20-Foot Vertical Spin Tunnel

NASA Langley Research Center

The Langley 20-Foot Vertical Spin Tunnel is a closed-throat, annular return wind tunnel operating at atmospheric conditions that is used to investigate spinning, tumbling, and free-fall characteristics of aircraft and spacecraft.

Wind Tunnel
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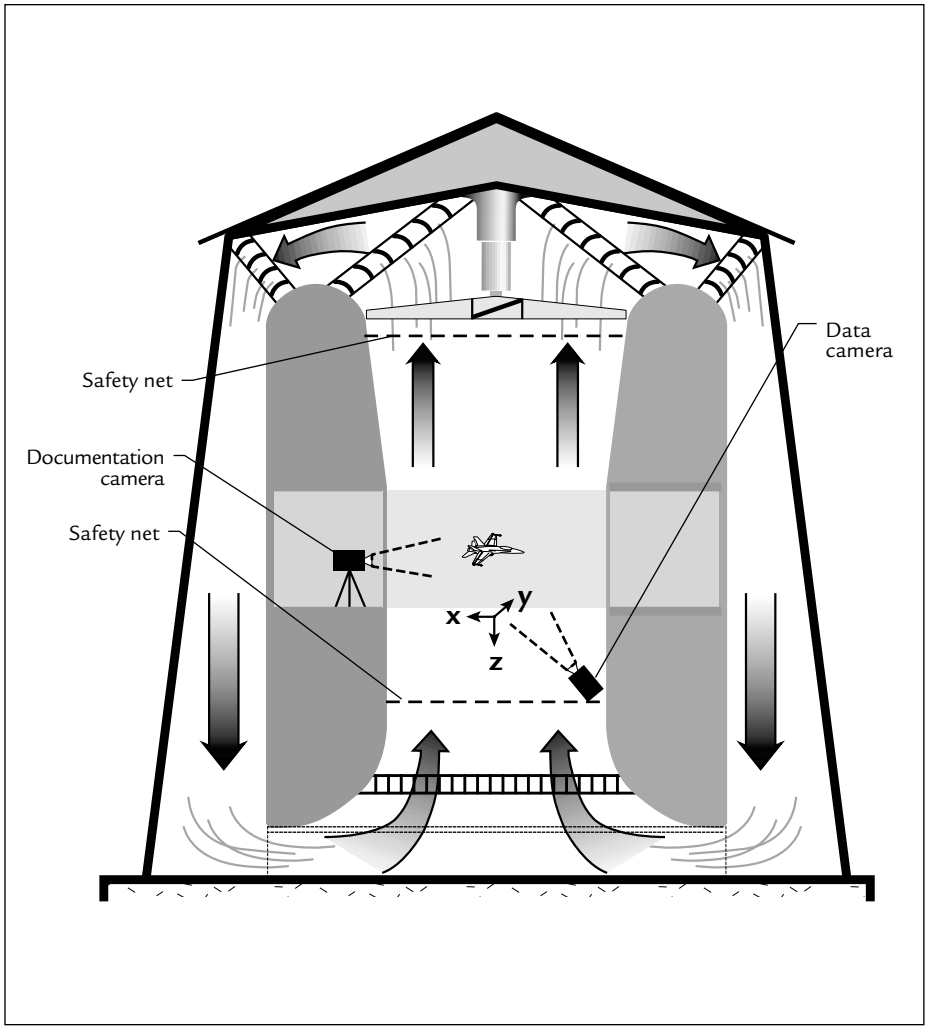
Test Section and Performance

The Langley 20-Foot Vertical Spin Tunnel (20-Ft VST) is a closed-throat, annular return wind tunnel operating at atmospheric conditions. The 12-sided test section is 20 ft across by 25 ft tall. The test section velocity can be varied from 0 to approximately 85 ft/s. Test section airflow is produced by a 3-bladed, fixed-pitch fan powered by a 400 hp direct current motor. This motor is equipped with a control system designed to allow rapid changes in fan speed, which results in maximum flow accelerations in the test section of -25 ft/s^2 to 15 ft/s^2.



Schematic of the 20-Foot Vertical Spin Tunnel flow.

