CRTI-IRTC

Science for a Secure Canada

SUMMER SYMPOSIUM 2003

Ottawa, Canada

June 24-25, 2003

PROGRAMME

SCIENCE FOR A SECURE CANADA • SUMMER SYMPOSIUM 2003

OTTAWA, CANADA • JUNE 24-25, 2003

Welcome to the 2003 CRTI Summer Symposium

It has been little more than a year since the Chemical Biological Radiological Nuclear (CBRN) Research and Technology Initiative (CRTI) was launched in May 2002. In that short time, federal science and technology (S&T) has seen the transformation of scattered individual CBRN labs and organizations coalescing into a unified national community. In the two rounds of project selections, in the three laboratory clusters and in pan-cluster activities, non-traditional partners have developed alliances to identify CBRN needs and responses to enhance the national security of Canada.

In this first Summer Symposium, with the theme of "Science for a Secure Canada," many of these CRTI community members will share their scientific and technological vision for CBRN preparedness in Canada. I am certain that you will be impressed with the level of knowledge that they bring to their work, as well as the progress that has already been made in the short time they have had to initiate their projects. In future years, the Symposium will broaden to give these and other project teams opportunities to report on their successes and milestones.

The goal for this CRTI Summer Symposium is to bring the national CBRN community together to share their knowledge on this very important aspect of federal S&T preparedness. I sincerely hope that you take advantage of this occasion to meet others in your field, to exchange that knowledge which will contribute to your own knowledge base, and to build Canada's collective S&T capacity to prevent, prepare and respond to CBRN terrorism. On behalf of the Steering Committee, I wish you a very interesting and productive meeting.

John Leggat
Assistant Deputy Minister (Science and Technology)
Department of National Defence and
Chief Executive Officer, Defence R&D Canada

PROGRAMME

TUESDAY JUNE 24, 2003

0730 **REGISTRATION & CONTINENTAL BREAKFAST**

0830 **ADMINISTRATIVE REMARKS**
Dr. **Cam Boulet**, Director, CBRN Research and Technology Initiative

0845 **WELCOME AND INTRODUCTION**
Dr. **R. Walker**, Director General R&D Programs, Defence R&D Canada & Moderator

0915 **THE PUBLIC SECURITY AND ANTI-TERRORISM AGENDA**
Mr. **Paul Kennedy**, Senior Assistant Deputy Solicitor General

1000 **BREAK**

1030 **CB S&T PREPAREDNESS IN THE U.S.**
Dr. **Elizabeth George**, Department of Homeland Security

1115 **COUNTER TERRORISM TECHNOLOGY CENTRE**
Dr. **Kent Harding**, Defence R&D Canada – Suffield

1200 **LUNCH**

1230 **THE BW PERIL: A HISTORICAL PERSPECTIVE**
Lunch Speaker: Mr. **John Bryden**, M.P.

1330 **SARS: A MODEL FOR BIO-TERRORISM RESPONSE IN PUBLIC HEALTH**
Dr. **Frank Plummer**, National Microbiology Laboratory, Health Canada

1415 **CRTI INTRODUCTION AND OVERVIEW**
Dr. **Cam Boulet**, Director, CBRN Research and Technology Initiative

1500 **BREAK**

1530 **BIOLOGY PORTFOLIO OVERVIEW**
Ms. **Helen Spencer**, Biology Portfolio Manager, CRTI

1600 **CHEMIST PORTFOLIO OVERVIEW**
Mr. **Norm Yanofsky**, Chemistry Portfolio Manager, CRTI

1630 **RECEPTION AND POSTER SESSION**

1900 **DAY 1 CONCLUDES**

WEDNESDAY JUNE 25, 2003

0730 **CONTINENTAL BREAKFAST**

0830 **WELCOME AND INTRODUCTION**

Dr. **Cam Boulet,** Director, CBRN Research and Technology Initiative

0845 **HORIZONTALITY IN FEDERAL SCIENCE**

Dr. **John Leggat,** Assistant Deputy Minister (S&T)
Department of National Defence

0930 **RADIOLOGICAL/NUCLEAR PORTFOLIO OVERVIEW**

Mr. **Ted Sykes,** Radiological/Nuclear Portfolio Manager, CRTI

1000 **BREAK**

1030 **CRTI INVESTMENT PORTFOLIO SESSION ONE**

Moderator
Dr. **Jack Cornett,** Health Canada & Radiological/Nuclear Cluster Leader -

ARGOS
Mr. **Brian Ahier**, Health Canada

Aerial Surveillance & Fixed Point Surveillance System for Canada
Mr. **Rob Shives**, Natural Resources Canada
Dr. **Kurt Ungar**, Health Canada

Molecular Imprinting
Dr. **Marie D'Iorio**, National Research Council

1200-1245 **LUNCH**

1245 **CRTI INVESTMENT PORTFOLIO SESSION TWO**

Moderator
Dr. **John Carey**, Environment Canada & Chemistry Cluster Leader

Standards for Personal Protective Equipment
Dr. **Eva Dickson**, Royal Military College

Development of Rapid Tests for Agro-Terrorism Agents
Dr. **Hana Weingartl**, Canadian Food Inspection Agency

CB Plus Chamber
Ms. **Julie Tremblay-Lutter,** Defence R&D Canada

1515 **BREAK**

1530 **CRTI INVESTMENT PORTFOLIO SESSION THREE**

Moderator
Dr. **Jean Hollebone**, Canadian Food Inspection Agency & Biology Cluster Co-Leader

Standoff Detection of Radiation and Bubble Detector Film
Dr. **Dean Haslip**, Defence R&D Canada – Ottawa

Monoclonal Antibodies
Dr **Jody Berry** Canadian Food Inspection Agency

Detecting Engineered Virulence Genes in Biowarfare Agents
Dr. **Rachel Fernandez**, University of British Columbia

1700 **CLOSING REMARKS**

Symposium Concludes

CRTI: Lessons Learned and Best Practices

Presenter: Dr. Robert Walker, Director General R&D Programs
Defence R&D Canada, 613-996-7215, robert.walker@drdc.rddc.gc.ca

CRTI was born out of the security environment leading up to and including the terrorist events of 2001. The federal science community undertook a risk assessment and capability gap analysis to determine how best to respond to the national security agenda.
As a result, CRTI was created to strengthen Canada's preparedness for, prevention of, and response to a CBRN terrorist attack through new investments in science, research and technology capacity. Within five months of the December 2001 budget announcement, CRTI was launched and operational. Comprehensive vision, leadership, a multi-disciplinary team, stakeholder buy-in and a comprehensive action plan were critical success factors for this timeline. As an innovative approach, the CRTI implementation team benefited from receiving a clear mandate with an urgent deadline, maximizing available skill sets, knowledge brokering and employing consensus driven decision making. The key lesson learned is that CRTI has demonstrated it is indeed possible to establish a national S&T program that engages all elements of the National Innovation System to address S&T issues of critical importance to the nation.

Science and Technology in the Context of National Security

Paul E. Kennedy, Senior Assistant Deputy Solicitor General, Solicitor General Canada

Presentation to the CRTI Summer Symposium Science for a Secure Canada
Chateau Cartier, Gatineau QC, June 24-24, 2003

Advances in the science and technology, in the pursuit of improving our way of life, have often been linked to national security concerns. With the changing global security environment and the threat of a chemical, biological, radiological or nuclear terrorist attack, the government continues to adopt the necessary measures to protect Canadians. These balanced measures reflect a renewed determination to collaborate with public and private sector partners, both in Canada and internationally, and to develop solutions that address our public safety and national security concerns and safeguard our individual rights and freedoms.

