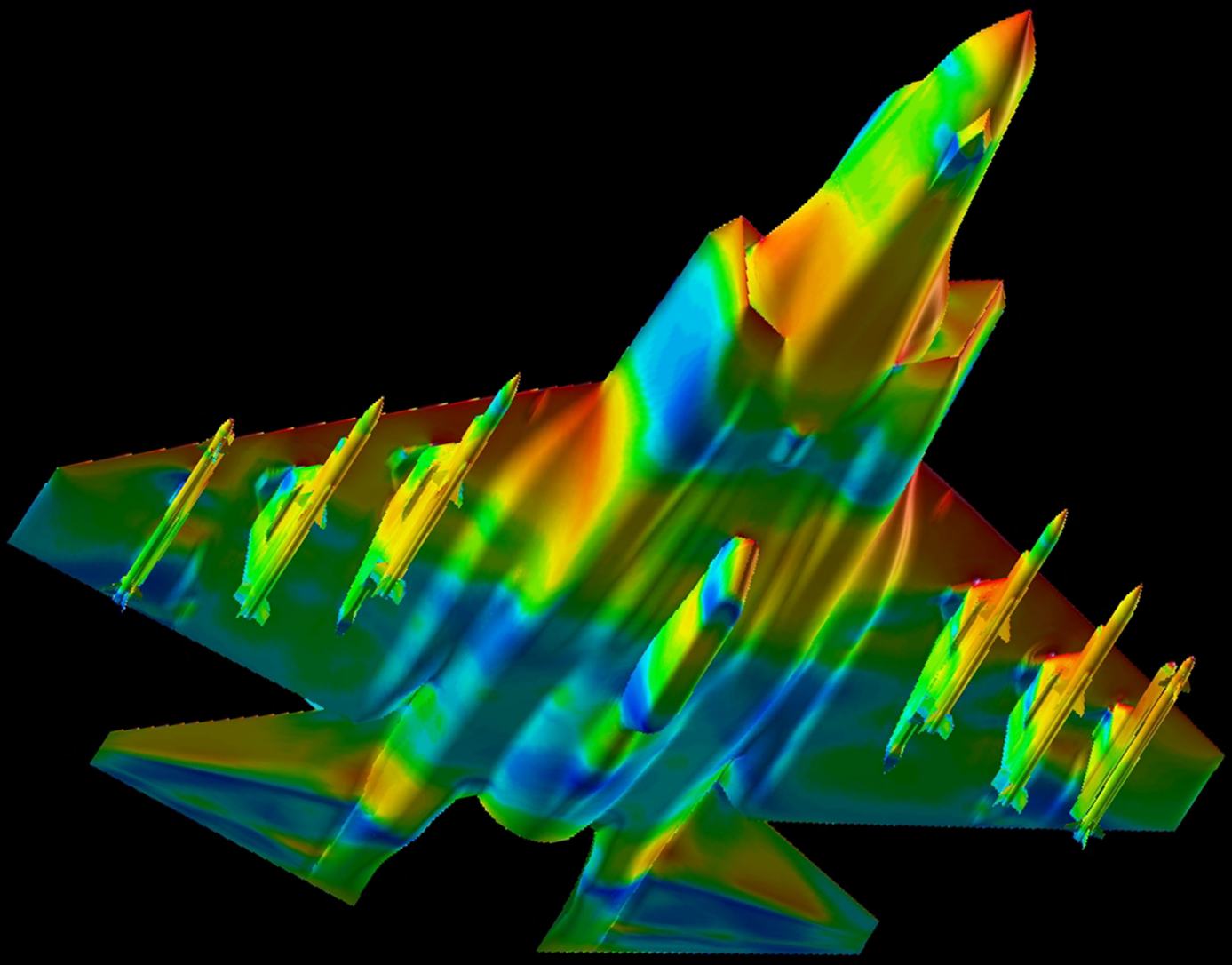
2003

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 Goals

1. Ensure proactive and sustained technical excellence in providing accurate, safe, secure, timely and efficient support to meet established requirements.
2. Provide a fully qualified, experienced and proactive management team committed to integrating and optimizing center-wide.
3. Ensure high asset (test facilities, plant, support facilities, utility systems and equipment) reliability, availability, maintainability and configuration management.
4. Apply information technology, systems and processes that integrate and streamline information flow to facilitate timely management decisions, enable reliable facility operations and provide high quality test and evaluation data.
5. Reduce and aggressively control the cost of AEDC test and support operations and services while maintaining technical excellence within manageable levels of risk.

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

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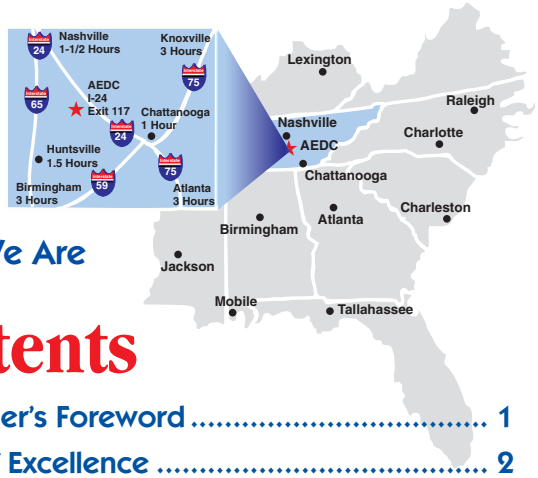

Where We Are

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ISO - AS9100 – World Class Aerospace Quality Standards

The government organization at AEDC became ISO AS9100 (Aerospace Standard) certified in early 2004. AEDC is only the second organization in Air Force Materiel Command to be ISO certified and is the first in the Air Force to receive the more stringent ISO Aerospace Standards certification. Aerospace Testing Alliance (ATA), the center's new single major support contractor is working towards full ISO aerospace standard certification in mid calendar year 2004.

To assure customer satisfaction, aerospace industry organizations must produce, and continually improve, safe, reliable products that meet or exceed customer and regulatory authority requirements. The globalization of the aerospace industry, and the resulting diversity of regional/national requirements and expectations, has complicated this objective. End-product organizations face the challenge of assuring the quality of, and integrating, product purchased from suppliers throughout the world and at all levels within the supply chain. Aerospace suppliers and processors face the challenge of delivering product to multiple customers having varying quality expectations and requirements.

ISO AS9100 standardizes, to the greatest extent possible, quality management system requirements for the aerospace industry. The establishment of common requirements, for use at all levels of the supply-chain, by organizations around the world, should result in improved quality and safety, and decreased costs, due to the elimination or reduction of organization-unique requirements and the resultant variation inherent in these multiple expectations.

Aerospace Standard AS9100 encompasses the quality management principles of the ISO standards and details more stringent aerospace industry-specific requirements. The internationally-accepted certification verifies that an organization has sound policies and practices in place to ensure quality of operations. AEDC elected to meet the more rigorous AS9100A standard and did so in record time. The preparation for this audit is usually 18 months; AEDC completed it in nine months

Commander's Foreword

In 2003, the center continued its transformation to better serve our customers and provide the best possible support to the nation's warfighters.

The year brought significant change that will provide better focus and reduce costs. This was the first full year of operation for two new key organizations; Maintenance and Investments.These organizations provide a better focus on maintaining our unique infrastructure and doing better focused long-range planning for significant facility upgrades. This allows the testers to focus on their prime mission, providing the best test and evaluation support in the world to our military, government and commercial clients.

The other major change was the selection of a new single support contractor for AEDC. This was the culmination of more than a year's hard work. The government team selected a single contractor to provide the work force to operate and maintain AEDC under government supervision. For the first time the process opened up the bidding to companies in the aerospace business and brought on a healthy competition to provide the best services to AEDC.

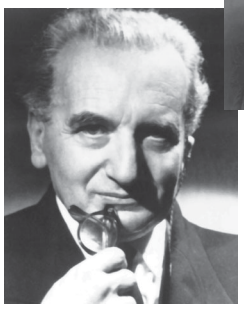
Aerospace Testing Alliance, a joint venture of Jacobs Sverdrup, Computer Sciences Corp. and General Physics Corp., produced the winning bid. The new company began transition in August, replacing the two previous contractors October 1. ATA's streamlined approach to management and operations, as well as the technical strengths they bring to the table, will enhance AEDC's operation. The contract, valued at up to $2.7 billion, has a potential length of 12 years in one-year options.

Another component of AEDC's future is the significant facility upgrades underway to increase efficiency, expand the testing envelope and in many cases reduce cost to our test customers. These include the multi-year Propulsion Wind Tunnel upgrades that will reduce the number of people required to run the facility and have the potential to reduce electrical cost for that single facility by almost $1 million per year. Also, significant upgrades to our two sea-level test facilities have increased their capabilities and the ongoing upgrade to the Aerodynamics and Propulsion Test Unit (APTU) will increase the facility's Mach number and run times.

The men and women of AEDC have a 52-year heritage of supporting the development of advanced flight systems that keep our nation on the cutting edge of flight technology and give our warfighters the best equipment in the world. The transformation underway will upgrade the center's capabilities that make it the world's premier ground flight simulation test facility, making AEDC America's air and space advantage.

DAVID J. EICHHORN
Brigadier General, USAF
Materiel Wing Director,
AEDC Commander

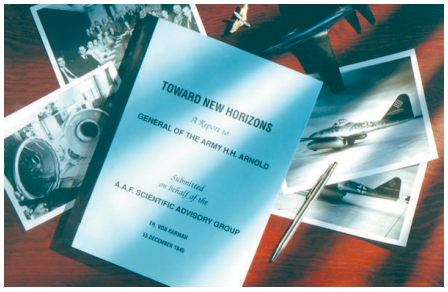
History of Excellence



General of the Air Force Henry 'Hap' Arnold (top) led the Air force in World War II. Dr. Theodore von Karman (bottom left) headed up the first Air Force Scientific Advisory Group. Dr. Frank Wattendorf (bottom right), a member of that group, proposed creation of AEDC.

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 Advisory 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 of the center began in 1950. President Truman dedicated the center on June 25, 1951, and 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 blueprint for future development that von Karman and the Scientific Advisory Group report, "Toward New Horizons," provided 50 years earlier.

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

Economic Impact

Arnold Engineering Development Center 's economic impact in Middle Tennessee exceeded $536 million for fiscal year 2003 that ended Sept. 30. This is an increase of almost $45 million from 2002.

The total economic impact includes the center's payroll, secondary jobs created locally through the spending of that payroll, and other expenditures for supplies, utilities, fuel and services and the spin-off impact of those purchases.

The economic impact data and secondary employment estimates were made using the TVA economic impact model methodology. The Air Force model, which uses a different, more conservative methodology, shows the center's economic impact at $417.1 million, up $35.2 million from last year.

AEDC employed 2,789 people in 2003.This number includes active duty military personnel from the Air Force, Navy and Army, government civilians and contractor personnel. Active-duty military personnel made up about four percent of the people at the center.

The 2,789 people employed at AEDC include military personnel, part time and temporary government civilians and contractor employees. Using the Tennessee Valley Authority (TVA) economic impact model methodology, it is estimated that an additional 1,928 secondary jobs were created in the local area, for a total of 4,717 jobs directly related to AEDC.

Examples of secondary jobs would be those created to build new houses or jobs created in local supermarkets, car dealerships and department stores.