Model Observation

Direct observation of the test is available during tunnel operations via panoramic control room windows. Also, S-VHS (Y-C) video cameras, time code generators, and tape decks are available for recording views of the model and test section while the tunnel is operating.

Data Acquisition and Processing

The 20-Ft VST dynamic model data acquisition system is a video based system that stores images of free flying models for posttest determination of attitude, position, and rates. Up to four charge coupled device (CCD) cameras provide input into the system to give maximum test section coverage. The system resides on a unix workstation and uses scientific-grade analog optical disks as storage media. After acquisition and image storage, a "pose estimation" algorithm is used to determine model attitude and location in the test section at up to 1/60-s time intervals from any single camera view. Data files are output in a spreadsheet format that is convenient for plotting. Parameters provided by the system are model roll, pitch, and yaw angles; x, y, and z coordinates of the model reference center in the tunnel reference system; and the spin rate.

The rotary balance data acquisition system is based on a PC desktop platform and is used to acquire and store force, moment, and surface pressure measurement data, as well as for rig motion control. Data output files are stored on disk and can be converted to most standard file formats.

Safety and Design Criteria

Both dynamically scaled and rotary-balance models have highly specialized design and fabrication requirements. As such, requirements specified by cognizant Vehicle Dynamics Branch personnel must be met. In addition, the model installation must have the approval of the facility safety head prior to tunnel operation.

Test Request Procedures

To get on the facility schedule, a test request must first be submitted to the Head, Vehicle Dynamics Branch. The request can be made via e-mail to wte+fm_20ft@larc.nasa.gov

Instrumentation

Data for free-flying models are obtained from up to four high-grade monochrome CCD video cameras that provide input into the facility dynamic model data acquisition system. These cameras provide 60-Hz imaging of retroreflective targets that are precisely positioned on the surface of the model relative to any appropriate reference system. Rotary balance force and moment measurements are made with internally mounted six-component strain-gage balances. Multiple surface pressure measurements are made with an electronically scanned pressure (ESP) system. Test section air speed is measured with a pitot-static system. In addition, barometric pressure and test section temperature are also measured. A variety of miscellaneous instruments, including hand held anemometers, force gages, electronic levels, and digital volt meters, are also available.

Rotary balance rig in stowed position.

Facilities Available to Users

A test rig to determine dynamically scaled model center-of-gravity location and moments of inertia about each axis is available at the facility. Because of the unique requirements of testing dynamically scaled models, direct interaction and consultation with engineers in the facility are required before model construction begins.

Model on swing rig.

Type of Testing

Dynamically scaled, free-flying models are used to investigate large angle, high rate phenomena. Aircraft models can be tested for spinning, tumbling, and other out-of-control situations. Spacecraft models can be used for free-fall and dynamic stability characteristics. Tests images are documented on high-resolution color video. The spin recovery characteristics of aircraft are studied by using remote actuation of the aerodynamic control surfaces of the models. Sizing of emergency spin-recovery parachutes systems for flight test aircraft is also available. Nondynamically scaled models can be mounted on a rotary balance apparatus to conduct six-component force and moment testing and surface pressure measurements of models under rotating conditions. Data from these tests are used to calculate the steady spin modes of a configuration, as well as to implement prediction of spins and other high angular rate maneuvers in six degree-of-freedom computer simulations.

Dynamically scaled free spin model with parachute.

Model Supports

The rotary balance arm suspends a model in the air stream at angles of attack from 0° to 90° and angles of sideslip between +/-45° while maintaining the relative position of the model reference center. Both top- and aft-mount stings are available. The rig may be rotated in both the clockwise or counterclockwise directions at up to 60 rpm. The system is capable of supporting models weighing up to 15 lb .

Model mounted on rotary balance.

Document Version 1.0

Operating Hours

The 20-Ft VST operates
one shift per day
Monday through Friday
Hours 7:30 am - 4:00 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

The 20-Ft VST Manager • NASA Langley Research Center • Mail Stop 153 • 18C West Taylor Street • Hampton, Virginia 23681-2199

phone: 757 • 864 • 1136 | **fax:** 757 • 864 • 7722 | **e-mail:** wte+fm_20ft@larc.nasa.gov | **web site:** http://wte.larc.nasa.gov