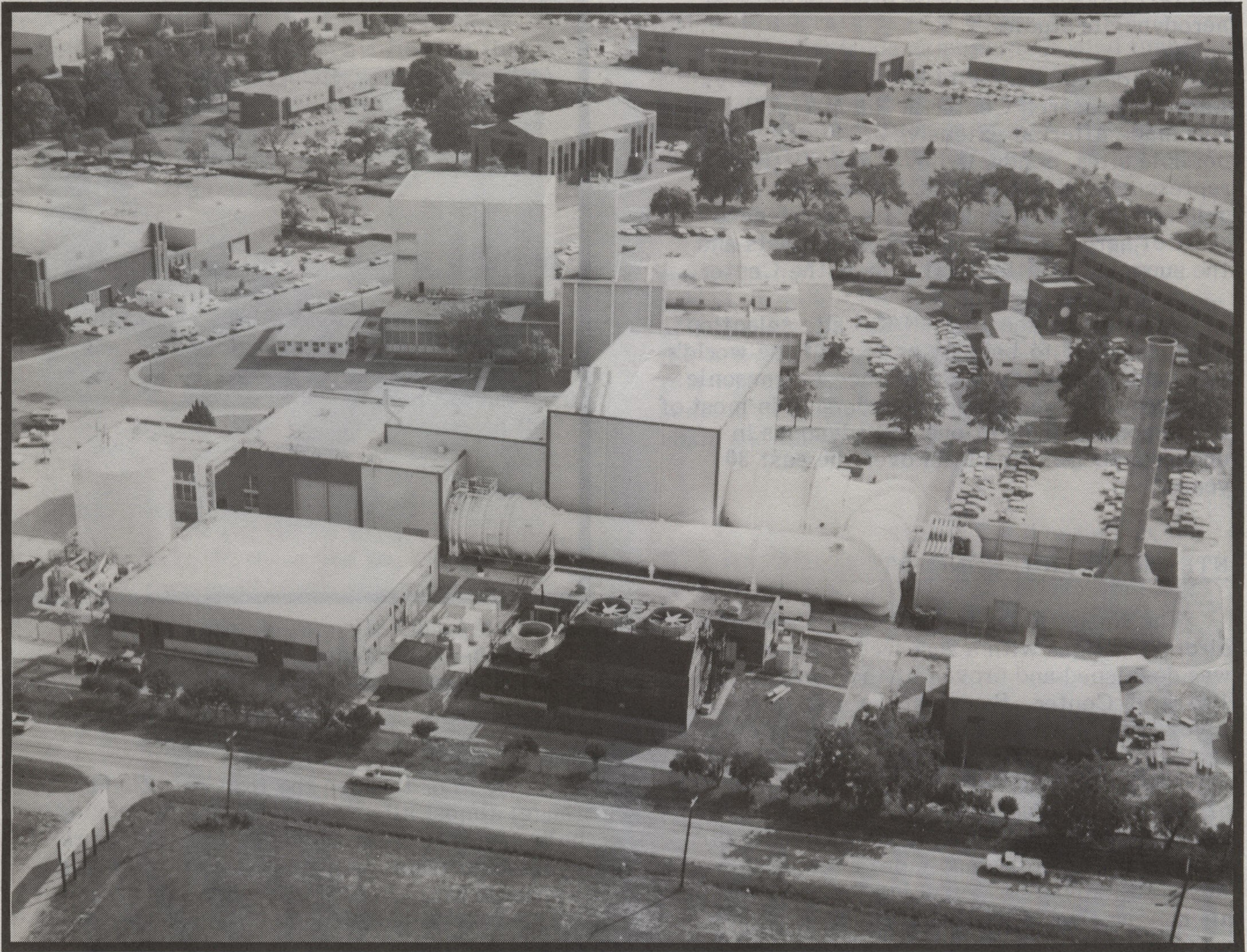


Aerial view of the National Transonic Facility

The National Transonic Facility

MEETING THE NEEDS OF GOVERNMENT AND INDUSTRY

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 future transport planes that will be more fuel-efficient than present aircraft.

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 aircraft and spacecraft designs that will fly in or through the transonic speed range. The cryogenic concept will provide far more precise design information than is now possible with more conventional wind tunnels.

