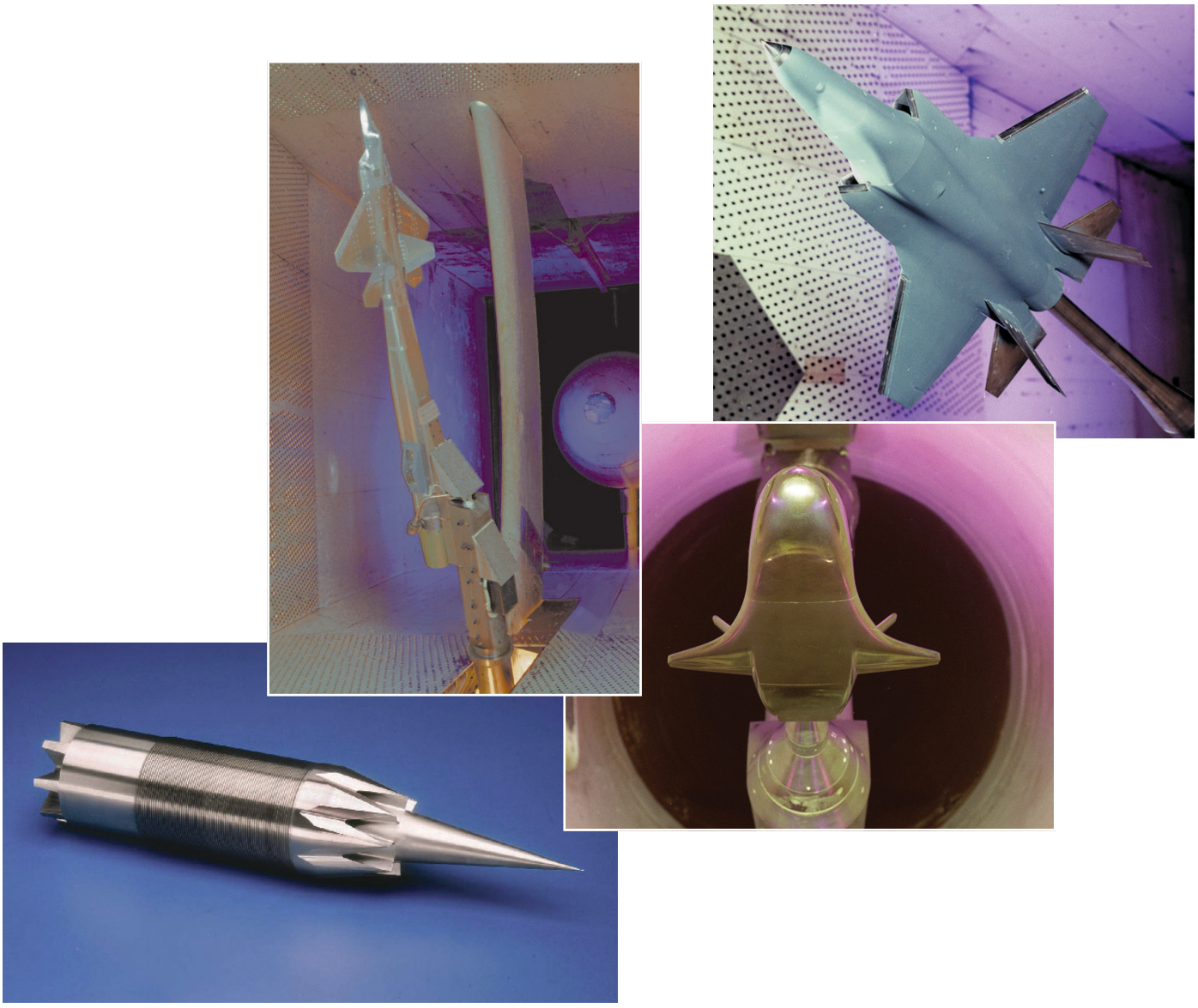

2001 Annual Report

Arnold Engineering Development Center

America's Aerospace Advantage

Who We Are

Arnold Engineering Development Center is the world's largest and most complex collection of flight simulation test facilities.

The 4,000 acres that comprise AEDC are part of the 40,000 acre Arnold Air Force Base. The base was dedicated June 25, 1951 by President Harry Truman. AEDC has tested virtually every high performance aerospace system the Department of Defense has developed since the mid 1950s.

Our Mission

To provide our customers with the world's most effective and affordable aerospace ground test and evaluation products and services. To ensure Arnold Engineering Development Center ground test facilities, technologies, and knowledge fully support today's and tomorrow's customers.

AEDC Strategic Objectives

1. Satisfy our internal and external customers and stakeholders
2. Reduce the unit cost of products and services each year
3. Increase our overall external customer business
4. Improve productivity each year
5. Nurture a high-performance work force.

An AEDC Public Affairs publication, edited and produced by ACS, the center support contractor for Arnold Engineering Development Center.

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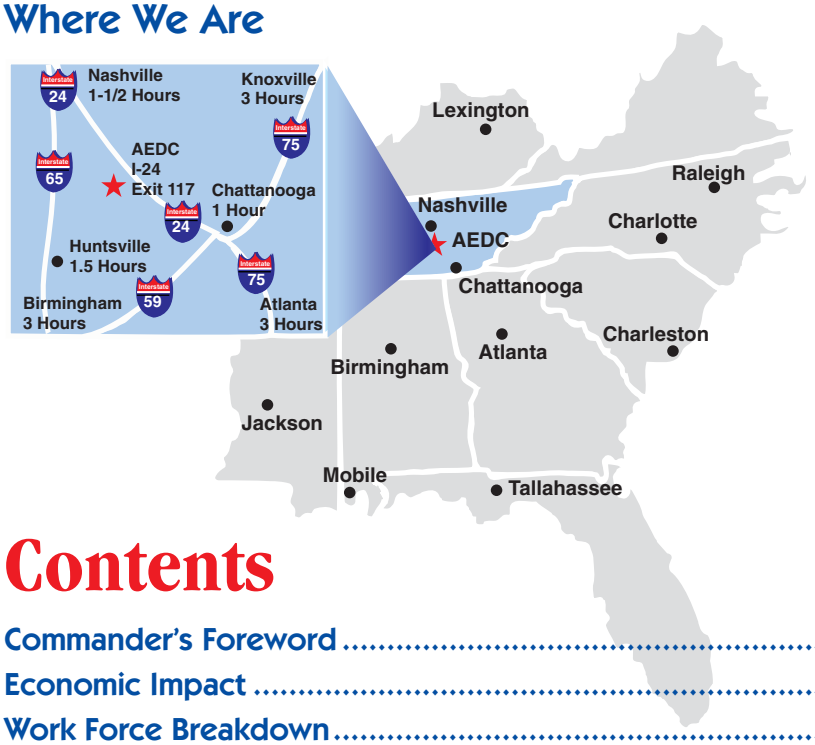
Where We Are



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ISO 9000 – World Class Quality Standards

To meet the highest quality standards and customer expectations, AEDC has worked hard to measure up to quality standards like ISO 9000, the worldwide standard for quality. AEDC's contractors–center support contractor ACS and test support contractor Sverdrup Technology Inc./AEDC Group–have been deemed ISO 9000 compliant by an auditing team from Georgia Institute of Technology.

ISO 9000 is a series of five individual, but related, standards on quality management and quality assurance. The ISO system created a set of standards for the exchange of goods and services. The primary objective of a compliant ISO 9000 operation is to have all major processes documented to reflect the actual way an organization performs work.

The Department of Defense's Software Engineering Institute has designated Sverdrup a level 3 organization according to its Capability Maturity Model. It's a distinction test customers look for in selectingorganizations that have taken quality steps in ensuring software is what it should be.

The Gartner Group, an independent service assessment firm, gave ACS world-class marks for the computer support it provides to AEDC.

Commander's Foreword

Every year the people of AEDC help the world take flight!

Our 50th anniversary year, 2001, helped us recognize and celebrate our contributions to aerospace engineering and the advancement of flight technology. We continue to push that technology forward, and the results are exciting.

We've had several "firsts" this year, to include the historic first ever free-flight of a scramjet. AEDC also contributed to the development of the Numerical Propulsion System Simulation software package (NPSS) that will enable multifidelity analysis in designing advanced propulsion systems. In addition we have brought a new space test capability on-line to test electronic propulsion thrusters for satellites.

In an effort to stay on top of ever-changing technology, we've adapted several testing areas to meet current capability needs in the industry. For example, we added a new test capability in our Decade Nuclear Radiation Effects Facility. We have also significantly increased our high performance computing capability to enable faster, and in some cases real time, analysis of test data.

Plus, AEDC is developing ways to provide more accurate and more interpretable testing data for our customers. NPSS is a perfect example of breaking down the barriers for testing propulsion systems. The development of a new portable digital inclinometer is another success in increasing angle calibration accuracy.

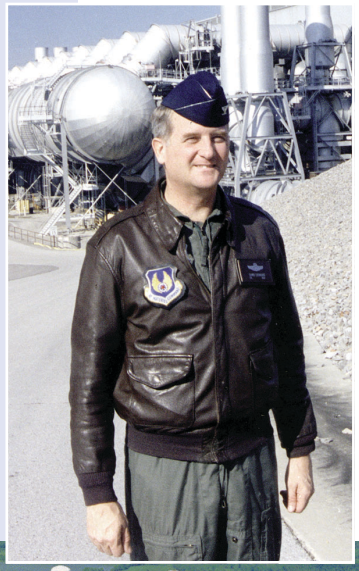
Our 50th anniversary air show helped us recall just how far we've come in aerospace technology since 1951. While our work ethic is still as strong as ever, our systems tested are exponentially more advanced. Today we continue to test the Air Force's new F-22 Raptor air dominance fighter and the new F-35 Joint Strike Fighter.

Our future is strong not only in defense programs, but in commercial testing as well. This year we tested the Boeing 767 and 747X, and we're looking forward to the possibility of more airline testing in the future.

The service we provide is vital to support America's military and economic defense. America is an aerospace nation, and AEDC plays a significant role in America's strong aerospace advantage.

AEDC has a long and proud history in aerospace systems development. If you would like more information on the test capabilities we offer or simply have an interest in visiting the center, please feel free to contact me through the Public Affairs office at (931) 454-4204.

David J. Eichhorn, Col., USAF
Commander



Economic Impact

Arnold Engineering Development Center's economic impact in Middle Tennessee was more than $487 million for fiscal 2001.

The economic impact data and secondary employment estimates are based on the Tennessee Valley Authority economic impact model methodology.

The Air Force model, which uses a different, more conservative methodology, shows economic impact at $382.7 million.

AEDC employed 2,835 people this year; these numbers include military personnel, government civilian and contractor employees with military personnel making up about three and a half percent.

The total economic impact includes the center's payroll, secondary jobs created locally through the spending of that payroll and other direct expenditures.

Examples of secondary jobs would be those created to build new houses or jobs created at local supermarkets. Direct expenditure examples include money spent to pay for utilities, service contracts with outside vendors and military health insurance paid to local hospitals or doctors.

In addition to the 2,835 people employed at Arnold Air Force Base, including part-time and temporary employees, the center gave a boost to the local economy by creating some 1,956 secondary jobs for a total of almost 4,800 jobs related to AEDC.

The payroll for AEDC government personnel and contractor employees was almost $138 million. Other direct AEDC expenditures were more than $176 million with the approximate payroll for the secondary jobs exceeding $51 million.

AEDC remains the single largest employer in Coffee and Franklin counties. The center employed 1,260 people in Coffee County and 705 from Franklin County.

Not reflected in AEDC's economic impact are the approximately 3,500 military retirees living in the local area surrounding Arnold Air Force Base who receive more than $50 million in retirement pay or the retirement pay of several hundred former government civilian employees and contractor personnel from AEDC.

The current replacement value for the aerospace testing complex at Arnold Air Force Base is more than $7 billion.

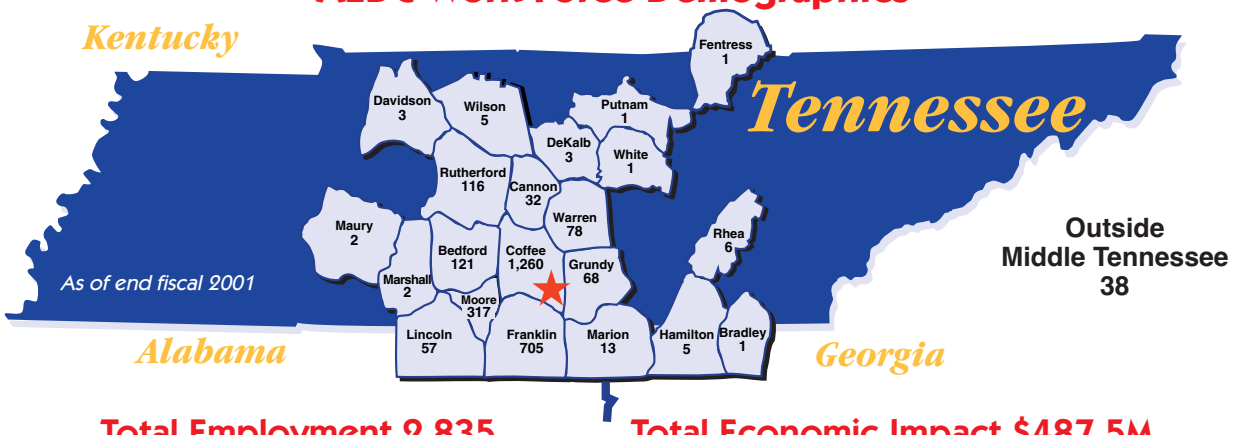
(See complete listing of facility values on page 10; a list of AEDC test facilities can be found on page 26.)

Fiscal 2001 Economic Impact Data

TVA Model Estimates for AEDC
As of Sept. 30, 2001

Direct Employment at AEDC	
Military	102
Government Civilian	202
Non-appropriated Fund	52
Sverdrup/ACS	2,531
AEDC Federal Credit Union	5
Base Exchange	5
Total	**2,835**
Secondary Jobs Created	1,956
Total Employment Impact	**4,791**
Economic Impact (in millions)	
Non-construction Expenditure	$ 330.5
Indirect Spin-off Impact	$ 155.3
Construction Expenditures	$ 0.6
Indirect Spin-off Impact	$ 1.2
Total Direct Expenditures	**$331.2**
Total Indirect Expenditures	**$156.4**
Total Economic Impact	**$487.5**

AEDC Work Force Demographics



Total Employment 2,835 **Total Economic Impact $487.5M**

Work Force Breakdown

Arnold is not a typical Air Force base in many respects, and one thing that has always made it distinct is its work force.

