Technology Opportunity
Glenn Research Center • Cleveland • Ohio
Technology Transfer & Partnership Office
TOP3–00218

Research Combustion Laboratory

Facility

The Research Combustion Laboratory (RCL) has more than 60 years of experience conducting scientific research of fuels, ignition, and combustion methods, and high-temperature materials.

Facility Description

To fit unique research goals, the laboratory's highly flexible test cells can tailor test conditions in subscale environments, including a low-flow ignition rig, a high-temperature thermal shock test bed for testing rocket materials, a low-thrust chemical rocket altitude facility, an air-breathing combustor rig, and several sea-level test stands. The facility is also capable of testing fuel cell technologies.

Propellants used in the RCL include gaseous hydrogen and oxygen, liquid hydrogen and oxygen, and hydrocarbon fuels to allow testing of rocket and air-breathing propulsion engines, components, fuel cells, and other power system components. A variety of nonconventional propellants can also be tested.

Facility Benefits

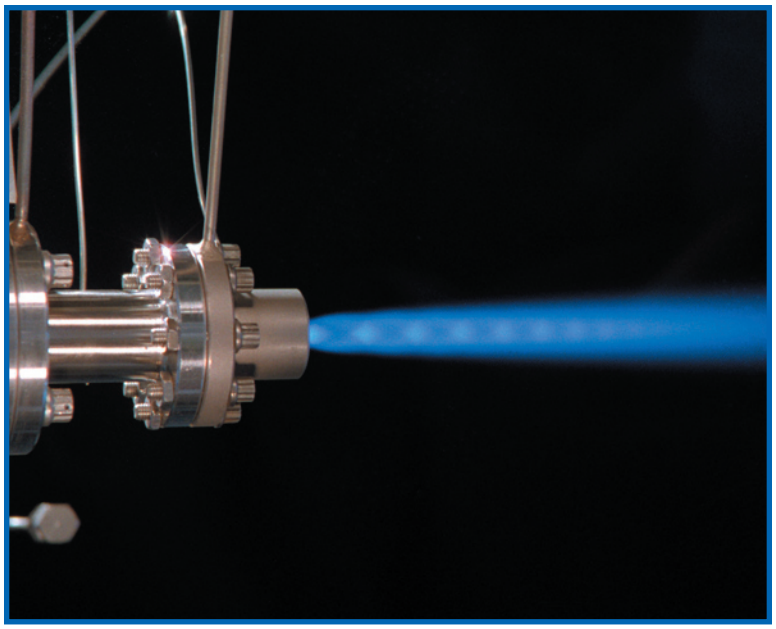
- Offers tailored test conditions in subscale combustion environments
- Capable of providing a variety of conventional and nonconventional propellants
- Equipped to provide high heat flux conditions or material and fuel testing
- Provides test conditions to study ignition and combustion methods

Commercial Applications

- Space shuttle thrusters
- Insulation and transfer technologies for cryogenic fluids
- Advanced ignition systems for next-generation launch vehicles

Programs and Projects Supported

- Next Generation Launch Technology (NGLT)
- Low Emissions, Alternative Power Propulsion and Power Resources (LEAP)
- Mars Hopper tests



RCL flametube test.

Capabilities

Combustion and Cryogenics Space Facilities				
Propellants	RCL–11	RCL–21	RCL–22	RCL–32
Volume (Scf)				
GH_2	70 000	140 000	140 000	70 000
LH_2		16 lb		
GOx	70 000	60 000	60 000	60 000
LOx	100 gal	50 lb		50 gal
HC		8 gal		100 gal
Ethanol	50 gal	8 gal		100 gal
Supply Pressure,				
GH_2		2400	2400	2400
LH_2		1800		1800
GOx		2400	2400	2400
LOx	1100	1800		1800
HC		1000		
Ethanol		1000		
Max flow (lb/sec)				
GH2	0.022	0.3	2.0	3.0
LH2		0.25		1.0
GOx	0.08	1.0	4.0	4.0
LOx		2		7
HC				
Ethanol		.1		

Combustion and Cryogenics Space Facilities				
Cooling				
Volume, Scf				
GH_2			140 000	70 000
LH_2				200 gal
Water, gal	100		1300	150 gal
Supply pressure, PSI				
GH_2			2400	2400
LH_2				1800
Water			1200	1500
Max flow, lb/sec				
GH_2			1.5	1.5
LH_2				1.5
Water, gmp		50	300	200
Deionized water		No	Yes	No
Other capabilities				
Max thrust, lbf	50	300	2000	2000
Altitude, ft	950 000			
NEC, haz atm	HAN; Xm46; Chemical/Material compatibility (Fume Hood)			

