



**Science at work for the new age of  
aerospace innovation**  
*Your partner for a sustainable, profitable  
aerospace industry*

**NRC·CMRC**



National Research  
Council Canada

Conseil national de  
recherches Canada

**Canada**

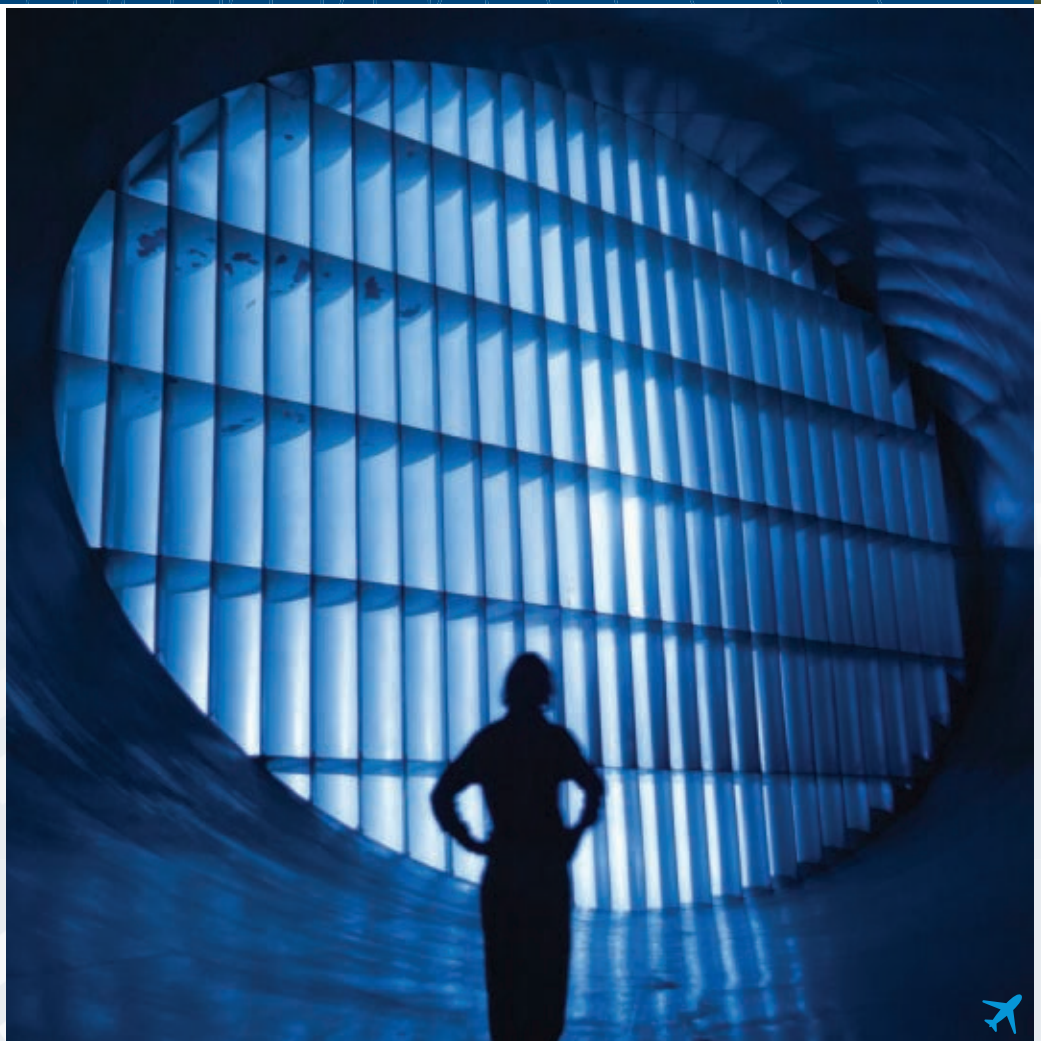
# Helping aerospace innovation take flight

Canada's aerospace industry is vibrant, innovative and complex, with a rich history and elite reputation on a global stage. As Canada's largest research and technology development organization, the National Research Council of Canada (NRC) is in a unique position to stimulate growth for the industry, and move products to market more rapidly.

Home to first-class research infrastructure and expertise, the NRC conducts research and technology development (R&TD) for all issues related to the design, manufacture, performance, use and safety of air and space vehicles. Our work covers every major concern in the aerospace industry—cost, weight, safety and the environment. We are in the business of providing solutions, and we want to work with you to develop a customized plan that will meet your technology needs.

## **Working in core and emerging aerospace technologies**

The NRC's clients come from across the globe to work with our team of experts and make use of our R&TD facilities in Ottawa (Ontario), Montréal (Quebec) and Thompson (Manitoba). We advance aerospace research in core areas, including aerodynamics, gas turbines, flight testing, aircraft structures and materials, and manufacturing. But that's just the beginning.





We have the unique competitive advantage of being able to draw from the expertise and ground-breaking research across the NRC's spectrum of disciplines and apply them to our aerospace R&TD. Our breakthroughs in nanotechnology are being explored to develop aircraft sensors and other structural applications; discoveries in marine biology are being examined to develop algal biofuels; and advances in battery technology are being researched to develop aircraft fuel cells.

Exchanging expertise and ideas between disciplines allows the NRC to offer rapid and cost-effective technological advancements in emerging areas.

“The future of aerospace will be driven by the needs of changing societies, as well as by the progress of disruptive technologies across many research fields. The NRC is uniquely positioned to react to those needs, and to draw from an extensive set of in-house and partner competencies. We are meeting short-term needs while also investing in technology platforms that will be critical for long-term success of the aerospace industry.”

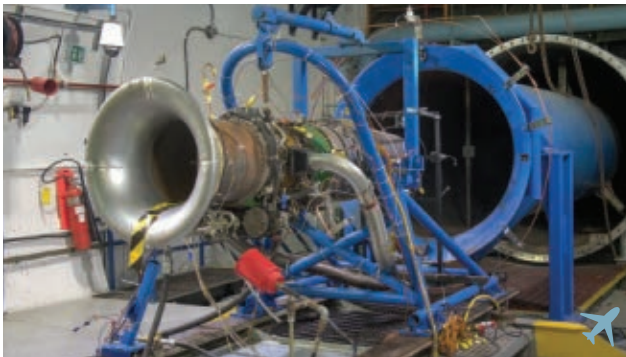
– Ibrahim Yimer, Director General, NRC Aerospace Research Centre

✈ The NRC's 9m wind tunnel is used for aerodynamic testing of aeronautical and non-aeronautical objects, including surface vehicles, ground-based structures, and parachutes.

