



Defence Research and  
Development Canada

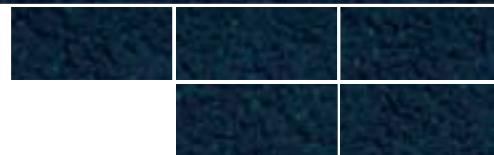
Recherche et développement  
pour la défense Canada



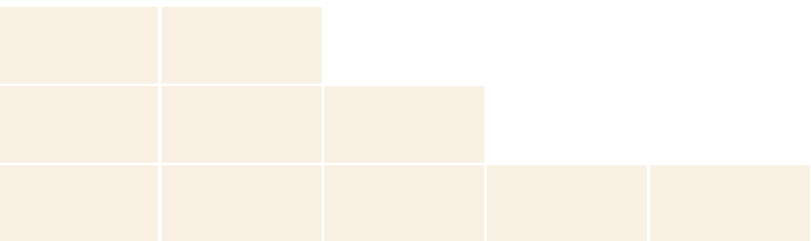
# DRDC

TEN YEARS OF SCIENTIFIC EXCELLENCE FOR  
CANADA'S DEFENCE AND SECURITY

ANNUAL REPORT FOR THE YEAR ENDING 31 MARCH 2011



Canada 



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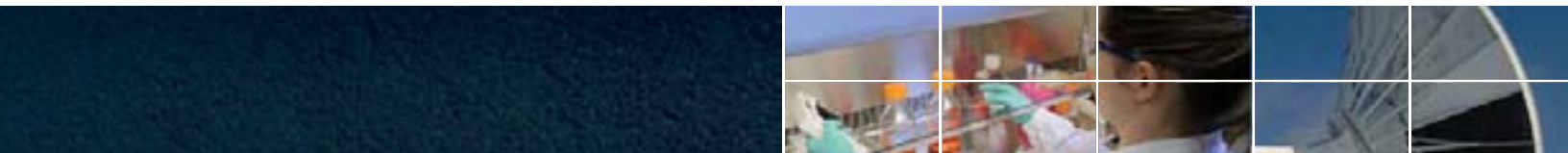
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# MESSAGE FROM THE CHIEF EXECUTIVE OFFICER

The year 2011 marked a major milestone for Defence Research and Development Canada (DRDC) as we celebrated our 10<sup>th</sup> anniversary as an agency within the Department of National Defence (DND). Since its creation in 2001, DRDC has ensured that the Canadian Forces (CF) are technologically prepared and operationally relevant by performing research, development and analysis, and providing science, technology and knowledge that have impact.

Operationally, this past year marked the end of Canada's combat mission in Afghanistan and a shift in departmental and governmental priorities. Our support to Canada's missions in the last decade is a cause for pride as we provided the best possible scientific advice and technical capabilities to the CF and DND.

In addition to providing science and technology (S&T) in support of DND and the CF, DRDC took on a greater role in responding to the Government of Canada priorities with respect to domestic security. We created the Centre for Security Science and provided integral support to domestic exercises and operations.

As we enter the next decade, the defence and security environment is becoming ever more complex and S&T solutions are needed more than ever. DRDC will continue to focus on S&T activities that are aligned with DND/CF requirements, have impact for our partners, and provide Canada with the solutions needed to support the national security, public safety and defence agendas. To achieve this, we will continue engaging the Department and the CF to articulate together the S&T needed to achieve effects that are meaningful and for which S&T is essential.

I continue to be impressed by the commitment and dedication of the staff at DRDC and I am confident that the excellence of their work will ensure that Canada's defence and security needs are met with world-class S&T.



Marc G. Fortin  
Chief Executive Officer, Defence Research and Development Canada





# OVERVIEW OF DEFENCE RESEARCH AND DEVELOPMENT CANADA



Defence Research and Development Canada (DRDC), a Special Operating Agency of the Canadian Department of National Defence (DND), is Canada's leader in science and technology (S&T) for national defence and public security. With approximately 1,600 employees and a budget of over 300 million dollars, the agency has a corporate office and 8 research centres across Canada, each with a unique combination of expertise and facilities that enable it to deliver world-class S&T programs. To do so, DRDC actively collaborates with industry, international allies, academia, other government departments and the national security community to ensure maximum benefit to and from the global innovation system.



## TEN YEARS AS A SPECIAL OPERATING AGENCY

In April 1947, the Defence Research Board (DRB), created by an amendment of the National Defence Act of 1927, assumed full legal status and authority bringing together various research and development establishments that had been created in Canada between World War I and World War II.

When formed, the DRB included seven research laboratories. In 1974, the laboratories of the DRB were integrated into DND through the formation of the Defence Research and Development Branch (DRDB). This was done to forge closer relationships between scientists and the military. The new branch was led by the Chief of Research and Development (CRAD), within the Assistant Deputy Minister (Materiel) group.

In 2000, DRDB officially changed to Defence Research and Development Canada (DRDC), a Special Operating Agency within DND.



Pictured (left to right) are Deputy Minister Robert Fonberg, Chief of the Defence Staff General Walt Natynczyk, Dr. Robert Walker (retired DRDC CEO), Dr. John Leggett (retired DRDC CEO), and the Vice-Chief of the Defence Staff Vice-Admiral Denis Rouleau who came to mark DRDC's tenth anniversary as a Special Operating Agency at a ceremony held at Department of National Defence headquarters on May 17, 2010, in Ottawa. Celebrating simultaneously were DRDC's research centres that joined the program via video conference to hear remarks from Dr. Walker, Mr. Fonberg and Gen Natynczyk.

## DRDC TIMELINE

### 1947

The creation of the Defence Research Board (DRB) unified various defence science laboratories which had previously existed autonomously:

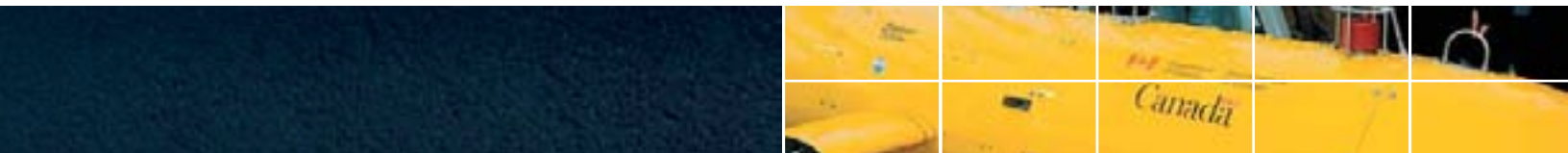
- Associate Committee on Aviation Medical Research: 1939 – present (DRDC Toronto);
- Defence Research Chemical Laboratories: 1941–present (DRDC Ottawa);
- Suffield Experimental Station; 1941–present (DRDC Suffield);
- Defence Research Kingston Laboratory: 1942–1964 (closed, programs transferred to Ottawa);
- Defence Research Establishment Atlantic: 1944–present (DRDC Atlantic);
- Canadian Armament Research and Development Establishment: 1945–present (DRDC Valcartier);
- Defence Research Northern Laboratory: 1947–1965 (closed, programs moved to National Research Council in the 1950s); and
- Radio Physics Laboratory: 1947 – (later, the Communications Research Centre)

### 1948

A new lab was added to the DRB family when the Pacific Naval Laboratory opened to carry out oceanographic studies and provide scientific services to the West Coast fleet.



Canadian Defence Scientist, Dr. Wilbur Franks, developed the Franks Flying Suit, the first anti-G suit used in wartime service, giving the Allies a distinct tactical advantage. This artifact is now housed on campus at DRDC Toronto.



## 1949

Operational Research Group, now DRDC CORA, was formed at the Defence Research Board.

## 1951

Defence Research Telecommunications Establishment was formed in Ottawa by uniting the Radio Physics Laboratory and the Electronics Laboratory.

## 1952

Defence Research Medical Laboratory was formed, later to be amalgamated into the Defence and Civil Institute of Environmental Medicine.

## 1969

Defence Research Telecommunications Establishment was transferred to the Department of Communications as the Communications Research Centre Canada which, on behalf of DND, retained responsibility for research in radar and defence communications.

## 1971

Defence and Civil Institute of Environmental Medicine, ancestor of DRDC Toronto, was formed by the amalgamation of Defence Research Establishment Toronto and the Canadian Forces Institute of Environmental Medicine.

## 1974

The Defence Research and Development (R&D) Branch, under the Chief of Research and Development, was formed with responsibility for both research and development, including the operation of six former DRB laboratories.

## 1995

Defence Research Establishment Pacific closed and consolidated with Defence Research Establishment Atlantic, leaving a small detachment to provide services to the West Coast fleet.

## 2000

DRDB officially changed to Defence Research and Development Canada (DRDC), a Special Operating Agency within DND, led by the Assistant Deputy Minister (Science and Technology), who is also the Chief Executive Officer of DRDC. Five research and development centres assumed their present-day names: DRDC Atlantic; DRDC Valcartier; DRDC Toronto; DRDC Ottawa; and DRDC Suffield.

## 2003

Operational Research and Development, now DRDC CORA, joined DRDC as the sixth centre with the mandate to deliver options, recommendations, and potential outcomes to key decision makers using a variety of tools and methodologies.



## **2005**

The DRDC Centre for Security Science (DRDC CSS) was created as a joint endeavour between DRDC and Public Safety Canada to deliver S&T services and support, and to address national public safety and security objectives. The Centre currently manages the Chemical, Biological, Radiological-Nuclear, and Explosives (CBRNE) Research and Technology Initiative (CRTI), the Public Security Technical Program (PSTP) as well as the Canadian Police Research Centre (CPRC).

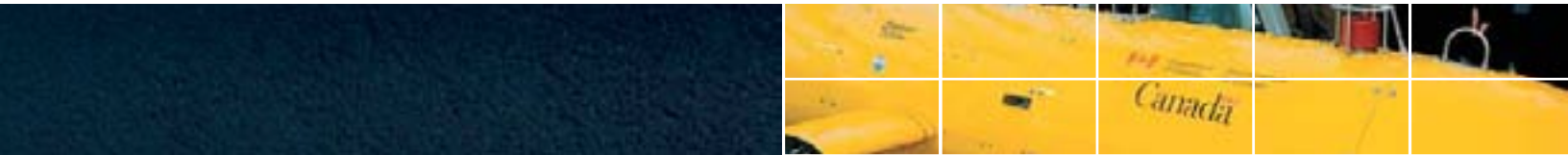
## **2008**

To respond to the research needs of both the Assistant Deputy Minister (Science and Technology) and the Chief of Military Personnel within DND, the Director General Military Personnel Research and Analysis (DGMPRA) joined DRDC to conduct strategic and operational research in the areas of personnel generation, personnel and family support, as well as operational and organizational dynamics.



Modern G-Suit Design.





## OUR MISSION

To ensure that the Canadian Forces (CF) are technologically prepared and operationally relevant by:

- Providing expert S&T advice to DND/CF;
- Conducting research, development and analysis to contribute new and improved defence capabilities;
- Anticipating and advising on future S&T trends, threats and opportunities;
- Engaging industrial, academic and international partners in the generation and commercialization of technology; and
- Providing S&T for external customers to enhance defence S&T capacity.

## OUR VISION

To be known worldwide as the best in S&T for defence and security.

## OUR VALUES

DRDC's values guide how we accomplish our mission and maintain excellence in science. These include:

**Commitment:** We demonstrate dedication and pride in working towards our vision.

**Client Focus:** We bring excellence to clients, both internal and external, by focusing our efforts on discovering and meeting their needs.

**Creativity and Innovation:** We foster a working environment of open innovation that can generate innovative solutions, approaches, products and services that improve the status quo.

**Leadership:** We actively and enthusiastically seek to exert influence and originate action to achieve our goals.

**Professionalism and Integrity:** Our aim is to achieve quality results in an honest and ethical manner, dealing with others respectfully and fairly.

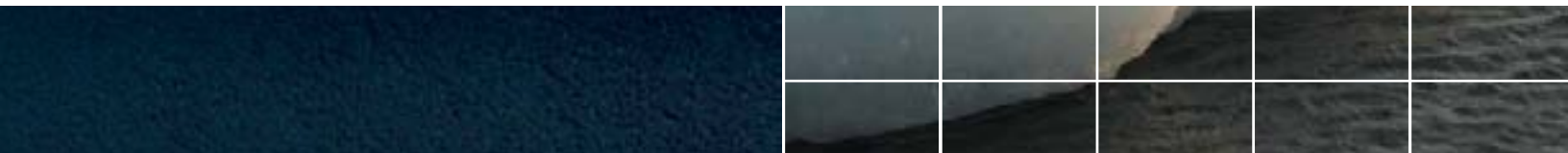
**Trust and Respect:** We are open, honest and responsible in our relationships and we recognize and value the contributions of others.

**Teamwork:** We demonstrate effective interpersonal skills, and work cooperatively and productively within and across DRDC to achieve common goals.



# STRUCTURE OF THE REPORT

This Annual Report presents some of our recent accomplishments in order to demonstrate the ways in which DRDC strives to enhance the capabilities of the Canadian defence and security community.



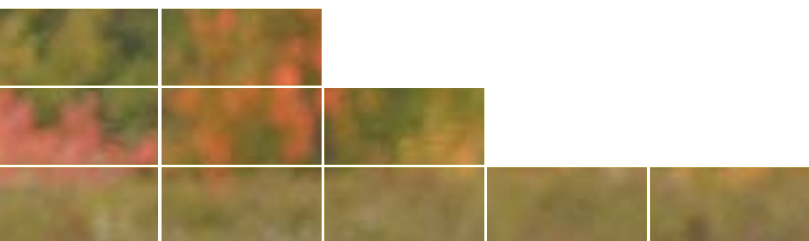
The section entitled “S&T Support to Defence and Security Operations and Exercises” provides an overview of some of DRDC’s many contributions that have led to the success of the activities carried out by our defence and security partners throughout the 2010–2011 fiscal year.

Another section, “Scientific Advice and Strategic Analysis,” highlights examples of how the expert advice of DRDC scientists is becoming increasingly integral to decision making in the ever more complex defence and security environment.

The success stories of the “Technology Development and Evaluation” section demonstrate how DRDC helps to incorporate the most advanced capabilities into Canadian defence and public security to ensure that ours are the best-prepared and best-equipped forces possible.

The section entitled “Internal Operations and Achievements” showcases best practices in internal operations through the examples of individual employees who have excelled in their work performance, earning recognition from the defence community both at home and abroad for their significant contributions to the objectives of DRDC.

This report concludes with our “Financial Statement,” which details our revenues and expenditures for the fiscal year 2010–2011. At the end of the report are the “Appendices and Tables,” which provide additional information about DRDC operations, research centres and programs.

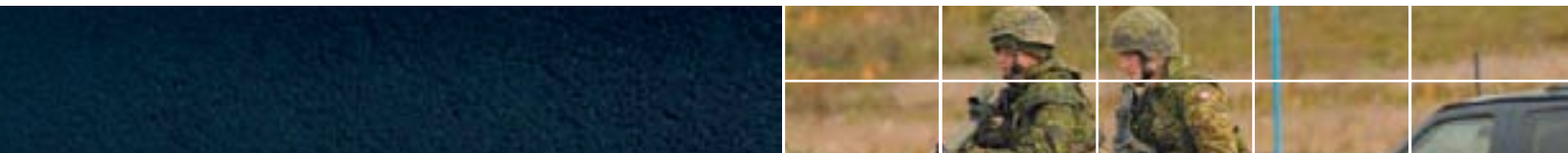


# S&T SUPPORT TO DEFENCE AND SECURITY OPERATIONS AND EXERCISES



The CF undertake many and varied operations and exercises in Canada and around the world. DRDC develops innovative technologies and provides analytical assistance in support of the CF and other domestic security partners to enable them to carry out their missions in such a way that mitigates risks and saves lives. The following stories illustrate some of our initiatives in this area.





