

NRC · CNRC

From Discovery to Innovation...

GLOBAL REACH
ACCESS

At Work on the World Stage



National Research
Council Canada

Conseil national
de recherches Canada

Canada

NRC VISION

Recognized globally for research and innovation, NRC is a leader in the development of an innovative, knowledge-based economy for Canada through science and technology.

This Vision is founded on five strategic pillars:

Outstanding People – Outstanding Employer

Recognition as a leading research organization distinguished by creativity and innovation

Excellence and Leadership in R&D

Integration of public and private strengths to create new opportunities and meet national challenges for Canada

Technology Clusters

Development of the innovative capacity and socio-economic potential of Canada's communities

Value for Canada

Commitment to the creation of new technology-based enterprises, technology transfer and knowledge dissemination to industry

Global Reach

Access to world-class science facilities, as well as global research and information networks. Stimulation of enhanced international opportunities for Canadian firms and technologies.

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Table of Contents

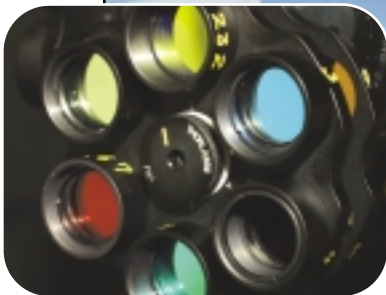
At Work on the World Stage

Accelerating Innovation through International Partnerships	2
Extending Canada's Global Reach	4
New and Renewed Partnerships	6
Exploring New International Opportunities	7
International Opportunities for SMEs	8
International R&D Collaborations – Benefits across the Board	9
Measuring Up to Improve International Trade	13
NRC – Science Lends a Helping Hand	13

Cover photo: Gemini North Telescope with northern circumpolar star trails. January 1999, Mauna Kea, Hawaii. Vancouver's AMEC Dynamic Structures, a frequent collaborator with the NRC Herzberg Institute of Astrophysics, has emerged as the world's premier builder of sophisticated observatory domes, such as Gemini North.

“Canada must become a champion and model of international S&T collaboration.” – *Report of the Expert Panel on Canada’s Role in International Science and Technology, June 2000*

