National Aeronautics and
Space Administration

Langley Research Center

NASA

Langley Researcher

SPECIAL ISSUE

December 5, 1983

National Transonic Facility

Vice President Bush to Speak at Ceremony

Vice President George Bush will be the principal speaker at the National Transonic Facility dedication ceremony tomorrow at 2 p.m.

NASA Administrator James M. Beggs and Langley Director Donald P. Hearth will take part in the program, which will be held on the lawn of the new cryogenic wind tunnel.

Other senior executive guests sharing the platform with the Vice President include Deputy Secretary of Defense Paul Thayer, Senator Paul Trible, Congressman Dan Glickman, Congressman Herbert Bateman, and McDonnell Douglas Chairman Sanford McDonnell.

Prior to the ceremony, Bush and other specials guests will tour the facility and senior commercial aircraft and industry people will participate in a Mini-Aero Inspection of Langley's aeronautical research-related facilities. A press conference for local and national editors and science writers is also scheduled.

Just prior to the ribbon-cutting the Tactical Air Command will fly a F-15 "DOD Salute to the NTF."

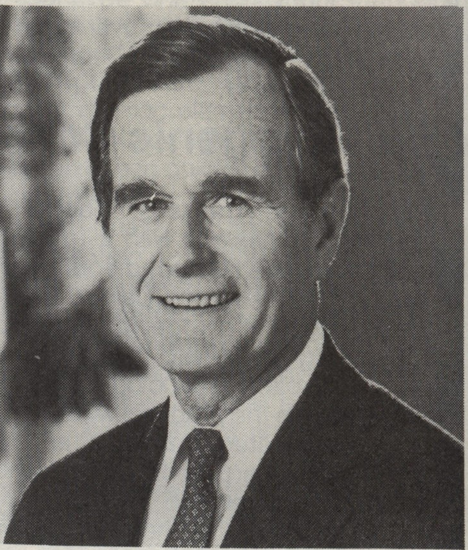
That evening the Langley Activities Association will honor those employees who worked on the NTF with a special toast at 5 p.m. on the grounds of the NTF.

A Transonic Aerodynamics Symposium will be held at the Activities Center today for about 150 industry, government, university and Department of Defense representatives. Twelve papers on transonic aerodynamics research will be presented during the day.

On December 7, an NTF Open House will be observed from 8:30 a.m. to 4:30 p.m. for employees, retirees and contractors to visit the facility.

Vice President George Bush was born in Milton, Mass., June 12, 1924. He graduated from Phillips Academy in Andover, Mass. in June 1942, and immediately enlisted in the U.S. Navy. At 18, he was the youngest commissioned pilot in the Navy at that time. He served from August 1942 to September 1945 as a naval aviation cadet and carrier pilot, and fought in the Pacific, winning three air medals and the Distinguished Flying Cross.

Returning home, he entered Yale University, completed his economic degree in 1948, graduating Phi Beta Kappa, and was captain of the varsity baseball team. In 1951, he co-founded a small royalty firm called Bush-Overby Development Company. In 1953, he co-founded Zapata Petroleum Corporation, and one year later, at the age of 30, he became president and co-founder of a



third firm called Zapata Offshore Company. This firm pioneered experimental offshore drilling equipment. Today much of the energy produced around the world is drilled for by the rigs that Zapata pioneered.

Bush served two terms in the U.S. House of Representatives, and he has served as U.S. Ambassador to the United Nations; Chairman of the Republican National Committee; Chief of the Liaison Office in the People's Republic of China; and as Director of Central Intelligence.

He became Vice President in January 1981.

NTF, 'Unique National Laboratory'

NASA's National Transonic Facility (NTF) is a unique national laboratory that will allow the United States to maintain its leadership in high-performance commercial and military aircraft, plus develop more efficient future transport.