✈ The NRC is assisting in the development of high-value, sustainable products from algal biomass, including **biofuels**.

✈ The NRC has demonstrated the world's first pilot-scale production of **boron nitride nanotubes (BNNTs)**. Pictured here, paper airplane made of BNNT exposed to 2000°C for over 2 minutes.

# Get on board with us



The NRC is looking for partners and collaborators to join our programs and bring innovative aerospace products to market. We offer R&TD contracts, consulting, fee-for-service testing, and calibrations for hundreds of companies and organizations worldwide. The NRC also develops and transfers technology through collaborative research contracts and licensing arrangements.

All our clients and partners enjoy a range of benefits, including:


- access to the NRC's world-class research infrastructure and unique expertise
- a range of laboratories registered to ISO 9001
- customized service options


- data integrity and confidentiality
- proven processes and security protocols to perform International Traffic in Arms Regulations (ITAR) and controlled goods projects
- maximal opportunities for collaboration between national and international industry partners and regulatory agencies
- access to a network of R&D and test and evaluation providers


### Our major research facilities:


- Aerospace Manufacturing Technology Centre
- cabin demonstrator facility, to be completed in 2018
- engine icing facilities, including the Global Aerospace Centre for Icing and Environmental Research (GLACIER)
- fleet of research aircraft, rotary and fixed-wing

- gas turbine engine and component test facilities
- materials and structures test facilities
- reverberant acoustic chamber
- vibration test facility
- wind tunnels

 **Engine test cell** at the NRC's Gas Turbine Laboratory.

 A technical officer working on **the NRC's interturbine transition duct rig**.

 Testing of anti-icing fluid on a wing section in **the NRC's 3m x 6m icing wind tunnel**.

 **The NRC's 9m wind tunnel** is used for aerodynamic testing of aeronautical and non-aeronautical objects, including surface vehicles, ground-based structures, and parachutes.

# The NRC's aerospace expertise and capabilities

At the NRC, it's our business to help your business soar. We happily tailor our services to your individual needs. Consider the possibilities:

## Design

- 3D digitizing and visualization
- Aero-acoustics measurement, testing and evaluation
- Aerodynamics research, testing and evaluation for fixed-wing and rotary-wing applications
- Aircraft cabin environment assessment
- Airframe structure certification
- Computational fluid dynamics
- Engine performance and certification
- Gas turbine engine research
- Human factors
- Ice accretion experiments and numerical modelling
- Modelling and simulation
- Numerical modeling of aircraft structures
- Software engineering
- Structural dynamics

## Manufacturing

- Advanced fibre placement technologies
- Advanced material removal
- Automation, robotics and intelligent manufacturing systems
- Bonding technologies
- Casting technologies
- Coatings and surface treatment technologies
- Manufacturing, machining and joining of aerospace components
- Metallic and ceramic materials
- Prototype manufacturing



NRC's Falcon 20 research aircraft

## Operations

- Aeromagnetic technologies
- Airborne simulation and sensors
- Aircraft icing and ice crystal generation
- Airworthiness certification
- Alternative fuels research
- Atmospheric characterization of weather systems
- Combustor and fuel nozzle development and evaluation
- Flight data recorder and playback centre
- Flight mechanics and avionics
- Flight testing
- Gas turbine aerodynamics and combustion
- High-performance computing
- Human-computer interaction
- Hyperspectral imaging technologies
- Icing formation, detection and mitigation
- Physiological monitoring
- Sense and avoid technologies

## Maintenance

- Assessment and life extension of aircraft structures, components and materials
- Intelligent systems for aircraft fleet maintenance and management
- Laser ultrasonic inspection techniques for aircraft
- Metrology with aerospace applications
- Non-destructive evaluation
- Prognostic health monitoring technologies
- Remote monitoring and decision support for aircraft fleet maintenance and management
- Structural health monitoring (SHM) technologies
- Structures and materials performance

**The future of aerospace is yours for the taking. We look forward to helping you take flight.**

# Aeronautical Product Development Technologies



Image courtesy of Bombardier.

The NRC joined forces with Bombardier Aerospace and L-3 MAS to certify the winglet structure of Bombardier's newest business jet, the Challenger 350.

## The challenge

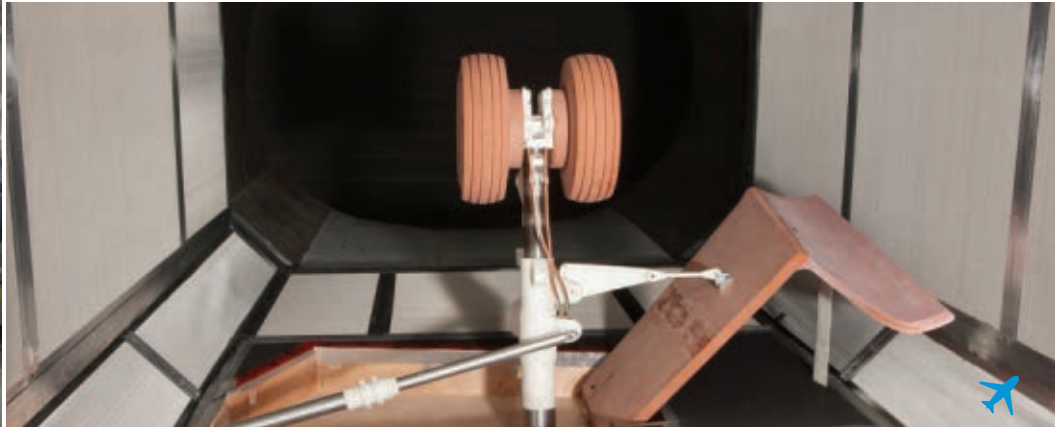
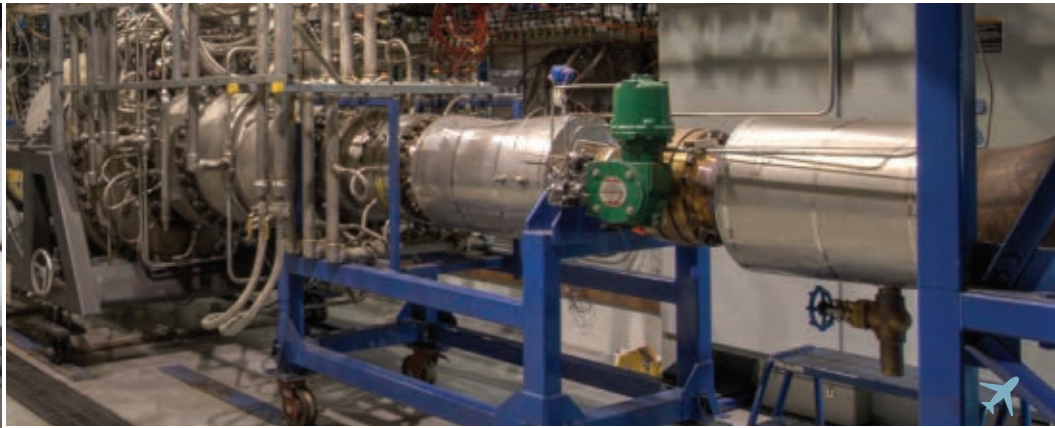
The time to bring innovative and competitive aeronautical products to market is significantly longer than in other industries due in part to the certification requirements. Technology development involves rigorous demonstration and qualification, usually in unique experimental facilities run by highly skilled professionals, where new products must be evaluated, refined and qualified in realistic operating conditions.