At Work on the World Stage



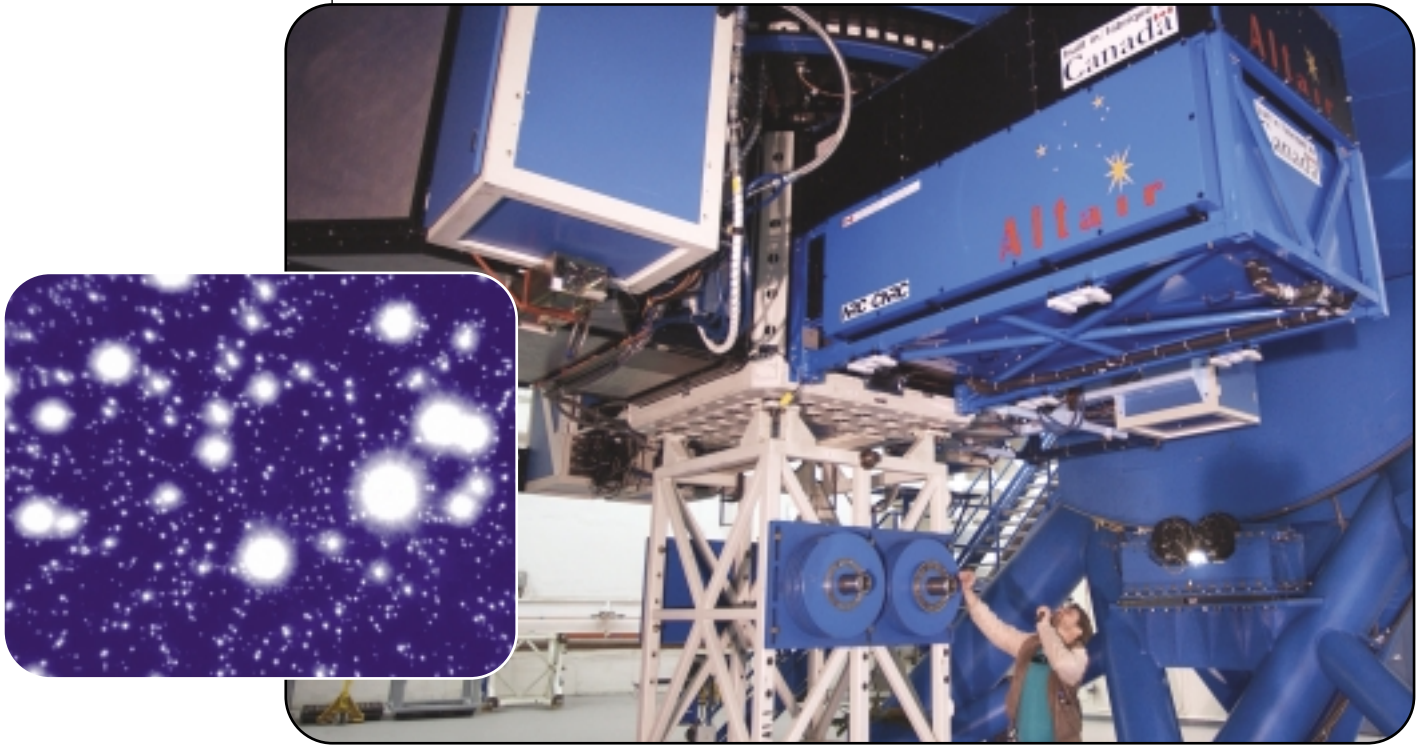
Accelerating Innovation through International Partnerships

Innovation is a global issue, rooted in each nation’s ability to create, exploit and transform new knowledge into the innovative products which can create a competitive edge in global markets. Canada’s participation in international S&T is vital for the nation to gain access to the new knowledge and the information it needs to succeed and innovate in the knowledge economy. Such access helps Canada stake a place in strategically important R&D areas and tap into the economic opportunities which this creates.

NRC has attracted worldwide attention for its research expertise, its track record of successful partnerships, its innovative programs for small and medium-sized businesses, its scientific standards work and its high-quality scientific and technical publishing. As a result of this reputation,

access

Installing Altair, Gemini North Telescope



Photos courtesy of Gemini Observatory

NRC is an active participant on the world stage, playing a key role in developing international research collaborations and partnerships.

NRC's international partnerships ensure that Canadians have access to the world's best S&T facilities, equipment and talent. Participation in these partnerships and strategic alliances also provides vital access to the knowledge produced by researchers

in other nations, a necessity for Canada and Canadian businesses. In addition, these alliances and collaborations help improve the international competitive position of Canadian firms by identifying key technology and business opportunities. At the end of the day, this global reach improves the quality and pace of knowledge creation by Canadian researchers in the public and private sector so that they can be more competitive in the international arena.



Opening of the exhibition pavilion at Biotech India 2003

Helping Meet National Priorities

To be among the world's top five in R&D and one of the most innovative nations in the world, Canada must be a full partner in international collaborative research ventures, which accelerate the pace of knowledge, discoveries and innovation. NRC, in its role as the ambassador for S&T, is helping brand Canada as a valued science and technology partner. This has resulted in significant international S&T alliances and knowledge networks of strategic importance to Canada.

Extending Canada's Global Reach

The international scientific research community has always cooperated across borders. Most of this cooperation occurs informally, researcher-to-researcher. Given the enormous benefits generated by these informal international partnerships, NRC has actively pursued international research partnerships and alliances on behalf of Canada. These efforts have produced significant results for all sectors of the Canadian economy. As of 2002–2003, NRC had 60 formal collaborations with 22 nations. NRC also boasts hundreds of other more informal alliances and collaborations.

