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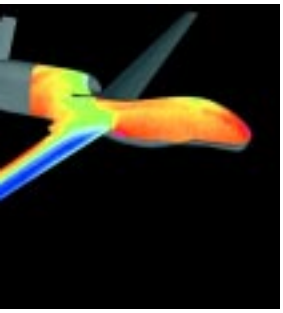

Annual Report

Arnold Engineering Development Center
Arnold Air Force Base, Tennessee

The world's premier flight simulation test facility

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 acres of 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 used since.

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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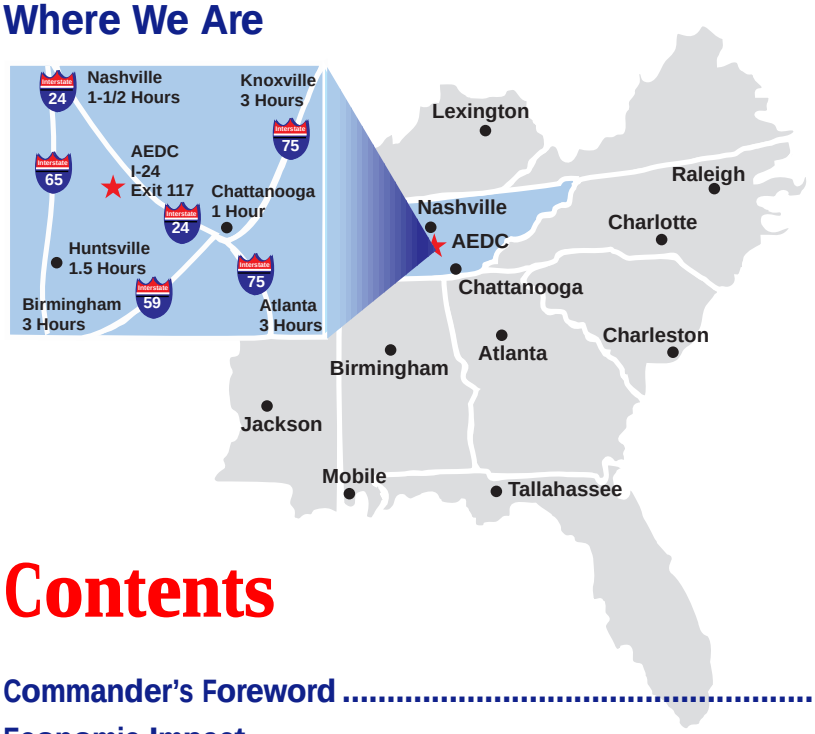
Where We Are



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ISO 9000

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.–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 2 organization according to its Capability Maturity Model. It's a distinction test customers look for in distinguishing organizations 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

Fiscal year 2000 was an exciting and hard-charging year for the men and women of Arnold Engineering Development Center. Team AEDC bounced back from the ups and downs of the previous year by developing solid relationships with new customers, opening new test and community support facilities, and upgrading old facilities for new and innovative test work.

Striving to provide the best possible service to our customers, AEDC reopened its 6,000-foot runway to allow for more reliable and secure delivery of large test articles to the center. The first delivery at the newly reopened runway occurred in July when a specially modified C-5 delivered the Geostationary Operational Environmental Satellite used to observe and help predict weather conditions.

The newly renovated Mark I Space Chamber provided the test facility needed to put this Loral-built satellite through its paces before its launch in the summer of 2001. A $1.5 million upgrade to the chamber delivered state-of-the-art cutting edge capabilities making it a key test facility at AEDC for the 21st Century. The men and women of AEDC partnered with the Space Systems/Loral engineers to successfully complete testing on the satellite and set a new test endurance record of 45 days, 22 hours, and 10 minutes for Mark I.

The upgrades to Mark I were not the only renovations going on at AEDC to make us the test center of choice for aerospace ground testing. A new, more efficient control room was completed to modernize and further automate our wind tunnel operations. The new system will allow faster, better, and cheaper testing for our customers. Additionally, a new dryer in the Propulsion Wind Tunnel facility will provide more efficient operation, reducing down time previously caused by dryer regeneration. Again, the bottom line is time and cost savings for our customers at the center.

While renovations and upgrades were taking place at the center's current facilities, the construction of a new facility was completed as well. I had the pleasure of cutting the ribbon on our new Decade Radiation Test Facility in February. This new facility provides high-powered x-rays to test our nation's space hardware against the effects of nuclear blast-caused radiation in space. I clearly expect to see AEDC play a key role in our country's National Missile Defense program in future years with the unique capability that this futuristic facility provides to the Department of Defense and the nation.

Although the infrastructure upgrades at the center in the last year alone are impressive, we know it is the people and their work practices that make us a world-class organization. For that reason, we continued to implement our reengineering program at the center designed to deliver greater efficiency through commercial off-the-shelf computer applications, providing an efficient logistics and business management system. The center now has a fully integrated COTS software package as the financial and transactional system of record.

As you can see, it has been an exciting year at AEDC reaching out to new customers, satisfying current customers, and preparing the center to be the world's best aerospace ground test center for the rest of the 21st Century. The men and women of Team AEDC stand ready to meet new challenges in 2001 and beyond and continue to deliver the quality test services and data the center is known for throughout the aerospace industry.

I think you will agree with me as you examine the following pages in this report, the ground testing for the Department of Defense and commercial industry rests in great hands for the future. If you have questions regarding the center and the capabilities we provide to the aerospace industry, please feel free to contact us through my Public Affairs office at (931) 454-4204.

Michael L. Heil, Col., USAF
Commander

Economic Impact

Arnold Engineering Development Center's economic impact in Middle Tennessee was more than $499 million for fiscal year 2000, an increase of almost $17 million from the previous fiscal year.

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 $387.5 million, also up from the previous year. AEDC employed almost 3,000 people this year; these numbers include military personnel, civilian and contractor employees with the military 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.

Fiscal 2000 Economic Impact Data

TVA Model Estimates for AEDC

As of Sept. 30, 2000

Direct Employment at AEDC	
Military	103
Government Civilian	251
Non-appropriated Fund	46
Sverdrup/ACS	2,567
AEDC Federal Credit Union	5
Base Exchange	5
Total	**2,977**
Secondary Jobs Created	2,054
Total Employment Impact	**5,031**
Economic Impact (in millions)	
Non-construction Expenditure	$ 324.8
Indirect Spin-off Impact	$ 152.7
Construction Expenditures	$ 8.4
Indirect Spin-off Impact	$ 13.2
Total Direct Expenditures	**$333.2**
Total Indirect Expenditures	**$165.9**
Total Economic Impact	**$499.1**

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 2,977 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 2,054 secondary jobs for a total of more than 5,000 jobs related to AEDC.

