NRC·CNRC

Gas turbine test facilities

For the research, development, testing and certification of next-generation engines and components

National Research Council Canada | Conseil national de recherches Canada

Canada

National Research Council Canada

NRC delivers advanced technology solutions to the aerospace, transportation and energy sectors, in civilian and military applications. Our unparalleled facilities, expertise and technology risk management capabilities help position NRC clients as global leaders, ensuring their competitive advantage in the marketplace.

About us

We work with aircraft and industrial gas turbine engine manufacturers, as well as component suppliers and system integrators, to develop and validate technologies that will meet stringent environmental, safety, cost-reduction, performance and fuel flexibility requirements. We also collaborate with fleet operators to validate and improve performance in special environments and to optimize life-cycle costs through technology-driven maintenance, repair and overhaul (MRO) practices.

NRC is looking into more aggressive inter-turbine transition duct geometries for reducing engine weight, using facilities such as the **Subsonic Turbine Rig**.

One of NRC's several specialized **high-pressure, optically-accessible test rigs** used to study combustion and fuel sprays.

Competitive Advantage

Innovation is a key competitive advantage in today's technology-driven, knowledge-intensive industry. Innovation is the engine that drives NRC's work with gas turbines for the aerospace, transportation and energy sectors.

Our expertise and capabilities

- advanced optical-based measurements
- alternative fuels for aviation and energy-production
- combustor and fuel nozzle development and evaluation
- diagnostics, prognostics and health monitoring (DPHM)
- engine and turbomachinery aerodynamics
- engine performance assessment and certification
- icing formation, detection and mitigation
- mechanical components and tribology (lubricants, bearings and gearboxes)

Our partners

NRC is looking for clients and partners to bring innovative aerospace and energy products to market. We offer research and development (R&D) services, consulting, fee-for-service testing and calibration services to hundreds of companies and organizations worldwide. NRC also develops and transfers technologies through collaborative research contracts and licensing arrangements.

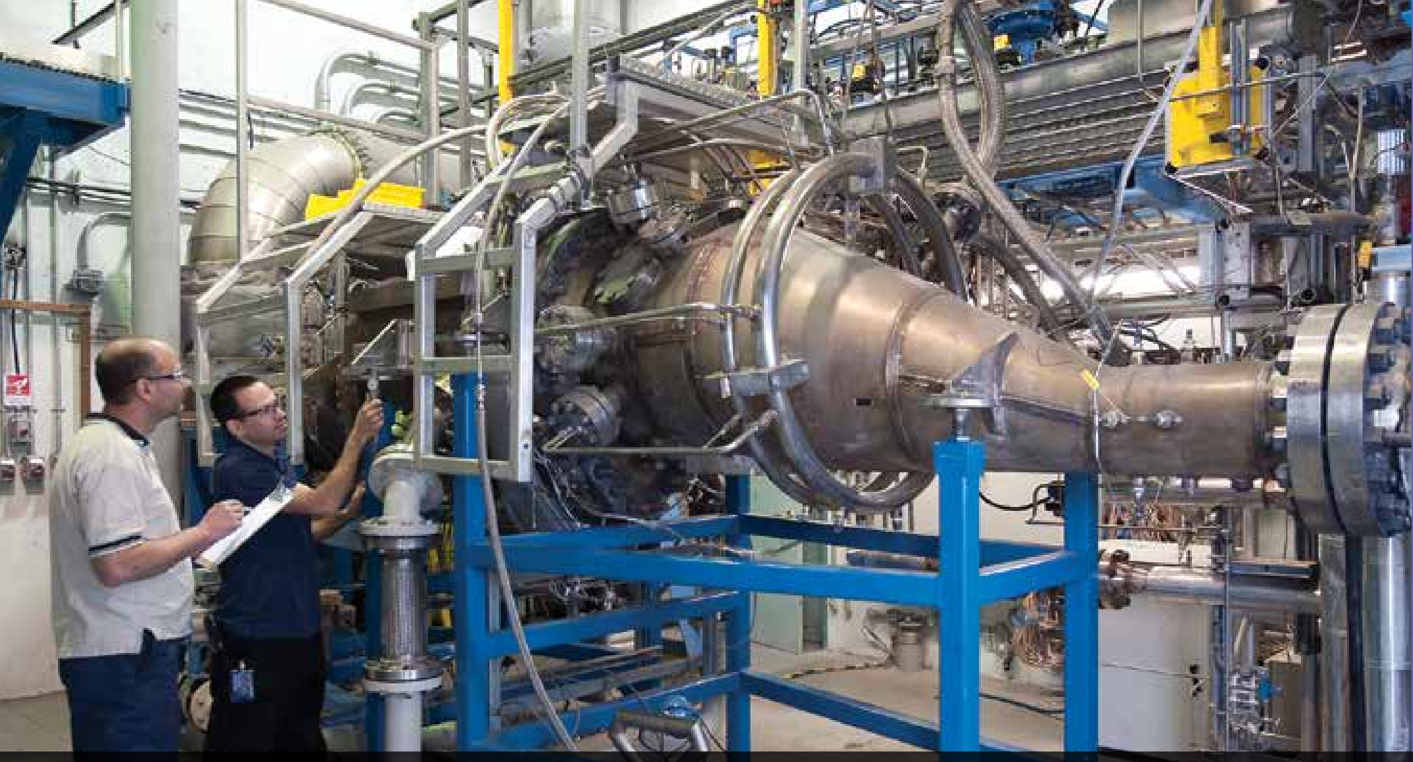
All our clients and partners enjoy a range of benefits, including:

- access to world-class research infrastructure and unique expertise
- customized service options
- data integrity and confidentiality
- maximal opportunities for collaboration between national and international industry partners and regulatory agencies
- access to a network of R&D providers

Our facilities

NRC's world-renowned facilities provide cost-effective platforms to de-risk new technologies, advance technology readiness levels and perform certification tests. Our advanced facilities are equipped for custom tests to meet specific and challenging product requirements. We foresee the needs and challenges of industry to identify future outcomes that will drive our research and technology focus, and to determine our facility investments.

Our gas turbine facilities are registered to the ISO 9001:2015 quality standard, covering all critical business and technical processes. In addition, all instrument calibrations are traceable to appropriate national and international standards. NRC clients expect the very best, and we deliver nothing less.


One of NRC's **combustion test cells** outfitted with a customer-provided test rig.

Combustion, fuels and emissions

NRC has a multitude of combustion and spray test facilities to support the research, testing and validation of low-emission, fuel-flexible combustion systems, as well as fuel spray nozzles and injectors at realistic high-pressure conditions.

To support the development of multi-fuel, and fuel-flexible combustion systems, NRC can augment its conventional fuel capabilities (diesel, Jet-A, and natural gas) with alternative fuels. NRC has high-pressure supply facilities for the delivery of vaporized higher-hydrocarbons (ethane, propane, butane, dimethyl ether, etc.), as well as inerts (carbon dioxide and nitrogen) for blending into natural gas to study the effects of fuel variability on combustor performance. Alternative liquid fuels (biodiesel, ethanol, synthetic jet fuels, etc.) can also be supplied via mobile liquid fuel tank hook-ups.