The need for this new research facility has been recognized at all levels 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 facility in the mid-1970's.

NASA and the Department of Defense (DOD) will share occupancy of the NTF about 80 percent of the time to conduct major transonic research programs. The remaining 20 percent of occupancy will be allocated to other government agencies, private industry, and university and scientific groups. Some of the first models to be tested in the facility will include advanced space shuttle models, the Boeing 767, the X-29A and several "pathfinder" aircraft models that will be used for general aerodynamic studies.

The decision to build the NTF at NASA's Langley Research Center in Hampton, Virginia, was made after an extensive study of several possible sites, conducted by a committee representing NASA and DOD. Langley was primarily chosen 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."

NTF CRYOGENIC CONCEPT

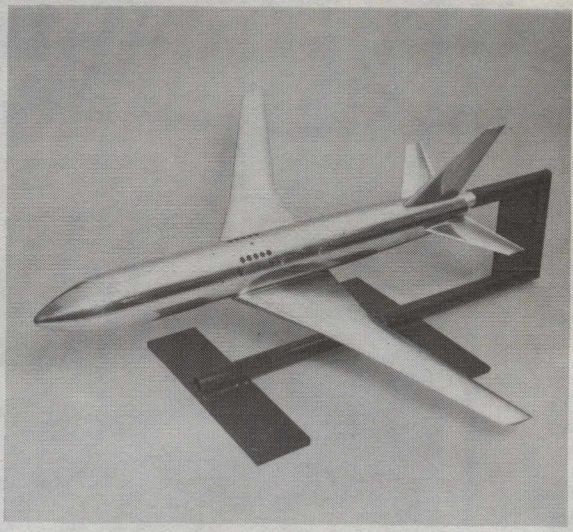
The National Transonic Facility will test aircraft designs with a research concept that was developed and proven at the Langley Research Center. Based on the adaptation of cryogenics (methods of producing extremely low temperatures) from space technology, the NTF will make possible the practical wind tunnel use of temperatures as low as 300 degrees below zero Fahrenheit. The cryogenic concept will make possible 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. The Reynolds number is determined by multiplying the size of an object (e.g., a wind tunnel model) by the speed and density of air flowing over it, then dividing the product by the viscosity of the air. This provides a Reynolds number that accurately relates the wind tunnel model to its full-scale counterpart.

Cryogenic temperatures will be obtained by evaporating liquid nitrogen in the tunnel's circuit, creating extremely cold nitrogen gas as the test medium (instead of the pressurized ambient air used in conventional tunnels). The NTF will provide Reynolds numbers up to 120 million at a speed of Mach 1.

THE ADVANTAGES OF CRYOGENIC TESTING

Existing wind tunnels cannot accurately provide design information for aircraft that



Pathfinder 1, one of many generic, high-efficiency transport models to be tested in the NTF.

must fly in or through the transonic flight range; almost all aircraft, from slow-moving helicopters to supersonic fighters and 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 tunnel's size); increase pressure in the tunnel; or decrease the tunnel's temperature.

Until development of the cryogenic concept, an adequate high-performance transonic wind tunnel was impractical. A tunnel large 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.

The traditional method of simulating transonic flight conditions with a model has been to increase the tunnel's air pressure. This also increases power, costs and loads on the model, which causes unwanted distortion. If taken too far, this distortion can cause errors in data as large as those that researchers seek to eliminate.