CB S&T Preparedness in the US

S. Elizabeth George, Ph.D.
Portfolio Manager for BioDefense Technologies
Deputy Portfolio Manager for Biological & Chemical Countermeasures
Science & Technology Directorate, Department of Homeland Security

The Department of Homeland Security is committed to protecting American citizens against further terrorist assaults. This is accomplished through threat assessment, border defense, critical infrastructure protection, and leadership in emergency response. The Science and Technology Directorate, the primary research and development component of the Department, is responsible for providing vision, strategic thinking, and the coalescing of R&D efforts for biological, chemical, and nuclear countermeasures to ensure that the best tools, technologies, and capabilities are available to achieve the Department's mission. Within the Biological and Chemical Countermeasures Portfolio, there are 7 major research areas: 1) system studies and planning tools, 2) urban monitoring systems, 3) detection, 4) bioassays for environmental monitoring and medical and agricultural surveillance, 5) forensics and attribution, 6) response and restoration, and 7) domestic demonstration and application programs. In the System Studies and Planning Tools Program, the primary focus is on providing the underlying tools and study results to support decisions, plans, priorities, and assessments. The goal of the Urban Monitoring Program is to develop and deploy a sustainable environmental monitoring capability for metropolitan areas and a National Special Security Event monitoring capability for the Nation at large. Next generation detection technologies will be developed, field-tested, and transitioned to commercialization in the Detection Program. Nationally validated DNA and protein assays to cover the full range of biological threats will be developed in the Bioassay Program, and the technologies and a knowledge base to facilitate comprehensive analysis and evaluation of diverse CB weapons-related samples will be generated in the Forensics and Attribution Program. In the Response and Restoration Program, technologies, systems, and protocols needed to efficiently and effectively decontaminate facilities and urban areas to restore them to full operations will be developed. Domestic Demonstration and Application Programs (DDAP) are integrated field demonstrations of next generation solutions which bring together the user, the technology, and concept of operations in a real world test of a particular solution. Overall, Biological and Chemical Countermeasures R&D activities will provide next generation solutions to provide for civilian defense against biological and chemical terrorism.

Counter Terrorism Technology Centre

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Abstract

The Counter Terrorism Technology Centre (CTTC) is co-located with Defence R&D Canada – Suffield laboratories and facilities, near Medicine Hat, in southeast Alberta. The CTTC is mandated to provide 1. Training: Scenario-Based Advanced Training for First Responders, 2. Reference Centre: Forensic and Definitive Identification of Chemical and Biological Agents involved in terrorism and other events, 3. Test and Evaluation of equipment and devices for use by First Responders, including development, validation and intercomparison. Direction to form the CTTC and some construction monies where provided in the Federal Budget of Dec 2001. Since then, CTTC leaders have focused on developing and implementing the First Responder Training provided under OCIPEP leadership, on establishing a new Biological Containment Laboratory, specifically designed to identify biological agents in various packages, including those containing chemical agents, and on the design and construction of buildings to provide scenario-based training modules for advanced First Responders. This presentation will describe features, current deliverables and plans for the CTTC. We will also describe how CTTC can serve the requirements of CRTI, in the interests of our National Security.

CBRN Terrorsim: Shaking Military Paradigms

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September 2001 and the subsequent anthrax letter attacks brought national security and the need for Chemical, Biological, Radiological and Nuclear (CBRN) counter-terrorism preparedness into focus. By in large, our understanding of the nature of CBRN terrorism derives entirely from military paradigms of chemical and biological warfare. These paradigms are intelligence, the CBRN threat list, hazard assessment, and the concept of defence as a deterrent. An examination of recent CBRN terrorism events such as the 1995 Sarin attack on the Tokyo subway system by a terrorist cult and the 2001 anthrax letter attacks in the United Sates of America show that military paradigms cannot be applied to CBRN terrorism. To develop sound CBRN counter-terrorism preparedness, prevention and response mechanisms new models recognizing the knowledge gaps for CBRN terrorism must be developed. Central to the development of investment priorities and strategies is a structured risk assessment, the involvement of a broad science and technology community, and greater recognition of the various response communities and requirements. This paper will examine the differences between CBRN warfare and CBRN terrorism and outline strategies for addressing science, technology, and knowledge gaps to more effectively prevent, prepare and respond to future CBRN terrorist acts.

Biology Portfolio

CRTI Symposium Abstract

Portfolio Manager: Helen Spencer, CRTI Secretariat, 998 - 6418, Helen.Spencer@drdc-rddc.gc.ca

Abstract

The Biology Portfolio, as one of the three CRTI Portfolios, encompasses CRTI projects and activities related to the biological sciences. The Biology Portfolio includes the CRTI Biology Laboratory Cluster which is led by Co-Chairs Dr. Frank Plummer of Health Canada and Dr. Jean Hollebone of the Canadian Food Inspection Agency (CFIA). This Cluster consists of more than 18 members from Canadian federal science based Departments and Agencies, ultimately representing more than 75 laboratories.

The Biology Portfolio also includes CRTI funded projects which are intended to accelerate technology into the hands of first responders, or to provide Canada with top notch focused research in the biological sciences. The goal of both categories of projects being to build capacity and capabilities towards better preparedness against terrorism.

Within the Biology Portfolio 9 Research & Technology Development and 4 Technology Acceleration projects totaling approximately $ 26.4 million have been awarded in the first two years. Over the same time period the Biology Cluster has awarded CRTI funding of approximately $ 7.1 million for acquisition projects improve capacity within federal biological laboratories.

This is a diverse Portfolio. Immune response against plague, detection of engineered virulence, point of occurrence detection equipment, and culture collections are some examples of the diversity of the elements. The activities of the Biology Laboratory Cluster as well as discussion on projects funded by CRTI in the biological sector will be highlighted.

Chemistry Portfolio

CRTI Symposium Abstract

Presenter: Norman Yanofsky, CRTI Secretariat,
Tel: 998-6417,E-Mail: norman.yanofsky@drdc-rddc.gc.ca

Cluster Team Lead: Dr. John Carey, Environment Canada,
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The Chemistry Portfolio includes the CRTI Chemicals Cluster of federal laboratories led by Dr. John Carey, Director General, Environment Canada. This cluster draws on the science strength of some of the approximately forty laboratories of the twelve partner federal departments participating in CRTI.

The Chemicals Cluster was awarded twelve Acquistion of Technology Projects worth $4.3 million, including $2.2 million of CRTI funding, in the first year of CRTI operation. In CRTI's second year, the Chemicals Cluster was awarded seven Acquistion of Technology Projects worth $ 3.3 million, including $ 1.6 million of CRTI funding. Among the highlights of the Chemicals Cluster activities carried out this past year were chemical warfare agent training for four member departments and international consultations with the US Centre for Disease Control (CDC).

As well, the Chemistry Portfolio includes CRTI funded projects in the Technology Acceleration category and Research and Technology Development category. In the first year of CRTI operation, there were eight projects with a value of $17.3 million and in the second year, six projects with a value of $8.6 million.

Because chemistry is a scientific discipline that is fundamental to all three portfolios, a number of the projects in the Chemistry Portfolio are pan-cluster in application. The Chemistry Portfolio is also carrying out outreach activities to engage new partners not typical of the current CRTI community. An example is the work being developed with the Social Sciences and Humanities Research Council to address the issue of Public Confidence and Psychosocial factors involved in terrorism.

Federal S&T for National Security

Presenter: Dr. John Leggat, Assistant Deputy Minister (Science and Technology , Department of National Defence and Chief Executive Officer, Defence R&D Canada (613) 996-2020, john.leggat@drdc-rddc.gc.ca

The creation of CRTI was based on a model of federal science and technology comprised of three elements: 1) understanding and assessing risk, 2) creation of laboratory clusters, and 3) integration of national partners. The success of such initiatives are dependent on scientific judgments of risk, correlating disparate sources of knowledge and creating adaptive, integrated national partnerships. Future S&T initiatives could build on this model and the lessons learned from the CRTI experience. A governing board of senior members of science based departments and agencies (SBDA) with a small secretariat and broad national and international linkages would lead the initiative. The mandate would be determined according to government priorities, cross-cutting science issues, risk assessment and gap analysis. Early indications of the model point to the integration of federal science and technology demonstrating results.