NRC's Hydrogen Supply Facility also enables the supply of hydrogen to our combustion test cells.

NRC's **High-Pressure Spray Facility** tests atomizer performance from atmospheric pressure to 2, 068 kPA (300 psi).

High-pressure combustion test cells (TC)

	Maximum capacity					Instrumentation
	Air flow rate	**Air pressure, absolute**	**Rig air temperature**	**Natural gas**	**Liquid fuels** (Jet A-1, diesel, other)	
TC 1	21.5 kg/s (47.5 lb/s)	2 170 kPa (315 psi)	922 K (650 ˚C) (1 200 ˚F)	0.68 kg/s (1.5 lb/s)	0.77 kg/s (1.7 lb/s)	Pressure sensors, thermocouples, strain gauges, noise, flow meters, emission analyzers
TC 2	24 kg/s (53 lb/s)	2 170 kPa (315 psi)	922 K (650 ˚C) (1 200 ˚F)	0.68 kg/s (1.5 lb/s)	1.36 kg/s (3.0 lb/s)	Pressure sensors, thermocouples, strain gauges, noise, flow meters, emission analyzers
TC 3	6.4 kg/s (14 lb/s)	1 930 kPa (280 psi)	922 K (650 ˚C) (1 200 ˚F)	0.34 kg/s (0.75 lb/s)	0.25 kg/s (0.57 lb/s)	Pressure sensors, thermocouples, strain gauges, noise, flow meters, emission analyzers

Specialized spray test facilities

	Capacity					Instrumentation
	Air flow rate	**Rig pressure, absolute**	**Air flow rate**	**Fuel temperature**	**Fuels**	
High-Pressure Spray Facility (HPSF)	205 kg/h (452 lb/h)	2 068 kPa (300 psi)	4.5 kg/s (10 lb/s)	Ambient	Mil-C (nozzle calibration fuel)	Non-intrusive optical diagnostics (PDPA, Malvern, PLIF, PIV, etc.) Physical probes
Atmospheric-Pressure Spray Facility (APSF)	68 kg/h (150 lb/h)	Ambient	0.23 kg/s (0.5 lb/s)	Ambient	Mil-C (nozzle calibration fuel)	
Optically-Accessible Single Injector System (OASIS) Facility	68 kg/h (150 lb/h)	1 034 kPa (150 psi)	0.14 kg/s (0.3 lb/s)	588 K (315 ˚C) (599 ˚F)	Jet-A, diesel and biofuels	

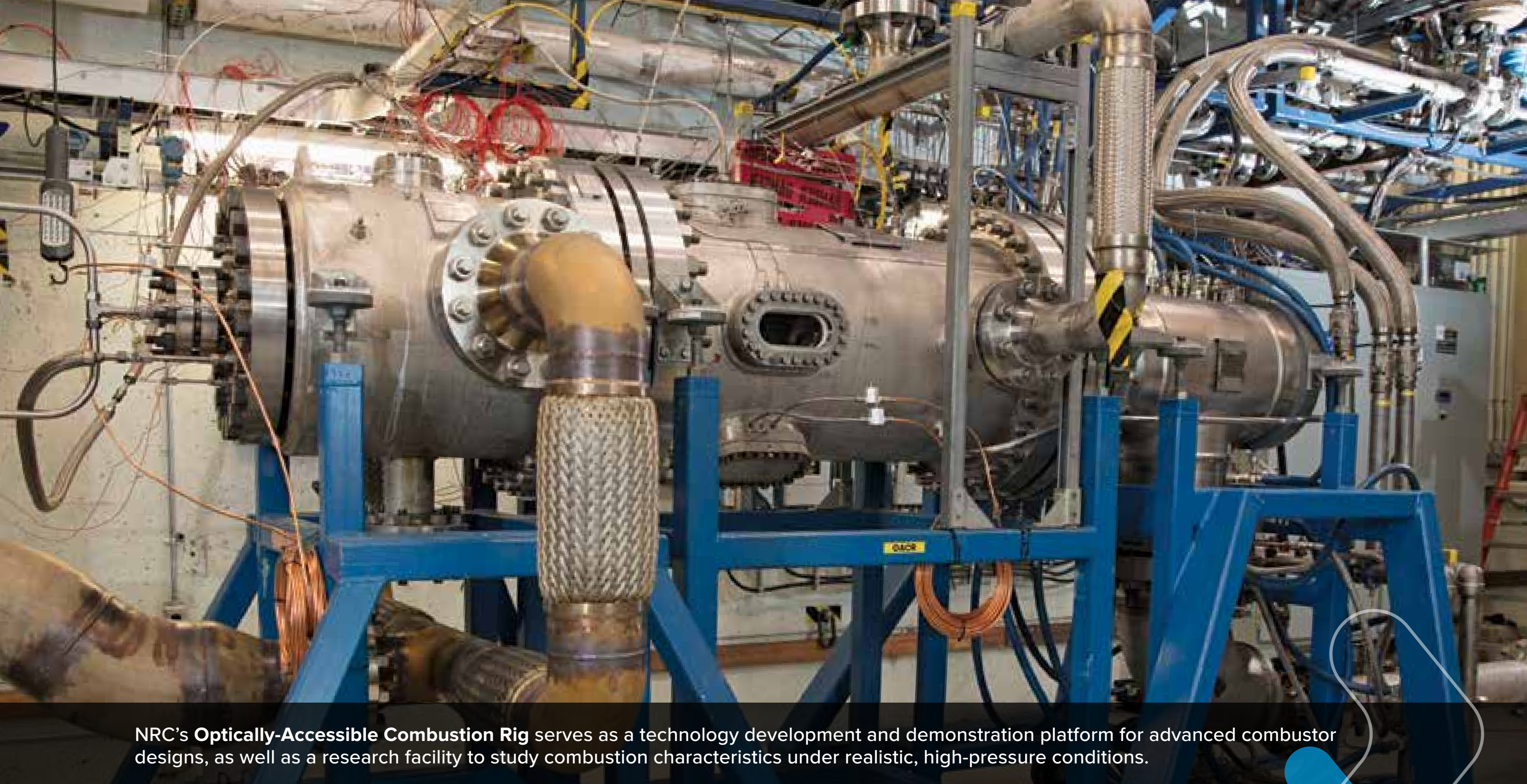
NRC's **Low-Pressure Optically-Accessible Combustion Rig**.

Combustion, fuels and emissions

Low-Pressure Optically-Accessible Combustion Rig (LOACR)

The Low-Pressure Optically-Accessible Combustion Rig (LOACR) is a specially designed facility to support low technology readiness level combustion projects, so that innovative new ideas and concepts can be optimized, validated and accelerated to higher pressure testing. The combustion rig allows for four-way optical access by laser-based diagnostics through its 4"x 6" quartz glass windows. Various combustion performance parameters, including emissions, lean blow-off limits, and ignition loops, can be evaluated for both gaseous and liquid fuels, including syngas and biofuels. Advanced laser-based diagnostics such as Phase Doppler Particle Analyzer, Particle Imaging Velocimetry, Planar Laser Induced Fluorescence and OH/CO Chemiluminescence enable detailed measurements of combustion flow structures and chemical species along with emissions gas analysis.