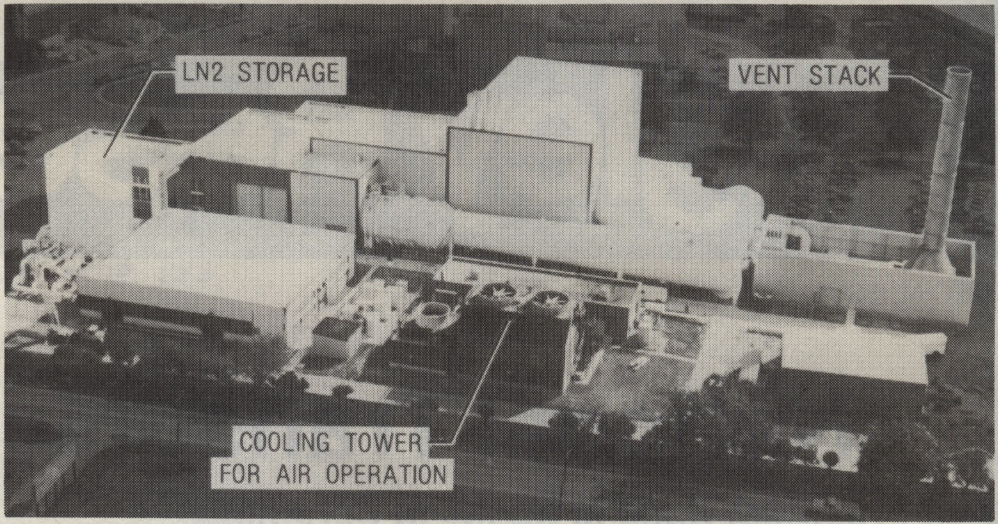
The NTF is a new kind of wind tunnel that uses cryogenic (extremely cold) nitrogen gas, rather than high-pressure air, to test models of advanced design aircraft and spacecraft that will fly in or through the transonic speed range. The cryogenic concept provides far more precise design information than is now possible with conventional wind tunnels.

The need for this new national research facility has been recognized within NASA, the Department of Defense, the U.S. aerospace industry, and the scientific community. The U.S Congress, agreeing with this assessment, authorized construction of the $85.8 million facility in the mid-1970's.

NASA and the Department of Defense (DOD) share occupancy of the NTF about 80 percent of the time to conduct major transonic research programs. The remaining 20 percent of occupancy is allocated for the use of other government agencies, private industry, universities and scientific groups.

The decision to build the NTF at NASA's Langley Research Center was made after an extensive study of several possible sites, conducted by a committee representing NASA and DOD. Langley was chosen primarily because of its experienced staff of aeronautical research specialists and the support facilities available at the Center.

A report by the DOD-NASA site selection panel referred to Langley as "one of the world's outstanding centers of excellence in transonic research . . . (it) has provided leadership in most of the important innovations and advances in understanding in this field over the past 30 years."



The National Transonic Facility is a new kind of wind tunnel that uses cryogenic (extremely cold) nitrogen gas, rather than high-pressure air, to test models of advanced design aircraft and spacecraft that will fly in or through the transonic speed range.

NTF Cryogenic Concept Explained

The National Transonic Facility is testing aircraft designs with a research concept that was developed and proven at the Langley Research Center. Based on the adaption of cryogenics (methods of producing extremely low temperatures) from space technology, the NTF makes possible the practical wind tunnel use of temperatures as low as 149 degrees below zero Centrigrade (minus 300 degrees Fahrenheit). The cryogenic concept provides higher and more accurate Reynolds numbers by reducing the viscosity of air moving through the wind tunnel.

(Reynolds number is a similarity measurement used in testing aircraft models in simulated flight conditions. A Reynolds number is determined by multiplying the size of an object (e.g., a wind tunnel model) by the speed and density of gas (usually air) flowing over it, then dividing the product by the viscosity of the gas. This provides a Reynolds number that accurately relates the wind tunnel model to its full-scale counterpart.)

Cryogenic temperatures are obtained by evaporating liquid nitrogen in the tunnel's circuit, creating extremely cold nitrogen as the test medium (instead of the pressurized ambient air used in conventional tunnels). The NTF can provide Reynolds numbers up to 160 million at a speed of Mach 1.