## G8/G20 SECURITY SUPPORT

In June 2010, international attention focused on Ontario as world leaders met first at the G8 Summit hosted in Huntsville, followed immediately by the G20 Summit hosted in downtown Toronto. The back-to-back security operations in support of the summits constituted one of Canada's largest and most complex domestic security operations. DRDC supported these efforts by providing operational analysis and scientific support to the Integrated Security Unit (ISU) led by the Royal Canadian Mounted Police (RCMP) through the Major Events Coordinated Security Solutions (MECSS) project. MECSS was a formal project implemented within DRDC's Public Security Technical Program (PSTP) that was originally focused on assisting authorities in reducing the security risk associated with the Vancouver 2010 Olympic and Paralympic Games

(V2010) through the coordinated application of science and technology.

As with V2010, MECSS assigned a Scientific Advisor to the ISU to provide direct S&T advice and support to the G8/G20 security partners (RCMP, Toronto Police Services, Ontario Provincial Police, Peel Regional Police and the CF) in such critical areas as personnel management, vehicle screening and maritime security. Through MECSS, DRDC coordinated S&T expertise and equipment for the duration of the events, tapping into skills and knowledge from within DRDC, as well as the broader federal S&T community.

One innovative capability that shone in Vancouver and again at the two summits was Science Town, a unique concept bringing together federal mobile laboratory capabilities, including DRDC's chemical and radiological-nuclear labs, for on-site chemical, biological, radiological-nuclear and explosive (CBRNE)



Civilian and military personnel work together as part of the G8/G20 security operations.



A DRDC scientist examines a radiation energy spectrum from a sample.



Federal Radiological Assessment Team scientists from DRDC and Health Canada interpret a radiation spectrum in the mobile nuclear laboratory.

and forensics analysis – complete with the scientific and technical support of federal experts from various departments and agencies.

Science Town enabled both on-site rapid triage and identification of suspicious material as well as the ability to recover and render safe contaminated evidence for the RCMP forensic services. The labs' mobile nature made on-site, in-depth analysis possible, saving travel time and costs while allowing for "what they are dealing with" information to be transmitted to first responders sooner than would otherwise be possible. Complementing Science Town was the deployment of the DRDC Command and Control, Computers, Communications, Intelligence, Surveillance and Reconnaissance mobile lab previously deployed at V2010 in support of the CF.

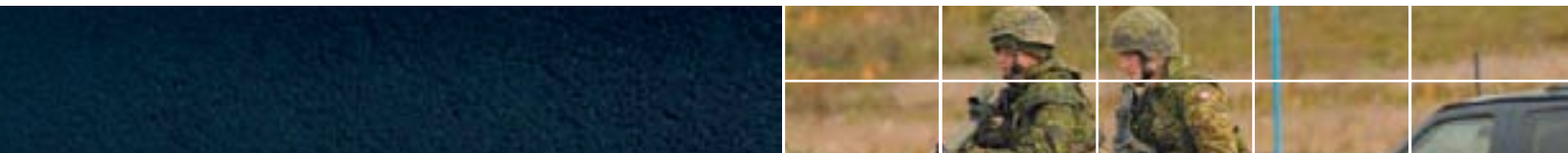
Complex review and analysis of data collected during pre-and post-summit events will ultimately provide a significant cost-savings template for future national major event security planners. DRDC's contribution to both V2010 and the G8/G20 has international value as well; the UK has asked Canada to share its federal S&T approach and lessons learned to support planning for the London 2012 Olympic Games. Through its leadership role in coordinating

public safety and security S&T efforts on behalf of the Government of Canada, DRDC plays an important role in developing and archiving the critical knowledge and processes that will ensure Canada and its allies provide increasingly effective domestic security operations during major event operations, whether they are summits, large-scale athletic events or dignitary visits.



A DRDC scientist performs radiation screening of a contamination swipe sample collected and delivered to Science Town by a member of the RCMP forensic identification services.





## OPERATION ATHENA

*Operation ATHENA* was Canada's military contribution of peace-support and combat forces to the International Security Assistance Force (ISAF) in Afghanistan. Focused on Kandahar Province in southern Afghanistan, *Operation ATHENA* had one over-arching objective: to leave Afghanistan to Afghans, in a country that is better governed, more peaceful and more secure.

2010-2011 saw a rapidly increasing demand for DRDC support in the theatre of operations. A total of twenty-five DRDC employees were deployed, including twenty civilians and five CF members, from seven different DRDC centres. This is double the number of personnel deployed in the previous year.

For several years, DRDC maintained a cadre of two defence scientists deployed in the Task Force Kandahar staff headquarters in direct support of the Joint Task Force Commander. One individual provided operational

analysis support and advised the Commander in areas such as campaign assessment, polling survey analysis and Significant Actions trend analysis. The second individual served as the Commander's Scientific Advisor and provides input on battle damage assessment, participates in field trials and coordinates reach-back into DRDC on technical and scientific matters.

During 2010-2011, DRDC deployed three teams of technical and scientific personnel into Afghanistan on short-term visits to address a range of issues. One group examined the role DRDC might play in-theatre with the stand-up of *Operation ATTENTION*, the new Canadian mission that followed *Operation ATHENA*, which supports training of the Afghanistan National Army. The other two groups worked as part of the *ARTEMIS* improvised explosive device (IED) detection capability project and the Canadian-TRIAD (C-TRIAD) Technology Demonstration Project, respectively.



C-IED ARTEMIS system deployed in Afghanistan.

## **ARTEMIS PROVIDES ADVANCED IED DETECTION**

Under the DRDC Counter-Improvised Explosive Device (C-IED) Technology Demonstration Project (TDP), DRDC developed an advanced detection capability against IEDs.

A team of defence scientists, CF personnel and industry contractors deployed to the theatre of operations in Afghanistan to conduct vital trials as part of the overall effort to defeat the IED threat. These trials, code-named ARTEMIS, garnered much interest from both the CF and North Atlantic Treaty Organization (NATO) partners. They provided real-time situational awareness for convoy commanders, as well as operational intelligence for mission planners, thus increasing safety for convoy operations.

Multiple ARTEMIS systems were deployed within the Afghanistan theatre under the command of the C-IED Task Force. The ARTEMIS deployment was supported by DRDC personnel on two Technical Assistance Visits in the past year.

## **C-TRIAD TDP DEVELOPS ADVANCED GEOSPATIAL INTELLIGENCE**

The Canadian AGI (Advanced Geospatial Intelligence) Analysis Team (CAAT) from DRDC was developed under the C-TRIAD TDP to participate in an international project formed to counter insurgent threats in Afghanistan.

For six months in 2010, the CAAT was deployed to Kandahar Airfield to participate for the first time in a mission that would

operationally demonstrate the use of a state-of-the-art technology to impede insurgent activity at both the tactical and strategic levels. The CAAT was effectively integrated into the complex command and control structure of Task Force Kandahar (TFK), delivering timely, relevant and actionable intelligence that was previously inaccessible.

Intelligence products created by the CAAT were successfully integrated into the intelligence production cycle of the All Source Intelligence Centre (ASIC) within TFK and have been used successfully on multiple occasions to direct military operations. The mission, characterized as a “game changer” by the commander TFK, had a significant impact on the CF as it safeguarded lives and protected assets.

This highly important work of *Operation ATHENA* is continuing in the development of technology and analysis, which will have far-reaching applications beyond the Afghanistan theatre of operations. All future CF international deployments will benefit greatly from DRDC’s cutting-edge contribution to *Operation ATHENA*.

This past year marked the start of *Operation Attention*, Canada’s transition from a combat role to a training role in support of the Afghanistan National Army. At the vanguard of this transition and at the request of senior ISAF leadership, DRDC deployed two defence scientists into the NATO Training Mission - Afghanistan Headquarters. Their mission was to conduct key personnel research and analysis in direct support of NATO efforts to build a more robust Afghan army.





## INFRARED COUNTERMEASURE TRIALS

In 2010, DRDC took on the vital task of developing infrared (IR) detection countermeasures for use on CF aircraft and conducted testing trials in the Afghan theatre of operations, where the aircraft were already deployed.

Normally, DRDC validates the effectiveness of such countermeasures on a CF base, but operational constraints required that the trials be conducted within a very short timeframe of less than four months. To complete this task, DRDC formed a multi-disciplinary team composed of defence scientists and engineers, military personnel and civilian consultants. A very tight schedule was established to develop the technical solutions and train the team for deployment. Despite the risks and unknowns inherent in this type of mission, the team members volunteered and all remained throughout the mission.

The dedicated team set up a modelling and simulation environment in Canada to decrease the time the tests would take overseas. At the same time, the team trained on the Valcartier and Kingston bases in preparation for deployment to Afghanistan.

The team developed a portable version of the HARFANG mobile laboratory that could be easily set up on site. Efforts were dedicated to reduce the mobile laboratory footprint and allow it's rapidly set up instead of days as usual. Moreover, the new laboratory was adapted to withstand the extreme conditions involving dust and oppressive heat. This laboratory significantly advanced DRDC's capacity to carry out this type of trial in a very short timeframe and in inhospitable conditions.

The mission was a great success. The data gathered in-theatre made it possible to validate the results obtained in the modelling process, confirming that the IR countermeasures developed by DRDC effectively protect CF aircraft against infrared-guided threats.



The C-130J "Super" Hercules puts on a light show as it displays infrared countermeasure flares.

## MARITIME FORCE PROTECTION TDP

The objective of the Maritime Force Protection Technology Demonstration Project (MFP TDP) is to advise the CF on force protection issues, affordable equipment procurement for detecting and mitigating water-borne attacks on ships in harbour or at anchor, requirements for command and control and methods for increasing survivability and recoverability of ships in the event of an attack.

The MFP TDP was successfully integrated into a naval port security operation called *Exercise PORT GUARD 2010*, which was one of the largest such operations in recent years. *Exercise PORT GUARD 2010* was a training event which took place from June 14 to 16, 2010 at Canadian Forces Base (CFB) Halifax. The exercise consisted of various live and simulated scenarios: man overboard drills, controlled access zone encroachment and intrusion, bomb threats, shadowing vessels and diver detections.

The MFP TDP was then employed to support the International Fleet Review security operation that quickly followed on June 29, 2010. This high-profile event revolved around the visit of Her Majesty Queen Elizabeth II as she reviewed the Canadian and Visiting Foreign Fleet in Halifax Harbour during the Canadian Naval Centennial.

The MFP team acted as an embedded component of the Port Security Unit (PSU), which is responsible for the security and protection of the base's assets and infrastructure, to support waterside security operations during this period. The services provided by the MFP team were two-fold: deployment of the Canadian Underwater Protection System (CUwPS),

and the provision of Command and Control (C2) expertise and methodology to support the operational planning and training events during *Exercise PORT GUARD 2010*. Notably, CUwPS, an integrated system for the detection, localization, and classification of underwater threats, is a prime example of a system created using MFP TDP advice and expertise. The primary sensors of the system are commercial-off-the-shelf and are integrated into a workable set of equipment and concepts with specific adaptations to military platforms.

The CUwPS system was deployed during *Exercise PORT GUARD 2010* in order to field and integrate the system into PSU operations. CF teams successfully operated the system to detect, classify and alert 100 percent of diver intruder events during exercises.

Following this successful fielding, the PSU Commander requested continued deployment of the CUwPS system during the International Fleet Review period to provide protection for the visiting ships HMS *ARK ROYAL* and USS *WASP*. Along with the deployment of the CUwPS, the team provided domain MFP expertise to the operational planning authorities for C2 as well as training support for a variety of systems, events, and incident management and communications tools throughout *Exercise PORT GUARD 2010* and the International Fleet Review.



## OPERATION CARIBBE

DRDC supported HMCS *TORONTO*'s deployment into *Operation CARIBBE* in January 2011 by providing sensing technologies and associated technical support. HMCS *TORONTO* was operating under the control of Canada Command, which was directly supporting an ongoing United States-led effort to halt drug trafficking in the international waters of the Caribbean Basin and Eastern Pacific. During this operation, HMCS *TORONTO* assisted the U.S. Coast Guard Law Enforcement Detachment in interdicting drug trafficking. This marked the first time that a Canadian Navy ship had conducted operations with a U.S. law enforcement authority.

DRDC S&T support allowed HMCS *TORONTO* to significantly extend its ability to track and follow contacts of interest at long range, and make a significant seizure which prevented 1 650 kg of cocaine, worth an estimated \$33M, from reaching North American markets. The crew of the boat from which the cocaine was intercepted was turned over to the local authorities for prosecution.

"Canadians can be proud of the impressive ability of their CF to work together seamlessly with other nations and agencies to tackle challenges to Canada's security and safety before they reach our shores," said a senior military member of Canada Command.



*Operation CARIBBE*



## **MARITIME SECURITY OPERATIONS IN THE PERSIAN GULF AND ARABIAN SEA**

During the summer of 2008, Canada contributed three ships and took command of the Combined Task Force (CTF) 150. CTF 150 is a coalition fleet conducting anti-terrorist and counter-piracy operations in the Persian Gulf and the Arabian Sea. As part of this deployment, a defence scientist was embedded in HMCS *IROQUOIS*, the command ship, to discover opportunities where DRDC could assist in the fleet's operational planning process. The scientist determined assistance was needed to track Vessels of Interest (VOIs). As a result, DRDC teams embedded in Maritime Forces Atlantic (MARLANT) and the CF Maritime Warfare Centre (CFMWC) developed the VOI Reconnaissance tool (VOIR).

The initial version of VOIR was developed rapidly in six weeks and delivered to HMCS *IROQUOIS*

in-theatre. The tool allowed an operator to provide details of a VOI, including its previously known location, suspected course and speed. VOIR calculates likely positions for the vessel at a specified time and can provide the time required for a helicopter to search the area of interest.

Since its initial development, VOIR has been deployed on each Canadian ship tasked with Maritime Security Operations in the Persian Gulf and the Arabian Sea. Feedback from each deployment has led to incremental improvements, which have been incorporated prior to any subsequent deployment.

VOIR has also been shared with international operational researchers at the Combined Maritime Forces (CMF) Command and through The Technical Cooperation Program (TTCP), an allied body that collaborates in defence S&T research. TTCP's Maritime Systems Action Group plans to incorporate VOIR as a module in a multinational, comprehensive tool set for maritime security operations.



HMCS *IROQUOIS*, HMCS *CALGARY* and HMCS *PROTECTEUR* in formation.





## EXERCISE CENTRAL GATEWAY 1

Large-scale periodic emergency preparedness training exercises are crucial to ensure Canadian authorities are equipped and ready to prevent, prepare for, respond to and recover from potential criminal or terrorist-caused events.

The Windsor–Essex County Regional Emergency Management Coordination Committee carries out an annual municipal and regional training exercise based on a series of escalating mock criminal activities and domestic terrorist events and threats. This past year, Exercise Central Gateway 1, a large-scale, four-day event, involved a number of activities in support of research efforts undertaken through DRDC's Chemical, Biological, Radiological, Nuclear and Explosives (CBRNE) Research and Technology Initiative (CRTI) and Public Security Technical Program (PSTP).

For years, Windsor has been actively involved in piloting a CRTI project to apply Capabilities-Based Planning (CBP) practices to emergency planning and security management. DRDC and its regional partners validated the findings of the CBP work done in Windsor–Essex County during Exercise Central Gateway 1. This included a consolidated risk analysis session involving several agencies and used a “full spectrum” scenario that encompassed the incident from start – before mock “adversaries” assembled their instruments – to the final stages of response and recovery. This type of analysis helps planners and decision makers identify possible gaps and thereby properly direct investments.