Throughout 2002–2003, NRC continued to build its strategic alliances, collaborations and networks around the world for Canada.

As evidence of this activity:

- ▶ NRC received over 180 incoming foreign delegations
- ▶ NRC led close to 40 formal outgoing missions to other countries (including Australia, Brazil, India, Japan, Mexico, Netherlands, Spain, Switzerland)
- ▶ NRC employees sat on over 600 international committees
- ▶ NRC attended 732 international conferences
- ▶ NRC also organized over 100 international conferences and workshops

All of these various partnerships provide direct and concrete benefits to Canada. Each international linkage, from participation in an international conference, a workshop or a formal research project, represents an opportunity for Canada to obtain new knowledge, access equipment and expertise and share the cost of large-scale research projects in order to support the effective development of technology-based Canadian SMEs.

The benefits of these global connections don't stop with R&D partnerships and networks. The NRC Industrial Research Assistance Program (NRC-IRAP) plays a key role in connecting small and medium-sized Canadian firms to international sources of expertise and to emerging market opportunities. For these firms, gaining access to international connections they



NRC: 2002–2003 – Access to international S&T for Canada*

- NRC-United Kingdom – 7 R&D projects, missions, visits and exchanges
- NRC-France – 12 R&D projects, missions, visits and exchanges
- NRC-Germany – 11 R&D projects, missions, visits and exchanges
- NRC-Spain – 2 workshops, 4 R&D projects pending, missions, visits and exchanges
- NRC-Czech Republic – 2 R&D projects pending, missions, visits and exchanges
- NRC-Taiwan – 15 R&D projects, workshops and exchanges
- NRC-Singapore – 10 R&D projects, missions, visits and exchanges
- NRC-Thailand – missions, exchanges
- NRC-Japan – missions, visits and exchanges
- NRC – access to worldwide astronomy facilities, projects and agreements for Canada's astronomers (e.g. Canada-France-Hawaii Telescopes, Gemini Telescopes, James Clerk Maxwell Telescope)
- NRC-CISTI, NRC-INMS – dozens of collaborative agreements and MOUs
- NRC-IRAP – missions, visits and competitive intelligence for Canadian SMEs

** Figures denote corporate-level agreements and do not include specific institute partnerships and collaborations*



MOU signing with SEPOCYT

might not otherwise have opens the door to new sources of technology, knowledge and opportunities which are critical to their growth and development.

The NRC Canada Institute for Scientific and Technical Information (NRC-CISTI) adds further impact to NRC's global reach through continued expansion of its international connections with similar organizations around the world. These connections

provide all Canadians with easy Internet access to the information resources of other major S&T libraries around the world.

New and Renewed Partnerships

On a federal level, NRC participates in the Canadian S&T Agreements with Germany, France, Japan and the European Union (EU). NRC is currently conducting 32 projects under these Treaties. On an agency level, last year, NRC strengthened its strategically important international R&D relationships, with the signing or renewal of four separate Memoranda of Understanding (MOU) and one Letter of Intent (LOI), which created opportunities for expanded bilateral collaboration:

- ▶ The NRC and Hermann Von Helmholtz Gemeinshalft Deutscher Forschungszentren e.V. (Helmholtz) MOU generated 32 proposals, which resulted in 11 projects, at a value of \$9 million over three years.



MOU signing with Helmholtz

Canada has a relatively small population base and must rely on international markets to grow its economy. Scientific and technical expertise may now reside almost anywhere in the world. Access to this expertise can lead to more timely development of technologies if complementary strengths can be brought to bear on a problem.