In addition to providing high Reynolds number measurements, the cryogenic concept also allows independent variation of both pressure and temperature. Reynolds numbers can now be varied independent of Mach number and dynamic pressure to study viscous effects.

Existing wind tunnels cannot accurately provide design information for aircraft that must fly in or through the transonic flight range; almost all aircraft, from slow-moving helicopters to supersonic fighters to possible future hypersonic transports, must pass through the transonic range between Mach 0.8 and Mach 1.2, or just below and above the relative speed of sound.

There are three ways to increase Reynolds numbers: increase the size of test models (and therefore the wind tunnel's size); increase wind tunnel pressure; or decrease a tunnel's temperature.

Increasing test model and wind tunnel size is impractical. A tunnel big enough to accommodate large scale-model aircraft would require the power equivalent of several naval aircraft carriers for its operation and would cost well over one billion dollars.

Increasing a wind tunnel's air pressure to simulate transonic flight conditions with a model also increases power, costs and loads on the model. Increased loading causes unwanted distortion that can, in turn, cause errors in data as large as those that researchers seek to eliminate.

With the cryogenic concept, both the general air flow field (the free air stream) around a model and the thin air flow on a model's surfaces (the boundary layer) can be fully duplicated at the same time in a practical-sized and high-performance wind tunnel. Energy usage remains about the same as in more conventional tunnels.

The primary advantages of using very low temperatures in wind tunnels were first conceived during the mid-1940's, but practical application of the principle was not proven until cryogenic tunnels were built at Langley in the early 1970's.

Cryogenic research at Langley was first led by Robert A. Kilgore, the late Harleth G. Wiley and Dr. Michael J. Goodyer, a British researcher and former resident research associate at Langley.

The researchers studied reduced wind tunnel temperatures as a way to provide reasonable suspension and balance systems. The low temperature concept soon became a serious contender for any future transonic wind tunnel.

The Langley research group built and successfully operated two pilot cryogenic tunnels, proving the basic concept for the study of transonic aircraft, and demonstrating that a fan-driven cryogenic tunnel can provide long test-run times and high Reynolds numbers with acceptable model loads, decreased construction costs and fewer power requirements.

Data Acquisition System

The NTF control and data system is highly automated because the tunnel is designed to produce data at a relatively high rate. All aspects of tunnel operation are automatically and continuously monitored, and a test can be completely programmed from startup to shutdown of the tunnel.

The data system complex consists of four central processing units that handle facility monitoring and communication, tunnel and model control, data acquisition and display, and data base management.

The monitoring and communication computer, for example, records measurements of tunnel pressure and stress, drive system temperatures and vibration, power consumption and liquid nitrogen flow rates. The tunnel and model control computer oversees Mach number, temperature, pressure and model attitude test conditions. The control computer can correct abnormal parameters or even shut down the tunnel if people or equipment are in danger.

The data acquisition and display system gathers information on steady-state force and pressure on models in the test section and in the model assembly rooms, and reduces a portion of the data almost in real time.

A communication system is connected to the central Langley computer complex and allows users to develop and correct computer programs before tests. During a test, data can be compared with theoretical expectations or with data from previous test runs within a few seconds by calling for information stored in computer memory banks.

Special computer programs can be transmitted to the NTF data system complex through a remote communications subsystem. On-line data processing programs will provide test engineers with information needed to direct research. Final data processing takes place off-line as soon as time allows.

A pool of common instrumentation will be available to users on request, mostly strain-gauge balances for use with aerodynamic models, pressure transducers and accelerometers. Users will generally supply any special test instrumentation required for a test program.

Description of NTF

The National Transonic Facility is built on the site of Langley's former Four-Foot Supersonic Pressure Tunnel. NTF uses the former tunnel's motor driven system, cooling tower, pumps, auxiliary equipment and some office space. Reuse of existing equipment and space saved about $20 million dollars in construction costs.

The NTF is a fan-driven, closed-circuit wind tunnel approximately 61 meters (300 feet) long and 14.6 m (48 ft) wide. It has a maximum operating pressure range of 130 psia, and an operating temperature range from 67 degrees C. (152 degrees F.) to minus 149 degrees C. (300 degrees F.).