Since its inception in the 1950s, Arnold's work force distribution has been about 10 percent government employees and 90 percent contractor employees.

The philosophy that created this unique distribution of people was simple — to save money and to create an experienced group of people who would know these unique facilities inside and out and who would remain here for a long time.

The philosophy has worked. The average age of the 2,835-member AEDC work force is 47, with an average of 16 years of experience at the center.

The government staff at AEDC, composed of military and civilian employees, provides management direction, resource allocation, oversight and contract administration.

Arnold's contractors are Sverdrup Technology Inc./AEDC Group – a Jacobs Engineering Company and ACS, a joint venture of Computer Sciences Corp., DynCorp and General Physics.

Sverdrup, led by General Manager Dr. David Elrod, conducts aerospace testing for the center.

ACS, led by General Manager Jim Nicholson, is the center support contractor.

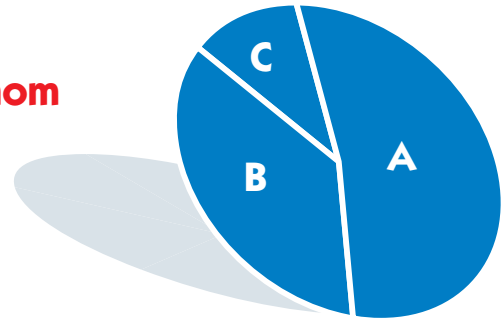
The consolidation of Department of Defense test facilities brought Navy employees to AEDC in 1993. Now there are about a dozen Navy personnel, including three officers.

To demonstrate its commitment to meeting the Navy's needs, the Air Force made the center's vice commander slot a Navy position. Navy Capt. Larry Judge currently fills that position.

(left to right) AEMTC secretary Bob Smith, Sverdrup/AEDC Group General Manager Dr. David Elrod, AEDC Vice Commander Navy Capt. Larry Judge, ACS Director of Base Services Mike Cunningham, Air Engineering Metal Trades Council President David Garner and Sverdrup Human Resources Manager Tom Quatrini. AEMTC hosted a statewide union conference held at Arnold.

Who Works for Whom

A	Sverdrup	54%
B	ACS	35%
C	AF/Navy	11%



What They Do

Craft	36%
Engineers/Scientists	30%
Technical Associates	15%
Administrative	14%
Managers/Supervisors	5%

Craft Employee Breakdown

Machinists	20%
Instrument Technicians	18%
Electrical	15%
Operating Engineers	10%
Pipefitters	7%
Police/Fire	5%
Storekeepers/Drivers	5%
Janitors	4%
Boilermakers	3%
Other	13%

Engineers/Scientists Breakdown

Mechanical	26.7%
Aeronautical/Aerospace	19.2%
Electrical	18.2%
Computer Science	8.1%
Mathematical	5.2%
Physics	5.2%
Industrial/General	5.2%
Other	12.2%

Bachelor's	60%
Master's	35.3%
Doctorate	4.7%

President Truman with Mrs. Henry Arnold unveiling the AEDC dedicatory plaque in front of thousands of guests at the dedication ceremony in 1951.

History

Photos:
1 General of the Air Force Henry "Hap" Arnold
2 Dr. Theodore von Karman
3 Dr. Frank Wattendorf

Before World War II ended, Commander of the Army Air Forces, General of the Army Henry H. "Hap" Arnold, was alarmed by the Germans' development of advanced jet aircraft and rockets. Had these sophisticated systems been introduced earlier, they could have changed the outcome of the war. Arnold learned the vitality of air research and development from the Germans.

"I had ... to project myself into the future ... and determine what steps the United States should take to have the best air force in the world 20 years hence," he said.

Arnold enlisted the help of Dr. Theodore von Karman, one of the world's leading aeronautical scientists. He asked von Karman to form a scientific group to chart a long-range research and development program for the future U.S. Air Force.

Members of this "Scientific Advisory Group" went to Germany in the last weeks of the war to study testing facilities and techniques. One member of the task force, Dr. Frank Wattendorf, penned a memo on the return trip calling for an Air Engineering Development Center for ground testing of aerospace systems.

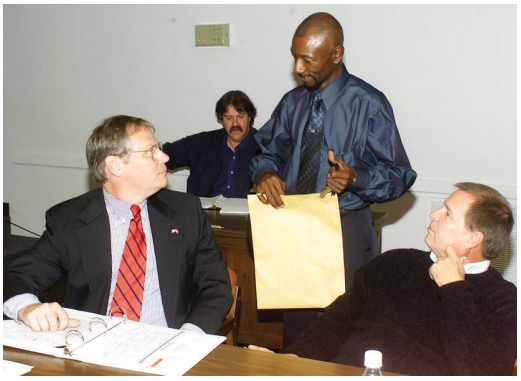
The memo became part of von Karman's 1945 study, "Toward New Horizons," that served as a blueprint for the future U. S. Air Force and for what is now AEDC.

Shortly thereafter, the Air Force began planning the development of the aerospace testing center. By 1949, the leading civilian and military scientists had completed the plan for such a facility. That year, Congress passed the Unitary Wind Tunnel Plan Act and the Air Engineering Development Center Act. President Truman signed it into law, setting in motion the establishment of AEDC.

Southern Middle Tennessee was selected because of its availability of land, water and power. Construction began in 1950. President Truman dedicated the center on June 25, 1951. The first tests were run here in 1953. Since then, AEDC has tested virtually every high-performance aerospace system in the Department of Defense's inventory.

At the dedication, Truman vowed, "Never again will the United States ride the coattails of other countries in the progress and development of the aeronautical art." His promise was renewed in 1995 in a study to determine where America should turn its aerospace research attentions in the 21st Century. The resulting report, "New World Vistas," serves as a kind of blueprint for future development that von Karman and the Scientific Advisory Group report, "Toward New Horizons," provided 50 years earlier.

Community Involvement



AEDC employee J. T. Northcutt (standing), serves as an alderman in Tullahoma. Northcutt also works with area youth.

AEDC personnel are very active in the cities and towns they live in as public servants holding political offices, teachers, youth leaders and volunteers. They are an integral part of communities all across the midstate from Tullahoma to Manchester, Winchester, Shelbyville, Murfreesboro and many other Tennessee cities (breakdown of employees by county on page 2).

During September 2000, a group of community leaders formed an organization to promote and support AEDC. The group, called the Arnold Community Council, looks for areas of common interest for our civilian and military populations to work together. The council played a role as community liaison and support for AEDC's 50th Anniversary Rededication Ceremony on June 25 and the air show on June 23-24.

Base people overwhelmingly supported Angel E-mail, providing an abundance of clothes and toys to needy families in the area.

The council includes key civic and government leaders from the nine local counties as well as AEDC's support contractors. The council's board of directors is made up of area mayors, industrial board representatives, county executives, area chamber representatives and other appointees from individual cities.The group gets regular updates from the AEDC commander and key staff on situations impacting the base. The council's board of directors meets monthly and continues to increase its membership rolls from businesses and individuals wanting to show their support for AEDC.

J. D. Sons, an AEDC water plant operator, is also an electrician. He often wires area churches, free of charge.

Arnold Community Council officers for 2001-2002: (left to right) Janna Hellums, secretary; Janice Bowling, president; Glenn Norfleet, vice president; Lana Woodard, treasurer.

AEDC workers help build homes with Habitat for Humanity.

Excessed computers are often donated to schools. This one is going to an ROTC program.

50th Anniversary

AEDC celebrates 50 years of national service, looks forward to next 50

The U.S. Army Parachute Team Golden Knights open the show with the presentation of the American Flag.

Two years of planning and tremendous community support led to one of the biggest and most successful events in Coffee County in recent memory. About 110,000 people attended a free air show June 23 and 24. The air show kicked off a celebration showcasing America's airpower at Tullahoma Regional Airport followed by a rededication ceremony June 25 at Arnold Air Force Base.

The Air Force Thunderbirds demonstration team thrills the crowd during their show closing performance.

The brainchild of AEDC personnel along with the Manchester, Tullahoma and Franklin County chambers of commerce air show coalition, the air show had people from all around the country and international visitors pass through the airport gates during those two days. This attendance surpassed the populations of Manchester, Tullahoma and Winchester combined.

Air show visitors witnessed the very airpower the Air Force's forefathers envisioned. Some 14 aerial demonstrations including the Thunderbirds, the Air Force's premier aerial demonstration team, and the Army's Golden Knights parachute demonstration team graced the Tullahoma skies during the event. Forty static displays, including an Air Force A-10 Thunderbolt II, a Tennessee Air National Guard C-130, a T-37 Tweet, a T-6A Texan II, a P-51 Mustang, a P-38 Lightning, a B-25 Mitchell and several Army vehicles and other vintage fighter and bomber aircraft were on hand for show-goers to enjoy.

But the community support beforehand and behind the scenes was the real star of this show, according to Murray King, air show director.

"We simply couldn't have pulled this off without the support we received from the local communities," King said. "This was a team success from the very start."

The start King referred to goes back to 1998 when first thoughts of an AEDC 50th celebration came up. Realizing a small base – with 100 active-duty military members, 200 government civilians and 2,700 contractors – had some limitations, center officials discussed their plans with representatives from the Manchester, Tullahoma and Franklin County chambers of commerce. As a result, the tri-chamber air show coalition was born.

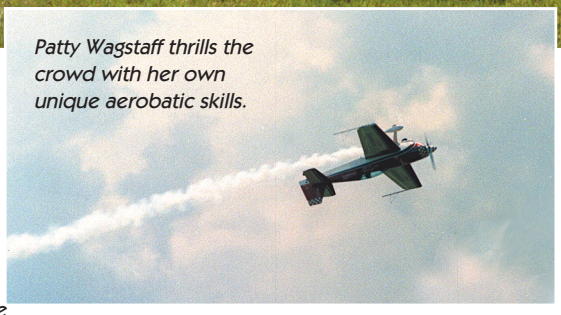
"When the people from Arnold decided they wanted to do something to commemorate their 50th anniversary, they knew they couldn't do it alone – there were just some things like buying the liability insurance for a civilian airfield, providing enough security, and contracting for city worker duties the Air Force couldn't do," said Marla Birdsong, tri-chamber air show coalition director."

General Lyles rededicates AEDC.

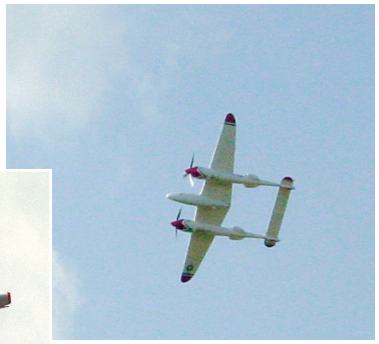
King said the tri-chamber coalition and other community sup-

The Aeroshell Aerobatic team does one of many maneuvers during their act.

Two young future pilots take in all of the action during the air show.



Patty Wagstaff thrills the crowd with her own unique aerobatic skills.



Lefty Gardner's P-38

An F-86 Sabre and a MiG-17 stage a mock dogfight.

Robert Arnold, grandson of General of the Air Force Henry "Hap" Arnold, accepts the baton from the Army Golden Knights after their jump at the air show.

port covered costs estimated to be more than $100,000. That support also included local businesses tossing in free billboard advertising, volunteers manning the five remote air show parking lots during the two days and a host of other contributions.

"I've never known of a community to come together for one single cause like ours did," King said. "It's very humbling."

Birdsong said this 50th celebration shows the true commitment the Air Force has in fostering a good neighbor relationship and continuing that into the future.

"We appreciate everything they've done for our nation," Birdsong said. "Since we've had this celebration, our communities are now paying attention to what truly is accomplished at AEDC, what their focus is, what their goals are and how important their research and technology is to the future of aerospace."

Gen. Lester Lyles, commander of Air Force Materiel Command, rededicated AEDC. Other special guests at the ceremony included speakers Congressman Van Hilleary, who represents Tennessee's 4th Congressinal district, and Robert Arnold, grandson of General of the Air Force Henry "Hap" Arnold, for whom the test center and base is named.

The activities recognized half a century of aerospace ground testing and support to the United States Department of Defense.

The 50th Anniversary Air Show was the biggest event held in Coffee County since President Truman dedicated AEDC in 1951. Base officials say they're confident the next 50 years will be even more exciting than the last, and they look forward to AEDC people - with help from the communities - keeping the Air Force in the forefront of technology and maintaining AEDC's reputation as America's Aerospace Advantage.

JE/Sverdrup

A Jacobs Company, Sverdrup Technology, Inc./AEDC Group

Mission

Sverdrup is AEDC's test support contractor. Our 1,360 employees operate and maintain the center's aerospace flight dynamics, space and propulsion test facilities. Primary services include test planning and execution, data analysis, technology development and application and facility maintenance. Auxiliary services provided include investment program planning, design and implementation; machining and fabrication, metallurgical/chemistry laboratory operation; and test data and controls design, development and implementation.

A Sverdrup boilermaker buffs the welds down on a replacement perforated plate liner in the collector duct of Sea Level Test Cell SL2.

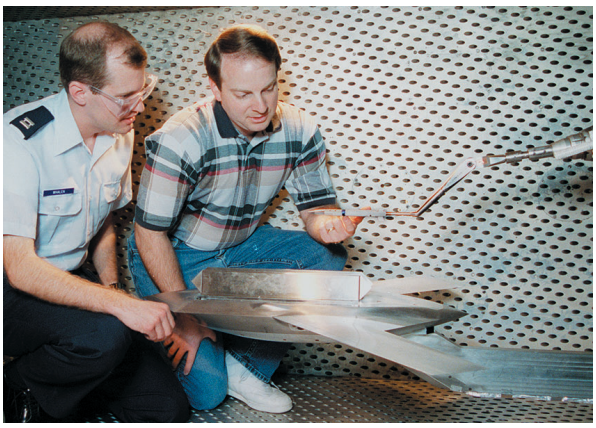
Fiscal 2001 Overview

During fiscal 2001, Sverdrup brought two major facilities (J-4 large rocket test facility and the 16-foot supersonic wind tunnel) out of long-term standby status into fully operational condition. The Boeing Delta IV liquid rocket motor was then tested in J-4. The test met all objectives ahead of schedule and under cost.

Fiscal 2001 test workload was steady through the first three quarters, but fell off considerably during the last quarter. Sverdrup took aggressive actions to reduce costs by constraining overtime, limiting use of consultants, reducing material expenditures and expeditiously moving personnel between jobs. These actions allowed the company to meet reduced budget reduction goals.