MOU signing with RIKEN

- ▶ The NRC and Centre national de la recherche scientifique (CNRS) MOU triggered 22 high-quality proposals for R&D funding over the next two years. Following peer review, 12 projects were selected in: advanced materials, plant biology, structural biology, astroinformatics, nanotechnology, molecular photonics and molecular electronics.
 - ▶ The NRC and the Japanese Institute of Physical and Chemical Research (RIKEN), under the Japan-Canada S&T Agreement renewed a MOU for collaborative research projects. The MOU will now run for another five-year period. Symposia run under the MOU have provided NRC with collaborative R&D opportunities in genomics (structural genomics of bacterial genomes, mammalian proteins, protein complexes and biological applications of synchrotron radiation).
- ▶ As a result of ongoing efforts to build Canadian S&T relationships with Spain, a LOI was signed with the Consejo Superior de Investigaciones Científicas (CSIC). Last year two additional workshops were organized with CSIC – on microelectronics and marine sciences (aquaculture) under this LOI. Their successful conclusion demonstrated that a MOU between NRC and its Spanish counterpart, SEPOCYT, would be beneficial to Canada. The MOU was negotiated and signed with the Spanish Secretary of State for S&T, and four collaborative research projects are being considered for funding.
 - ▶ NRC and the Academy of Sciences of the Czech Republic signed a LOI in 2003. This has led to the development of two projects which will receive joint financial support.

Exploring New International Opportunities

In the past year, NRC continued to expand its sphere of influence in the international community and explored some new international partnerships, taking the first steps towards more active collaborations through workshops and, eventually, formal bilateral arrangements.

NRC led a major Canadian mission to India to expand S&T collaborations between the two countries; the delegation included representatives from seven Canadian companies, two universities, Agriculture and Agri-Food



NRC-IRAP mission to Russia

Canada, Environment Canada and NRC. As a direct outcome of the trip, which included 32 meetings with senior public and private sector executives, workshops in IT and biotechnology are being planned for the purpose of identifying joint collaboration opportunities.

In addition, NRC welcomed over 50 high-level delegations during the year.

International Opportunities for SMEs

In 2002–2003, NRC-IRAP undertook technology missions with SMEs to Spain, Russia, Germany, Korea, China, Thailand and Taiwan. All of these missions helped Canadian SMEs identify potential new technology alliance opportunities, partners and collaborators. By the end of the fiscal year, the 65 SMEs involved in the missions

had signed 40 MOUs, six contracts and four joint ventures. NRC-IRAP also undertook a series of exploratory missions to over 25 countries and participated in several missions organized by the Department of Foreign Affairs and International Trade as well as individual provincial missions.

In addition to technology missions, NRC-IRAP signed or extended a number of key international arrangements:

- ▶ NRC-IRAP extended its participation in the Intelligent Manufacturing Systems (IMS) agreement. Thirteen international projects are now under development, with participation from Canadian industry (including SMEs), academia and NRC research institutes. Canada has, for the first time, taken the lead in three project proposals.

- ▶ The Canada-Israel Industrial Research and Development Foundation Agreement was extended for another year. This initiative assists SMEs in both countries to find potential partners for the further development and commercialization of their innovations. It also provides financial support for certain agreed-upon joint activities.
- ▶ In 2002–2003, in collaboration with the NRC Institute for Marine Biosciences, NRC-IRAP recruited the Southeast Asian Fisheries Development Center in Thailand as an international member of the Canadian Technology Network (CTN). NRC-IRAP established links with fisheries resources across Asia that will benefit Canadian firms seeking access to the Asian market or Asian R&D.

International interest in NRC-IRAP and CTN remained strong, with representatives making information presentations and receiving delegations in increasing numbers throughout the year.

International R&D Collaborations – Benefits across the Board

International R&D collaborations benefit all of the partners through the generation of new knowledge, new technologies and new business opportunities which lead to improved quality of life in their countries. Recent highlights include:

Award Winning International Collaboration for Structural Testing of CF-18 Aircraft

The NRC Institute for Aerospace Research and Australia’s Aeronautical and Maritime Research Laboratory were selected by the International Council of the Aeronautical Sciences (ICAS) to receive the prestigious ICAS-von Karman Award in 2002 for their collaboration in a highly successful international research and testing program to manage the structural life of the CF-18 Hornet aircraft.