The payroll cost for AEDC government personnel and contractor employees was almost $200 million. Other indirect expenditures were more than $163 million with the approximate payroll for secondary jobs exceeding $53 million and another $120 million in indirect spin-off impact.

Direct expenditures include money spent to pay for utilities, service contracts with outside vendors and military health insurance paid to local doctors and hospitals.

This figure does not include another conservatively estimated $60 million in retired pay paid to retired military personnel in the local area. In addition, the conservative estimate is that $26 million is paid to government and contractor civilians who retired from AEDC and live in the local area.The retired pay also generates another $40.4 million in spin-off effect.

The base figures also do not include test customers like Pratt & Whitney and GE who maintain staff at AEDC to manage tests of their products or other customers who spend time at AEDC during the year to take part in the test process.

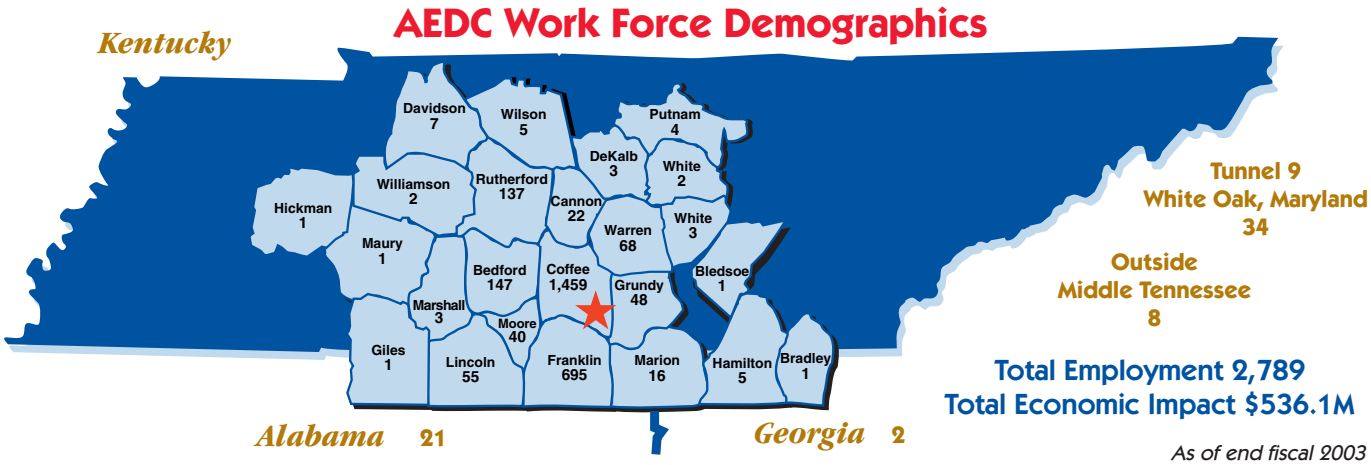
The current replacement value for the aerospace testing complex at Arnold Air Force Base is $7.6 billion.

Fiscal 2003 Economic Impact Data

TVA Model Estimates for AEDC
As of Sept. 30, 2003

Direct Employment at AEDC	
Military	121
Government Civilian	264
Non-appropriated Fund	46
Sverdrup/ACS	2,348
AEDC Federal Credit Union	5
Base Exchange	5
Total	**2,789**
Secondary Jobs Created	1,928
Total Employment Impact	**4,717**
Economic Impact (in millions)	
Non-construction Expenditure	$ 361.4
Indirect Spin-off Impact	$ 169.9
Construction Expenditures	$ 1.9
Indirect Spin-off Impact	$ 2.9
Total Direct Expenditures	**$363.3**
Total Indirect Expenditures	**$172.8**
Total Economic Impact	**$536.1**

AEDC Work Force Demographics



As of end fiscal 2003

Community Involvement

Center employees make a difference in communities all across the Midstate, including Tullahoma, Winchester, Manchester, Shelbyville, Murfreesboro and a host of other Tennessee cities (breakdown of employees by county on page 8).

Many AEDC employees devote their time away from work to community service by holding political office, teaching or otherwise volunteering with religious and community organizations, including the Boy and Girl Scouts and many civic clubs.

Base employees also help raise funds for many worthwhile causes to support needy families at Thanksgiving and Christmas, as well as in the annual Combined Federal Campaign. Base personnel also help groups like Habitat for Humanity, assisting in the construction of homes. AEDC personnel are also major players in the annual Special Olympics each spring.

Arnold Community Council

(left to right) Arnold Community Council Officers - Harry Brittain, secretary; Lana Woodard, treasurer; Walt Wood, vice president and Jeff Fishman, president.

The Arnold Community Council (ACC) is a coalition formed in 2000 to support and promote AEDC. The board of directors includes community leaders, area political officials and business people from 10 Middle Tennessee counties surrounding Arnold Air Force Base. The group receives monthly briefings from the AEDC commander and key staff on situations and events impacting the base.

The number of individual and business memberships in the ACC continues to increase each year thanks to five special committees, including a proactive membership committee. The ACC supports quarterly and annual military awards programs, an annual veterans picnic and several other base activities. Members speak to civic groups about the mission and value of AEDC and interact with elected officials on a state and national level discussing the importance of the center.

The ACC held an annual membership appreciation banquet in May with, then, Air Force Material Command Commander Gen. Lester Lyles as guest speaker. Because of an overwhelming response from area residents wanting to attend the event, the banquet was moved from AEDC's Arnold Lakeside Club to the Manchester-Coffee County Convention Center.

2003 Special Olympics

An AEDC employee celebrates with two Special Olympians.

AEDC's Color Guard leads the 2003 Area 13 Special Olympic opening ceremonies.

A Jacobs Sverdrup employee explains the 100-meter dash to two Special Olympic competitors.

Community Health and Safety

An AEDC employee watches as a phlebotomist with the Red Cross prepares to receive a blood donation during a blood drive at AEDC.

Tri-Chamber Air Show Coalition

The Tri-Chamber of Commerce Coalition of Manchester, Tullahoma and Franklin County assisted in organizing the center's Centennial of Flight Air Show in June 2003. More than 80,000 people attended the two day air show that celebrated 100 years of powered flight. This successful event brought closer ties between the three communities involved and the base, and comments from many of the air show performers that this is one of the best air shows in the country.

2003 Centennial of Fight Air Show

Local communities were a partner in sponsoring AEDC's 2003 Centennial of Flight Air Show. The air show included (clockwise) acts like a wing walker on a vintage Waco biplane, National Aviation Hall of Fame stunt pilot Patty Wagstaff, an F-15–F-86 Heritage Flight and the U.S. Army Golden Knights parachute team.

AEDC Awareness

Above, a tour guide explains the workings of the Propulsion Wind Tunnel complex to visitors.

At Right, AEDC hosts local civic leaders in an "Evening at Arnold" program to increase awareness of the center's mission.

- Kids Rocket Launch
- Toys for Tots
- Youth Rifle Safety Classes
- Tullahoma Christmas Parade
- Habitat for Humanity
- Haven of Hope Shelter for Battered Women
- Soapbox Derby
- Coffee County Air Force Junior ROTC
- Civil Air Patrol
- Hands-On Science Center
- Meals on Wheels

An AEDC driver/operator and EMT IV checks a triage tag on a disaster drill "victim" prior to transporting him via ambulance to a local hospital for more definitive care.

Honoring our Veterans

Second Lt. James Hooper was one of the AEDC military force to serve food to more than 70 military veterans and staff members from the Alvin C. York Medical Center and the Tennessee Veterans Home from Murfreesboro, Tenn., during AEDC's annual VA picnic.

A retired Navy master chief shares a sea story with Navy Capt. Larry Judge, AEDC vice commander.

Transition

AEDC is upgrading the Propulsion Wind Tunnel facility to reduce operation costs and improve service to customers. Part of the upgrade involves replacing two massive drive motors for the facility with new 60,000 horsepower motors.

Fiscal 2003 was a year of significant transition at AEDC.

The center stood up two major new organizations, Maintenance and Investments, to help put better focus on those areas. These new organizations allow the testing community to focus on their primary job, providing the world's best aerospace testing to our customers.

Maintenance can focus solely on providing the right preventative and responsive maintenance, and investments can work long range upgrades, improvements and modifications, as well as acquiring new facilities to meet future testing requirements.

This year was a significant milestone also as the Air Force selected a single new contractor to provide the personnel and services to operate and support the center's test facilities and infrastructure. It has been 23 years since AEDC had only one major support contractor.

Aerospace Testing Alliance (ATA) was named the winning bidder to provide these services to AEDC on June 30, 2003.

ATA is a joint venture of Jacobs Sverdrup, Computer Sciences Corp. and General Physics Corp. Their contract has a possible length of 12 years in one year increments and is worth up to $2.7 billion.

ATA replaced AEDC testing contractor Jacobs Sverdrup and mission support contractor Aerospace Center Support. Both of those eight year contracts expired on Sept. 30, 2003.

Transition from the previous two support contractors began in August, with ATA beginning operations on Oct.1, 2003.

ATA hired the majority of its employees from the two previous contractors. Combining and streamlining functions led to immediate manning efficiencies and cost savings as ATA started out the contract with about 2,150 employees, including almost 100 people working for six ATA subcontractors.

The new company organization has six departments and two special groups reporting to the Office of the General Manager versus 13 major departments in the two previous contractors.

Part of ATA's winning bid included 34 initiatives that are designed to drive further efficiencies to help hold down and reduce costs to our test customers.

The government will watch very closely how effective ATA is in following through with these actions.

One of the requirements for the new company is that it become ISO 9000 certified by the summer of 2004. The government has already achieved

Dr. David Elrod, Aerospace Testing Alliance (ATA) general manager for gives an all-hands briefing to a capacity audience of AEDC contractor employees on the transition to ATA at the Coffee County Conference Center in Manchester.

ATA is led by General Manager Dr. David Elrod (right) and Deputy General Manager John Miller (left).

ATA Vision

ATA will be a trusted partner in delivering best value warfighter support and asset stewardship to AEDC.

Aerospace Testing Alliance

Core Values

- Be accountable for our own actions.
- Ensure the safety of individuals and equipment.
- Demonstrate the highest integrity and ethical standards.
- Communicate clearly and openly.
- Deliver professional and technical excellence.
- Nurture, enable and treat people fairly.
- Align with customer goals and objectives.
- Use disciplined and innovative processes.
- Continually improve in all that we do.

ISO Aerospace AS9100 certification. AEDC is the first U. S. Air Force organization to achieve this more stringent certification.

ATA is also working to achieve the ISO Aerospace certification in early summer 2004.

Several construction projects, specific to the increased security posture at military installations since Sept. 11, have increased the overall security of the installation.

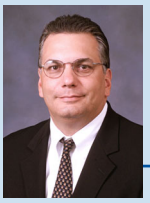
An Air Force officer reviews data with a contractor metrologist in AEDC's Precision Measurement Equipment Laboratory.

ATA Organization

Office of the General Manager

Dr. David Elrod
General Manager

John Miller
Deputy General Manager



Safety & Health Group
Jon Lessard
Manager

Performance Management Group
Chip Stepanek
Manager

Resource Provisioning Department

Steve Pearson
Director

Information Tech & Systems Department

Ken Foster
Director

Investments & Design Department

Richard Wakeman
Director

Integrated Test & Evaluation Department

Philip Stich
Director

Facilities O&M Department

Bert Coffman
Director

Support Services Department

Keith Humphryes
Director

Work Force Breakdown

Arnold is unique in the Air Force not only because of its world-class test facilities, but also because of its distinctive work force, which are about 85 percent contractor employees and 15 percent government personnel.