Capacity		
Air flow rate	**Air pressure**	**NG flow rate**
18 lb/min	120 psi	2 lb/min

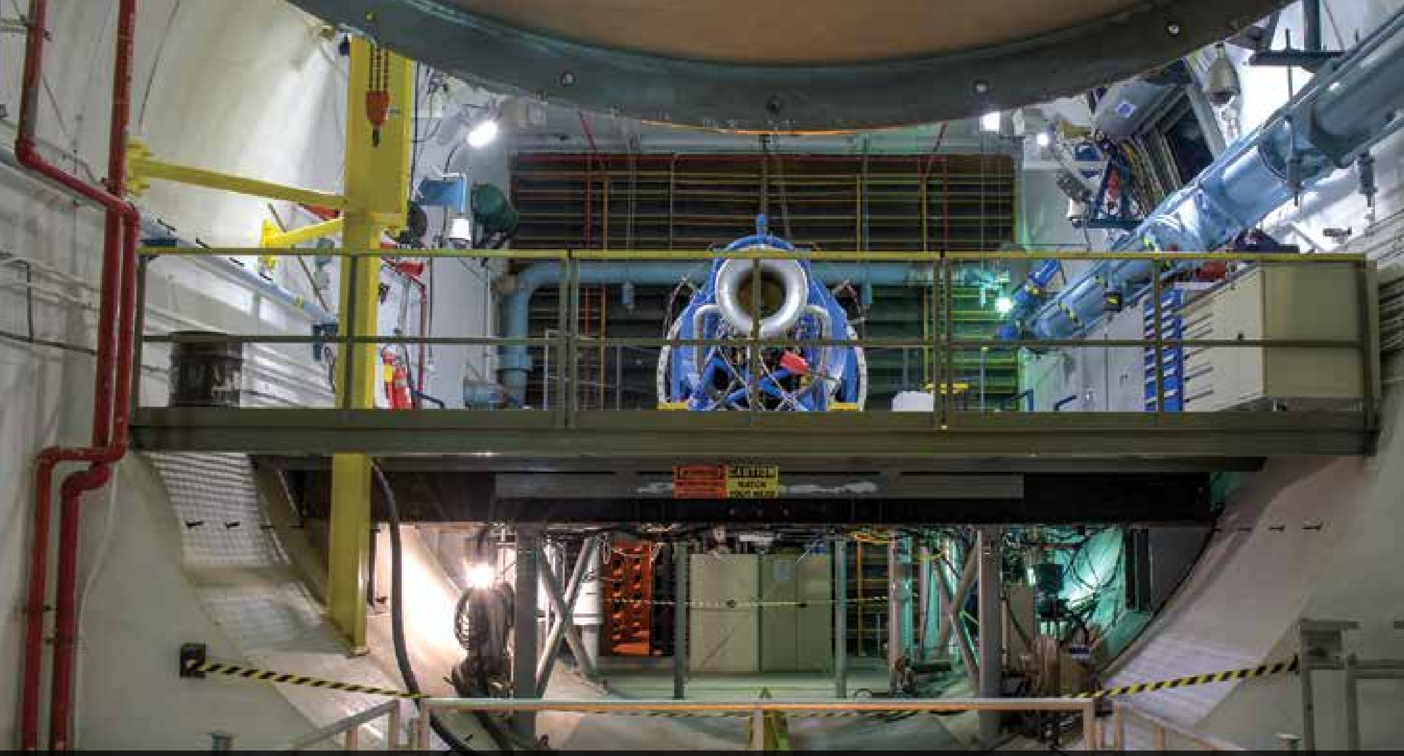


NRC's **Optically-Accessible Combustion Rig** serves as a technology development and demonstration platform for advanced combustor designs, as well as a research facility to study combustion characteristics under realistic, high-pressure conditions.

Optically-Accessible Combustion Rig (OACR)

NRC's high-pressure rated Optically-Accessible Combustion Rig (OACR) is capable of accommodating combustion hardware with a diameter of up to 45 cm (18 inch) and length of up to 120 cm (47 inch). The OACR also provides five-way optical access to cater to any state-of-the-art laser-based combustion and fuel diagnostics.

	Capacity			
	Air flow rate	Rig pressure, absolute	Air temperature	Fuels
Main Air	14.5 kg/s (32 lb/s)	2 068 kPa (300 psi)	922 K (650 ˚C) (1 200 ˚F)	Designed for various liquid and gaseous fuels
Cooling Air	6.6 kg/s (14 lb/s)	2 068 kPa (300 psi)	Ambient	



NRC operates multiple **engine test cells** for the testing and certification of gas turbine engines.

Engine performance and operability

NRC offers a number of gas turbine engine test cells to support performance, operability and certification testing, including icing, bird-ingestion, blade-off, alternative fuel certification, and endurance trials.

NRC's engine test cells are equipped for:

- endurance or cyclic testing
- full authority digital engine control (FADEC) and control logic testing
- thermomechanical testing
- ingestion testing for water, ice slab, sand, volcanic ash and birds
- altitude and moderate attitude testing
- operability testing
- icing testing and certification
- blade-off testing
- alternative fuels testing and certification

	TC 1	TC 2	TC 4	TC 5
Engine type	Turboshaft/jet	Turboshaft/jet	Turbofan/jet	Turbofan/jet
Dimensions	4.6 m (15 ft) x 4.6 m (15 ft) x 10.7 m (35 ft)	4.6 m (15 ft) x 4.6 m (15 ft) x 10.7 m (35 ft)	7.6 m (25 ft) x 7.6 m (25 ft) x 22.9 m (75 ft)	4.6 m (15 ft) x 4.6 m (15 ft) x 22.9 m (75 ft)
Thrust/power	4 000 SHP at 4 500 rpm	9 000 SHP at 3 600 rpm	222 kN (50 000 lbs)	222 kN (50 000 lbs)
Air flow	50 kg/s (110 lb/s)	50 kg/s (110 lb/s)	454 kg/s (1 000 lb/s)	227 kg/s (500 lb/s)
Inlet	Heated 32 °C (90 °F) at 9.1 kg/s (20 lb/s)	Ambient	Ambient with icing tunnel	Ambient with icing tunnel
Design and correlation	SAE AIR 4989, SAE ARP 4755		SAE AIR 4869, SAE ARP 741	

- Emissions (gaseous and particulate matter) measurement capability available in any test cell
- 1 000+ channel DAS and state-of-the-art high-speed dynamic DAS in all test cells
- Conventional and alternative fuels (including biofuels) at flow rates of up to 32 500 kg/h (71 500 lb/h)
- 4 storage fuel tanks at 40 000 litre (10 567 US gal) capacity
- Additional capabilities: Infrared thermography, particle detection probes for sand or volcanic ash detection, hailstorm simulation rig, air cannons for bird and hailstone ingestion testing, compressor/exhauster capability, and engine flow simulator

NRC has several test facilities capable of performing engine and probe icing for airworthiness certification.