Sverdrup reduced staffing by 38 employees during fiscal 2001 as a result of normal attrition, and although the test workload decreased, a significant increase in investments work (approximately 25 percent) was added during the year. They were able to accommodate this increase using personnel reassigned from test support and by outsourcing a record high amount of work. Through aggressive work force and work scheduling actions, Sverdrup was able to deliver on all critical work—and at a significantly lower cost than originally estimated.

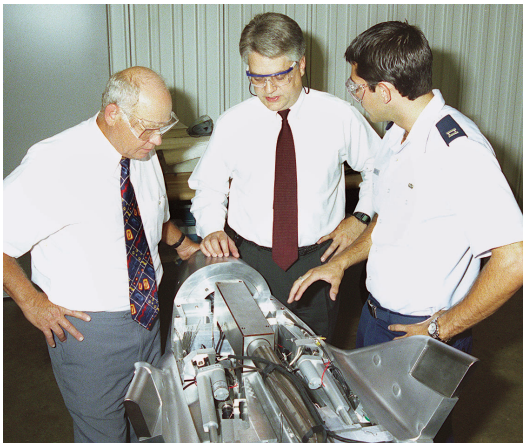
Late in fiscal 2000, Sverdrup successfully negotiated a landmark win-win contract with their labor union work force. This contract significantly increased work assignment flexibility and returned a portion of the expected savings to the employees in improved benefits. During fiscal 2001, the center began receiving the benefits of work assignment flexibility.



Capt. Martin Whalen examines 1/10-scale models of the Unmanned Combat Air Vehicle and a weapon in the center's 4-foot transonic wind tunnel.

Fiscal 2002 Forecast

During fiscal 2002, AEDC will be supporting many national weapons systems and commercial programs such as the Joint Strike Fighter, F-22, F100 engine, X-37 and Unmanned Combat Air Vehicle.



Frank Jackson, director of the Aircraft Systems Department, Sverdrup General Manager Dr. David Elrod and Capt. Jeff Phillips examine a wind tunnel model of NASA's X-38.

The challenges for the coming year are:

- Maintain the anticipated gains available through the new labor union contract
- Move our marketing, safety and environmental performances to the next level
- Continue strengthening our partnerships with major aerospace systems developers to grow future workload
- Maintain capability and capacity in light of reduced staffing

ACS

A joint venture of Computer Sciences Corp., DynCorp and General Physics

Fiscal 2001 Overview

ACS played a key leadership role in completing the implementation of a new center-wide integrated logistics system as well as a new business management system. These efforts will ensure better service to customers while lowering costs.

ACS Vice President and General Manager Jim Nicholson (left) talks with new ACS Deputy General Manager John Miller (right) about the AEDC contract.

Additional measures implemented to better manage costs were a centralized approach to desktop computer management including pre-programmed computer refresh rates and service level agreements that define pre-negotiated levels of service and maintenance response times.

The AEDC 50th Anniversary celebration was a major event that included a two-day air show, a rededication ceremony and the AEDC Open House. ACS support, particularly civil engineering, security, fire, emergency management and public affairs, was crucial to the celebration's success. It is estimated that more than 110,000 visitors enjoyed the celebration activities.

An intensive inventory and spare parts cleanup was performed by ACS in fiscal 2001. More than 14,000 items were reviewed, with 37 percent of these items identified as excess to current needs.

Throughout fiscal 2001, ACS provided sustained support to the center's environmental program, meeting all goals and supporting Air Force compliance with state and federal environmental laws and regulations.

Recent acts of terrorism in the U.S. caused the center to heighten its security posture and employ additional measures to protect its workforce and national test assets. In its role as mission support contractor, ACS provided additional security capabilities to AEDC, including deploying a trained auxiliary security force to assist full-time AEDC police officers and providing key management support to the AEDC Battle Staff. ACS is committed to providing a safe workplace for its employees and protecting the center's vital test capabilities.

ACS worked in partnership with AEDC's test contractor Sverdrup in numerous cooperative efforts, including utilities outage management, test support operations, environmental, safety, health and quality programs, marketing and public affairs in order to assure customer satisfaction.

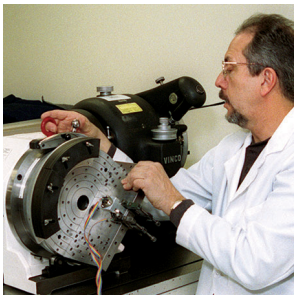
Fiscal 2002 Forecast

Fiscal 2002 will present significant challenges including:

- Providing test support and utilities at a reasonable cost while meeting a challenging and flexible workload under the constraints of reduced funding.
- Working closely with the Air Force and test support contractor partner, Sverdrup, to leverage technology and find new and more efficient ways to meet customer requirements.
- Identifying and implementing rightsizing opportunities and organizational changes that take advantage of new technology along with the right skills to more efficiently support the center's mission.
- Maintaining increased vigilance and an enhanced security posture that continues to protect our workforce and facilities as America engages in the war on terrorism.
- Continuing to improve our safety, quality and environmental programs that support the Air Force and our contractor partner.

Mission

ACS is AEDC's support contractor. Its employees support the center with a wide range of services including: information technology, desktop computer operations and maintenance, center communications, test utility operations, environmental, safety, industrial health and quality assurance; calibration, chemical and photo laboratories, civil engineering, transportation, materials management, fire protection, security services, emergency management, food services, custodial and public affairs.



ACS precision inspector Louis Crawford calibrates a digital inclinometer as part of a joint Sverdrup/ACS training program. The device increases test article calibration accuracy tenfold and reduces calibration time from hours to minutes.

Firefighters from AEDC and local community fire departments "practice" responding to a "real life" situation. AEDC sponsored this training for aircraft emergencies. AEDC has mutual aid agreements with area fire departments and often provides training opportunities to these groups.

Directorate of Operations

Mission

Provide fast, effective and affordable test and evaluation services to DoD customers, U.S. government agencies and commercial corporations. Ensure that test capabilities, technology and analysis will support both today's and tomorrow's customers.

The Directorate of Operations manages operations and maintenance of AEDC's Research and Development Test & Evaluation infrastructure and investment programs to meet testing requirements; develops future workload to establish resource requirements for budget and operating contract formulation; manages the allocation of resources between the approved annual program for test, analysis, research, technology, operations, maintenance, repair, improvement and modernization; interfaces with DoD, government, and commercial acquisition and development organizations to provide project and engineering management for test, research and technology projects; directs investment programs to sustain and modernize test facility infrastructure and technology programs to improve AEDC test capabilities; develops new test capabilities to satisfy future requirements; and evaluates test support contractor's performance.

The Directorate of Operations team: (left to right) Maj. David Swinney, Ron Polce, Col. Craig Christen and Terry Tucker.

Fiscal 2001 Overview

The Directorate of Operations oversees and manages the AEDC testing divisions including Aerodynamics, Aeropropulsion, Space and Missiles and Technology. A recap of fiscal 2001 is provided in the pages that follow, along with a forecast for fiscal 2002 in each of our major mission areas.

AEDC's total customer funding for all testing in fiscal 2001 was $99.5 million—a decrease of more than $20 million from fiscal 2000 due primarily to a reduction in propulsion testing. Air Force-led projects represented about one-third of the center's total workload, with commercial programs making up another third of the total. The remaining third of the workload was composed of a combination of ballistic missile defense, Navy, Army and other government programs. The general trend in testing has been stable, but fiscal 2001 was the first year of a projected lull in aeropropulsion development testing following the completion of development for the Joint Strike Fighter engine. Commercial and Advanced Missile Signature Center testing are continuing to grow.

Some of the major test programs AEDC supported in fiscal 2001 include the Air Force's top priority program, the F-22 Raptor air dominance fighter, development work for the Joint Strike Fighter, continuing testing for the Joint Direct Attack Munition, and cryogenic liquid propellant rocket engine testing for the Boeing Delta IV Evolved Expendable Launch Vehicle (EELV). Many other programs

FACILITY VALUE	Funding Year	Original Cost ($M)	Replace Value (FY95 $M)	Replace Value (FY00 $M)	Replace Value (FY01 $M)
Initial Central Facility	**1951**	**83**	**996**	**1,063**	**1,088**
ETF-B (T-Cells)	1951	12	139	148	152
PWT (16S, 16T)	1952	185	2,500	2,668	2,731
VKF (ABC)	1952	16	193	206	211
Computer & Support Equip.	1953	143	456	487	498
ETF-A (J-Cells)	1955	10	100	107	109
Rocket Cells J-3	1960	3	23	25	25
Rocket Cells J-4	1961	12	86	92	94
Arcs	1965	20	130	139	142
APTU	1970	15	67	72	73
ASTF (C-1, C-2)	1977	625	1,453	1,551	1,587
T-3, T-5, T-7, T-9	1980	15	26	28	28
Rocket Cells J-5	1983	30	43	46	47
Rocket Cells J-6	1990	226	270	288	295
Ranges	1990	45	50	53	55
DECADE	1992	60	63	67	69
NAWCAD (4 Cells)	1994	62	65	69	71
Total AEDC Value		**1,561**	**6,600**	**7,108**	**7,328**

America's Aerospace Advantage

AEDC tests support development of flight systems including (from left) F-35 Joint Strike Fighter (page 10), Delta IV Launch Vehicle, F/A-18 Super Hornet, Boeing 747, and F-22 Raptor

such as national and theater missile defense, space access, commercial and various classified programs were also tested in fiscal 2001.

Fiscal 2002 Forecast

In fiscal 2002, the center will continue to provide support for the F-22, F/A-18E/F and F-35 Joint Strike Fighter as well as commercial tests.

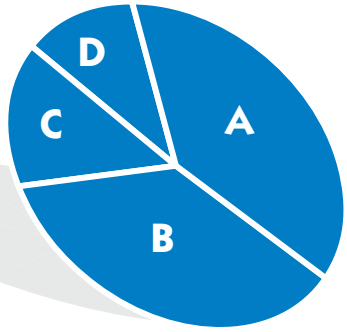
Active testing in the 16-foot supersonic tunnel resumes in fiscal 2002. We also anticipate our first customer test of new electric space propulsion systems in the recently renovated 12V Space Chamber. Ballistic missile, national missile defense and space access programs are also scheduled. Upgrade and modernization work will continue on the Propulsion Wind Tunnel complex, as well as data and control systems for critical test cells. A military construction project funded in fiscal 2002 will allow AEDC to close the aging Engine Test Facility (ETF) air supply infrastructure. Other investments will continue to improve testing productivity and environmental factors while lowering life cycle costs to the test customers and DoD.

Total replacement cost for AEDC test facilities now exceeds seven billion dollars.

Government, commercial and educational organizations interested in testing at AEDC should visit our extensive Web site at www.arnold.af.mil or contact the Directorate of Operations at (931) 454-6418 (DSN 340-6418), where they will be directed to the appropriate test/technology program manager.

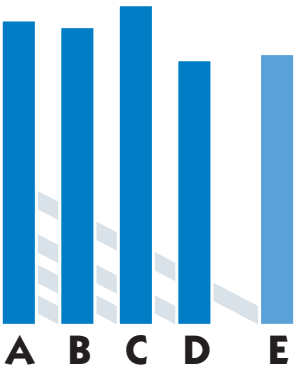
Fiscal 2001 Total Workload by Revenue

A	Air Force	37%
B	Commercial	36%
C	OSD	15%
D	Navy	9%
D	Other	3%



Test Mission Areas Total Earnings

A	FY98	$114.4M
B	FY99	$111.9M
C	FY00	$120.1M
D	FY01	$99.5M
E	FY02 Projected	$101.8M



Product Area Earnings

FY	98	99	00	01	02
Aerodynamics	29.6	19.3	24.9	26.3	26.0
Aeropropulsion	54.9	59.9	63.3	43.3	42.4
Space & Missiles	23.9	22.1	21.8	20.3	23.3
Technology*	5.0	4.6	9.4	9.7	10.1

**FY98 to FY99 technology programs embedded in product area earnings*

Aerodynamics

Mission

Provide fast, effective and affordable aerodynamic test and evaluation services for the DoD, U. S. government agencies and commercial aerospace corporations and ensure test capabilities support today's and tomorrow's customers. Test assets include the large transonic and supersonic tunnels (16T and 16S), medium-sized transonic tunnel (4T) and hypersonic tunnels (A, B and C) and supporting plants. Analysis and computational modeling, such as computational fluid dynamics, are also key assets.

Fiscal 2001 Overview

The earnings for the Aerodynamic Product Area were $26.2 million in fiscal 2001, marking a six percent increase over fiscal 2000 earnings. The increase in earnings was related to Joint Strike Fighter development work, returning Joint Direct Attack Munition testing and improved aerodynamic testing efforts.

AEDC and the Boeing Company signed a three-year contract for wind tunnel testing. In fiscal 2001 AEDC provided almost 1,500 hours of testing in the center's 16-foot transonic wind tunnel on upgrades to two Boeing commercial airliners, the 747 and 767.

Productivity gains, coupled with cost reduction initiatives, improved customer communication and increased emphasis on marketing, were overarching themes for the Aerodynamic Product Area. In keeping with those themes, the Propulsion Wind Tunnel Sustainment Program (PWT SP) has made significant progress on the modernization of the large 16-foot wind tunnels. On-cart systems for data acquisition and test article attitude control, coupled with major control room improvements such as the 16-foot transonic/supersonic video control room wall, are providing customers with state-of-the-art test and evaluation tools that have improved cycle time and lowered costs.

Lt. Col. Chris Smith (left) leads the aerodynamic team with Gary Mattasits his deputy and Navy Cmdr. Andrew Dean.

Other major investment efforts aimed at improving tunnel operational efficiencies were also completed. They include the installation of two new 16-foot transonic tunnel data support systems, reworking the 16-foot transonic tunnel cooler system, reactivation of the 16-foot supersonic tunnel and preparation work for the 16-foot supersonic tunnel sustainment testing.

In preparation for several high-pressure-air tests scheduled for fiscal 2002, the significant task of bringing the 16-foot supersonic wind tunnel back on line after being mothballed for more than four years was completed. After thorough checkout, the tunnel was run at speeds from Mach 1.6 to Mach 2.3. More validation runs will be made to incorporate the same test instrumentation advances already installed in the 16-foot transonic tunnel.

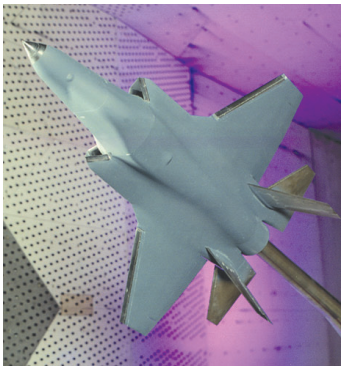
The newly implemented product data manager software proved to be an invaluable tool to both AEDC's PWT personnel and their customers by providing accessible, accurate and rapid information access. This system allowed for near-real-time information integration and relay and was key to the success of several major test programs conducted this year.