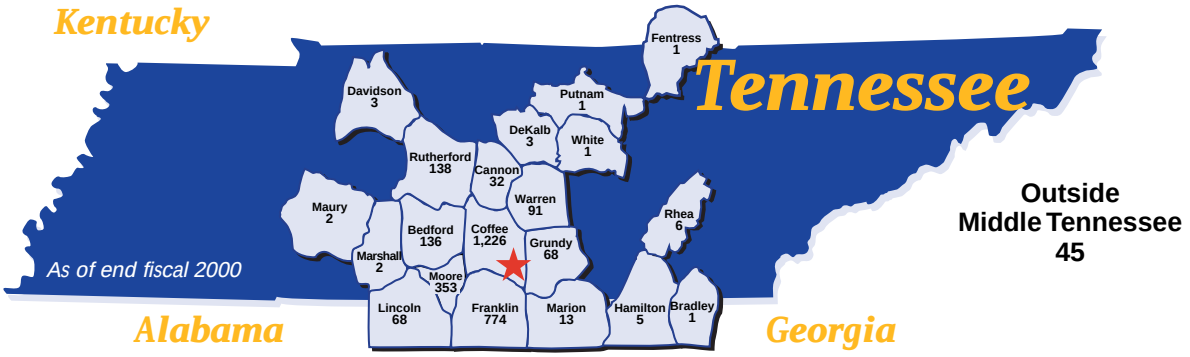
The payroll for AEDC government personnel and contractor employees was about $126 million. Other direct AEDC expenditures were almost $207 million with the approximate payroll for the secondary jobs exceeding $54 million.

AEDC remains the single largest employer in Coffee and Franklin counties. The center employs about 1,226 people in Coffee County and 774 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 about $50 million in retirement pay or the retirement pay of several hundred government civilian employees and contractor personnel from AEDC.

The current replacement cost for the aerospace testing complex at Arnold Air Force Base is more than $7 billion. (See complete listing of facility values on page 8; list of AEDC test facilities can be found on page 24.)

AEDC Work Force Demographics



Total Employment 2,977 **Total Economic Impact $499.1M**

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 2,977 member AEDC work force is 47, with an average of 16 years of experience at the center.

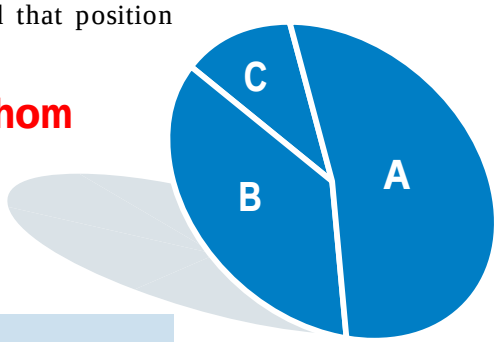
The government staff at AEDC, composed of military and civilian employees, provides management direction, resource allocation, oversight and contract administration.

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 testing for the center. ACS, led by General Manager Jim Nicholson, is the center support contractor. ACS employees perform functions such as information technology, communications, test utility operations; environmental, safety, industrial health and quality assurance; civil engineering, transportation, materials management, fire, security, emergency management, food services, custodial, and public affairs.

The consolidation of Department of Defense test facilities brought Navy employees to AEDC in 1993. Now there are about a dozen Navy personnel, including two 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. Elmer Standridge filled that position throughout fiscal year 2000.

Who Works for Whom

A	Sverdrup	53%
B	ACS	35%
C	AF/Navy	12%



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 H. "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 in 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 scientists. He asked von Karman to form a scientific group to chart a long-range research and development program for the U. S. Air Force.

Members of this "Scientific Advisory Group" went to Germany after 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 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 the kind of blueprint for future development that von Karman and the Scientific Advisory Group report, "Toward New Horizons," provided 50 years earlier.

Reengineering

Fiscal 2000 Overview

With new integrated logistics systems in place, the center focused on the business management systems and the processes and software to support them in fiscal year 2000. There were three software releases in fiscal 2000 to make PeopleSoft® financial software the center's financial system of record.

Release 4 was deployed in the spring and consisted of establishing PeopleSoft® General Ledger software as the general ledger for AEDC's test and support contractors. This release made PeopleSoft® the system of record for the contractors.

Release 5 was deployed in the late summer and centered around the workload planning process. The new processes and software establish how AEDC contracts for and eventually executes the work in fiscal 2001. This included establishing rates, estimating the cost of doing the work at AEDC and estimating the price for customers.

Release 6 was deployed in the fall and made PeopleSoft® the financial system of record for AEDC. This release allows all of the center's financial computations and processes to be accomplished in PeopleSoft®. Growing from the Release 5 processes for estimating, Release 6 captures the actuals for both project costs and pricing for our customers. AEDC now has a fully integrated commercial-off-the-shelf (COTS) software package as its financial and transactional system of record. The financial system is also integrated with Primavera® P3E software to provide an integrated project management function for AEDC.

Some of the more pertinent Release 6 outcomes are:

- A new projects-billing process giving users the ability to record customer funding and apply funds to a project. The billing process—driven by the price estimate and billing schedule—allows funds to be used based on a priority established at the time the funds are applied to the project.
- A new capability allows entry of DoD labor hours into PeopleSoft® so that all AEDC labor hours are captured and processed against work in Synergen®. This allows full-time accounting. Timekeepers have been identified and will be trained in the new process to capture the chargeable time of DoD personnel.

Fiscal 2001 Forecast

Limited follow-up work will continue into fiscal 2001 on Release 6 to complete the transition and verify the accuracy of the system along with reporting requirements. The fiscal 2001 program also will implement five initiatives to include asset health, integrated schedule, performance management, project management and time & labor.

Mission

The AEDC Reengineering Joint Program Office was formed to implement an efficient logistics and business management system.

AEDC Vice Commander Navy Capt. Elmer Standridge led reengineering efforts in fiscal 2000.

Sverdrup

A Jacobs Engineering Company

Mission

Sverdrup is AEDC's test support contractor. Its 1,500 employees operate and maintain the center's aerospace flight dynamics, space and propulsion test facilities.

Fiscal 2000 Overview

Fiscal year 2000 workload was originally forecast to be lower than normal and at about the same level as fiscal 1999 actuals. As the year progressed, the workload expectation varied considerably, but ultimately the actuals exceeded first-of-year forecasts by approximately 10 percent. This increase was partially due to an increased marketing emphasis.

Weapons separation test on B1-B Lancer bomber

Sverdrup reduced staffing during fiscal 1999 by 156 employees in anticipation of the lighter workload in fiscal 2000 and with expectations that the less than normal workload condition would extend through fiscal 2002.

NASA Microwave Anisotropy Probe satellite above Mark I Space Environmental Chamber

In order to accommodate the temporary increase in test workload in the second half of fiscal 2000 without adding staff, we worked closely with the client and prioritized all test and non-test work to ensure delivery on the most critical work. Through aggressive work force and work scheduling actions, we were able to deliver on all critical work – and at a significantly lower cost than originally estimated.

Late in the fiscal year, Sverdrup also successfully negotiated a landmark win-win contract with our labor union workforce. This contract significantly increases work assignment flexibility and returns a portion of the expected savings to the employees in improved benefits. As a result of this and other actions, we earned the highest ever award fee score for a test mission area contractor.

Fiscal 2001 Forecast

It appears that test workload may remain below normal levels through fiscal 2002. The decision not to add staffing to accomplish the temporary workload increase in the last half of fiscal 2000 will help us to control costs during this lower workload period. However, with some aggressive marketing in fiscal 2001, the company hopes to increase the target workload. During fiscal 2001, AEDC will be supporting many national weapons systems and commercial programs such as the Joint Strike Fighter, F-22, F100 engine, X-37 Unmanned Combat Air Vehicle and the Loral commercial satellites.

Sverdrup Vice President and General Manager Dr. David Elrod (right) with Air Engineering Metal Trades Council President David Garner (left) and Secretary Bob Smith (center)

The challenges before us are:

- Achieve 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.

