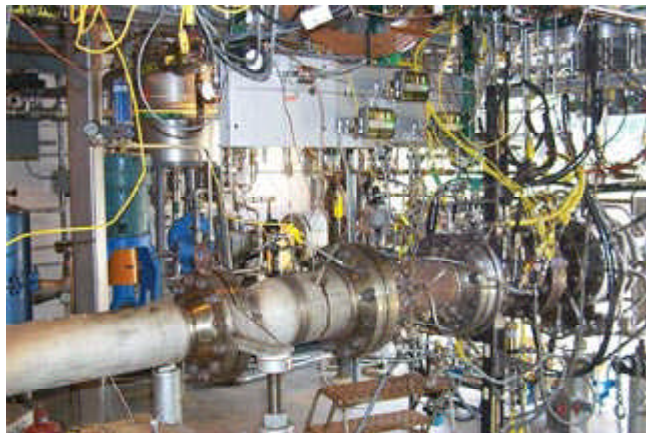


# Hydrogen/Air Fuel Nozzle Emissions Experiments

The use of hydrogen combustion for aircraft gas turbine engines provides significant opportunities to reduce harmful exhaust emissions. Hydrogen has many advantages (no CO<sub>2</sub> production, high reaction rates, high heating value, and future availability), along with some disadvantages (high current cost of production and storage, high volume per BTU, and an unknown safety profile when in wide use). One of the primary reasons for switching to hydrogen is the elimination of CO<sub>2</sub> emissions. Also, with hydrogen, design challenges such as fuel coking in the fuel nozzle and particulate emissions are no longer an issue. However, because it takes place at high temperatures, hydrogen-air combustion can still produce significant levels of NO<sub>x</sub> emissions. Much of the current research into conventional hydrocarbon-fueled aircraft gas turbine combustors is focused on NO<sub>x</sub>-reduction methods. The Zero CO<sub>2</sub> Emission Technology (ZCET) hydrogen combustion project will focus on meeting the Office of Aerospace Technology goal 2 within pillar one for Global Civil Aviation reducing the emissions of future aircraft by a factor of 3 within 10 years and by a factor of 5 within 25 years.

Recent advances in hydrocarbon-based gas turbine combustion components have expanded the horizons for fuel nozzle development. Both new fluid designs and manufacturing technologies have led to the development of fuel nozzles that significantly reduce aircraft emissions. The goal of the ZCET program is to mesh the current technology of Lean Direct Injection and rocket injectors to provide quick mixing, low emissions, and high-performance fuel nozzle designs.

An experimental program is planned to investigate the fuel nozzle concepts in a flametube test rig. Currently, a hydrogen system is being installed in cell 23 at NASA Glenn Research Center's Research Combustion Laboratory. Testing will be conducted on a variety of fuel nozzle concepts up to combustion pressures of 350 psia and inlet air temperatures of 1200 °F. Computational fluid dynamics calculations, with the Glenn-developed National Combustor Code, are being performed to optimize the fuel nozzle designs.



*Hydrogen flametube rig located in cell 23 of Glenn's Research Combustion Laboratory.*

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