Exercise Central Gateway 1 included an explosives scenario involving radiological contamination. It featured re-enactments of three actual operational calls that had been received by the RCMP and

Ontario Provincial Police explosive disposal units. The objectives of the explosives scenario, coordinated through the CRTI, were to evaluate the current provincial capability to respond and the private sector's ability to help with the remediation process. This scenario also provided an opportunity to test the activation of Canada's CBRNE Emergency Response Assistance Plan, led by Transport Canada.

DRDC also provided a technology demonstration of the ground-breaking, low-cost Multi-Agency Situational Awareness System (MASAS) that provides the capability to link many disparate communications systems by leveraging open geospatial standards, alerts, messaging protocols and operational policies across jurisdictions, including U.S. agencies. The development and operationalization of MASAS represents a large federal effort led by DRDC, in partnership with Natural Resources Canada and Public Safety Canada. Integrating MASAS into the exercise introduced responder agencies to the enhanced, interoperable situational awareness afforded by MASAS in the context of a multi-agency response.

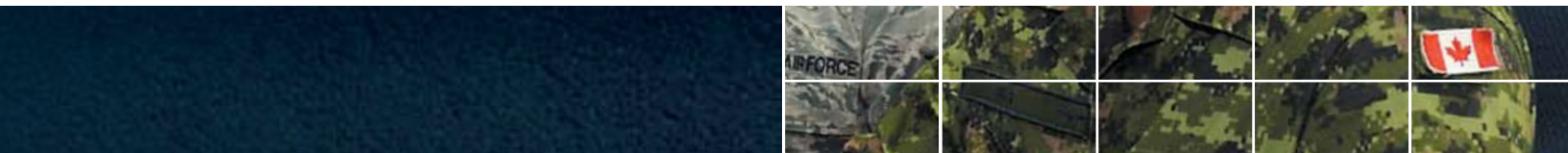
Exercise Central Gateway 1 successfully reinforced relationships among varied defence and security stakeholders, highlighted capability gaps, and identified challenges to be overcome to ensure smooth, seamless and efficient multi-agency interactions in response to threats.



# STRATEGIC AND OPERATIONAL ADVICE



Canadian civilian and military decision makers are often faced with complex defence and security challenges. Sound scientific advice and innovative solutions are, of necessity, becoming more and more an integral part of informed decision making. To this end, DRDC scientists are recognized as invaluable assets who provide rigorous evidence-based analysis and subject matter expertise, which are readily integrated into the decision options and solutions for Canadian defence and security. The stories that follow provide a few select examples of DRDC's acting in this role as scientific advisor.



## 700 MHZ SPECTRUM FOR PUBLIC SAFETY

The demise of analogue broadcast television has allowed the reallocation of the vacated 700 MHz part of the radio-frequency spectrum. Given the excellent propagation properties of this frequency band, public safety stakeholders recognized a unique opportunity to lay the foundation for a national mobile broadband communications network. This network would allow various public safety agencies to better plan, coordinate and execute their missions using the most up-to-date communications technology, whether it be for their day-to-day operations or for responding to crisis events.

In close collaboration with the Communications Research Centre (CRC), and in response to a very high priority request in December 2010 by the Emergency Services Chiefs of Canada, DRDC led a rigorous analysis of the requirements of the 700 MHz broadband spectrum for public safety mobile broadband data communications. This technical evidence contributed significantly to Industry Canada's decision to allocate a portion of the precious spectrum (valued at \$1.5B) to the creation of the public safety communications network.

DRDC will continue to provide technical advice that will shape the national architecture and implementation plan for the segment of the 700 MHz spectrum allocated for public safety. This capability will provide transformational improvements to public safety broadband communications for the foreseeable future.

## IMPACT OF DEPLOYMENTS TO TASK FORCE AFGHANISTAN

DRDC continually studies the human resources effects of deployment on CF members and their families to gain a better understanding of the impact of deployment and to provide insight into future deployment activities. In addition, DRDC regularly provides statistics to Veterans Affairs Canada to inform planning for provision of support to veterans, such as disability benefits.

This year's contributions and findings were captured in a number of studies, including the estimated number of CF members deployed to Task Force Afghanistan (TFA), attrition and demographic analyses of these members, injury statistics and identification of contributing factors leading to changes in attrition frequency.

Several key insights were documented and are helping to improve monitoring of the physical and mental health of CF members returning from TFA. One study indicated that attrition rates for TFA are slightly lower than those of other operations. DRDC developed a methodology to identify how a variety of influences on these numbers affects attrition rates, including years of service and multiple deployment issues. This new methodology allows DRDC to establish the overall impact of TFA deployments on attrition, providing valuable information for future operational planning cycles and assisting in discerning which policy changes may have influenced attrition.

## ADVISORY BRIEFS TO THE CANADIAN SURFACE COMBATANT PROJECT

Over the course of the last two years, DRDC scientists have worked closely with the Canadian Surface Combatant (CSC) Project to provide a series of briefings on current and future capabilities regarding marine and combat systems, including sensors and weapons. These briefings provide the project team with a view of both the state of, and the trend in, technology in these critical areas. This information will be used to support the development of CSC platform design and capability requirements for the next generation of Canadian warships.

## LIFE AFTER SERVICE STUDY

The Life after Service Study was developed to examine how well CF personnel adapt to their transition to civilian life in terms of income, health, disability and determinants of health. DRDC, in collaboration with Veterans Affairs Canada (VAC) and Statistics Canada, initiated the study in 2009 and carried it out in 2010. Multi-department research efforts resulted in the development of a new methodology, inter-departmental letters of agreement, and final reports that will be used to improve current VAC and DND/CF programs and services. The study represents an important step in understanding the health and transition experiences of CF veterans. Furthermore, it will enable a level of improvement to take place in this transition process.

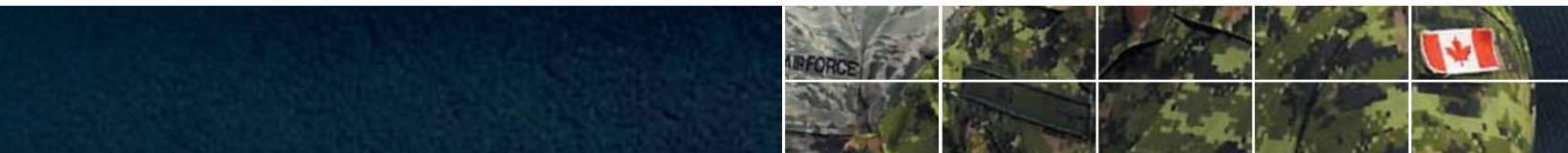


Canadian Surface Combatant Project simulation imagery.

## HUMAN DIMENSIONS OF OPERATIONS STRATEGIC ANALYSIS

The first DRDC Human Dimensions of Operations (HDO) Strategic Analysis was completed in April 2010. It provided insight into the readiness, resilience and readjustment of personnel involved in Joint Task Force Afghanistan. More specifically, it included the results from the surveys that were administered across the deployment cycle (pre-deployment, in-theatre, and post-deployment). This was the first strategic-level report of HDO results based on an entire rotation. Its results have assisted in the validation of military ethics and pre-deployment training programs. Results of this report were presented to Chief of Land Staff and the Army Council for their consideration.





## IMPROVING THE CANADIAN FORCES SELECTION MODEL

Each year, more than 20,000 Canadians apply to join the CF. In the past few years, the CF has met or exceeded the recruitment requirements, with an annual intake of about 6,000 new personnel.

The CF uses a thorough selection process to choose the highest quality recruits from among those who apply to join the CF. In recent years, the need to strengthen the CF selection process and to take full advantage of changes in technology and Internet use has become more and more apparent. Incorporating such changes could allow new options to be used in the administering of selection tests across the nation that would be more efficient and would enable recruiters to reach more Canadians. In addition, ways of improving the creation and secure management of critical tests such as the CF Aptitude Test (CFAT) data are being examined.

Over the last year, a team of military and civilian researchers within DRDC developed novel approaches, leveraged scientific networks, and implemented a series of innovations to improve the CF selection process. These include transforming the personality assessment components of the process to improve the resulting selection of successfully performing members, and establishing a capability to administer the CFAT to applicants online.

Achieving this success required initiative and perseverance in order to create a shared vision among all stakeholders and to break down institutional and procedural barriers. Collectively, these efforts position the CF to successfully fulfill their defence and security mandate by increasing their ability to hire the right candidates for the right jobs more efficiently and effectively.



# TECHNOLOGY DEVELOPMENT AND EVALUATION



Through its technological expertise, DRDC helps to ensure that our CF are optimally equipped and prepared for current and future defence priorities and requirements. Where technological gaps exist, DRDC develops and evaluates new capabilities, which will be incorporated and put into service by the CF. By connecting defence and security needs to industry capabilities, DRDC provides maximum S&T value for money to DND/CF while positioning Canadian industry for success. The following examples feature some of DRDC's technological accomplishments.

## DRDC EMPLOYS HYPERSPECTRAL TECHNOLOGY IN THE DESERT AND IN THE ANTARCTIC

DRDC uses hyperspectral technology in its search for effective methods related to the safe and reliable stand-off detection of improvised explosive devices (IEDs) in support of the CF. It has become evident to DRDC scientists that the versatility of hyperspectral imaging methods is demonstrably unmatched. Detectors mounted in airplanes can pinpoint soil disturbances and buried objects, as well as distinguish between natural and man-made materials. These methods are also used in numerous remote sensing applications such as forestry, geology, firefighting, agriculture, and search and rescue.

From the frozen tundra to the desert, these enhanced capabilities will have profound implications for a number of military and civilian applications. These include situational IED route management, establishing and maintaining the necessary baseline surveys integral to the CF's expanding mission to safeguard Canada's Arctic sovereignty, and monitoring climate change in the fragile and sensitive high latitudes of both the Arctic and the Antarctic.

### Hyperspectral Technology Goes Airborne in Antarctica

In February 2011, a unique opportunity was crafted through a combination of location, cooperation and scientific expertise, when DRDC, the British Antarctic Survey (BAS) and an industry partner combined resources to conduct the world's first airborne hyperspectral survey of Antarctic Special Protected Areas (ASPAs).

The Antarctic team, operated from the BAS Rothera Base on Adelaide Island, Antarctica, flew three state-of-the-art detectors spanning the ultraviolet (UV), near infrared (IR), shortwave IR, and thermal IR wavelengths. Developed after more than two decades of scientific cooperation between DRDC and industry, the detectors feature improved spatial resolution, robust hardware and a standard processing solution. The instruments, mounted in a BAS Twin Otter aircraft, were extensively tested in the extreme conditions typical of high latitudes.

In excess of one terabyte of data was gathered, which will be used to generate extensive vegetation and geological maps of the ASPAs. Since some data collection coincided with a multispectral satellite-borne imager overpass, coordination of the data from both sources, combined with extensive ground truth records, will significantly expand the usefulness of both.



Antarctic Hyperspectral Survey Team.



## HERCULES OBSERVER TRAINER

The CF operates aircraft in theatres where personnel are threatened by missiles and gunfire. Aircrew of CC-130 transport aircraft operating in combat areas employ visual scanning to detect and coordinate reaction to small arms, anti-aircraft artillery, surface-to-air missile, helicopter, and fixed-wing threats. Observers in the aircraft report the existence and location of the threats and recommend defensive manoeuvres. Their reports must be quick, accurate and consistent in order for their aircraft to evade threats.

The CC-130 community identified the need to enhance aircrew threat detection, recognition and reaction through the use of simulation exercises to improve preparation for flying in hostile theatres of operation. In response, DRDC created a prototype observer trainer that accurately simulates airborne and ground-based threats under a variety of loadmaster duties and operational conditions, and included adaptation for night vision goggles. The system also networks with flight deck simulators and can be used with future transport plane replacements and other CF aircraft. The prototype proved so successful that 426 Squadron included the Hercules Observer Trainer (HOT) prototype in training at CFB Trenton before it was fully functional.

DRDC worked together with a team of contractors to upgrade the HOT design, focusing on two objectives. The first was to transfer the HOT to industry to contribute to Canada's high-technology economy and make the HOT more supportable for the CF. The second was to expand the capabilities of the HOT by improving the visual scene and enabling the aircrew to train with night vision goggles. Version 1 of the HOT has been licensed to a private industry corporation and is now being marketed internationally.

The impact of HOT has already been significant. It is fully endorsed and being used by 426 Squadron at CFB Trenton as a team training device for all

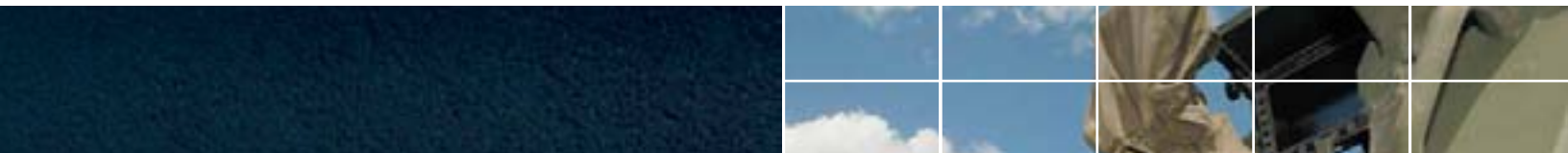
new loadmaster lesson plans. Its scope of use has extended to the development of tactical procedures. In addition, it allows loadmasters and aircrew to train in a simulated team environment, which was not available prior to this system.

The successes of this trainer have already been extended to our allies and partners and it can be adapted to meet the requirements of training for other aircraft and crew responsibilities, such as C-17 crew, helicopter door gunners, search and rescue, and air-to-air refueling. The superior training provided by the HOT not only helps to mitigate operational risks, but also contributes to a safer operating environment for CF members when deployed to threat zones.



The Hercules Observer Trainer simulates operational threats to CF aircraft in order to enhance aircrew threat detection.





## LAV III BELLY ARMOUR KIT

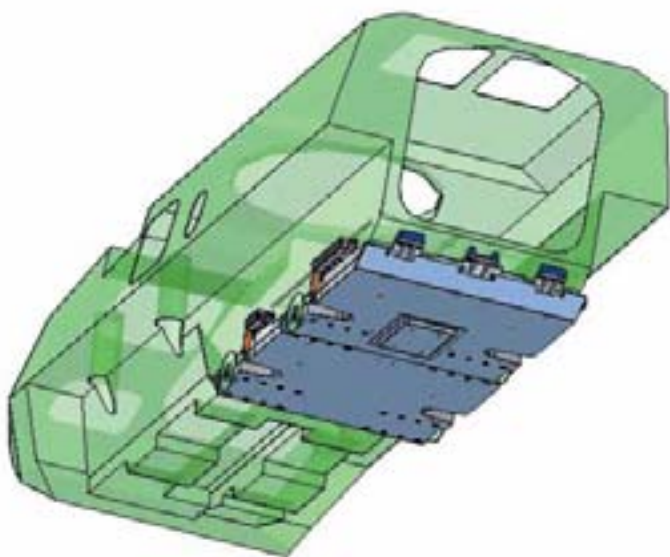
The increasing and deadly use of landmines and improvised explosive devices (IEDs) buried in Afghanistan roadways required urgent action by DRDC scientists to improve the effectiveness of the underbody or belly armour of the Light Armoured Vehicle III (LAV III), which is a primary means of soldier transport.

The successful result was the Belly Armour Kit (BAK), which substantially heightens the survivability of LAV occupants driving over undetected landmines or IEDs. DRDC conducted design and prototype integration trials with the CF to meet the required performance criteria, which included maximizing the underbelly protection of the occupants against fragmentation and blast threats, minimizing negative impact on LAV mobility; ensuring the kit was removable, low-maintenance and able to be installed in the field; and delivering the final package within a four-month timeline.