ACS

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

Fiscal 2000 Overview

Fiscal year 2000 was a very productive year for ACS. The joint venture provided reliable, sustained support to a test schedule that increased above projections as the year went on, playing a major role in satisfying test customers.

The year ended with an excellent safety record, an amazing accomplishment considering the wide variety of tasks and equipment used by the support contractor.

Another major accomplishment was increased cross-craft certification to make our talented work force even more versatile in responding to customer requirements.

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

ACS Vice President and General Manager Jim Nicholson (center) with Tommy Rust (left), business agent for the International Guards Union, and Hogan McDonald (right), vice president of the Air Engineering Metal Trades Council

ACS played a key leadership role in bringing new maintenance and business systems and processes on-line on schedule for the centerwide reengineering effort aimed at improvements to provide the best service to the customer at the lowest cost.

ACS worked in partnership with test contractor Sverdrup in many cooperative efforts, including outage maintenance management, test support, environmental, safety and quality assurance operations.

Theresa Cates' suggestion saved the center $28,000.

ACS also played a key role in reopening the Arnold Air Force Base airfield so that test customers could deliver test articles by air directly to the test facilities.

Through negotiations with health care insurance providers and involvement of our work force to better manage sick leave, fringe costs for fiscal 2000 were reduced from fiscal 1999 levels.

The work by the members of the ACS support team, in close partnership with Sverdrup, led to "excellent" award fee ratings for both six-month periods.

Fiscal 2001 Forecast

Next year will be a challenge as the company continues to optimize new software logistics and management software systems and processes brought on-line through the center's reengineering effort.

Providing test support and utilities to meet a changing, flexible test workload will be a challenge in 2001. Working closely with our customer and our test support contractor partner, Sverdrup, will be key in supporting efforts by the center to leverage technology and find new and more efficient ways to meet customer requirements.

Finally, continuing to improve our safety, quality and environmental programs and support for our customer and our contractor partner will be a key to success for fiscal 2001.

Mission

ACS is AEDC' s center support contractor. Its 900 employees support the center with a wide range of services including: information technology, desktop operation 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.

Precision Measurement Equipment Lab Manager John Adcock (left) confers wtih instrument technician Mike Sain about temperature transducers.

Directorate of Operations

Mission

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

Specifically, the Directorate of Operations manages operations and maintenance of AEDC's RDT&E 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.

Fiscal 2000 Overview

The Directorate of Operations oversees and manages all of the AEDC testing divisions or product areas, including Aerodynamics, Aeropropulsion, Space and Missiles and Technology. A recap of fiscal year 2000 is provided in the pages that follow, along with a forecast for fiscal 2001 in each of our major product areas.

AEDC's total funding for all testing in fiscal 2000 was over $120 million – an increase of more than $8.2 million from fiscal 1999. Air Force-led projects, including joint programs, represented almost half of the center's total workload, with Navy-led service and joint programs making up another quarter of the total. The remaining quarter of the workload was composed of a combination of commercial testing followed closely by ballistic missile defense, NASA and Army programs. The general trend is an increase in the percentage of joint programs (primarily Air Force/Navy) with a corresponding decrease in service-specific test programs. Commercial and BMDO testing are also continuing to grow.

Some of the major test programs AEDC supported in fiscal 2000 included the Air Force's top priority program, the F-22 Raptor air dominance fighter, due to enter service in 2004. The Navy's newest strike-fighter, the F/A-18E/F Super Hornet, has begun full production and will start deploying aboard aircraft carriers in 2001. Both competing prototypes of the Joint Strike Fighter were also tested in the center's wind tunnels and jet engine test cells. The first test by Space Systems/Loral in our recently upgraded eight-story tall Mark I Space Chamber was their

FACILITY VALUE	Funding Year	Original Cost ($M)	Replace Value (FY95 $M)	Replace Value (FY00 $M)
Initial Central Facility	**1951**	**83**	**996**	**1,063**
ETF-B (T-Cells)	1951	12	139	148
PWT (16S, 16T)	1952	185	2,500	2,668
VKF (ABC)	1952	16	193	206
Computer & Support Equip.	1953	143	456	487
ETF-A (J-Cells)	1955	10	100	107
Rocket Cells J-3	1960	3	23	25
Rocket Cells J-4	1961	12	86	92
Arcs	1965	20	130	139
APTU	1970	15	67	72
ASTF (C-1, C-2)	1977	625	1,453	1,551
T-3, T-5, T-7, T-9	1980	15	26	28
Rocket Cells J-5	1983	30	43	46
Rocket Cells J-6	1990	226	270	288
Ranges	1990	45	50	53
DECADE	1992	60	63	67
NAWCAD (4 Cells)	1994	62	65	69
Total AEDC Value		**$1,561**	**$6,660**	**$7,108**

Test before flight.

AEDC tests support development of flight systems from the unmanned Global Hawk (left) to the Boeing and Lockheed Martin Joint Strike Fighter designs, to space systems like Space Systems/Loral weather satellites, to the Navy's F/A-18E/F Super Hornet, to the Air Force's next generation air-dominance fighter, the F-22 Raptor (right).

most complex weather satellite, the NASA/NOAA GOES-M. Many other programs such as national and theater missile defense, space access, commercial and various classified programs were also tested in fiscal 2000.

Fiscal 2001 Forecast

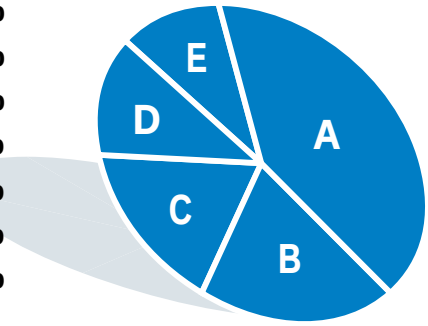
In fiscal 2001 we anticipate providing continuing support for the F-22, F/A-18E/F and JSF as well as commercial tests for Boeing of their 777, 767 and 747 airliners. We also anticipate additional commercial satellite tests for Space Systems/Loral as well as new electric space propulsion system tests in the recently renovated 12V Space Chamber. Ballistic missile, national missile defense and space access programs such as the X-37 are also scheduled. Upgrade and modernization work to the Propulsion Wind Tunnel complex, engine test cell control rooms and the development of new computational modeling and simulation tools to support ground and flight tests 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.

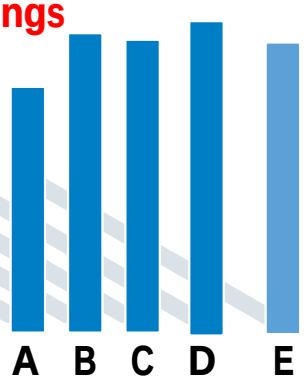
Fiscal 2000 Total Workload by Revenue

A	Air Force	40%
B	Joint	20%
C	Commercial	13%
D	Navy	11%
E	BMDO	5%
E	NASA	4%
E	Army	4%
E	Other	3%



Test Mission Areas Total Earnings

A	FY97	$93.9M
B	FY98	$114.4M
C	FY99	$111.9M
D	FY00	$120.1M
E	FY01 Projected	$111.4M



Product Area Earnings

FY	97	98	99	00	01
Aerodynamics	33.8	29.6	19.3	24.9	26.3
Aeropropulsion	33.1	54.9	59.9	63.3	54.1
Space & Missiles	21.8	23.9	22.1	21.8	21.0
Technology*	5.2	5.0	4.6	9.4	9.6