## The collaboration

Prospective clients and partners include original equipment manufacturers (OEMs), regulators and lower-tier suppliers whose products require prototyping, testing and certification facilities as well as world-class aviation experts that are needed during the technology readiness level (TRL) 4 to 9 development cycle.

## The impact

The NRC's aeronautical product development technologies reduce the time and risks associated with prototyping, testing and certification, thereby helping to accelerate product delivery. The NRC will work to reduce aeronautical product development risk for Canadian industry by providing priority access to national facilities and innovative testing technologies to accelerate by three months their product development programs.



“Our recent work with NRC to test and certify the winglet structure of our newest business jet, the Challenger 350, brought great results. NRC helped devise a customized testing program that satisfied all our testing requirements and allowed us to arrive at an innovative solution and ensure the safety of our aircraft.”

- Sylvain Leger, Section Chief,  
Bombardier Aerospace

✈ **The NRC's Research Altitude Test Facility** can evaluate characteristics of industrial combustors operating under cold-weather conditions and facilitate relight, ignition and blowout characterization under realistic altitude conditions for combustors and engines burning a variety of aviation fuels.

✈ **The NRC's combustion test cells** are equipped with compressed air, cooling water and the complete range of fuels and have the flexibility to be configured according to the requirements of specific tests.

✈ Landing gear being tested in **the NRC's 2m x 3m wind tunnel**, a world-class facility for subsonic aeronautical and industrial testing.

# Advanced Manufacturing



In **physical vapor deposition (PVD)**, a variety of methods (cathodic arc evaporation, magnetron sputtering and electron beam evaporation) are used to deposit thin films onto various workpiece surfaces through the condensation of a vaporized form of the desired film materials.

## The challenge

The manufacturing industry is undergoing intense change through the maturation and convergence of technologies aimed at increasing production efficiency, quality improvement, minimal wastage, mass customization of products, and energy consumption. To adapt to these changes and maintain global competitiveness, Canadian companies need to change the way they think about manufacturing. The infrastructure and the connectivity within manufacturing organizations and supply chains must be fundamentally overhauled through a coordinated national effort.

## The collaboration

Partners and prospective clients in advanced manufacturing include aerospace and ground transportation original equipment manufacturers, systems integrators, small and medium-sized enterprises across the supply chain, academia and other research organizations in Canada and around the world.

## The impact

The NRC works with clients and partners across manufacturing supply chains to develop, demonstrate, and transfer key technologies supporting improvements in manufacturing efficiency. The key goal is to boost productivity for each manufacturing partner and client by at least 25% relative to existing technologies. This can be achieved through reducing manufacturing costs in the factory, including costs associated with design, supply, processing and assembly. By 2030, the NRC will help re-position Canada's manufacturing sector in global rankings for value-added suppliers by:

- increasing manufacturing value-added labour productivity with improved analytics, machine connectivity, maximized asset utilization, increased automation, and more energy efficient manufacturing facilities and operations

- creating and de-risking integrated multidisciplinary technology platforms for advanced manufacturing technologies such as additive manufacturing, robotics, modelling and simulation, digital design systems, advanced sensors, and artificial intelligence
- partnering globally with industry, academia, and others to transform business models with more collaborative supply chains and flexible modular manufacturing, and accelerating prototyping to significantly reduce time to market

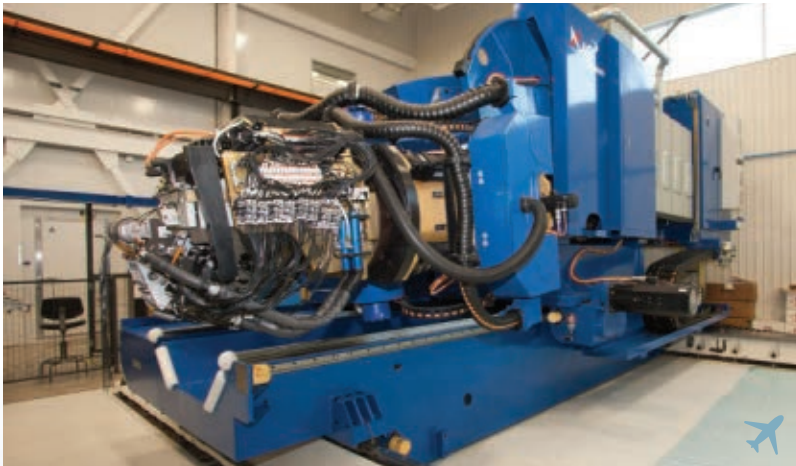
The NRC will help Canadian supply chains across all tiers by increasing manufacturing added value and enabling lower tier companies to provide higher tier services through technology development and software system integration. Through industry consortia, the NRC will also increase efficiency by disseminating knowledge about new and emerging technologies and processes.






“The NRC has proven to be an outstanding partner, a remarkable advisor and a valuable idea generator. We appreciated their full support. It is because of this collaboration with the NRC that we succeeded in industrializing the cold spray technology.”

