GREEN AVIATION RESEARCH & DEVELOPMENT NETWORK

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## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Page</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>04</td>
<td>MESSAGE FROM THE CHAIRMAN</td>
</tr>
<tr>
<td>05</td>
<td>MESSAGE FROM THE EXECUTIVE DIRECTOR</td>
</tr>
<tr>
<td>06</td>
<td>FOR A GREENER AEROSPACE INDUSTRY</td>
</tr>
<tr>
<td>07</td>
<td>GARDN II FACTS AND FIGURES</td>
</tr>
<tr>
<td>08</td>
<td>SUCCESS STORY</td>
</tr>
<tr>
<td>09</td>
<td>GARDN’S COLLABORATIVE RESEARCH PROJECTS</td>
</tr>
<tr>
<td>14</td>
<td>GOVERNANCE</td>
</tr>
<tr>
<td>16</td>
<td>MEMBERS &amp; PARTICIPANTS</td>
</tr>
</tbody>
</table>
According to Air Transport Action Group (ATAG), nearly 3.6 billion passengers travelled worldwide by plane in 2015, producing 770 million tonnes of CO₂ per flight.

The global aerospace industry has set clear targets: improve the energy efficiency of the fleet by 1.5% per year, stabilize the production of CO₂ by 2020, cut the total volume of CO₂ in half by 2050 and reduce noise pollution from aircraft. With increasingly stringent International Civil Aviation Organization (ICAO) regulations, which promote these targets, an organization like GARDN certainly has a leading role in reducing the environmental footprint of aerospace products and services. Since its inception, this funding program has led to more than 30 collaborative research projects.

GARDN now plays a critical role not only in enhancing the competitiveness of Canadian aerospace, but also in meeting the targets the Canadian government has set to be an innovative, prosperous and sustainable development-conscious nation. We are more determined than ever to see GARDN’s mandate renewed by 2019.

I am very pleased, once again, to sign this annual report, which shows green aerospace innovation in motion. To the entire GARDN community of companies, universities, research centres and colleges, I would like to thank you for your collective environmental innovation efforts in aerospace. I also wish to acknowledge the support of the Government of Canada and the Business-Led Networks of Centres of Excellence Program, which continues to make our achievements in environmental innovation possible.

I hope what you read here proves helpful.

JIM QUICK
Chairman of the Board
President & CEO of the Aerospace Industries Association of Canada (AIAC)
MESSAGE FROM THE EXECUTIVE DIRECTOR

2016 marks the official launch of the third round of GARDN II projects. I am delighted to see the collaboration of many key players in the aerospace sector.

Our network now has more than 40 members from industry, research institutions and international organizations, convinced of the importance of reducing the environmental footprint of this vital sector of our economy.

The third call for proposals, in collaboration with the Consortium for Aerospace Research and Innovation in Canada (CARIC), was the key event of the year. It not only led to four new research projects, but also the extension of an existing GARDN project through CARIC’s financial support. The four newly launched research projects have been added to the GARDN II portfolio, which now includes a total of 16 projects — all aimed at a cleaner, quieter, more sustainable aviation industry.

Since GARDN’s inception, 33 research projects have been brought to life, developing more than 50 key technologies for the future of the aviation industry in Canada and abroad. We are proud to foster a creative approach to developing green aerospace technology, ensuring collaboration between members of the aerospace community in the supply chain and investing in the training of highly qualified personnel at research institutions.

This year, in addition to new R&D projects, GARDN had the opportunity to participate in major green aviation events, both nationally and internationally. The highlight of the Global Sustainable Aviation Forum, held by ATAG on May 10, 2016, was Air Canada’s announcement on the involvement of the Montreal-Trudeau Airport (YUL) in a GARDN project. We are very pleased to welcome the participation of a key aviation organization that recognizes the potential of our collaborative research.

Through its areas of research, GARDN II projects have successfully demonstrated the potential of a competitive industry with a small environmental footprint, which includes more than 40 aerospace organizations. I would like to thank and commend you for your outstanding green aviation initiatives.

I look forward to working with you again on new projects!

Sylvain Cofsky
Executive Director
FOR A GREENER AEROSPACE INDUSTRY

The Green Aviation Research and Development Network (GARDN) is a non-profit organization created in 2009 with funding from the Business-Led Network of Centres of Excellence (BL-NCE) of the federal government and Canadian aerospace industry. GARDN’s mission is to help support and increase Canada’s competitiveness in the aerospace industry — by reducing the environmental footprint of the next generation of aircraft, engines and avionics systems developed in the country.

Through its significant involvement in research and development projects, GARDN strives to foster the ongoing development of technology and procedures for a more CLEAN, QUIET, SUSTAINABLE aviation to achieve the environmental objectives of the global aerospace industry:

- Creativity in the development of greener aviation technology
- Collaboration between different-sized companies in the supply chain
- Investment in research institutions to train qualified personnel
- Life cycle of business projects and services factored into the environmental impact

ABOUT BL-NCE

The Business-Led Network of Centres of Excellence (BL-NCE) supports innovation in the private sector, responding to real-world challenges with the right expertise. These extensive networks of cooperative research increase private sector investment in Canadian research and accelerate the transformation of laboratory ideas into vital solutions for the private sector.
GARDN II
FACTS AND FIGURES

SOME NUMBERS...