Engine and probe icing

NRC delivers engine icing certification testing and analysis, as well as development of ice detection and mitigation systems for aircraft and engines.

For more than 60 years, NRC has performed icing simulation testing in its Ottawa-based test cells. Current NRC icing system capability can produce a liquid water content of up to 4.0 g/m^3 over a 15 to 45 µ range of median volumetric diameters. These facilities rely on ambient air temperatures to produce the desired conditions during winter months (December through March), and deliver icing testing at lower cost.

NRC icing facilities and capabilities include:

- specialized icing instrumentation development
- laser measurement techniques for measuring droplet diameters
- techniques for snow and ice crystal ingestion
- ice slab or hail stone ingestion (FAR 33.77 testing)
- hail storm simulator
- Iso-Kinetic Probe for accurate total water content measurements
- FAR 33.68 icing certification testing

As a partner in the Global Aerospace Centre for Icing and Environmental Research (GLACIER), NRC has developed and currently operates the icing system for certifying large turbo fan engines in Thompson, Manitoba, Canada.

NRC's **Research Altitude Test Facility** can evaluate engines and components under simulated altitude operating conditions burning a variety of aviation fuels.

Altitude testing

With this unique facility, NRC has developed a significant capability to study the performance degradation of aircraft instruments (air data probes) and aircraft engines that have been exposed to ice-crystal clouds. Our Research Altitude Test Facility (RATFac) can simulate a range of altitudes (up to 15 760 m or 51 700 ft), temperatures (-58 °C to 48 °C), Mach numbers (0.15 to 0.8), relative humidities (1% - 90%), and representative ice crystal conditions with ice water content of up to 20 g/m^3 over a 55 to 300 micron range of ice crystals median volumetric diameters.

The RATFac is equipped for the following types of testing:

- altitude operability
- attitude restart
- icing and ice crystal ingestion
- air data probe
- alternative fuel
- reciprocating engine
- APU, turboshaft or drone engine
- optical flow measurement instrumentation

RATFac specifications

Maximum flow rate (unrefrigerated/ undried air)	11.2 kg/s (24.6 lb/s)
Minimum altitude (refrigerated dried air)	100 m (330 ft)
Maximum altitude	15 760 m (51 700 ft)
Minimum temperature at min. flow rate 0.23 kg/s (0.5 lbm/s)	-43 °C (-45.4 °F)
Minimum temperature at max. flow rate of 4.5 kg/s (10 lbm/s)	-50 °C (-58 °F)
Heated inlet air at a flow rate of up to 1.8 kg/s (4 lbm/s)	+48 °C (+118 °F)

Experimental and computational analysis are used in concert to reduce the losses in both compressors and turbines.

Turbomachinery aerodynamics

NRC has the capabilities and research infrastructure to develop gas turbine engine fuel-efficiency improvements through advancements in engine turbomachinery (compressors, turbines and inter-stage ducts), engine inlet and exhaust systems, as well as the testing and validation of engine probe performance.

Large-Scale Subsonic Linear Cascade

This subsonic test facility consists of an open-circuit wind tunnel with a variable-incidence linear cascade test rig. The rig tests the aerodynamics of turbine and compressor airfoils, at design and off-design conditions. The air flow can reach a maximum flow rate of about 5 kg/s at a total pressure rise of about 1.8 kPa. The wind tunnel is capable of maintaining stable velocities from 3 m/s to 30 m/s at the inlet of the cascade. Turbulence grids can augment the 0.3% background turbulence intensity to 5% upstream of the cascade. The rig's precision traverse mechanisms can take detailed measurements upstream and downstream of the cascade.

The test section has a span of 20 cm and the airfoil chord is typically 7.5 cm for a cascade with 9 blades.

Large-Scale Transonic Linear Cascade

The cascade test rig records the aerodynamics and heat transfer of transonic turbine vanes. The vane span is 11.3 cm, and the vane chord is typically 17.5 cm for a cascade with 6 blades. This continuous flow facility allows air to be drawn into the cascade at a maximum flow rate of 5 kg/s. The isentropic exit Mach number can be varied between 0.3 and 1.4. The data obtained can include surface static pressure, quasi-wall shear stress, flow-field pressure (time-resolved and time-averaged), angle, and total temperature distributions.

Aggressive inter-turbine duct testing in the **Subsonic Turbine Rig Facility**.

Turbomachinery aerodynamics

Low-Subsonic Probe Calibration Rig

Pressure and hot-wire probes are calibrated in this blow-down rig prior to testing at subsonic speeds. The rig consists of an open-circuit wind tunnel with a 16:1 axisymmetric large core jet. Jet flow uniformity is guaranteed between 1 m/s and 60 m/s at a low free stream turbulence intensity of 0.3%. The rig allows for variation in the roll, pitch and yaw angles without changing the absolute position of the probe tip. The traverse mechanism provides ±70° probe rotations in pitch and yaw with an estimated accuracy of ±0.01°.

High Speed Probe Calibration Rig

NRC's cold flow, suction-type rig has a large test section (175 cm^2) and is capable of delivering uniform flow between free stream Mach numbers of 0.15 and 1.2. The rig can operate at subsonic and transonic conditions with high blockage tolerances.

Other measurement capabilities

- temperature and multi-hole pressure probe measurements
- multi-wire, hot-wire and surface-mounted hot-film measurements
- schlieren flow visualization
- particle image velocimetry

Subsonic Turbine Rig

NRC's rotating cold flow axial turbine rig simulates the aerodynamics present in a low-pressure turbine stage, allowing for the investigation of engine representative flows. The rig allows for a large variation in flow conditions with a fully modular turbine stage featuring changeable stator and rotor geometries, and a downstream annular test section with changeable casing and hub sections. The facility is pictured on page 2.

Co-axial Subsonic Exhaust Rig

This cold flow subsonic facility consists of a co-annular open circuit wind tunnel with fully isolated core and bypass flow controls. The wind tunnel delivers flow velocities up to 60 m/s in the bypass and 100 m/s in the core. The core inlet diameter is 8", the bypass annulus inlet inner diameter is 10" and outer diameter is 19". This facility can be instrumented to suit any data acquisition requirements.

The **Oil-Free Bearing Rig** is used to evaluate the steady-state and dynamic characteristics of foil bearings.

Mechanical components

NRC's expertise in mechanical components helps clients and partners extend the life and optimize the performance of their mechanical equipment and rotating machinery – at higher operating speeds, under heavier loads, and in harsher operating environments.