“This Canadian-led partnership with large National Facility telescopes in Australia, the U.S., and Germany is producing major advances in our knowledge of the origin and development of the Milky Way Galaxy in which we live. Once again the past year has seen the DRAO deliver data of outstanding quality, on schedule, to the international astronomy community.”

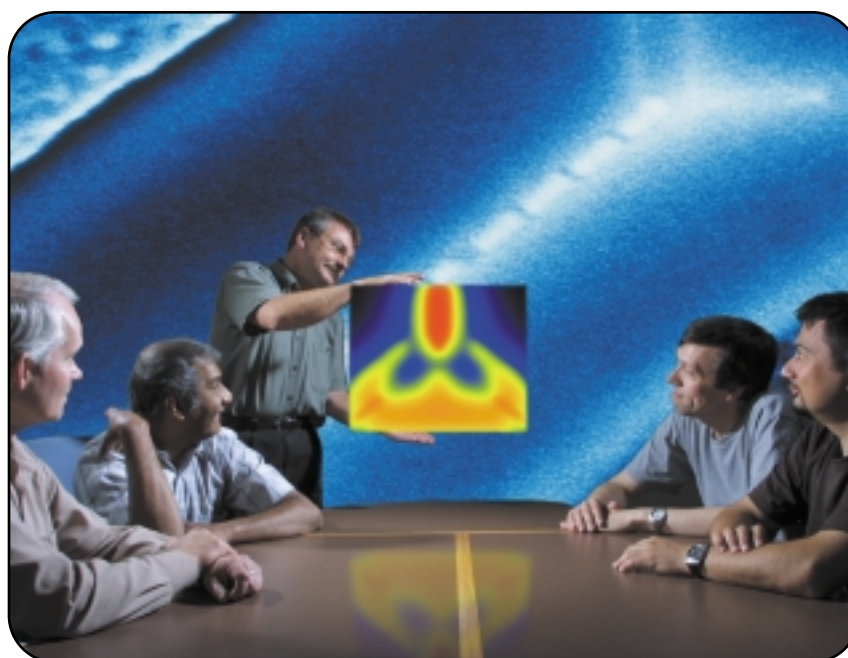
– Professor A.R. Taylor, Principal Investigator, International Galactic Plane Survey

The project, initiated in 1989 and known as the International Follow-On Structural Test Program, is a Canada-Australia joint project that has become one of the longest-running international programs, producing multi-billion dollar savings in military aircraft fleet management and life extension, as well as demonstrating new fatigue testing techniques and new methods for fatigue load reduction.

Collaboration Secures Canada’s Position in Emerging Technology

Plans have moved forward for CERION II – Canada-European Research Initiative on Nanostructures – the second phase of a highly productive international collaboration.

The partnership involves 18 European universities, six Canadian universities and two separate NRC institutes. The original agreement provided a link between Canadian universities and European researchers through exchange visits, joint projects and annual workshops. CERION has funded research collaborations which led to papers and articles in high-impact journals such as *Nature*, *Science* and in *Physical Review Letters*. This research partnership has helped to create the international respect Canada enjoys in the area of quantum physics research and has put Canada in a strategically important position in this leading-edge R&D field.



Members of the Quantum Physics Group, NRC-IMS

Human Frontiers Science Program Recognizes NRC Collaboration

NRC and its partners from the Netherlands and Japan were awarded a prestigious Human Frontiers Science Program (HFSP) grant to study the “Molecular basis and neurobiology of a post-infectious autoimmune disease: the Guillain-Barré syndrome.” The HFSP is an international non-government association devoted to the promotion of interdisciplinary research in life sciences. The team of four laboratories will share a total of US\$450,000 per year for three years, starting in September 2003.