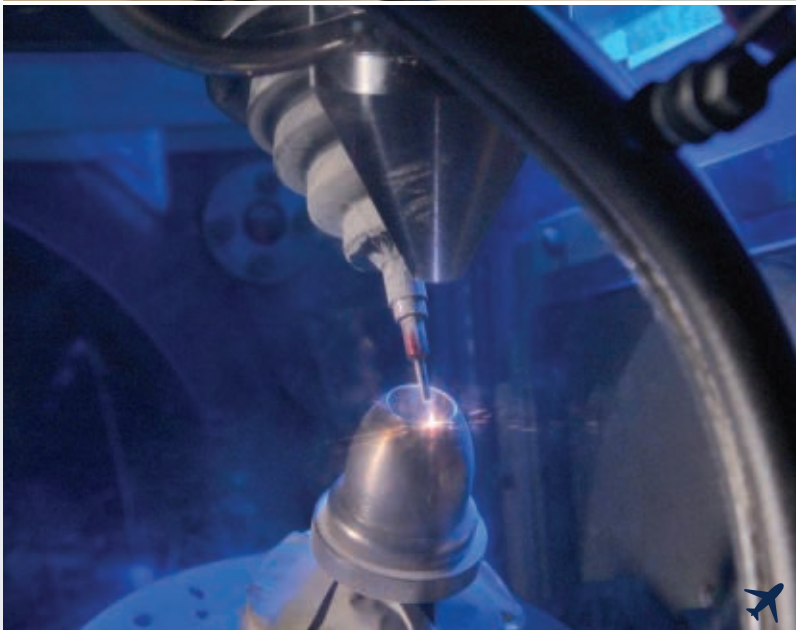
– Vince Pagnotta,  
General Manager,  
Pratt & Whitney Canada



 **The NRC's Aerospace Manufacturing Technologies Centre** is a hub of modern manufacturing that helps industry develop, demonstrate and implement next-generation manufacturing methods, such as hybrid laser-arc welding.

 The NRC is researching **automated fibre placement** technologies, which combine filament winding with automated tape placement, and is best suited to the production of medium to large-sized parts with moderate to high degrees of curvature and a high level of structural integration.

 The NRC possesses **advanced laser and electron beam materials processing capabilities** and technology, including laser and electron beam additive manufacturing, surface modification and welding.



# Air Defence Systems

## The challenge

Maintaining existing and future Royal Canadian Air Force (RCAF) fleets comes with a heavy financial and environmental burden for Canada. With the acquisition of new and modernized equipment fleets in the RCAF, the demands on the maintenance and material programs have increased. This is due not only to the expansion in the number of platforms, but the requirements associated with maintaining technologically advanced fleets.

There is also a growing expectation that readiness levels of fleets must be maximized in order to meet operational demands in a security environment that continues to be unpredictable and volatile.

## The collaboration

Prospective clients and partners for air defence systems expertise and support include the Department of National Defence (DND) and other government departments, original equipment manufacturers and the sustainment industry for the military sector, and Canadian aerospace small and medium-sized enterprises. The industries work towards similar objectives as that of the ADS program to support DND.

## The impact

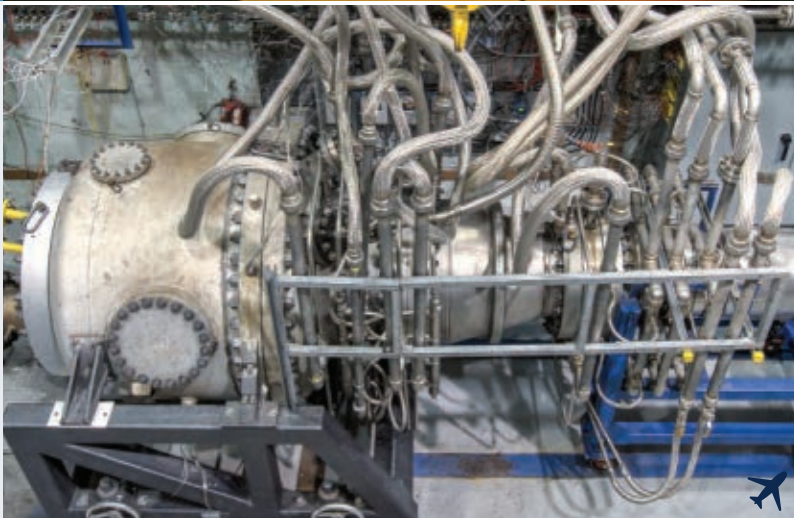
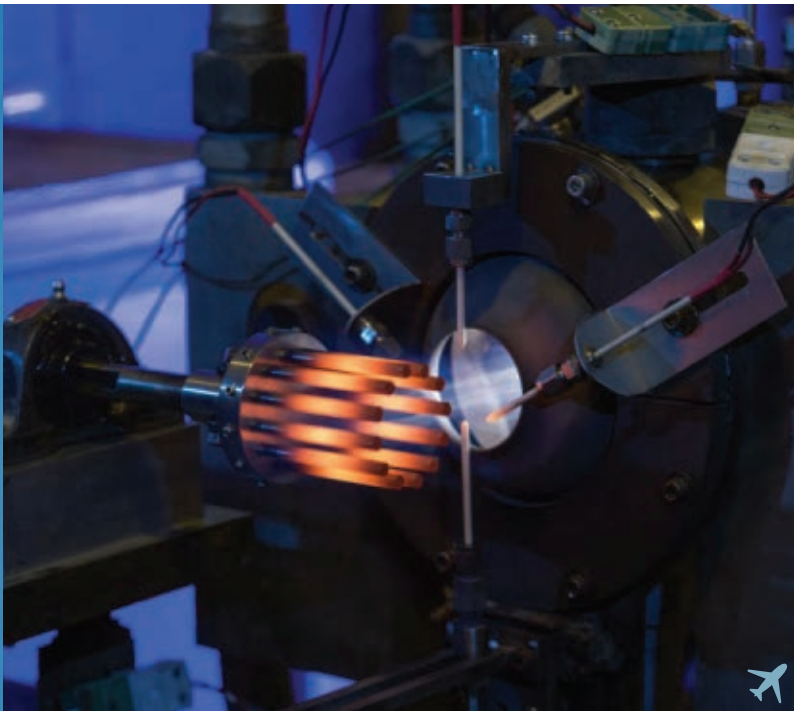
The NRC aims to reduce the cost of RCAF operations while minimizing their environmental footprint. The NRC offers access to technology demonstration and airworthiness certification facilities, as well as to the expertise required to help bring technologies to market. Specifically, the NRC works with government and industry clients and partners to develop and demonstrate technologies that will:

- reduce fuel burn by 20% by 2019-2020
- reduce CO<sub>2</sub> emissions by 20% by 2019-2020
- reduce the costs of RCAF operations by 10% by 2016 and 20% by 2019 (based on 2009 figures)

The NRC also aims to transfer 50% of technologies developed or enhanced by its work in Air Defence Systems to the civilian aerospace sector, thus providing the civilian aerospace industry with cutting-edge tools and methodologies.



