High Velocity Burner Rigs

The state-of-the-art burner rigs (two facilities) at the NRC Institute for Aerospace Research (NRC Aerospace) are used to test the endurance of turbine hot section materials and components. Testing is done in a high velocity hot gas jet generated by a laboratory combustor system (Becon model LCS 4B & LCS-4C) that closely simulates the mixing, flow, and combustion chemistry of fuels in turbine engine combustors. Performance of such pre-qualification testing in a burner rig is far less expensive than full qualification tests conducted in an engine.

Much of the burner rig work is done in collaboration with industry, universities, government agencies, or other research institutes through fee-for-service or cost-shared collaborative research contracts.

The SMPL management system has been registered to ISO 9001:2000

General specifications

Hot gas temperatures up to 1500°C (or higher with pre-heated air) and velocities up to Mach 0.8 (depending on temperature) can be produced in the burner rigs. The two-stage combustor design allows gas temperature to be varied independently of the gas velocity for parametric studies.

Controlled amounts of contaminants can be added to the fuel and to the combustion air for hot corrosion investigations. Solid particulate matter can also be added to the combustion gases for high temperature erosion studies. The test coupons or components under evaluation can be thermally cycled in the rigs to simulate the start-up and shut-down conditions in engines. Such conditions are often responsible for thermal fatigue damage accumulation in hot parts.

Flat plate specimens, back face air-cooled

Hollow specimens, internally cooled

Solid specimens

Thermal barrier coated components, internally cooled

The combined effects of cyclic oxidation, hot corrosion, erosion and thermal fatigue on the durability of coupons or components can be investigated simultaneously if needed.

Typical applications

The NRC Aerospace burner rigs are used to support:

- development of new materials and sensors
- repair techniques and qualification testing of repaired components
- validation of life prediction models for hot section components
- simulation of engine malfunctions such as engine over-temperature
- cyclic oxidation testing to specific thermal cycles
- hot corrosion testing of materials to VAMAS or other testing specifications

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- erosion testing at turbine hot-section temperatures
- thermal fatigue testing with on-line monitoring of crack initiation and crack growth in test specimens by alternating current potential drop (ACPD)
- endurance testing of components or sensors to specified simulated flight cycles.

Test program support

- Design of experiments including full instrumentation
- Materials and components testing
- Analyses including microstructural evaluation
- Reports.

Technical specifications

Burner rigs:	• The LCS 4B & LCS-4C are programmable modular combustor systems developed by Pratt and Whitney Aircraft and manufactured under licence by Becon Inc.
Gas temperature ranges:	• Up to 1300°C with “A” type combustion liners and up to 1500°C with “B” type liners for the LCS-4B combustor • Higher gas temperatures are obtained by preheating the inlet air used for combustion. Currently, the inlet air can be preheated up to 400°C for the LCS-4C combustor
Gas velocity:	• Up to Mach 0.8 depending on temperature
Fuel types:	• Compatible with jet fuels as well as marine diesel fuels
Nozzle geometries:	• Circular (5.1 cm and 7.6 cm diameter) • Rectangular (3.8 cm high x 6.4 cm wide) • Special nozzle geometries available on request
Specimen holders:	• Four types of carousels are available to accommodate: – 8 solid pins of 0.95 cm diameter – 12, 18 & 24 solid pins of 1.27 cm diameter – 12 hollow pins of 1.27 cm diameter (with internal cooling) – 6 flat sheet coupons 8.00 x 3.98 cm (with back face cooling) • Rotational speeds up to 1500 rpm • Programmable for specimen translation between hot gas jet and cooling air jet for thermal cycling • Custom-made specimen holders are available for specific tests (eg. for cooled coupons or components)
Specimen temperature monitoring:	• Wire thermocouples monitor test progression (up to 32 channels for static tests and 8 channels for rotating carousels). Infrared pyrometry is also available
Contaminant injection:	• Artificial sea salt solution injection system for hot corrosion studies (other chemical solutions can be handled on request) • Solid particulate injection system for high temperature erosion studies

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