NRC's tribology capabilities include:

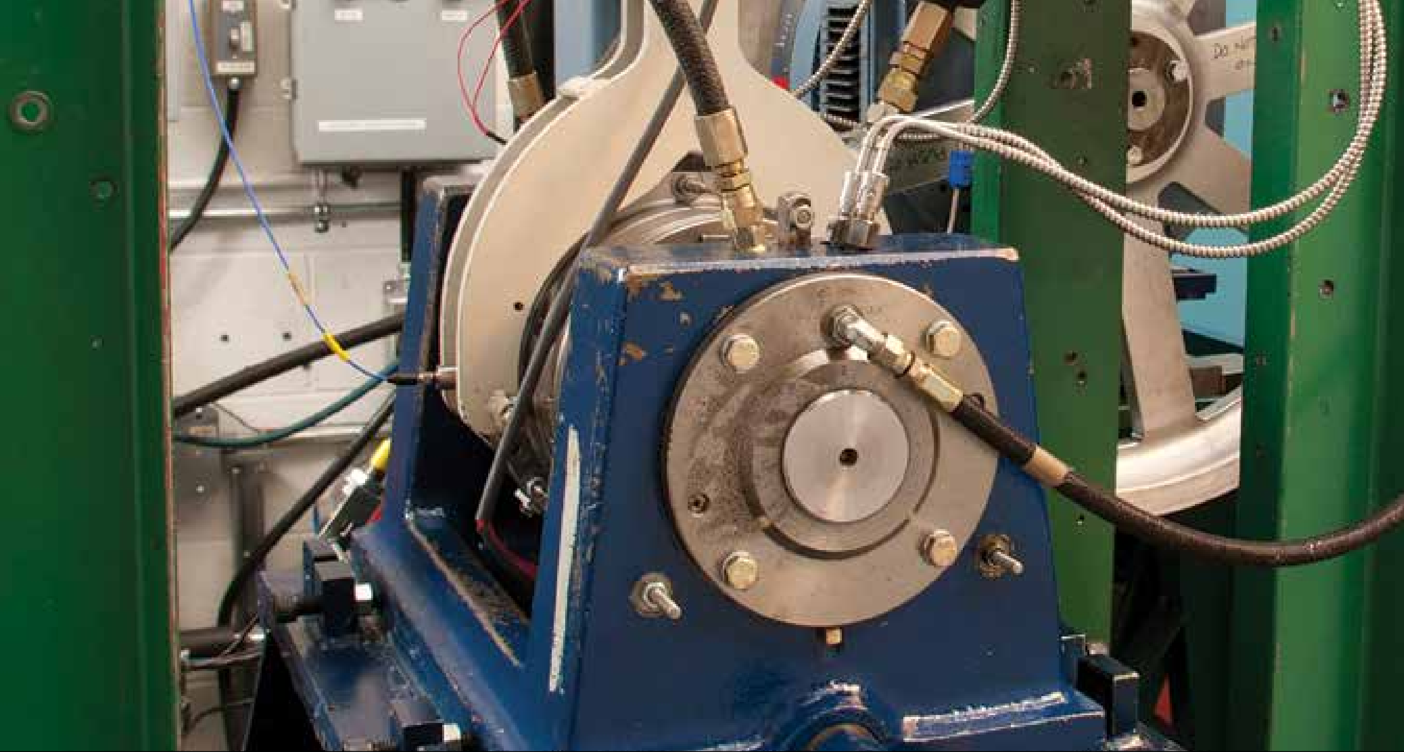
- investigation of steady-state and dynamic performance of journal bearings using unique test facilities and a state-of-the-art computer modelling for plain and tilting pad bearings
- performance evaluation and skidding identification of high-speed rolling-element bearings
- diagnostics, prognostics and health management (DPHM) for rolling-element bearings and gears
- experimental investigations of steady-state and dynamic performance of gas foil journal bearings
- evaluation of materials for honeycomb and abradable seals

Abradable Seal Rig

NRC's test rig simulates operational wear using a bladed disc that is driven by an air turbine. Axial and radial movement of the fixtured test sample is controlled by a dual-axis incursion system; incursion rates between 2.5 µm/s and 760 µm/s are possible. The maximum blade tip speed is 425 m/s.

Tests can be performed at ambient and high temperatures (up to 300 °C).

Rotational speeds and incursion rates are determined by the test specification. Rotational speed, incursion rate, incursion forces and rub temperature are recorded by a data acquisition system. Post-test the erosion of the seal is measured and recorded, along with test blade material loss. Test samples are usually returned to the customer for further investigation at their facility.



The **Journal Bearing Dynamic Rig** evaluates steady-state and dynamic properties of hydrodynamic journal bearings.

Mechanical components

High-Speed Rolling-Element Bearing Rig

This test rig features an overhung, simply-supported shaft and is capable of speeds above 35 krpm with test bearing radial loads as high as 4.5 kN. The rig is powered by a 22 kW hydraulic motor, through a belt-and-pulley system. Radial load is applied using a hydraulic ram by way of an overhead cable-pulley system. The bearing under test is located at the overhung section of the shaft and can be lubricated via jet or under-race.

Rotational speeds, loads and oil flow rates may be held constant or varied dependent upon the test specification. A telemetry system permits the measurement of inner race bearing temperatures. Bearing load, race temperatures, power loss and accelerations are monitored and recorded by a data acquisition system. In addition, roller skidding can be evaluated using specialized instrumentation.