The tunnel's test section is 2.5 m (8.2 ft.) square and 7.6 m (25 ft.) long. It is a slotted-wall configuration with six slots in both the top and bottom walls and two slots in each sidewall. (Slotted walls reduce the effects of tunnel wall interference with air flow and the propensity of air flow to "choke" in transonic wind tunnels.)

The test section's top and bottom walls each have 15 windows—15.2-cm (6 in.) in diameter—and there are three smaller windows in each sidewall. The windows allow special model photography during tests, including stereo photographs to measure model deformation, and Schlieren photos and shadowgraphs for air flow visualization. Each sidewall has 10 lighting windows.

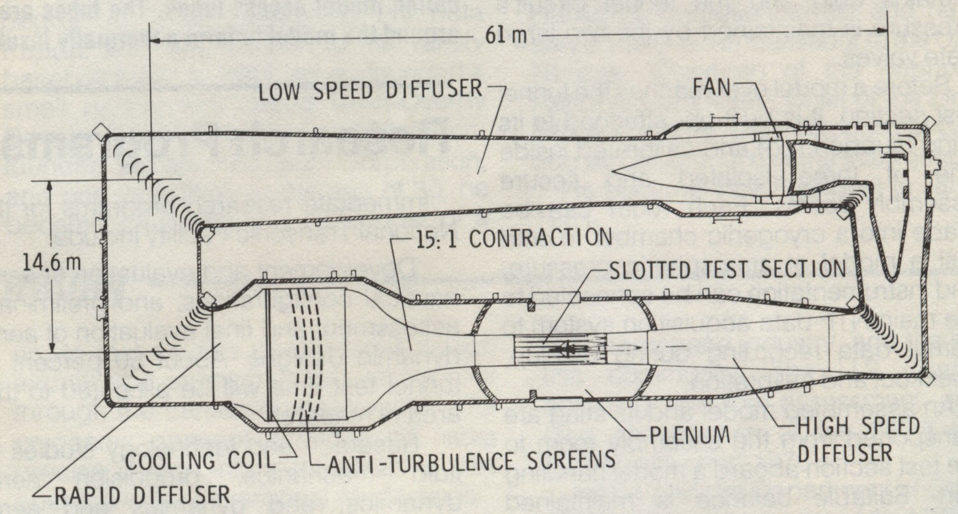
Gasified nitrogen or dry air can be used as the tunnel's test medium. When the tunnel is operated cryogenically, heat is removed by evaporating the liquid nitrogen, which is sprayed into the tunnel circuit upstream of the fan. The tunnel must be vented to maintain constant pressure. When non-cryogenic air is used for higher temperature operation, heat is removed by a water-cooled heat exchanger (cooling coil).

The cryogenic nitrogen gas leaves the tunnel through an exhaust system that includes a 36.6 m (120 ft.) vertical vent stack. The gas is vented from the tunnel circuit through a horizontal tube, called a muffler, that reduces noise. The gas is then mixed with outside air drawn into the base of the exahust system. The mixture, when released from the stack, is cold but environmentally safe, since nitrogen is the most common element of the air we breathe. The stack is tall enough to allow the gas mixture to quickly dissipate in the atmosphere.

The high-quality air flow required for tunnel operation is provided by four fine-mesh anti-turbulence screens located in the settling chamber (the large tunnel section upstream of the test section). The test medium is contracted by a ratio of 15:1 between the chamber and the nozzle throat, just before it enters the test section.

About 325 square meters (3,500 sq. ft.) of sound absorbing panels, located upstream and downstream of the tunnel's fan, minimizes noise. The NTF is expected to be the quietest of any transonic wind tunnel.