Since its deployment to Afghanistan, field incident data analysis, incident reports and feedback from the CF clearly demonstrated that the LAV III BAK provided significant survivability improvement against underbelly IED attacks. Thus, it greatly contributed to the reduction of troop casualties.

The system was integrated on LAV III as part of the LAV Operational Requirements Integration Tasks (LORIT) program, which also included a series of automotive and survivability upgrades on the LAV III. Several of these additional improvements, such as the integration of ballistic curtains inside the crew compartment, the use of roof-suspended seats and the improved side protection systems are also good examples of technologies that were demonstrated through DRDC's direct support to operations.

The BAK is an excellent example of how DRDC expertise can evolve from the fundamental assessment of problems to the development of fielded systems capable of addressing complex issues and answering critical operational requirements.



3-D rendering of the LAV III Belly Armour Kit.



A close-up of the Landmine Protection LAV III Belly Armour Kit.

## DRDC TAKES ON INTEGRAL ADVISOR ROLE IN NEW DND VEHICLE ACQUISITIONS

In 2010–2011, DRDC's role as an integral advisor in major acquisition projects was taken to a new level with its integral participation in the acquisition processes for the new Close Combat Vehicle (CCV) and Tactical Armoured Vehicle (TAV). For the first time, DRDC acted as the main advisor for the survivability and firepower aspects of the projects.

In addition, another first for DRDC was realized when DRDC participated in the Solicitation of Interest and Qualification committees, bidders' conferences, project evaluation strategy, and preparation of the Requests for Proposals (RFPs) for both projects. It was decided that full-scale vehicle testing would be conducted for each contender responding to the RFP. This was the first time such a test series was incorporated into a Canadian vehicle fleet acquisition project.

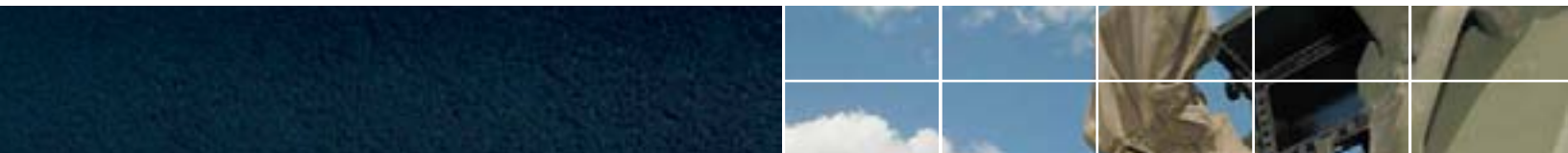
## TEAM TRAINING IN VIRTUAL REALITY WITH CONSTRUCTIVE AGENTS

In response to the high demands of Force Generation training, the Vice Chief of Defence Staff directed DND to consider modelling and simulation (M&S) to help overcome any potential deficiencies in current approaches. DRDC was given the task of exploring Virtual Reality (VR) simulation for team training and analyzing the Human Factors associated with making VR a practical training tool.

DRDC collaborated with Maritime Helicopter personnel at 12 Wing Shearwater to validate a VR Landing Signals Officer (LSO) training simulation. This involved leveraging a Helicopter Deck-Landing Simulator, which was developed to allow pilots to train ashore. It also involved introducing an LSO workstation and networking the human modelling framework Simulated Operator for Networks (SimON). SimON is able to reduce the demands on operational personnel, who are typically required to serve as role players by filling in for missing team members during training.



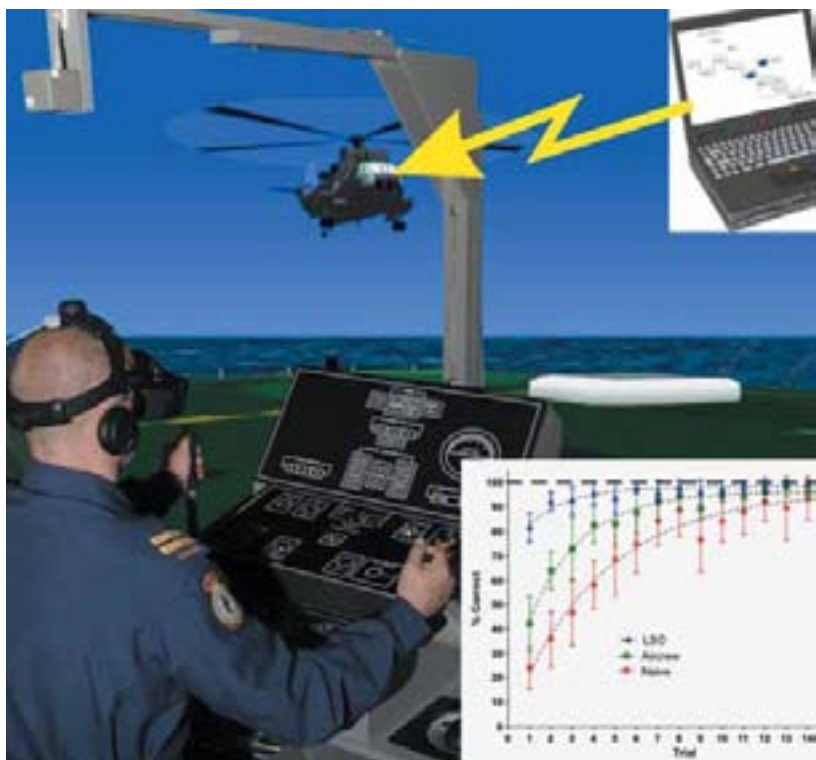
Maritime Helicopter personnel train using virtual reality simulators.



The 12 Wing validation study employed a Reverse Transfer of Training paradigm to minimize the risks associated with Forward Training Transfer methods in operational domains. Results indicated that the approach was very successful for teaching the procedural aspects of the LSO's task. Preliminary reports have been published for the supporting operational unit and a paper was presented at the Behaviour Representation in M&S conference (BRIMS 2011). Command staff and instructors in Shearwater noted that the simulation could be put into useful service immediately. Further work is planned to extend the application of these and other VR technologies to demonstrate their potential in other domains such as tank crew training as well as for use in route finding training for submarine crews.

## AESA IMAGING RADAR SYSTEM

DRDC specialists have teamed up with industry partners to develop a next-generation Active Electronically Scanned Array (AESA) Imaging Radar System. This new technology provides a Canadian product that is smaller, lighter, lower in both cost and power consumption, and having greater flexibility than conventional systems. For example, an AESA imaging radar can form multiple beams that allow scanning without mechanical steering and can perform multiple functions concurrently through fast switching and the use of multiple waveforms. In a related project that led to the successful creation of AESA, DRDC radar algorithms were successfully incorporated into the APS-508 radar, which is part of the upgrade of the CP-140 maritime patrol aircraft.



Landing Signals Officer (LSO)  
training simulation.

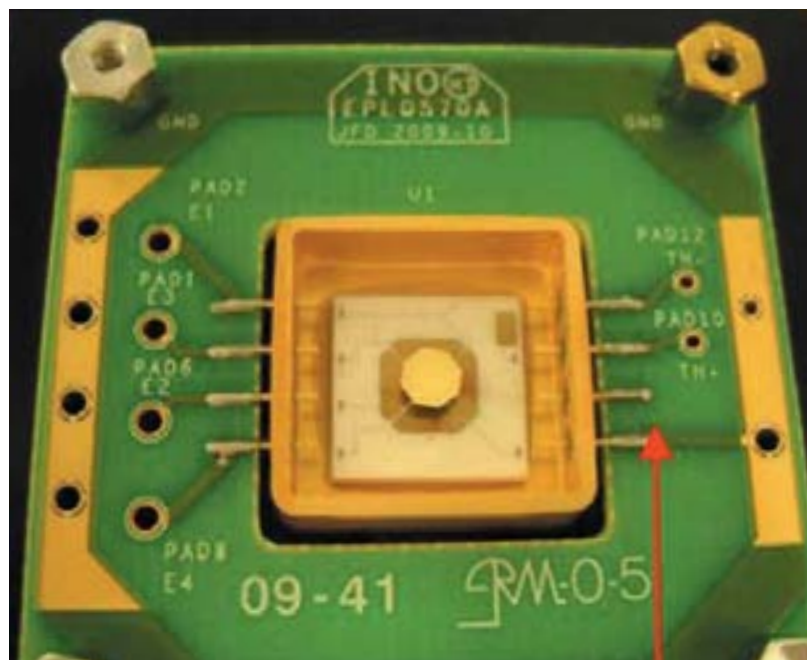


## MICRO-ELECTROMECHANICAL SYSTEMS-BASED LASER BEAM STEERING DEVICE

Although lasers are now found in many civilian and military applications, precise steering of a laser beam in space is still a technological challenge. Current steering solutions, based on opto-mechanical systems, have considerable limitations when they must be used in an environment that has significant mechanical constraints such as excessive vibration or size. In order to obtain a sturdy, compact, lightweight laser beam director, DRDC mandated industry to develop a prototype for a micro-device based on micro-opto-electro-mechanical systems (MOEMS) technology, which would be potentially more robust.

The resulting micro-device, called a micro-electro-mechanical system or MEMS, consists of an octagonal mirror with a usable diameter of 3 millimetres placed in a 15-millimetre sealed capsule that is attached to a 40-millimetre electronic board and controlled by a specialized interface. During tests at DRDC with the micro-device, a laser beam with a mean power greater than one watt was pointed on an angular range of 40 degrees by 60 degrees within a response time of less than 0.5 seconds. These are noteworthy performances that put DRDC and its industry partner on the leading edge of research in this field.

In addition, the design of the micro-device's mirror, which is unique to a MEMS device, made it possible to solve several technological problems that were related to mirror design. With this development, DRDC and its industry partner have made a significant contribution to the international effort to not only miniaturize laser beam steering devices, but also to make them more robust.



A close-up of the new 40-millimetre micro-opto-electro-mechanical laser beam steering system.



## BLAST TUBE ACQUISITION MARKS BLAST INJURY PROGRAM MILESTONE AND NEW CAPABILITY

DRDC's new Blast Injury Program marked a significant milestone as it took delivery of a new blast simulator in December 2010. This simulator is a specially designed gas-dynamic shock tube, which represents a one-of-a-kind capability. It is a substantial improvement over blast simulators that are currently being used in this very active research field. It is able to generate air shock waveforms that simulate those from such current blast threats as improvised explosive devices (IEDs).

DRDC will use the laboratory simulator to assess the biomechanics of blast injury, which in turn will lead to the development of possible therapies, treatments, and countermeasures such as improved protective technologies. Operationally, the simulator will be able to turn around several tests a day, a notable advancement for blast-injury research within DRDC. This new capability places DRDC in the forefront of blast wave simulation with regard to traumatic brain injury (TBI) research.

The medical priorities for the CF focus on three major causes of injury and death in theatre: hemorrhage or massive bleeding, issues surrounding tourniquet release, and blast-induced neurotrauma or brain injury. In response to these priorities, a multidisciplinary effort within DRDC has developed a blast injury research program focused primarily on brain injury. In collaboration with Canadian and American universities, other NATO laboratories, and industrial partners, research is being conducted to examine the effects of blast-related neurotrauma using imaging, as well as neurobehavioural, pathological and biochemical endpoints, with an emphasis on ensuring that the actual blast physics of the exposures reflect today's battlefield. This has allowed for the rapid development of ever-larger neurotrauma models. These efforts will support ongoing work aimed at mitigating the effects of blast-induced traumatic injury and answering fundamental questions concerning its origins and treatment, which are areas of concern for both the CF and Public Security.



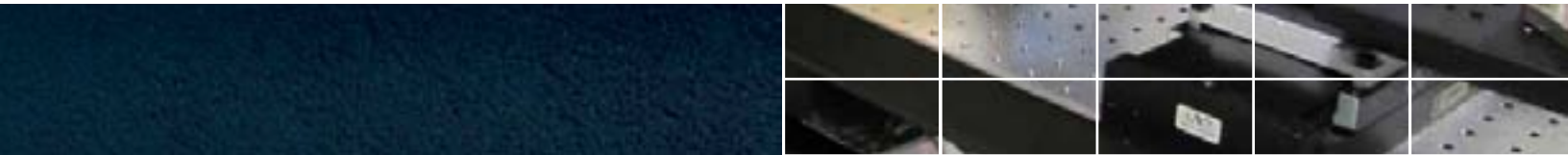
DRDC scientists pose beside our newest blast simulation tube.



# INTERNAL OPERATIONS AND ACHIEVEMENTS



DRDC's successes arise from a combination of several factors working together, which include the quality and relevance of our research, the excellence of our operations, the skills of our workforce, and the effectiveness of our work environment. These factors create a strong foundation on which to build and strengthen our capacity for success. We celebrate our successes by recognizing and rewarding our achievements.



## MOVING FORWARD AS AN ORGANIZATION

### FOSTERING VALUED PARTNERSHIPS IN DEFENCE AND SECURITY

#### International Relations

Partnerships are at the core of DRDC's success in delivering S&T solutions to DND/CF. These partnerships increase DRDC's S&T capacity to support departmental core processes, shorten fielding times for technology solutions, and improve access to global leading-edge S&T advancements. DRDC nurtures and maintains a portfolio of trusted bilateral and multilateral partnerships with the S&T organizations of Canada's defence and security partner nations and military allies. Common solutions lower the cost of defence and security technology development for each participant, through cooperative effort and burden sharing. This promotes interoperability through shared technology developments and processes, and increases global security through a mutual understanding of the state of the art in defence and security technologies. In 2010–2011, DRDC successfully launched the *Guide to International Partnerships* in order to provide a strategic framework for these partnerships and to ensure that these investments were linked to key departmental priorities and so aligned with the capability needs of the CF.

In October 2010, DRDC hosted the Technical Cooperation Program (TTCP) Principals Meeting. The TTCP is a forum for Canada, the U.S., the U.K., Australia and New Zealand to collaborate on S&T related to defence and security. The annual Principals Meeting featured strategic sessions as well as presentations from all scientific groups. Canada was instrumental in moving forward the modernization efforts of the organization that would further develop, share and integrate the emerging defence S&T and advance the military capabilities of the five member nations.

#### Industry Relations

Defence Research and Development Canada has recognized the need for a higher level of ambition for the S&T investment in order to increase the success of both DRDC and the Canadian defence industrial base. As a key component of the Canadian innovation system, industry is an important partner for DRDC, DND and the CF. It is a major source of innovative ideas and has the capability to translate concepts into reality. Engaging Canadian industry across the spectrum of DRDC's activities was an important focus for 2010–2011. In particular, DRDC, in partnership with the Canadian Association of Defence and Security Industries (CADSI), held a DRDC Outlook Day in order to outline DRDC's strategic approach to R&D and to highlight upcoming requirements and future directions.

DRDC also launched a series of consultations with industry in 2010 in order to better understand how it could contribute to the outcomes of the Canada First Defence Strategy and the Defence S&T Strategy. DRDC was interested in determining how to refine both the DRDC-industry relationship as well as the defence S&T role concerning their contribution to the CF and Canadian economic development. DRDC was also looking for ways to further encourage and support industry investments in R&D within the Canadian defence and security sector. Industry confirmed that DRDC is a valued partner particularly because the agency is able to provide expertise and insight into the capability needs of the CF. Companies were also supportive of DRDC's co-investment and co-development model regarding technology development.

In June 2010, DRDC further engaged and supported the Canadian defence industrial base by participating in CADSI's annual CANSEC trade show. DRDC hosted the Future Technology Watch Showcase, which highlighted the success of the departmental S&T investment and profiled the co-development/co-investment model of innovation adopted by DRDC. Along with tabletop displays throughout the showcase, six sessions focused on the DRDC partner groups and also featured presentations from Canadian companies involved in technology development in those areas.