The NRC's structural life extension testing on DND's CF-18 fighter jets helped ensure safe flight and gain years of usage for the current fleet. Image: OP Impact, DND.



“NRC has conducted aerospace investigations on behalf of DND since the Second World War. Given the significant synergies and similarities between civil and military aviation, NRC provides science & technology support to DND performing technical investigations in the engineering specialties of aircraft structures and materials, non-destructive testing, flight sciences, aero-propulsion and flight research. NRC facilities continue to provide requisite strategic and sensitive aerospace laboratory support that is maximizing affordability and sustainability of Royal Canadian Air Force fleet.”

– Kirk Shaw,  
Director of Technical Airworthiness  
and Engineering Support to the RCAF,  
Department of National Defence

- ✈ **The NRC's burner rig** is able to evaluate a number of high temperature coatings.
- ✈ **1.5 m trisonic wind tunnel** is a pressurized tunnel capable of running in the subsonic, transonic and supersonic flow regimes.
- ✈ **The NRC's gas turbine engine research facilities** assist industry in developing and evaluating engines and components.

# Civilian Unmanned Aircraft Systems



Unmanned systems will allow more efficient powerline monitoring and inspection.

## The challenge

Unmanned flight finds itself in a state similar to manned aviation at the end of World War I: the technologies have proven their value in a military context, but have yet to be fully exploited for civilian and commercial purposes. Military unmanned aircraft systems (UAS) have not successfully been exploited for civil applications because:

- the high cost of military systems makes them unsuitable for commercial operations
- worldwide regulations make it difficult to use UAS for commercial purposes
- businesses are reluctant to be early adopters of this technology

## The collaboration

Prospective clients and partners for the NRC's civilian unmanned aircraft systems support and expertise include end-users from various industries, such as electrical power utilities and the pipeline industry as well as UAS and aerospace OEMs, service providers and technology developers and regulatory authorities.

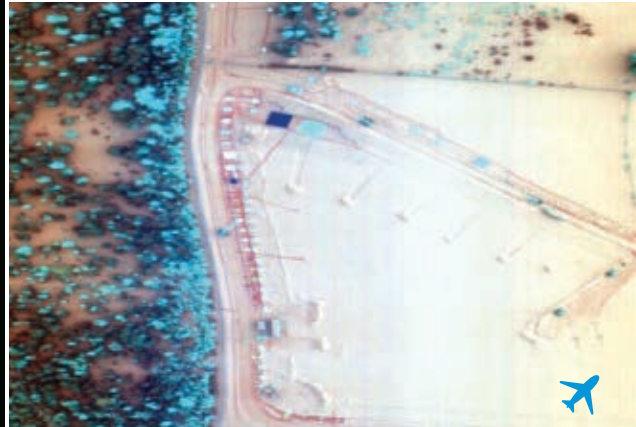
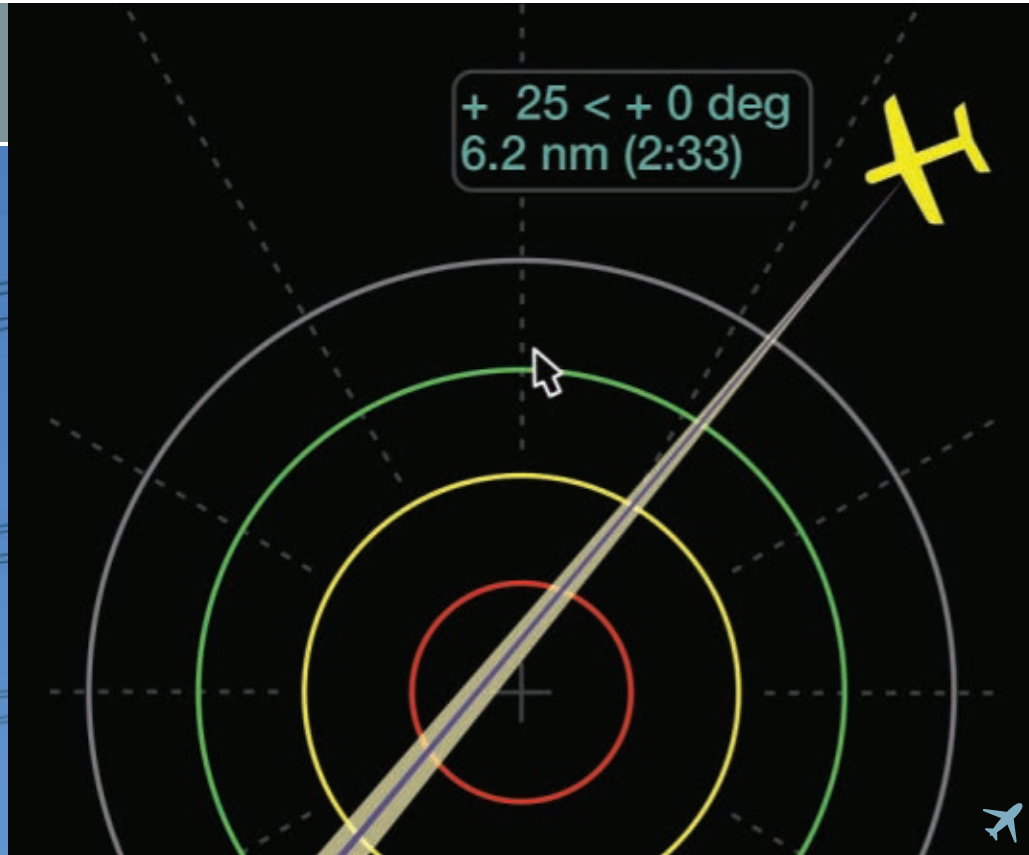
The NRC collaborates closely with other government departments, such as the Canadian Coast Guard, on the investigation, demonstration and adoption of commercial UAS technology to support their mandates.