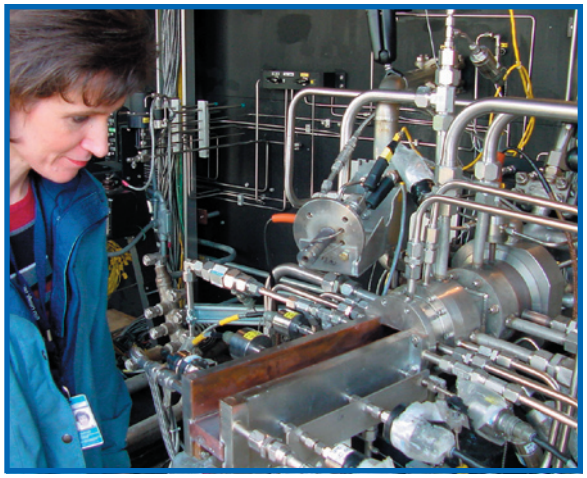
Facility Testing Information

http://facilities.grc.nasa.gov

Contacts

Wayne M. Bartlett, Facility Manager
NASA Glenn Research Center
Phone: 216–433–5745
Fax: 216–433–8551
E-mail: Wayne.M.Bartlett@nasa.gov

Technology Transfer & Partnership Office
E-mail: ttp@grc.nasa.gov
http://technology.grc.nasa.gov



Cooled panel nozzle extension test.

Research Combustion Laboratory (RCL)

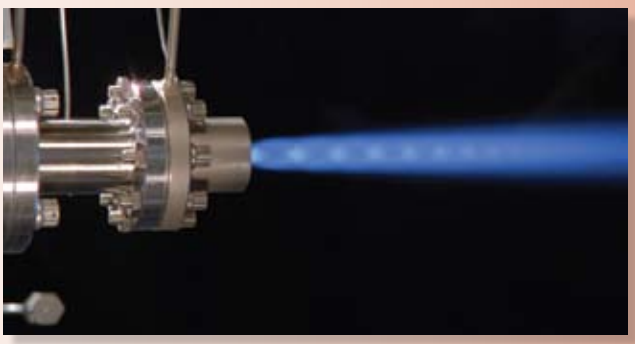
The RCL develops advanced propulsion concepts and evaluates safer propellants for launch vehicles and spacecraft thrusters and advanced ignition systems for next-generation launch vehicles.

The RCL consists of a suite of flexible test cells, including five sea-level combustion stands, three altitude combustion stands, the *Heated Tube Facility* (HTF) for studying heat transfer properties of fuels, and two test cells for studying advanced fuel cells. The RCL provides a safe environment for testing aviation and chemical rocket propellants, including liquid and gaseous hydrogen, oxygen, and methane- and kerosene-based fuels.

A variety of tests are performed in the RCL including altitude performance testing, chemical rocket ignition systems, high-temperature thermal testing, sea-level testing of chemical rocket engine components, fuel cell and electrolyzer components, and regenerative fuel cell systems. The RCL has evaluated safer propellants for space shuttle thrusters, ignition systems for next-generation launch vehicles, and lightweight high-temperature materials for aeronautics and space applications.

The *Small Multi-Purpose Research Facility* (SMiRF) evaluates the performance of the thermal protection systems required to provide long-term storage (up to 10 years) of cryogenic propellants in space. The SMiRF provides the ability to simulate space, high altitudes, and launch pressure environments; conduct calorimetry tests on prototype insulation systems; and safely handle gaseous and cryogenic propellants. The SMiRF features a 72- by 100-in. diffusion-pumped high-vacuum chamber with a cold wall capable of simulating the thermal cycle of a lunar day. The facility's pumping system is augmented with mechanical pumps that are capable of matching a launch pressure profile.

The *Altitude Combustion Stand* (ACS) facility provides a system to test combustion components at a simulated altitude. The facility is equipped with an axial thrust stand, gaseous and cryogenic liquid propellant feed systems, water-cooled diffuser, data acquisition system, facility control system, spray cooler, and multistage vacuum ejector systems. Construction of this facility was completed in 2008 and engine testing began in 2009. The facility can accommodate engines from up to 2,000 lb force thrust and combustion chamber pressure to 1,000 psia. Depending on the size, engines can be fired at sea level or into a test tank that is evacuated to a simulated altitude up to 110,000 ft.



Flametube test (RCL—Cell 21)

Cooled-panel nozzle extension test (RCL—Cell 22)

Cryocooler preparation for zero boiloff test (SMiRF)

Altitude Combustion Stand test

Space Combustion Facilities

Research Combustion Lab

Supports testing of propulsion components and materials in sub-scale combustion environments ranging from 5 lbf to 2,000 lbf thrust. Propellants include GOX, LOX, GH2, LH2, & Hydrocarbons

RCL-21

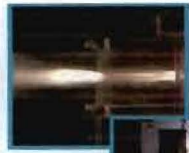
Low Flow, Ignition Rig

RCL-11

Low Thrust Chemical Rocket Technology Facility

Heated Tube Facility

A unique national asset providing fuel thermal stability and physics of cooling at high heat fluxes



RCL-22

High Temperature Thermal Shock Test Bed

B-Stand

Relocation Site (Operational Late FY05)

4,000 lbf Thrust Stand with 130,000 ft simulated altitude

RCL-31/32*

Sea Level Thrust Stand with Laser Diagnostics & H2O or GH2 Cooling

*RCL-31 Operational in FY05