**FY97 to FY00 technology programs embedded in product area earnings*

Aerodynamics

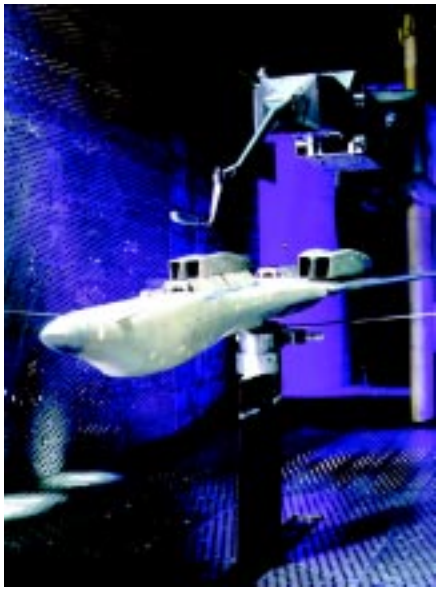
Mission

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 2000 Overview

The earnings for the Aerodynamic Product Area were approximately $24.9 million in fiscal 2000, marking a 29-percent increase over fiscal 1999 earnings. The increase in earnings is related to Joint Strike Fighter development work.

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.



Weapons separation test from B-1B Lancer in 16-foot transonic wind tunnel

While the PWT SP is an ongoing effort, other major investment efforts aimed at improving tunnel operational efficiencies were completed. These investments include a new air drier facility, a new flex-nozzle control system for the four-foot transonic tunnel, a new high-pressure air system for the 16-foot transonic tunnel and new field breakers for the entire Propulsion Wind Tunnel complex.

Accessible, accurate and rapid access to information is the key to any successful acquisition effort, including test and evaluation. Efforts to develop an Integrated Test Information System that can integrate and share near-real-time test information during any phase of an acquisition program have taken a major step forward with the application of Matrix-One Software®.

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 2001 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.

Advances in technology will enable customers to evaluate designs within weeks or days as opposed to months. To support this technology, AEDC will have to support multiple short-duration tests with little advance notice. AEDC will have to participate early in the development effort with an in-depth knowledge 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.

Test programs at AEDC will be designed using a global system model. Investments are being made to optimize every aspect of the process including planning, scheduling, execution, analysis and reporting. Non-intrusive technology to speed up data acquisition and accuracy will be implemented as will a virtual presence capability to remotely monitor and redirect testing in real time. Plant support will be automated and its maintenance proactive rather than reactive.

Multiple exposure photo of weapons separation from F-22 Raptor air dominence fighter

Inside the supersonic circuit of the propulsion wind tunnel

New air drier for PWT wind tunnels

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

Facilities Upgrades

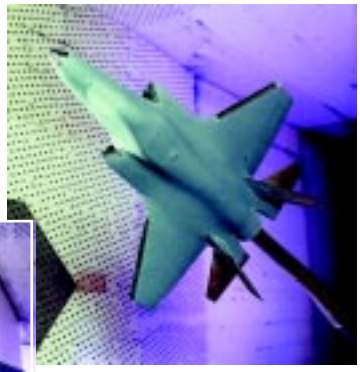
An $81.4 million multi-year facility sustainment and upgrade program of AEDC's large wind tunnel infrastructure began in fiscal 1998. The Propulsion Wind Tunnel Sustainment Program includes upgrading the main drive, acquiring a second atmospheric air drier, replacing two of four main drive motors and improving the airflow quality of the 16-foot supersonic wind tunnel. An aggressive cycle-time reduction program is under way, focusing on process streamlining and new test technologies such as pressure sensitive paint and virtual flight testing.

Analysis and Evaluation

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

Integrated Test and Evaluation

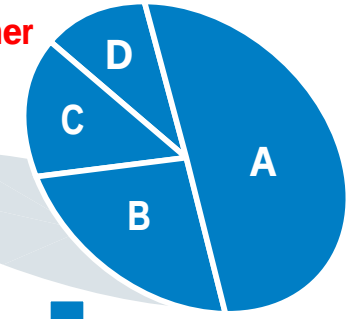
Flight-testing is risky and expensive. To mitigate the risks, AEDC is increasing the use of integrated test and evaluation techniques. An integrated, knowledge-based approach to developmental test and evaluation tasks can reduce acquisition costs by increasing the integration of computer modeling and wind tunnel simulations. This, in turn, can decrease the number and duration of individual flight tests and their associated costs without increasing program risk. AEDC has several successful pilot programs directly supporting flight tests on programs such as the F-22. These programs integrate computational modeling and simulation with ground and flight tests to reduce the cost, cycle time or risk of these critical weapons development programs.



Lockheed Martin X-35 JSF (above) and Boeing X-32 JSF (left)

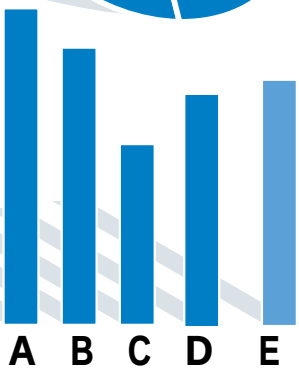
Fiscal 2000 Workload by Customer

A	Joint	50.5%
B	Air Force	22.6%
C	Commercial	15.4%
D	Other Government	7.3%
D	Navy	4.2%



Aerodynamics Total Revenue

A	FY97	$33.8M
B	FY98	$29.6M
C	FY99	$19.3M
D	FY00	$24.9M
E	FY01 Projected	$26.3M



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 today's and tomorrow's customers. Key assets include the Aeropropulsion Systems Test Facility engine test cells: C-1 and C-2 and Sea Level test cells SL-2, SL-3 and SL-1, and the Engine Test Facility test cells: J-1 and J-2 and T-1 through T-5, T-11 and T-12.

Fiscal 2000 Overview

The Aeropropulsion Product Area continued to grow for the second consecutive year with earnings increasing nine percent from fiscal year 1999 to 2000. Aeropropulsion generated $63.3 million of revenue in fiscal 2000, over half of AEDC's total reimbursement revenue.

One major driver in this increase was Component Improvement Program (CIP) tests. Testing included Pratt & Whitney F100 engines for the F-15/F-16. The CIP Accelerated Mission (endurance) tests were the first revenue-generating tests in the newly operational SL-3 sea-level test cell. Digital engine controls for the B-1's GE F101 engine underwent flight certification testing in the J-2 altitude test cell. These CIP projects accounted for more than one third of the total product area revenue earned in fiscal 2000.

The other major portion of fiscal 2000 revenue can be attributed to testing of the F119 engine for the F-22. Altitude development testing was completed for flight envelope expansion in test cell C-1. Testing in support of the Initial Service Release milestone and engine flight clearance both were accomplished during the F119 testing in cells C-1 and SL-2. The second third of this year's revenue was earned through the F119 projects.

Testing was completed for the Joint Strike Fighter (JSF) Concept Demonstration Assessment for both F119 engine variants in test cells C-1 and J-2. These tests accounted for a notable percentage of the business area revenue earned in fiscal 2000.

