AEDC–Unique Mission, Unique Facilities

The world's premier flight simulation test facility

By Claude Morse
AEDC Public Affairs

The Arnold Engineering Development Center located at Arnold AFB, Tenn. has a unique and vital Air Force mission.

AEDC also operates a unique former Navy test facility, Hypervelocity Tunnel 9 in White Oak, Md. as a remote operating location.

Not only is AEDC's mission unique, but 27 of the center's 58 flight simulation test facilities, worth some $6 billion, are unique in the United States while 14 are unique in the world.

AEDC is the Department of Defense's ground flight simulation test center. It is not well known outside the research and development and test and evaluation world.

That may be because only a small military contingent of about 100 military members and some 200 government civilian employees are assigned there. Government people make up about 10 percent of the center's workforce. The remaining approximately 2,500 people at AEDC are employed by two support contractors ACS, a joint venture of Computer Sciences Corp., DynCorp and General Physics provides center support, while Sverdrup Technology, Inc./AEDC Group, a Jacobs Engineering Company, operates the centers flight simulation test facilities.

Since its dedication in 1951 by President harry Truman, the center has played a critical role in developing every high-performance flight system in use by the U.S. Air Force, Navy and Marines has been tested at AEDC, and has benefited by the center's unique test facilities and highly skilled workforce.

AEDC's test facilities simulate flight for models of aircraft, spacecraft, rockets and bombs in small and large wind tunnels that can simulate speeds up to Mach 18.

The center's jet engine test cells allow manufacturers to test jet engines under the full flight envelope from sea level to altitudes above 100,000 feet at speeds up to Mach 3.5 and under icing and other environmental conditions.

Unique in the world high-altitude rocket test capability allows testing of actual rocket motors at high altitude. Upper stage rocket motors for the Minuteman and Peacekeeper ICBMs, the submarine launched Polaris, Poseidon and Trident missiles, as well as the Saturn V (for the Apollo Program) the Titan, Atlas and the next generation EELV upper stage rocket motors can only be tested under simulated high altitude flight conditions at AEDC.

The center's Space chambers have tested full scale Global Positioning Satellites and the shrouds that cover satellites on the tips of rockets to insure they will open in space.

Coming up is commercial testing of communications and weather satellites for Space Systems Loral in a 10-year $30 million contract.

Today AEDC is helping develop the F-22 Raptor, the Joint Strike Fighter, The Navy's F/A-18 Supper Hornet plus helping keep the F-15 Eagle and F-16 Fighting Falcon and the B-1 Lancer and B-2 Spirit on the cutting edge of flight technology.

In addition the center has long term alliances with Pratt & Whitney, GE, Boeing and Lockheed Martin to test commercial flight systems like the engines for the new Boeing 777. Last year about 16 percent of AEDC's work was commercial, helping to offset the cost to the taxpayers of operating and upgrading facilities at this unique national test center to support the military and economic defense of the nation.

TEST BEFORE FLIGHT AEDC

AEDC test complex at Arnold AFB, Tenn – Inset picture is remote operating location Hypervelocity Tunnel 9 in White Oak, Md.

Aeropropulsion Systems Test Facility (Photo by Gary Barton)

ASTF simulates flight envelope for jet engines

By Darbie Sizemore
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Aeropropulsion Systems Test Facility provides pilots with confidence in engine performance

Pilots don't expect perfect conditions when flying, but they do expect their plane's engine to perform perfectly no matter the environment.

Test aircraft propulsion systems in true mission environments without leaving the ground is the mission of the Aeropropulsion Systems Test Facility at AEDC.

Located on a 57-acre site, ASTF, the only test facility of its kind in the free world, provides a simulated altitude environment duplicating an aircraft's flight envelope for testing thrust capabilities and fuel usage in military and commercial jet engines with up to 100,000 pounds of thrust at altitudes up to 100,000 feet and speeds up to Mach 3.8. It is an open-circuit facility housing two test cells. The facility, which during construction used nine months of the nation's steel production, contains 320 miles of electrical cable and the world's largest butterfly valve—32 feet in diameter and weighing 170 tons—according to the Guiness Book of World Records.

At $625-million, ASTF is the largest single-line-item military construction project in Air Force history. Congressional and presidential approval for construction was granted in September 1976. Construction began in 1977. It took seven years to build the facility and involved as many as 1,000 workers during much of the construction period.

The facility reached initial operation capability in September 1985.

During testing, atmospheric air is compressed, heated or cooled as required to simulate flight conditions and supplied to the propulsion system in the test cell.

The air supply compressors can provide up to 1,500 pounds of air per second into the test cell to simulate airspeeds up to more than 2,000 miles per hour. The compressors, totaling 215,000 horsepower, are started by the largest Variable Frequency Starting System in the western world. An additional 1,400 pounds per second of airflow is available by drawing outside air directly into the test cell.

A massive refrigeration system is used to duplicate the flight environment for high altitude and low-speed missions. Two large coolers and enough refrigeration equipment to cool 6,000 average American homes are available to dry and cool the air to minus 20 degrees Fahrenheit. The air can be cool to as low as minus 100 degrees Fahrenheit if mission required.

Providing properly conditioned air to the propulsion systems to simulate supersonic flight conditions calls into play the largest air heaters in the western world. These heaters can burn either natural gas or waste aviation fuel and generate enough heat—one billion BTUs per hour—to raise the temperature of the airflow to a maximum of 1,020 degrees Fahrenheit, which is enough to heat 2,200 average houses on a subzero windy day.

