Aerodynamics Laboratory

The Aerodynamics Laboratory of the NRC Institute for Aerospace Research (NRC Aerospace) is located in Ottawa at both the Montreal Road and Uplands sites of the NRC. The Laboratory engages in research and provides services to clients in fixed- and rotary-wing aerodynamics, and in the aerodynamics of bluff bodies such as surface vehicles and ground-based structures. Sophisticated computational fluid dynamics (CFD) tools coupled with wind tunnel data provide cost-effective support for research and product development.

Facilities
The Laboratory supports eight wind tunnels including a 1.5 m x 1.5 m trisonic pressurized blowdown, and six low speed wind tunnels: 9 m x 9 m, 2 m x 3 m, 3 m x 6 m (open circuit propulsion and icing), 0.9 m x 0.9 m, 5 m diameter vertical, and 0.57 m x 0.57 m altitude icing, as well as a small water tunnel. A unique low Reynolds number facility is under development to study the aerodynamics of Micro Air Vehicles. In addition to the facilities, the Laboratory has recognized expertise in wind tunnel correction methodologies, pressure sensitive paint technology, flow mapping, and aerodynamic noise measurement. The individual facilities are described in separate fact sheets.

The experimental facilities are complemented by a range of computational facilities, the most recent being a 120-node PC-based cluster. Smaller clusters and UNIX work stations are also available and used in conjunction with commercial and in-house developed CFD codes.

These facilities support industrial, government and university clients, as well as in house research projects. Projects are normally of a customized nature and extensive efforts are applied to derive innovative approaches in instrumentation, software and operations to meet client needs.

Bluff-body aerodynamics
NRC Aerospace is recognized worldwide for its research and commercial activities in wind engineering and surface vehicle aerodynamics. Its Aerodynamics Laboratory has tested some of the world's major structures to determine wind loads and wind-induced response. Of particular note is the ability to test bluff bodies at very high Reynolds numbers, a topic of research interest, and one generating commercial contracts. Recent projects include large-scale bridge section model testing and inclined cable aerodynamics.

The Laboratory also investigates the aerodynamics of trucks, trains, cars, buses, motorcycles, ships, etc. at both full and model scale, in support of fuel efficiency, stability, and aerodynamic noise studies. Recent projects include vehicle wake surveys, and large-vehicle engine cooling studies.

Fixed-wing aerodynamics
NRC Aerospace has expertise in a wide range of issues associated with civil and military aircraft aerodynamics. Experimental and computational approaches are used to support R&D through the full spectrum of flight, from

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subsonic to supersonic across a wide range of Reynolds numbers, in icing and in turbulence. Expertise goes beyond providing data; it includes interpretation of results and impacts on vehicle flight dynamics.

The Aerodynamics Laboratory has an active program with Canada's Department of National Defence (DND) for supporting stores clearance from aircraft. This work has a computational component using chimera grids in conjunction with in-house flow solvers, and complementary experimental components using the trisonic wind tunnel. A current project is the development of a captive trajectory system designed to improve the accuracy, precision and efficiency of the wind tunnel test program.

The Laboratory works extensively on issues related to the effects of ice accretion on aircraft performance. Computational approaches are used to predict adverse flow separations on a roughened wing. Experimental research has included validation of holdover times for various anti-icing fluids in the large propulsion/icing facility. Current projects include numerical and experimental evaluation of icing effects for a third-party modified airfoil section.

NRC Aerospace also has an active research program in the aerodynamics and flight mechanics of small flight vehicles. Experiments are being conducted with international part-ners to examine the fluid mechanics of these vehicles at low Reynolds numbers in a unique facility wherein loads can be accurately obtained under these demanding conditions. An active computational program using large-eddy simulation to predict incipient separation on aerofoils has shown promising results. Preliminary computations on simple configurations with moving parts show promise for future small-scale UAV applications.

Missile aerodynamics is also an established area of expertise, both computationally and experimentally. Current projects include numerical evaluations of several hypersonic missile configurations.

Research in aeroelasticity and unsteady aerodynamics is being carried out in close collaboration with DND to support high-performance combat aircraft operation.

Rotary-wing aerodynamics

NRC Aerospace engages in R&D associated with rotary-wing air vehicle performance. A CFD simulation using chimera grids of a four-bladed flapping rotor is under development, building on the earlier success of a two-bladed configuration. Experimental and computational research efforts are underway examining the issues related to simulation fidelity for rotorcraft missions.

The Aerodynamics Laboratory has also developed high-fidelity experimental capabilities to assess operational envelopes associated with the launch and recovery of helicopters from aviation-capable ships as well as on-deck loads. Current projects include studies to support icing certifications for civil and military helicopter clients.

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