NASA TECH BRIEF

NASA Pasadena Office

Continuous-Flow Variable-Density Wind Tunnel Facilities

The unique features of the continuous-flow variable-density wind tunnel facilities at the Jet Propulsion Laboratory permit a variety of conventional and novel tests to be performed at supersonic and hypersonic speeds. Typical tests include: force and moment measurements; pressure measurements; temperature and heat-transfer measurements; free-flight model testing; telemetry measurements; multi-gas testing; low-Reynolds number studies.

The facilities include a 20-inch supersonic wind tunnel and a 21-inch hypersonic wind tunnel which utilize two-dimensional flexible nozzles to provide an almost infinite choice of test section Mach numbers within a specified range. The hypersonic wind tunnel uses a pair of solid-block throats with an adjustable throat height in the test section; the blocks remain dimensionally stable for all practical purposes in spite of the temperature of the high-pressure air supplied to it.

Moisture is removed from the air used in the tunnels; about 90% of the moisture content is removed by refrigeration, and activated-alumina beds extract most of the remainder. Air is supplied to both tunnels by a compressor plant which contains eleven centrifugal compressors that can be grouped into a variety of configurations; a twelfth (axial-flow type) is used to reduce tunnel supply pressure below atmospheric pressure. Air supplied to the hypersonic wind tunnel is heated by electric power so that condensation does not occur in the test section; an after cooler extracts heat from the exhaust air so that problems inherent with the compression of hot air are minimized.

The Mach-number range of the supersonic wind tunnel varies from 0.3 to 0.8 and 1.3 to 5.0 (runs at $M = 5.6$ have been made), with corresponding earth pressure altitude simulation from about 5 to 55 km. The geometric test section is 18 inches wide (46 cm) and nominally 20 inches high (51 cm).

The hypersonic wind tunnel can be operated over a Mach-number range of 4.0 to 11.0, and will simulate an earth altitude pressure from 85,000 to 220,000 feet (about 26 to 67 km). Supply air temperature can be varied from 38° to 730°C. The wind tunnel test section is 21 inches wide (about 53 cm) at the downstream end and height is adjustable from 15 to 28 inches (38 to 71 cm); each side wall diverges approximately 0.5 degree to compensate for boundary-layer thickness.

The basic model suspension system of both wind tunnels features a vertical traverse and a crescent-type support that can be pitched by remote control; sidewall mounts are available in the supersonic tunnel.

A variety of test instrumentation displays quantitative data in analog, digital, or visual form. The information is collected automatically by a computer-controlled recording device that serves both tunnels and the test preparation area. The device has a total capability of 30 strain-gage channels, 200 thermocouple channels, and eighteen 36-bit data channels.

Test programs conducted in the wind tunnel facilities are usually prefaced by a test proposal which defines the technical objectives, indicates the required

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wind tunnel test conditions, describes the model and its suspension, and lists the necessary raw and reduced data. A project engineer is assigned to the test; an advanced planning conference, a model design conference, and a pretest conference are held to acquaint government or industry contractors and all project personnel with test requirements.

Note:

Requests for further information may be directed to:

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