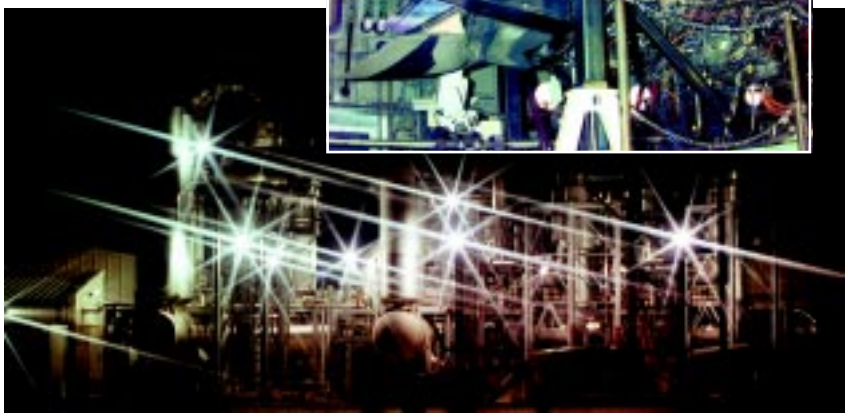
Commercial testing decreased from 16.5 percent in fiscal 1999 to 15.6 percent of the total workload in fiscal 2000. However, two significant commercial programs were tested throughout the fiscal year. In test cell T-3, Siemens-Westinghouse tested multiple configurations of their commercial ground power unit low-emission combustor. Qualification testing was also completed on the Williams International P8300-15 engine for the European (Germany/ Sweden) Taurus missile.

Navy test workload increased slightly in fiscal 2000 from 0.2 percent to 0.8 percent of the total earnings. The Joint Expendable Turbine Engine Concept (JETEC) II technology demonstrator expendable engine was tested in cell T-11. Army test workload was also supported by the product area, with the T-55 Turboshaft engine altitude test in T-12. The T-55 powers the Army's CH-47 Chinook.

Fiscal 2001 Forecast

Aeropropulsion projects a modest decline in revenue in fiscal 2001. Despite continued declining DoD budgets (with the associated reduced number of acquisition programs) 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

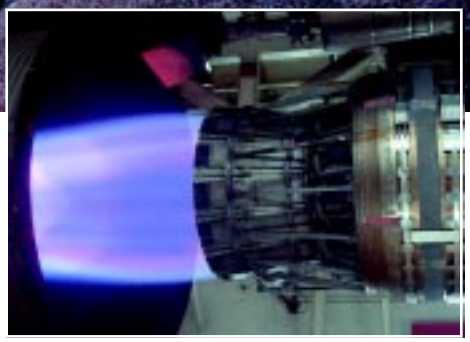
P&W F119 engine for F-22 Raptor in sea-level test cell SL-2



Sea-level environmental test facilities at night

Allison AE3007 engine for Global Hawk unmanned aerial vehicle

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



Pratt and Whitney F100 engine for the F-15 Eagle

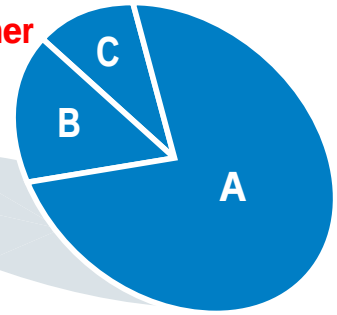
test operations and maintenance program assure excellent test support while protecting both the test article and the infrastructure. Through benchmarking activities with commercial engine producers and other DoD agencies, we are eliminating noncompetitive cost areas and business practices. Our customers have greater flexibility to tailor the specific test services required, thus reducing both price and required test times. Emphasis is also being placed on best practices and compliance with ISO 9000 standards. Data systems are also being upgraded to improve data acquisition, display capabilities and reliability. This will also reduce down time and cut maintenance costs. Plant control systems are being upgraded to make them more efficient and cheaper to operate.

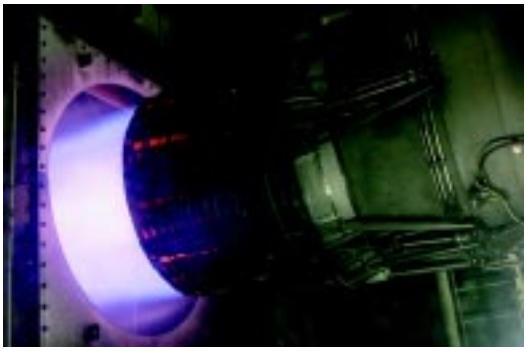
As in fiscal 2000, the F100 CIP testing will continue to account for a major portion of fiscal 2001 year's revenue, as will the ongoing testing of the F119 engine for the F-22. The amount of commercial testing is expected to grow slightly.

EDAPS reduces the cost of testing because of real-time monitoring of data parameters.

Fiscal 2000 Workload by Customer

A	Air Force	72%
B	Commercial	16%
C	Joint Strike Fighter	11%
C	Navy	<1%
C	Army	<1%

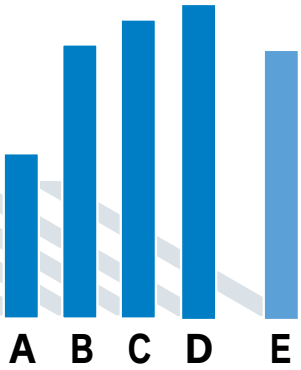




The General Electric F101-GE-102 engine is used in the B-1B bomber.

Aeropropulsion Total Revenue

A	FY97	$33.1M
B	FY98	$54.9M
C	FY99	$59.9M
D	FY00	$63.3M
E	FY01 Projected	$54.1M



Space and Missiles

Fiscal 2000 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, hypersonic aerodynamics, nuclear weapons effects and missile signatures.

The Space and Missiles Product Area saw a decrease in total testing during fiscal year 2000, but continued with significant investment in each of its sub-product areas to prepare for projected out-year funding increases in space technology.

Space and Missiles generated $21.8 million in revenue during fiscal 2000. That revenue came from a variety of customers.

The J-6 large rocket test cell assisted the Intercontinental Ballistic Missile program office with its Aging Surveillance program. One Minuteman III motor and one Peacekeeper motor were tested at altitude conditions to verify performance characteristics of the aging solid fueled rocket motors. The facility also tested two Minuteman III Stage II and five Minuteman III Stage III qualification motors under the Propellant Replacement Program, in the final phase before the program enters the production phase.

The center's hypersonic test units conducted testing in support of the Ballistic Missile Defense Organization (BMDO) Theater Missile Defense (TMD) and National Missile Defense (NMD) programs. These included a series of tests conducted in the Hypervelocity Ballistic Range G Facility in support of the Army Theater High Altitude Area Defense (THAAD) program. Nineteen shots were conducted to investigate how chemical or biological agents will break up in the atmosphere after being impacted by the THAAD interceptor. Testing continued on the NMD Lethality Program with 16 sub-scale projectiles launched against sub-scale simulated targets. Work on the Defense Advanced Research Projects Agency Scramjet Technology effort was started and will continue next year. Laboratory experiments were conducted during the second year of a three-year Test Technology Development and Demonstration (TTD&D) project sponsored by the Office of the Secretary of Defense. The goal of this project is to develop methodologies required to upgrade the Range G facility for impact lethality testing at speeds up to 10 km/sec.

Under the Reentry Systems Applications Program, the hypersonics sub-product area supported the Naval Air Warfare Center in the High Enthalpy Aerothermal Test H1 arc-heated facility. A four-run entry served to develop and qualify essential materials for the Navy's Trident Submarine Launched Ballistic Missile thermal protection system. Arc test activity also supported NASA's HyperX program and the Air Force's HySet program with leading edge testing in the H2 arc-heated facility. Arc testing was suspended for the last half of the fiscal year due to equipment failure.