Currently, the ASTF cells are testing F119 engines for both the F-22 Raptor and the Joint Strike Fighter.

Pratt & Whitney F119 engine for the Air Force's F-22 Raptor.

Rocket Development Test Cell J-4 tests rockets at high altitude

By Tina Barton
AEDC Public Affairs

AEDC's Rocket Development Test Cell J-4 provides unmatched testing of liquid-propellant rocket engines and solid-propellant rocket motors.

Built in the early 1960's, J-4 is a 48-feet-diameter, 82-feet-tall vertical test cell provides simulated altitude testing up to 100,000 feet. With its large-volume vertical dehumidification chamber reaching 260 feet below ground level, it can support engines with thrust levels up to 1,500,000 pounds. In addition, J-4's unique temperature-conditioning system is designed to maintain the test article at temperatures from 50° to 110° degrees Fahrenheit.

Key test capabilities consist of accurate and repeatable six-component thrust measurement, variable altitude and soft shut-down capabilities to preserve hardware. Additional capabilities include providing nozzle development and deployment, ignition performance, long-duration altitude (mission duty cycle), heat transfer effects and post-test heat soak, vibration and dynamics, failure analysis and vertical spin testing.

In 1996, a $9.7 million upgrade added new cryogenic and hypergolic propellant system test capabilities, and in 1997, J-4 was the test site for the first engine to power a new generation of space launch vehicle upper-stage propulsion systems, the Evolved Expendable Launch Vehicle.

"The AEDC J-4 facility has capabilities unmatched anywhere in the world," said Don Skinner, J-4 program manager and coach of the Space and Missiles Department Missiles and Rockets branch. "With the new upgrades, the facility is ready to support upper stage engine testing to reduce risk and improve reliability of propulsion systems for DoD and commercial missions."

Because of its large size and accessibility, J-4 can accommodate an extensive range of state-of-the-art diagnostic instrumentation able to acquire up to 500,000 data samples per second. Test cell instrumentation includes laser fluorescence, infrared and ultraviolet imagery, high-speed video and real-time radiography to verify system performance and structural integrity and to characterize plume signature phenomenology and flowfields.

Top. A Titan Stage II LR-91 rocket motor fires under high altitude conditions in J-4.

Right. 260 feet down at the bottom of J-4 (Photo by Craig Logan)

During the past 40 years, J-4 has supported more than 400 tests. Liquid-propellant engines tested include the LR-91 (Titan II/III/IV, EELV), LR-87 (Titan IIIC), J2 (Apollo/Saturn V), J2S (Post-Apollo), RL-10 (Delta III/IV), and TR-201 (Delta). Solid propellant motor testing includes Peacekeeper Stage II, Minuteman Stages II and III, Trident Stage III, Super BATES, Small Intercontinental Ballistic Missile Stage II and STAR 27 and 13A motors.

Decade: DoD's One-of-a-kind Facility

By Tina Barton and 2nd Lt. Tisha David
AEDC Public Affairs

A new, one of a kind facility located at AEDC provides the Department of Defense with a unique test capability. Decade is the unique facility that answers questions about how nuclear explosions in space effect U.S. Defense Systems.

The Decade facility will test communication, navigation, surveillance and tracking satellites as well as interceptor systems.

"Decade is a world class, one-of-a-kind, radiation environment simulation facility that partially replaces the critical capability lost when underground nuclear testing was eliminated," said Ken Brandon, AEDC program manger said. "Because we no longer conduct underground nuclear testing, the simulator partially replaces that capability in a safer, more cost effective way."

The Decade simulator produces the X-ray portion of a nuclear explosion within a highly shielded test cell during a test lasting approximately 40 nanoseconds—about the time light travels across a room. It consists of a pulse power train with 288 high-energy storage capacitors that store electrical energy for a short period of time.

During a test, operators charge these capacitors to voltage levels of up to 100,000 volts of electricity. Then they discharge the capacitors to produce a 10 terawatt-pulse electron beam that impacts on a target producing the x-ray pulse.

Sensors on or near the test article, measure and document the amount and type of X-rays produced. The entire sequence takes approximately two minutes.

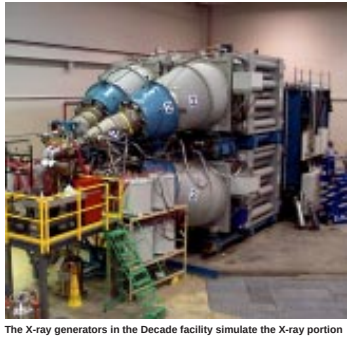
"Later this year decade will be capable of producing cold X-rays," said Brandon. "These sources will make it ideal for testing larger systems like communication satellites, ground-based interceptor sensors and missiles that could be exposed to a nuclear event in space."

According to Lavell Whitehead, AEDC test contractor project manager, the system will provide nuclear weapons effects testing at a much lower cost than underground testing.

"With previous ground tests, you got one shot at it," said Whitehead. "If something went wrong a whole year's effort and money could be lost. With Decade, if something goes wrong, it can be repeated within a couple of hours at minimal cost. This increased flexibility allows customers to make additional shots in order to obtain the required data with minimal time constraints."

Outside of Decade building (AEDC Photo Lab)

"The Decade team," said Brandon, "is working very hard to provide the nation's premiere nuclear weapons effects test capability at the lowest possible cost to the consumer."



The X-ray generators in the Decade facility simulate the X-ray portion of a nuclear explosion. (AEDC Photo Lab)