## The impact

The NRC has taken a leadership role in supporting and facilitating the development of UAS technologies in Canada to meet the needs of industry. By 2019, the NRC will prove the commercial value of UAS through mission-oriented and cost-effective

demonstrations in targeted Canadian industrial sectors. These include:

- monitoring and surveillance of critical infrastructure, such as powerlines and pipelines, for detection of leaks or breakages, degradation, encroachment on right of way and environmental damage
- using magnetic, gravity and hyperspectral sensors to locate areas of interest for further exploration surrounding oil, gas and minerals surveys
- surveying Canadian landscape for the early detection of forest fires and surveying wildlife
- using UAS-based eye-in-the-sky surveillance to enhance situational awareness for first responders and emergency communications
- providing surveillance of areas of potential threat to protect cargo ships and their loads against manned and natural threats



The NRC offers access to a fleet of nine research aircraft that can be adapted to UAS testing needs. The NRC helps facilitate collaboration between Canadian UAS developers, UAS service providers, high-level end-users and regulators to align UAS technologies

with current and future regulatory requirements. Working with the NRC will ensure access to all the detailed performance and economic data required to make business decisions about adopting UAS technologies.

**✈ Sense and avoid technology**  
 – The NRC developed a collision course intercept display mobile application for iOS. This screen shot shows an intruder on a collision course.

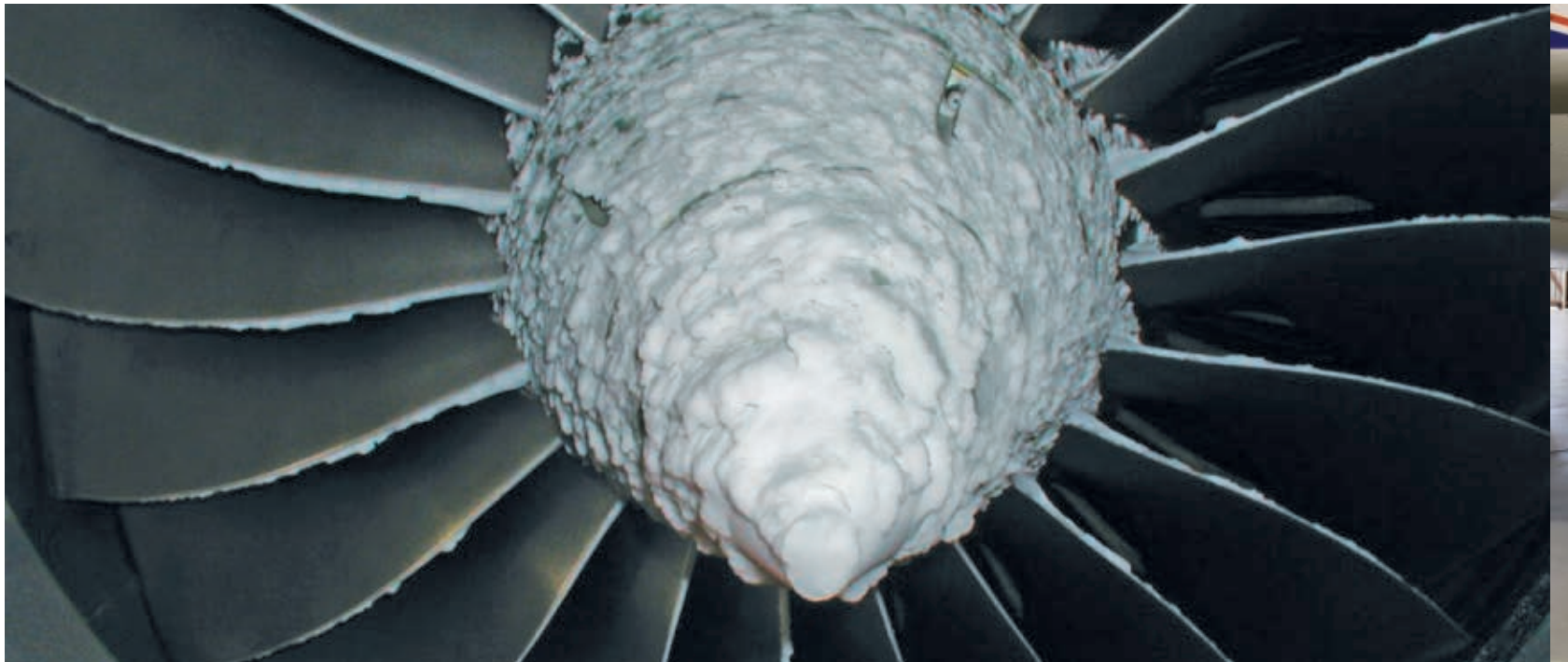
**✈ The NRC's TREX 700E UAV helicopter** is an unmanned vehicle that can be used for a range of testing, including the collection of flight data for intelligence, surveillance and reconnaissance.

**✈** Scientists and engineers at the NRC have made some key enhancements to, and are developing new applications for **hyperspectral imaging technologies**.

“NRC’s expertise in unmanned aircraft system technologies and technology demonstration allows us to carry out missions to validate the use of UAS in monitoring Canada’s coasts and littoral regions.”

– José Fernando Mojica,  
 Director, Marine and Civil Infrastructure  
 and Environmental Response,  
 Canadian Coast Guard

# Aviation Icing Expertise



The NRC has experts and facilities to research the fundamental phenomena of ice crystals and conventional icing, and to test engines and other aeronautical systems in these conditions.

## The challenge

Icing is a significant challenge for aircraft designers and operators, posing safety and cost issues in Canada and around the world. Equipment manufacturers bear the high costs of certifying products against icing with increasingly stringent regulations. Airlines are faced with a burdensome range of costs associated with icing, including flight delays, de-icing operations and re-routing of flights.

## The collaboration

Prospective clients and partners include aircraft operators, aircraft original equipment manufacturers (OEMs), engine OEMs, and instrument suppliers.

