0.3-Meter Transonic Cryogenic Tunnel

NASA Langley Research Center

The Langley 0.3-Meter Transonic Cryogenic Tunnel is used for testing two-dimensional airfoil sections and other models at high Reynolds numbers over a Mach number range of 0.1 to 0.9.

Wind Tunnel
ENTERPRISE

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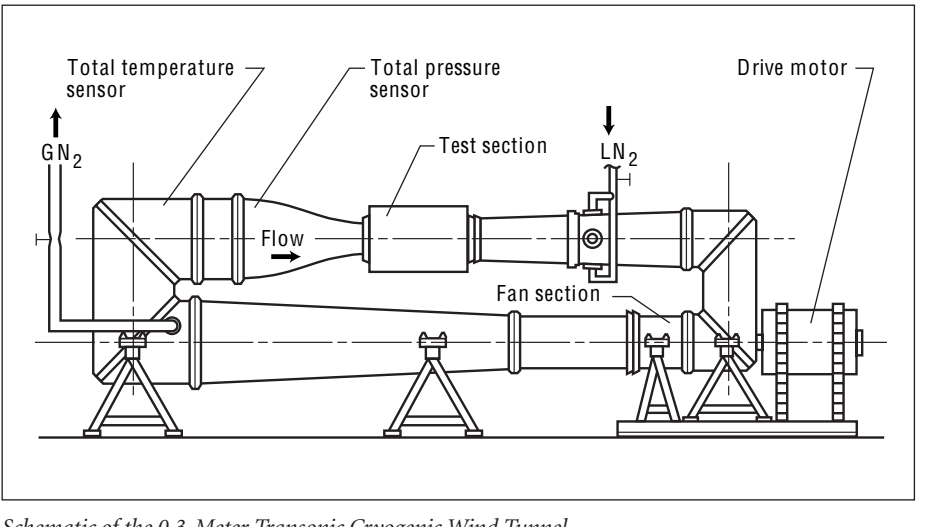
Test Section and Performance

The Langley 0.3-Meter Transonic Cryogenic Tunnel (0.3-M TCT) is used for testing two-dimensional airfoil sections and other models at high Reynolds numbers. The adaptive walls, floor and ceiling in the 13- by 13-in. (33- by 33-cm) test section can be moved to the free-stream streamline shape which eliminates or reduces wall effects on the model. The Mach number, pressure, temperature, and adaptive wall shapes are automatically controlled. The test section has computer-controlled angle-of-attack and traversing wake survey rake systems. Two inches of honeycomb and two antiturbulence screens (total of five screens) have been added to the settling chamber. The contraction section has been replaced with a scaled version of the NTF contraction section. The normal test medium is gaseous nitrogen, GN2, which is injected as a cryogenic liquid. Up to 56,000 gallons of liquid nitrogen, LN2, can be stored in on-site tanks, which are refilled either by truck or directly by pipeline from a nearby manufacturing plant. The facility can also use air or a heavy gas (sulfur hexafluoride, SF6), with a restricted test envelope, as the test medium. Air and SF6 are used only at ambient temperature and require the use of a heat exchanger, not shown below, just before turn 3.

The tunnel is oriented vertically with test section and plenum, high-speed diffuser, screens, spacer, and contraction sections forming the upper leg.

At ambient conditions, the tunnel is approximately 38 ft between the center lines of the vertical legs and approximately 6 ft between the centerlines of the upper and lower legs. Because of the large operational temperature envelope, the stagnation end of the tunnel is free floating and is allowed to contract and expand along the length, width, and height. The fan housing section is the fixed point for the tunnel and encloses the 12-bladed aluminum fan, bearing housing, and drive shaft connection. The fan is driven by a water cooled, 3000-hp, 4600-V variable frequency motor. The vent system, consisting of three 4-in. vent valves in the lower leg just before turn 3, is used to maintain the tunnel at a desired pressure. The safety relief system, consisting of two 4-in. relief valves set to 94 psia and a 6-in. rupture disc set to 108 psia, is connected to the upper leg just after turn 4 and prevents over pressurization of the tunnel. The relief valve and rupture disc lines are each sized to relieve the maximum nitrogen injection rate. The tunnel has interlocks and fail-safe systems that shut down and vent the appropriate systems when electric, lubrication, hydraulic, cooling water, or pneumatic systems failures or gas leaks are detected.



Schematic of the 0.3-Meter Transonic Cryogenic Wind Tunnel.

0.3-M TCT Characteristics

Mach number	0.1 to 0.9
Reynolds number, per foot	up to 100 x 10^6
Pressure, psia	14.7 to 88
Temperature, degrees F	- 320 to 130

High-Pressure Air, Cooling, and Hydraulic Capability

High-pressure (350 psi) and low-pressure (100 psi) air sources are available at the tunnel site. These sources are located external to the tunnel and can be used for such tasks as leak checking of the model orifices or calibration of auxiliary research devices. Hydraulic capability for model work is not available.

Model Supports

Two-dimensional models spanning the 13-in. test section are supported in circular turntables on either side of the test section. By way of dual connecting rods attached to the turntables, an angle-of-attack range from -9° to 32° can be attained. Testing with strain-gage balances is limited and would necessitate adaptation of a special sidewall-mounted elbow. Roll capability with this device is currently nonexistent.

