The facilities of NASA Langley’s Scramjet Test Complex - the Combustion-Heated Scramjet Test Facility, the Direct-Connect Supersonic Combustor Test Facility, and the Arc-Heated Scramjet Test Facility - have been conducting hypersonic propulsion research since the 1960’s.

The Scramjet Test Complex facilities have the capability to test integrated engines, supersonic combustors, and inlets at simulated flight Mach numbers from 3.5 to 8, and Reynolds numbers from 0.035x10^6 to 6.8x10^6 per foot.

Data from these facilities have been used to improve engine reliability and robustness, to develop control laws for flight research projects and to calibrate and verify Computational Fluid Dynamics codes used to analyze scramjet engine performance.

Upgrades in recent years have improved the performance, reliability, and capabilities. Modifications include a PLC-based control system, a 20MW DC power supply, improved fuel and air supply systems at the Arc-Heated Scramjet Test Facility, and a fuel heater that supplies cracked JP fuel for the Direct-Connect Supersonic Combustion Test Facility.

The Scramjet Test Complex facilities have made significant contributions to major research programs such as the Hypersonic Research Engine, NASP, and Hyper-X.
Facility Benefits

- Three complementary facilities dedicated to research in hypersonic air-breathing propulsion and related subject areas.
- Different test media and overlapping simulated test condition ranges.
- Fuels include: hydrogen, silane/hydrogen igniter or piloting, gaseous hydrocarbon mixes, and heated cracked JP fuel.
- PLC-based control systems can control test article components.
- Data acquisition systems and post processing capabilities provide rapid data reduction turn around.

Facility Applications

- The Scramjet Test Complex has made significant contributions to NASA’s hypersonic air-breathing propulsion research programs, the NASP Program, Hyper-X (X-43), and HIFiRE.
- All NASP Program major competitors tested their engine designs in these facilities.
- Flow path and propulsion control laws for the Hyper-X (X-43) Mach 7 vehicle, developed with data from the Scramjet Test Complex facilities, enabled the X-43 vehicles to achieve world record performance goals.

Characteristics

<table>
<thead>
<tr>
<th>Facility</th>
<th>Arc-Heated Scramjet Test Facility</th>
<th>Combustion-Heated Scramjet Test Facility</th>
<th>Direct-Connect Supersonic Combustor Test Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test medium</td>
<td>Dry air</td>
<td>Hydrogen-air combustion products with oxygen replenishment</td>
<td>Hydrogen-air combustion products with oxygen replenishment</td>
</tr>
<tr>
<td>Simulated flight Mach number</td>
<td>4.7 to 8</td>
<td>3.5 to 6</td>
<td>4 to 7.5</td>
</tr>
<tr>
<td>Flight Reynolds number, ft⁻¹</td>
<td>0.035x10⁶ to 2.2x10⁶</td>
<td>1.0x10⁶ to 6.8x10⁶</td>
<td>2.0x10⁶ to 8.0x10⁶</td>
</tr>
<tr>
<td>Total pressure limit, psia</td>
<td>675 psia</td>
<td>50 to 500</td>
<td>115 to 500</td>
</tr>
<tr>
<td>Total temperature, degrees R</td>
<td>2000 - 5200</td>
<td>1300 - 3000</td>
<td>1600 - 3800</td>
</tr>
<tr>
<td>Test time, sec.</td>
<td>120</td>
<td>20</td>
<td>120</td>
</tr>
</tbody>
</table>

Instrumentation

A large pool of instrumentation can be shared among facilities

- Six-component strain gage balances
- Electronically scanned pressure transducers in a wide array of ranges
- Temperature sensors
- Heat flux gages
- Flow rate meters
- Visual access for Schlieren and non-intrusive laser based test techniques

Data Acquisition and Processing

- PC based COTS
- Front ends: 192-230 Channel A/D multiplexor
- 512 channel pressure scanner
- DAS rate: 10-50 Hz
- Customer computers: available
- High speed DAS: available
- Classified capability: Yes

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