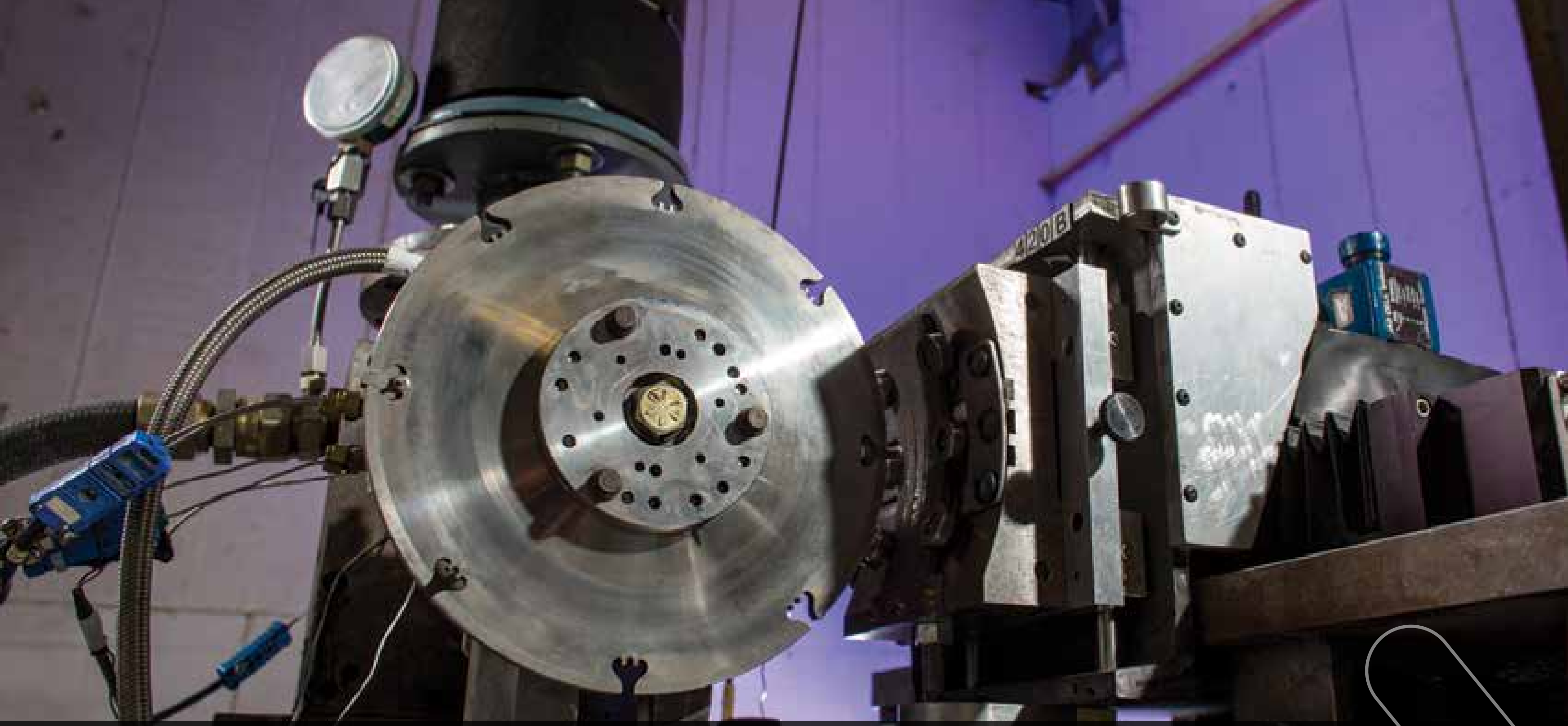
Journal Bearing Dynamic Rig

This facility features a simply-supported, rotating shaft and a free-floating test bearing housing located at the shaft midspan. A 37 kW variable speed electric motor, driving through a belt-and-pulley system, provides shaft speeds of up to 16.5 krpm. Static load is applied hydraulically through a spring-isolated cable-pulley system and two orthogonal electromagnetic shakers apply dynamic loads to the stator. Each shaker is connected to the test bearing housing through a flexure that ensures that the test bearing housing is unconstrained in directions perpendicular to the shaking force.

Rotational speeds and loads may be held constant or varied, depending on the test specification. Bearing load, position, acceleration, power loss and metal temperatures are monitored and recorded by a data acquisition system.

Oil-Free Bearing Rig

This test rig features a simply supported shaft with a test bearing surface 0.2 m long and 0.07 m in diameter and is capable of operating at speeds up to 60 krpm. The test rig also has the capability of both steady-state and dynamic testing with loads up to 3.5 kN. Test bearing operating characteristics such as temperature, friction force, shaft orbit, and vibration are recorded by a high speed data acquisition system, enabling in-depth data analysis.



The **Abradable Seal Rig** simulates operational wear using a bladed disc and a test coupon fixed to a motion table.

The facility is used to evaluate bearings that use air as their medium of lubrication. Rotational speeds and loads (static or dynamic) may be held constant or varied depending upon the test specification. Bearing load, position, acceleration, power loss and temperature are monitored and recorded by a data acquisition system.

Journal Bearing Static Rig

This rig features a fixed shaft supported on tilting-pad journal bearings and a free-floating test bearing housing located at the shaft midspan. A 110 kW variable speed electric motor provides shaft speeds of up to 16 krpm. A hydrostatic loading system eliminates friction between mating surfaces, permitting the transfer of high loads to the test bearing while still allowing the capability of measuring rotational friction losses. Rotational speeds, loads and oil flow rates may be held constant or varied dependent upon the test specification. Bearing load, position, power loss and metal temperature are monitored and recorded by a data acquisition system.

Traction Motor Bearing Rig

This facility is capable of testing full-size traction motor bearings under the severe operating conditions found in rail cars. It features a fixed shaft supported on pillow-block bearings. Four hydraulic cylinders are connected to the bearing housing through double flexure pivots and generate a maximum radial load capability of 182 kN. This load is applied at an angle of 20° from the vertical. A 110 kW variable speed electric motor provides shaft speeds up to 600 rpm. Rotational speeds and loads are typically held constant and bearing performance is evaluated based on operating temperature and power loss. Key parameters are monitored and recorded by a data acquisition system.