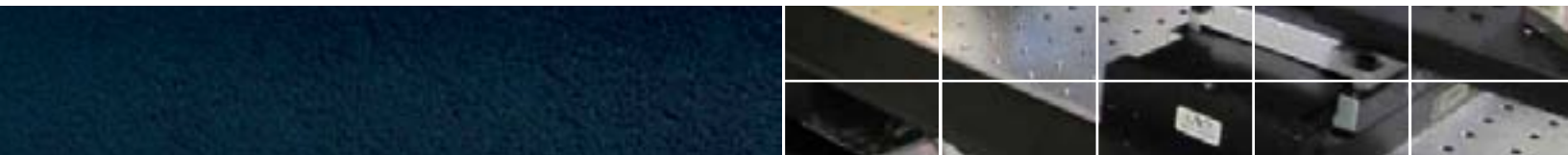
Under DRDC's leadership and in partnership with Industry Canada, DND established an Enhanced Priority Technology List. The list allows for a better alignment of the government's defence technology objectives with the development of Canadian advanced technologies in areas relevant to the future operational requirements of the CF. Aligning priority technologies with Industry Canada's Industrial Regional Benefits

program demonstrates a more coordinated approach to defence industrial development across government departments. The Enhanced Priority Technology List will leverage Canadian industry's capacity to develop transformational technologies and services that meet the short-, medium- and long-term operational requirements of DND while also growing the defence industrial base in Canada.

### Academia

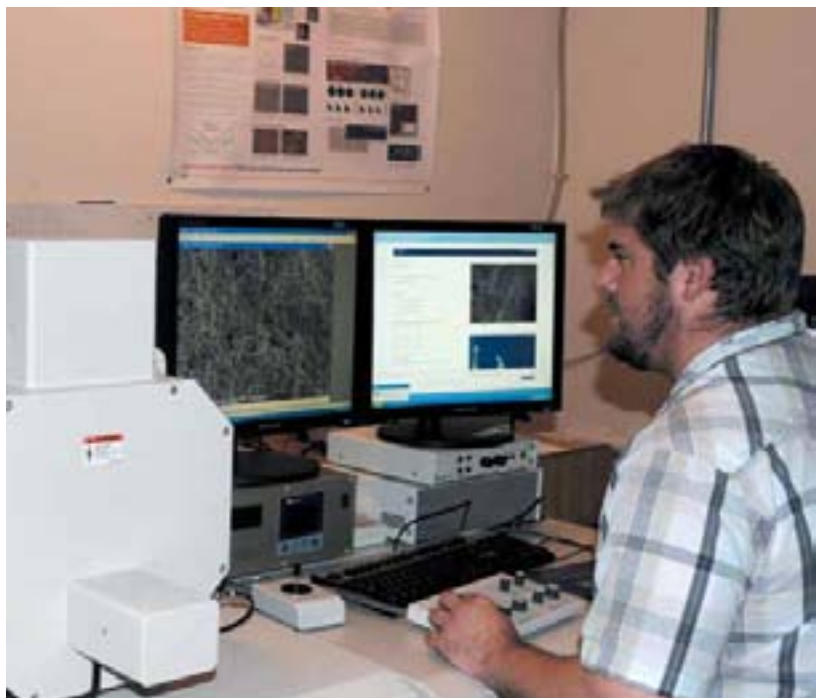
There is a long history of collaboration in Canada between DRDC and the Canadian academic community in order to leverage R&D investments and ensure departmental access to university-based human and knowledge resources. The Defence and Security Research Institute (DSRI) represents an investment in cooperation and collaborative research, technology development and analysis between the Royal Military College of Canada (RMC) and DRDC. DRDC is also engaged at different levels with the Canadian Tri-Councils, which include a series of successful collaborations under the DND/ Natural Sciences and Engineering Research Council of Canada (NSERC) Research Partnership Program. Grants were awarded through this program in 2010-2011, based on peer-review, to support university-based research carried out in collaboration with DND and Canadian-based companies.





## DOCKYARD LABORATORY RECAPITALIZATION

Since September 2008, DRDC's Dockyard Laboratories located on Canada's east and west coasts have been refitting their facilities with new instruments and test equipment bought under the auspices of the Scientific Outfit for Dockyard Lab Project. These laboratories, which support both our R&D and materials advisory activities, were using instruments that often dated from the 70s and 80s, and so were clearly having difficulties collecting data, maintaining calibrations, and handling the increasing volumes of work. Equipment that has been procured under this project includes new or upgraded gas chromatograph / mass spectrometers, hand-held x-ray analyzers, and scanning electron microscopes for both labs. In addition, a salt fog chamber has been procured for the Pacific lab, and a corrosion analyzer suite, electrochemical/corrosion test system and auto-hardness tester has been procured for the Atlantic lab. With this major overhaul, the labs are now well positioned to continue their excellent R&D and advisory activities well into the future.



DRDC Organic Chemical Technologist Ryan Glendinning operates a Scanning Electron Microscope with Energy Dispersive X-Ray Analysis, which is used for imaging material surfaces at high magnification, and elemental analysis.



DRDC Mechanical Technologist Tom Lemczyk conducts an experiment to determine the mechanical properties of a steel sample using a servo-hydraulic material testing system.

## ACKNOWLEDGING OUR ACHIEVEMENTS

Acknowledging the achievements and successes of its employees is an integral part of DRDC's organizational culture. DRDC is committed to recognizing employees for the excellence of their work and will continue to demonstrate how very much they are appreciated. Exemplary qualities such as initiative, integrity, leadership, teamwork, dedication and perseverance are vital to DRDC's continuing success. DRDC, therefore, proudly acknowledges these attributes when they are displayed by personnel.

### TTCP Awards

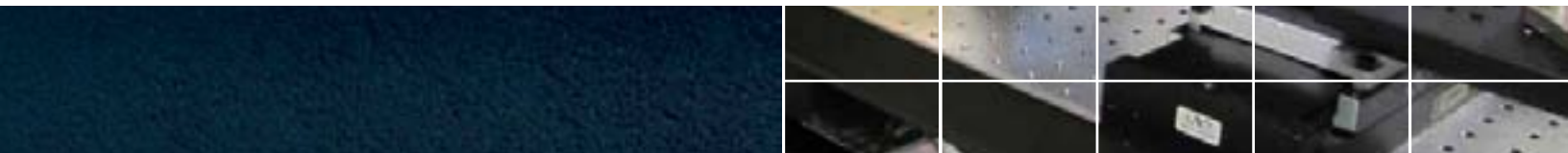
The Technical Cooperation Program (TTCP) is the most important defence collaboration program in which Canada participates. Each year, TTCP recognizes individuals who have made significant contributions to cooperative research activities and who have enhanced the technological strength of military forces.

**Leon Cheng, Shannon Farrell, and Allison Nolting** (DRDC Atlantic) received the MAT Group award for their contributions to TTCP collaboration in Characterization of Magnetostrictive & Magnetic Shape Memory Materials, and for significant advances in the development and exploitation of novel magnetostrictive and magnetic shape alloy technologies for defence applications – laying the groundwork for developing international acceptance standards and contributing to future substantial enhancement of military capabilities of the TTCP member nations.

**Jean-Marc Garneau** (DRDC Valcartier) received the TTCP Personal Achievement Award (SEN Group) for faithful and dedicated service to the EO Sensor Systems SEN TP-4 Panel and for leading the member nations to advance multisensory/multispectral programs for target detection and classification in heavy clutter. As the TTCP SEN TP-4 Canadian National Leader, he made significant contributions in leading group and TP/AG/Project interactions. His commitment to his panel and the Sensors group led to a series of joint trials, MUST 2000, conducted in Canada, Hawaii and Australia. The data provided a quantitative assessment of individual and integrated targeting surveillance sensors.

**Geoffrey Sunahara, Jalal Hawari (NRC), Guy Ampleman, Sylvie Brochu, and Sonia Thiboutot** (DRDC Valcartier) received the WPN Group team award for contributions to TTCP collaboration in Environmental Tolerance Values for Defence Sites Contaminated with Energetic Materials, and for significant contributions to collaborative research on the ecotoxicology of energetic materials and the ecological risk assessment of ranges at defence installations in the TTCP nations. Scientifically based Environmental Tolerance Values and bioaccumulation data for explosives, propellants, and related energetic materials were developed for use by site managers to assess exposure risks, and to ensure the sustainable management of these facilities. The data have been made available to the TTCP nations in the book "Ecotoxicology of Explosives."

**Kendall Wheaton** (DRDC Corporate), **George Prudat** (CF Warfare Centre), and **David Bowen** (Sparktek Ltd) received the JSA Group team award for contributions to TTCP Collaboration in JSA Group Technical Panel 4 & Action Group 15 and for demonstrating the integration of modelling and simulation with real world coalition C2 systems using a systems engineering process – which



enabled early demonstration of technology gaps in planned acquisitions to support ongoing operations in Afghanistan. The results had immediate impact on coalition operations, and demonstrated a gap in the pre-acquisition system of systems for all TTCP countries.

## NATO Awards

**Sharon Abel** (DRDC Toronto) and members of the NATO RTO HFM-147 Technical Team received a Panel Excellence award in recognition and appreciation of their contribution to “Advanced Personal Hearing Protection Technology.”

**Sandy Babcock, Paul Massel** (DRDC CORA), and **Gitanjali Adlakha-Hutcheon** (DRDC Corporate) received the NATO Scientific Achievement Award for their work with SAS 066 Joint Operations 2030 in recognition of exceptional effort in significant RTO activities, excellence and originality in the scientific and technical content therein, as well as outstanding results in terms of military benefit.

**Linda Bossi** and **Stephen Boyne** (DRDC Toronto) each received a NATO Scientific Achievement Award for their work on Task Group RTO SCI 178/RTG 043 “Integration and Interoperability Issues for Dismounted Soldier System Weapon Systems.” Ms. Bossi led the Human Factors Sub-Group, and Mr. Boyne participated as HF Advisor to the Technical Interfaces and Powered Rail Groups.

**André Morin** (DRDC Valcartier) received the NATO Scientific Achievement Award for his work with SCI-192 Advanced Electro-Optical Countermeasure Concepts.

**Keith Stewart** (DRDC Toronto) and members of the NATO RTO HFM-160 Technical Team received a Panel Excellence award “Measurement of the Effectiveness of Psychological Operations as part of Information Operations.”

## International and National Awards

**Fred Cameron** and **Geoff Pond** (DRDC CORA) were honoured at the 27th International Symposium on Military Operational Research (ISMOR) in September 2010 by the Administrative Sciences Association of Canada (ASAC) for Best Overall Paper for their paper entitled “Military Decision Making Using Schools of Thought Analysis – A Soft Operational Research Technique, with Numbers.” They also received honourable mention for their paper entitled “Applying Schools of Thought Analysis to Military Decision Making,” which was selected from papers submitted in the Management Science stream at the 2010 Annual Meeting of the Administrative Sciences Association of Canada.

**Neil Carson** (DRDC CORA) received the CJCS Award for Distinguished Public Service and for his exceptional service as a Canadian Defence Scientist at the North American Aerospace Defense Command, Peterson Air Force Base, Colorado. During a 10-month period, Mr. Carson was instrumental in developing a process to model North American Aerospace Defense Command Air Sovereignty Alert requirements. Mr. Carson’s outstanding service to NORAD and his country has brought great credit upon the command and both nations.

**Neil Carson** and **Jean Denis Caron** (DRDC CORA) received the MORS Walker Award for their article entitled “The Maritime Timeline Analysis and Requirements Toolset (M-TART),” which was rated the best technical article published in *Phalanx* for the preceding calendar year.

**DRDC** was a co-recipient of the Alouette Award from CASI (Canadian Aeronautics and Space Institute) as part of the CanX-2 team led by the University of Toronto Institute of Aerospace Studies (UTIAS) – Space Flight Laboratory. The award was presented at the ASTRO 2010 conference in Toronto on 4–6 May 2010. Maj Pascal Tremblay, Group Leader, Space Systems Group, attended to accept on behalf of DRDC. CanX-2 (Canadian Advanced Nanospace eXperiment) was the second nanosatellite launched to demonstrate technologies (e.g., propulsion system, custom radios, attitude sensors and actuators) that will be employed in the CanX-4/5 nanosats for a formation flying mission. DRDC’s contribution included project definition, funding, and access to our ground station facility. The Alouette Award is given to an individual or team who made an outstanding contribution or advancement to Canadian space technology, science, applications or engineering.

**Allan Keefe** (DRDC Toronto) was recognized by the Royal New Zealand Air Force Aviation Medical Unit for his work in transferring DRDC Toronto’s Pilot Anthropometric Selection Software and cockpit assessment methodology as part of an Air and Space Interoperability Council Test Project Arrangement.

**Allan Keefe** (DRDC Toronto) was recognized by the Royal New Zealand Air Force Aviation Medical Unit for his work in transferring DRDC Toronto’s Pilot Anthropometric Selection Software and cockpit assessment methodology as part of an Air and Space Interoperability Council Test Project Arrangement.

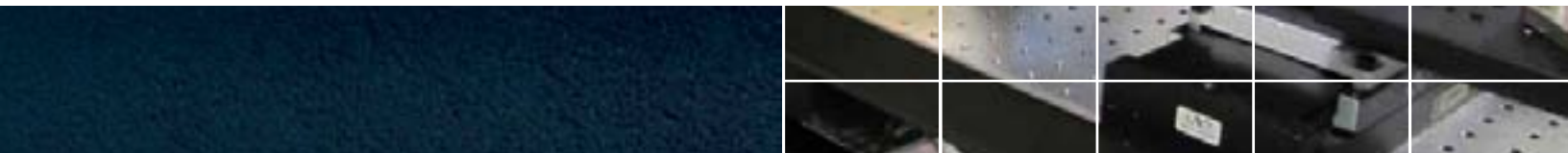
**Steve Palmer** (DRDC CSS) received a Canadian Advanced Technology Alliance’s Public Sector Leadership Award. This is presented to a leading individual from the public sector to recognize a significant contribution to the development and application of advanced technology in Canada. As Director of the Canadian Police Research Centre (CPRC), a DRDC CSS program, Mr. Palmer has shown excellence in advancing the CPRC mandate of ensuring that the best equipment and information is available to the emergency responder community – police, fire and paramedics.

A paper co-authored by **Michel Paul** (DRDC Toronto) entitled “Melatonin Treatment for Eastward and Westward Travel,” published in *Psychopharmacology*, was selected as one of the best publications for Sleep Medicine 2011.

**Thayananthan Thayaparan** was recognized as a Fellow of the Institute of Engineering and Technology (IET), which is the European counterpart of the (North America-based) Institute of Electrical and Electronics Engineers (IEEE). Fellowship of the IET is awarded to members who have demonstrated superior individual responsibility, sustained achievement and significant professionalism during their career in the field of science, engineering or technology.

**Antony Zegers** (DRDC CORA) won the Best International Paper award at the 27th International Symposium on Military Operational Research (ISMOR) in September 2010 for his paper entitled “Matrix Game Methodology Development and Employment for Vancouver 2010 Olympics Marine Security Planning.”





## DND/CF Awards

**Andrew Billyard, Ben Taylor, Chad Young and John Donohue** (DRDC CORA) received the DM/CDS Innovation Award for the delivery of comprehensive data to identify low performing, low priority programs under the Strategic Review process. They designed a proprietary software tool in a short time period to meet the tight deadlines and demands of the review.

