The Langley 16-Foot Transonic Tunnel offers a unique combination of wind tunnel conditions for inlet, nozzle, and aerodynamic testing across the transonic speed range at atmospheric conditions.
Test Section and Performance

The Langley 16-Foot Transonic Tunnel (16-Ft TT) is an atmospheric, closed circuit tunnel with a Mach number range of 0.2 to 1.25. The test section of the tunnel is octagonal with a distance of 15.5 ft across the flats. The twin 34-ft diameter drive fans form a two-stage axial flow compressor with counterrotating blades and no stator. Boundary layer control during transonic operation is achieved with a 35,000-hp axial flow compressor that is able to remove up to 4.5 percent of the tunnel flow from the plenum that surrounds the test section.

16-Foot TT Characteristics

- Mach number: 0.2 to 1.25
- Relative altitude, feet: 1000 to 28,000
- Reynolds number, per foot: $1 \times 10^6$ to $4 \times 10^6$
- Dynamic Pressure, psf: 65 to 920
- Stagnation Pressure: Atmospheric
- Stagnation Temperature, degrees F: 40 to 180

High-Pressure Air, Cooling, and Hydraulic Capability

High-pressure air lines, cooling water lines, and hydraulic lines are available in the tunnel strut head for connection to model components. Two individually controlled high-pressure air systems are available, each capable of providing up to 15 lb/sec mass flow at 1800 psi. Air is slightly heated to maintain a constant temperature at the model. A pair of multiple critical venturis is used to measure the mass flow rate of the air.

Model Observation

Photographic (both 70 mm and digital) and video coverage of the test section are available from the sidewalls and ceiling. Video images of the model can be recorded with key tunnel parameters superimposed on the screen.

Test Techniques

Various flow visualization techniques, such as ultraviolet oil, paint, or fluorescent minitufts, are available to investigate boundary layer transition or flow separation locations on the model. In addition, pressure sensitive paint (PSP) techniques have been developed to acquire global surface pressure measurements. Finally, a video-based model deformation system is available to optically determine deflection and rotation values of model components.

Data Acquisition and Processing

The standard data acquisition system consists of an analog-to-digital converter that is capable of acquiring 128 channels of analog data (up to 1000 Hz) and 40 channels of digital data and a UNIX computer. A 40-channel dynamic data acquisition system is also available. Final data are reduced on a separate UNIX workstation. For data analysis, the facility provides UNIX and Macintosh computers. Customer supplied computers can be networked to the data reduction system if desired. Secure data links are available for classified projects.

Safety and Design Criteria

Langley's LHB 1710.15 Wind Tunnel Model System Criteria is the guideline for model design and fabrication. Model installation and any exceptions to this document must have the approval of the 16-Ft TT Safety Head on a case-by-case basis to assure personnel and tunnel hardware are not exposed to risk.

This document is available on the Wind Tunnel Enterprise web site at URL http://wte.larc.nasa.gov
Type of Testing

The 16-Ft TT has supported most major military programs both in their developmental stage and in on-going propulsion integration research. This long history has included the F-14, F-15, F-18, and B-1, as well as the more recent Navy Advanced Technology Fighter (NATF), the AX, and the Joint Advanced Strike Technology (JAST) Program. The tunnel has also supported NASA programs by doing extensive testing for the Space Shuttle, the X-33, and experimental programs such as Highly Maneuverable Aircraft Technology (HiMAT).

The facility has a proven record of successful tests and satisfied customers, with a capable staff to assist at all stages of testing from model design through final data.

Instrumentation

The 16-Ft TT can handle various internal 6-component strain-gage balances. Flow-through balances are available for propulsion tests. The data acquisition system can acquire data for up to five balances on one model. Typical corrections to the balance are balance interactions, temperature effects, attitude tares, axes orientation, and pressure and momentum (flow) tares.

The electronically scanned pressure (ESP) system provides high accuracy measurement of steady-state model and facility pressures at rates up to 20,000 ports per sec. The system utilizes modules each containing 32, 48, or 64 individual transducers ranging from -2.5 to 100 psi. Up to 16 modules and 1024 pressure sensors may be used. On-line calibrations are performed as required to insure overall system errors not greater than ±0.25 percent of full scale. Up to 100 independent static pressure transducers and up to 40 dynamic pressure transducers can be connected to the model and facility.

Model attitude is computed with sensitive pitch accelerometers. Accelerometer packages, which can be mounted inside the model, are available to measure pitch only (one accelerometer) or pitch and roll (three accelerometers).

Model Supports

The model support system is a circular-arc segment that provides an angle-of-attack range from -9° to 24° (offset knuckles are also available from 5° to 25°). The pitch strut incorporates a roll drive with a range of ±90°, which is able to provide pitch and yaw data. The normal force load capability of the strut is 10,000 lbs. Sting and strut combinations are available for testing of aerodynamic models as well as air struts that provide high-pressure air for the study of inlets and nozzles.

Facilities Available to Users

Two model buildup bays are provided at the facility for buildup of models. Also, a calibration area provides instrumentation and propulsion air systems for further calibrations that may be required to quantify deflection constants and propulsive tares.

Facility Productivity Rates

The average productivity rates for a given class of wind tunnel test in terms of data points per user occupancy hour (UOH) are presented in the following table:

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Points/UOH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance test</td>
<td>. . . . . . 15</td>
</tr>
<tr>
<td>Stability and control test</td>
<td>. . . . . . 35</td>
</tr>
<tr>
<td>Propulsion test</td>
<td>. . . . . . 19.5</td>
</tr>
<tr>
<td>Inlet test</td>
<td>. . . . . . 15</td>
</tr>
</tbody>
</table>

Test Request Procedures

The first step of the test process is to submit a test request form. The form can be filled out electronically or printed for mailing at the Wind Tunnel Enterprise web site. A posttest questionnaire is also available at this site. The URL is http://wte.earc.nasa.gov
Our customers are encouraged to provide feedback to the facility for our continuous improvement process.
Operating Hours

The 16-Ft TT operates
two shifts per day
from 10:00 pm Sunday
to 3:00 pm Friday

Facility User's Guide

Additional facility information can be found in the facility user's guide at the Wind Tunnel Enterprise web site.
http://wte.larc.nasa.gov

For more information contact

The 16-Ft TT Manager • NASA Langley Research Center • Mail Stop 280 • 11 West Taylor Street • Hampton, Virginia 23681-2199

phone: 757-864-3043 | fax: 757-864-8850 | e-mail: wte+fm_16ft@larc.nasa.gov | web site: http://wte.larc.nasa.gov