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

A BRIEF HISTORY OF CRYOGENIC TESTING

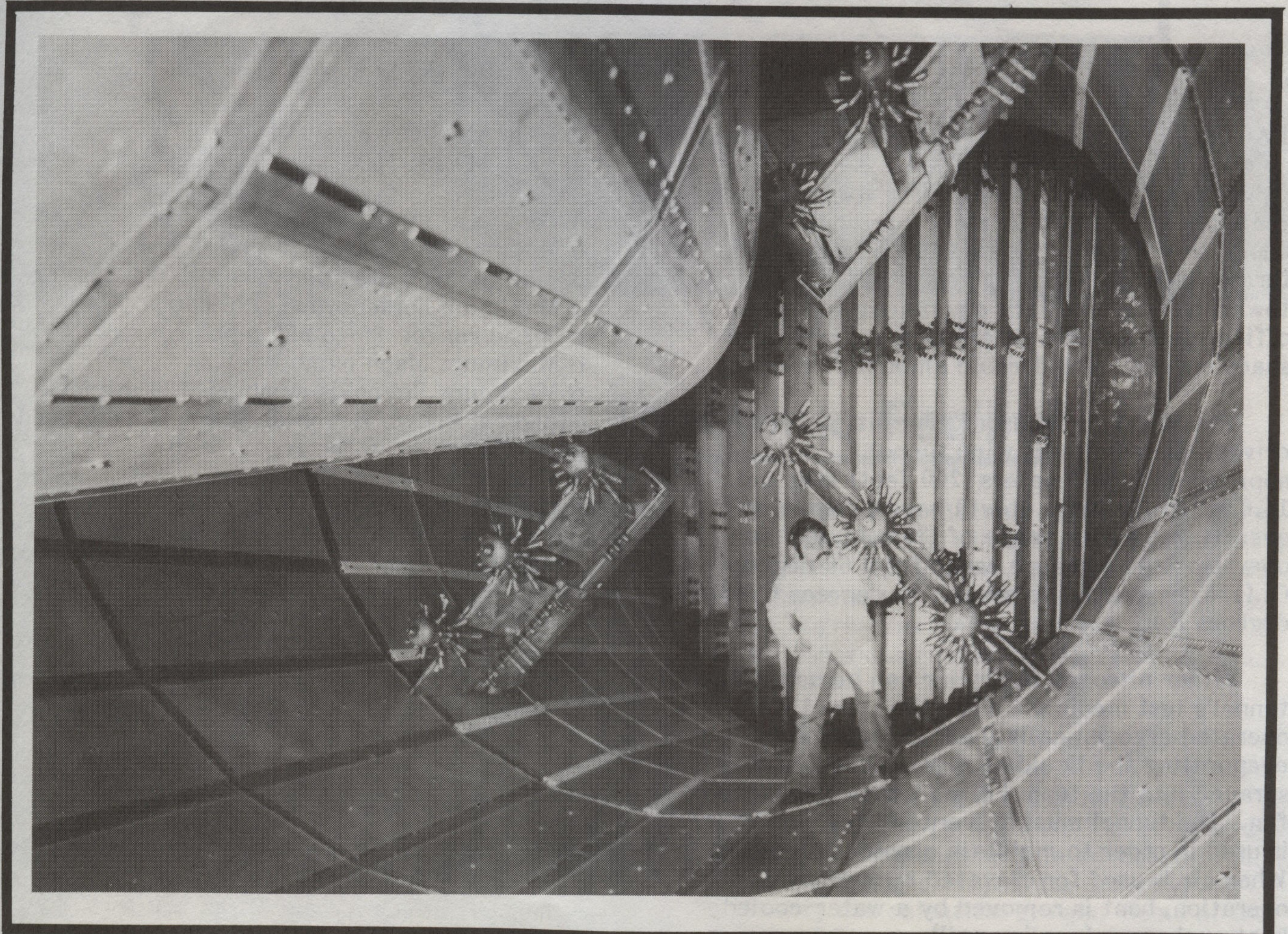
The primary advantages of using very low temperatures in wind tunnels were first conceived during the mid-1940's, but practical application of the principle was not proven until cryogenic tunnels were built at Langley in the early 1970's.

Early cryogenic research at the Langley Research Center was led by Robert A. Kilgore, the late Harleth G. Wiley and Dr. Michael J. Goodyer, a former resident research associate at Langley.