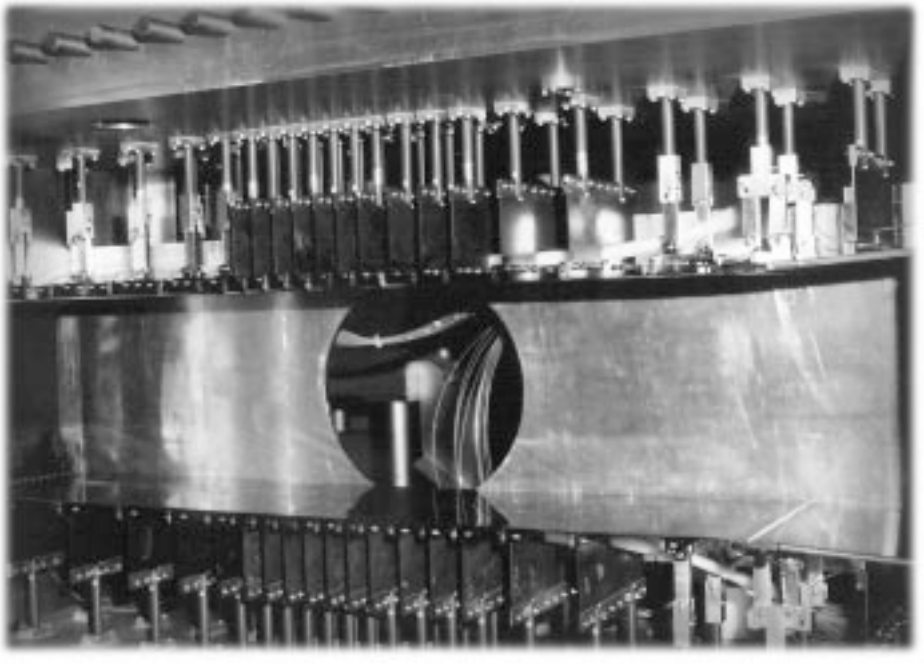
Model Observation

Model turntables on both sides of the test section are equipped with clear quartz crystal model viewing windows for photographic and video coverage of the test section. Video images of the model can be recorded.

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 0.3-M TCT 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



Adaptive wall control system

In the cryogenic mode of operation, the 0.3-M TCT can attain very high Reynolds numbers. Minimized wall interference testing can be achieved by streamlining the top and bottom adaptive walls throughout the tunnel Mach number range (0.1-0.9). These two capabilities provide a very powerful tool for conducting two-dimensional aeronautical research at transonic speeds. The facility can also be configured for testing in either or SF6 and air. The facility has recently conducted two-dimensional testing for a U.S. aircraft company, supported in-house skin friction measurements, and pursued University sponsored research projects.

Instrumentation

The 0.3-M TCT has recently acquired an electronically scanned pressure (ESP) system, which provides high accuracy measurements of steady-state model and circuit pressures at rates up to 20,000 ports per sec. The system utilizes scanners (each with 16 individual transducers) ranging from 5 psid to 100 psid. Up to 405 pressures can be measured. On-line calibrations are performed as required to insure overall system errors not greater than ±0.25 percent of full scale. Aerodynamic drag is determined by use of a wake rake attached to a dedicated 30-psid ESP scanner which is referenced to tunnel total pressure. Model attitude is computed using either a sensitive angular encoder or an accelerometer. Thermocouples are available to measure temperatures either on the model or inside the tunnel.

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.larc.nasa.gov Our customers are encouraged to provide feedback to the facility for our continuous improvement process.

Data Acquisition and Processing

The standard data acquisition system consists of an analog-to-digital converter, which is capable of acquiring 192 channels of analog data (up to 50 kHz) and 32 channels of digital data, and a UNIX computer. Final data are reduced on a separate UNIX workstation. Customer supplied computers can be networked to the data reduction system if desired.

Facility Productivity Rates

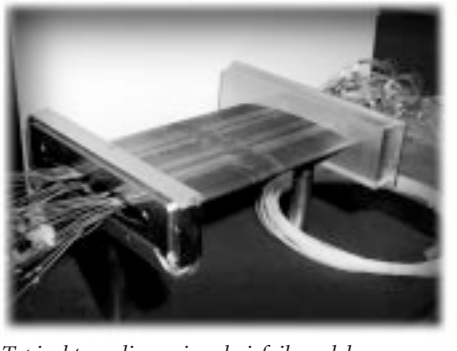
The facility is utilized primarily for a wide variety of research and development programs rather than production-type testing. In addition, major changes to the control and operation of the facility have recently been completed, as well as a significant upgrade to the data systems. Therefore, current productivity rates have not been determined.

Test Techniques

The 0.3-M TCT has utilized focused Schlieren, infrared transition detection, hot films and wires, and laser velocimeter flow visualization techniques. Under development is a temperature sensitive paint (TSP) technique that is capable of investigating transition or separation locations on the models. Pressure sensitive paint (PSP) techniques for this facility are just beginning to be developed.

Facilities Available to Users

A basic shop and buildup area is provided at the facility for buildup and preliminary checkout of models. Grinders, drill presses, and a band saw, along with basic hand tools, are available at the facility for very rudimentary model work. Any high precision machining or fabrication should be accomplished prior to arrival at the facility. Drawings for dimensional references of items such as the turntables are available for model design and fabrication.



Typical two-dimensional airfoil model

Operating Hours

The 0.3-M TCT operates
one shift per day
Monday through Friday
Hours 7:00 am - 3:30 pm

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

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