**Lt Lori Coady** (DRDC Toronto) received a commendation from the CO of the 1st Royal Newfoundland Regiment for outstanding professionalism and dedication in support of Her Royal Highness, The Princess Royal, Princess Anne's visit on 22–25 May 2010. Summarizing her work for this event, Lt Coady's commendation stated: "Your deeds and actions truly exemplify the Regiment's motto Better than Best."

**Phil Eles** (DRDC CORA) was awarded the Canadian Forces Medallion for Distinguished Service, the highest honour bestowed on civilians for service of a rare and exceptionally high standard, which accrues great benefit to the Canadian Forces as a whole. His work has helped Canada make strategic decisions in response to Afghan public opinion and to evolve enemy tactics, techniques and procedures. His dedication in developing state-of-the-art research and analytical products has enhanced Canada's contribution to the Afghanistan mission.

**Ron Funk** (DRDC CORA) received the Canada COM Certificate of Appreciation for his professionalism and support of JTF Games in their preparations for *Operation PODIUM*. He led a team that carefully studied the communication between the Games Joint Operations Centre and other organizations,

including the RCMP and the Provincial Regional Emergency Operations Centre. His efforts served to maximize the effectiveness of communications and information passage as well as the design of the Games Joint Operations Centre. Mr. Funk also provided key insights into the structure and culture of the RCMP, allowing JTF Games to better anticipate reactions under different circumstances. Mr. Funk's praiseworthy efforts served our mission partners. His efforts and professionalism contributed significantly to the provision of a safe and secure Vancouver 2010 Olympic Winter Games.

**Peter Gizewski** (DRDC CORA) was recognized with the Commander Land Force Command Commendation for his outstanding professionalism, dedication and academic contribution as a core member of the Land Force concept development project team, charged with writing and publishing *Land Operations 2021 – Adaptive Dispersed Operations: The Force Employment Concept for Canada's Army of Tomorrow*. Attributed to his integral involvement, this publication is the conceptual guide from which land capabilities and force generation must evolve to ensure the continued success of Canadian Forces land operations.

**LCdr Simon Gowan** (DRDC Toronto) received the CO CFEME Commendation for outstanding vision and leadership in renewing and expanding the research program within the underwater warfare and clearance diving domain.

**LCol Dwayne Hobbs** (DRDC Toronto) was awarded a Chief of Defence Staff Commendation for leadership and professionalism in building a network of local Afghan contacts, providing insight and analysis, and creating a unique intelligence picture that predicted future enemy action.

**Sgt Avril Jno-Baptiste-Jones** and **Ross Pigeau** (DRDC Toronto) received the Colonel Carl Walker Commendation. This Commendation is presented in memory of Colonel Carl Walker, the Commanding Officer of CFEME and Associate Director General of DRDC Toronto from 2004–2008. Carl Walker was a champion of the symbiotic relationship between DRDC Toronto and CFEME, and continually encouraged a collaborative atmosphere among our military and civilian staff. This award is given to the DRDC Toronto or CFEME staff member who has most demonstrated this spirit of cooperation and team building in keeping with the legacy left by Col Walker's efforts. This award is presented jointly by the DG of DRDC Toronto and the CO of CFEME as a testament to this spirit of cooperation.

**Matthew Lauder** (DRDC Toronto) received the South-West Asia Service Medal for his participation in efforts to combat terrorism.

**Peter Lockwood** (DRDC CORA) received the DM Commendation for his many exceptional contributions to intelligence analysis.

**Susan McIntyre** (DRDC CSS) was awarded the DM Commendation, which recognizes meritorious achievements by DND employees. It was awarded for her exceptional work in leading an interdepartmental team to develop a national After Event Review for security planning for the Vancouver 2010 Games, on behalf of the Privy Council Office's Coordinator for 2010 Olympic and G8 Security.

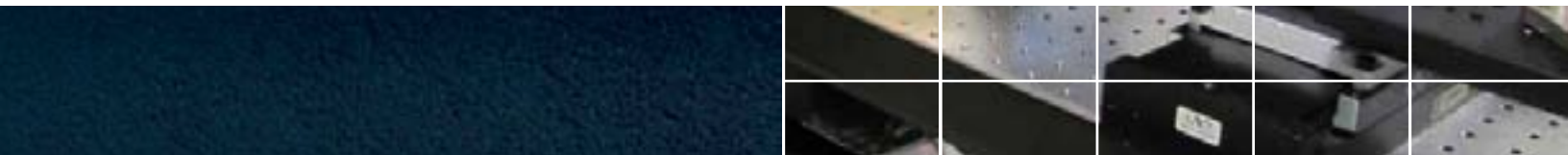
**LCol Colin Murray** (DRDC CSS) received the Chief of Defence Staff Commendation for his outstanding work as Director of the Major Events Coordinated Security Solutions (MECSS) project. The primary mandate of this Privy Council Office-directed multi-departmental and multi-jurisdictional initiative was to reduce the security risk associated with the Vancouver 2010 Games. Its success there prompted its implementation at the G8 and G20 summits, where it was also highly effective.

**MWO Jim Ogston** (DRDC Suffield) received the South Alberta Light Horse Regimental Medal in recognition of his distinguished service and assistance to the Regiment since 2005. It was presented to him for "exceptional service to the Regiment and for his vision of a Regimental Museum."

**John Porter** (DRDC Atlantic) received three awards related to his support to operations in Afghanistan:

1. Medallion of Excellence from General David Petraeus (ISAF Commander)
2. General Service Medal
3. Certificate of Appreciation – Support to Operations – *Operation ATHENA*

**Maj Gary Ralph, Capt Jody Weathered, WO Dean Thompson, Sgt Rick Auger, Sgt Al MacFarlane, Sgt Will Cook, MCpl Lissa Taylor, MCpl Brian Butler** and **Bill Martell** (DRDC Toronto) of the Life Preserver/Survival Vest (LP/SV) Team received the CO CFEME Commendation for outstanding work in the design, test and evaluation of critical Aircrew Life Support Equipment, enhancing the safety and performance of pilots flying the Hawk aircraft.



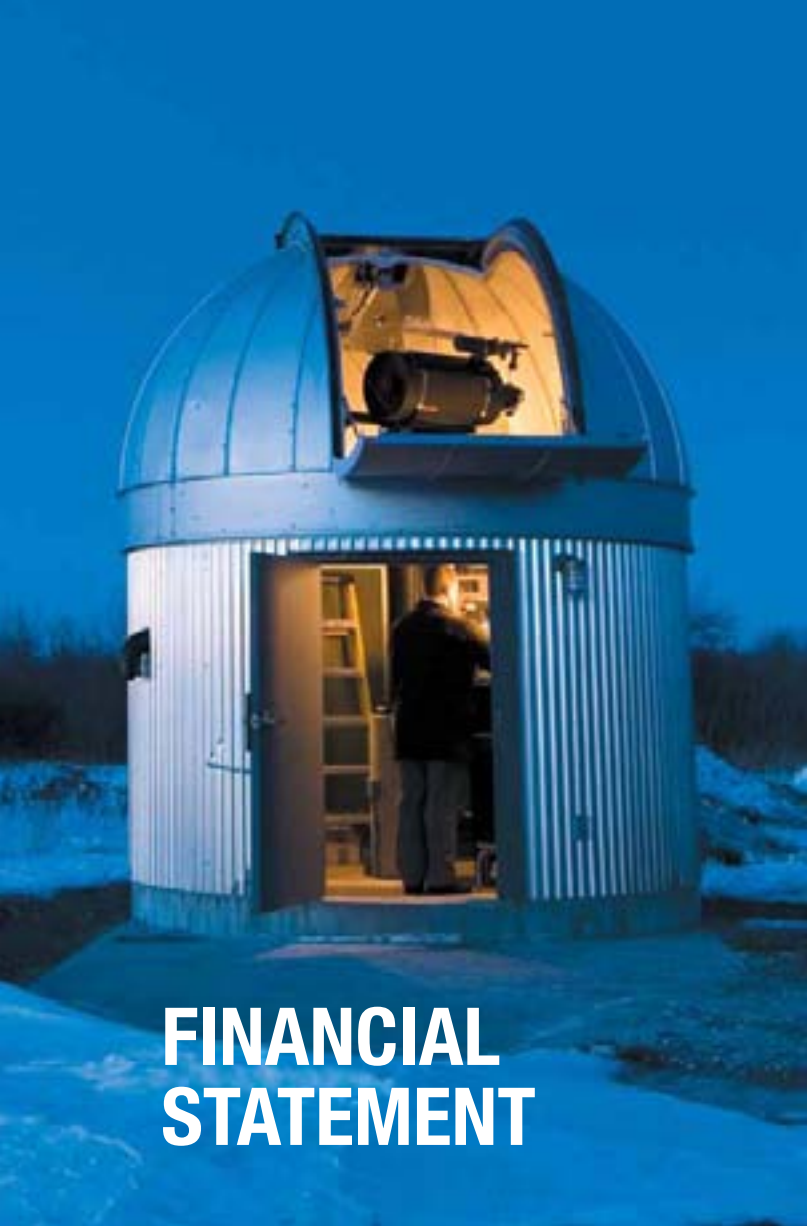
**Pete Smith** (DRDC CORA) received the Maritime Commander Commendation in recognition of dedicated, innovative, responsive and effective leadership and support in developing and enhancing Canada's Maritime Security and Domain Awareness while serving with the Maritime Forces Atlantic Operational Research Team. Mr. Smith was recognized for the quality of the advice and tools he delivered, and the mentoring and guidance provided to those who will follow.

**Adrienne Turnbull, Michel Couillard** (DRDC CORA) and **Kyle Fraser** (DGMPRA) received the Support to Operations Certificate and Bar (deployment to Afghanistan) for their tireless and dedicated support to the Canadian Forces and for increasing the profile of Defence Research and Development Canada within the operational community, while deployed in an expeditionary theatre under arduous, stressful and demanding working conditions.

**Donna Wood** and **LCol Colin Murray** (DRDC CSS) received the ADM (S&T) Commendation in recognition of their exceptional leadership in their roles of Director and Project Manager of the MECSS project, respectively.

**Donna Wood, LCol Colin Murray** (DRDC CSS) and **Inspector Jane MacLatchy** (RCMP) were the First Runners-up for the Project Management Institute Project of the Year award. The purpose of the award is to honor and publicize superior performance and execution of exemplary project management, which was demonstrated by these three individuals in their work on the MECSS project.

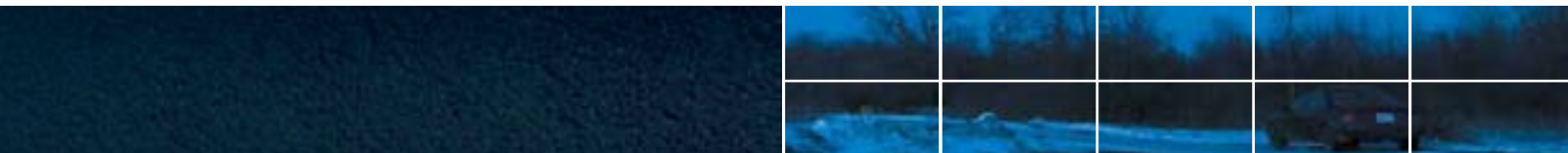




# FINANCIAL STATEMENT



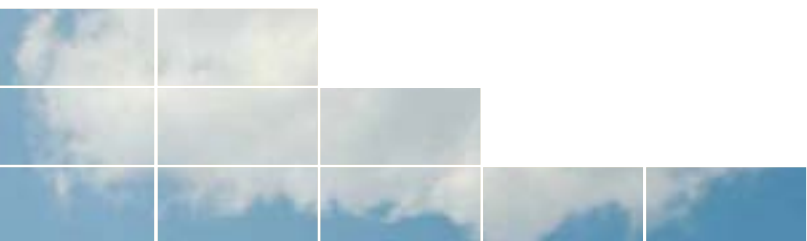
This table summarizes the funds DRDC received and expended in fiscal year 2010–2011 to carry out its program. The values shown are in thousands of dollars, with negative variances shown in parentheses.



FUND TYPE			
	REVENUES (\$000)	EXPENDITURES (\$000)	VARIANCE (\$000)
Salary and Wages	135,345	133,864	1,481
Operations and Maintenance	36,000	35,958	42
R&D Contracting	132,746	127,258	5,488
Environment and Infrastructure	14,203	11,797	2,406
Capital	28,020	27,298	722
Revenue	(3,500)	(2,422)	(1,078)
<b>Total</b>	<b>342,815</b>	<b>333,753</b>	<b>9,062</b>

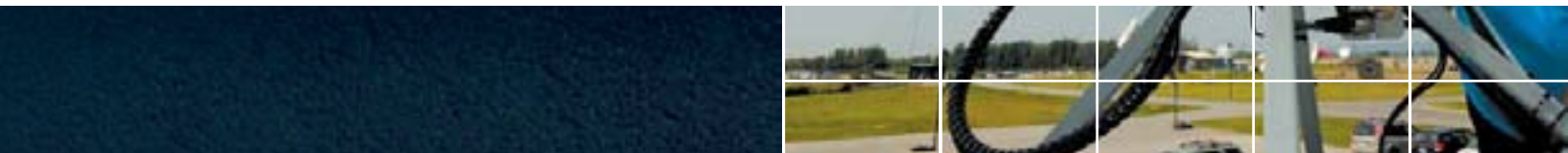
Source: DRDC and Assistant Deputy Minister (Finance and Corporate Services).

Note: Due to rounding, figures may not add up to totals shown.



# APPENDICES AND TABLES





## **APPENDIX 1 DEFENCE R&D CANADA'S CENTRES**

DRDC is made up of 8 research centres – each with a unique combination of expertise and facilities to carry out world-class S&T – in addition to a Chief of Staff organization, an operations centre, and a corporate services centre.

### **DEFENCE R&D CANADA – SUFFIELD**

DRDC Suffield and its Experimental Proving Ground are among Canada's key defence S&T assets and have long been active in the development of effective defensive countermeasures against the threat of chemical and biological weapons. DRDC Suffield also has important programs of work in military engineering, casualty management, and autonomous intelligent systems. The Counter Terrorism Technology Centre at DRDC Suffield contributes to Canada's ability to respond to domestic and international CBRNE incidents and specializes in live agent training and chemical/biological testing and evaluation.

### **DEFENCE R&D CANADA – TORONTO**

DRDC Toronto is Canada's centre of excellence for human effectiveness S&T in the defence and national security environment. Using a systems-based approach, the centre covers all aspects of human performance and effectiveness, including individual and team performance, human-technology interaction, and social and psychological factors that affect the resolution of conflict. DRDC Toronto also supports the operational needs of the CF through research, advice, test and evaluation, and training in undersea and aerospace environments.

### **DEFENCE R&D CANADA – OTTAWA**

DRDC Ottawa is the leader in defence technology related to electromagnetic sciences. Its expertise includes radio frequency (RF) sensing, RF electronic warfare, RF communications technology, network information operations, space systems, synthetic environments, and radiological defence.

### **DEFENCE R&D CANADA – CENTRE FOR SECURITY SCIENCE (CSS)**

DRDC CSS is a joint endeavour between DND and Public Safety Canada, which provides S&T services and support to address national public safety and security objectives. DRDC CSS' mission is to strengthen, through investments in S&T, Canada's ability to prevent, prepare for, respond to, and recover from accidents, natural disasters, or terrorist and criminal acts that impact the safety and security of Canadians.

### **DEFENCE R&D CANADA – CENTRE FOR OPERATIONAL RESEARCH AND ANALYSIS (CORA)**

DRDC CORA is our centre of excellence for operational research and analysis and the prime delivery centre for decision support to DND/CF. Its efforts span force development, resource allocation, acquisition, force generation and readiness, improved operational effectiveness and efficiency, strategic analysis, scientific and technical intelligence, and the achievement of departmental policy goals.