Like DoD budgets, most customer budgets continued to tighten. While AEDC's aerodynamics testing capabilities are generally regarded as being the best in the world, efforts are under way to locate additional resources to fund major investment programs. Together with efforts to "right-size" the workforce and test service options, these investment programs will ensure that Aerodynamic Product Area customers will always receive the most affordable, effective and technologically advanced services available.

Fiscal 2002 Forecast

Operational readiness in today's economic environment is challenging, particularly with our aging infrastructure and its associated maintenance backlog. The lack of funding is directly linked to declining DoD budgets and reduced number of acquisition programs. Projected earnings for fiscal 2002 are $26 million. Over half of this is associated with the Joint Strike Fighter.

Advances in technology will enable customers to evaluate designs within weeks or days as opposed to months and evaluate data in real-time versus hours to days. To support this technology, AEDC must support multiple short-duration tests with little advance notice. AEDC will have to participate early in the develop-



The Lockheed Martin X-35 candidate for the Joint Strike Fighter was tested in the 16-foot Transonic Wind Tunnel. AEDC tested both the Lockheed Martin and Boeing competitors for the Joint Strike Fighter, is the planned replacement for the F-16 and A-10 for the Air Force, early F/A-18s for the Navy and the AV-8A Harrier for the Marine Corps and the Royal Navy.

Inside the supersonic circuit of the propulsion wind tunnel

Boeing 767 inside AEDC's 16-foot transonic wind tunnel

ment effort and continue to play an integrated role in the development of program requirements. Only in this way can the center support future customers with the right information at the right time for the right price.

Controlling the price of testing remains our greatest near-term challenge. New technology and improved processes have reduced and will continue to reduce the cost of producing test data. Major plant upgrades, investments in automation, improved test techniques and a proactive approach to testing will also help produce positive results in support of price reduction.

Facilities Upgrades

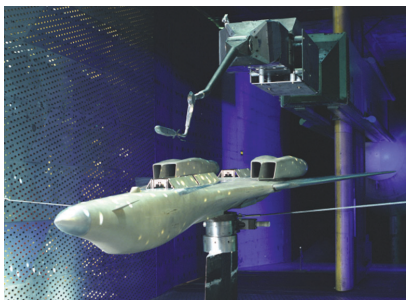
An $81.4 million multi-year facility sustainment and upgrade program of AEDC's large wind tunnel infrastructure began in 1998. The Propulsion Wind Tunnel Sustainment Program included completion of maintenance on compressor blade adaptors, turning vane blades, plenum evacuation system compressor drive units and placement of 14-foot expansion joints in the 16-foot transonic tunnel. Failures in two large 35,000 hp motors required extensive work to bring them back on line, making the 16-foot transonic and supersonic tunnels main drive system fully mission capable. A total of 191 preventive maintenance actions were completed this year.

Analysis and Evaluation

Test and evaluation tools include wind tunnels, and computational capabilities such as computational fluid dynamics codes, semi-empirical codes, graphical analysis systems and techniques, and pressure sensitive paint. The continued development of these and other such tools is a high priority.

Integrated Test and Evaluation

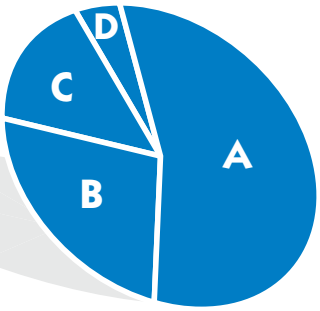
Aerospace weapon test programs consist of modeling and simulation, ground testing, and flight-testing. AEDC is increasing the availability of integrated test and evaluation techniques to reduce cost, schedule, and performance risks to these programs. This integrated, knowledge-based approach can reduce acquisition costs by increasing the integration of computer modeling and wind tunnel simulations. This, in turn, is integrated with flight-testing to reduce costs without increasing program risk. AEDC has several successful pilot programs with Edwards and Eglin Air Force Bases directly supporting flight tests on programs like the F-22. These programs integrate computational modeling and simulation with ground and flight-testing to reduce the cost, cycle time, and risk of these critical weapons development programs.



Models of the B-1B Lancer bomber aircraft and the Joint Standoff Weapon in AEDC's 16-foot transonic wind tunnel for a weapons separation test.

Fiscal 2001 Workload by Customer

A	Commercial	54.8%
B	Navy	24.2%
C	Air Force	16.1%
D	Other Government	4.9%



Aerodynamics Total Revenue

A	FY98	$29.6M
B	FY99	$19.3M
C	FY00	$24.9M
D	FY01	$26.2M
E	FY02 Projected	$26.0M

Aeropropulsion

Mission

Provide fast, effective and affordable aeropropulsion test and evaluation services for the DoD, U.S. government agencies and commercial aerospace corporations, and ensure that test capabilities, technologies and analysis support both present and future customers. Key assets include the Aeropropulsion Systems Test Facility engine test cells: C-1 and C-2, Sea Level test cells SL-2, SL-3 and SL-1, and the Engine Test Facility test cells: J-1, J-2, T-11, and T-12.

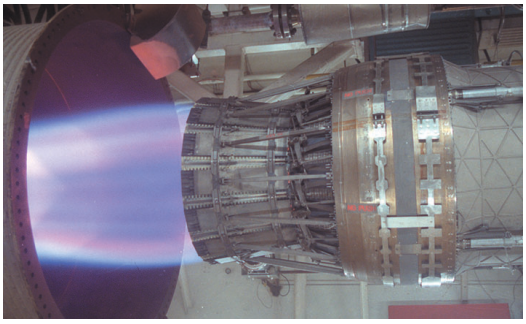
Fiscal 2001 Overview

Aeropropulsion generated $43.3 million of revenue in fiscal 2001, accounting for almost half of AEDC's total reimbursement revenue. The three primary customers were the Air Force, Navy and commercial industry.

One major driver in Aeropropulsion was Component Improvement Program (CIP) testing. The Pratt & Whitney F100-229 was the major CIP customer in fiscal 2001. Testing of these engines provides technical and logistical insight into jet engine performance, durability, and reliability for the USAF's premier F-15 Eagle and F-16 Fighting Falcon fighter aircraft. CIP-related projects accounted for 27 percent of the total workload in 2001.

Another major portion of fiscal 2001 revenue can be attributed to testing of the Pratt & Whitney F119 engine for the F-22 Raptor, the Air Force's new air dominance fighter. Initial service release qualification testing was completed in test cells C-1 (altitude qualification) and SL-2 (accelerated mission testing).

The General Electric F110-GE-132 Enhanced Fighter Engine (EFE) was tested in Test Cell J-2 this year. The engine was part of the EFE qualification program.



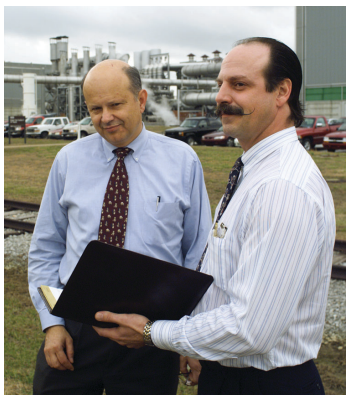
The Pratt & Whitney F100-229, powerplant for the F-15 Eagle, was the major CIP customer in fiscal 2001.

Fiscal 2002 Forecast

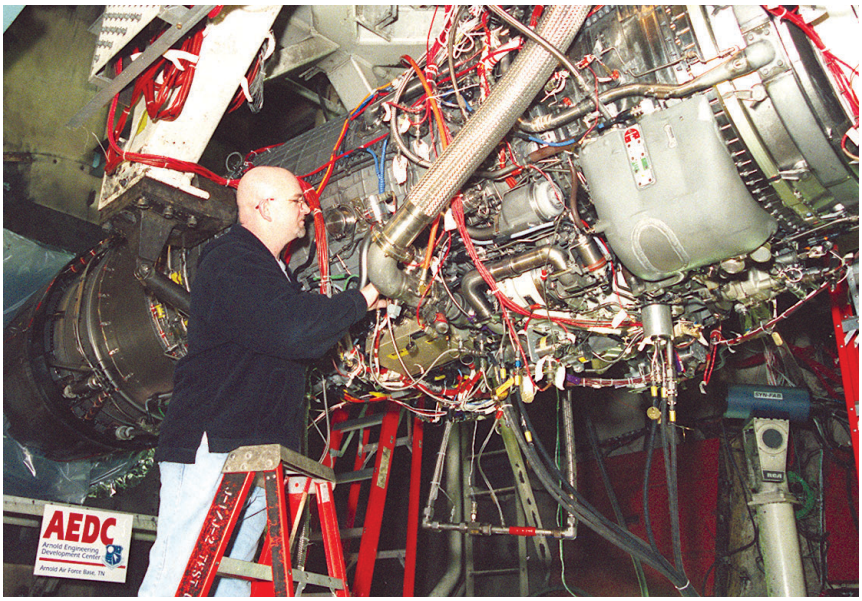
Aeropropulsion projects a slight decline in revenue in fiscal 2002.

Responding to acquisition program needs, the business area strives to focus on reducing the cost of engine test services and translating these savings into reduced prices for our customers. Ongoing investments in a balanced test operations and maintenance program assure excellent test support while protecting both the test article and test infrastructure.

Through benchmarking activities with commercial engine producers and other DoD



Navy employees Jack Walters (left), AEDC deputy director of propulsion test and Jeff Albro who manages testing of the Pratt & Whitney F119 engine for the F-22 Raptor



An outside machinist checks components on the F110-GE-132 EFE engine during installation. The engine arrived at AEDC in January after completing performance tests at GE's Peebles, Ohio, test facility and will undergo about 220 hours of altitude testing in Aeropropulsion Test Cell J-2 to validate and qualify engine performance. The 35,000-pound-thrust engine was chosen as the powerplant for Lockheed Martin's Block 60 F-16 aircraft.

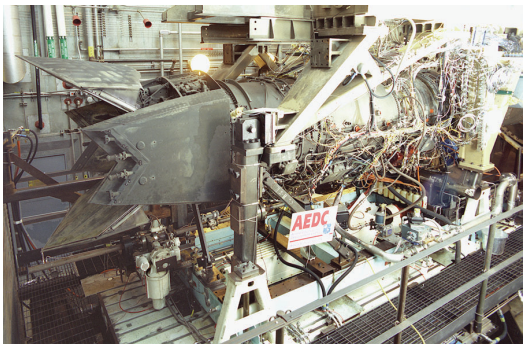
Aeropropulsion Systems Test Facility tests large turbofan commercial and military engines under simulated flight conditions.

agencies, aeropropulsion is eliminating non-competitive cost areas and business practices. Our customers have greater flexibility to tailor the specific test services required, thus reducing both price and required test times.

As in fiscal 2001, the F100 CIP testing will continue to account for a portion of the fiscal 2002 revenue. Aeropropulsion will see the increased testing of the Pratt & Whitney F119 engine, used in the F-22, in AEDC's C-1 and SL-2. The GE F110-100 engine, used in the F-16, will begin endurance testing in the middle of the fiscal year.

The amount of commercial testing is expected to grow with the development of stronger partnerships with General Electric, Pratt & Whitney and Rolls-Royce.

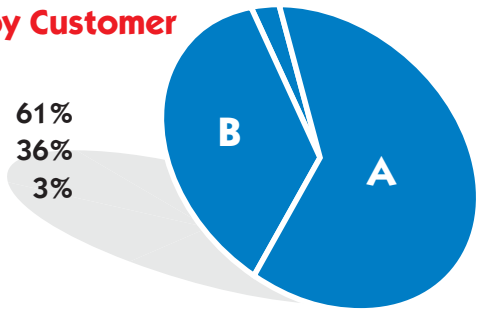
(Right) Don Martin smooths a freshly poured foundation at the corner of the Engine Test Facility Office building. (Above) The Rust and Dust Phase III project involves putting in sizeable stainless steel air duct connecting the Aeropropulsion Systems Test Facility to Plant A.



Pratt & Whitney's F119 engine, powerplant for the F-22 raptor, completed its two-year Initial Service Release test program in fiscal 2001. While in AEDC's C-1 test cell, the engine underwent 4,330 Total Accumulated Cycles, 1,037 engine operating hours and set a new test pace record of 28 days. The testing done at AEDC provides pilots with the confidence in knowing the engine will perform as expected and not stall during critical mission cycles. It also gives them assurance the engine will hold up to the aerodynamic flight conditions.

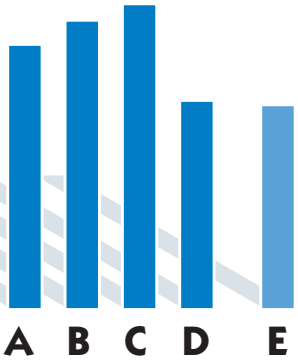
Fiscal 2001 Workload by Customer

A	Air Force	61%
B	Commercial	36%
C	Navy	3%



Aeropropulsion Total Revenue

A	FY98	$54.9M
B	FY99	$59.9M
C	FY00	$63.3M
D	FY01	$43.3M
E	FY02 Projected	$42.4M



Space and Missiles

Fiscal 2001 Overview

Mission

Provide fast, effective and affordable test and evaluation services for the DoD, U.S. government agencies and commercial aerospace corporations, and ensure test capabilities to support today's and tomorrow's customers. Test and evaluation services include a broad range of technical disciplines that are divided among five areas: rocket propulsion, space environmental, hypersonics, nuclear weapons effects and missile signatures.

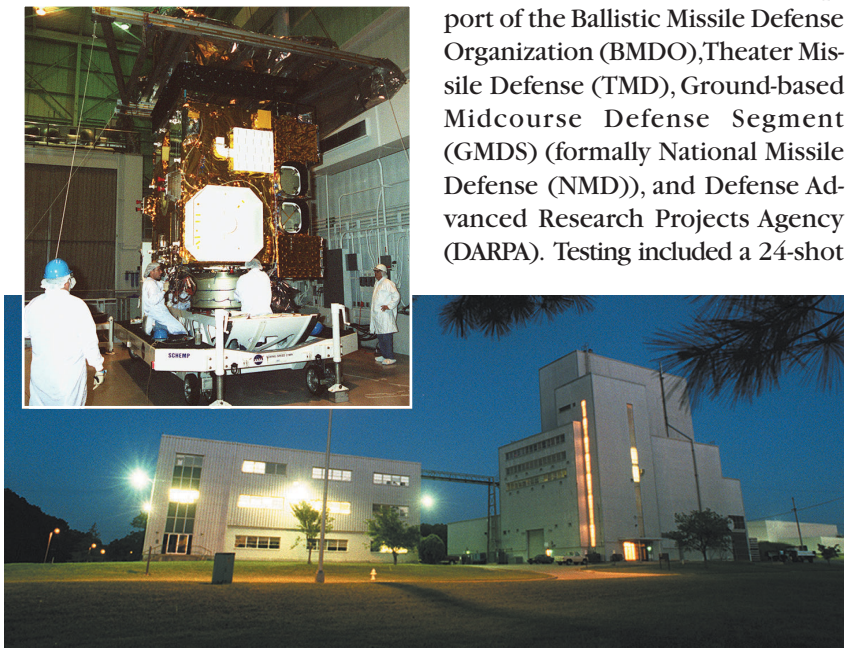
Army Lt. Col. James Hesson heads up Space and Missiles.