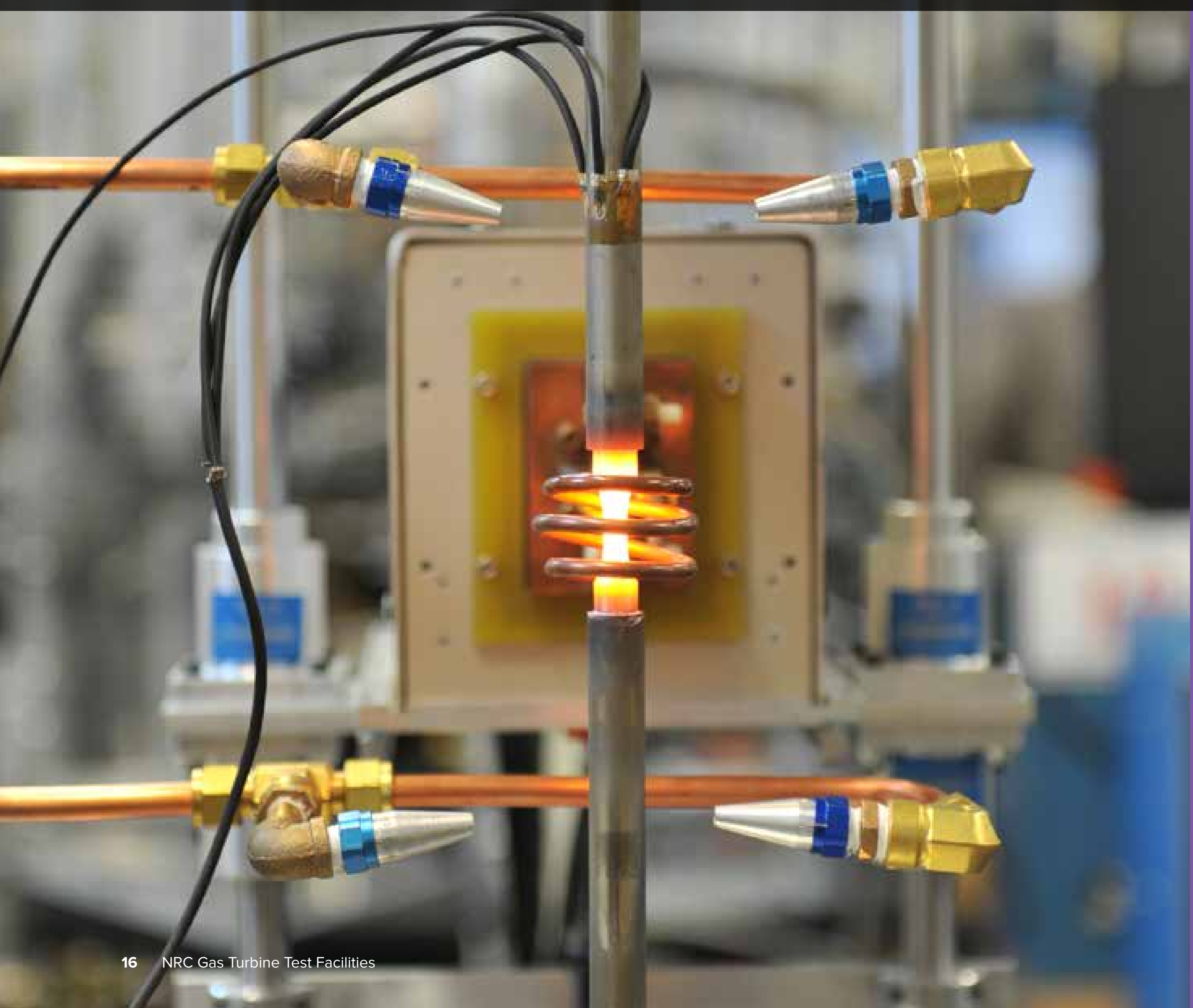
Structures and materials performance

We offer unique expertise and comprehensive state-of-the-art facilities for the design, evaluation and qualification of new, legacy, and repaired engine components and materials.

Our R&D in gas turbine materials engineering focuses on issues related to the structural integrity, durability and reliability of cold and hot-section engine components. We have the knowledge and facilities to design, conduct and evaluate material tests ranging from the simple static coupon level to complicated component mission level tests in various environments. Materials evaluation capabilities include airworthiness certification for new materials, process validation, life extension technologies, and emerging concepts for life cycle management of engines and their components.

Our experienced and professional staff has a record of exceeding our customers' expectations with quality results. Our strength is derived from our insight on various test techniques and analysis methods to enhance our clients' test experience while providing exceptional value.

Ultrasonic high-cycle fatigue test rig is used for materials fatigue testing at 20 kHz.



Key Facilities and Capabilities

High-Temperature Fatigue and Fracture Mechanics Facility: simulate service conditions; static or cyclic forces and temperatures typical in a gas turbine engine

- Temperature range: up to 1 700 °C (resistance) and 2 000 °C (induction)
- Force capacity: up to 250 kN (56.2 kip)
- Environments: air, inert or high-vacuum
- Proficiency: thermomechanical fatigue, creep, fatigue, and fatigue crack growth rate with potential difference and compliance crack monitoring methods
- Ultrasonic high-temperature high-cycle fatigue (20 000 Hz, >1 000 °C) with mean loading
- Combined multi-axial and fretting fatigue of turbine subcomponents

Thermomechanical fatigue (TMF) **tests** are used to characterize the behaviour of component materials for gas turbines and jet engines, which are subjected to fluctuating temperatures and cyclic loads.

Structures and materials performance

Materials and Components Processing

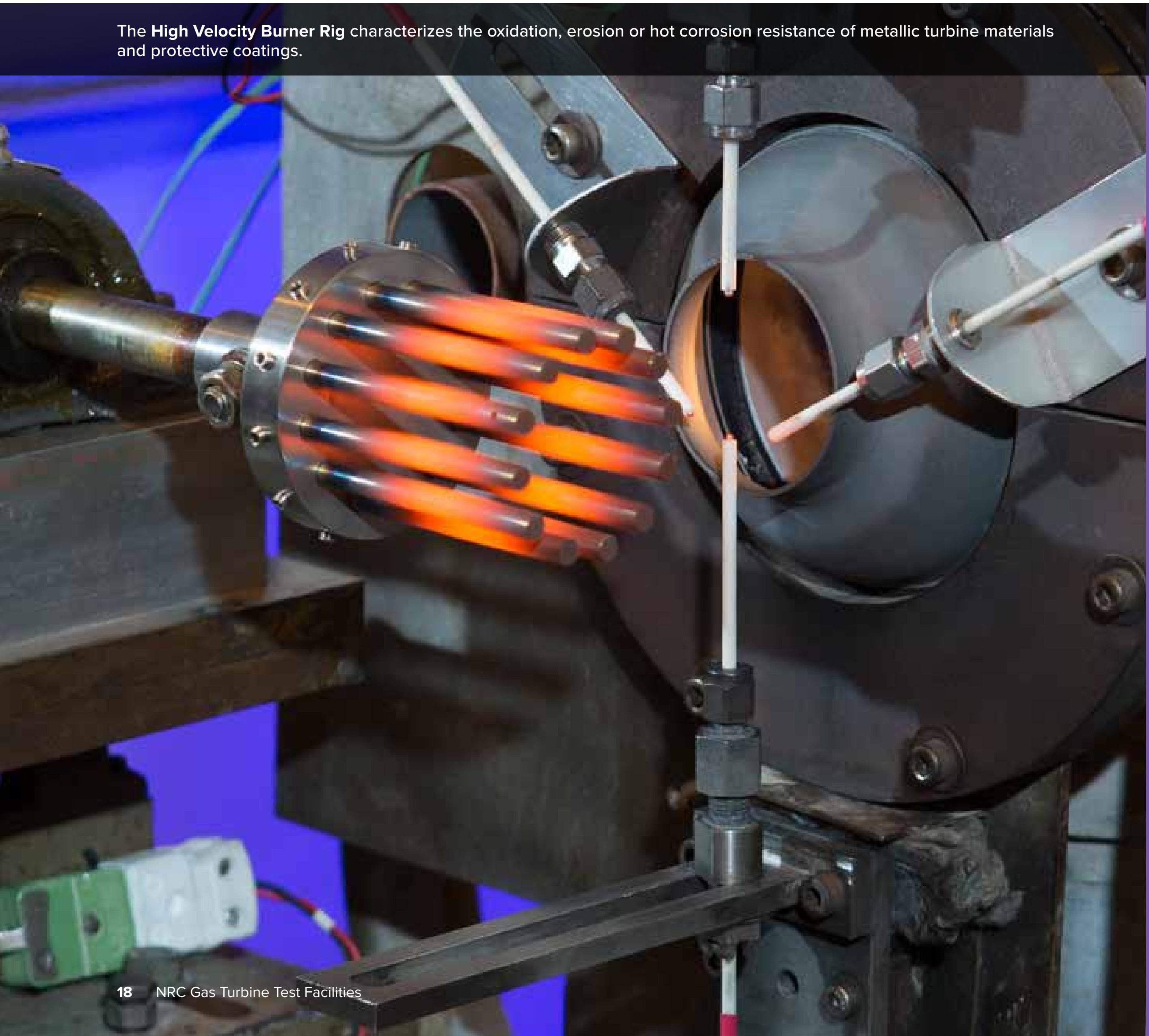
- **Hot isostatic pressing (HIPing):** up to 2 000 °C (3 632 °F) and 200 MPa (29 ksi) with 26 cm (10.2 in.) long x 12 cm (4.7 in.) diameter working zone for processing, rejuvenation and repair of materials and components.
- **Vacuum heat treatment:** up to 2 000 °C (3 632 °F), 1.33 x 10^{-3} Pa (10^{-5} Torr), 0.3 m x 0.3 m x 0.3 m (11.8 in. x 11.8 in. x 11.8 in.) work zone for sintering, brazing and heat treatment of materials and components with gas quenching capability; various atmosphere heat treatment furnaces.

