AEDC
Arnold Engineering Development Center
Arnold Air Force Base, Tenn. 37389
An Air Force Materiel Command Test Facility
America's Aerospace Advantage
Test Before Flight
www.arnold.af.mil

The von Karman Gas Dynamics Facility Wind Tunnels

Arnold Engineering Development Center, (AEDC) located in southern Middle Tennessee, is the nation's largest aerospace ground test facility complex. The complex includes 58 aerodynamic and propulsion wind tunnels, rocket and turbine engine test cells, space environmental chambers, arc heaters, ballistic ranges and other specialized test units. Twenty-seven of the test units have capabilities unmatched in the United States and 14 have capabilities unmatched in the world. Using its ground test facilities, AEDC supports propulsion, aerodynamic, reentry, trans-atmospheric and space-flight systems testing.

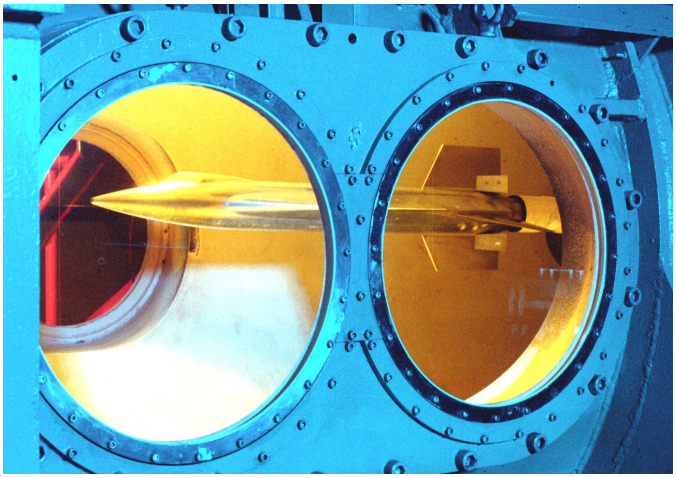

Photo no. 92-156501

A model of the X-15 rocket shown in AEDC's von Karman Gas Dynamics Facility wind tunnel A. The X-15 underwent air worthyness and stability testing in the late 1950s. AEDC played a major role in the development of the X-15 and continues to provide instrumental aeronautical tests for U.S. military, NASA, and commercial air and space craft.

Terms to Know

Mach number—a ratio unit of speed, named after Austrian philosopher and physicist Ernst Mach (1838-1916), used when talking about aircraft or missiles; defined as a ratio of the speed of an aircraft to the speed of sound in the undisturbed medium (air) through which the body is traveling. Mach 1 is approximately equal to 717 miles/hour at sea level.

Transonic—speeds at or near that of sound.

Supersonic—speeds above Mach 1.

Stores—fuel tanks, bombs, external pods or missiles that are carried by an aircraft.

AEDC Wind Tunnels

AEDC's wind tunnels include the Propulsion Wind Tunnels (PWT) 16T, 16S and 4T, the von Karman Gas Dynamics Facility (VKF) Supersonic and Hypersonic Wind Tunnels A/B/C and Hypervelocity Tunnel 9 Wind Tunnel, located in White Oak, Md. Individual fact sheets are available for further information on the Propulsion Wind Tunnels Facility and the Hypervelocity Tunnel 9 Facility.

The von Karman Gas Dynamics Facility Hypersonic Wind Tunnels (A/B/C)

The von Karman Gas Dynamics Facility has three continuous-flow units, Tunnels A, B and C. The tunnels are used extensively to obtain large aerodynamic and aerothermodynamic databases that are used to develop supersonic and hypersonic flight vehicles. Virtually every high-speed flight vehicle has required testing in Tunnels A/B/C, from reentry and tactical vehicles and space capsules, to the X-planes and winged vehicles.

Since the early 1970s, for example, various models of the space shuttle have been tested in these tunnels to determine the aerodynamic relationship between its main components—the orbiter, the external tanks and the two solid rocket boosters.

VKF Wind Tunnel Operation

Air is the working medium used in all VKF tunnels. They may be operated for hours at a time using air supplied by a nine-stage compressor system that is an eighth of a mile long and is driven by electric motors providing up to 92,500 horsepower. Air is stored in two reservoirs with a combined capacity of approximately 542,000 pounds. This air is used to simulate jet flows from the models and provides high-pressure air for the power ejectors in all facilities at AEDC.

Tunnel A

Tunnel A is a 40-inch squared, continuous, closed-circuit, variable density, su-

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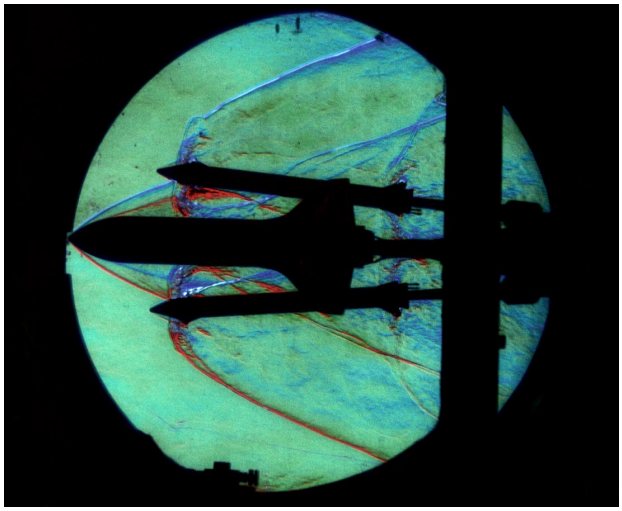
A 6-percent scale model of Boeing X-37 undergoes wind tunnel testing in AEDC's Tunnel A.