The Space and Missiles Product Area earned $20.3 million in fiscal 2001, which represents a nine percent decrease in test revenue from fiscal 2000. Space and Missiles continued with significant investment in selected sub-product areas to meet future ground testing requirements.

In September 2001, cryogenic liquid propellant rocket engine testing returned to AEDC's J-4 Rocket Development Test Cell with three simulated altitude test firings of the Pratt & Whitney RL10B-2 engine. The engine provides Boeing's Delta IV Evolved Expendable Launch Vehicle (EELV) with the highest performance upper stage engine of any current launch system. Testing supported Boeing's qualification of the engine's large carbon/carbon nozzle expansion skirt, built using new production techniques.

The J-6 large rocket test cell supported the Intercontinental Ballistic Missile Program Office's Minuteman III Production Quality Assurance (PQA) program. Two MM Stage II and two Stage III Propellant Replacement Program motors were tested under simulated altitude conditions to verify performance characteristics prior to production.

The Center's hypervelocity ballistic range facilities conducted testing in support of the Ballistic Missile Defense Organization (BMDO), Theater Missile Defense (TMD), Ground-based Midcourse Defense Segment (GMDS) (formally National Missile Defense (NMD)), and Defense Advanced Research Projects Agency (DARPA). Testing included a 24-shot series in the Ballistic Range S-3 Facility for the Army TMD Program and 10 G-Range sub-scale projectile launches at speeds of 15,600 mph against sub-scale simulated nuclear targets for the GMDS Lethality Program. Range G also supported DARPA's Scramjet Technology effort with the first successful launch of a hydrocarbon-fueled scramjet at Mach 8 with successful motor ignition producing a net positive thrust in flight. Fiscal 2001 was the final year of a three-year Test Technology Development and Demonstration (TTD&D) project sponsored by the Office of the Secretary of Defense investigating methodologies to upgrade the Range G facility to conduct impact lethality testing at speeds up to 22,400 mph.



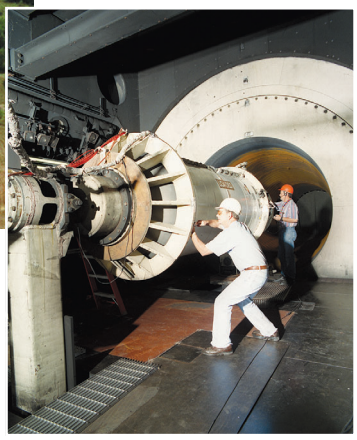
(Above) Space environmental test facilities test satellites and components under vacuum conditions. (Top) Space Systems/Loral's GOES-M weather satellite removal from Mark I.

The hypersonics sub-product area supported the Naval Air Warfare Center's Reentry System 11-run entry in the H1 arc heater to develop and qualify essential materials for the Navy's Trident Submarine Launched Ballistic Missile thermal protection system. Arc test activity also supported the Air Force's Reentry Vehicle Applications Program with thermal ablation testing in H1. Work continued on the H3 large arc heater in preparation for Navy and Air Force tests in fiscal 2002 and the transition to a production test capability in the years to follow.

Hypersonics completed Mach 4 test capability upgrades to the Aerodynamic and Propulsion Test Unit. These modifications enable APTU to run at higher velocities, higher enthalpies, and with a more realistic air composition. These improvements were verified during check-out runs in preparation for the Navy Dual Combustor Ramjet engine test program.

AEDC Hypervelocity Wind Tunnel 9 complex at White Oak, Md., is now fully integrated into the hypersonic infrastructure at AEDC. The combined hypersonic wind tunnel capabilities provide world-class test environments from take-off through Mach 16.5. Tunnel 9's primary customer this year was BMDO. Recent activities in support of BMDO have taken advantage of the seamless integration of test capabilities by providing critical aerodynamic and aerothermal data on a common Theater High Altitude Area Defense (THAAD) test configuration in both Tunnel 9 and Tunnel B. This enhanced capability provided the productiv-

J-6 High Altitude Solid Rocket Test Facility



The AEDC J-6 test team fired this Minuteman Stage 2 solid-propellant rocket motor at a simulated altitude of 100,000 feet in the center's large rocket test facility J-6. The test's purpose was to demonstrate the adequacy of the remanufacturing processes and to demonstrate the motor met performance requirements. The motor serves as the second propulsion stage of the Minuteman III Intercontinental Ballistic Missile strategic weapon system.

ity benefits of continuous test time in Tunnel B and realistic flight environments in Tunnel 9. This integrated capability will be leveraged to support future customers in the hypersonic community.

The completion of the initial operational capability for the Tunnel 9 aero-optical suite was highly successful and is now test ready for the THAAD and similar programs. Validation of a highly accurate measurement system combined with new optical instrumentation has provided test customers with a test capability never before available.

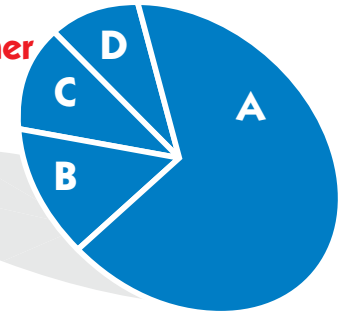
A three-year TTD&D project sponsored by OSD is underway. The goal is to develop advanced sensors to extend the new aero-optics capabilities as well as to develop the interface between that capability and the target-scene-generation capabilities of hardware-in-the-loop facilities being used to support BMDO interceptor development.

The Advanced Missile Signature Center (AMSC) field measurement group was very active supporting BMDO, DTRA, USASMDC, AFRL, DIA/MSIC, DARPA, CECOM, ARL and other organizations. Data is archived at the AMSC and is available to organizations that meet access requirements. Total fiscal 2001 core budget from BMDO was over $2.4M and additional funding was provided for the AMSC to support the development of the "Virtual Data Center" (VDC) classified network. BMDO tasked the AMSC to lead the effort to make the VDC available to three of the BMDO Major Defense Acquisition Programs. In addition the AMSC staff was funded by BMDO to support several sensor development programs for new aerial collection platforms. AMSC is continuing to load Tactical Missile Signature data into the NTSDS with funding from the National Ground Intelligence Agency. A proposal for a project was prepared by the AMSC and was accepted for funding. The result will be a signature data matrix for an Anti-Tank Guided missile training simulator. Primary Modeling and Simulation (M&S) efforts focused on predicting signatures of foreign tactical missiles for use in measured and predicted signature assessments. Other efforts in the last year included monitoring a BMDO Small Business Innovative Research effort to improve the efficiency of radiation prediction codes, and acquiring the NATO developed NIRATAM/NEOTAM signature prediction code.

Testing of the NASA/NOAA GOES-M satellite in the Mark I space chamber set a record of 45 days, 22 hours and 10 minutes at a space vacuum condition.

Fiscal 2001 Workload by Customer

A	OSD	65%
B	Air Force	13%
C	Commercial	12%
D	Army	7%
D	Navy	2%
D	Other Government	1%



Space and Missiles Total Revenue

A	FY98	$23.9M
B	FY99	$22.1M
C	FY00	$21.8M
D	FY01	$20.3M
E	FY02 Projected	$23.3M

Sensor test chamber 7V supported National Missile Defense (NMD) programs through evaluation of the BMDO Transfer Radiometer and checkout and characterization of the HALO Upgrade Dual-Color Infrared Sensor. This was the first airborne sensor designed to look at a space background tested in the AEDC space chambers. The test was a successful demonstration of that capability. A $21-million, seven-year contract was signed with The Boeing Company to establish a ground-based closed-loop simulation capability for system-level testing of the NMD Ground-Based Interceptor (GBI) Kill Vehicle. This capability will be developed in space vacuum chamber 10V.

Decade's new water coupler joins 4 modules to a single load, creating a new test capability.

The Decade Radiation Test Facility

Electric Propulsion (EP) test capability was developed in the 12V Chamber with the successful firing of a Hall thruster at simulated deep space environment conditions. This capability allows AEDC to test EP thrusters at high vacuum and low temperature conditions that more closely simulate the actual operating environment of the thruster. Funding provided by BMDO to sustain space sensor test capabilities in 7V and 10V supported a variety of facility upgrade efforts throughout the year.

The Decade Radiation Test facility (DRTF) Quad X-ray simulator was modified to change from the hot (hard) X-ray mode to the cold (soft) X-ray mode. This involved removing the current switching hardware assembly, which was specifically designed to produce the hot X-ray portion of the X-ray spectrum, and replacing it with a hardware assembly specifically designed to produce cold X-rays. The cold X-ray hardware configuration was then put through a series of performance tests to optimize its performance characteristics. These tests will continue into the early part of fiscal 2002.

The initial planning and design for a $37.7M DoD funded enhancement to the DRTF was accomplished, a five-year program that will provide an unprecedented national capability to closely simulate the total spectrum of photon radiation emitted by a nuclear blast in space. This capability will provide our nation with a previously unavailable means to insure that our space assets (satellites, missiles, missile interceptors, etc.) are survivable.

Fiscal 2002 Forecast

The business area expects a small increase in total tests. Past forecasts predicted large increases in space technology spending by the Air Force over the next decade, but many of the key programs have met technical and funding challenges. The Space and Missiles growth period is now expected to start in fiscal 2004 and fiscal 2005. During fiscal 2002, Space and Missiles will remain heavily committed to investing in test facilities in preparation for that projected increase in workload.

Rockets

AEDC is projecting liquid rocket engine test programs for both commercial and Air Force Evolved Expendable Launch Vehicle programs, along with an increased involvement with foreign test customers.

Several new domestic upper stage engines are being planned along with follow-on qualification tests for Boeing's Delta IV RL-10B2 high performance liquid engine. To meet the expanded requirements for future engine tests, AEDC is planning to upgrade the J-4 facility to extend test run times up to 1,000 seconds. Extended run times will provide a more realistic test simulation and considerable overall cost savings by reducing the number of test periods required for test program objectives. Coupled with the projected engine test programs is AEDC's plan to upgrade J-4 for testing complete cryogenic and storable propellant upper stage systems.

The nation's ICBM fleet continues to undergo testing at AEDC. The second and third stages of both the Minuteman III and Peacekeeper ICBMs are tested in the J-6 Large Rocket Development Test Facility to assess both motor production quality and aging effects. J-6 will remain involved in the Minuteman III PRP, with two tests to qualify the production motors. J-6 will also support Peacekeeper Stage II and Stage III Aging and Surveillance (A&S) Programs.

Hypersonic Testing

The use of hypersonic systems has received increased attention in the DoD for space access missions. AEDC hypersonic test

infrastructure represents the majority of the nation's hypersonic T&E capability. The combined hypersonic infrastructure of wind tunnels, ballistic ranges and propulsion facilities will be extremely useful in the development of high speed strike systems, defensive interceptors, and access to space platforms.

The Range G Hypervelocity Ballistic Range is the only facility in the U.S. capable of meeting the lethality requirements of the BMDO GMDS Program. The Live Fire Test and Evaluation (LFT&E) phase of testing for GMDS will begin in fiscal 2002. Testing for Boeing, the prime contractor for the GMDS program, will be conducted to obtain data in support of flight-testing. Near-full scale lethality testing for the Navy Theater Wide (NTW) program as well as efforts to develop test capabilities in support of THAAD LFT&E are also anticipated.

As the USAF looks to hypersonics for access to space and other missions, it is expected that Tunnel 9 will continue to provide high Mach number T&E for vehicle configurations and engine inlets. Hypersonic test support for BMDO will continue as the various interceptor programs look to Tunnel 9 for sensor window testing. Development of the complete aero-optics test capabilities are expected to be completed this year, and planning continues to conduct seeker window tests in support of BMDO's technology programs. New data requirements for high-speed aerodynamics and aerothermodynamics are evident, and BMDO will continue to rely on Tunnel 9's unique capabilities.

Environmental Space

Support to the NMD GBI program will continue in the 7V and 10V sensor chambers. Significant design, procurement, and fabrication efforts will be completed for the AEDC GBI 10V Upgrade Program in support of an initial operating capability at the end of fiscal 2003. Fiscal 2002 will see the first customer test of an Electric Propulsion thruster in thermal-vacuum chamber 12V. This new test capability will provide customers with a high-vacuum, low temperature space environment during EP thruster operations. Material bake-out tests and contamination studies will be performed in our smaller thermal-vacuum chambers. BMDO funding to sustain space sensor test capabilities in 7V and 10V will continue to support a variety of facility upgrade studies and efforts throughout the year.

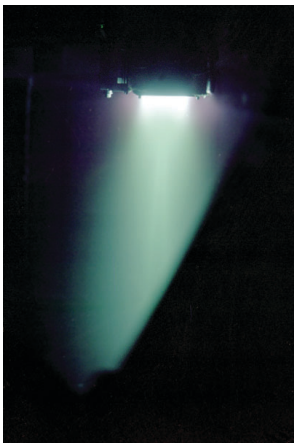
Nuclear Weapons Effects

In the early part of fiscal 2002, work in the Decade Radiation Test Facility will focus on optimizing the performance characteristics of the plasma radiation source that produces the cold (soft) X-ray portion of the X-ray spectrum produced by a nuclear blast. This effort is supporting the Defense Threat Reduction Agency's long-range plan to consolidate its nuclear weapons effects simulation capability to AEDC.

In parallel with this effort and continuing for the remainder of fiscal 2002, a major effort will be continuing development, design, acquisition and integration of the key hardware components required for the $37.7M DoD-funded enhancement program that has been underway since fiscal 2000. This program is scheduled for completion in fiscal 2005 and involves the addition of a second Decade Quad, a prompt gamma source, debris gamma and electrons, and a cryogenic test chamber replete with dynamic scene generation and nuclear clutter. This effort will result in a nationally unique nuclear weapons effects test capability, allowing exposure of test articles to multiple simultaneous nuclear environments, which will more accurately replicate the time history of a nuclear event. The enhanced DRTF is projected to play a critical role in the test and evaluation of critical components of the National Missile Defense System as well as all forthcoming national space systems.