The philosophy behind this distribution, which has been in place since the center's inception in 1951, is to save money and create an experienced group of people who would make their careers at AEDC.

That philosophy has worked. The average age of the 2,789 member work force is 47, with an average of 16 years experience at the center.

AEDC's government staff is composed of military personnel and civilian employees and provides management direction, resource allocation, oversight and contractor administration.

The contractors in 2003 were Sverdrup Technology Inc./AEDC Group – a Jacobs Engineering Company, and ACS, a joint venture of Computer Sciences Corp., DynCorp and General Physics.

Sverdrup conducted aerospace testing and ACS was the center support contractor. Both contracts expired on Sept. 30, 2003 with Aerospace Testing Alliance (ATA) taking over as AEDC's single contractor Oct. 1, 2003.

The consolidation of Department of Defense test facilities brought Navy and Army personnel to AEDC over the last several years.

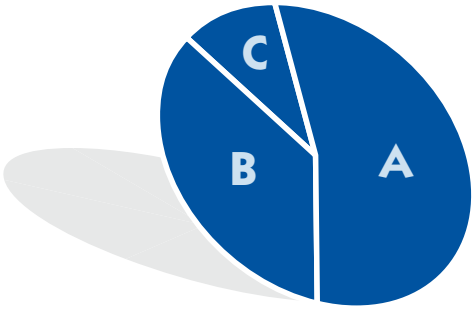
The Air Force made the center's vice commander slot a Navy position, occupied by Navy Capt. Larry Judge. Army Col. James Hesson serves as the center's Army Aviation and Missile Command Liason.

An independent duty medical technician checks out a patient. AEDC's government staff, composed of military personnel and civilian employees, represent 15 percent of the AEDC work force.

AEDC's skilled contractor craftsmen are critical to the center's operation.

FY03 Breakdown

A	Sverdrup	50%
B	ACS	35%
C	AF/Navy/Army	15%



What They Do

Craft	34%
Engineers/Scientists	27%
Technical Associates	11%
Administrative	24%
Managers/Supervisors	4%

Craft Employee Breakdown

Machinists	15%
Instrument Technicians	17%
Electrical	14%
Operating Engineers	12%
Pipefitters	9%
Police/Fire	8%
Storekeepers/Drivers	8%
Janitors	4%
Other	13%

Engineers/Scientists Breakdown

Mechanical	22.5%
Aeronautical/Aerospace	15.4%
Electrical	15.4%
Computer Science	8.5%
Mathematical	4.9%
Physics	6.1%
Industrial/General	5.9%
Other	21.3%

Bachelor's	63%
Master's	32.8%
Doctorate	4.2%

Alliances

AEDC was established to ensure that America always lead, not follow in the aeronautical arts.

In the more than five decades since AEDC was established, it has grown to a complex of 58 test facilities, worth more than $7.6 billion that can simulate the operating environment from sea level to outer space for aircraft, missiles and space systems.

The center provided services critical to the development of some of the best flight systems ever seen by man and allowed the American military to dominate the air.

Testing at the center is critical to America's successful access to space for manned and unmanned systems.

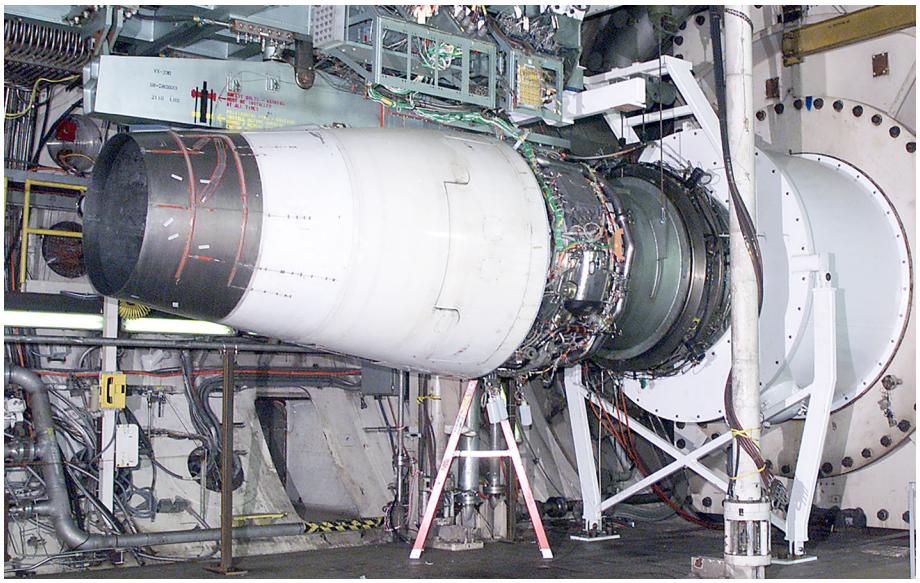
AEDC was born as a bold idea. The men and women who came to Tennessee in the early 1950s played a critical role in winning the Cold War by creating an air engineering research and development center unlike anything before.

More than once in the center's half a century of serving the nation, the people of AEDC have transformed the way they do business to be more efficient and better serve their customers' needs. Not just developing new testing technology and facilities, but relationships that serve the military and economic defense of the nation.

In the last decade of the 20th century, the center forged new alliances and relationships to better serve the nation and recognize the global aspect of American aerospace leadership.

Legislation in the early 1990s gave the center commander more flexibility in doing commercial business to utilize available resources to benefit the nation's aerospace industry.

The center also forged long-term alliances with key aerospace companies, as well as educational institutions and other high technology government and private organizations. These brought non-traditional revenue to AEDC and helped start the transformation to better serve the nation in the 21st century.



The PW6000, the engine selected to power the Airbus 318, undergoes testing in AEDC's C-2. This test was a commercial engine test performed under the AEDC alliance with Pratt & Whitney.

Some Key Alliances

Major Industry Alliances:

- Boeing
- General Electric Aircraft Engines
- Lockheed Martin
- Pratt & Whitney (United Technologies)

Educational Alliances:

- Air Force Institute of Technology
- Hands-on Science Center
- Middle Tennessee State University (MTSU)
- Motlow State Community College
- Tennessee Technological University
- University of Maryland
- University of Tennessee Space Institute
- Vanderbilt University

Other Government Agencies:

- AEDC/NASA/DOE (Tri-Lateral Alliance)
- Air Force Seek Eagle Office
- Defense Threat Reduction Agency
- DOE - Oak Ridge National Laboratory
- NASA - Ames Research Center
- NASA - Lewis Research Center
- NASA - Langley Research Center
- NASA - Stennis Space Center
- Naval Air Warfare Center Aircraft and Weapons Divisions
- Tennessee Valley Authority

Community Agreements/Alliances/ Membership:

- AEDC Heritage Foundation
- Alvin C. York VA Medical Center
- Local Police, Fire and Ambulance Services
- Southern Tennessee Medical Center
- Tennessee Correction Academy
- Tennessee Economic and Community Development Agency

Directorate of Mission Support

Mission

Responsible to the AEDC commander for all aspects of the center's mission support including communications, computers, information services, environmental management, civil engineering, medical aid services, security forces and "services" activities. The directorate is also responsible for planning, programming, budgeting and executing Air Force Materiel Command (AFMC) Mission Support Mission Area (MSMA) resources to achieve the command and center strategic objectives.

Col. Quincy Purvis (left) heads the Mission Support Directorate. Bill Gray serves as technical director.

Fiscal 2003 Overview

The Support Directorate maintained base computer and network systems to meet Air Force Materiel Command (AFMC) availability goals, executed critical test and support infrastructure projects, responded to the increased emphasis on security, improved military readiness and maintained environmental compliance.

The directorate's Communications Division supported a number of DoD, Air Force and AFMC Information Technology (IT) programs including: Public Key Infrastructure (PKI), Windows 2000, GeoBase, Time Compliance Order (TCO) and High Performance Computing. The 2,317 AEDC communication and computer systems were accredited and all systems maintained compliance with Notice to Airmen (NOTAMs). A Storage Area Network (SAN), capable of 6 Terabytes of storage, including a tape backup system for fast backup of data without using the Network, was installed. The SAN greatly reduced network traffic allowing network bandwidth to be used for data transmission instead of lengthy backups.

AEDC is now in position to start server consolidation efforts to reduce the number of servers being managed and maintained, as well as the number of servers requiring technical refresh.

A member of the AEDC Security Forces checks a vehicle during a random vehicle inspection.

Civil Engineering executed more than $14 million in maintenance, repair, construction and renovation projects for the center's test and support infrastructure. These projects will keep AEDC viable to support national defense today and in the future. The team also awarded antiterrorism/force protection projects valued at nearly $3.5 million, scheduled for completion in fiscal 2004, greatly increasing the center's security.

Demolition of the Tunnel F complex and Environmental Management Facility began this year. Two Military Construction Program (MILCON) Projects, Phase 4 of the fighter engine inlet upgrades and Aerodynamic and Propulsion Test Unit (APTU) upgrades, are well underway.

Security and emergency response forces continued to provide vigilant support to Arnold Air Force Base and the center's 40,000-acre installation and multi-billion dollar infrastructure. Efforts to upgrade all facilities at AEDC to meet Air Force and AFMC Anti-Terrorism/Force Protection requirements are underway. The AEDC Security Office hosted the Headquarter (HQ) Air Force Information Security Program Manager's Conference.

Logistics Readiness trained and equipped eleven military members for deployment in 2003. They also planned a successful deployment exercise to Camp Warlord at Little Rock AFB.

The Materials Management team completed a five-year effort to clean up the spare parts inventory, significantly reducing the number of line items required in storage.

AEDC maintained environmental compliance with state and federal permits, concluded the renewal of our five-year wastewater discharge permit and continued aggressive restoration activities in conformance with our Resource Conservation and Recovery Act Permit. The center also implemented facility improvements in both the test operations and support areas to reduce compliance risk, maintained our emphasis on integrated natural resource management, and finalized a programmatic agreement with the State Historic Preservation

officer, establishing a process for management of historic and cultural assets at AEDC in compliance with Section 106 of the National Historic Preservation Act.

The Services Division provided significant improvements, including the installation of new sports flooring, free weights, selectorized resistance equipment and new cardio equipment in the Fitness Center. The master program plan was revamped to include six new incentive programs, 11 new individualized/instructional classes, 13 new water programs associated with a local recreation center partnership program and two additions to the group exercise classes.

In addition, a master maintenance plan was implemented for the entire facility. As a result of these efforts, the Fitness Center was given a respectable three out of five-star rating for AFMC's "Five-Star Fitness" award criteria.

The Community Activities Center purchased furniture for the lounge/entertainment area, computer chairs for the library, two boats for the Marina rental fleet and a camping trailer for the FamCamp.

The Community Center staff provided an educational one-week science camp for the youth, including activities, such as constructing and launching model rockets.

The Wingo Inn installed a keyless lock entry system to address safety concerns and provide additional convenience for lodging customers. Lodging upgrades and the addition of a new wing have been included on the Arnold AFB Military Construction (MILCON) project list.

While customer service is always a priority within Services, improving productivity and efficiency is crucial. The Non-Appropriated Fund Accounting Office successfully implemented 100 percent electronic funds transfer for all Non-Appropriated Fund employees complying with Air Force Services Agency.

