Protective Gear (CHEM023AP)

Researchers with the Soldier and Systems Protection Group at DRDC in Suffield, Alberta have increased their capacity to assess how toxic agents, including chemical warfare agents (CWAs), such as sulphur mustard and nerve agent VX, permeate protective materials.

Co-funded by CRTI, the recent purchase of a Fourier transform infrared (FTIR) spectrometer will allow researchers to determine how different toxic agents permeate protective equipment, like clothing, respirators, and tarpaulins, and how the rate of diffusion changes over time. This information will be used to build a database and will afford military personnel and first responders the ability to judge how long a given material can be expected to function as a barrier to toxic agents. The FTIR spectrometer can also be used to test the effectiveness of decontamination methods.

The instrument's step-scan and depth-profiling functionalities can demonstrate whether a toxic agent is still present in the material and if so, how fast it starts to desorb and off-gas. With this information, researchers can assess the severity of the threat.

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Fourier transform infrared spectrometer

New Workstation Automates Sample Preparation Process (CHEM024AP)

The RapidTrace Automated Solid Phase Extraction (SPE) Workstation recently acquired by the Canadian Food Inspection Agency's laboratory in Calgary, Alberta promises to eliminate time-consuming manual extraction techniques from emergency investigations into samples that are suspected of being deliberately contaminated with chemicals. The advantages of the workstation will also benefit the lab's routine chemical residue testing programs.

Assisted by CRTI, the Calgary lab purchased the new workstation to replace the manual SPE of substances to be measured—such as pesticides, drug residues, environmental, and other chemical contaminants—from food, animal feed, and fertilizer samples. RapidTrace is a modular, highly scalable, high-throughput SPE platform that automates and rigorously controls every step of the SPE process, giving lab staff a level of reproducibility that cannot be obtained with conventional techniques.

RapidTrace Automated Solid Phase Extraction Workstation

To take advantage of the capabilities of RapidTrace in providing clean extracts, lab staff have been developing analytical methods compatible with the size of the extract that can be handled by the workstation. These methods target higher detection levels suitable for assessing contaminants that are not currently identified through existing analytical methods but that are of concern in the case of an accidental or intentional contamination emergency.

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New HPLC Aids Chemical Warfare Agent Identification (CHEM026AP)

The analytical research facility at DRDC in Suffield, Alberta is the Canadian laboratory responsible for analyzing samples suspected to contain chemical warfare agents (CWAs), such as sarin, lewisite, and mustard. It also serves as CRTI's analytical training site for other government scientists participating in CRTI's Chemical Laboratory Cluster. To maintain these capabilities, DRDC Suffield recently requested funding from CRTI to purchase a new high-performance liquid chromatography (HPLC) instrument.

The lab's current HPLC is 10 years old and was not designed for the low flows associated with packed capillary HPLC. With increased mass sensitivity, analytical resolution, and speed, packed capillary HPLC is the separation technique of choice for trace-level CWA identification.

In addition to fulfilling DRDC's need to meet the increasing demand for CWA analysis by packed capillary HPLC, the new instrument will be used for exploratory research and development, CWA identification in an emergency, and for forensic and training purposes.

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New System to Improve Performance of Chemical Detectors (CHEM027AP)

A new vapour generation system promises to determine the capabilities of chemical detection equipment currently used by first responders and to help develop methods to prevent chemical warfare agents (CWAs) and other contraband and dangerous goods from entering Canada. Purchased with funding by CRTI, it will be installed and operated in Ottawa at the Laboratory and Scientific Services Directorate of the Canada Border Services Agency (CBSA) and will ensure that labs in Canada can work together in response to a chemical terrorist act or emergency. The new generator will be similar to a model recently purchased by the DRDC lab in Suffield, Alberta.

The new generator will be calibrated to traceable standards developed by the National Institute of Standards and Technology for the highest measurement quality. It will enable lab staff to deliver calibration standards directly to the ion mobility spectrometers (IMS), as well as other equipment to help determine the limits of detection and to locate trace amounts of chemical agents or other contraband.