Advanced Missile Signature Center

BMDO support and funding for data center operations and Virtual Data Center deployment continues in fiscal 2002 at the $2.5M level. Additional resources are also expected for processing legacy data and for capability modernization. As the BMD architecture expands to include a boost defense segment, AMSC support to the missile defense community should grow. Execution of the HPCMO CHSSI task will also build capability for expanding support to other HWIL and scene simulation customers. Measurement support to BMDO, DIA, Air Force and Army programs is forecast to continue with several high visibility measurement programs planned.



Fiscal 2002 will see the first customer test of an Electric Propulsion thruster in thermal-vacuum chamber 12V. The new capability meets special requirements for space operations, including low ambient pressure during thruster operations.

Technology

Mission

The Applied Technology Division develops technologies that enable faster, more effective and affordable test services for AEDC's three test product areas to ensure that test capabilities, techniques and analysis support today's and tomorrow's customers. These technologies include new or improved test techniques, test facility capability (performance, efficiency, productivity), instrumentation, information processing, computational techniques, analyses and foreign technology assessments. The division also provides applied technology and analysis services to a wide range of external customers.

Sverdrup Instrument Technician Specialist Joe Money demonstrates the operation of an AEDC Infrared Radiometer System used on a tactical missile signature test to Air Force Project Manager Kevin Gooder.

Marc Bauer (right), a Sverdrup engineer, describes the operation and calibration of an AEDC-built infrared circular variable filter wheel instrument to Kevin Gooder. The instrument was reconfigured and calibrated for two separate missile tests during the summer.

Fiscal 2001 Overview

In fiscal 2001, the Applied Technology Division carried out a $22 million program, of which $9.7 million was customer funded.

The three AEDC product areas fund programs to benefit their specific areas. These tend to be near-term and requirements-driven. Examples are: The Wind Tunnel Flow Diagnostics, Pressure Sensitive Paint (PSP), Model Attitude and Deformation (MA&D), Captive Trajectory System test techniques, and Jet Interaction (JI).

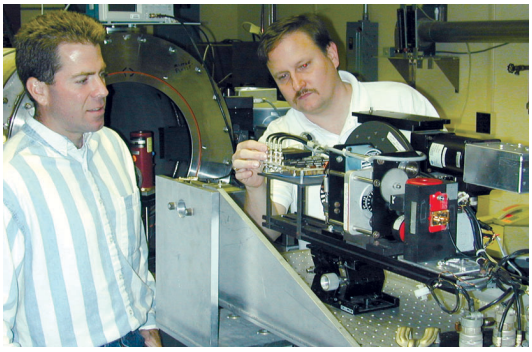
Propulsion technology developments have been focused on test techniques, information management, engine structural analysis, instrumentation, diagnostics and facility technologies. The programs tackle development challenges on the F-22, Joint Strike Fighter, and Unmanned Aerial Vehicles.

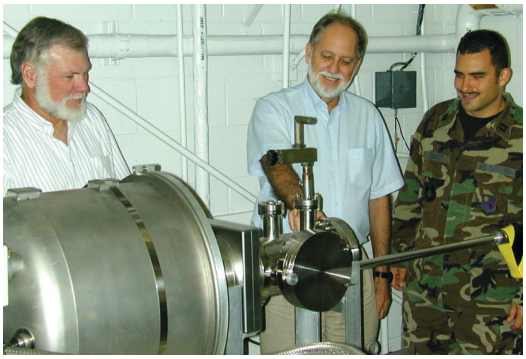
Space technology emphasis has been towards increased facility capability, hypersonic test techniques, instrumentation, nuclear weapon effects, and rocket test and analysis enhancement.

A major part of the program was core handling technologies that have joint application to the product areas or those with projected payoffs five to 10 years in the future.

These include: the introduction and integration of new sensor technology into the production environment, reducing test installation time, and improving system performance and reliability. Advanced turbulence modeling simulating unsteady shear layer applications will improve the store separation accuracy for advanced aircraft and the capability to predict aerodynamic flow fields for inlets.

The program works on efforts funded by external sources like the Small Business Innovation Research (SBIR) program, the DoD Test Technology, Development and Demonstration (TTD&D) program, the Air Force Office of Scientific Research (AFOSR) and various other technology customers.





Bill Bertrand and Bob Wood review the capabilities of the newly developed low temperature satellite materials outgassing measurement facility with Capt. Bart Stewart.

The division emphasizes working with other organizations to leverage its investments in research. Partners include NASA (Langley and Glenn Research Centers and Marshall Space Flight Center), Boeing Co., Air Force Research Laboratory, University of Tennessee Space Institute, Vanderbilt University, Air Force Institute of Technology, University of Maryland, the DoE Oak Ridge National Laboratory, the DoE Sandia National Laboratory and the DoD High Performance Computing Modernization Office.

Fiscal 2002 Forecast

The fiscal 2002 workload is expected to stay at the same level as 2001. Providing faster, cheaper access to customer test data and analysis will be a key part of the program. The program will still support future PSP improvements as well as the demonstration/transition efforts associated with MA&D, CTS, JI and force balance technology development. Further developments will be sought in distortion synthesis, icing certification, data validation manager, dynamic data measurement and analysis, measurement techniques and plant control automation support. Cost and test efficiency will be major targets.

Successful collaboration will continue with the AFOSR and TTD&D, which fund development of new AEDC test or modeling and simulation techniques. The SBIR program will continue to be an important part of the total effort. New programs for funding technology will begin in 2002 including the Test and Evaluation Science and Technology program and the Technology Insertion and Risk Reduction program.

High Performance Computing

Fiscal 2001 Overview

AEDC maintains the Department of Defense's High Performance Computing Modernization Program's eighth most powerful computer capability and the most powerful Test and Evaluation site in the Department of Defense.

The center's mission requires reliable, time-critical, secure processing of test information in near real-time with high performance computing (HPC) systems connected to test facility networks. In addition to a real-time requirement, the center supports a substantial modeling and simulation mission in support of the Integrated Test & Evaluation (IT&E) initiative.

In fiscal 2001, HPC resources supported a wide variety of testing and modeling and simulation work across the center. This effort included support for operational systems such as the B-1B, F/A-18, F-16, Joint Direct Attack Munition (JDAM), and new systems—the F-22 Raptor, Unmanned Combat Air Vehicle (UCAV) and Joint Strike Fighter (JSF).

Thirty-five AEDC projects, involving multiple weapon system acquisition programs, used HPC resources at the center.

In fiscal 2001, the center upgraded two HPC systems resulting in a 25-percent increase in computational capability on these systems. This upgrade increased the center's total computational capability from 267 gigaflops to 324 gigaflops, a 21-percent increase.

Fiscal 2002 Forecast

The center's HPC effort is pursuing initiatives to reduce test cycle time and cost by infusing computational simulation into test processes. These include:

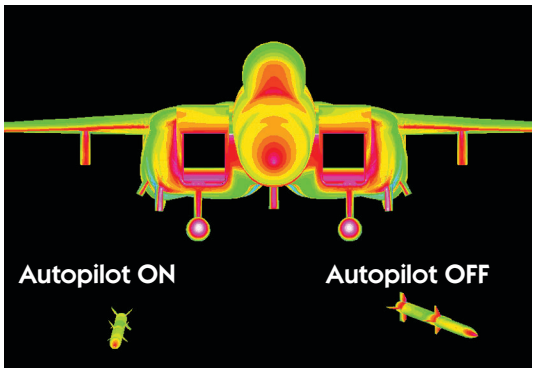
Model-based test data validation - Test data is compared with real-time simulations in order to provide time-critical diagnostics for instrumentation in hostile environments.

Non-intrusive instrumentation - Pressure-Sensitive Paint (PSP) is one of many non-intrusive techniques that promise to substantially decrease labor costs and increase data production, especially for wind tunnels.

Integrated test information - Many data flows will be fused interactively into a single real-time stream. These flows include test data, archived data, management information and simulations.

Test-Driven Computational Fluid Dynamics – CFD calculations that are driven by the test schedule are used in direct support of real-time analysis and non-intrusive instrumentation.

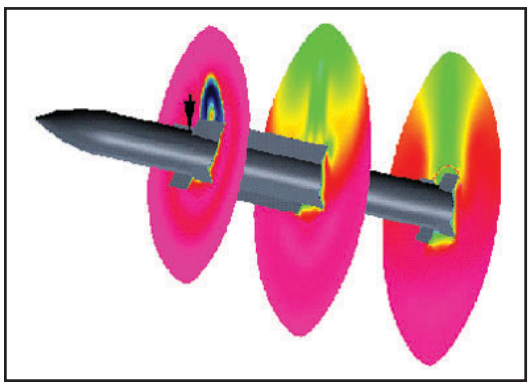
The center is pursuing a $5 million upgrade to the existing HPC system to meet fiscal 2004/2005 computational requirements. The increased need is brought on by higher customer demand for both real-time computing and modeling and simulation during the ground-testing phase of weapon system development and sustainment. If fully funded, AEDC's current HPC capacity of 324 gigaflops will be increased to 700 gigaflops.



The right half shows the AIM-120C release without autopilot control. The motion of the missile is completely controlled by gravity and the aerodynamic forces on the missile as influenced by the aircraft flow field. In the left half, the missile is under the control of the autopilot. The store is literally flown away from the aircraft.

Mission

Provide the real-time and off-line computational resources required to meet AEDC's test and evaluation mission.



Computational modeling demonstrates the effects of transient thrust as created by the on and off pulsing of control jets used to maneuver the missile towards its target.

Directorate of Support

Mission

Responsible to the AEDC commander for all aspects of installation support, including communications, computers, logistics, utilities, security, fire protection, civil engineering, environmental management and base services. The directorate also plans, programs, and budgets support mission area resources to achieve the center's strategic objectives and evaluates the center's support contractor, ACS.

Fiscal 2001 Overview

The Support Directorate continued its pursuit of excellent support to the AEDC Test Mission Area through improved computer systems, through critical utility upgrades, by maintaining environmental compliance, by preparing and executing sound security and emergency response procedures and by making numerous facility improvements.

AEDC leads Air Force Materiel Command (AFMC) in computer network security efforts and stands as a benchmark for other Air Force bases. Under a new center-wide centralized Personal Computer management effort, the center support contractor ACS reviews requirements, procures, receives, stages, and installs new PCs, excesses old PCs and makes PC and component recommendations. This has produced significant cost savings and increased productivity. The directorate also upgraded the High Performance Computing systems increasing their capacity by 21 percent.

Col. Pat Eagan, director of AEDC support, talks with his team during a staff meeting.

In the area of utilities, the center continued test utilities process modernization by initiating combined control of the water and steam systems for the Aeropropulsion Systems Test Facility control room and greatly reducing operating labor cost and integrating test and support controls. The completion of a cooling tower construction project reflects a commitment to upgrade infrastructure.

AEDC partnered with the Tennessee Valley Authority to re-lamp AEDC buildings, reducing power costs and improving lighting. AEDC also began replacement of inefficient buried underground steam lines. AEDC also agreed to cooperate with TVA on their proposed $300 million, 510 megawatt, natural gas-fueled power generation plant to be located on base. AEDC continued its world-class performance in utility management by providing critical test support utilities with minimal test schedule or cost impact.

AEDC security police enforce higher force protection conditions.

In the area of environmental management, AEDC maintained environmental compliance with all permits, continued aggressive restoration activities outlined in our corrective action management plan meeting all regulatory milestones, identified several pollution prevention alternatives that reduced AEDC's environmental risk and maintained our course in ecosystem management protecting rare, threatened and endangered species located at AEDC.

Security and emergency response forces continue to provide excellent support to Arnold Air Force Base and the center's 40,000-acre installation and multi-billion dollar infrastructure. They planned and provided outstanding installation support for AEDC's successful 50th Anniversary Air Show and Rededication ceremonies. This support included partnering with many local organizations to provide mutual security, fire and logistic support.

Security forces responded appropriately to enforce heightened security following the Sept. 11 attacks on America.

The Civil Engineering organization initiated, executed and completed more than $25 million in construction, renovation and upgrades to the center's test infrastructure. These necessary projects will keep AEDC viable to support national defense today and tomorrow.

The Services Division constantly strives to improve the quality of life for customers. Air Force Materiel Command Year of the Family (YOFAM) initiatives enhanced Services programs and played a significant role in improving the morale of families. This year the golf

AEDC Commander Col. David J. Eichhorn visits the Arnold Community Center. Stephanie Watson (left), Arnold Air Force Base Youth of the Year, helps students with their artwork.

Carroll Engineering Analysis Building, named after the first AEDC commander, houses high-performance computing assets.

course obtained a $78,000 grant to improve drainage on the course. The Arnold Lakeside Club had a "face lift."

The Wingo Inn telephone system was upgraded, and front desk computers were equipped with the new "lodging touch system" that speeds up the check in and out procedure with better accountability.

The Community Center continued to soar with the "Camp Adventure" youth program; participation has quadrupled within the last four years. The first-ever "Family Child Care" program was initiated to address child care needs at AEDC, with headquarters providing training and $2,700 worth of items for the lending library. The marina procured an 18-foot ski boat and added a new pontoon boat and ski boat to renovate the fleet.

Fiscal 2002 Forecast

Continuing health and quality of life improvements through superior facility management and projects will always be the Support Directorate's top priority.

Test facility and infrastructure upgrades will continue to improve capability and reduce cost. Projects in fiscal 2002 include phase 4 of the fighter engine inlet upgrades in the Engine Test Facility, the hypersonics development project and completion of the Decade Radiation Test Facility improvement project.

On the support side, the first phase of the headquarters building heating ventilation and air conditioning renovation and several paving and re-roofing efforts begin. YOFAM projects totaling $189,000 will be initiated, starting with the housing area beach shoreline, wall improvement, repaving of the tennis courts, pavilion repair and construction of a new volleyball court.

Commissary/BX customer Carrie Baxter and her son, Spencer, take advantage of the new maternity parking space. The new parking spot is part of a Year of the Family initiative.

Military Support Facilities/Functions

Medical Aid Station - A small Air Force medical aid station looks after the needs of assigned active duty military personnel. Limited pharmacy service is available for active and retired uniformed services members and their dependents two days a week. The pharmacy schedule and formulary are available on the AEDC Web site at http://www.arnold.af.mil/aedc/medicine.htm#PHARMACY or call (931) 454-5351.