Hypersonics continued with upgrades to the Aero Propulsion Test Unit (APTU) to prepare the facility for a Mach 4 test capability in fiscal 2001. The modifications will allow APTU to run at higher velocities, higher enthalpies and with a more realistic air composition. Upon completion of the upgrades, APTU will be capable of testing full size scramjets, one of the key enabling technologies of hypersonic flight.

The Advanced Missile Signature Center (AMSC) and the field measurement activity within the Technology Division were consolidated in fiscal 2000. This change provides focus to the Signature sub-product area. Renovation of the mass data storage system was completed and has resulted in greater capacity at reduced operation and maintenance costs. The Tactical Missile Signatures (TMS) support activity growth in fiscal 1999 continued through fiscal 2000 and the field measurement programs continued to produce ad-

(Above) Space environmental test facilities test satellites and components under vacuum conditons. (Top) NASA/NOAA GOES-M satellite built by Space Systems/Loral being readied for a test.

J-6 High Altitude Solid Rocket Test Facility

ditional data for the TMS database. The BMDO Virtual Data Center, although operational (with all of the BMDO Data Centers connected), was placed in a "maintenance only" mode in fiscal 2000. A decision was made to renew efforts on the VDC in fiscal 2001 at a level of about $1.9M. Efforts in support of the Defense Intelligence Agency National Target/Threat Signature Data System have continued with establishment of AMSC as a node on their network and the loading of TMS data. Modeling and simulation efforts in the last year were devoted to analysis of a Russian radiation code purchased by the Air Force Office of Scientific Research European Office of Advanced Research and Development, and monitoring of a BMDO Small Business Innovative Research effort to improve the efficiency of radiation prediction codes.

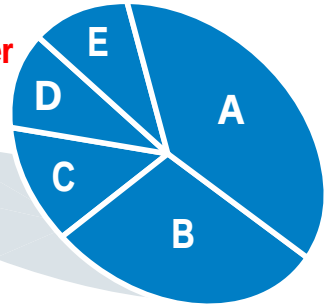
The Environmental Space Chambers provided services to a diverse set of customers in the sensor calibration, space contamination, thermal-vacuum and aerospace materials areas. The center supported the Army's Ground Based Interceptor (GBI) program with sensor calibration and evaluation in the 7V Vacuum Chamber. The 10V and 7V chambers provided material bake-out and evaluation services to NASA. Mark I spent most of the year undergoing a major renovation, resulting in a modern satellite test capability. In September, testing began in Mark I on the first satellite of a 10-year contract with a commercial satellite communications company.

Several important milestones were achieved in the area of Nuclear Weapons Effects (NWE) Testing. The Decade Radiation Test Facility's x-ray simulator achieved initial operational capability in fiscal 2000, and began characterization tests. During this period the NWE team also supported the Defense Threat Reduction Agency-funded acquisition of a plasma radiation source configuration to allow the Decade-Quad to provide a soft x-ray spectrum.

The former Navy Hypervelocity Wind Tunnel No. 9 complex at White Oak, Md., now in its third year of management by AEDC, has become an integral part of the total AEDC capability matrix, filling out the high Mach number (to Mach 16.5) and high pressure regime of wind tunnel operation. Support for BMDO has been primary through the year. A major milestone was reached when Tunnel 9 demonstrated the capability to obtain highly accurate, highly sensitive aero-optical measurements for interceptor seeker window testing in the Mach 7 true-temperature test leg. When full development is completed in fiscal 2001, that capability will provide a unique ground test site where theater missile defense seeker windows can be tested with full aerothermal and optical operation in a dupli-

Fiscal 2000 Workload by Customer

A	OSD	37%
B	Air Force	29%
C	Other Government	11%
D	Commercial	11%
E	NASA	6%
E	Army	4%
E	Navy	2%



Space and Missiles Total Revenue

A	FY97	$21.8M
B	FY98	$23.9M
C	FY99	$22.1M
D	FY00	$21.8M
E	FY01 Projected	$21.0M

260 feet down–renovations to the J-4 altitude liquid rocket motor test cell

cated flight environment. A three-year TTD&D project sponsored by the OSD at BMDO's behest began this year. 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.

Tunnel 9's strong support to NASA hypersonic vehicle technology development continued as a key, high-Mach-number aerostability entry was completed in support of the X-37. Finally, refurbishment of the Tunnel 9 vacuum plant was completed on schedule and under budget, including rewind of several electric drive motors, refurbishing bearings in the drive train, and installing a new monitoring system to improve Tunnel 9's preventive maintenance program.

Fiscal 2001 Forecast

The Space and Missiles Business Area expects a small increase in total tests for fiscal 2001. 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 2001, Space and Missiles will remain heavily committed to investing in test facilities in preparation for that projected increase in workload.

The mirror for the Far Infrared Submillimeter Telescope (FIRST) satellite program is shown being installed inside Space Environment Chamber 10V for testing.

Rockets

AEDC is projecting liquid rocket engine test programs into the new century 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 approximately 1,000 seconds duration. Extended run times will not only provide a more realistic test simulation, but will also offer considerable overall cost savings by reducing the number of test periods typically 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 fleet of ICBMs continues to undergo testing at AEDC. The second and third stages of both the Minuteman III and the Peacekeeper ICBMs are tested in the J-6 Large Rocket Development Test Facility to assess aging effects. These aging/surveillance test programs will continue throughout the lives of the missiles. J-6 will also remain involved in the Minuteman III PRP, with four tests scheduled in fiscal 2001 to qualify the production motors for use in the fleet.

Hypersonic Testing

The Range G Hypervelocity Ballistic Range Facility is the only facility in the U.S. capable of meeting the lethality requirements of the BMDO NMD Program. Lethality impact testing for NMD will continue in fiscal 2001. Forty shots are planned in support of THAAD, Navy Theater Wide, NMD, and DARPA Scramjet Technology. Small-scale testing for the TTD&D program will also be completed in fiscal 2001 to develop and demonstrate the 10-km/sec capability that will meet the needs of NMD and future TMD programs.

Hypersonic test support for BMDO will also continue as the various interceptor programs look to Tunnel 9 primarily for sensor window testing. Development of the complete aero-optics test capabilities are expected to be completed this year, and plans are on the books to conduct seeker window tests in support of BMDO's Aerothermal Interceptor Technology program. Support to NASA will continue, as testing in support of the X-38 program will address complex aero-heating issues, primarily in the body flap region of that vehicle at Mach numbers from 10 to 16.5.

The Navy and Air Force reentry material qualification programs in the AEDC high-enthalpy facility H1 will extend into fiscal 2001. An additional 18 tests on candidate nose tip, heat shield, and antenna window materials

Aeropropulsion Test Unit creates hypersonic test conditions.

will be conducted for the Submarine-Launched Ballistic Missile and ICBM programs. The Army THAAD and NASA HyperX programs and further Navy R&D work will complete the high-enthalpy facility's test schedule for fiscal 2001.

Environmental Space

In fiscal 2001 AEDC will further spool up testing of commercial communications satellites. Support to the NMD GBI program will continue in the 7V and 10V sensor chambers. The 10V will remain a key player in the NMD End-to-End Hardware-in-the-Loop test capability, with ongoing upgrades to secure that role. Support to NASA in fiscal 2001 will include materials testing in the 10V and space contamination studies in the research laboratory. Significant marketing efforts will focus on the Space Based Infrared System, the Exoatmospheric Interceptor Technology program, and commercial satellite manufacturers.