NATIONAL TRANSONIC FACILITY
PLAN OF TUNNEL CIRCUIT



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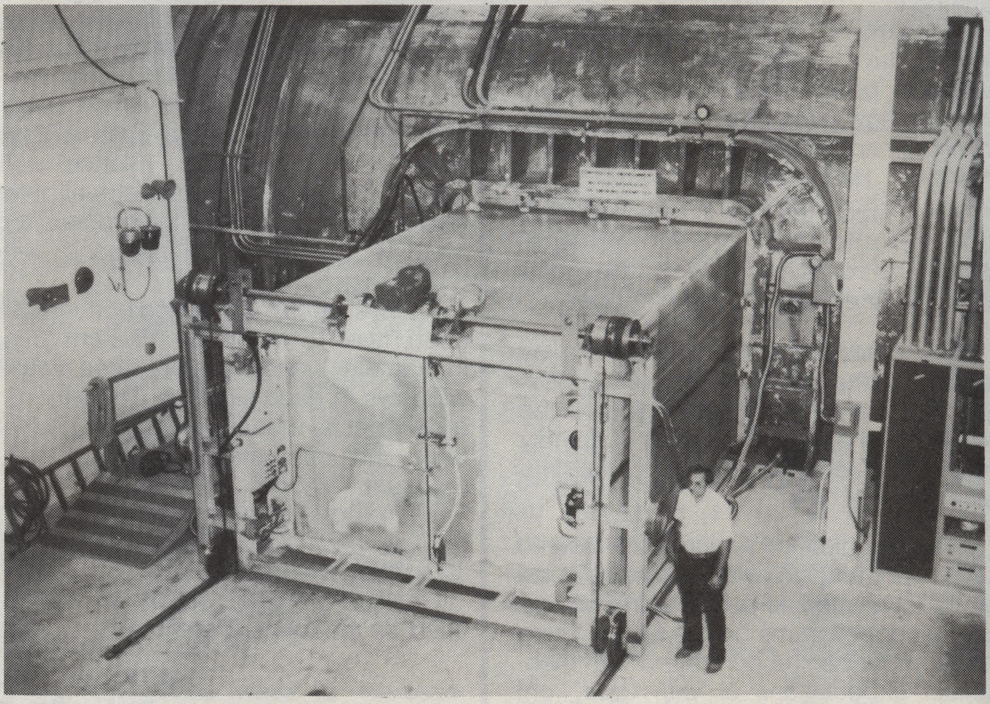
Model Access and Preparation of Models

Models can be adjusted during a test run without depressurizing the entire tunnel—and with a minimum loss of nitrogen and time—through the use of a plenum. This large pressure chamber, in which the test section is located, can be isolated from the main tunnel by large gate valves located upstream and downstream of the plenum. When the plenum is isolated, it can be vented to the atmosphere and conditioned to provide a safe environment in which to make changes or adjustments to a model.

A test model can also be separately isolated for rapid access inside the test section with two large housings called model access tubes. The tubes are inserted from either side of the plenum and closed abound the model to form a thermally insulated enclosure in which people can safely work. The plenum remains cold and the tunnel circuit's pressure is maintained by the two large gate valves.

Before a model ever reaches the tunnel test section, it is built-up, attached to its sting (support rod) and calibrated inside one of three isolated and secure assembly rooms. Each room can be made into a cryogenic chamber to cold test a model at atmospheric pressure, and instrumentation can be connected to the main NTF data acquisition system to permit data recording during buildup, checkout and calibration.

An assembled model and its sting are transported from the assembly room to the test section aboard a model handling cart. Suitable balance is maintained through center-of-gravity requirements.



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Research Programs Planned for Tunnel

Immediate research programs for the National Transonic Facility include:

Development and evaluation of aeronautical configurations, and preliminary assessment and final evaluation of aerodynamic designs. About 50 percent of tunnel test time will be allocated to this area of research.

Reserach and technology studies of fluid mechanics, propulsion aerodynamics, and dynamics and aeroelasticity.

Two "pathfinder" wind tunnel models are being tested to demonstrate the tunnel's technology and to make available to users criteria required for NTF models and test programs.

The NTF is operated by Langley Directorate for Aeronautics. Users of the tunnel pay prorated costs of occupancy plus the actual costs of nitrogen and electrical power used during a test program.