VA Clinic - The Alvin C. York VA Medical Center operates a satellite clinic at AEDC to save area veterans the drive to Murfreesboro, Tenn. The VA clinic also serves AEDC's active duty military personnel. For information on the clinic contact (931) 454-6134.

Base Exchange & Commissary - A small military exchange and commissary serve active duty and retired military members and their families. The facilities are open Tuesday through Saturday, except federal holidays. For information on the Base Exchange call (931) 454-5014/5016. For information on the Commissary call (931) 454-5921/7249. More information is available on AEDC's Web site at http://www.arnold.af.mil/aedc/tenants.htm

Military Personnel/ Casualty Assistance/ Retiree Affairs - A small military personnel office is available to assist with military personnel issues, including retiree affairs. They can be contacted at (931) 454-4308 or through the AEDC Web site at http://www.arnold.af.mil/aedc/military.htm

Environment

Mission

AEDC's Environmental Management Division manages conservation, pollution prevention, restoration and compliance within existing regulations.

AEDC emphasizes environmental stewardship as a part of everyone's day-to-day job. The environmental management division effectively manages conservation, pollution prevention, restoration and compliance with existing regulations.

AEDC recognizes the magnitude of the challenge represented by that commitment. The center is a large industrial complex that requires the use of large amounts of fuels, oils, hydraulic fluids, refrigerants, antifreeze, solvents, acids and other similar materials to accomplish its test mission. While we are diligently seeking to eliminate or replace hazardous materials with environmentally friendly ones, we will continue to have to use these materials in significant quantities for the foreseeable future. Therefore, it is absolutely essential that AEDC satisfy all environmental requirements as we accomplish our test mission. To do otherwise puts not only our environment, but also our test mission at risk.

Every AEDC employee is familiar with those things in their workplace that represent a threat to the environment, and they are getting involved in eliminating or controlling them. "Excellence" goes beyond merely meeting the standards. We are committed to setting the standard by which others will be judged in the future.

Workers installed a pipe extraction system at one of the trenches at the Coffee County Landfill. All 11 trenches have been completed, and the entire upgraded system is operational.

AEDC has developed a Geographic Information System to facilitate the mapping of various components of the resource management program. The system enhances the ability to make better management decisions by locating facilities or conducting operations where there will be limited environmental impact.

Ecosystem management is an important aspect of the AEDC environmental program. AEDC accomplishes resource management objectives through the formation of partnerships with environmental agencies and organizations and the development of conservation programs. To date, rare plant and animal investigations have revealed the presence of at least 68 rare, threatened and endangered species on base property. Two federally protected species, the Gray Bat and Eggert's Sunflower, are located at the installation. AEDC entered into a partnering arrangement with the U.S. Fish and Wildlife Service to promote and enhance the management of these species.

AEDC consistently seeks to better integrate the management of irreplaceable biological, cultural and land resources within the overall framework of the test mission.

Pollution prevention and conservation go hand-in-hand to preserve the environment for future generations. A hazardous material pharmacy tracks hazardous materials throughout their life cycles as they are received, issued and used. The recycling operations center consists of a baler and a used-oil space heater.

Restoration Program Manager Dennis Flatt briefs Community Advisory Board members and base officials during a tour of AEDC environmental restoration sites.

Pollution prevention initiatives include an environmental approach to waste management. AEDC saves more than $35,000 in hazardous waste disposal by improved processing of oil-soaked absorbents, aerosol cans and excess materials. The model shop reduced the generation of hazardous waste from a fluid eliminator by more than 50 percent with the installation of a coolant wizard. The wizard cleans the coolant and extends the lifecycle of the coolant.

Our pesticide management program pursued environmentally friendly pesticides and fertilizers used on base and reduced the dependency on higher toxicity pesticides used in the past. The paint shop cut up to 80 percent of hazardous materials generated from paint stripping with the introduction of a new portable blasting machine. The photo lab came up with a new chemical precipitation method for silver recovery from photographic processing saving more than $2,000 a year.

One other major pollution prevention effort has been the recycling of waste oil and

Trichlorethylene (TCE) at AEDC engine test cells and heating and air conditioning units on base. Used oil is now recycled and reused in AEDC plants, and TCE is put back into refrigeration systems. Prior to this practice, used waste oil and TCE were disposed of as hazardous waste.

AEDC maintains an aggressive program of hazardous waste cleanup from past industrial practices under the DoD Installation Restoration Program. Community involvement is crucial to the cleanup effort.

The community is kept informed of important site activity through a variety of information sources. One of these primary sources is the Community Advisory Board — a community-based committee designed to act as a focal point between AEDC and the local community. The CAB meets regularly to review and comment on technical documents and plans relating to ongoing restoration activities at AEDC. Another source of environmental information to the local populace is the ENVISION newsletter. This quarterly product is written and produced by the Environmental Management Division and distributed to 650 homes and businesses in the communities surrounding AEDC. Environmental news is also published in the base newspaper, the HIGH MACH, and released to the local media.

Five water treatment facilities treat groundwater contaminated as a result of past disposal practices. These facilities clean four million gallons of groundwater each month.

Pump back projects on local base creeks not only reduce the risk of pollution's being allowed to enter local waterways, but the facilities allow for the operational reuse of the water, saving the cost of pumping cooling water from Woods Reservoir.

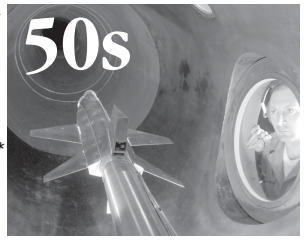
AEDC has an excellent environmental track record, but our vision for the future is to do even more. To secure our ability to execute our mission and serve our customers, we must have impeccable environmental performance. The future of the center's vital national test mission depends on it. In fact, the center's vision includes the statement of becoming "a model of environmental excellence for our communities."

New photo lab equipment makes silver recovery from photographic processing much more efficient. The recently purchased system is managed by Eddie Wright, seen here checking the equipment.

A new blasting machine in the AEDC paint shop eliminates up to 80 percent of hazardous materials generated from paint stripping.

AEDC Test Facilities

Wind Tunnels



X-15

16T - *16-foot Transonic*
16S - *16-foot Supersonic**
4T - *4-foot Transonic**
Tunnel A - *Supersonic**
Tunnel B - *Hypersonic **
Tunnel C - *Hypersonic and Aerothermal**
APTU - *Aerodynamic and Propulsion Test Unit**
Tunnel 9 - *Hypervelocity (AEDC White Oak, Md.)**

Apollo Capsule

Ranges

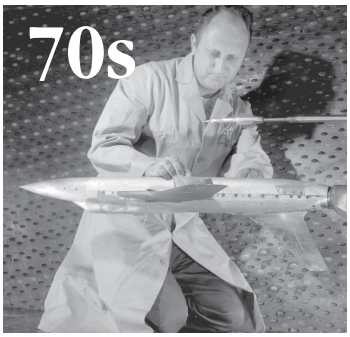
G-Range - *Hypervelocity Range/Track**
***I-Range**
S-1 - *Hypervelocity Impact Range*
S-3 - *Bird Impact Range*

Radiation

MBS - *Modular Bremsstrahlung Source*
Decade - *Radiation Test Facility**

Contamination

BRDF - *Bidirectional Reflectance Distribution Function*
COP - *Cryogenic Optical Properties Chamber*
SMOG - *Space Materials Outgassing Chamber*
SAM - *Solar Absorption Measurements Chamber*



F-105 Thunderchief

Cryogenic Vacuum

4x10 - *Propulsion/Plume Effects Chamber*
CroVac - *Cryogenic Vacuum*

Propulsion Research Cells

R1A1 - *Combustion Research Cell*
R1A2 - *General Research Cell*
R2A2 - *Freejet Research Cell*
R1D - *Icing & Severe Weather Simulation**
R1E - *General Research*
R2H - *Ultra-High Altitude Research Test Cell**

Rocket Altitude Test Cells

J-3 - *Vertical Liquid/Solid Rocket Test Cell* †*
J-4 - *Vertical Liquid/Solid Rocket Test Cell**
J-5 - *Horizontal Solid Rocket Test Cell* †*
J-6 - *Horizontal Solid Rocket Test Cell**

Gas Turbine Engine Test Cells

T-1 - *Propulsion Development Test Cell †*
T-2 - *Propulsion Development Test Cell †*
T-3 - *Propulsion Development Test Cell **
T-4 - *Propulsion Development Test Cell*
T-5 - *Propulsion Development Test Cell †*
T-7 - *Propulsion Development Test Cell †*
J-1 - *Propulsion Development Test Cell*
J-2A - *Propulsion Development Test Cell*
J-2 - *Propulsion Development Test Cell*
T-11 - *Small Turbine Engine Test Cell*
T-12 - *Turboshaft Engine Test Cell †*
C-1 - *Aeropropulsion Systems Test Facility**
C-2 - *Aeropropulsion Systems Test Facility**
SL-1 - *Sea Level Test Facility*
SL-2 - *Sea Level Test Facility*
SL-3 - *Sea Level Test Facility*

Space Shuttle

Thermal Vacuum Chambers

Mark I - *Aerospace Environmental Chamber*
12V - *Aerospace Chamber*

Sensor Test Facilities

FPCC - *Focal Plane Characterization Chamber*
DWSG - *Direct Write Scene Generator*
7V - *Aerospace Chamber**
10V - *Aerospace Chamber**

Arc Heaters

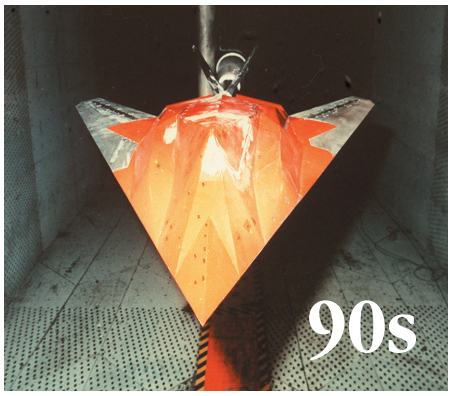
H-1 - *High-Enthalpy Ablation Test (HEAT) Unit**
H-2 - *High-Enthalpy Ablation Test (HEAT) Unit **
H-3 - *High-Enthalpy Ablation Test (HEAT) Unit**
HR - *Sensor Checkout †*

Component Check Out

7A* - *Vacuum*
UHV - *Ultra-High Vacuum*

Others

ACL - *Air Calibration Lab*
AMSC - *Advanced Missile Signature Center**



F-117 Nighthawk

** Unique facilities*
† Inactive or standby

Major Systems Tested at AEDC

Fighters

F-4 Phantom II, F-5 Freedom Fighter, F-14 Tomcat, F-15 Eagle/Strike Eagle, F-16 Fighting Falcon, F/A-18 Hornet, F/A-18 E/F Super Hornet, F-20, F-22 Raptor, F-35 Joint Strike Fighter, F-105 Thunder Chief, F-111 Aardvark, F-117A Nighthawk, LAVI (Israel)

Attack

A-6A Intruder, A-7 Corsair II, AV-8A Harrier, A-10 Thunderbolt II, A-37

Bomber

B-52 Stratofortress, B-58 Hustler, B-1 Lancer, B-2 Spirit, FB-111

X-15 Rocket Plane

Transports/Tankers/Special Mission

C-130 Hercules, C-141 Starlifter, C-5 Galaxy, C-17 Globemaster III, KC-135 Stratotanker, E-3A (AWACS) Sentry, EF-111 Raven, V-22 Osprey

Trainers

T-6 Texan II, T-37 Tweet, T-38 Talon, T-46, Dornier Alpha Jet

F-105 Thunderchiefs with KC-135

Experimental/Prototype/ Demonstrators

YA-9, YF-17, Microfighter, YF-23, X-32 and X-35 Joint Strike Fighter Prototypes

X-Planes

XB-70 Valkyrie, X-29, XT-4 (Japan), X-15, X-24A, X-24B, X-24C, X-30 National Aerospace Plane, X-32 and X-35 Joint Strike Fighter Demonstrators, X-33 (Lockheed Martin Skunk Works), X-43, X-37, X-38

Unmanned Aircraft

Firebee, Global Hawk, UCAV

Space Shuttle launch

Commercial

Boeing 747, Boeing 767, Boeing 777, Airbus

Air-to-Air Missiles

AIM 120 Advanced Medium Range Air-To-Air Missile (AMRAAM), AIM 9 Sidewinder

Munitions

GBU-31/32 Joint Direct Attack Munition (JDAM), AGM 154 Joint Standoff Weapon (JSOW), ALS 101

Cruise Missiles

Air Launched Cruise Missile, Ground Launched Cruise Missile, Navy Tomahawk Cruise Missile, Short Range Attack Missile (SRAM), AGM 158 Joint Air-to-Surface Standoff Missile (JASSM)

Intercontinental/Submarine-Launched Ballistic Missiles

Polaris, Poseidon, Trident, Atlas, Titan, Minuteman, Peacekeeper

Other Missiles Tested

Quail, Army Sergeant Missile, Bomarc, Hedi, Little John, Maverick, Navy Standard Missile, Nike-Zeus, Patriot, Army Pershing, Snark, Sprint, Thor-Delta, Walleye, THAAD

Manned Space Programs

Mercury, Gemini, Apollo, Skylab, Dynasoar, Space Shuttle, MOL (Manned Orbiting Laboratory), Space Station

Satellites and Space Probes

NAVSTAR Global Positioning Satellite, Transtage, IUS, Pam, Star 12-48, Discoverer, Voyager, FLTSATCOM, Intelsat VI, Miniature Vehicle, Eris, Sagittar, Pathfinder, Space Probe, Viking, NOAA/ GOES-M Weather Satelite, NASA-MAP, GBI

Apollo spacecraft takes man to the moon

Space Launch Vehicles

Atlas, Saturn V, Scout, Titan II, Titan III, Titan 34D, Vanguard, EELV, Hardware in the Loop, Ground-Based Missile Defense/Lethality

Gas Turbine Engines

Pratt & Whitney
- *TF33 (B-52, KC-135, C-141)*
- *F100 (F-15/F-16)*
- *F119 (F-22/JSF)*
- *4084, 4090, 4098 (Boeing 777)*

General Electric
- *J-85 (T-38, F-5, A-37)*
- *F101 (B-1)*
- *F110 (F-16, F-14)*
- *F118-100 (B-2)*
- *F404 (F-117A, F/A-18)*
- *F414 (F/A-18)*
- *TF39 (C-5)*

Rolls-Royce
- *F402 Pegasus (AV-8B Harrier)*
- *Trent 800 (Boeing 777)*

Orneda - Iroquois (AVRO CF-105 Arrow)
Williams - F415-WR-400 (Tomahawk)
Allison - AE3007 (Global Hawk, Embraer 145, Citation X)
Lycoming T-55 (CH-47-D Chinook)

F-117 Nighthawk Stealth Fighter

Test before flight.