Astronomy Collaborations Stimulate Economic Activity

NRC provides Canadian scientists with access to international observatories and is a participant in numerous key international collaborations. Astronomy is “Big Science” and the leverage of NRC’s international partnerships opens large and challenging projects and new opportunities for Canadian industry. In the past year, as part of a project known as the EVLA (Expanded Very Large Array) correlator, High Density



Photo courtesy of Gunnar Briste

Researchers at the NRC Canadian Hydraulics Centre (NRC-CHC) helped Danish power producers protect their 70-metre high wind turbines against sea ice damage. NRC-CHC tested a number of designs, modeling the force of ice hitting the towers used to secure the wind turbines. Under some conditions, ice could generate vibrations strong enough to interfere with the actual turbine blades and their operation.

Design Inc. of Kelowna won a major contract to lay out the EVLA circuit boards. The company took advantage of the project to acquire additional design tools and, as a consequence, is now able to compete for other leading-edge contracts.



Photo courtesy of NRAO/AUI

“There is no doubt that the level of precision and repeatability achieved in your yacht testing far exceed what is achieved anywhere else in the world that I know of. You obtain variations on repeat testing, weeks or perhaps even months apart, on the order of 0.5% in drag and 1% in lift. Variations elsewhere are two to four times as large.”

– Professor Jerome H. Milgram, Massachusetts Institute of Technology (MIT)



Will They Still Call It Silicon Valley?

NRC scientists in collaboration with researchers from France's Centre national de la recherche scientifique (CNRS) are working towards the creation of a post-silicon world for electronics and data transmission networks. The benefits are faster, flexible and more cost-effective data display and transmission using organic materials and polymers. The new Organic Photonic and Electronic Network founded as part of the collaboration addresses the challenges of designing and fabricating efficient organic photonic and electronic devices and integrating these to address future needs of the information and communication technology sector. This NRC-CNRS collaboration brings together expertise in physics and chemistry of materials, laser physics and spectroscopy, condensed matter and optoelectronic device physics.

NRC Helps Swiss Team Win America's Cup

The NRC Institute for Marine Dynamics (NRC-IMD), in partnership with OCEANIC Consulting, played a key role in the 2003 America's Cup, the most prestigious yacht race in the world. The team was contracted to undertake performance evaluation tests for two different race syndicates, the American Team, Oracle, and eventual race winner, the Swiss Team, Alinghi.

International trade agreements now require all signatories to accept the results of measurements and tests provided by any of the others. To justify this acceptance, a great deal of work is required by national metrology institutes around the world.

The achievement caps a 10-year long involvement of NRC-IMD in three America's Cups and paves the way for an expanded client list.

Measuring Up to Improve International Trade

In today's global economy, fair and open trade depends on accurate, consistent and easily comparable measurement standards. National metrology institutes in countries around the world ensure the quality and uniformity of measurement, a role played in Canada by the NRC Institute for National Measurement Standards (NRC-INMS). Such organizations also work with each other to break down the barriers to trade which result from different standards and measurement practices in different countries.

NRC-INMS helps facilitate trade in a number of ways. It develops new instruments and

measurement methods; maintains physical entities such as primary standards and certified reference materials; compares them with those of other countries; and provides specialized services including calibration laboratory technical assessments to Canadians. NRC-INMS represents Canada on over 150 international committees and is a leader in international comparisons. Over the past year, NRC-INMS participated in 42 such comparisons as part of the Mutual Recognition Arrangement of the Comité international des poids et mesures. In addition, NRC-INMS was involved in the planning or implementation of some 12 comparisons under the auspices of the Sistema Interamericano de Metrología (Inter-American Metrology System).

As the result of this work, Canada's standards are now recognized by all of our major trading partners, helping remove technical barriers to international trade and increase Canadian exports.