### **DIRECTOR GENERAL MILITARY PERSONNEL RESEARCH AND ANALYSIS (DGMPRA)**

DGMPRA responds to both the Assistant Deputy Minister (S&T) and the Chief of Military Personnel to ensure that military and civilian personnel research needs are met. DGMPRA personnel conduct strategic and operational research in the areas of personnel generation, personnel and family support, and operational and organizational dynamics. DGMPRA provides expert and evidence-based advice that feeds directly into CF policy and the DND decision making process to better recruit, train, educate, prepare, support, honour and recognize military personnel and their families, as well as to enhance operational and organizational effectiveness.

### **DEFENCE R&D CANADA – VALCARTIER**

DRDC Valcartier has world-leading expertise in optronic systems, information systems, and combat systems. The scope of activities includes spectral and geospatial exploitation, tactical surveillance and reconnaissance, command and control decision support systems, intelligence and information, system of systems, energetic materials, precision weapons, weapons effects and protection, and electro-optical warfare. The Defence engineering Valcartier section brings together multidisciplinary teams to offer the CF state-of-the-art scientific expertise, world class facilities, and turnkey project management.

### **DEFENCE R&D CANADA – ATLANTIC**

Defence R&D Canada – Atlantic has world-leading expertise in antisubmarine warfare, mine and torpedo defence, air and naval platform technology, the modelling and simulation of ship and combat systems, shipboard command and control, maritime information and knowledge management, emerging materials, power sources, and signature management. This expertise is applied primarily to the maritime defence and security domains, but also to the air and land environments.

### **DEFENCE R&D CANADA – CHIEF OF STAFF (COS)**

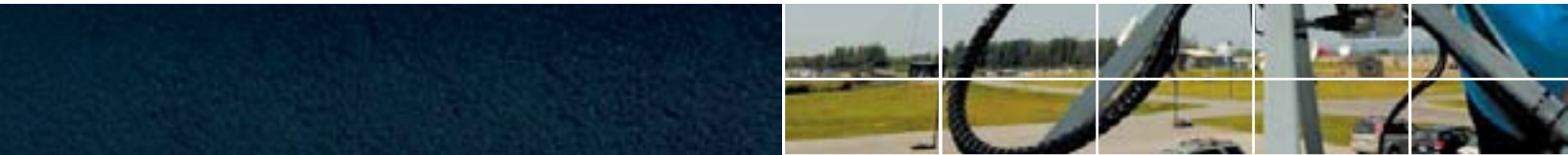
The COS organization is responsible for providing corporate leadership for DRDC. The Chief of Staff is a member of the DRDC executive and represents the organization on behalf of the Assistant Deputy Minister (S&T).

### **DEFENCE R&D CANADA – SCIENCE AND TECHNOLOGY OPERATIONS**

DRDC S&T Operations provides central coordination, strategic planning, delivery oversight of S&T programs, and support to operations through established interfaces with DND/CF and external partners.

### **DEFENCE R&D CANADA – CORPORATE SERVICES**

DRDC Corporate Services provides functional direction and central management of our corporate services and acts as an interface between DRDC, DND, and the Government of Canada.



## APPENDIX 2 DEFENCE R&D CANADA'S S&T PROGRAM

### PARTNER GROUPS

DRDC focuses its S&T activities in areas of critical importance to future CF operations. Our key objective is to ensure that the CF are technologically prepared for operating in a defence environment that will see increased emphasis on interoperability with allies, technology-driven warfare, and new asymmetric threats.

Our S&T program is developed in consultation with our partner groups in the following six areas: Integrated Capabilities; Maritime; Land; Air; Personnel; and Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance – as outlined below.

The DRDC S&T program is delivered through thrusts – packages of scientific and technical activities. Each thrust addresses a broad spectrum of issues and involves a team of our staff working with external partners that include academia, industry and allies. In the fiscal year 2010–2011, the total value of our S&T program was approximately \$480 million. This figure includes internal costs such as salaries and overhead, R&D contracts, and external and in-kind contributions. Please refer to the tables at the end of this report for additional details on our S&T program.

### INTEGRATED CAPABILITIES

The Integrated Capabilities S&T program aims to achieve objective and timely decision support, to anticipate future challenges, and to foster innovation through various projects and initiatives that ensure DND/CF have the capabilities necessary for assigned missions in line with defence policy. The program is

executed through four research thrusts: Strategic and Future Environment, Operations Analysis and Integrated Solutions, Special Operations, and CBRN Hazard Protection.

### MARITIME

The Maritime S&T program identifies specific objectives and activities to be pursued, and outputs to be produced, for the Maritime partner group. It also identifies the resources required to meet the research and development priorities established by the partners for ships, submarines and maritime aircraft and their systems. The program is arranged in six thrusts: Above-Water Warfare, Maritime Command and Control, Underwater Warfare, Naval Platform Technology, Maritime Domain Awareness, and Integrated Maritime Decision Support.

### LAND

The Land S&T program provides leadership and expertise to the Army and other stakeholders to define concepts, analyze options and develop capabilities for land operations. The program complements the forward-looking developments by means of support to the capabilities currently being acquired under capital equipment projects. The program is organized along six thrusts: Command, Sense, Act, Shield, and Sustain, linked to the Army's operational functions, and also Integrated Land Analysis.

### AIR

The Air S&T program supports the Air Force goals of integrated CF operations at home and abroad by the discovery, development, and integration of advanced S&T. The program is delivered through six thrusts, created in accordance with the Air Force functions terminology from aerospace doctrine: Command, Sense, Shape, Move, Sustain, and Analyze.



## PERSONNEL

The Personnel S&T program is designed to provide scientifically valid advancements in human resources and social science knowledge in areas that substantially benefit DND/CF in their pursuit of operational tasks and missions or departmental priorities today and in the future. The program is executed through five thrusts: Plan, Recruit and Train; Prepare, Support and Recognize; Individual and Organizational Operational Effectiveness; Human Integration; and Medical Intervention.

## COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS, INTELLIGENCE, SURVEILLANCE AND RECONNAISSANCE (C4ISR)

The C4ISR S&T program supports the joint and national-level commander and staff in work on communications, information and knowledge management; information architecture and information technology; information operations; command and control; surveillance; intelligence; and space. The program is comprised of five thrusts: Command and Control, Communications and Computer Network Operations, Intelligence, Surveillance and Space, as well as Scientific and Technical Intelligence Support and Advice.

## DRDC FUNDING MECHANISMS

The DRDC S&T Program is delivered via two interconnected mechanisms: the Applied Research Program and the Technology Demonstration Program. In addition to these, two programs are designed to fund smaller projects: the Technology Investment Fund provides funding for forward-looking, high-risk, but potentially high-payoff, research projects, and the Defence Industrial Research Program supports partnerships with Canadian industry. Projects in all four programs span the range of the six partner groups.

## APPLIED RESEARCH PROGRAM

The Applied Research Program is DRDC's main research and development program, which is made up of projects distributed among the six partner groups previously mentioned. Its objective is to advance the knowledge base of defence science, investigate novel and emerging technologies, and explore the military application of those technologies within the CF.

## TECHNOLOGY DEMONSTRATION PROGRAM

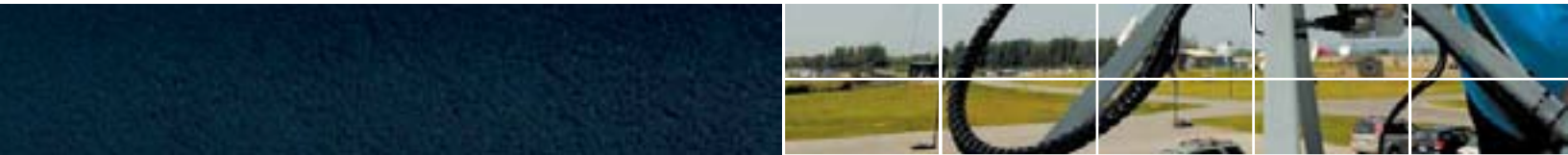
The Technology Demonstration Program (TDP) demonstrates technologies fostered by DRDC and Canadian industry in the context of real and potential future CF capabilities, concepts, doctrine, operations and equipment. The TDP is aimed at concept development and evaluation for force design purposes and is, therefore, typically not focused on hardware development.

## TECHNOLOGY INVESTMENT FUND

The Technology Investment Fund supports forward-looking, high risk, but potentially high-payoff, research projects to ensure a dynamic DRDC technology portfolio that is consistent with the Defence S&T Strategy, which will lead to important new in-house competencies.

## DEFENCE INDUSTRIAL RESEARCH PROGRAM

The Defence Industrial Research Program strengthens and supports the Canadian defence industrial base through the provision of financial and scientific support for eligible industry-initiated research projects relevant to the defence of Canada and/or its allies. The objective is to stimulate research and innovation that will enhance Canada's ability to share in the development of technologies to meet Canadian, NATO's and other allied defence requirements.



## APPENDIX 3 PATENTS, LICENSES, AND ROYALTIES

DRDC manages its intellectual property through patents, copyrights, trademarks and licences. Over the course of the 2010–2011 fiscal year, DRDC filed 12 applications and was granted the following 13 new patents:

1. Method and Apparatus for Eddy Current Detection of Material Discontinuities
2. Multi-Mode Pipe Projector
3. Linearizing Technique for Power Amplifiers
4. Super-Compressed Detonation Method and Device to Effect Such Detonation (Switzerland)
5. Combination Vaccine for Enhancing Immunity Against Brucellosis
6. Respirator End-of-Service Life Probe
7. Super-Compressed Detonation Method and Device to Effect Such Detonation (United States)
8. Composition for the Treatment of Infection with Human Influenza Viruses
9. Thin, Stretchable Chemical Vapour Protective Garment Worn Next-to-Skin
10. Light Modulating Microdevice
11. Image Projector with Flexible Reflective Analog Modulator
12. Desert
13. Fluted Link for Wiring

DRDC has granted 12 license agreements in the 2010–2011 fiscal year and they are:

1. Bracco Diagnostics Inc. for the “Decontamination Intellectual Property”
2. ABB Bomem Inc. for the “CATSI-EDM and the CASSIDI Algorithm”
3. Ultra Electronics Maritime Systems for the “System Test Bed (STB) Software”
4. Parisien Research Corporation for the “System Test Bed (STB) Software”
5. MDA Systems Ltd for the “SAR Imaging Modes and Ground Moving Target Indicator (GMTI)”
6. General Dynamics Canada Ltd. for the “System Test Bed (STB) Software”
7. Exactearth Ltd. for the “Automatic Identification System (AIS) Payload of the Maritime Monitoring and Messaging Microsatellite (M3MSat)”
8. MDA Systems Ltd. for the “Biosense”
9. Akoostix Incorporated for the “System Test Bed (STB) Software”
10. Omnitech Electronics Incorporated for the “Rapidly Deployable System”
11. Akoostix Incorporated for the “Star Software”
12. Gladstone Aerospace Corporation for the “Hercules Observer Trainer (HOT)”

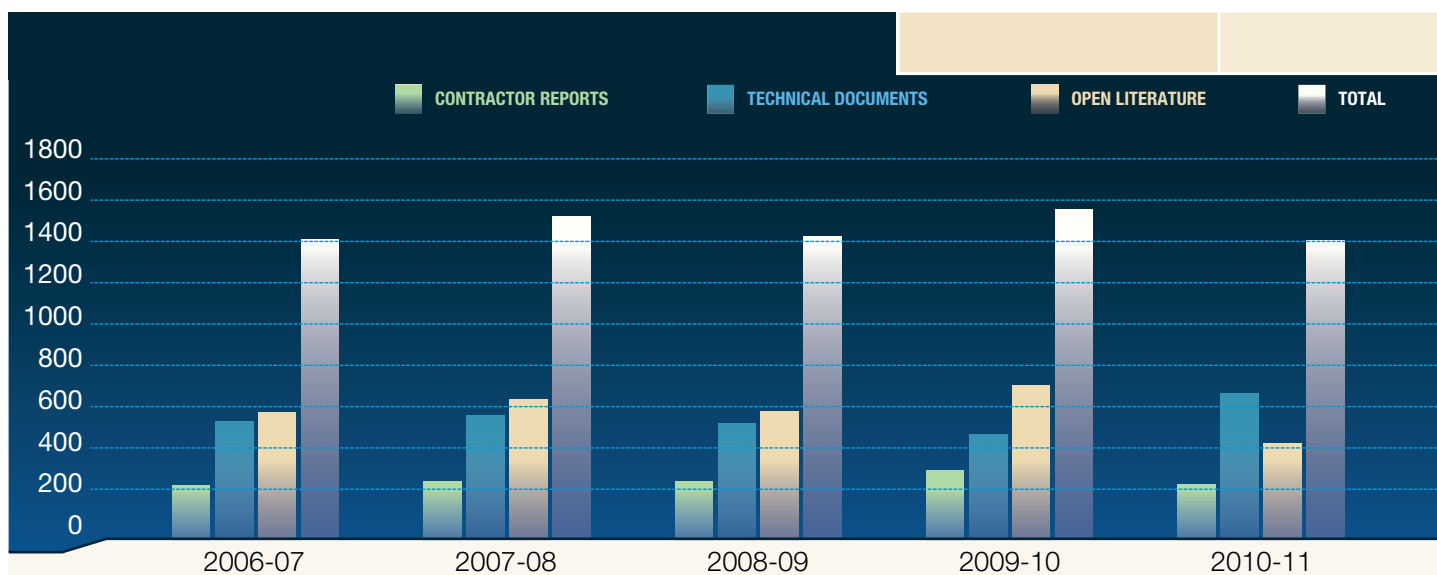
Our Licensees reported \$2,796,862.88 in royalties generated for 2010–2011.

DRDC paid \$310,828.89 in Public Servant Inventor Awards for 2010–2011.

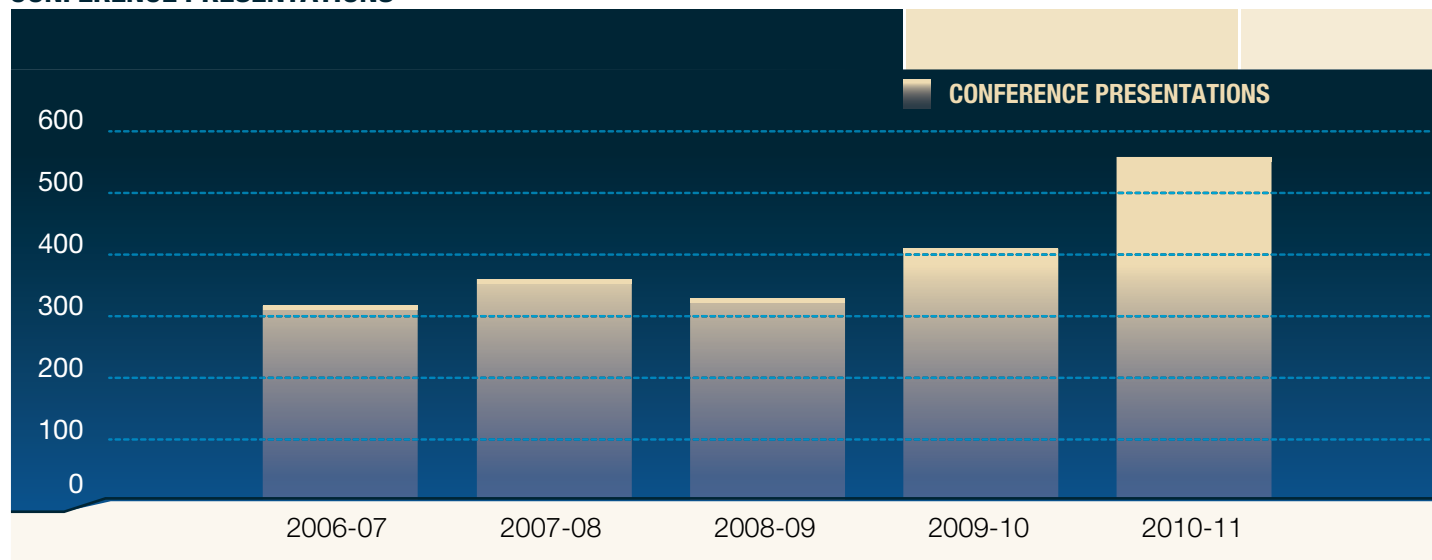
## APPENDIX 4 PUBLICATIONS AND CONFERENCE PRESENTATIONS

By promoting the results of our S&T activities through publications and conference presentations, DRDC transfers knowledge to clients in DND/CF as well as to colleagues in academia, industry and government.