Radio-Nuclear Portfolio

CRTI Symposium Abstract

Portfolio Manager: Ted Sykes, CRTI Secretariat, 995-6090, Ted.Sykes@drdc-rddc.gc.ca

Cluster Team Lead: Dr. Jack Cornett, HC- RPB, 954-6647, Jack_Cornett@hc-sc.gc.ca

CRTI has created clusters of federal laboratories as elements of a Canadian response network to build S&T capacity to address the highest risk terrorist attack scenarios. Membership is comprised of Federal Government Laboratories with a mandate or active role in a cluster's area of interest. Affiliate members include those laboratories with lead on cluster related projects or expertise in an area of special interest. Partners can include non-federal government laboratories working in special interest areas.

The Radiological-Nuclear (R/N) Cluster Team Lead is Dr Jack Cornett, Director of Health Canada's Radiation Protection Bureau. He leads the cluster and reports back to the CRTI Steering Committee. A Portfolio Manager R/N, Mr. Ted Sykes, has been appointed by the Director CRTI to act as the link between the Laboratory Cluster and the CRTI Secretariat, as well as the interface with individual Project Managers assigned to the portfolio.

Within Canada's R/N community, Health Canada has been assigned responsibility to implement the Federal Nuclear Emergency Plan (FNEP). The belligerent use of radioactive materials has been examined by the cluster and gaps in response capabilities have been identified. Tabletop risk response and field exercises have been conducted to test the FNEP response plan. To address known gaps, a number of coordinated CRTI Acquisition, Technology Acceleration and Research and Technology Development projects have been initiated. Looking to the future, risk assessment and gap analysis will be refined, and new CRTI project proposals will be encouraged in targeted areas.

ARGOS Decision Support System for Radiological-Nuclear Emergency Management

CRTI 0080TA

Presenter: *Brian Ahier, Health Canada (Nuclear Emergency Preparedness and Response Division), 613-954-6674, brian_ahier@hc-sc.gc.ca*

Project Leader: *as above*

Project Team: *Michel Jean (Environment Canada – Canadian Meteorological Centre-Environmental Emergency Response Division)*
Steen Hoe (Danish Emergency Management Agency)
Lars Henrik Jacobsen (Prolog Development Center A/S)

Partners: *Rob Shives (Natural Resources Canada – Radiation Geophysics)*
Kurt Ungar (Health Canada – Environmental Radiation Hazards Division)

Objective

The Federal Nuclear Emergency Plan (FNEP) provides the federal preparedness and response framework for all radiological-nuclear (RN) emergencies affecting Canadians and supports the National Counter-Terrorism Plan in RN consequence management. FNEP emergencies involve 20+ federal organisations, many of which are responsible for key consequence assessment data. Tools are required to integrate this data and support decisions on response measures. In this project, Health Canada's Nuclear Emergency Preparedness and Response Division is collaborating with Environment Canada - Canadian Meteorological Centre (CMC) and other key federal partners to implement in Canada the international ARGOS RN Decision Support System. ARGOS is made available through partnership with the Danish Emergency Management Agency and Prolog Development Center (PDC). Canadian implementation of ARGOS requires core software enhancements in order to interface with Canadian radiation surveillance, monitoring, modelling and forecasting data sources and capabilities. CMC is accelerating development and distribution of local and regional meteorological modelling capabilities supporting RN emergency response. Health Canada is also working with other FNEP partners, including Natural Resources Canada - Radiation Geophysics and Health Canada - Environmental Radiation Hazards to integrate aerial and fixed point surveillance and laboratory sample analysis data.

Progress

Progress on this project began with completion of the Project Charter, the first within the CRTI framework. Following membership of Health Canada in the ARGOS Consortium of member countries and the negotiation of contracts with the industry partner, meetings were held in Ottawa with all partners to review Canadian data sources and specifications, and determine the design specifications for the first two phases of the project plan. Phase 1 covered the development of ARGOS data import facilities and modules for Canadian data, including base maps, real-time meteorological data ands aerial surveillance datasets. Phase

2 focuses on the interface with CMC modelling capabilities, including atmospheric plume trajectories and dispersion modelling.

Preliminary discussions on Phases 3 and 4 of the project have also taken place. These two phases address the interface with Health Canada's fixed point gamma surveillance network and Laboratory Information database, and CMC short-range atmospheric dispersion models.

To date, PDC and CMC have worked closely on interfacing CMC meteorological resources with the ARGOS core software. ARGOS is now capable of automatically launching a run of the long range dispersion model at CMC's computing facility in Dorval, QC, and integrating the results. ARGOS can

- generate the input files for CMC
- upload the input files to a chosen CMC ftp server
- monitor the CMC ftp server and correctly interpret the messages
- download the output files from the chosen CMC ftp server
- display the results (by isotope, by time step, by output type)
- publish the sequence of long range dispersion images to a web server

CMC is working in parallel on enhancements to their modelling capabilities, which are used directly within ARGOS. Achievements to date include the development and delivery of the atmospheric modelling database, and the ability to handle ARGOS inputs.

Health Canada has continued work on the importation of the base mapset and demographics dataset for Canada.

PDC has delivered the latest version of the ARGOS software (ARGOS 6), encompassing all of the Phase 1 design requirements. This software has been installed within Health Canada and is undergoing testing.

Outlook

The goal of this project is to implement ARGOS as an operational federal emergency response tool by end of 2nd quarter 2004. The next step in the project is to validate the current version of ARGOS with a live CMC or Health Canada ftp server, and to configure the automatic data import services for the rest of the data suppliers considered within the scope of the CRTI project framework. Other tasks for this year include integrating real-time radar data, fixed point surveillance and laboratory results, and implementing the NucInfo data exchange module. Finally, it is intended to provide access to the ARGOS outputs through the FNEP Emergency Communications Website and the eMAP GIS web-distribution system, developed and implemented in partnership with Environment Canada – Atlantic Region.

Development of Molecular Imprinting Techniques for Sensing Applications

CRTI Project Number (0120RD)

Presenter: Dr. Karim Faid, National Research Council, (613) 998-5375, karim.faid@nrc-cnrc.gc.ca

Project Leader: Dr. Marie D'Iorio, National Research Council, (613) 993-4597, marie.d'iorio@nrc-cnrc.gc.ca

Project Team: Names and Organizations

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Major Jean-Francois Legault

Department of National Defence (Defence R&D Canada - Suffield)
Dr. Carmela Jackson Lepage

Objective

The principal objective of this project is the development of real-time and portable novel detection devices capable of enhancing the capabilities of the first responders or military personnel to ascertain or rule-out the presence of harmful agents on-site or off-site. The use of innovative imprinting techniques to deposit artificial recognition elements on targeted surfaces will provide the users with robust and affordable devices that can be adapted to a

variety of detection purposes. Arrays of chemically and spatially-resolved functional groups are imprinted onto defined substrate surfaces. The projected application will be the recognition of complementary molecules and moieties. Coupled with sensors for the real-time detection and identification of these targeted species, using standard surface analytical or photonic techniques, these materials will be used for *the rapid detection of toxic agents*. Moreover, multiple applications are expected in various other areas such as in the pharmaceutical and biotechnological industries, where control of surface chemistries is needed.

Progress

This project started in January 2003 with funding released by mid-February. By April 2003, all, but one, of the new required personnel had been hired by the various collaborators. A model system has been defined, and a detailed work plan established. During this period, the computer modeling studies on this model system have started, with the molecular dynamic simulations of several molecular systems. The conformations of these systems were optimized and the energy minimized. The surface modifications and characterizations have been initiated. Functionalized substrates have been developed and fully characterized and used to attach a derivative of the target molecule to the surface. This derivatized substrate is used to form recognition cavities by the utilization of functionalized monomers and their subsequent crosslinking and attachment/transfer to a second substrate. Polymers with multi-functional groups are being synthesized and characterized and will be used as universal recognition templates.

Outlook

In the coming months, the development and characterization of specifically functionalized substrates will be pursued along with the synthesis of the multi-functional polymers to be used as the recognition templates. The selected model system will be tested and the selectivity of the functional template investigated. The molecular modeling studies of the model system will be completed while live agent simulation studies will be initiated.