AEDC military members make their way through the "High Step" obstacle at "The Rock" during their deployment exercise at Camp Warlord. The deployment exercise was planned by AEDC's Logistics Readiness.

Fiscal 2004 Forecast

The Support Directorate will maintain a focus on efficient and effective support services in fiscal 2004.

The Communications Division will manage a significant change in AEDC's approach to consolidate Information Technology (IT), eliminating duplication of effort, which is expected to yield more effective and efficient IT services.

Civil Engineering Projects in fiscal 2004 include construction of a new Applied Technology Laboratory Facility and a new SL-2/SL-3 Support Building, expansion of the fire station, and execution of 25 utility, infrastructure, paving, roof, and Heating, Ventilation, Air Conditioning Facility (HVAC) system projects.

Security Forces will deliver two new programs to AEDC; a fully-trained/certified Explosive Detector Dog Team and an organic Combat Arms Training and Maintenance (CATM) Program. The CATM Program provides a qualified instructor for weapons qualification, training and weapons maintenance for Security Force and mobility weapons.

Environmental Management will negotiate a new Resource Conservation and Recovery Act (RCRA) Part B permit for continuance of our hazardous waste operations.

Services will continue their focus on customer service as they transition the Fitness Center to a Non-Appropriated Fund operation.

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 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 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.

During fiscal year 2003 AEDC maintained the health of its forests through efforts which included harvesting 157 acres of pine trees.

Every AEDC employee is familiar with hazardous materials in their workplace that represent a threat to the environment and is involved in their elimination or control. "Excellence" in all we do goes beyond merely meeting the standards. We are committed to setting the standard by which others will be judged in the future.

AEDC has a Geographic Information System (GIS) to facilitate analysis of ecosystem structure, function and composition, the environmental effects of proposed actions, and document change in various components of the environmental management program. The system enhances our ability to make better management decisions by rapid and accurate assessment and evaluation of new facility locations and minimization or elimination of environmental impacts from the implementation of approved operations. In fiscal 2003, improvements were made in our GIS system through creation of a GIS aerial photography library, conversion of the existing Intergraph-based GIS to Environmental Systems Research Institute ArcGIS, and development of the capability to process and use satellite imagery for environmental analysis.

Integrated natural resource management is an important aspect of the AEDC environmental program. AEDC consistently seeks to better integrate the management of irreplaceable biological, cultural and land resources within the overall framework of the test mission. 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 68 rare, threatened and endangered species on base property. Two federally protected species, the Gray Bat and the Eggert's Sunflower, are present on the installation. We have entered into a partnering arrangement

An AEDC zoologist identifies a bat to species for inventory work. A red bat is shown undergoing examination.

with the U. S. Fish and Wildlife Service to promote and enhance the management of these species.

Activities accomplished in 2003 which enhanced rare and sensitive species habitats include treating 2,070 acres for control of invasive plant species and conducting controlled burning on 1,650 acres. Activities, which enhanced the health of the forest, included reforestation of 91 acres, site preparation on 245 acres, and pine harvesting on 157 acres.

Pondy Woods on the northern portion of Arnold Air Force Base.

AEDC's restoration ecologist picks garlic mustard, an invasive plant, from an area around the AEDC airfield.

Pollution prevention and conservation go hand-in-hand to preserve the environment for future generations. A hazardous material pharmacy was established to track hazardous materials throughout their life cycle as they are received, issued and used. A dedicated recycling facility with a baler and a used-oil space heater supports the center's recycling program.

Pollution prevention initiatives include an environmental approach to waste management. AEDC saves more than $35,000 annually 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 that cleans and extends the lifecycle of the coolant.

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

One other major pollution prevention effort is the recycling of waste oil and Trichlorethylene (TCE) at AEDC engine test cells and test unit refrigeration systems. Prior to this practice, used waste oil and TCE were disposed of as hazardous waste.

Pump back projects on local base creeks reduce the risk of pollution being allowed to enter local waterways and allow for the operational reuse of the water, thereby saving the cost of pumping additional cooling water from Woods Reservoir.

AEDC strives to maintain an aggressive program of hazardous waste cleanup from past industrial practices under the DoD Environmental Restoration Program. Stakeholder involvement is crucial to the success of the cleanup effort.

The local community is kept informed of important site activity through a variety of information sources. One of these primary sources is the Community Advisory Board (CAB)-a committee consisting of AEDC personnel and local residents. The CAB meets regularly to discuss plans relating to ongoing restoration activities at AEDC. Another source of environmental information to the local populace is the ENVISION newsletter. This semi-annual product is written and produced by the Environmental Management Division and distributed to 600 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.

Teaming with the Tennessee Department of Environment and Conservation (TDEC), AEDC has volunteered to adopt state corrective action reforms that streamline the investigation and remediation process of environmental sites. A testament to this streamlined process was AEDC's ability to finalize a work plan and complete fieldwork on a $1.1 million project at the retention reservoir and former chemical treatment pond. The project focused on mapping and assessing the bottom of the retention reservoir and treatment pond to see if contaminants were present in the sediments. This effort was completed in a fourteen-month period instead of the three years it would have taken prior to the reforms initiative.

An important step in the AEDC restoration program took place in May 2002 with the completion and approval of a Resource Conservation and Recovery Act (RCRA) facility inspection for the Coffee County Landfill. Final remedy alternatives are now being evaluated at the 97-acre landfill, which will include continued operation and maintenance of the gas and groundwater recovery systems at the landfill.

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."

Investments

Mission

The Investment Directorate is responsible for the planning, programming, and execution of all new/modified test infrastructure assets, and programs for the development of new test techniques, modeling tools and instrumentation. The Investments Directorate also manages AEDC's systems engineering and configuration management processes and maintains AEDC's engineering standards.

James Parker (right) leads the Investments Division with the aid of Lt. Col. Robert Walker.

Fiscal 2003 Overview

Fiscal 2003 marked the first year for the Investments Directorate, which has accomplished significant milestones in the establishment of a critical investments planning process and the completion of investment programs vital in posturing AEDC for the test workload expected in fiscal 2004.

In fiscal 2003, the Directorate established three AEDC center-level instructions that document the approved processes for investment planning, investment program management, and systems engineering and configuration management.

In the area of investment projects, AEDC executed a $65-million program in fiscal 2003 that included $27.3 million for major Improvement & Modernization (I&M), Central Test and Evaluation Investment Program and MILCON support investments, $24 million for Aeropropulsion investments, $6.2 million for Flight Systems investments, $3.8 million for core investments and $3.7 million for Space and Missile investments.

AEDC continued toward completion of the $80 million Propulsion Wind Tunnel Facility Sustainment Program through the procurement of two new starter motors and an adjustable frequency starting and control system.

The Sustainment Program will increase productivity and reduce cycle time for the PWT facility and save $1.3 million per year in energy utilities.

In fiscal 2003, the Investments Directorate provided critical support for two MILCON programs at AEDC–the Jet Engine Air Induction Upgrade (Phase 4) and the Hypersonics Upgrade.

The fourth phase of the Jet Engine Air Induction Upgrade provides improved airflow, temperature and pressure control for the Engine Test Facility J test cells and allows for the reduction of older less reliable test infrastructure. The Hypersonics Upgrade will improve AEDC's Aerodynamic and Propulsion Test Unit test facility to enable testing of scramjet and ramjet engines at Mach 6 through Mach 8 for up to six minutes.

An AEDC operating engineer and ironworker make a final placement of the SL-3 thrust stand legs.

Fiscal 2004 Forecast

In fiscal 2004, AEDC will continue to upgrade test and facilities infrastructure with an investment program anticipated at $53 million. In addition, fiscal 2004 will mark the completion of the PWT Sustainment Program and the MILCON programs-the Jet Engine Air Induction Upgrade (Phase 4) and the Hypersonics Upgrade.

(right) An AEDC electric technician operates the compressors and heaters for a turbine engine test from the new ETF Control Room. The control room consolidates six old control rooms like the one above.

A construction worker welds a manway in one of four unique large-capacity tanks as part of a $11.2 million military construction project underway at AEDC's Aerodynamic and Propulsion Test Unit.

AEDC personnel review the future addition/renovation plans for PWT's Control Building shown in the background.

AEDC workers prepare one of the PWT main drive motors for installation. The M2/M3 motor replacement project is part of the Propulsion Wind Tunnel (PWT) Sustainment Program, an estimated $80 million, four-phase, seven year program to upgrade four main areas in the PWT test facility.

Investment Projects

A	FY03	$61.0M
B	FY04 Projected	$52.0M

Data unavailable for previous years because they were embedded in product area budgets.

Maintenance

Mission

Deliver the advertised test supporting products and services safely when needed and without interruption with a vision that emphasizes providing these capabilities at the "right cost," without adversely impacting our environment. Assure future test programs benefit from a long-range approach to asset management, which results in capability sustainment and stewardship. Finally, empower and motivate our workforce to perform required tasks efficiently and effectively while supporting AEDC's test missions through the operation and maintenance of the center's plants, laboratories, fabrication facilities, utilities, instrumentation, data and control systems.

Col. Craig Priebe (left) heads the Maintenance Division. His deputy is Dick Rumph.

The Directorate of Maintenance is responsible for management of the operations and maintenance of AEDC's Research and Development Test & Evaluation (RDT&E) infrastructure and equipment, which consists of national aerospace ground test facilities, industrial plants, test cell utilities, laboratories, instrumentation, controls, and data systems that support of 24-hour per day, seven days per week operations.

The directorate plans and coordinates test and maintenance activities with AEDC test divisions, civil engineering, and the support contractors to optimize, as a system, economics, throughput, and resources; analyze test performance requirements, cost goals, schedules and operations to identify improvements in efficiencies, effectiveness, and customer satisfaction. It establishes requirements and advocates modernization and repair of RDT&E facilities and equipment to meet immediate and future mission needs; generates future technology requirements for facilities and equipment; supports the center's business management processes for fiduciary responsibilities and provides evaluation of support contractor operations and maintenance efforts.

An AEDC craftsman performs maintenance on the Propulsion Consolidation and Streamlining Project.

Fiscal 2003 Overview

With the award of the Aerospace Testing Alliance contract at AEDC, significant changes are being made in maintenance execution.

A cornerstone of the transition is the development and release of a maintenance standard for the center, which will augment the contract performance work statement in the areas of tool control, foreign object debris, configuration control and professional image.

Several new performance measures will assure an across-the-board look at availability, reliability and maintainability of the center's mission critical assets.

We have developed an "across-the-board" approach to cost reduction and have laid out a combined Operations & Maintenance (O&M) roadmap to guide our actions. This integrated approach ensures that we recognize gains as soon as possible and leverage individual initiatives to maximize those gains.

Every area of our business is addressed and improvements continue to be recognized. The directorate has successfully culminated the first phase of its journey to achieve operations and maintenance excellence and is entering a second phase of improvement strategies for fiscal 2004.

Maintenance excellence strategies were developed in previous years and execution and implementation of these initiatives are either complete or on-track to complete in 2004.

The next phase of improvement begins with fully integrating test cell maintenance and utility maintenance into a consistent approach with plant maintenance philosophies and beginning to focus on data mining and analysis. This will capitalize on the new data systems put into place during the first

phase of the journey and will allow pinpointing the specific cost drivers that can provide maximum returns if streamlined.