Between 2014 and 2019, the GARDN II program will support green aerospace research and development projects.

16 collaborative research projects
$19.8M in total project value

Nearly 40 organizations, including companies, universities, colleges and research centres, are involved in the pursuit of greener aviation.

17 SMEs among the industrial members, which...
8 are conducting R&D projects
13 research institutions
22 companies of all sizes
134 researchers
4 international organizations

The results of GARDN’s efforts not only directly meet the needs of the industry, but also achieve the environmental objectives of the government and ICAO:

19 developed prototypes
5 ready-to-market technologies
45 filed patent applications
SUCCESS STORY

GARDN PROJECT KEY TO A NEW CANADA-UKRAINE COLLABORATION

GARDN is proud that two GARDN projects were key to a new collaboration between Esterline CMC Electronics (CMC) and Ukrainian company Antonov.

Esterline CMC has entered into a long-term agreement to offer its CMA-9000 Flight Management System with its displays and GPS on a number of Antonov aircraft, such as the AN-148/158/178 and AN-124. The announcement was made during the 2016 Farnborough International Airshow.

The decision to select the CMA-9000 was driven partially by its comprehensive airline standard vertical navigation (VNAV) capability. The efforts of the GARDN I and II programs towards improving the efficiency of the VNAV profiles greatly assisted CMC in achieving this program award. The optimized vertical profiles minimize fuel burn, directly reducing CO₂ and NOx emissions while saving the end customer both money and time.

“The GARDN programs that continue today with the École de technologie supérieure (ETS) Larcase research team have directly contributed to this strategic win with Antonov,” said Rex Hygate, Business Development Manager at Esterline CMC Electronics.

“Green aviation and collaborative research are essential to the future of the Canadian aerospace industry and its ability to announce technologies and partnerships such as the one between CMC and Antonov. We are proud that a green technology supported by GARDN has led to a collaboration between Ukraine and Canada, and we are confident that Canadian industry will continue to develop world-class green aviation technologies in the future,” said Jim Quick, AIAC President & CEO.

CMC launched the project FLIGHT MANAGEMENT PERFORMANCE OPTIMIZATION II in partnership with ETS as part of the GARDN II program in 2014. The objective of the project was to optimize the vertical and horizontal path of the aircraft within the flight management system by taking into account the required time of arrival, the wind grids and meteorological conditions. This GARDN II project was the extension of a first project, OPTIMIZED DESCENTS AND CRUISE, which was launched in 2009 as part of GARDN I.

“This is a perfect example of the importance of collaborative R&D initiatives, and we are pleased with the benefits that GARDN’s projects have generated for Canadian innovation. As a result of projects from the GARDN I and II programs, the technology developed by CMC and ETS will bring great benefits for clean and sustainable aviation,” added Sylvain Cofsky, GARDN Executive Director.
GARDN’S COLLABORATIVE RESEARCH PROJECTS

GARDN II, the second GARDN program, took flight in 2014 with the mission to invest more than $25 million in collaborative research and development projects with players from the research community and industry.

The aim of their research? Contribute to cleaner, quieter, more sustainable aviation.

Launched in 2016, the third round of GARDN II adds four new research projects to the portfolio of the second program.

1ST ROUND PROJECTS

PWC-23
Aero Gas Turbine Engine Exhaust Non-Volatile Particulate Matter (nvPM) Emission Baseline Measurement and Modeling

OBJECTIVE
Invest in a design system for lowering non-volatile Particulate Matter (nvPM). nvPM has been determined to be a potential source for greenhouse gas. Investing in nvPM reduction will not only benefit the environment, but also will help P&W remain competitive in a market that is now demanding for cleaner (lower emissions) aircraft engine exhaust.

CMC-21
Flight Management Performance Optimization II

OBJECTIVE
Optimize the vertical and horizontal path of the aircraft within the Flight Management System by taking into account the Required Time of Arrival, the wind grids and meteorological conditions.

The main motivation of the project is to reduce overall carbon emissions and flight costs.
OBJECTIVE

A continuation of prior work, the GARDN II project involves the development of a novel aircraft concept which is designed to satisfy various performance and stability and control (S&C) requirements.

This aircraft concept will then be tested in a wind tunnel test campaign to validate the S&C characteristics. Various alternative designs will be tested in addition to the baseline configuration.

OBJECTIVE

Define a supply chain management framework to provide industrials with the capacity to prioritize eco-responsible purchasing actions, define technologies’ green specifications and efficiently treat environmental information.

The acquired knowledge will offer a collaboration model fully adapted to the Canadian

OBJECTIVE

Leverage new technologies, develop new design methodology, and mature concepts in support of a low-noise large regional turboprop aircraft meeting stringent noise requirements.