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State-of-the-Art Microplate Reader to Improve Analysis of Chemical Threats (CHEM028AP)

With funding from CRTI, the Toxicology Research Division of Health Canada's Food Directorate plans to purchase a high-performance, modular microplate reader to increase its technical capability to analyze chemical hazards that may be introduced into the food supply through a terrorist act.

The most advanced technology of its kind, the new monochromator-based, filter-free system will enable researchers to develop assays to detect multiple analytes simultaneously, using a whole spectrum of wavelengths and with much higher sensitivity, speed, specificity, and sample capacity than their current means. The reader will also be used to analyze a variety of biochemical and toxicological "end points," such as immunological responses, protein and DNA damage, apoptosis, and antioxidant defences. These end points can then be used to predict, monitor, and assess the carcinogenic, mutagenic, neurotoxic and other potentially harmful effects of exposures to food-borne chemical hazards, such as abrin and shiga-like toxins. These increased detection capabilities are also anticipated to be of great value to forensic investigations, and in training provided to first responders.

It is anticipated that the Division's ongoing research, which spans a multitude of disciplines such as molecular biology, biochemistry, immunotoxicology, and proteomics, will also be greatly enhanced by the acquisition.

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HPFB scientist uses microplate reader to conduct assay with cultured cells

New Portable Instruments Lead to Faster Detection of Toxic Industrial Materials (CHEM029AP)

Given the large quantities of toxic industrial materials (TIMs) manufactured, stored, transported, and used throughout North America, the threat of a chemical spill and its consequences are of significant concern. To bolster Canada's preparedness for such an event, CRTI and Environment Canada agreed to co-fund the purchase of new TIMs detectors for on-site analysis.

The new portable, lightweight equipment, which includes several flame photoionization instruments and detectors and a spectrophotometer, will replace old instruments that are long past their shelf life. The new equipment will enable researchers at Environment Canada's Environmental Technology Centre (ETC) to measure many target compounds, including identified chemical warfare agents (CWAs), in air and water. The acquired equipment will complement the Centre's extensive inventory of portable detection devices and will be deployed in one of five emergency response vehicles in the event of an intentional or accidental spill.

Given their portability, these instruments are likely to be used by first responders in the future. Before their adoption by the first responder community, however, extensive evaluation and testing is required.

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New Mass Spectrometer to Enhance Capacity to Detect Heavy Metal (CHEM030AP)

In collaboration with CRTI, the Environmental Technology Centre (ETC) at Environment Canada will acquire an inductively coupled plasma/mass spectrometer (ICP/MS) to rapidly analyze intentional and accidental hazardous spills in the environment.

The new ICP/MS will replace the existing lower resolution ICP unit, which is now out of service, and will be used in tandem with other spectrometry instruments at the Centre. The ICP/MS offers the powerful capability to analyze unknown compounds and is the tool of choice for detecting several targeted heavy metals including zinc, mercury, and chromium.

The acquisition of the new ICP/MS reflects Environment Canada's ongoing commitment to developing the knowledge and tools for oil and chemical spill preparedness. It also supports a larger cooperative effort between Environment Canada and the United States Environmental Protection Agency (US EPA) to mitigate the effects on public health and welfare, the environment, and property, by providing coordinated and integrated responses to polluting incidents on either side of the border.

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Atomic Emission Detector Provides Broad-Spectrum Toxic Chemical Screening (CHEM031AP)

Researchers with Environment Canada's Emergencies Science and Technology Division (ESTD) are intimately familiar with the possible consequences of large-scale chemical or oil spills. In addition to providing the first line of defence in the field, ESTD scientists and lab technicians have been working behind the scenes for close to 30 years to better understand the effects of spilled hazardous materials and to develop tools to assist in mitigating their impact on the environment.

With the list of toxic industrial chemicals that could be released accidentally or intentionally into the environment continuing to grow, the ESTD turned to CRTI for financial assistance to broaden their capabilities to detect organic contaminants.

The procurement of an atomic emission detector (AED) module, used in conjunction with a gas chromatograph (GC), will provide multi-element analysis with excellent sensitivity, increasing productivity and enhancing analytical confidence. It can be used to characterize unknown compounds in hazardous waste samples, monitor for chemical warfare agents (CWAs), their precursors, and breakdown products, and screen for organo-metallic species containing tin, mercury, lead, selenium, and arsenic.