Nuclear Weapons Effects

Work began in fiscal 2000 to add significant additional capability to the Decade Radiation Test Facility (DRTF) through Office of the Secretary of Defense Central Test and Evaluation Investment Program (CTEIP) funding. Test capability additions include a second Decade quad, a prompt gamma source, debris gamma and electrons, and a cryogenic test chamber replete with dynamic scene generation to include nuclear clutter. Initial funding for that effort started in fiscal 2000 and will continue through fiscal 2004. Completion of the CTEIP enhancements will result in a nationally unique NWE test capability, allowing exposure of test articles to multiple simultaneous nuclear environments, which more accurately replicates the time history of a nuclear event. The enhanced DRTF is projected to play a critical role in test and validation of critical components of the National Missile Defense System.

Advanced Missile Signature Center

BMDO has directed that data center management be transferred from the Joint National Test Facility to BMDO headquarters starting in fiscal 2001.The fiscal 2001 core budget for the AEDC/AMSC is $2.01M. Additional funds of approximately $1.9M are to be divided among the three BMDO data centers to continue development of the BMDO Virtual Data Center Network. Growth in AMSC support to Tactical Missile Signature customers, independent of BMDO activity, is expected to continue in fiscal 2001. A large effort to develop standards for signatures, measurement, and archival, which began in fiscal 2000, will carry over into fiscal 2001 with the interest of the Central Measurements and Signals Intelligence Office, the Range Commanders Council and the Defense Intelligence Agency.

The Decade Radiation Test Facility (above) and X-ray quad (left) simulate radiation effects of a nuclear explosion.

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.

Fiscal 2000 Overview

In fiscal 2000, the Applied Technology Division carried out a $22 million program, with the three AEDC product areas each funding programs to benefit their specific areas.

These product area-funded technologies tend to be near-term and requirements-driven.

Another major part of the program was the core technology effort handling technologies of joint application to the business areas or those with projected payoffs 5 to 10 years in the future.

The AEDC Applied Technology Program works on efforts funded by various external sources such as the Small Business Innovation Research program, the DoD Test Technology, Development and Demonstration program, the Air Force Office of Scientific Research and various outside technology customers.

About 50 technology and analysis projects were performed during fiscal 2000. Although Sverdrup performed the majority of the technology program, consultants, universities and other contractors also participated.

The Applied Technology Division has emphasized working with other organizations to leverage its investments with more than $1 million of leveraged research performed. Partners include NASA, Boeing, Air Force Research Laboratory and the High Performance Computing and Modeling Office.

Fiscal 2001 Forecast

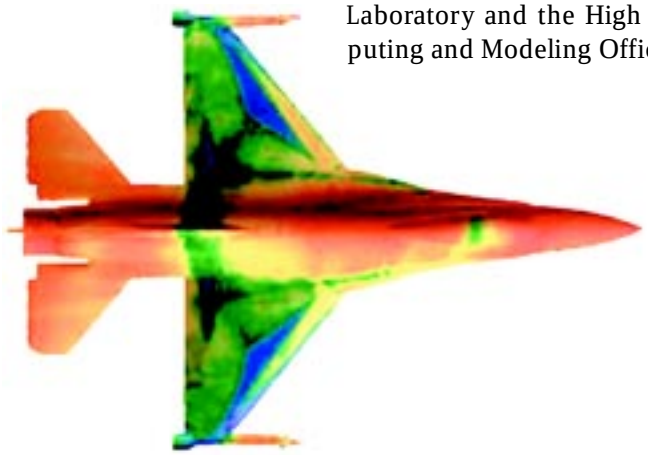
In fiscal 2001 the applied technology workload is expected to stay at the same level as fiscal 2000.

Improved information technology providing faster, cheaper access to customer test data and analysis will be a key part of our program. AEDC will also make improvements to non-intrusive test article measurement systems such as Pressure Sensitive Paint technology.

The successful collaboration with the Air Force Office of Scientific Research, which funds development of new AEDC test or modeling and simulation techniques, will continue.

The Small Business Innovation Research program has grown to be an important part of the total effort. Many small business research and development firms are participating in test technology developments for AEDC, with the technology team working to improve planning for these project initiations and transitioning its completed developments to the test community.

Technology leveraging will continue to be emphasized in fiscal 2001. The leveraging of the National Project for Application-Oriented Research in Computational Fluid Dynamics Alliance (NPARC) serves as a model and will focus this year on unstructured grid generation technology.



F-16 Fighting Falcon model with pressure sensitive paint (right), PSP image (above)

High Performance Computing

Fiscal 2000 Overview

AEDC maintains the Department of Defense's High Performance Computing Modernization Program's (HPCMP) eighth most powerful computer capability and the most powerful Test and Evaluation (T&E) site in the DoD.

The center's mission requires reliable, time-critical, secure processing of test information in near real-time with 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 year 2000, 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 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 more than 15 DoD weapon system acquisition programs, used HPC resources at the center.

In fiscal year 2000, the center completed a $4.9 million upgrade to its HPC. Among a number of improvements this funding provided, it more than doubled the computational capability of AEDC's HPC systems from 112 gigaflops to 267 gigaflops, increased by 10 times the throughput of the Central Computer Facility HPC network, and enabled 64-bit addressing and parallelism.

Unmanned combat air vehicle weapon separation test in 4-foot transonic wind tunnel

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

The center will upgrade two HPC systems resulting in at least a 25-percent increase in computational capability on these systems. This upgrade will increase the center's total computational capability from 267 gigaflops to 324 gigaflops, a 21-percent increase, making AEDC the seventh most powerful computer facility within the HPCMP and preserving its reputation as the most computationally powerful T&E site within the DoD.

Mission

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

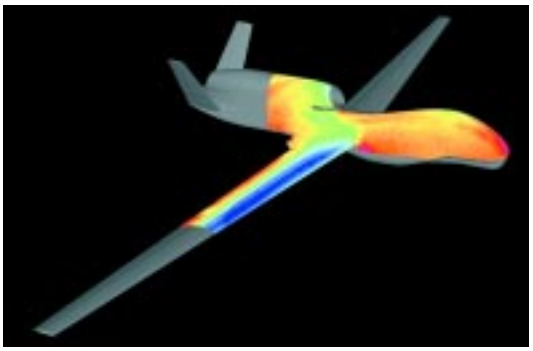
High performance supercomputer

Fiscal 2001 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.



Pressure Sensitive Paint image of Global Hawk unmanned air vehicle

Directorate of Support

Mission

Responsible to the AEDC commander for all aspects of center support, including communications, computers, logistics, utilities, security police, 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 2000 Overview

The Support Directorate continued its pursuit of excellent support to the AEDC Test Mission Area through improved computer systems security, upgrades to the center's High Performance Computing systems, implementation of new cost-effective, commercial-off-the-shelf business management systems, and numerous facility improvements.

The directorate oversaw installation by the center support contractor of several new improvements to computer systems security and network firewalls, ensuring the protection and integrity of data at AEDC.

AEDC leads Air Force Materiel Command (AFMC) in network security efforts, and stands as a benchmark for other Air Force bases.

The center completed full implementation of the SYNERGEN®, METAPHASE®, PeopleSoft® and other commercial-off-the-shelf software products to move AEDC into world-class business practices.

AEDC trained more than 2,000 people to use these new software tools to manage and program the center's work.