The projected outcome of this project will be the demonstration of the 2D molecular imprint concept through the development of a platform technology capable of performing recognition and detection of a target molecule through the use of surface characterization techniques such as surface plasmon resonance or waveguide-based techniques. This project is expected to lead to the development of portable and direct sensing devices for first responder intervention and training. Moreover, the availability of such real-time sensing and screening devices may have a direct effect on public confidence through the assurance that potential threats can not only be handled efficiently but also prevented through the use of state of the art detection technologies. The main strength of this proposed methodology is the integration of the recognition and detection subsystems on a chip. The incorporation on a chip of the chemical and/or biological recognition elements along with the analytical element (such a micro-photonic analytical method) will allow the development of self-contained, compact, robust real-time sensing devices.

Protecting the first responder against CB threats

CRTI 0029RD

Presenter: Eva Dickson, Project Manager and Team Leader, Body Protection; Royal Military College of Canada (RMC), 613 541 6000 ext 6217, dickson-e@rmc.ca

Project Team:

Dr. Ron Weir, RMC, Tom Beardall, Phoenix OHC**,** Dr. Ugis Bickis, Adjunct Assoc. Professor, Dept of Chemistry & Chemical Engineering, RMC, and Phoenix OHC**,** Dr. Brian Harrison; Adj. Professor, Dept of Chemistry & Chemical Engineering, RMC and Sorbecon Consultants Inc.**,** Drs. Ih Chu and Rick Moody, Health Canada, Dr. Scott Duncan, DRDC Suffield**,** Maj. Pierre Caron, DNBCD 2-5, Physical Protection**,** Dr. Bill Kournikakis, DRDC Suffield**,** Dr. Simon Smith and Glenn Long, 3M Canada, Randy Templeton, DuPont Canada, Dr. Shankar Narayan, Adsorption Technology Consultant**,** S/Sgt. John Bureaux and Sgt. Bill MacDonald, RCMP National CBRN Response Team and RCMP Emergency Mgmt Section, Allan Parisien, CBRN Training OCIPEP

Objective

First responders such as firefighters, police, and emergency medical personnel are the front line of response to a CBRN terrorist incident. As the recent SARS outbreak has demonstrated, providing proper protection, along with the appropriate guidance on when and how to use this protection, is critical to keeping the first responder community able and willing to perform their required tasks in the case of a large-scale incident. The project will develop approaches to equipment specification, selection and use that *manage* the risk to the wearer. Any such approach must take into account that this risk includes not only possible exposure to CB agents, but also the risk of injury resulting from other types of associated hazards -- in addition, overprotection must be avoided as it places undue physiological burden on the wearer and reduces compliance, as well as potentially limiting safe performance of required job functions. In this project, first responder equipment will be assessed against CB threats, using a combination of scenario development, operational and laboratory assessments, and performance and toxicity modeling. The user community will actively participate in the project throughout the standards development process and in the equipment assessment program, both by acting as test participants, and by providing guidance as to the assessment methodologies and equipment types that will best reflect actual use. New standards will be recommended and potential deficiencies will be identified, to ensure that the first responder has the necessary guidance to use and select equipment for terrorist response. Guidance to the user will be provided in user symposia as well as in a variety of documents that will outline selection procedures, and describe performance of equipment evaluated under realistic conditions of use.

Progress

Work on the project started in January 2003. The project spans a number of parallel project streams, and progress in selected areas will be outlined.

First responder interactions

A first responder symposium was hosted by this project and the CRTI secretariat, in order to foster interactions with the community and obtain input on the Canadian user community's needs and understanding of personal protection. Participants in the symposium were educated on the nature of CBRN risks and some of the issues when attempting to perform their job function while selecting equipment that provides the appropriate level of protection, and numerous linkages were formed with the first responder community that will be participating in the standards development and equipment evaluations.

Equipment evaluation and standards

Initial discussions have been held with a variety of standards agencies in Canada and in the US in order to determine the best way forward for standards recommendations.

Evaluation of body protection equipment against chemicals in liquid and vapour form is being performed at RMC at the Chemical Protection Test Facility. This facility includes an exposure chamber in which two individuals wearing protective clothing can be exposed to either vapour or liquid chemical agent simulant. A similar facility will be used at DRDC Suffield for bioaerosol exposure. In a linked CRTI project 0100TA, a third facility is being constructed at Suffield, the CB^{plus} chamber, which will use a moving mannequin for exposure to these same types of agent simulant.

The methods being used for evaluation against percutaneously toxic vapour challenges are well established through previous program collaborations. Using these established methods, three different first responder protective configurations have so far been evaluated against vapour exposure, in conjunction with the US Chemical Weapons Improved Response Program (CWIRP) and the RCMP.

On the other hand, methods for evaluation of full systems against liquid contact hazard in an operationally significant environment have not existed. Therefore, under this program (jointly funded by the US CWIRP under a bilateral agreement), we have developed a full system test for liquid contact hazard. The general test format has been finalized, and testing is proceeding on firefighter turnout gear, using volunteers from the Kingston Fire Department and Aberdeen Proving Ground Fire and Rescue. These evaluations, approximately half complete, have already demonstrated which components of the equipment system are most vulnerable, the size of liquid drop that is a significant potential hazard, and which rescue activities are likely to result in the highest liquid contact hazard. Results will ultimately be used to provide guidance as to possible rescue activities and stay times in a chemically contaminated area.

Outlook

In the next year, work will be completed on the first phase of operational liquid contact evaluations of firefighter and tactical police equipment. Bioaerosol test capabilities will be established. Evaluation of the CB Blast Protective Helmet prototype under development in linked project CRTI0161TA will be performed. As in body protection, the quality of respiratory protection is defined not only by the materials and construction of the respirator, but by how it is used and worn in operational circumstances. Methods for evaluation of operational levels of protection provided by air purifying respirators and self-contained breathing apparatus will be developed, leveraging on the UK military respiratory protection program.

Initial approaches will be taken towards various risk assessment and modeling procedures. On the body protection side, these will incorporate laboratory studies of dermal uptake of a variety of toxic chemicals and chemical agents, to supply better data to support human toxicity estimates. For respiratory protection, work will commence on modeling the performance of air purifying respiratory canisters against a large number of potential threat chemicals, in order to identify potential weaknesses and determine ways in which broad spectrum, balanced protection could be more effectively delivered using such systems.

In the area of standards, the basic approach to developing a protective standard will be determined in conjunction with the standards and user communities (body and respiratory protection standards developed separately or combined as a system).

The project will span four years in total, so much of this work will continue over an extended period. The ultimate outcomes of the project will include a variety of user guidance documents, equipment standards recommendations based on the best available human toxicity data and models, education of the user community as to equipment capabilities and limitations, and feedback to industry to assist in developing next generation first responder equipment with CB protective capabilities.

Systems Level Simulant Test Chamber for CB Personal Protective Ensembles and Equipment, with an Articulated Mannequin Capability (CB Chamber)

CRTI Project 0100TA

Presenter: Julie Tremblay-Lutter, DRDC/DSTHP 4, (613) 995-7627, Julie.Tremblay@drdc-rddc.gc.ca

Project Champion: Dr. Ken Johnson, DRDC/DSTHP, (613) 992-2877

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Ken Torrance, Amtech Aeronautical Limited
Mike Greenley, Greenley & Associates
Ted Timmons, Greenley & Associates
Dr. Eva Dickson, Chemistry Department, Royal Military College
Maj Pierre Caron, Directorate Nuclear Biological Chemical Defence, DND

Objective

The CB Chamber is a CRTI Technology Acceleration project that will establish a world leading chemical and biological (CB) test and evaluation chamber (with mannequin) at Defence R&D Canada (DRDC) Suffield. The chamber capabilities will permit the evaluation of First Responder and military clothing and equipment protection using liquid, vapour, and aerosol CB threat simulants in environments with a range of temperature, humidity, and wind conditions. Systems under evaluation will be worn by a state of the art articulated human form mannequin. The mannequin will mimic selected human movement sequences. A separate breathing headform is planned to allow the evaluation of respiratory protection and integrated headwear systems. The Chamber will be operated via a computer controlled data acquisition and control system that will provide precision in the release of the threat simulant, and in the manipulation of the thermal, moisture, and air flow environments.