Major AEDC Test Facilities
Nominal Values

ENGINE TEST FACILITY	Test Section Size		Total Temperature, °R	Speed Range	Pressure Altitude (Nominal), ft	Capacity of Installed Thrust Stand, lb	Primary Use*
	Cross Section, ft	Length, ft					
Propulsion Development Test Cell T-1***	12.3 diam	39 to 57	380 to 1,110	Mach 0 to 3.0	Sea Level to 80,000	30,000	(2) (6) (9)
Propulsion Development Test Cell T-2***	12.3 diam	42 to 50.5	380 to 1,110	Mach 0 to 3.0	Sea Level to 80,000	30,000	(2) (6) (9)
Propulsion Development Test Cell T-3	12 diam	15	450 to 1,660	Mach 0 to 4.0	Sea Level to 100,000	20,000	(2) (3) (6) (9) (11)
Propulsion Development Test Cell T-4	12.3 diam	39 to 47.8	380 to 860	Mach 0 to 3.0	Sea Level to 80,000	50,000	(2) (6) (9)
Propulsion Development Test Cell T-5 ***	7 diam	17	395 to 660	Mach 0 to 2.0	Sea Level to 80,000	2,000	(2) (6) (9)
Propulsion Development Test Cell T-6 ****	3 diam	18	430 to 760	Mach 0 to 3.0	Sea Level to 90,000	None	(1) (3) (4) (6) (7) (11)
Propulsion Development Test Cell T-7 ***	7 diam	9	395 to 1,110	Mach 0 to 3.0	Sea Level to 80,000	1,000	(2) (6) (9)
Propulsion Development Test Cell T-11	10 x 10	17	395 to 860	Mach 0 to 2.0	Sea Level to 80,000	2,000	(2) (6) (9)
Propulsion Development Test Cell T-12	10 diam	20	396 to 860	Mach 0 to 2.0	Sea Level to 80,000	None (7,000 hp)	(2) (6) (9)
Propulsion Development Test Cell J-1	16 diam	65	395 to 1,210	Mach 0 to 3.2	Sea Level to 80,000	50,000	(2) (3) (6) (9)
Propulsion Development Test Cell J-2	20 diam	67.3	395 to 1,110	Mach 0 to 3.0	Sea Level to 80,000	50,000	(2) (3) (6) (9)
Propulsion Development Test Cell J-2A****	18.3 diam	32	(Wall, 144)	Static	450,000	20,000	(1) (5) (11)
Sea Level Test Cell SL-1	24 x 24	50	Ambient	Static	Sea Level	52,500	(2)
Sea Level Test Cell SL-2	24 x 24	62	395 to 720	Mach 0 to 1.1	Sea Level	50,000	(2) (6) (9)
Sea Level Test Cell SL-3	24 x 24	50	395 to 720	Mach 0 to 1.1	Sea Level	30,000	(2) (6) (9)
Propulsion Development Test Cell C-1	28 diam	57	360 to 1,480	Mach 0 to 3.8	Sea Level to 100,000	100,000	(2) (3) (6) (9)
Propulsion Development Test Cell C-2	28 diam	57	360 to 1,110	Mach 0 to 3.0	Sea Level to 100,000	100,000	(2) (6) (9)
Rocket Development Test Cell J-3**	12 diam	26 High					
	17 diam	20, 30, 40 High	– – –	Static	125,000	200,000	(1) (5)
Rocket Development Test Cell J-4	48 diam	82 High	– – –	Static	100,000	500,000	(1) (5) (11)
Rocket Development Test Cell J-5 ***	16 diam	50 to 85	– – –	Static	100,000	300,000	(1) (5) (11)
Rocket Development Test Cell J-6	26 diam	50 to 85	– – –	Static	100,000	500,000	(1) (5) (11)

PROPULSION WIND TUNNEL FACILITY	Test Section Size		Total Temperature, °R	Speed Range	Pressure Altitude (Nominal), ft	Dynamic Pressure, psf	Reynolds No./ft ($x10^{-6}$)	Primary Use*
	Cross Section, ft	Length, ft						
Propulsion Wind Tunnel 16T	16 x 16	40	540 to 600	Mach 0.06 to 1.6	Sea Level to 90,000	2 to 1,100	0.2 to 6.0	(6) (9) (14)
Propulsion Wind Tunnel 16S ***	16 x 16	40	580 to 1,080	Mach 1.5 to 4.75	45,000 to 155,000	25 to 550	0.1 to 2.4	(6) (7) (9) (14)
Aerodynamic Wind Tunnel 4T	4 x 4	12.5	540 to 600	Mach 0.2 to 2.0	Sea Level to 65,000	20 to 1,400	2.0 to 7.0	(6) (14)

HYPERVELOCITY WIND TUNNEL 9	Test Section Size, in.	Total Pressure, psia	Total Temperature, °R	Speed Range	Pressure Altitude, ft	Dynamic Pressure, psf	Reynolds No./ft ($x10^{6}$)	Primary Use*
Aerodynamic Facilities	33 diam Free Jet	1,000 to 11,500	1,500 to 1,750	Mach 7.3 to 7.9	50,000 to 97,000	986 to 10,450	4.3 to 48.4	(6) (7) (15)
	60 diam	500 to 14,000	1,700 to 1,800	Mach 9.5 to 10.2	81,000 to 155,000	144 to 4,000	0.86 to 20	(6) (7)
	60 diam	300 to 19,000	2,460 to 3,160	Mach 12.8 to 14.1	128,000 to 220,000	20 to 950	0.11 to 3.8	(6) (7)
	60 diam	3,200 to 19,500	2,900 to 3,150	Mach 15.5 to 16.4	154,000 to 191,000	87 to 465	0.53 to 2.55	(6) (7)
Thermal Structural Facilities	11.3 diam Free Jet	2,800 to 5,600	3,200 to 3,400	Mach 6.7 to 6.8	38,000 to 52,000	3,500 to 6,900	4.0 to 8.0	(6) (7) (16) (17)

von KARMAN GAS DYNAMICS FACILITY	Test Section Size, in.	Total Pressure, psia	Total Temperature, °R	Speed Range	Pressure Altitude, ft	Dynamic Pressure, psf	Reynolds No./ft ($x10^{6}$)	Primary Use*
Supersonic Wind Tunnel A	40 x 40	1.5 to 200	530 to 750	Mach 1.5 to 5.5	16,000 to 151,000	53 to 1,780	0.3 to 9.2	(6) (7) (14)
Hypersonic Wind Tunnel B	50 diam	20 to 900	700 to 1,350	Mach 6 to 8	98,000 to 180,000	43 to 590	0.3 to 4.7	(6) (7) (14)
Hypersonic Wind Tunnel C	50 diam	200 to 1,900	1,650 to 1,950	Mach 10	132,000 to 188,000	43 to 430	0.3 to 2.4	(6) (7) (14)
Aerothermal Wind Tunnel C	25 diam Free Jet	200 to 2,000	1,220 to 1,900	Mach 8	95,000 to 149,000	132 to 1,322	0.7 to 7.8	(6) (7) (13)
	25 diam Free Jet	20 to 180	720 to 1,660	Mach 4	56,000 to 105,000	231 to 1,928	0.2 to 8.1	(6) (7) (13)
Aerodynamic and Propulsion Test Unit (APTU)	192 diam	20 to 300	700 to 2,000	Mach 0.9 to 4.1	Sea Level to 80,000	500 to 9,300	1.1 to 3.16	(1) (3) (4) (6) (7) (9) (11) (12) (13)
Hypervelocity Range/Track G	120 diam	– – –	– – –	To 24,000 fps	Sea Level to 244,000	– – –	– – –	(8) (10)
Hypervelocity Impact Range S1	Target Tank 30 diam	– – –	– – –	To 32,000 fps	Sea Level to 244,000	– – –	– – –	(10)
Bird Impact Range S3	240 x 144	– – –	– – –	200 to 1,400 fps	Sea Level	– – –	– – –	(10)

ARCS	Nozzle Exit Diameter, in.	Model Enthalpy, Btu/lb	Model Pilot Pressure, atm	Mach Number	Erosion Simulation		Primary Use*
					Dust Particle Diameter, μm	Dust Velocity, fps	
High Enthalpy Ablation Test Unit (HEAT) H1	1.12 to 3.0	1,500 to 9,000	8 to 95	1.8 to 3.5	70 to 200 Graphite	5,800 to 7,300	(13)
High Enthalpy Ablation Test Unit (HEAT) HR **	1.8 to 3.2	2,000 to 5,200	19 to 77	1.1 to 4.0	– – –	– – –	(13)
High Enthalpy Ablation Test Unit (HEAT) H2	5, 9, 24, 42	2,000 to 5,200	0.14 to 3.4	3.4 to 8.0	– – –	– – –	(7) (13)
High Enthalpy Ablation Test Unit (HEAT) H3	5, 9, 24, 42	1,500 to 9,000	8 to 75	1.1 to 3.5			

Major AEDC Test Facilities
Nominal Values

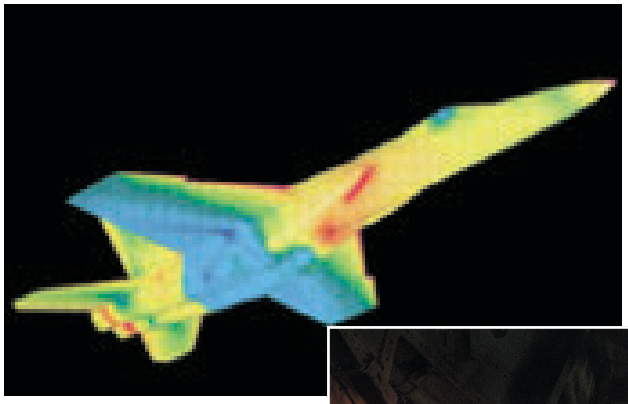
AEROSPACE CHAMBERS	Test Section Size		Wall Temp., K	Chamber Empty Pressure, torr	Pressure Altitude, miles (1962 U.S. Std Atm)	Thermal Radiation Simulation	Primary Use*
	Cross Section, ft	Length, ft					
Mark I	42	(Vert.) 82	77	10^{-7}	210	Collimated Solar and Programmed Heat Flux	(5)
10V	10	(Vert.) 30	77	10^{-7}	200	Tungsten Lamps	
12V	12	(Vert.) 35	77	10^{-7}	200	8-ft-diam Xenon Solar and Programmed Tungsten Lamps	
7V	7	24	<20	10^{-7}	200	N/A	
FPCC	5	5	<20	10^{-7}	200	N/A	
DWSG	Varies	Varies	<20	N/A	200	N/A	
BRDF	3	5	AMB	10^{-5}	AMB	N/A	
COP	2	3	77	10^{-5}	200	N/A	
SAM	2	15	77	10^{-7}	200	Xenon Lamp	
SMOG	2	1	AMB	10^{-5}	AMB	N/A	
7A	3	5	<20	10^{-7}	200	– – –	
UHV	2	3	<20	10^{-7}	200	N/A	

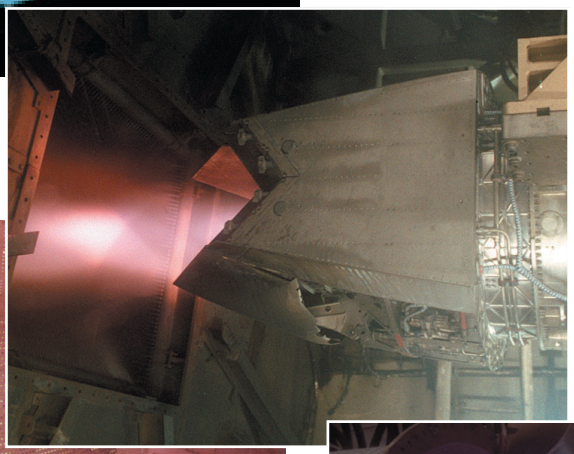
DECADE RADIATION TEST FACILITY	Average Dose	Area	Dose Rate	Pulse Width FWHM	Vacuum Chamber Size	Average Peak Diode Voltage	Primary Use*
Bremsstrahlung Sources							
Decade Quad	20 krads (Si)	2,000 cm^2	1 x 10^{11} rad/se	<50 msec	5-ft diam x 10-ft length	<1.8 MV	(18)
MBS	410 rads (Si)	3,000 cm^2	1 x 10^{10} rad/sec	30 nsec	5-ft diam x 10-ft length 2-ft diam x 3-ft length	< 200KV	(19)
Plasma Radiation Sources Decade Quad	Under development. Source intensity >30KJ, debris-free area >150 cm^2.						(20)

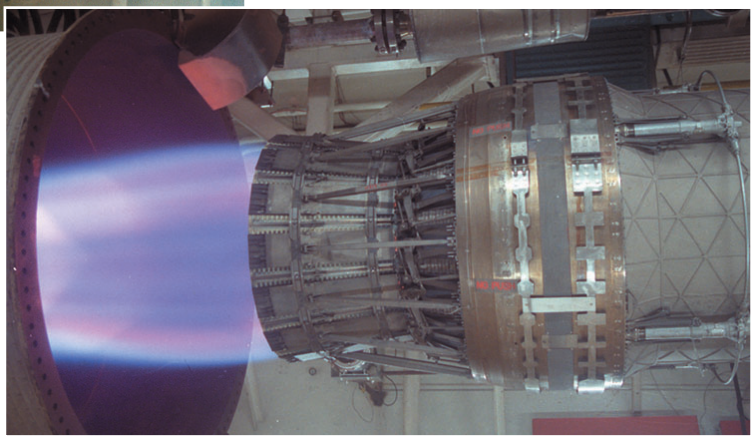
USE LEGEND: * Testing of (1) Rockets, (2) Turbojets (3) Ramjets (4) Missile Base Heating Models, (5) Space Environmental Tests, (6) Aerodynamic Models, (7) Aerothermodynamic Models, (8) Aeroballistic Models, (9) Combined Aerodynamic Inlet and Propulsion System Tests, (10) Impact Studies, (11) Free-Jet Expansion of Rocket Exhaust Plumes, (12) Ablative Materials, (13) Ablative and Erosive Materials, (14) Store/Stage Separation (15) Shroud Separation, (16) Thermal Structural, (17) Aero-Optics, (18) Electronic Sub-Assemblies, (19) SGEMP and Cables, (Optics and Coatings)

** Currently Mothballed
*** Standby Status
**** Currently Non-Operational

01/02







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