The Test Operations Modernization and Integration Project, Propulsion Consolidation & Streamlining, and Propulsion Wind Tunnel Sustainment initiatives project huge gains in both the O&M areas through automation and consolidation coupled with infrastructure reduction. Most important, our work in the safety and environmental areas continues to be a strong focus for all of our areas.

Our focus areas include:

- Supporting AEDC's Strategic Plan by establishing and achieving innovative and aggressive cost reduction and enhanced reliability performance goals.
- Striving for safety and environmental excellence.
- Implementing a "One Plant/Cell Concept" for both Operations and Maintenance to include utility plants.
- Continuing to improve and standardize world-class integrated logistics processes across AEDC.
- Completely integrating Asset Stewardship, in plant, utilities and test cells
- Leveraging best practices already in place from plant, utilities, and test cells.
- Fully implementing a centralized plant, utilities, test cell and Model Shop Work Control Center for maintenance that also manages the utilization of Operations Personnel during non-test periods – Evolve and move this concept to other applicable areas
- Developing and utilizing the full potential of our Computerized Maintenance Management Service and other information systems available.
- Evolve the investment program requirements process across all of the Research and Development Test & Evaluation Area Assets.

During the last award fee period of the previous contracts, we learned that disciplined execution of procedures was not where it should have been and that configuration management was far weaker than required. In 2004, the directorate will work towards greater adherence to procedures and to the development of one consistent approach and process for control of configuration. Also an Instrumentation & Controls Department was created Oct. 1, 2003.

Fiscal 2004 Forecast

In fiscal 2004, the directorate will provide support for the major weapons systems, as well as commercial tests.

In order to achieve these objectives, many tools are necessary to include reliability-centered maintenance concepts, exploiting the latest technologies and incorporating them into our condition-based maintenance program, enhanced data analysis, increased operator/maintainer and maintainer/operator usage, evolved planning and scheduling, overall work force flexibility and full implementation of a comprehensive asset management plan.

To ensure that the asset management strategy for RDT&E, machine and fabrication assets, and laboratory assets are in alignment with AEDC strategies, the performance measures and focus areas are tied directly to the center strategic plan.

The approach for delivering and maintaining high levels of availability and reliability is based on the concept of cultivating a total systems culture and aggressively applying system engineering principles across all phases of AEDC's systems' life cycles.

The total systems approach will avoid sub-optimization, partial repairs, redundancy, and ineffective actions leading to poor performance and increased costs.

The directorate recognizes that essentially all activities impact availability and reliability to some extent. Maintenance, investments, mission support, and integrated scheduling obviously play a large role and we will consider each when making decisions and developing strategies for O&M of our RDT&E assets.

Workload Projections by Test Cell

Test Cell	Units	FY04 Workload
PWT 16T	UOH	1,620
PWT 16S	UOH	0
PWT 4T	UOH	1,570
Tunnels A, B, C	UOH	200
Small (T5/11/12, SL-2/-3)	AOH	350
Small (SL-2/-3 Sea Level)	SLOH	1,480
Medium (T1/2/4, J1/2)	AOH	520
Large (C1/2)	AOH	690
T3	AOH	0
Chambers - Complex	OSH	870
NEW (DECADE)	WEEK	13
J4/J6	Firings	4
ARCS	Runs	44
APTU	Runs	11
Range G/I	Shots	8
Tunnel 9	OpDay	105
ASMC	Manhours	49,000
S&M Sustainment	Manhours	103,000

Key: UOH User Occupancy Hour
AOH Air-On Hour
SLOH Sea Level Occupancy Hour
OSH Occupancy Shift Hour
OpDays Operational Days

Directorate of Operations

Mission

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

Col. Vince Albert (center) heads the Directorate of Operations assisted by Tom Best and Army Col. James Hesson.

The Directorate of Operations manages operations of AEDC's Development Test & Evaluation activities, which include: projecting future workload to establish resource requirements for budget and operating contract formulation; allocating resources within the approved annual program for test, analysis, technology and operations; interfacing with DoD, government, and commercial acquisition and development organizations to provide project and engineering management for test and technology projects; directing technology programs to improve AEDC test capabilities; defining new test capabilities to satisfy future requirements; and evaluating the base contractor's performance. Additionally, the Directorate of Operations provides critical input to Maintenance and Investment Directorates for infrastructure and investment programs to meet current and future testing requirements.

Fiscal 2003 Overview

The Directorate of Operations oversees and manages the AEDC testing divisions including Aerodynamics (Flight Systems), Aeropropulsion, Space and Missiles and Technology.

A recap of fiscal 2003 is provided in the pages that follow, along with a forecast for fiscal 2004 in each of our major mission areas.

AEDC's total customer funding for all testing in fiscal 2003 was $103 million – an increase of $12.7 million from fiscal 2002 due primarily to increase in turbine engine testing.

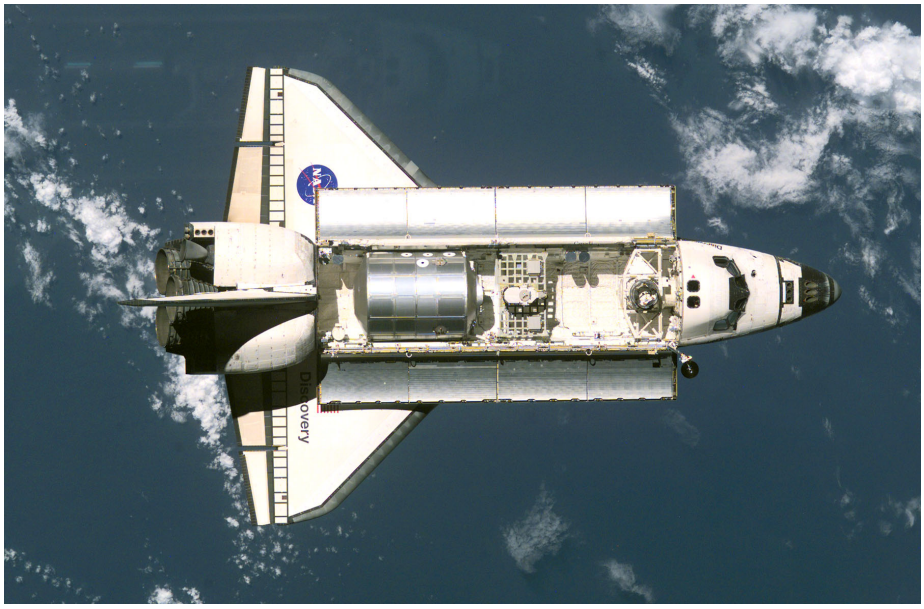
Air Force-led projects represented 33 percent of the center's total workload, with joint and commercial programs making up 45 percent of the total. The remaining 22 percent of the workload was composed of a combination of Missile Defense Agency (MDA), Navy, Army and other government programs.

Some of the major test programs AEDC supported in fiscal 2003 include the Air Force's top priority program, the F/A-22 Raptor air dominance fighter, development work for the F-35 Joint Strike Fighter (JSF), continuing testing for the Joint Direct Attack Munition (JDAM), Minuteman III and Peacekeeper testing support to the Intercontinental Ballistic Missile Special Program Office (SPO), and support to the National Aeronautics and Space Administration on the Shuttle Return to Flight Program. Many other programs, such as national and theater missile defense, space access, commercial and various classified programs, were also tested in fiscal 2003.

Fiscal 2004 Forecast

In fiscal 2004, the center will continue to provide support for the F-35 JSF, F/A-22 Raptor, NASA Shuttle Return to Flight, F-15 Eagle, F-16 Fighting Falcon and F/A-18E/F Super Hornet, as well as commercial tests.

The first quarter of fiscal 2004 is programmed for extensive maintenance and investment activity to prepare for the F-35 JSF turbine engine test programs starting in the second quarter, and upgrade and sustainment



AEDC supported NASA with return-to-flight testing for the Space Shuttle.

AEDC testing supports development and sustainment of the DoD's top-priority fighter/attack aircraft. Left to right, the F-35 Joint Strike Fighter, the Navy F/A-18 Hornet and the Air Force F/A-22 Raptor.

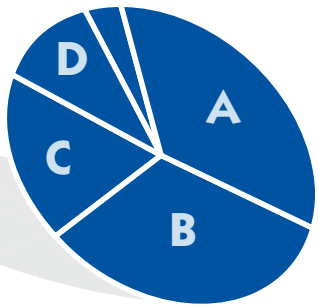
activities for the Propulsion Wind Tunnels Facility. The Pratt & Whitney F119 and other Engine Component Improvement Program tests continue to be the largest occupant in our large propulsion test cells. AEDC will see an increase in commercial engine work in fiscal 2004.

Support to ballistic missile, MDA and space access programs are also expected to remain at the same level as in fiscal 2003. A military construction project funded in fiscal 2003 will allow AEDC to close the aging Engine Test Facility air supply infrastructure in fiscal 2004. 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 $7.6 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.

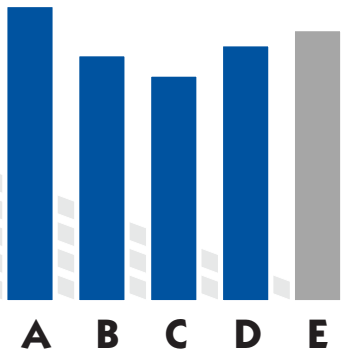
Fiscal 2003 Total Workload by Revenue

A	Air Force	33%
B	Joint	33%
C	Other Government	18%
D	Commercial	12%
E	Other DoD	4%



Test Mission Areas Total Earnings

A	FY00	$119.4M
B	FY01	$99.6M
C	FY02	$91.4M
D	FY03	$103.6M
E	FY04 Projected	$109.7M



Product Area Earnings

FY	00	01	02	03	04
Flight Systems	24.9	26.3	25.0	28.1	23.8
Aeropropulsion	63.3	43.3	32.8	41.5	55.9
Space & Missiles	21.8	20.3	23.5	22.4	20.8
Technology	9.4	9.7	10.1	11.6	9.2

Flight Systems

Mission

Provide fast, effective, and affordable aerodynamic test and evaluation services for the Department of Defense, U. S. government agencies, and commercial aerospace corporations and ensure that 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), hypersonic tunnels (A, B and C), and supporting plants. Analysis and computational modeling, such as computational fluid dynamics, are also key assets.

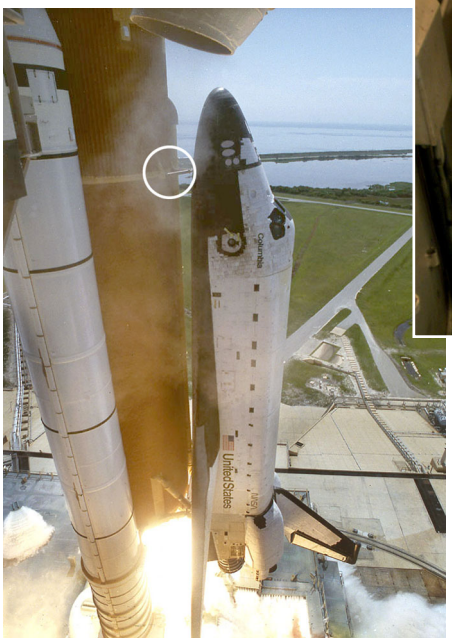
Gary Mattasits (right) leads the Flight Systems Division assisted by Marc Skelley.