Progress

The project is in the implementation phase. Chamber requirements are defined. A detailed design specification is nearing completion and a design/build contract award is imminent. The mannequin requirements definition is complete. Negotiations with a mannequin manufacturer are ongoing.

In developing the chamber requirements, the project team has built on the requirements defined for the CB*plus* Combat Uniform Technology Demonstration Project. Additional requirements are defined to address the testing of First Responder equipment. The project team conducted site visits to the UK and Netherlands to obtain a first-hand demonstration of international capabilities and feedback on how to advance chamber capabilities. Separate visits were conducted with mannequin manufacturers in the UK and US to determine capabilities of existing systems and the potential to advance those capabilities.

Outlook

The project is scheduled for completion in August 2005. Over the summer of 2003 the project team will develop a design specification for the mannequin and continue to negotiate with a mannequin manufacturer. Contract award for the detailed design and build of the chamber will occur in early July. The schedule for the design/build will result in a facility in place at DRDC Suffield in early summer 2005. Once the chamber is commissioned and accepted, there will be a series of tests conducted as part of a collaborative study. The aims of the study are to prove the capabilities of the chamber while providing a means for employing new standards and testing First Responder equipment developed under two other CRTI funded projects.

The introduction of the Chamber will allow government acquisition teams to practice "simulation based acquisition", by using the facility to confirm requirements for future acquisition projects, then using the chamber to evaluate bid contenders, and to conduct final acceptance testing of clothing and equipment items. Similarly, industrial teams wishing to sell products to the First Responder (civilian and military) community will be able to use the facility during their internal R&D cycles and to achieve product certification.

Bubble Detector Film

CRTI-0204RD

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Objective

This project will develop a sensitive, non-electronic, real-time indicator of radiation exposure suitable for detecting radioactive contamination, particularly alpha- or beta-emitters. This new technology will have many applications in radiation safety and emergency response. For instance, the Bubble Detector Film (BDF) could be made into a disposable strip with an adhesive backing that could be stuck to the pant leg or boot of a first responder. If the first responder walks into a contaminated area, the strip will become contaminated and produce a visible and timely warning. Another significant application involves making swipes from the BDF. Swipes are traditionally used to sample potentially contaminated surfaces, and must be analysed in a laboratory setting. Contaminated BDF swipes, however, would be instantly recognizable without sophisticated analysis.

Progress

Bubble Detector Film is based on some fairly complicated chemistry, which must at least be appreciated in order to understand the progress that this project has made. Part of this process includes the reactions taking place in a photographic emulsion. A photographic emulsion consists of a silver halide in a gelatin matrix. Upon exposure to radiation, some of the silver ions in the emulsion are converted to metallic silver. In the presence of a photographic developer, these metallic silver grains catalyze the production of more metallic silver, permitting a chemical amplification of up to one billion. Some developers release hydrogen ions when they are oxidized. When these are used, the chemical amplification also produces an increase in hydrogen ion concentration, which is synonymous with an increase in acidity, or a decrease in pH. Radiation exposure is thus

linked to a decrease in pH, which can be easily detected with electronic probes or through the use of pH-sensitive dyes. Unfortunately, this system is not sufficiently sensitive to be used for radiation dosimetry.

The other half of the BDF is the conventional Bubble Detector (BD). In a BD, superheated droplets are dispersed in a gel medium. Neutron interactions in this gel deposit sufficient energy in a sufficiently small volume to nucleate the droplets. The droplets then become visible as bubbles, and can be counted to assess radiation dose. This technology is generally not used for radiation other than neutrons, because other forms of radiation do not produce sufficient energy densities to nucleate the droplets.

The Bubble Detector Film marries the technology of the photographic emulsion to that of the bubble detector. The concept is to impregnate the BD with a photographic emulsion, and to use a BD gel medium whose physical integrity is sensitive to pH. Thus, when radiation exposure occurs and the pH drops, the gel matrix is weakened and the superheated droplets are released. This combination should have the sensitivity required for contamination detection and monitoring.

Progress so far has concentrated on analyses of BDF components, and in particular on ensuring that these components will be compatible when they are put together. In the laboratory, we have demonstrated the change in pH produced by radiation exposure on various emulsion-developer combinations. These pH changes have been detected with electronic pH meters and through the use of dyes. We have demonstrated the ability to produce Bubble Detectors over a wide range of pH, using both UV polymerization (pH 3.7-6.5) and redox polymerization (pH 6-8). We have worked with a number of possible developers capable of operation over a wide range of pH; at this point, we are particularly interested in ferrous oxalate (pH < 1) and ferrous EDTA (pH 3.2-11).

Outlook

Work has begun on identifying the best options for cross-linkers in the gel matrix (these are the components that will dissolve, releasing the droplets). We prefer to use cross-linkers that are influenced directly by pH changes. However, we are also considering cross-linkers that are sensitive to other chemicals, which in turn are encapsulated by pH-sensitive polymers. We have also begun looking at various embodiments of the BDF, including a concept in which the concentration of dissolved gas is very high. This puts the BDF into a kind of "Geiger mode" in which individual bubble eruptions may have cascade effects in the rest of the BDF. This could make the device extremely sensitive.

Standoff Detection of Radiation

CRTI-0203RD

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Objective

This project will construct a fieldable prototype standoff radiation detector. Conventional radiation detectors work on the principle of "direct" detection, whereby the radiation must actually enter the detector to be counted. This has the significant drawback that a radiation surveyor must enter a radiation field in order to detect it. This project will construct a detector based on "indirect" detection, allowing detection of a radiation field from a distance. This will allow detection of contaminated areas prior to entry, or will allow characterization of such areas to identify areas of high and low dose rate, to facilitate mission planning.

Progress

Standoff detection of radiation is a significant challenge. There are very few avenues by which "indirect" detection may be accomplished. The most promising of these is by detecting the faint light emitted by ionized molecules in the air surrounding a radioactive source. Fortunately, these emissions occur in colour bands of specific relative intensities, which makes them easier to sense against high levels of background light from other sources. Furthermore, because the spectrum of emissions is unique, misidentification of extraneous light is significantly lessened.

Several techniques could be used to sense these emissions. Our system employs custom-fabricated mirrors and optical filters to simultaneously image a scene of interest in several wavelength bands. These images are then processed to look for the signature of radiation-induced photoluminescence. At present, we have a laboratory prototype system that works

on this principle. In field tests, we have demonstrated the ability to detect alpha, beta, and gamma radiation from considerable distances, and we have made continual improvements in the design of the optical system and in the data analysis.

Progress in this early phase of the project has been devoted to the optical and mechanical design of the new prototype detector. We have settled on a preferred optical design based on hundreds of simulations of various optical systems with an optical design code. In fact, the detailed optical design of the detector is now complete, and the mechanical design is almost complete. A full-scale mockup of the detector has been built, which has permitted us to envision the final product and identify any interference between components.

Most of the commercial components have been ordered, and construction of the major optical components is now well underway. Some of these optical components have now been completed. On first inspection, they are very impressive. These components will be tested shortly against our requirements.

Development of the data analysis software has also started. We have identified some shortcomings with hardware that we have received, and these have now been rectified.

There is also an ongoing effort in field-testing. While we do not yet have enough components for the device to perform any meaningful field tests, it is still possible to make meaningful measurements with our laboratory prototype system. These measurements are valuable because they help us to set constraints on the capabilities of this and future systems. This is all the more important because of the uniqueness of this research. Almost every experiment we have performed has been the first of its kind.