NRC – Science Lends a Helping Hand

NRC conducts world-class R&D in areas such as marine biosciences and seafood safety, medical diagnostics and devices, agricultural and pharmaceutical biotechnologies, construction codes and materials standards for buildings and infrastructure, aerospace and metrology. All are vital to ensuring public health and safety, not only for Canadians, but for others around the world. In 2002–2003, NRC continued its long tradition of “R&D for the public good” through a number of international efforts.





produce new marine toxin standards and reference materials. Work has resulted in the creation of 11 new or replacement Certified Reference Materials for toxins. The new standards will have enormous, life-saving impact for millions of people in the Pacific region dependent on seafood for their livelihood and as their main source of protein. NRC-IMB continues to be a leader in the study of marine toxins and has achieved a number of world firsts involving the discovery of new sources of toxins and the discovery of a new family of toxins (spirolides).

Establishing New Standards for GMO Foods

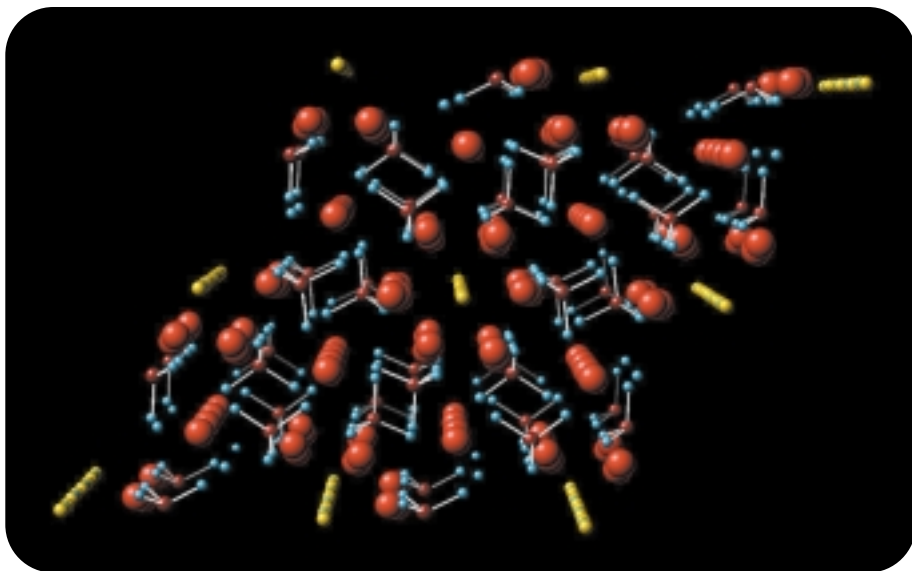
In the past year, the NRC Institute for National Measurement Standards and the Canadian Food Inspection Agency signed an MOU to establish measurement standards for Genetically Modified Organism testing. Quantitative measurement of GMO is a key issue facing the agriculture and food services sector. The ability to effectively measure GMO content will help secure Canada's continued access to foreign markets.

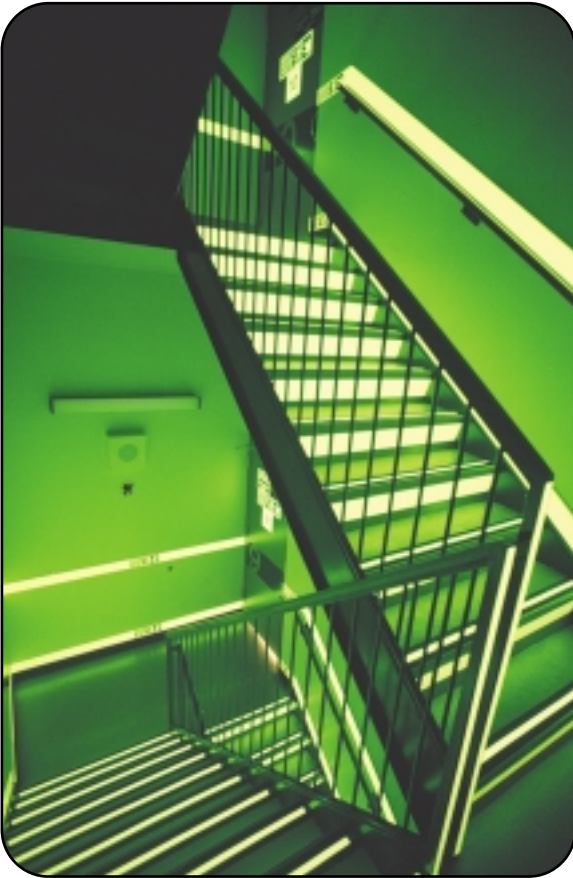
Improving Marine Toxin and Reference Standards