With AEDC government team leadership, the support and test contractors completed their consolidation of their Safety, Health, Environmental Management, and Quality offices. The contractor consolidation has produced productivity increases and significant cost savings across all center functions.

AEDC implemented a new materials management concept that brings all material handling processes under one management team. Under this new management concept, commodity teams control all purchasing, receiving, supply distribution, and warehousing management. Each team knows its suppliers, users, and the items in stock or on back order through the use of the new software tools, such as SYNERGEN®. The center established five Material Re-Ordering (MRO) contracts that provide next day delivery of ordered items from off-base suppliers, significantly reducing warehouse inventory.

Plans that began in fiscal 1999 to re-open the airfield were finalized and the airfield was reopened allowing air transport of test articles directly to the center, VIP travel, and a continued partnership with the Tennessee Air National Guard. The first test article was delivered to AEDC by air in July.

The Services Division was recognized as the best small base morale, welfare and recreation operation in Air Force Materiel Command. AEDC's services operation serves a diverse customer base of active duty, and retired military personnel, government civilians and the center's contractor workforce and their families. Services innovations developed at AEDC have been used as a model for MWR and lodging program improvements across the command.

Services completed a $400,000 quality of life renovation project of the Arnold Community Center. The project was designed as a model for consolidating services activities at small Air Force bases.

The center completed upgrades to the installation's rail line to allow customers an economical and safe method of transporting test articles to AEDC.

AEDC's rail lines were upgraded to better serve customers.

Youth enjoy activities in Arnold's new community center.

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

The directorate oversaw initiation and completion of more than $27 million in construction, renovation, and upgrades to the center's test infrastructure.

AEDC was the first base in AFMC to fully transition from the AUTODIN message system to the new Defense Message System.

Fiscal 2001 Forecast

The center's High Performance Computing systems will be upgraded, increasing the total capability by more than 20 percent.

Test facility upgrades will continue to improve capability and reduce cost. Projects in fiscal 2001 include a Decade support facility, fighter engine inlet upgrades in the Engine Test Facility, the Propulsion Wind Tunnel Sustainment Project and completion of Aeropropulsion Systems Test Facility water cooling tower addition.

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

Arnold Air Force Base's 6,000-foot runway

The migration to Microsoft Windows 2000 operating system will begin in January 2001 and will be phased in before year's end.

Under a new center-wide centralized PC management effort, center support contractor ACS reviews requirements, procures, receives, stages, and installs new PCs, restages and excesses old PCs, and makes PC and component recommendations.

The directorate will provide support to AEDC 50th anniversary events to include the June 2001 Air Show.

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 people 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 at Arnold Air Force Base. 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.

Endangered species such as the Eggert's Sunflower and the Gray Bat are found at Arnold Air Force Base.

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 such 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 is 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.

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.

Recycling of food waste via worm composting eliminates a cafeteria solid waste stream.

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. We have 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. Pollution prevention initiatives include the establishment of a hazardous material pharmacy and recycling center. The pharmacy tracks hazardous materials throughout their life cycle as they are received, issued and used. The recycling operations center consists of a baler, a worm composting facility and a used-oil space heater. Cafeterias on base send their food wastes to the recycling operations center instead of sending them to the landfill. More than 2,500 pounds of food waste is fed to the 300,000 worms at the center every month.

Pollution prevention initiatives include an environmental approach to waste management. AEDC saved 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.

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.

Several waste water treatment facilities were opened during the year to treat groundwater contaminated as a result of past disposal practices.

Pump back projects completed 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."

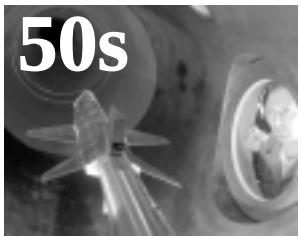
Trapping of insects permits planning for ecosystem management strategies for many years to come.

Gas collection system collects and burns methane gas from the old Coffee County Landfill located on base.

AEDC Test Facilities

Wind Tunnels

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



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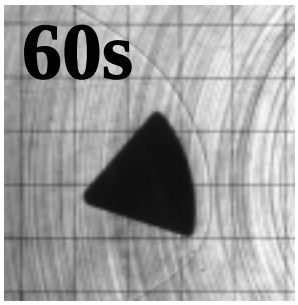


Apollo Capsule

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**
Phoenix

Contamination

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

F-105 Thunderchief

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*

Cryogenic Vacuum

4x10 *- Propulsion/Plume Effects Chamber*
CryoVac *- 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-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*

Others

IVA *- Impact, Vibration, and Acceleration*
ACL *- Air Calibration Lab*
AMSC *- Advanced Missile Signature Center**

F-117 Nighthawk

** Unique facilities*

Major Systems Tested

Arnold, AFB, Tenn.

1953-2000

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-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

X-15 Rocket Plane

Bomber

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

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

F-105 Thunderchiefs with KC-135

Trainers

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

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-33 (Lockheed Martin Skunk Works), X-43, X-37

Space Shuttle launch

Unmanned Aircraft

Firebee, Global Hawk, UCAV

Commercial

Boeing 747, Boeing 767, Boeing 777 Airbus

Air-to-Air Missiles

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

Cruise Missiles

Air Launched Cruise Missile, Ground Launched Cruise Missile, Navy Tomahawk Cruise Missile, Short Range Attack Missile (SRAM)

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

Apollo spacecraft takes man to the moon

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, NASA-MAP

Space Launch Rockets

Atlas, Saturn V, Scout, Titan II, Titan III, Titan 34D, Vanguard, EELV

Gas Turbine Engines

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

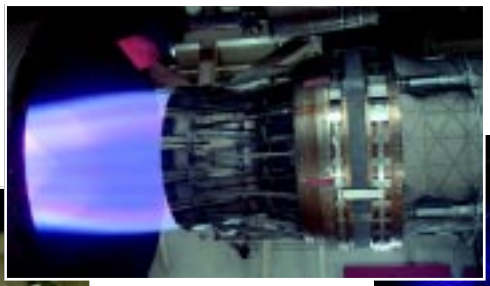
General Electric
- *J-85 (T-38, F-5, A-37)*
- *F101 (B-1)*
- *F110 (F-16, F-14)*
- *F404 (F-117A, F/A-18)*
- *F414 (F/A-18)*
- *TF39 (C-5)*

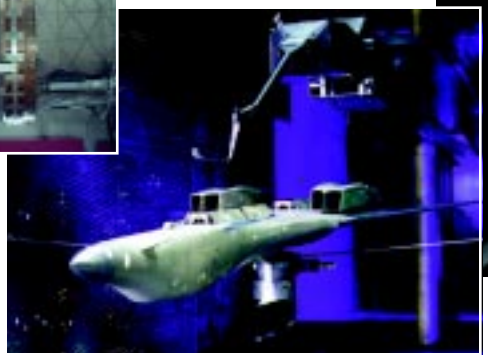
Rolls-Royce
- *F402 Pegasus (AV-8B Harrier)*
- *Trent 800 (Boeing 777)*

Orneda - Iroquois (AVRO CF-105 Arrow)
Williams - F415-WR-400 (Tomahawk)
Allison - AE3007 (Global Hawk, Embraer 145, Citation X)

F-117 Nighthawk Stealth Fighter

Test before flight.





Arnold Engineering Development Center
Arnold AFB TN 37389
www.arnold.af.mil

An Air Force Materiel Command Test Center