This dissemination is a means of demonstrating our expertise and increasing awareness of our organization. The following charts show the history of our publication and presentation activities over the last five years.



### CONFERENCE PRESENTATIONS





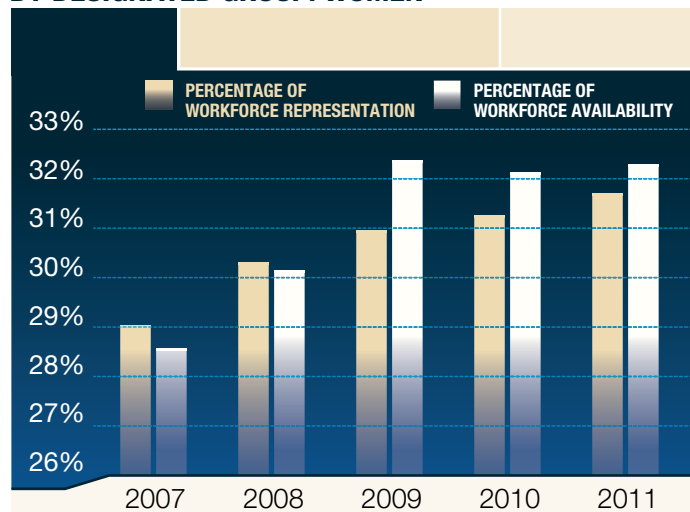
## APPENDIX 5 EMPLOYMENT EQUITY WORKFORCE REPRESENTATION

The charts below show DRDC's progress over the last five years in building a workforce that is increasingly representative of the Canadian population. Employment equity considerations were included in our human resources plan to ensure a better integration and consideration for workforce management.

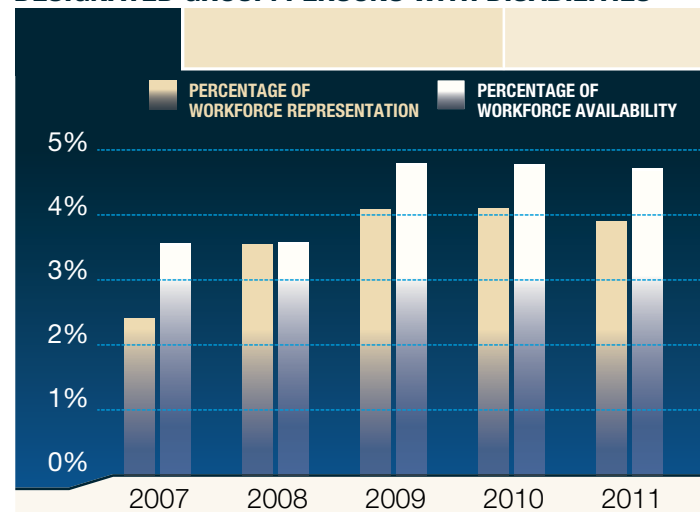
The data depicts a significant variance (> 2 percent) in our representation of visible minorities in comparison with external labour market availability. DRDC continues to focus on increasing the participation of visible minorities in our workforce.

Employees are encouraged to self-identify to ensure an accurate representation of the workforce composition and managers are encouraged to consider organizational needs when conducting recruitment.

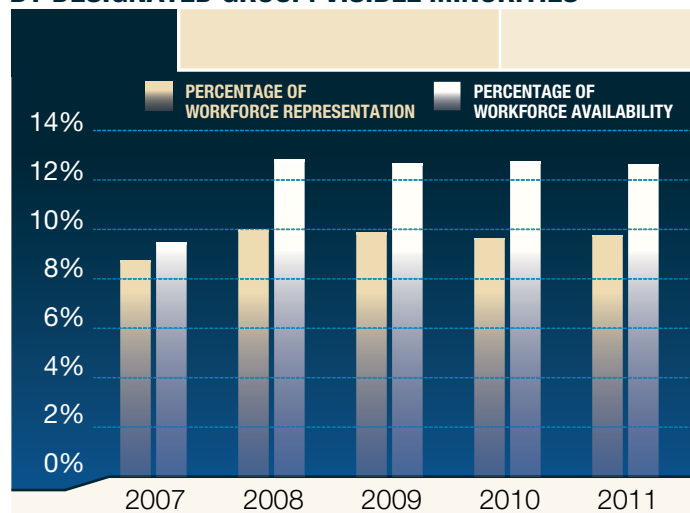
### EMPLOYMENT EQUITY REPRESENTATION BY DESIGNATED GROUP: WOMEN



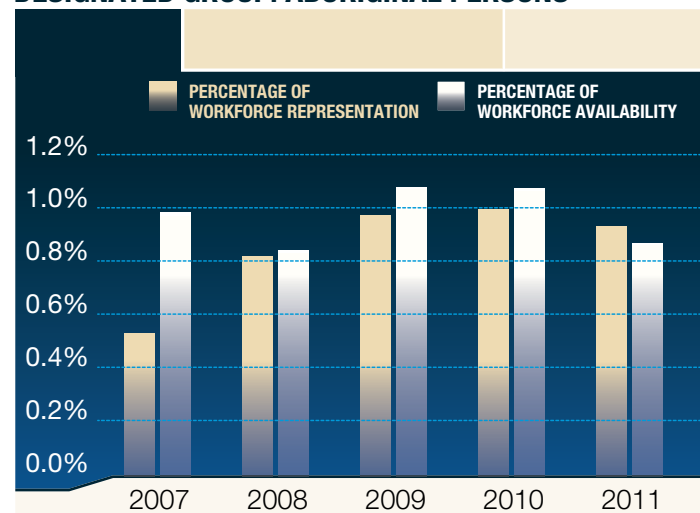
### EMPLOYMENT EQUITY REPRESENTATION BY DESIGNATED GROUP: PERSONS WITH DISABILITIES



### EMPLOYMENT EQUITY REPRESENTATION BY DESIGNATED GROUP: VISIBLE MINORITIES



### EMPLOYMENT EQUITY REPRESENTATION BY DESIGNATED GROUP: ABORIGINAL PERSONS



## APPENDIX 6 ARRANGEMENTS FACILITATING INTERNATIONAL COLLABORATION

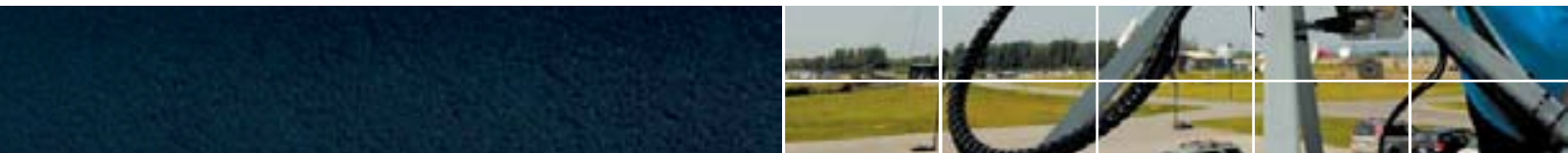
DRDC's international collaborative activities are carried out under a number of international arrangements which facilitate information exchange, collaborative projects and the exchange of personnel and equipment in some cases. The most active multilateral arrangements include The Technical Cooperation Program (TTCP) involving Australia, the U.K., the U.S., and New Zealand; the NATO Research and Technology Organization (NATO RTO) involving 27 nations; and the Multilateral Master Information Exchange Memorandum of Understanding (MOU). Given the number of participants, especially NATO RTO, these collaborative activities tend to focus on activities within the lower technological readiness levels (TRL).

Next to its traditional allies, Canada is also closely engaged with the Netherlands and Sweden and collaborating on more advanced projects under the trilateral MOU. Similarly, the Trilateral Technology R&D Projects Agreement with the U.K. and the U.S. provide Canada with a platform for carrying out research on a technologically more advanced scale. Several bilateral arrangements including MOUs with each of Australia, Germany, France, the Netherlands, Norway, the U.K. and the U.S. facilitate close bilateral collaboration in Defence S&T typically at a higher TRL.

In addition, DRDC has arrangements to advance its defence and security research via its Public Security Technical Program that is now linked with the U.K. Centre for the Protection of National Infrastructure. This MOU Concerning Public Security S&T complements the bilateral Agreement with the U.S. on S&T for Critical Infrastructure Protection and Border Security with the U.S. Department of Homeland Security. A further MOU to Combat Terrorism with the U.S. completes the international arrangements in this area.

The vast linkages established via bilateral and multilateral arrangements are very important tools for DRDC in that they facilitate its goals to obtain S&T results in the most efficient and cost-effective manner. Partnerships offer a way of joint knowledge generation, access to knowledge outside of Canada, application of allies' knowledge and S&T integration, which all lead to greater interoperability with Canada's allies and ensure that DRDC achieves its goals in providing the CF with the most advanced technology and scientific advice possible.

The table below lists the international arrangements in which DRDC participates and the approximate number of projects associated with each arrangement in fiscal year 2010–2011.



ARRANGEMENTS	NUMBER OF PROJECTS / ACTIVITIES
The Technical Cooperation Program (TTCP) (AU, CA, NZ, UK, US)	300
NATO Research and Technology Organization (NATO RTO)	200
Classified MOUs	30
Canada–US MOUs (Master Data Exchange Arrangement, Technology Research and Development Program)	25
The Public Security Technical Program (PSTP) (CA–US)	18
MOU on R&D for Combat Terrorism (CA–US)	17
Canada–Netherlands–Sweden Trilateral MOU	12
Canada–Australia Defence S&T Bilateral	11
Canada–UK Defence S&T Bilateral	10
Canada–France Defence S&T Accord	8
Canada–Norway Defence S&T Bilateral	5
Canada–Germany Defence S&T Bilateral	5
<b>Total</b>	<b>641</b>

**TABLE 1 VALUE OF DRDC S&T PROGRAM BY PARTNER GROUP**

PARTNER GROUP	INTERNAL COSTS <sup>1</sup> (\$000)	R&D CONTRACTS (\$000)	EXTERNAL CONTRIBUTIONS <sup>2</sup> (\$000)	TOTAL VALUE (\$000)
Integrated Capabilities	22,504	10,831	17,428	50,764
Maritime	42,301	12,403	20,033	74,738
Land	41,914	26,337	49,536	117,788
Air	20,660	14,542	32,226	67,428
Personnel	27,852	13,748	12,756	54,356
Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance	36,672	20,904	57,908	115,484
<b>Total S&amp;T Program</b>	<b>191,904</b>	<b>98,766</b>	<b>189,887</b>	<b>480,557</b>

<sup>1</sup> Internal costs include salary and wages, overhead, and operations and maintenance.

<sup>2</sup> External contributions include cash and in-kind contributions from sources external to DRDC.

**TABLE 2 VALUE OF DRDC S&T PROGRAM BY CANADIAN FORCES CAPABILITY**

<b>CAPABILITY/ CORE PROCESS</b>	<b>STRATEGY AND POLICY<sup>3</sup> (\$000)</b>	<b>FORCE DEVELOPMENT (\$000)<sup>4</sup></b>	<b>CAPABILITY PRODUCTION (\$000)</b>	<b>FORCE GENERATION (\$000)<sup>5</sup></b>	<b>FORCE EMPLOYMENT<sup>6</sup> (\$000)</b>	<b>TOTAL VALUE (\$000)</b>
Command	0	41,988	14,516	3,682	2,473	62,658
Sense	0	60,998	57,403	3,067	6,623	128,091
Act	0	8,618	29,539	1,002	4,770	43,929
Shield	1,933	20,109	86,463	2,324	8,128	118,957
Sustain	2,060	27,025	36,064	4,370	11,186	80,705
Generate	900	14,996	4,353	12,176	1,369	33,794
Integrated	3,632	6,808	883	191	909	12,423
<b>Total S&amp;T Program</b>	<b>8,525</b>	<b>180,543</b>	<b>229,220</b>	<b>26,812</b>	<b>35,458</b>	<b>480,557</b>

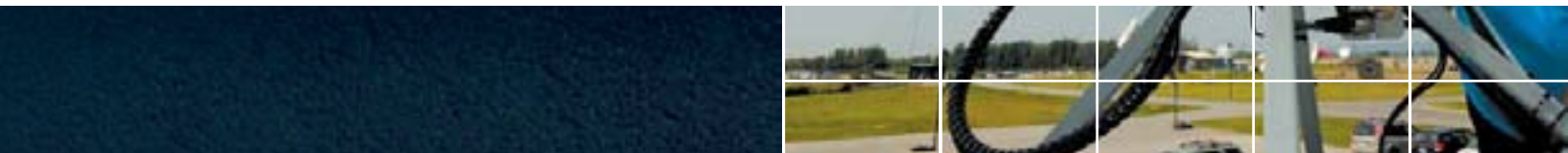
<sup>3</sup> Strategy and policy is a process for developing a roadmap by which DND/CF, as an instrument of government, will meet the defence and security objectives of the Government of Canada.

<sup>4</sup> Force development is longer-term planning associated with the creation and maintenance of military and departmental capabilities tailored to and aligned with the security environment and available resources.

<sup>5</sup> Force generation is the process by which forces are trained, equipped and assembled for potential operations. The process is completed once the forces are declared operationally ready and their command is transferred to the field.

<sup>6</sup> Force employment is the exercise of authority over assigned forces in the field. It includes planning, directing, coordinating and controlling these forces in the conduct of operations.





**TABLE 3 VALUE OF DRDC S&T PROGRAM BY TIME HORIZON**

PARTNER GROUP				
	TIME HORIZON I <sup>7</sup> (\$000)	TIME HORIZON II <sup>8</sup> (\$000)	TIME HORIZON III <sup>9</sup> (\$000)	TOTAL VALUE (\$000)
Integrated Capabilities	21,708	18,269	10,787	50,764
Maritime	33,160	27,269	14,309	74,738
Land	58,021	39,697	20,070	117,788
Air	31,837	24,548	11,043	67,428
Personnel	19,796	24,061	10,500	54,356
Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance	46,621	34,101	34,762	115,484
<b>Total S&amp;T Program</b>	<b>211,143</b>	<b>167,944</b>	<b>101,470</b>	<b>480,557</b>

<sup>7</sup> Time Horizon I refers to the enhancement and maintenance of current capabilities and includes projects that are expected to be completed within one to five years.

<sup>8</sup> Time Horizon II refers to the replacement of current capabilities and includes projects expected to come to fruition within five to ten years.

<sup>9</sup> Time Horizon III refers to the acquisition of new capabilities and includes projects that extend ten years and beyond.



## CONTACT INFORMATION

DRDC publishes its Annual Report to describe its operations for the fiscal year covered by the report, and includes information about its performance and any other information that the Deputy Minister of National Defence may require.

Our goal is to ensure that this report can readily serve as a quick and easy reference, personal or professional, to keep readers up to date on what DRDC and, by extension, Canada is doing in the area of S&T for defence and public security.

We invite you to get in touch with us should you have any suggestions or questions.

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