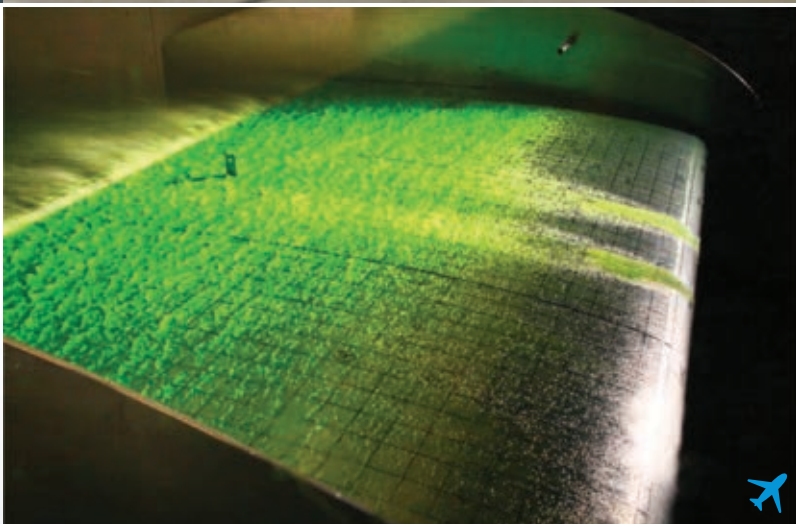
We also collaborate with national and international industry partners, and regulatory agencies, to develop certification standards and engineering tools for demonstrating compliance with these standards. The NRC has long-standing relationships with international icing experts through its membership in the Ice Crystal Consortium, Aircraft Icing Research Alliance, Engine Harmonization Working Group and High Altitude Ice Crystals program.

## The impact

The NRC will increase the competitiveness of the Canadian aerospace industry by developing, demonstrating, and testing next-generation icing qualification technologies and solutions, and transferring them to industry.

Together with its clients and partners, the NRC will respond to industry's hurdles with these technical goals:

- develop sensors for ice detection and calibration of the icing environment
- develop remote sensing technology for icing condition detection
- validate engine performance under icing conditions
- reduce ice accretion in engines, wings, and on probes and validate probe performance under icing conditions
- reduce ice shedding damage on airframe
- enhance ice crystal, supercooled large droplets and mixed phase testing capabilities
- develop scaling laws for sea level facilities
- develop 3-D morphogenetic icing code



“The European Aviation Safety Agency (EASA) chose NRC to execute a significant research project because of their world-class facilities, experience on similar projects and their reputation within the international community. During the testing phase, we were impressed by the quick turnaround time for data processing and NRC’s flexibility in adapting tests according to EASA’s needs. We have developed an excellent relationship with NRC and look forward to collaborating on future projects.”

– Alberto Fernandez Lopez,  
European Aviation Safety Agency

✈ **The iso-kinetic probe** is the only instrument in the world capable of providing accurate measurements of total water content at high altitudes, high airspeeds, and in high ice and water mixture concentrations.

✈ An anti-icing fluid test performed in **the NRC’s 3m x 6m icing wind tunnel**, the only facility in the world that can accommodate full-scale, full-speed, cold-temperature tests with fluids.

✈ **The Global Aerospace Centre for Icing and Environmental Research (GLACIER)** is the world’s foremost facility for researching engine icing.

# Working and Travelling on Aircraft

## The challenge

To keep pace with the continued growth in air travel, the number of aircraft in service will double by 2030. Over the typical lifespan of an airframe, the cabin will be completely upgraded every 4 years and new flight deck avionics will be required every 10 years. These changes drive a growing market for new technologies.

## The collaboration

Prospective clients and partners include owners and operators of commercial aircraft, airframers, as well as cabin and cockpit systems manufacturers and integrators.

## The impact

The NRC supports its clients in the design, fabrication and testing of innovative new aerospace products that improve passenger comfort, safety, en route efficiency and the air travel experience for all.

The NRC provides the potential for increased market share and operating margins for original equipment manufacturers (OEMs), while lowering cost and improving the bottom line for operators. The NRC proposes to:

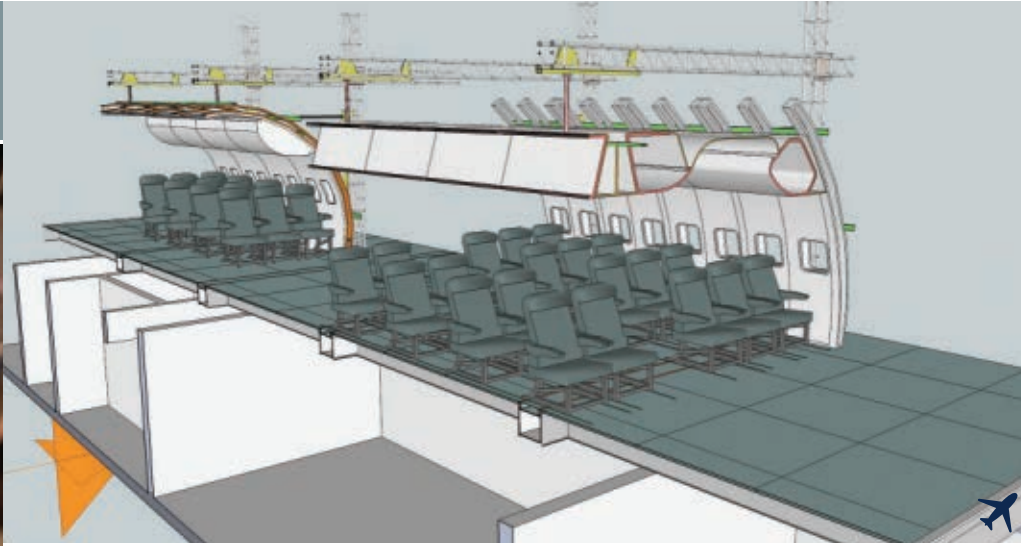
- engage industry in cabin and avionics demonstrations that showcase new technology, rapid design techniques and effective validation methods that will lead to faster acceptance of innovations



As part of a project on aircrew workload analysis, the NRC used electrooculography sensors to capture pilot eye movements.

- develop technologies that improve passenger comfort and address global integration of ergonomics, lighting, acoustics, vibration, thermal comfort and air quality
- develop technologies that optimize aircrew performance in a challenging work environment
- work with industry to reduce design cycle time for cabin and avionics technology





“NRC signed a licensing agreement with Dart Aerospace and transferred the technology to us to produce novel seat cushions for medium lift helicopters. NRC’s expertise has been crucial for us to move this valuable technology from the conception stage to market.”

– Peggy McDonald,  
Dart Aerospace

✈️ A depiction of **the NRC’s Cabin Demonstrator Facility**, scheduled to be completed in 2018. The facility will be used to evaluate passenger responses to novel technologies or designs integrated into a flexible cabin environment.

✈️ **The NRC’s Acoustic Transmission Loss Facility** is used for a variety of acoustics and noise research and testing, including the characterization of active and passive personal hearing protection performance.

✈️ The NRC’s new **Human-rated Vibration Test Facility** will enable testing and evaluation of physiological and psychological responses to vibration, an important issue for helicopter flight crew and passengers.