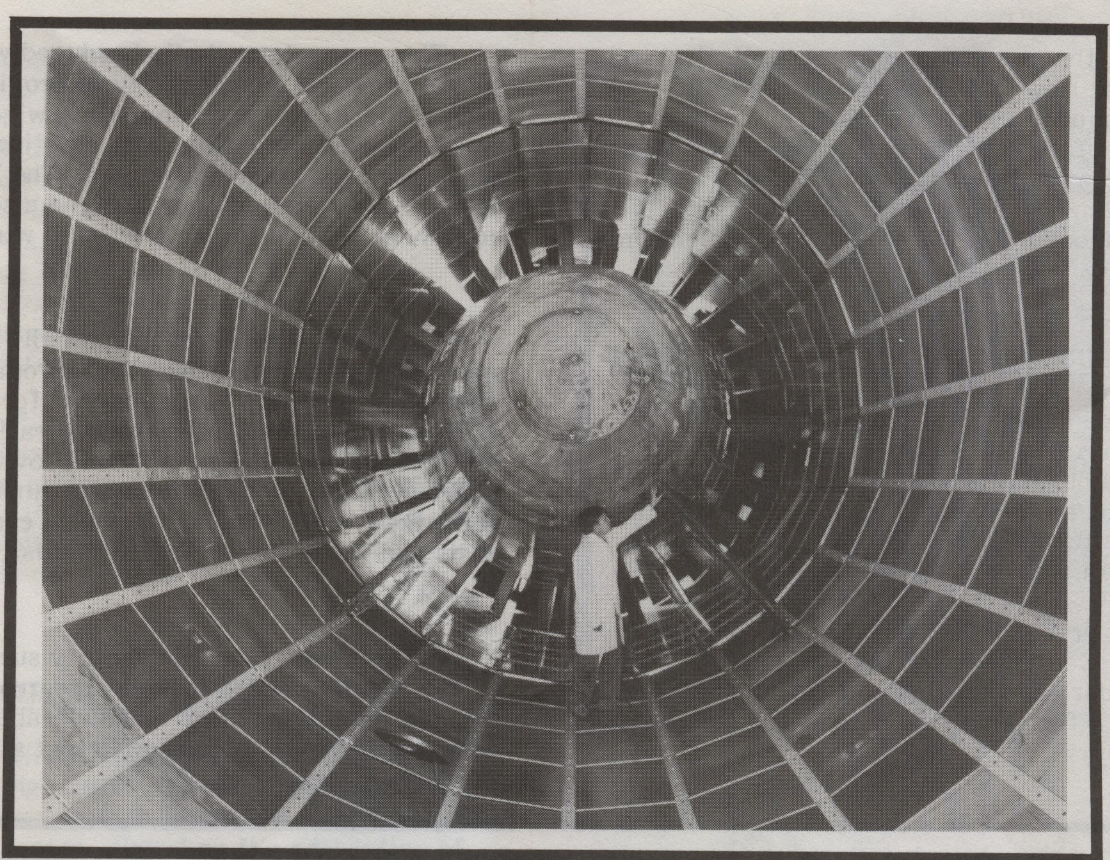
The researchers studied reduced wind tunnel temperatures as a way to provide reasonable Reynolds numbers in a wind tunnel size that was compatible with existing suspension and balance systems. The low temperature concept soon became a serious contender for any future transonic wind tunnel.

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 lower power requirements.

An improved research facility such as the NTF is vitally needed to meet the growing demand for larger, more maneuverable, more complex and more energy-efficient aircraft.



Liquid nitrogen injector station



The NTF's 126,000-horsepower fan and nacelle.

FACILITY DESCRIPTION

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 drive system, cooling tower, pumps, auxiliary equipment and some office space. Reuse of existing equipment and space saved a considerable amount of money.

The National Transonic Facility is a fan-driven, closed-circuit wind tunnel approximately 61 meters (200 feet) long and 14.6 m (48 ft) wide. It will have a maximum operating pressure range of 130 psia, and an operating temperature range from 66 degrees C. (150 degrees F.) to minus 195 degrees C. (300 degrees F.).

Either 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 when nitrogen is used in order to maintain constant pressure. When air is used for elevated temperature operation, heat is removed by a water-cooled heat exchanger (cooling coil).

NATIONAL TRANSONIC FACILITY CHARACTERISTICS

- Test gas: nitrogen and air
- Maximum pressure: 130 psi
- Minimum low temperature: minus 320^{o}F.
- Maximum horsepower: 126,000
- Speed range: 85 to 850 mph
- Maximum Mach number: 1.2
- Maximum Reynolds number: 120 million (highest known Reynolds number in a ground-based facility in the free world)
- Volume: 230,000 cubic feet
- Circuit length: 497 feet
- Cost: $85.6 million (essentially on budget target)