Fiscal 2003 Overview

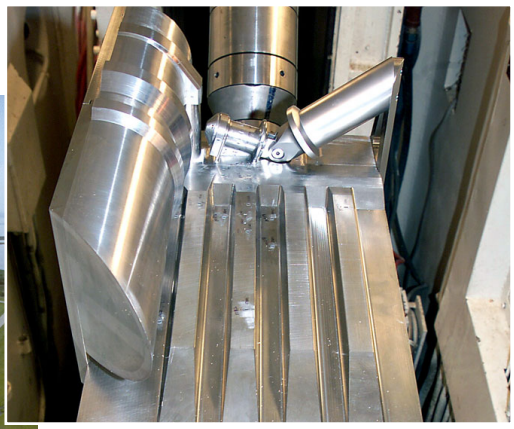
The earnings for the Flight Systems Product Area were $29 million in fiscal 2003, marking a 20 percent increase over fiscal 2002. The increase in earnings was related to work from the Joint Strike Fighter (JSF) program, National Aeronautics and Space Administration and Air Force testing.

The Propulsion Wind Tunnel (PWT) Sustainment Program remains an ongoing effort. In fiscal 2003, the PWT Sustainment Program began work on new state-of-the-art operations center for the 16-foot transonic wind tunnel (16T), and continued with the installation of the new PWT main drive starting system. The starting system is comprised of two new 60,000 horsepower starting motors and a new variable speed starting system. Other major investments aimed at improving PWT tunnel operation efficiencies completed in fiscal 2003 include replacing motor controls for PWT Plenum Evacuation System, implementation of 16T stator blade continuous sweep controls, providing improved model access for changes during testing, and replenishment of critical component supplies for the PWT main compressors, PES, and high pressure and process air compressors in von Karman Gas Dynamics Facility (VKF). Data acquisition system upgrades in the 4-foot transonic wind tunnel (4T) were completed under Real Time Display and Analysis Program to acquire steady-state test article pressures, force, and pressure and temperature data to support facility integration efforts of Advanced Instrumentation Data and Controls System Program.

Other investments initiated in PWT in fiscal 2003, furthering these goals, include repairs to 16T roll mechanisms, damaged during continuous sweep testing, and design of new mechanisms to meet those test demands, replacement of nonfunctional balances in balance inventory, and replacement of PES valves. A multi-year effort began in fiscal 2003 to restore propulsion test capabilities to both the 16-foot transonic (16T) and the 16-foot



The Space Shuttle Columbia lifts off on June 20, 1996. The circle indicates an area identified as the bipod ramp area of the shuttle. NASA has efforts underway to redesign or modify the area to return the space shuttle to flight. (photo provided by NASA)



A full-scale model of the redesigned bipod closeout area is mounted to the wall of the 4-foot transonic aerodynamic wind tunnel at the Air Force's Arnold Engineering Development Center. Test personnel prepare to expose the model to wind velocities up to Mach 2 to determine if foam loss would occur. Data from the test is assisting NASA with space shuttle component redesign efforts, critical to the safe return-to-flight mission.

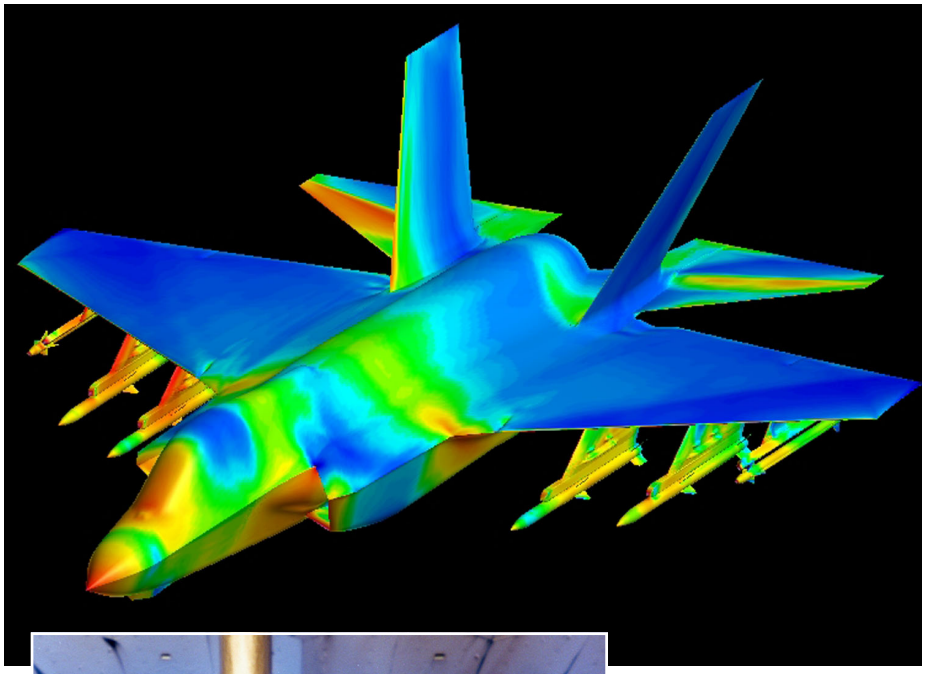
supersonic wind tunnel (16S) for upcoming propulsion test programs.

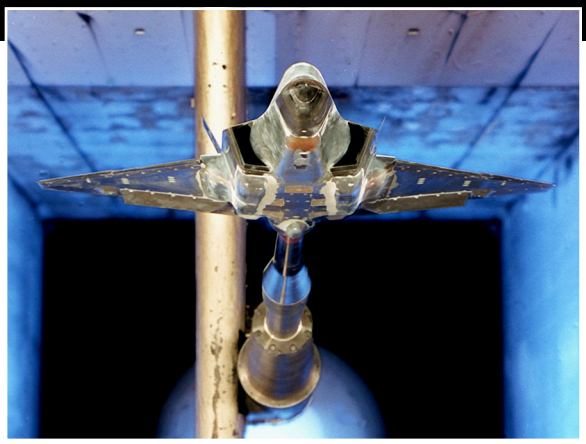
Major investments aimed at improving the VKF small tunnels' operational efficiencies completed in fiscal 2003 included restoration of critical component monitoring system, required for safe operation of the Tunnel A flex nozzle, replacement of small tunnel data acquisition components, replacement of Tunnel C components critical to safe operation of the tunnel, and replacement of desiccant in plant process air dryers. Ongoing investments being executed in the small tunnels and VKF, in preparation of anticipated space access support testing, included the refurbishment of the captive trajectory system and model injection systems in tunnels A, B and C, refurbishing V Plant process dryers, and replacement of V Plant facility monitoring computers.

Fiscal 2004 Forecast

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. In turn, this can decrease the number and duration of individual flight tests and their associated costs without increasing program risk.

AEDC continues to be successful in supporting the warfighter through testing programs such as the F-35 Joint Strike Fighter, Global Hawk, Small Diameter Bomb and weapons separation for the Air Force Seek Eagle Office. In addition, AEDC Flight Systems support other government agencies, such as the National Aeronautics and Space Administration, with several tests scheduled for fiscal 2004. All of these programs integrate computational modeling and simulation with ground and flight test to reduce the cost, cycle time and risk of these critical weapons development programs.



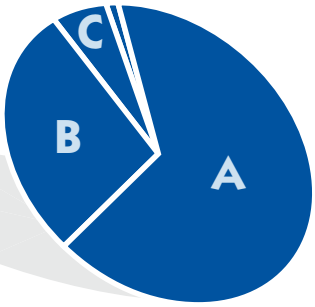


Above, an image of the F-35 Joint Strike Fighter carrying wing-mounted weapons is modeled using Computational Fluid Dynamics.

At left, a 1/12-scale model of the F-35 Joint Strike Fighter is positioned on a sting in the AEDC's 16-foot transonic wind tunnel.

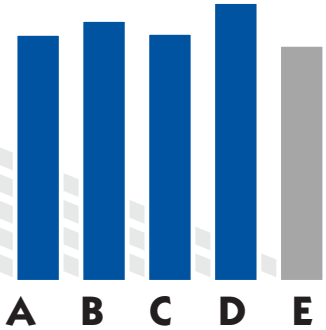
Fiscal 2003 Workload by Customer

A	Joint	64.5%
B	Air Force	28.0%
C	Other Government	6.2%
D	Navy	1.3%



Flight Systems Total Revenue

A	FY00	$24.9M
B	FY01	$26.3M
C	FY02	$25.0M
D	FY03	$28.1M
E	FY04 Projected	$23.8M



Aeropropulsion

Mission

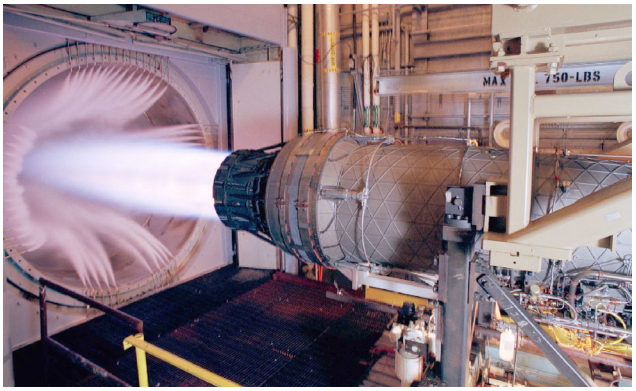
Provide fast, effective and affordable aeropropulsion test and evaluation services for the Department of Defense, U.S. government agencies and commercial aerospace corporations, and ensure that test capabilities, technologies and analysis support both present and future customers. Key assets include the Aeropropulsion Systems Test Facility test cells: C-1 and C-2, the Sea Level test cells, SL-2 and SL-3, and the Engine Test Facility test cells: J-1, J-2, T-3, T-4 and T-11.

Lt. Col. Bruce Magoon (right) leads the Propulsion Testing Division, assisted by his deputy, Susan Vining.

Fiscal 2003 Overview

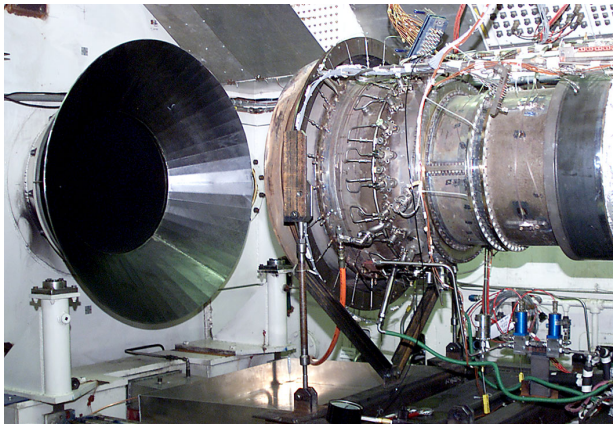
Aeropropulsion generated $43.0 million of revenue in fiscal 2003, accounting for over 40 percent of AEDC's total reimbursement revenue. The primary customers were the Air Force, Navy, commercial industry and the Joint Strike Fighter (JSF) Program Office. This test workload was a significant accomplishment since four major test cells were taken out of service for five months each during the year. Test cells C-1 and C-2 were unavailable January through May for the ASTF valve refurbishment major maintenance project, while test cells J-1 and J-2 were unavailable from May through the rest of the fiscal year for the Propulsion Consolidation and Streamlining MILCON project.