Environmental Test Systems

High Velocity Burner Rigs: simulate high velocity, hot gas environment typical in a gas turbine engine

- Temperature range: up to 1 600 °C (2 912 °F)
- Gas velocity: up to Mach 0.8
- Fuel types: jet fuel and marine diesel fuel
- Proficiency:
  - Cyclic oxidation - high velocity cooling is available for both external and internal cooling
  - Hot corrosion - contaminants can be added to both the fuel or combustion air
  - Erosion - solid particulate matter can be added to combustion gases

The **High Velocity Burner Rig** characterizes the oxidation, erosion or hot corrosion resistance of metallic turbine materials and protective coatings.



Spin Rig Facility: is used for experimental validation of prescribed lives of critical rotating components of gas turbines

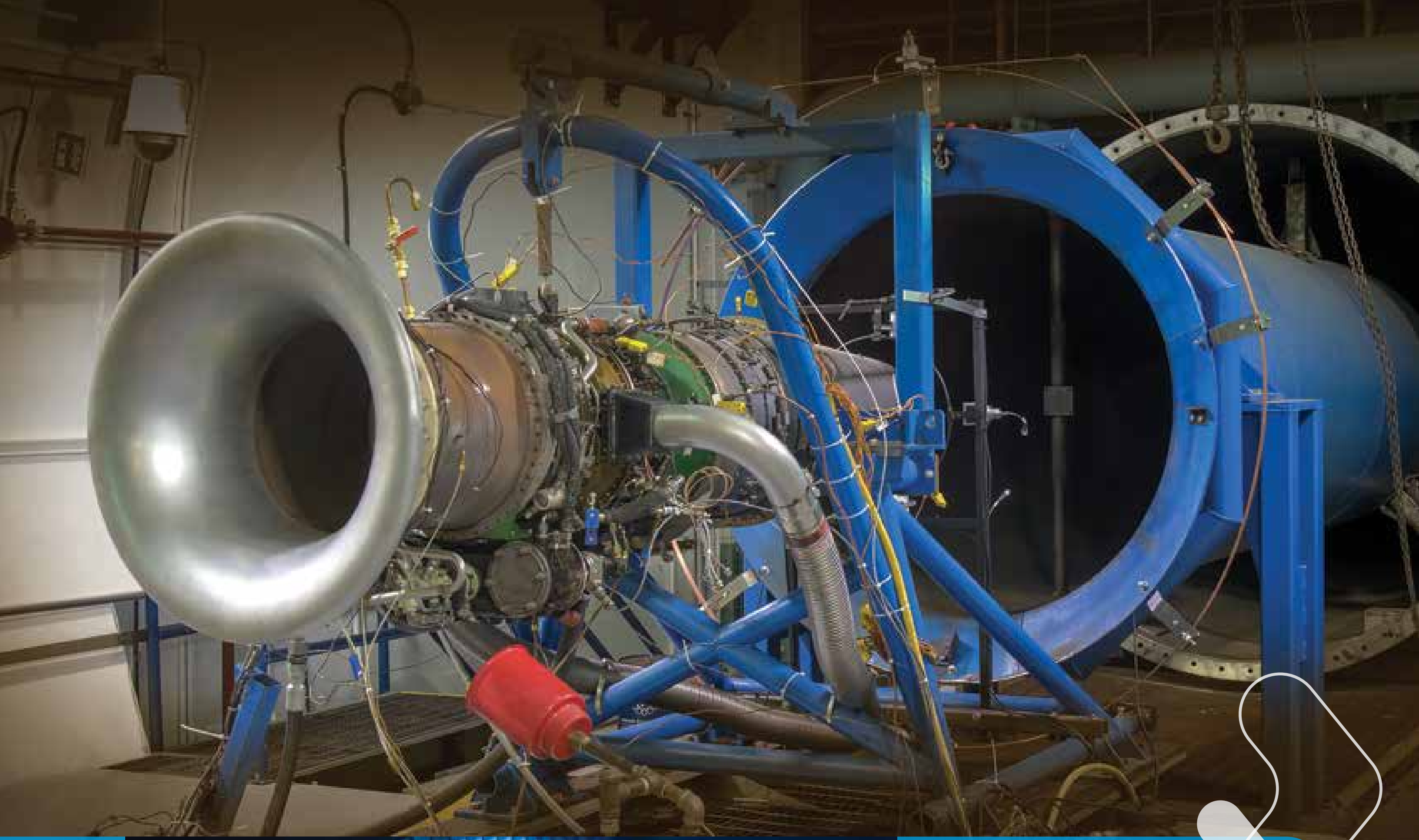
- Pit dimensions: 1.2 m (48 in.) depth × 1.2 m (48 in.) diameter
- Temperature range: from RT to 800 °C (1 472 °F)
- Rotational speed: up to 100 000 rpm
- Proficiency: NDT inspection of components by Level II inspectors and test design

Microstructural Analysis

- Standard metallographic equipment and Optical microscopy with Clemex Vision image analyzer
- Two scanning electron microscopes (SEMs) including: Philips XL-30 SFEG SEM interfaced with Pegasus - TEAM Integrated EDS (Apollo X) & EBSD System with light element detection capability. This system is an advanced materials characterization facility providing both elemental composition and crystal structure results.

Various characterization techniques such as elemental spot, line, and mapping analyses, phase identification analysis, micro-texture analysis, grain boundary structure analysis, and light element detection can be achieved.

A turbine disc (top) with direct current potential drop (DCPD) instrumentation for detecting the formation of a fatigue crack and measuring fatigue crack growth occurring at a fir tree blade slot in the disc.



Accelerating emerging gas turbine technologies

NRC has access to significant resources that allow us to explore innovative approaches to products and processes that will transform research and technology development. We offer our clients the unique competitive advantage of connecting with experts from a broad spectrum of disciplines within NRC:

- Biologists with expertise in marine biology are developing algal biofuels.
- Chemical engineers with expertise in battery technology are developing aircraft fuel cells.
- Scientists with expertise in ultrafast laser inscribed fiber Bragg gratings are developing sensors with femtosecond lasers that are ideal for testing in harsh environments, such as gas turbines.

By exchanging expertise and ideas between disciplines, NRC offers rapid and cost-effective technological advancement in new and exciting areas. No other single organization in Canada offers industry-coordinated access to this level of collaboration and wide-ranging research infrastructure.

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