Outlook

The next year will see several parallel activities in progress. Design activities will continue, although these are largely complete at this time. As components are completed or delivered, and as sub-assemblies are constructed, type testing will be an important part of this work. Work will also accelerate on the data analysis software, a key to providing timely and reasonable results from this sensor. Our program of field trials will also continue. This summer will see additional measurements employing the old laboratory prototype. We also expect to begin meaningful field-testing of parts of the new device as the year continues.

The Development of Recombinant Monoclonal Antibodies for the Treatment and Detection of Bio-Terrorism (BT) Agents.

CRTI Project Number 0091RT

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Advisory Team: Paul Kitching, NCFAD/CFIA ; Kent Harding, DRDC-Suffield ; Grant McClarty, NML/Health Canada ; Gary Glavin, NML/Health Canada ; Frank Plummer, NML/Health Canada ; Greg Horsman, CPHLS.

Objective

This project is focused on the development of protective and diagnostic monoclonal antibodies (mAbs) for the detection, prophylaxis and post exposure treatment of bacterial and viral agents. This project is initially limited to antibody development for Alphaviruses, Foot-and-mouth Disease Virus, and Anthrax toxins. However, the knowledge gained in this project will advance Vaccine design for other potential agents of Bio-Terrorism and infectious pathogens in general of both humans and animals.

Project Objectives

Aim 1. Identify candidate microbe components for vaccine development against BT agents (anthrax, alpha viruses and Food-and-Mouth Disease virus).
Aim 2. Develop monoclonal antibody-based rapid diagnostic reagents for BT agents of anthrax, Food-and-Mouth Disease virus and alpha viruses.
Aim 3. Develop monoclonal antibody-based treatments for the BT agents of anthrax and alpha viruses (Venezuelan Equine Encephalitus [VEE], Western Equine Encephalitus [WEE], and Eastern Equine Encephalitus [EEE]).

Progress

Anthrax Toxins:

Successful vaccines for the prevention of infection with *Baccillus anthracis* include both subunit (toxin) based vaccines such as the AVA, and live-attenuated (non-encapsulated) spore vaccines (eg. Sterne strain). Animal studies suggest that antibody responses to recombinant PA toxins are protective to live challenge, however, little is known about the immuno-protective mechanisms for protection with the Sterne vaccine. This information will be important for designing new improved active and passive vaccines. To understand

this better, we initiated serological studies on serum collected from AVA-vaccinated humans, live spore-vaccinated cattle (Sterne), and we immunized non-human primates (cynomologous macaques) with the Sterne spore vaccine, to compare antibody responses to anthrax toxins. Our initial studies show clear differences in the magnitude of the IgG responses to the PA toxin in bovines and primates receiving the spore vaccine. Further study is required to determine if the vaccinated primates will maintain their antibody levels months after vaccination and to complete the immunochemical and immunobiological characterization of these immune responses. However, our data strongly suggests that antibody responses against the components of lethal toxin (PA + LF) may be most important for development of therapeutic lead molecules.

We have generated panels of monoclonal antibodies against synthetic peptides corresponding to neutralizing domains of the PA and the LF toxins, as well as to whole recombinant PA and LF toxin. Small lots of recombinant anthrax toxins were expressed in non-hazardous bacterial expression systems. We have confirmed toxicity of small lots of these toxins in using the J774A.1 macrophage cell line. Scale-up expression of these toxins is underway. The initial lots have been used to develop procedures to produce monoclonal antibodies via the hybridoma fusion method on immune BALB/c mice. These monoclonal antibodies are now being used to develop new antigen detection systems for confirmatory diagnostics in ELISA, Mass spectrometry, fluorescence detection and Electron microscopy. The anti-toxin Mabs are also being assessed in the in vitro neutralization assay on macrophage lines.

Foot-and-Mouth Disease: Foot and Mouth disease virus is the most infectious virus known and is a serious economic and health concern in livestock. The virus is extremely variable in its antigenic composition and current vaccines are type specific and rely upon accurate identification of an infecting strain as they do not cross-protect. Quality reagents capable of firstly screening for all FMDV infections and secondly typing the infecting strain are a critical gap in protecting our herds. Successful vaccines for the prevention of infection with FMDV include inactivated whole virus. Antibody responses to the VP1 protein are protective and can prevent infection. Indeed, neutralizing mAbs have been found to map to a variable domain in the VP1 protein. Antibody responses to synthetic peptides corresponding to this domain are type-protective upon challenge with homologous strain of FMDV in animals given these peptides. We have utilised this information to produce type-specific immunogens for the production of monoclonal antibodies to this domain in 3 strains of FMDV (C, A24cruzeiro, O1manisa). Similarly we have produced and purified whole FMDV for use as inactivated antigen in monoclonal antibody production. We have produced panels of monoclonal antibodies to the type C-VP1-peptide and are in the process of characterizing these further. We will continue to broaden our coverage for other strains of FMDV.

Recombinant Monoclonal Antibody:

The binding domains from neutralizing monoclonal antibodies are being cloned and sequenced and expressed in recombinant expression systems to produce chimeric human - mouse IgG. The binding domains of several Mabs to VEE, FMDV, and PA toxin have been sequenced and the methods for the cloning and expression of these domains are being transplanted to the Winnipeg Labs from the Scripps Research Institute (La Jolla). Protective recombinant Mabs will be compared to other anti-toxin mabs prior to making decisions regarding commercial mechanisms for scale-up and production. Recombinant Mab construction to other alphaviruses and to the anthrax toxins and FMDV are underway.

Alphaviruses:

We have generated a single chain variable fragment (ScFv) antibody from a well-characterized monoclonal antibody (MAb) against Venezuelan equine encephalitis virus (VEE), by cloning variable regions of the heavy (V(H)) and the light (V(L)) chain antibody genes, connected by a DNA linker, in phagemid expression vector. Murine monoclonal antibody 1A4A1 has been shown to recognize a conserved neutralizing epitope of envelope glycoprotein E2 of Venezuelan equine encephalitis virus. It is a potential candidate for development of a recombinant antibody for both immunodiagnosis and immunotherapy. In order to minimize the immunogenicity of murine antibodies and to confer human immune effector functions on murine antibodies, a recombinant gene fusion was constructed.

Outlook

This project has met or exceeded progress to projected scientific milestones to date. We will stream existing Mabs into conventional diagnostic development as well as evaluate them in new forward looking technologies. We would expect to have Mabs to all of our targets in the next year and to begin biological evaluations. This project will produce therapeutic lead Mabs for therapeutic development and for diagnostic Mabs. These reagents will help protect Canada's frontline responders from these potential BT agents or chimeric derivatives thereof.

New Technologies For Surveillance Of Biowarfare Agents And Identification Of Engineered Virulence Genes

CRTI Project Number CRTI0064RD

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Objective

An innocuous bacterium becomes a lethal weapon by the introduction of a virulence gene. The technology for gene transfer in organisms such as *Bacillus anthracis* and *Yersinia pestis* has existed for over a decade, and therefore there is an urgent need to develop the capability to identify introduced virulence genes in engineered biowarfare strains. Current methods lack resolving power to find unknown insertions. Whole-genome sequencing of all suspected biowarfare agents is impractical, and microarray-based approaches, while powerful, are limited to genes present only in the reference strains. We will adapt our novel DNA scanning technology, which couples the resolving power of two-dimensional DNA electrophoresis with comparative genomic hybridization, to rapidly identify engineered genes. We call this technology Bacterial Comparative Genomic Hybridization or BCGH. To identify an unknown virulence gene using BCGH, the engineered biowarfare strain habouring the novel gene is compared against a related lab reference strain. DNA fragments from the two strains are combined, displayed in 2-dimensions, blotted onto a membrane, and sequentially probed (hybridized) with DNA from each individual strain. The engineered gene is identified as a novel spot(s) that can be excised from a parallel gel, cloned and sequenced to reveal its identity. This information can be used to tailor therapy and develop surveillance strategies.