As in fiscal 2002, the major driver in Aeropropulsion continued to be engine Component Improvement Program (CIP) testing. Air Force CIP funded testing of the Pratt & Whitney (P&W) F119 engine for the F/A-22 Raptor, and the P&W F100 engine for the F-15 Eagle and F-16 Fighting Falcon fighter aircraft. Navy CIP funded testing of a new afterburner radial flameholder for the General Electric (GE) F404 engine used in the F/A-18 Hornet.



The Pratt & Whitney F100-PW-220 engine, powerplant for the F-15 and F-16 fighter aircraft, undergoes sea-level RAM testing in a Sea Level Test Facility in support of the Component Improvement Program.

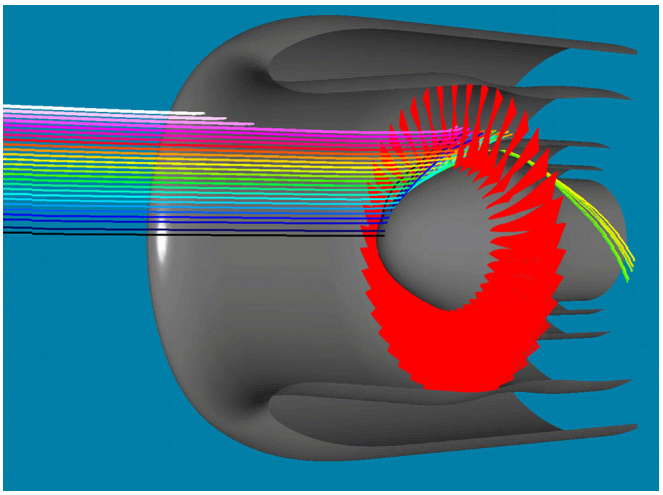
One of the most significant aeropropulsion testing accomplishments was completion of the Air Force Research Laboratory (AFRL)-funded P&W XTC67/1 Advanced Turbine Engine Gas Generator (ATEGG) Core. This test demonstrated the hottest steady-state operation ever achieved in a gas turbine engine, a significant milestone for the Integrated High Performance Turbine Engine Technology Program.



The combustor rig for the Pratt & Whitney F135 engine for the F-35 Joint Strike Fighter was tested in Propulsion Development Test Cell T-11 in support of the Systems Development and Demonstration phase of the program. The upcoming F135 engine test program, estimated at $200 million, is one of the largest and longest-lasting test programs in the center's 53-year history.

Commercial-funded testing included a second development test of the Rolls-Royce Mk951 Adour Engine, facility correlation and altitude certification tests of the P&W PW6000 for the Airbus A318, and an altitude test of the combustor for the International Aero Engines V2500 Engine used in the Airbus A320. Additionally, Rolls-Royce and P&W funded extensive facility preparation efforts to prepare for testing the Rolls-Royce Trent 900 and GE-P&W Engine Alliance GP7200, respectively, in fiscal 2004.

The JSF Program Office spent over $5.5 million in fiscal 2003 for AEDC to accomplish several facility preparation efforts that are needed for P&W F135 JSF engine Systems Development and Demonstration testing that is scheduled to begin in January 2004. Addition-



Computational Fluid Dynamics modeling of ir flow through the first stage of a gas turbine engine.

ally, a P&W F135 combustor system test to evaluate the proposed SDD combustor configuration was conducted in test cell T-11 during April 2003. Preparation efforts, which included test planning; test support systems design, procurement and fabrication; test cell preparation and installation of required support hardware; and initiation of support system checkouts, were directed at three test cells (J-2, SL-3, and C-1) that will support altitude and sea-level Ram development as well as qualification testing of the P&W F135 SDD engines. Ram is used to describe a type of Accelerated Mission Test (AMT), e.g. Ram AMT. In a sea level Ram AMT, air is forced (rammed) into the inlet of the engine at elevated pressure (above ambient) to simulate forward motion. Ram air is provided using the air supply compressors of the plant.

Fiscal 2004 Forecast

Aeropropulsion projects a major increase in revenue in fiscal 2004. This is primarily due to the significant amount of scheduled P&W F135 JSF engine SDD testing.

As in fiscal 2003, engine CIP testing will continue to account for a major portion of the fiscal 2004 revenue. Air Force CIP will fund testing of the P&W F119 engine, used in the F/A-22, in test cells C-1 and SL-2; testing of the P&W F100 engine, used in the F-15 and F-16, in test cells J-1 and SL-2; as well as the Service Life Extension Program testing of the GE F110 engine, used in the F-16, in test cell J-1. Air Force Research Laboratory-funded advanced development engine testing will also be conducted in test cell C-1 with the P&W XTE67/SE1 Joint Technology Demonstrator Engine test, in support of the high cycle fatigue initiative. Additional military engine testing will include the Rolls-Royce AE3007 engine, used in the RQ-4A Global Hawk, in test cell T-4.

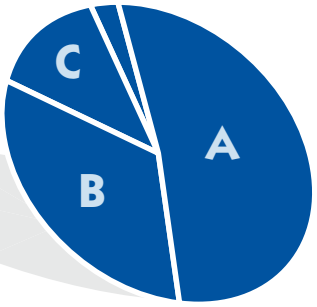
Commercial testing will become a much increased portion of the overall Aeropropulsion test workload in fiscal 2004 with the Rolls-Royce Trent 900, the GE-P&W Engine Alliance GP7200, and the P&W PW6000 all planned for testing in test cell C-2 in fiscal 2004. Additionally, the Rolls-Royce Mk951 Adour engine is scheduled to return to test cell T-4 for a follow-on third development test.

In support of the JSF Program Office, AEDC will continue with P&W F135 engine test cell preparations for J-2, SL-3, and C-1 as additional engine support systems are brought on-line for the JSF engine test program. Conventional Take-Off and Landing/Carrier Variant and Short Take-Off and Vertical Landing P&W F135 engine variants will be tested at altitude and sea level Ram conditions starting in J-2 during the second quarter of fiscal 2004 and in SL-3 during the third quarter of fiscal 2004, respectively. Testing should continue in these cells through the remainder of the year.

An AEDC craftsman examines the General Electric F404-GE-402 engine in AEDC's T-4 Propulsion Development Test Cell. The engine, which powers the Navy/Marine Corps F/A-18 Hornet, underwent development testing at AEDC in 2003.

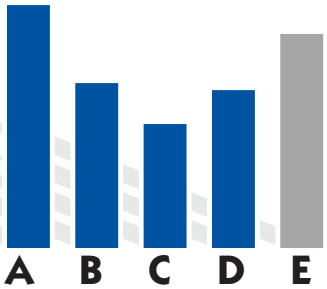
Fiscal 2003 Workload by Customer

A	Air Force	52%
B	Commercial	31%
C	Joint	14%
D	Navy	3%



Aeropropulsion Total Revenue

A	FY00	$63.3M
B	FY01	$43.3M
C	FY02	$32.8M
D	FY03	$41.5M
E	FY04 Projected	$55.9M



Space and Missiles

Mission

Provide fast, effective and affordable test and evaluation services for the Department of Defense, U.S. government agencies and commercial aerospace corporations by maintaining technical excellence in space technologies and ensuring test capabilities are available to support today's and tomorrow's space development requirements. Space and Missile test and evaluation services include a broad range of technical disciplines that are divided among five areas: rocket and air-breathing propulsion, space environments, hypersonics, nuclear weapons effects and missile signatures.

Lt. Col. Curtis Amble (left) directs the Space and Missile Division with the assistance of Lt. Col. Jay Cossentine (right).

Fiscal 2003 Overview

The Space and Missiles Test Division has categorized its customer base into four strategic areas: Missile Defense, Long Range Strike, Space Access and Space-Based Missions. The Space and Missiles product area earned $22.4 million in fiscal 2003, a 4 percent decrease in test revenue from fiscal 2002.

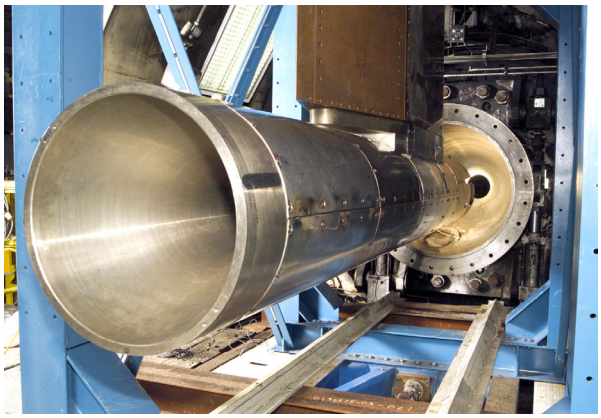
Missile Defense

The Missile Defense mission area remains a top priority. The Missile Defense Agency (MDA) has identified several AEDC assets as core test and evaluation (T&E) infrastructure to support development and fielding of the Ballistic Missile Defense (BMD) System: Hypervelocity Wind Tunnel 9 in White Oak, Md., the 7- and 10-foot thermal vacuum space chambers, Hypervelocity Ballistic Range G and the Advanced Missile Signature Center (AMSC).

MDA continues to provide significant financial resources to maintain the skills and infrastructure to ensure viability of their selected core ground test facilities at AEDC and provide technical support to their program elements.

In fiscal 2003, MDA provided nearly $10 million for core skill and facility sustainment purposes and $4 million in program element tests and upgrades for specific test efforts.

Tunnel 9 provided critical test support for developing kill vehicle technologies. The endo-atmospheric aero-optical test capability was completed and is ready for system level interceptor testing of MDA Block 2006 programs. In addition, design and requirements definition were completed for upgrading the high pressure, Mach 8 capability to be used in a dynamic pitch mode. It is anticipated that this capability will be used to validate performance for more energetic missile boosters and assessment of the accuracy of kill vehicles for Theater High Altitude Air Defense (THAAD), Ground-based Midcourse Defense (GMD) and Kill Interceptor programs.

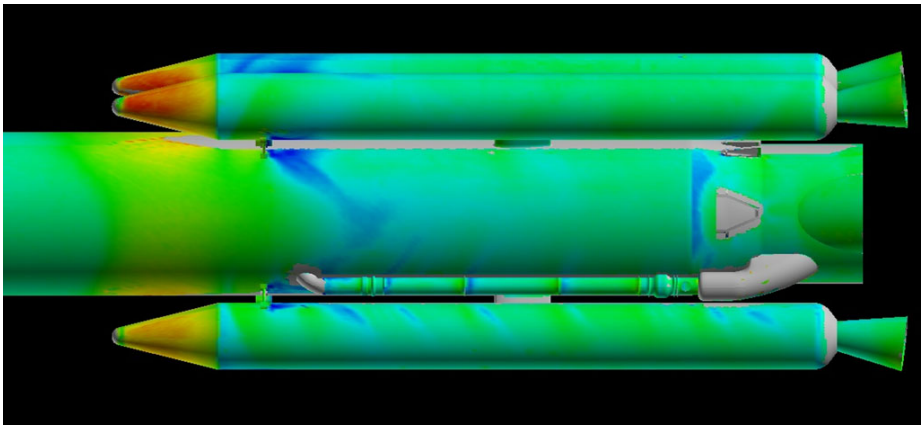


The Dual Combustion Ramjet is mounted in AEDC's Aeropropulsion Test Unit (APTU). Tests conducted in APTU marked the first time a fully integrated hypersonic cruise missile engine, using conventional liquid hydrocarbon fuel, was tested at critical take-over conditions.