The instrument will be particularly beneficial for trace-level analysis where sample cleanup is difficult, such as pesticides in soil, water, or agricultural samples. A GC/AED system with related software can narrow the numbers of possible pesticides in a sample from hundreds to one or two in less than 14 minutes.

Atomic emission detector module with a gas chromatograph

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Forensics Laboratories

Provincial Centre to Provide National Forensic Capacity (FOR001AP)

The Government of Ontario's Centre of Forensic Sciences (CFS) in Toronto will soon be supporting provincial and federal response efforts and investigations into terrorist attacks with the upcoming purchase of a gas chromatography/tandem mass spectrometry (GC/MS/MS) instrument, a device that separates chemical mixtures and accurately identifies them. The GC/MS/MS will enable CFS scientists to analyze samples from the crime scene of a chemical terrorist act in partnership with the Royal Canadian Mounted Police Forensic Laboratory Services, and determine the cause of death according to medical and legal requirements.

Forensic toxicologists needed a highly sensitive instrument able to detect and identify the degradation products of chemical warfare agents (CWAs) in human tissues and fluids, such as blood and urine. Organophosphate nerve agents, such as tabun, sarin, and soman, break down or degrade into non-toxic compounds when ingested in the body, making it difficult to identify a cause of death. Since no such capacity existed in Canada's forensic laboratories, CRTI agreed to help finance the purchase of the GC/MS/MS instrument. Once in place, CFS staff will use the new instrument to develop methods for the analysis of drugs and poisons that have also been identified as threat agents.

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Police Investigators Looking Forward to Safer Investigations (FOR002AP)

Each of the Royal Canadian Mounted Police's (RCMP'S) four Regional Forensic Identification Support Sections will soon be equipped to detect, identify, and examine samples suspected of containing chemical or biological (CB) agents in particulate or vapour form. The new equipment will provide crime scene investigators on routine and terrorist cases with the controlled environment needed to safely open hazardous samples.

Police investigators in Canada are not currently able to analyze suspicious samples in this type of controlled environment. But with the risk of containers or packages becoming contaminated with CB agents a real possibility, the need to protect police investigators and forensic specialists in search and seizure operations and on routine investigations has become urgent. CRTI agreed, providing funding to purchase biological safety cabinets and Rapid Analyte Measurement Platforms (RAMPs) to enable the RCMP to safely manage CB agents during criminal and terrorist investigations.

To be installed at forensic facilities in Vancouver, British Columbia; Edmonton, Alberta; Ottawa, Ontario; and Halifax, Nova Scotia, the Class II biological safety cabinets are containment systems that will enable investigators to detect and identify high-risk toxic gases, vapours, and particles and perform routine case examinations without harm to the evidence, the environment, or themselves. The RAMP biological detection systems will provide first responders with rapid, on-site, reliable diagnostic information.

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Radiological-Nuclear Laboratories

Radiation Barrier Set Up Across Canada (RN001AP)

It took three years and financial assistance from CRTI, but Health Canada's Radiation Protection Bureau succeeded in installing 51 sodium iodide (NaI) radiation threat detectors at fixed locations across Canada to create an integrated, online network that transmits measurement data on a daily basis to scientists in Ottawa. The 51 NaI highly sensitive radiation probes were set up to provide an impenetrable radiation barrier that covers the complete spectra of artificial radiation sources that might be a threat to an area.

Installed at nuclear power plants, Atomic Energy of Canada Limited's (AECL's) Chalk River Laboratories, ports large enough to berth nuclear-powered marine vessels, and cities with sizeable populations, the detectors measure atmospheric radiation in real time, identify specific nuclides for risk assessment, and provide alert capabilities. The surveillance capabilities of the network are further enhanced by transmitting data to the Canadian Meteorological Centre, which uses atmospheric transport modelling to trace the movement, dispersion, and deposition of emissions, and to the Accident Reporting and Guidance Operational System (ARGOS) to provide decision-making support to Health Canada during nuclear emergencies.