The NRC Institute for Marine Biosciences (NRC-IMB) in collaboration with NRC-INMS successfully completed a three-year Asia-Pacific Economic Cooperation project to develop and validate new analytical methods and

Putting Research to Work for the Environment

As part of an NRC MOU with the Agency of Science, Technology and Research of Singapore (A*Star), researchers will be working to turn fly ash produced by garbage incinerators into a usable construction product. Fly ash is classified as a hazardous material because of the range of heavy metals it contains, making disposal difficult





and expensive. Chances for safe disposal, and even reuse, are much more promising if the toxic metals can be trapped in stable synthetic “rock-like” materials made from other non-hazardous minerals also found in the fly ash. The research entails the study and characterization of the properties of “stable” mineral structures which, through advanced ceramic processing, will be turned into new synthetic “rock-like” materials. After further study and testing, these new materials will eventually be extruded to create roofing tiles. Work will be carried out by an interdisciplinary team of researchers from the NRC Institute for Chemical Processes and Environmental Technology

NRC research into evacuation behaviour following the 1993 bombing of the WTC produced a number of lifesaving recommendations, such as applying photo-luminescent paint to key surfaces in stairwells. In the 1993 incident, smoke and darkness impeded evacuation efforts, a situation avoided on September 11. The innovation helped thousands escape safely before the towers collapsed.

and the NRC Institute for Research in Construction (NRC-IRC).

NRC – Helping Investigate the World Trade Center Attack

As the world came to terms with the September 11 tragedy, researchers from NRC-IRC played a key role in making sense of the disaster. A team of experts was called upon to investigate and report on the performance of the affected buildings in the vicinity of Ground Zero. Among them was an NRC-IRC expert in building performance – the only member from outside the U.S. invited to join the study. Another NRC-IRC researcher, a specialist in human behaviour during fire, studied first-person accounts of attack survivors. But NRC connections to this story go even further. NRC carried out research of evacuation procedures following the 1993 bombing of the World Trade Center. The project resulted in a number of key recommendations that helped save lives years later following the September 11 attack.



Standing through Fire

Research into the collapse of buildings in the World Trade Center complex and the surrounding area highlighted one central problem: technology is producing stronger construction materials, but pays too little attention to fire resistance. NRC-IRC research determined that high-strength concrete used to carry the heavy loads of giant buildings performs poorly in high intense fires. This is because pieces break off in the early stages of a fire, a process called spalling. Research also pointed to several solutions, such as addition of tiny polypropylene or steel fibres to the concrete. In a fire, the polypropylene fibres melt and create microscopic channels to let steam escape. Steel fibres bind the concrete

together more strongly, and can reduce and delay spalling for two or three hours in a fire. Such research is now influencing building codes around the world.

Listening and Learning from the Survivors

Intense media coverage of the September 11 attack produced a number of first-person accounts from attack survivors. NRC-IRC, in collaboration with the National Fire Protection Association (NFPA), decided to collect these survivors' stories to help document the event and gain new insights into behaviour during fires. Study of these accounts will help improve evacuation procedures.