The technology advancement to TRL6 of noise reduction concepts is a must for the development of a new large environmentally-friendly turboprop aircraft.

OBJECTIVE

Reduce noise impact of aircraft operations in the vicinity of airports by leveraging new technologies, developing new design methodology and maturing concepts in support of a low-noise business and commercial aircraft.

The project will lay groundwork to help reducing the adverse effects of the expected large increase in aircraft traffic volumes in Canada and elsewhere in the next decades.
2ND ROUND PROJECTS

NU-21
Energy Efficient Aircraft Configurations and Concepts of Operation

OBJECTIVE
Investigate novel air vehicle configurations, advanced propulsion systems, and noise reduction techniques to enable cleaner and quieter UAV operations and air transportation. This includes the development of a hybrid gas/electric propulsion system that will allow advanced technologies such as distributed propulsion. The technology will be demonstrated using Nebula’s existing VTOL fixed wing UAV air frame.

The research will develop an analysis of lightweight and flexible wings and unique energy harvesting methods on the flexible wing structures and the testing of physical prototypes.

CLEAN

SRS-21
Turboprop Flight Advisory System (FAS) for Cruise Fuel Burn Reduction

OBJECTIVE
Reducing the fuel burn and corresponding CO₂ emissions of small commercial turboprop aircraft (19 or less seats) during the cruise flight phase using a software application installed on stand-alone Electronic Flight Bag (EFB) device.

The main motivation for developing an EFB-based solution stems from the need to achieve an average improvement in fuel efficiency of 1.5% per year per industry target.

CLEAN

LTA-21
Integrated Electric Propulsion Systems for Aircraft

OBJECTIVE
Ensure that constituent technology components for an aerospace-grade Integrated Electric Propulsion System (IEPS) are commercially available, operationally viable, meet Certification Authority requirements, and are through-life supportable in a cost effective way.

This project will give involved business entities a jump on a key emerging branch of aerospace technical capability.
OBJECTIVE
Validate the performance of additive manufacturing (AM) process for aerospace non-structural parts, the use of standard post-manufacturing processes required and evaluate the certification of aerospace parts produced by AM.

At the end of the project, the performance of parts made by AM will be compared to certifiable machined parts used as reference.

HD-21
Additive Manufacturing for Landing Gear

NEC-21
Assessment of Likely Technology Maturation Pathways Used to Produce Biojet from Forest Residues (The ATM project)

WG-21
Canada’s Biojet Supply Chain Initiative (CBSCI): Enabling 2020 Carbon Neutral Growth

OBJECTIVE
Advance the development and production of biojet fuels in Canada from sustainable biomass feedstocks.

The project will assess the potential of producing biojet from Canada’s considerable forest residue resources, using the experience of Canada’s established forest products sector and the pellet sector.

OBJECTIVE
Demonstrate the operational feasibility of biojet fuels in the domestic jet fuel supply system, catalyze the development of the domestic biojet sector by using HEFA biojet, validate CND biojet supply chain elements, and generate hands-on experience with biojet handling and integration to develop best practices in a Canadian context. CBSCI blending activities will occur at Montreal-Trudeau International Airport (YUL).
3rd ROUND PROJECTS

PWC-24
Development of Innovative Aerodynamic Performance Enablers for Gas Turbine Engine Compressors

OBJECTIVE
Focus on validating new findings in terms of axial compressor design strategies to maintain nominal performance and stall margins. The objective of the proposed research is to validate the findings from research experimentally on a real compressor design in a representative environment to validate the predicted design improvements through testing of original designs versus a newly proposed design based on the desensitization strategies.

SUSTAINABLE

PWC-25
Aero Gas Turbine Engine Exhaust Non Volatile Particulate Matter (nvPM) Emission Baseline Measurement and Modeling to Predict

OBJECTIVE
Invest in a design system for lowering nvPM. Non-volatile particulate matter has been determined to be a potential source for GHG and detrimental to human health. Investing in nvPM reduction would not only benefit the environment, but help P&WC remain competitive in a market that is now demanding cleaner (lower emissions) engines on aircraft.

CLEAN

WG-22
Civil Aviation Alternate Fuel Contrail and Emissions Research (GAAFCER)

OBJECTIVE
Enhance the T33 emissions instrumentation by the addition of a CPC 3776 ultra-fine aerosol sensor and denuder to differentiate between volatile and non-volatile particles, and then undertake jet emissions and contrail measurement flights.

CLEAN

OPT-21
Development of an Electric Propulsion System to Convert Gliders for Self-Launch Operations to Reduce the Environmental Footprint

OBJECTIVE
Demonstrate that electric propulsion is feasible and viable to support glider launch operations with multiple flights per hour with quick battery replacement in-between flights, develop the Canadian expertise in electric propulsion for general aviation-sized aircraft, and increase awareness for green aviation through a project that is “accessible” to Canadian citizens.

CLEAN QUIET SUSTAINABLE
GOVERNANCE

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