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Radiation threat detectors set up across Canada

Rapid Aerial Mapping of Radioactivity Now Possible (RN002AP)

Using funds provided by CRTI, the Radiation Geophysics Section of Natural Resources Canada (NRCan) acquired the capacity to mobilize state-of-the-art equipment in less than four hours to conduct high-sensitivity aerial mapping of man-made and naturally occurring radioactivity on the earth's surface.

Transporting the radiation detection systems by helicopter

Under the Government of Canada's *Chemical, Biological, Radiological and Nuclear Strategy*, NRCan is responsible for providing response capabilities for real-time aerial mapping of radioactivity dispersed accidentally or intentionally. Yet prior to purchasing three mobile gamma-ray spectrometers and two more sensitive gamma-ray and neutron radiation monitoring systems, NRCan had to rely on the private sector to provide aerial surveillance services. As a result, response times varied from a few days to a few weeks.

With the new rapid response system instruments, NRCan can better fulfill its emergency responsibilities. The instruments are kept in Ottawa and can be transported to anywhere in Canada within four hours to detect radioactive sources from the air and pinpoint their location on the ground. The information is transmitted in near real time to a ground-based receiving system. Within minutes, accurate coordinates and colour maps showing the source locations can be produced to guide ground crews in their search, recovery, and containment efforts.

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Survey plan for using radiation detection systems

Human Monitoring for Radiological Contamination Goes State-of-the-Art (RN003AP)

With financial assistance from CRTI, Health Canada's Radiation Protection Bureau (RPB) in Ottawa now possesses state-of-the-art body counters to identify individuals who have been contaminated with radioactive material with greater efficiency. The high-resolution – whole-body counters can separate complex mixtures of radionuclides like those associated with a radiological-nuclear (RN) event.

The RPB also acquired an upgraded lung counter system capable of analyzing actinides such as plutonium and uranium, and completed the shielding in the counting room. The RPB's deployable facilities were further enhanced by the acquisition of two additional portable portal personnel (P3) monitors, which have increased the rate at which potentially contaminated individuals can be screened in the field to up to 1,000 people per hour. A hand-held germanium detector with full spectroscopy capabilities was also acquired.

CRTI also provided funding to the Chalk River Laboratories of Atomic Energy of Canada Limited (AECL) to procure the necessary equipment for a transportable monitoring and internal dose assessment system for the evaluation of contaminated first responders. This equipment is used in international intercomparisons, annual staff training, and routine standby use at AECL, and would complement the screening capabilities of Health Canada and DRDC in the event of a large-scale radiological emergency.

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New whole body counter detects radiation exposure with greater efficiency

Lung counter at Health Canada's Radiation Protection Bureau

Radiation workers line up for screening by a portable portal monitor

Lab Capacity to Assess Radiation Exposure Enhanced (RN004AP)

Two of the four laboratories that comprise Canada's biological dosimetry service network purchased automated laboratory equipment with the assistance of CRTI to meet the expected surge in demand to assess radiation exposure during a large-scale radiological or nuclear terrorist attack.

The new equipment enables scientists at the Ottawa labs of the Consumer and Clinical Radiation Protection Bureau at Health Canada and DRDC to conduct biological dosimetry using the cytogenetic-based dicentric assay, flow cytometry, and protein array technology. Through biological dosimetry, scientists can estimate radiation exposure in members of the general public and first responders by analyzing the biological damage caused by radiation when physical dosimetry resources are unavailable, in dispute, or overwhelmed by demand. The results of the assays enable scientists to provide information on exposed persons to health professionals for implementation of medical intervention strategies or to incident commanders who should restrict the first responders from acquiring further exposures.

The Consumer and Clinical Radiation Protection Bureau acquired a BD FACSCalibur, a multicolour flow cytometer system that sorts and analyzes white blood cells as indicators of radiation exposure. DRDC Ottawa purchased a Bio-Plex Suspension Array System, which simultaneously analyzes up to 100 different biomolecules as potential biomarkers of radiation exposure. Both labs also acquired automated microscope-scanning systems to speed up the search for chromosome aberrations as indicators of radiation exposure.

