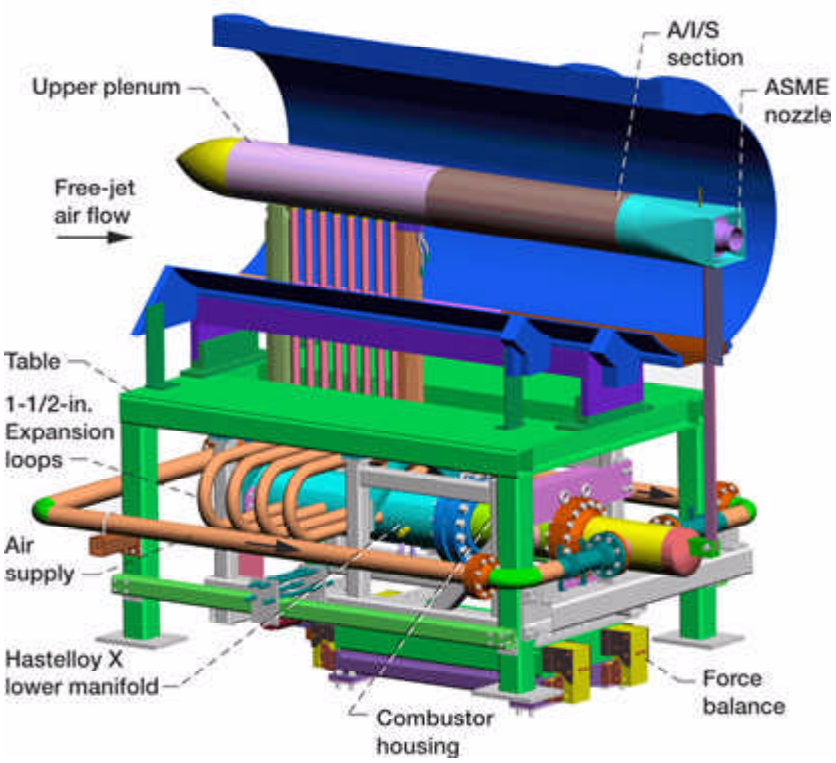
High-Flow Jet Exit Rig Designed and Fabricated

The High-Flow Jet Exit Rig at the NASA Glenn Research Center is designed to test single-flow jet nozzles and to measure the appropriate thrust and noise levels. The rig has been designed for the maximum hot condition of 16 lbm/sec of combustion air at 1960 °R (maximum) and to produce a maximum thrust of 2000 lb. It was designed for cold flow of 29.1 lbm/sec of air at 530 °R. In addition, it can test dual-flow nozzles (nozzles with bypass flow in addition to core flow) with independent control of each flow. The High-Flow Jet Exit Rig was successfully fabricated in late 2001 and is being readied for checkout tests. The rig will be installed in Glenn's Aeroacoustic Propulsion Laboratory.

The High-Flow Jet Exit Rig consists of the following major components: a single-component force balance, the natural-gas-fueled J-79 combustor assembly, the plenum and manifold assembly, an acoustic/instrumentation/seeding (A/I/S) section, a table, and the research nozzles. The rig will be unique in that it is designed to operate uncooled. The structure survives the 1960 °R test condition because it uses carefully selected high-temperature alloy materials such as Hastelloy-X. The lower plenum assembly was designed to operate at pressures to 450 psig at 1960 °R, in accordance with the ASME B31.3 piping code. The natural gas-fueled combustor fires directly into the lower manifold. The hot air is directed through eight 1-1/2-in. supply pipes that supply the upper plenum. The flow is conditioned in the upper plenum prior to flowing to the research nozzle. The 1-1/2-in. supply lines are arranged in a U-shaped design to provide for a flexible piping system.



High-Flow Jet Exit Rig.

Three-dimensional computer-aided design model of the table support structure holding the piping, the plenum/manifold assembly, the force balance, the combustor assembly, and the acoustic instrumentation seeding section. Illustration shows Hastelloy-X lower manifold, air supply, 1-1/2-in. expansion loops, table, free-jet airflow, upper plenum, A/I/S section, ASME nozzle, force balance, and combustor housing.

The combustor assembly checkout was successfully conducted in Glenn's Engine Component Research Laboratory in the spring of 2001. The combustor is a low-smoke version of the J79 combustor used to power the F4 Phantom military aircraft. The natural-gas-fueled combustor demonstrated high-efficiency combustion over a wide range of operating conditions. This wide operating envelope is required to support the testing of both single- and dual-flow nozzles.

Key research goals include providing simultaneous, highly accurate acoustic, flow, and thrust measurements on jet nozzle models in realistic flight conditions, as well as providing scaleable acoustic results. The High-Flow Jet Exit Rig is a second-generation high-flow test rig. Improvements include cleaner flow with reduced levels of particulate, soot, and odor. Choked-flow metering is required with ±0.25-percent accuracy. Thrust measurements from 0 to 2000 lbf are required with ±0.25-percent accuracy. Improved acoustics will be achieved by minimizing noise through large pipe bend radii, lower internal flow velocities, and microdrilled choke plates with thousands of 0.040-in.-diameter holes.

Glenn contacts: Robert.J.Buehrle, 216-433-8735, Robert.J.Buehrle@grc.nasa.gov; Paul A. Trimarchi, 216-433-3824, Paul.A.Trimarchi@grc.nasa.gov
Authors: Robert J. Buehrle and Paul A. Trimarchi
Headquarters program office: OAT
Programs/Projects: AAPL, UEET, QAT