# Investing in aerospace innovation... with real results

The National Research Council Industrial Research Assistance Program (NRC IRAP) helps Canada's small and medium-sized enterprises (SMEs) reach their innovation potential. The NRC IRAP provides its clients with technical and business advice as well as funding and other product development services to build their innovation capacity and help commercialize their products in the global marketplace.

Companies that demonstrate both the desire and potential for technology and innovation-based growth can work with the NRC IRAP to create a development plan tailored specifically to their needs. Through IRAP, the NRC has benefited the aerospace industry by providing assistance and expertise for exciting R&TD projects. Recent projects include:

- Technical and business advisory services to the Manitoba Aerospace Human Resources Council Inc., to help small aerospace companies in Manitoba improve their manufacturing and innovation capabilities.
- Technological advice to Canadian Composites Manufacturing R&D Inc. (CCMRD) Technology Committee, and financial support for CCMRD and its coordinating projects.
- Technical and business advisory services and financial support to small Unmanned Aerial Systems (sUAS) manufacturer Aeryon Labs Inc., allowing them to hire additional engineers to create improved payload systems for their unmanned aerial vehicles.

To speak with one of our Industrial Technology Advisors in your area, contact us today!

1-877-994-4727  
publicinquiries.irap-pari@nrc-cnrc.gc.ca



“Our success has been strengthened with the support of IRAP. Our deepest respect and gratitude goes to our Industrial Technology Advisor, and to the entire NRC-IRAP team for enabling companies like Aeryon Labs to solve complex problems, break new ground and push the limits of what is possible.”

– Dave Kroetsch,  
President & CEO Aeryon Labs Inc.

# International technology partnering for innovative Canadian companies

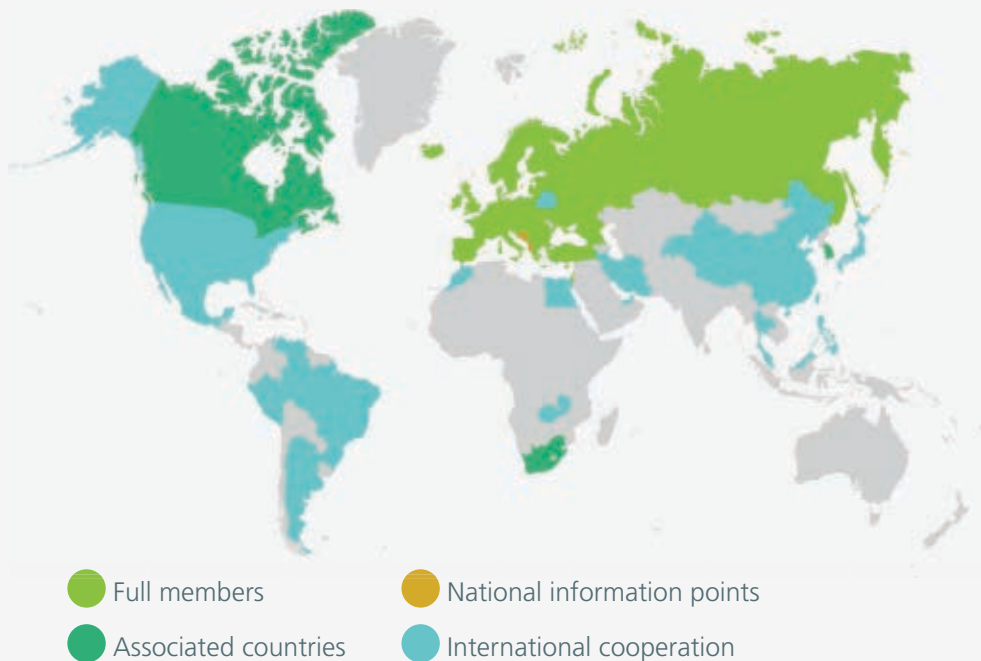
The EUREKA network facilitates international R&D projects to accelerate the market-readiness of your product, process and/or service. It promotes an industry-led approach where companies and other participants decide the way the project comes together and evolves, from the “bottom up”. They decide on the project’s duration and its outcome. EUREKA believes this fast and flexible approach is the most effective way for an innovation to reach the market before the competition.

## How can EUREKA help you?

- Access to support and funding for eligible innovative firms
- Access to intelligence on technology and markets
- Collaboration with credible partners via the EUREKA network
- Access to new markets through technology partnering
- Investment leveraging to de-risk R&D projects
- Simplification of complexities inherent to multiple international partners

The “EUREKA label” significantly enhances the visibility and guarantee to potential private investors that the project has successfully passed the stringent assessment process.

## Access to 40+ countries



## Is EUREKA right for you?

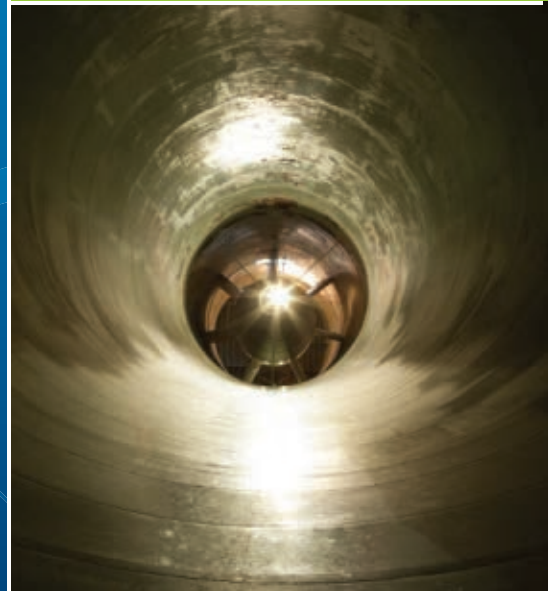
- You possess a desire and capability to source knowledge abroad by “tapping” global talents to address technical gaps.
- You need to collaborate globally to adapt your product, process or service to meet other global market characteristics.
- Your technology or product offers advantages in a foreign marketplace.
- You have the financial backing to broaden to new markets or could attract investment through development of your technology for global needs.

To start the dialogue on how EUREKA can help, visit [www.nrc-cnrc.gc.ca/EUREKA](http://www.nrc-cnrc.gc.ca/EUREKA) and contact a Canadian EUREKA representative. More information also available on [www.eurekanetwork.org](http://www.eurekanetwork.org).



## We're ready for liftoff. Are you?

The NRC is open for business. Contact us to discuss your project or find out more about how we can support your organization.



### Contact

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