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Scientist uses the Bio-Plex Manager software to analyze data generated in the Bio-Plex Suspension Array System

Enhancements to Notification System Facilitate Faster and More Coordinated Response to RN Emergencies (RN005AP)

Canada's *Federal Nuclear Emergency Plan* (FNEP) provides the operational framework within which federal departments prepare and respond to both terrorist-related and non-terrorist-related radiological-nuclear (RN) emergencies. In an RN emergency, rapid activation of FNEP emergency response structures and solid information management are critical in mitigating the impacts of the emergency on public health, the environment, property, and services. As the federal lead for RN emergency response under the FNEP, Health Canada is responsible for alerting over 20 federal departments with response roles and facilitating the exchange of response information among all participating organizations.

With assistance from CRTI, Health Canada purchased network infrastructure and notification equipment and services to enable the Department to implement an operational, secure, and easily maintained FNEP information portal and emergency notification system. The completed system will host specialized RN emergency preparedness and response tools, including the FNEP web-based information exchange system, geographical information system, and emergency contact database. In an RN emergency, the system will enable all FNEP member departments and designated officials to receive emergency notification information via notification terminals, telephone, pager, fax, or e-mail, and host a gateway for the exchange of emergency information with other federal departments, the operational community, and first responders.

Capabilities provided by the system will be used in all preparedness and response activities under the FNEP, significantly improving inter-agency cooperation, coordination, and decision making.

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A sample page from the emergency contact database

Multimedia messaging terminal for public safety notification

Delivering Faster, More Accurate Environmental Sample Results to First Responders (RN006AP)

With assistance from CRTI, the Radiation Protection Bureau (RPB) of Health Canada has taken important steps to ensure laboratory data are delivered faster and with greater confidence to decision makers and first responders in the field in the event of a radiological or nuclear emergency.

The purchase of a multilingual Laboratory Information Management System (LIMS) will enable researchers to track and analyze samples from radiological monitoring stations across the country on one centralized platform. These results can then be quickly streamed into the Accident Reporting and Guidance Operational System (ARGOS), Health Canada's decision support system. The LIMS platform can also be used to share information with other members of CRTI's Radiological-Nuclear Laboratory Cluster and partners. The system is currently in the final stages of testing for gamma-ray measurements of air particulate, and researchers expect to roll out the thermalluminescent dosimetry portion later this fall.

The RPB has also prepared lab processes to meet the requirements for International Organization for Standardization (ISO) 9001:2000 certification. This certification ensures that the same successful lab processes are followed at all times, providing an even greater level of confidence in the quality of the results and making the processes more efficient. The quality manual has been completed, as have most of the quality work instructions. Once the LIMS is live, any required changes to work instructions will be made. This will allow the lab to operate for the required period of stability in preparation for an internal audit. An external audit will follow to achieve ISO certification.

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Six Canadian Cities Ready to Deploy Meteorological Equipment (PAN001AP)

Six major Canadian cities are now equipped with portable meteorological tracking equipment for plotting the course of dangerous chemical, biological (CB), or nuclear agents released into the air by a terrorist attack or other means. With funds provided by CRTI, Environment Canada purchased ground instruments, computers, and instrument packages (radiosondes) that are carried aloft on weather balloons, and delivered them to technical offices in Halifax, Nova Scotia; Montréal, Quebec; Toronto, Ontario; Winnipeg, Manitoba; Edmonton, Alberta; and Vancouver, British Columbia. This equipment will provide data on air temperature, air pressure, humidity, wind speed, and wind direction from the earth's surface to an altitude of about 25 kilometres to help weather officials on the ground project the path of the dangerous CB or nuclear agents.

This equipment replaces earlier obsolete and difficult to operate equipment owned by Environment Canada. It is also much easier to transport and can be set up quickly to facilitate emergency management. The equipment is also well suited to respond to accidents involving hazardous materials and to natural disasters. Response teams have already dispatched the equipment in Hamilton and Trenton, Ontario and Halifax to help track Hurricanes Isabelle and Juan. It was also used to help water bombers battling forest fires in Kelowna, British Columbia and to track the path of smoke from incineration fires used to contain avian influenza (bird flu) in British Columbia's Fraser Valley.