- We will profile *Bacillus anthracis* (anthrax), and *Yersinia pestis* (plague), *Francisella tularensis* (tularemia), *Burkholderia pseudomallei* (melioidosis), and *E. coli* O157, *Salmonella typhi*, *Shigella flexneri*, *Yersinia enterocolitica* (the food-borne pathogens). Restricted pathogens and BioSafety Level 3 organisms will be cultured by NML and DRDC. For these, DNA only will be provided to the UBC labs.
- Display parameters (fragmentation conditions, gel composition, temperature, time, etc.) will be determined empirically for each of the organisms. The sensitivity, quality assurance and quality control of BCGH will be assessed using a panel of spiked genes representing a spectrum of sequence composition.
- Technology transfer will be jointly executed between the University and Federal project participants.
- Standardization and refinement at Federal sites will be carried out by NML and DRDC laboratories.
- State of the art software (BioNumerics from Applied Maths) will be used to analyze and archive the 2D-DNA profiles, as well as to communicate between the partner laboratories.

Progress

- The project was initiated in January 2003. A draft contract from PWGSC was received by UBC in May 2003 and is undergoing final revision.
- Personnel for the project have been recruited by UBC (4 individuals), NML (2) and DRDC (1).
- UBC has established a functional 2D DNA Display facility.
- NML and DRDC labs are awaiting receipt of 2D DNA display equipment.
- Protocols for isolating high-quality DNA suitable for 2D DNA display have been established for non-pathogenic strains simulating *Y. pestis*, *Y. enterocolitica* and *B. anthracis*.
- Personnel at DRDC and NML are undergoing training in their respective Biosafety Level 3 laboratories.
- In-house software developed at UBC is being used and adapted to predict optimum DNA display parameters *in silico* based on sequenced genomes of biowarfare strains.
- Attempts to display DNA of lower G+C content by changing the gel composition and run temperature have yielded promising results; however as a backup, UBC is experimenting with an alternate form of displaying DNA of lower G+C organisms.

Outlook

2003-2004:

- The NML and DRDC labs will isolate DNA from *Y. pestis* and *B. anthracis* for UBC labs
- 2D DNA facilities will be established and personnel will be trained at the NML and DRDC labs. A workshop will be held at UBC in September 2003.
- DNA displays will be generated for *Y. pestis*, *B. anthracis* and *Y. enterocolitica*.
- Analysis and archiving of 2D DNA displays will be initiated and will be on-going.
- Non-radioactive imaging protocols will be developed at the NML and UBC sites.
- BCGH conditions will be tested using a panel of spiked genes.

Expected final outcomes:

- Completed 2D display and BCGH analysis of *Y. pestis*, *Y. enterocolitica*, *B. anthracis*, *F. tularensis*, *B. pseudomallei*, *S. typhi*, *E. coli* O157, and *Y. enterocolitica*.
- Completed protocol standardization and technology transfer to NML and DRDC including streamlining of protocols for routine use in diagnostic and forensic laboratories.

In a bioterrorism event, the identification of the engineered gene will facilitate diagnosis, surveillance, vaccination and therapeutic measures that can be targeted at the virulence gene or gene product to control disease outbreaks.

CBRN Blast Protective Helmet

CRTI 0161TA

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Project Team: Med-Eng Systems, RCMP, RMC, DRDC

Objective

The objective for this CRTI project, being led by the Royal Canadian Mounted Police (RCMP) Explosives Disposal and Technology Section in partnership with Med-Eng Systems, is the design, development, and evaluation of a new CBRN Blast Protective Helmet. This new system will be multi-purpose, using a common helmet shell, with three unique interchangeable visors suited for IEDD (Improvised Explosive Device Disposal) involving CB agents, conventional EOD/IEDD threats, and Search operations. The CB visor(s) will comprise a complex curvature visor (or visors) to accommodate a wide range of SCBA facemasks. The EOD/IEDD visor will provide the highest levels of blast and fragmentation resistance, while the visor for Search operations will be lighter, with an enhanced field of view. Current practice involves having three completely different helmet-visor systems to appropriately address all three of these operational environments, which is costly and logistically burdensome. However, the CBRN Blast Protective Helmet system, with its various modular visors, will reduce the overall cost of head protection to the first responder and permit on-site decisions to be made regarding the most efficient and appropriate protection to be selected, depending on the threat scenario.

Progress

At this point in the development of the CBRN Blast Protective helmet, advanced prototypes are undergoing refinement in order that they be subjected to a significant testing and evaluation program. Getting to this stage in the project has required significant efforts in initial investigations and design work.

In order to ensure a successful design of the CBRN Blast Protective helmet, which will be enthusiastically adopted by bomb disposal technicians, Med-Eng Systems (MES) felt it was important to carry out initial design investigations to help steer the design process. These investigations involved two primary fronts. The first was a questionnaire/interview form that was distributed to bomb disposal technicians throughout Canada and the United States. This form was able to provide MES with a broad range of information about what attributes would be desirable for

the end user in the helmet. The second front of initial investigation was a determination of the SCBA systems that the CBRN Blast Protective Helmet would be designed to integrate with. One of the motivations for this helmet project is to address shortfalls with the existing SRS-5 helmet system, which currently integrates with a limited number of SCBA systems. As a result, a primary feature of the CBRN Blast Protective Helmet is that it be able to fit with a much wider range of SCBA systems to accommodate the range of equipment that is in use by first responders.

The design phase of this project, which is at an advanced state but still ongoing, comprises numerous activities to develop and prototype the various components of the CBRN Blast Protective Helmet. At a very basic level, the helmet is composed of the following:

- The Shell: to be composed of an advanced ballistic composite material, and manufactured using a unique "expandable bladder" mold that will allow the helmet to have a negative draft angle.
- The Visor: to protect the face and is critical in reducing acceleration and overpressure injury. There are to be three visors for this helmet system: CB, EOD/IEDD, and Search.
- Visor Attachment System: used to hold the visor to helmet is designed to allow the visor to be opened and closed with one hand, and will allow the end user to easily interchange visors, depending on the perceived threat.
- Visor Shock Absorbers: located on the visor attachment system, will serve to absorb some of the impact when the helmet is exposed to a blast event.
- Visor Demisting Appliqué: this is a heated transparent layer placed on the inside of the visor that will prevent fogging of the visor even the most humid and damp environmental conditions.
- Visor Wiper: this is a rubber piece that sits atop the visor to prevent liquids from getting inside the visor.
- Impact Liner: the impact liner sits within the helmet shell and serves to reduce the acceleration felt by the user during a blast event, and in case of any subsequent impact with the ground or an object.
- Helmet Sizing System: since the helmet is designed to be "one size fits all", helmet sizing for the wide range of head sizes is a challenge. What has been designed are three different sized comfort liners (each adjustable within their size range) that can be easily inserted and removed from the helmet by means of a zipper.
- Retention System: the function of this true four-point retention system is to ensure that the helmet rests comfortably on the head of the user.
- Environmental Awareness System (EAS): The EAS is essential for the user to be able to hear clearly the noises in the ambient environment surrounding the individual. Through the use of stereo microphones and speakers, the technician will also be able to hear from which direction a sound is emanating. Communications are also of utmost importance to the technician. Both wireless and hardwire communications will be compatible with the CBRN Helmet. The EAS system will also comprise a ventilation system to provide fresh air to the face of the user.

Outlook

Over the course of the next year, the design of the CBRN Blast Protective Helmet will be finalized, and an extensive evaluation program will be executed. Blast testing with instrumented anthropomorphic mannequins, to be carried out in cooperation with the RCMP and Defence Research and Development Canada (DRDC), will be performed to ensure adequate blast resistance of the helmet. Chemical vapor testing will be performed at the Royal Military College of Canada with individuals equipped with a full ensemble of protective equipment placed within an environmentally controlled chamber filled with a vapor of chemical threat simulant. Similar testing involving an aerosol simulating a biological agent will also be carried out at DRDC Suffield. Moreover, limited tests, in partnership also with DRDC Suffield will be performed to assess the effectiveness of the system to protect against CB agents that are explosively driven. Finally, beta samples of the CBRN Blast Protective Helmet will be assessed in validation studies as part of two other CRTI Projects: Standards for Personal Protective Equipment for First Responders (CRTI0029RD) and the CB Plus Chamber (CRTI0100TA

Rapid (<1h) DNA-based diagnostic tests to identify two bacterial biothreat agents.