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Space shuttle separation tests performed at the AEDC examined dual solid booster separation from the shuttle and external tank. This Schlierern phot shows a test in wind tunnel A in the von Karman Gas Dynamic Facility at the center in 1974.

personic wind tunnel with a Mach number range of 1.5 to 5.5.

Devoted primarily to explorations of aerodynamic design, Tunnel A's unique feature is its computer controlled continuous-curvature nozzle that can vary the tunnels Mach number. Tunnel A can obtain a maximum temperature of 290 degrees Fahrenheit.

Tunnel B

Tunnel B is a 50-inch, closed-circuit hypersonic tunnel with continuous-flow capability with a Mach number capability of 6 and 8. Provided with air heated to a maximum of 900 degrees Fahrenheit with natural gas-fired heaters. Tunnel B is also primarily explores aerodynamic design.

Tunnel C

Tunnel C is the third continuous-flow tunnel in the VKF facility with a Mach number capability of 4, 6, and 10. It offers an aerothermal environment for testing materials proposed for use on space vehicles and aircraft. The one-of-a-kind wind tunnel makes it possible to subject flight hardware to a combination aerodynamic and thermodynamic—or heating—effects up to 1,440 degrees Fahrenheit so engineers can study how aerospace vehicles and materials respond to the combined effects of external heating, internal heat conduction and pressure loading.

Special photographic techniques are used in the tunnels to visualize shock waves and heating patterns.

Captive Trajectory Support Testing

The Captive Trajectory Support (CTS) systems for the AEDC wind tunnels allows computer-controlled, six-degrees-of-freedom positioning of a missile, bomb, or any other store in close proximity to the aircraft (parent) model. Operational CTS systems exist in Tunnels A, B and C. Applications in the PWT transonic and supersonic test units consist of store separation and flow-field mapping.

VKF History/ Background

The origin of AEDC's VKF may be traced back to the end of World War II, when General of the Air Force H.H. "Hap" Arnold —then Army Air Forces commander and the man for whom the center was named —sought to determine how the Germans had made such rapid progress in developing high-performance jet aircraft and rocket-powered missiles. He enlisted the help of Dr. Theodore von Karman, one of history's great aeronautical scientists, to conduct a survey of the German facilities as the war was ending.

Dr. von Karman's subsequent report recommended the Air Force create a center with "...wind tunnel facilities to attain speeds up to three times the velocity of sound, with large enough test sections to accommodate models of reasonable size, including jet propulsion units, and one ultrasonic wind tunnel for exploration of the upper frontier of the supersonic speed range. Ample facilities for the study of combustion and other characteristics of propulsion systems at very high altitudes should be provided..."

The decision to proceed with a gas dynamic facility was made in 1950 at a Washington, D.C., meeting by representatives of the Air Force, Navy, NACA (forerunner of NASA), the government's Research Development Board and the aircraft industry.

The Actual directive to the Corps of Engineers to proceed with construction did not come until almost two years later.

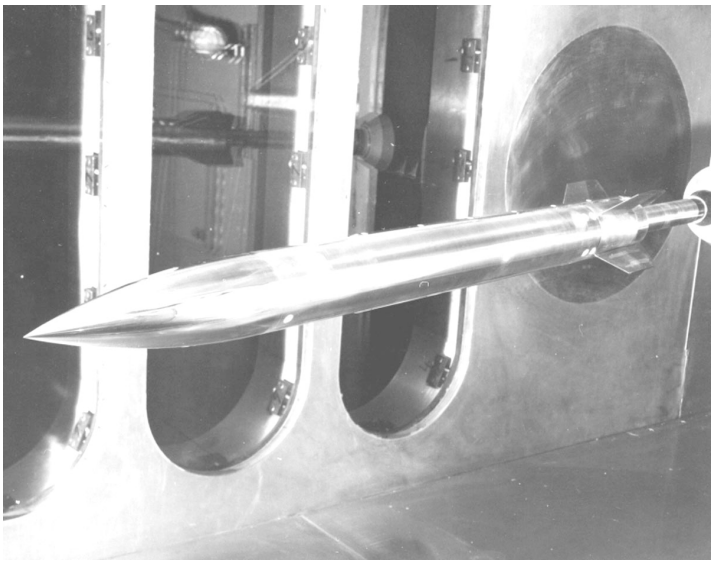

Photo no. 91-630

The Patriot Missile undergoes aerodynamic testing in AEDC's von Karman Gas Dynamics Facility wind tunnel A.

In 1959, two years after completion of the two large continuous-flow tunnels, the facility was renamed after Dr. von Karman, then chief scientific advisor to the Air Force and an enthusiastic participant helping AEDC.

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Release # 2002-202