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Weather balloons carrying radiosondes transmit meteorological data to Environment Canada field stations

New meteorological tracking equipment can be quickly mobilized in emergencies involving hazardous materials and to natural disasters

Mobile Labs to Detect Dirty Bombs Available for Deployment Across Canada (RN007AP)

DRDC is continuing its efforts to enhance the country's ability to respond to a possible nuclear emergency through the purchase of four mobile nuclear laboratories fitted to the backs of Ford trucks. Purchased with the assistance of CRTI, the self-contained labs can detect and analyze radiological dispersion devices—also known as "dirty bombs"—and clandestine radiological sources, on land or in water. Response teams can now respond rapidly to radiological-nuclear hazards with the field-sampling and analytical tools they need to provide technical information to decision makers.

Located in Vancouver, British Columbia; Whiteshell, Manitoba; Ottawa, Ontario; and Halifax, Nova Scotia; the mobile labs can be easily deployed or airlifted to an emergency site anywhere in Canada. Response teams can identify the nature and extent of radiological contamination and predict where and how it will disperse through the air using the suite of state-of-the-art data acquisition, analysis, and communication equipment. Research staff are already using the mobile labs for data acquisition and analysis in field trials, responder-training exercises, off-site environmental impact assessments, decommissioning nuclear facilities, and with the United States Army.

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Each mobile nuclear lab is comprised of a Ford truck equipped with a suite of state-of-the-art data acquisition, analysis, and communication equipment

Federal First Responders to Be Outfitted with Radiation Monitoring Devices (RN008AP)

National Dosimetry Services (NDS) can now provide personal radiation monitoring devices to federal first responders in the event of a radiological or nuclear emergency.

Since 1951, NDS has been distributing dosimeters to employees in workplaces where ionising radiation may be present, such as medical and dental practices, hospitals, the military, and mining or refining companies. The information obtained from monitoring individual dosages is then used to evaluate workplace practices and safety standards. These data are maintained in a National Dose Registry, thereby providing early warning on the potential damaging health effects of radiation exposure.

NDS is responsible for providing dosimetry services to first responders in the event of a radiological-nuclear incident. As a result of funding from CRTI, the Federal First Responder Automated Emergency Dosimeter System (FFRAED) now has the capacity to deliver 10,000 radiation dosimeters within one day of an event and to change those dosimeters after one week of use if necessary. This capability will ensure that NDS can provide essential short- and long-term support, advice, and assistance to federal emergency workers.

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NDS' current barcoded thermoluminescent radiation dosimeter card

New Equipment Increases Capacity of Nuclear Mobile Labs (RN009AP)

With funding from CRTI, DRDC recently acquired several small, but critical instruments to complement the vast array of radiological sampling and analytical equipment contained within its four mobile nuclear laboratories.

Located in Vancouver, British Columbia; Manitoba; Ottawa, Ontario; and Halifax, Nova Scotia the mobile labs were commissioned by CRTI in 2003 to ensure that the appropriate equipment and personnel could be deployed in a timely manner in the event of a radiological-nuclear terrorist attack. In the course of training exercises conducted on the use of the mobile labs, field technicians agreed that each unit would benefit from the addition of a few small instruments. CRTI subsequently funded the purchase of a laser range finder, a neutron probe for the portable survey meters, and a collimator for the labs' germanium detectors. The Department of Fisheries and Oceans also received funding from CRTI to procure equipment that will be used in conjunction with the mobile units.

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Radiation Detectors Get Power Boost (RN010AP)

The Canadian public's first line of defence against the release of radioactive material into the air is a series of radiation detectors located near five nuclear power generating stations and at the Atomic Energy of Canada Limited's (AECL's) Chalk River Laboratories. These fixed-point sodium iodide (NaI) detectors, as they are known, have been collecting data since 2002. With funding provided by CRTI, the Radiation Protection Bureau (RPB) at Health Canada has been developing a prototype system for expanding the capabilities of the detectors through the purchase of new equipment.