CRTI 0154RD

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Objective

Rapid (<1h) fluorescence-based PCR assays will be developed for the specific, ubiquitous, and sensitive detection and identification of *Yersinia pestis* and *Francisella tularensis* to allow for the appropriate and timely identification of these potential biothreats. These assays will be developed for the Smart Cycler platform by targeting unique sequences in conserved chromosomal genes and pathogen-associated virulence genes. These assays will include liquid and dried reagent formulations and a rapid sample processing procedure to prepare samples for analysis, and will be tested *in vitro* against live agents spiked into various clinical and environmental samples.

Progress

Several evolutionary conserved chromosomal genes and virulence genes have been selected as targets for multiplex PCR assay design. Relevant strains useful for ubiquity and specificity testing, have been identified and procured from partner collections and from outside sources based on geographic and phylogenetic diversity. Genomic DNA required to generate sequence information for probe and primer design has been prepared from selected microbial strains. Genomic DNA from pathogenic strains has been isolated from various strains using a method developed at the IDRC that provides sterile preparations and fulfills the requirements for subsequent use (sequence analysis, molecular typing, PCR). Sequence information has been generated for several conserved chromosomal gene targets from several strains of each pathogen, and also from their closely related species. Sequence information has also been generated for virulence genes associated with *Y. pestis* (*pla*, *ymt*, *caf1*) and *F. tularensis* (*fopA*, *tul4*).

Outlook

Over the next year, primers and probes will be designed for specific PCR amplification of conserved and virulence gene targets, based on sequence information generated during the project and from existing database sequences. These will be evaluated and developed initially using standard PCR protocols coupled with standard agarose gel electrophoresis, and then adapted to fluorescence-based amplicon detection using SYBR Green I and fluorescent probes (i.e. Taqman system). During this time, rapid sample preparation methods will be investigated and specification/qualification assessment of critical assay components will be initiated by our industrial partner in preparation for developing and manufacturing dried reagents and assay protocols for live agent testing. Preparations to conduct live agent testing in the federal laboratories (planned for the final phase of this project) will be initiated. The final outcomes of the project will include rapid (<1h) DNA-based diagnostic assays for *Yersinia pestis* and *Francisella tularensis* validated to industrial standards; capability at two federal sites to detect and identify *Yersinia pestis* and *Francisella tularensis* in various clinical and environmental sample types using these assays; species-specific and strain-specific sequence data for future molecular research of these organisms.

Rapid Triage Management Workbench

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Susan Guérette, Communications

Objective

The objective of the Rapid Triage Management Workbench (RTMW) project is to enable collaboration amongst first responders, to capture and share information in response to a CBRN event. The RTMW will be used by first line response health professionals to enter data on victims/patients, to prioritize and communicate with the hospital, record the needs, treatments and disposition of casualties of a CBRN event. It will be designed to provide accurate, up-to-date information that can be shared by all caregivers and greatly improve the quality of care for victims.

Progress

A comprehensive project team has been established representing collaboration between the private sector (WorldReach Software Corporation), public sector organizations (National Capital CBRN Health Planning Team, the National Research Council of Canada) and

educational institutions (Carleton University). Team members offer medical expertise in acute care and triage, software design and engineering, human factors, as well as extensive experience dealing with first response to CBRN events.

The project charter has been granted, and details of the contract between the federal government and WorldReach Software Corporation are now being finalized. Project plans have been finalized and functional sub-teams have been assigned to begin the process of identifying user and technical requirements that will drive software development. An internal project website has been established giving team members a secure repository for project-related information. An external site is planned to keep key stakeholders up to date about progress of the project.

Once the contract is signed, the software design team will commence working towards a Critical Design Review that defines and tests user and technical requirements prior to actually developing the software.

Outlook

It is anticipated that the final version of the triage software and an accompanying software training program will be completed by March 31, 2004. The potential for a successful outcome is excellent given the strong level of support the project has received from the moment of conception amongst first responders and medical end users.

All project plans including specific plans concerned with quality management, risk management, communications, and configuration management are scheduled for completion at the end of June, 2003. A privacy impact assessment will be completed by September, 2003 to ensure that privacy issues are considered throughout the software development cycle. First responders will test an early version of the RTMW software during tabletop and field trial exercise programs in October, 2003.

Transition of the software to commercialization will take place once end users incorporate RTMW within their operations to assist in the collection and prioritization of feedback. End users have committed to using RTMW on disaster exercises for at least one year by integrating the product into their procedures, workflow and training. The transition will test the software, implementation and training approach resulting in a product ready for commercialization.

Evaluation of GM-CSF for Acute Radiation Syndrome

CRTI Project Number 0085TA

Presenter: Vadim Tsvetnitsky, Cangene Corporation, 905-405-2904, vtsvetnitsky@cangene.com

Project Leader: Jack Cornett, Radiation Protection Branch, Health Canada,

Project Team: Don Stewart, Cangene Corporation
Slavica Vlahovich, Radiation Protection Branch, Health Canada
Steve McGregor, Cangene Corporation
Mike Hradecky, PWGSC
Ted Sykes, CRTI

Objective

The primary objective of the project is to evaluate the clinical efficacy of Cangene's pipeline product GM-CSF (recombinant human granulocyte macrophage colony-stimulating factor) in improving recovery of radiation exposure victims. The study will be conducted in non-human primates. The secondary objective is to develop a longer-lasting formulation of GM-CSF.

Progress

Cangene has produced three commercial scale batches of Leucotropin® (GM-CSF) so that the finished drug substance is now available for the study. The study has been designed with a staged approach to first estimate a sub-lethal dose of radiation, a worst case scenario in acute radiation exposure, followed by a full efficacy study to determine how much better radiated animals treated with Leucotropin® will recover compared to a non-treated group. Negotiations with the contract research organization which will conduct the animal work is nearing completion and should be finalized by the end of June 2003.

A postdoctoral scientist has been hired to conduct the bench scale laboratory work required to produce a longer lasting PEGylated version of GM-CSF protein.

Outlook

We plan to start the first phase of animal studies in August, 2003 and the second phase in October, 2003. Study data will be available by April 2004. Following that, Cangene plans to prepare a supplemental New Drug Submission for Health Canada to seek an approval for the additional indication for the Leucotropin™.

The development of PEGylated GM-CSF should continue for the full duration of the project. In addition to looking into new ways to modify GM-CSF, we will conduct studies to determine the impact of the modifications on the protein biological activity, stability and other parameters.

Therapeutic Antibodies to Ebola and Marburg Viruses

CRTI Project Number 0087RD

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Helen Spencer, CRTI

Objective

The objective of the project is to discover, evaluate and develop neutralizing monoclonal and polyclonal antibodies to Ebola and Marburg viruses as potential therapeutic compounds.

Progress

The two-year project was initiated in January 2003. Since then we have been able to demonstrate that serum from mice vaccinated with Ebola glycoprotein offers passive immunization against the viral challenge, suggesting that antibodies recognizing this protein are neutralizing. Work is underway to produce hybridoma cells that would express those antibodies. At the same time, we have achieved progress in creating a naïve phage display library, which we will use to develop fully human monoclonal antibodies specific for Ebola and Marburg viruses.

Outlook

We plan to complete the phage display library construction by October 2003, a prerequisite to panning for the specific anti-Ebola antibodies. By January 2004 we anticipate that first monoclonal antibodies produced with hybridoma technology would be available for testing their neutralization capacities, and the first human monoclonal antibodies would be on hand for the tests by April 2004.

By October 2003 we anticipate the initiation of the immunization program with goats or sheep with Ebola glycoprotein or another comparable agent to produce polyclonal antibodies. It is expected that purified polyclonal antibodies from this program could be tested in neutralization assays by the end of November 2004.