Radiation experts have created and are currently testing a trial product that addresses the detectors' vulnerabilities to a loss of power, inoperable telephone lines, and an inability to measure high dose rates in the event of a massive release of radioactive material. With the new prototype, decision makers can continue to receive sensitive measurements of radiation dose levels on auxiliary power for up to 24 hours, even if the first detector should become saturated. In the event that the regular telephone system fails, they will also still be able to receive data over dedicated emergency-use cell-phone lines or satellite communications.

Staff at the RPB will continue to test their prototypes until April 2006 to see how well they stand up to Canadian winter conditions.

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Command Centre Equipment Facilitates Coordinated Nuclear Emergency Response (RN011AP)

The expertise provided by scientists in a multi-departmental nuclear response team can be better used in managing the consequences of a radiological or nuclear terrorist attack now that DRDC Ottawa has put in place the infrastructure needed to support a command centre.

With the assistance of CRTI, DRDC Ottawa purchased the computers, peripherals, network hardware, and communications equipment required to establish a command centre for collecting and processing all of the data needed to plan for and respond quickly and effectively to a radiological emergency. The command centre enables high-ranking officials to be part of the decision-making chain directly linking them to the scientists in the field.

The command centre equipment is scalable to meet the needs and complexity of an emergency and will be housed in the laboratories at DRDC Ottawa, Atomic Energy of Canada Limited, and the Canadian Nuclear Safety Commission. Following testing during a field exercise in February 2005, DRDC Ottawa plans on purchasing additional equipment to further enhance the command centre's capabilities.

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Detection Instruments in Cargo Van Improve Radiation Surveillance (RN012AP)

With funding provided by CRTI, the Radiation Geophysics Section of Natural Resources Canada (NRCan) purchased a Dodge Sprinter cargo van equipped with radiation detection instruments to add ground-based surveillance capabilities to its airborne gamma-ray and neutron radiation monitoring systems.

The highly sensitive Exploranium™ GR-660 series of instruments measure man-made and natural radiation from land vehicles or helicopters. While the detection instruments were purchased for their aerial mapping capability, NRCan opted on a cargo van to reduce the costs associated with testing and developing the instruments in a helicopter.

More than a test-bed for airborne detection and location, the cargo van will enable scientific staff at NRCan to develop the capacity of the system to detect and locate radiation sources from the ground. Plans include developing radioactivity maps of urban areas, such as Ottawa, Ontario where the van and GR-660 instruments are located, prior to any nuclear incident. NRCan staff will also compare and calibrate the system with the vehicle-mounted detection units currently being tested in Royal Canadian Mounted Police cars.

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NRCan's radiation surveillance equipped van at CRTI's 2005 Summer Symposium in Ottawa, Ontario.

Cross-Canada Radiation Detectors Continue to Improve (RN013AP)

With financial assistance provided by CRTI, Canada's online network of 51 stationary sodium iodide (NaI) detectors was substantially improved following the purchase of new computer equipment, software, and upgrading of a high-volume air sampler for collecting particulates in Amherstburg, Ontario, across the river from the Fermi II nuclear plant near Detroit. Repairs to broken detectors were also made.

Health Canada's Radiation Protection Bureau installed the network at nuclear power plants, ports large enough for nuclear-powered marine vessels to berth, and cities with sizeable populations. These selected locations provide a detailed and comprehensive picture of radiation levels to scientists in Ottawa, Ontario and the Canadian Meteorological Centre, and to the Accident Reporting and Guidance Operational System (ARGOS) that provides decision-making support to Health Canada during nuclear emergencies. Although 51 of the NaI detectors had been recently installed, new computer technology, breakdowns in the detectors, and gaps in the surveillance network identified since data collection began had made the system upgrade a priority. Software improvements alone enable the identification of more nuclides, improve alert capabilities, and provide ever-lower detection limits.

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High air-volume particulate sampler

New Forensic Dosimetry Equipment Puts Canada on Par with International Colleagues (RN014AP)

Determining whether an area has been exposed to radiation days, weeks, or even years after the fact just got easier for scientists at DRDC Ottawa with the acquisition of a new attachment for the automated radiation dosimetry reader purchased last year.

Minerals in inorganic materials like bricks, gyprock, and concrete absorb radiation when they are exposed to a radioisotope source. To find out whether a given area has ever been exposed to radiation, scientists use the automated reader to heat samples from the floors, walls, or other items in the area so that they can emit light—the resulting thermoluminescence is proportional to the amount of radiation absorbed by the material. On its own, however, the reader can only provide an average dose response for all the grains contained in a sample. With assistance from CRTI, DRDC Ottawa acquired a single-grain optically stimulated luminescence (OSL) attachment that will enable scientists to measure the radiation dose absorbed by a single grain of a mineral.

Optically stimulated luminescence (OSL) reader with single-grain attachment

By measuring grain by grain, scientists can immediately determine with one pulse of light whether the grains are luminescent, enabling them to focus only on materials that will give them the best signal in the least amount of time. The attachment provides a more accurate distribution of radiation doses, which provides more precise, and ultimately, more accurate data. In addition to its application in terrorism scenarios, the capability provided by the reader and the new attachment can also be extended to radiation accidents, or in the event of suspected exposure to a lost radioisotope source.

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New Satellite Stations to Fill Communications Gap in an RN Emergency (RN015AP)

When Health Canada and its partners under the *Federal Nuclear Emergency Plan* (FNEP) found themselves waiting overnight for data to arrive during a field exercise in Suffield, Alberta, the need for a reliable communications system became clear.

Due to the volume of the data to be transmitted in a radiological-nuclear (RN) emergency and the speed with which it must be transferred, Health Canada sought CRTI funding to purchase two satellite-based data systems that could handle the data load. With help from CRTI, Health Canada will purchase and operate two ground-based, deployable communications stations. The system under consideration can be easily deployed by ground or air transportation, can be set up in less than 15 minutes, and only requires a 12-volt power source. It provides a broadband satellite Internet connection from anywhere in the northern hemisphere that will enable the transfer of large data files between field teams and assessment systems like Health Canada's Accident Reporting and Guidance Operational System (ARGOS)—even from areas without any communication interfaces or services.

These stations will be operationally deployed by the Radiation Protection Bureau of Health Canada and its partners during an RN emergency, and will be used in field exercises to maintain their state of readiness and to train personnel on their use.

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Transportable broadband Internet satellite system

Nuclear Emergency Decision Makers to Receive Streamlined, Integrated Data (RN016AP)

New network infrastructure equipment and custom software will integrate the radionuclide data generated by two federal laboratories in the Radiological-Nuclear (RN) Laboratory Cluster, allowing decision-making authorities to receive the electronic radionuclide data they need when managing a nuclear incident.

Assisted by CRTI, staff at Health Canada will bring together on one centralized platform the two radionuclide data streams produced by labs in the Verification and Incident Monitoring (VIM) section and National Monitoring Section (NMS). Software being developed by experts in both labs will pass raw radionuclide data from NMS to be processed by the automated tools in the VIM section, and reformat the results to pass back to the NMS Laboratory Information Management System (LIMS). The VIM section will use the LIMS to electronically track all VIM sample data and results. Once data from both labs is in the LIMS, the experts can then report it to Health Canada, and the RN lab cluster. The VIM section network also passes information to the Comprehensive Test Ban Treaty Organization (CTBTO). With both data streams in the VIM lab, the CTBTO will receive a more geographically and historically complete sample base for Canadian radionuclide measurements.

The centralization of the data from both labs will lay the groundwork necessary for developing a common data exchange platform for labs in Canada, the United States, and Europe that are a part of the RN Laboratory Cluster.

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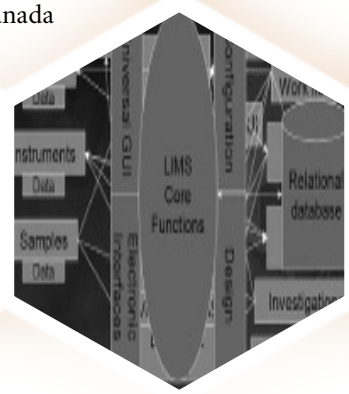

LIMS schematic

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