The space environments team provided technical and test support for MDA on several efforts. The 7-foot thermal vacuum space chamber (7V) supported a joint U.S. Navy/Japan Defense Agency interceptor sensor calibration. Additionally, the 7V Chamber was radiometrically characterized and calibrated using the National Institute Standards & Technology BMDO Transfer Radiometer in order to reduce uncertainty of the measurements from 7V in support of the Wide-Body Airborne Surveillance Program (WASP) Dual Colored Infrared Sensor test coming in fiscal 2004.

The 10-foot thermal vacuum space chamber (10V) chamber hardware-in-the-loop upgrade program for GMD testing completed a successful Critical Design Review in April 2003. This capability will project infrared and visible light scenes that include up to 5 targets or decoys in a mission simulation. Once on-line, this facility will be dedicated to GMD for testing of the GBI sensor until test program completion. This will provide significant advancement in the capability to test the recognition and discrimination capabilities of these multi-spectral sensors for use by other programs including interceptor sensors, aircraft sensors, satellite sensors and sensor block upgrades. Major components have completed design and significant fabrication is still underway.

The space environments team also supported the MDA by testing to two targets and countermeasures deployments in the center's Mark I space chamber for Air Force Research Laboratory/Countermeasures Hands-On Program (AFRL/CHOP). MDA has re-



The Evolved Expendable Launch Vehicle (EELV) using pressure sensitive paint.

quested the space environments team to serve in the role of executing agent for construction of a sensor calibration facility at Space Dynamics Laboratory at Utah State University for MDA's Russian American Observation Satellites sensors.

Hypervelocity Ballistic Range G conducted impact lethality test in support of the MDA and their GMD program. The tests provided data on subscale projectile launches against subscale simulated nuclear targets for the Boeing GMD Lethality Program that support GMD's Integrated Flight Test Program. AEDC also continued with the second year of a five-year G-Range upgrade program designed to launch larger sub-scale projectiles that more closely simulate the actual interceptor in support of the THAAD Live Fire Test and Evaluation (LFT&E) Program in 2007.

The I Range facility was brought back into operation to support tests for the Naval Surface Warfare Center. A total of 17 shots were conducted to measure the effect of altitude on the performance of reactive materials used to improve the kill effectiveness of air defense warheads.

The Advanced Missile Signature Center (AMSC) provides archival, analysis and distribution services for the DoD and continues to be active in supporting the MDA, Defense Threat Reduction Agency, U.S. Army Space and Missile Defense Command, Air Force Research Laboratory (AFRL), Defense Intelligence Agency/Missile and Space Intelligence Center (DIA/MSIC), Defense Advanced Research Projects Agency (DARPA), U.S. Army Communications-Electronics Command, Army Research Laboratories and other organizations, although MDA and associated execution agencies are the primary customers.

AMSC subject matter experts have been tasked to support the Near-Field Infrared Experiment (NFIRE) and Wide-body Airborne Surveillance Platform (WASP) programs to provide principal investigator expertise. These projects have linked test support with the space environments team. AMSC will also collaborate with the DIA National Signatures Program program office to expand the National Target/Threat Signatures Database System.

AMSC continues to support the Missile and Space Intelligence Center and was assigned the data collection responsibility for another Special Access Required exploitation program in fiscal 2003.

Work continued on the High Performance Computer Management Office Common High Performance Computing Software Support Initiative project to generate real-time 3-dimension missile fly-out signatures for insertion into an Anti-Tank Guided Missile hardware-in-the-loop training simulator. Other modeling and simulation efforts focused on developing a code for transient plumes for the MDA/Battlefield Environment Simulation Tool Modeling & Simulation effort. Additional AMSC Modeling & Simulation (M&S) efforts began to model Debris and Laser Radar signatures for the MDA Scene Generation Integrated Product Team.

The AMSC reviewed the MDA Small Business Innovation Research proposals for fiscal 2003 and was selected to monitor several Phase I projects. Monitoring of several Phase II projects continue.

Long Range Strike

Long Range Strike mission requirements are being driven by recent wartime conflicts that have demonstrated the utility of precision guided weapons and destruction of time critical targets. The Navy, DARPA and the Air Force all project the need to develop air breathing hypersonic propulsion systems for rapid response weapon systems to destroy time critical targets. These missiles could also serve as penetrators and submunition dispensers. In support of long range strike systems technology development, the Aerodynamic and Propulsion Test Unit (APTU) successfully completed a total of 39 test runs at Mach 3.5 and 4.1 for the Navy Dual Combustor Ramjet. These runs demonstrated the ability of the Mach 6 missile to achieve ignition and sustained combustion at lower Mach numbers.

This testing paves the way for development of a lightweight vehicle under the DARPA HyFly program, which will return to APTU in fiscal 2005 prior to flight test.

A major APTU Facility Performance Upgrade Program ($3.6 million MILCON project and $0.16 million of center funds) commenced in fiscal 2003 to expand hypersonic propulsion test capability to Mach 8 for up to six minutes. A total of three shots were conducted in Hypervelocity Ballistic Range G for DARPA to investigate the feasibility of using ballistic ranges to test scramjet engines as a low cost alternative to flight test.

Further, the U.S. Air Force and Navy continue to sustain ballistic missile systems and develop new Concept of Operations for these systems. Currently, nose tip replacement, heatshield and antenna window materials are areas of major concern and the High Enthalpy

Ablation Test (HEAT) team supported development and qualification of thermal protection materials for the Navy's Trident Submarine Launched Ballistic Missile and thermal ablation testing for the Air Force's Reentry Vehicle Applications Program.

AEDC, the Navy and the Air Force continued to cooperatively develop test capability for larger-scale, higher-pressure arc heater to provide better simulation of the flight environment and minimize the effects of scaled models.

The J-6 Large Solid Rocket Motor Test Facility supported the Intercontinental Ballistic Missile (ICBM) Program Office's Minuteman III Production Quality Assurance and Peacekeeper Aging and Surveillance Programs testing two Minuteman Propellant Replacement Program motors and a Peacekeeper Stage III motor.

Access to Space

The access to space mission area is driven by Air Force and NASA requirements for cheaper, operationally responsive, and more reliable payload launch systems.

Experience has shown that heavy lift Expendable Launch Vehicle (ELV) requirements will require altitude testing. The Air Force Evolved Expendable Launch Vehicle (EELV) program and the NASA next generation launch technology have the potential to require use of J-4. Although no support was provided this year to these programs, key facility upgrades were completed in J-4 to support development of a projected heavy lift second stage for EELV. Renewed interest in refurbishment/replacement of hypersonic orbital vehicles brought testing of the USAF/NASA X-37 vehicle to Tunnel 9 this year. This program obtained data to validate models that lacked fidelity due to data deficiencies in the critical high Mach number test regime.

Space-Based Missions

Space-Based Missions activity is in the Global Positioning Satellite (GPS), communications, and surveillance or Force Enhancement operational mission area. The current focus of this area is to replace aging legacy systems with systems that provide increased capability around the globe in all environments with high bandwidth, secure and jam-resistant communications. The satellite community is also strongly pursuing situational awareness technologies, miniaturization, autonomy, and increased operational life technologies in order to reduce the overall launch and operational costs associated with these systems.

AEDC successfully demonstrated a significant advancement in space test technology with the Characterization of Combined Orbital Surface Effects facility. This facility, developed under an Office of the Secretary of Defense-sponsored Central Test and Evaluation Investment Program (CTEIP) effort, successfully demonstrated the capability to test space materials under a broad range of conditions simultaneously. This test capability allows researchers to test for the synergistic effects of atomic oxygen, solar spectrum, spacecraft outgassing, and ion engine backflux within a single chamber, in contrast to conventional techniques that test for one or two effects at a time.

The Decade Radiation Test Facility (DRTF) Quad X-ray simulator, operating in the cold X-ray hardware configuration, was put through a series of performance tests to optimize its performance characteristics. These DTRA funded research and development tests will continue into 2004. The Office of the Secretary of Defense CTEIP Decade Radiation Test Facility enhancement project, was terminated in late fiscal 2003, pending an 18-month risk assessment study by DoD.

Fiscal 2004 Forecast

The Space and Missiles business area exists to support a broad customer base in fielding systems in the four space mission areas. Current projections for fiscal 2004 predict a similar workload to that of fiscal 2003. However, due to the broad nature of our test support these numbers could fluctuate significantly within each mission area. During 2004, Space and Missiles will remain heavily engaged with programs to determine investment requirements for test facilities to meet national mission requirements in the out years.

An AEDC engineer puts the finishing touches on the X-37 model prior to testing at Mach 14 in Hypervelocity Wind tunnel 9 at AEDC's remote facility in White Oak, Md.

Missile Defense

The near-term MDA test requirements focus on the planned development of Midcourse Defense Systems. MDA will focus on two systems to develop for the Midcourse phase, a Ground-Based Midcourse Defense (GMD) System and the Aegis Ballistic Missile Defense System. MDA plans to continue technology development via two-year acquisition spirals for these systems through fiscal 2009. Additionally, Live Fire Test & Evaluation (LFT&E) of the THAAD System and its lethality is projected well beyond fiscal 2004 and requires advances in lethality test simulation of flight-test intercepts.

Hypersonic test support for MDA 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 MDA's technology programs. It is anticipated that MDA will continue to rely on Tunnel 9's unique capabilities.

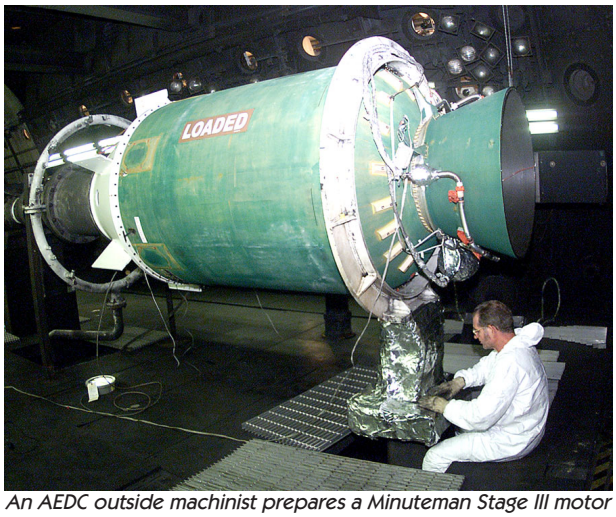
The Space Environments Team will continue to support MDA. The first quarter of the fiscal year will be focused on three consecutive MDA sensor tests in the 7V Chamber. The first will be a return entry of the Wide-body Airborne Sensor Platform/Primary Support Sensor (WASP/PSS). The WASP/PSS is followed by the return of the joint Japanese Defense Agency-Navy interceptor sensor, which in turn will be followed by the Near Field Infrared Experiment (NFIRE) satellite sensor. After completion of these test entries, the 7V Chamber will be down for maintenance for the rest of the fiscal year to replace the cleanroom and collimating optics.

In fiscal 2004, the 10V hardware-in-the-loop budget for the GBI has been set at $1.53 million, including labor, consultants and materials, out of a total 10V upgrade budget of $50 million from 2001 through 2006. A number of major procurements will be completed or near completion early in 2004 with delivery of all major equipment. Installation and integration into the chamber will begin in summer 2004. Boeing's schedule stretches have pushed the Initial Operating Capability to the end of 2006.

Additionally, an MDA-funded MILCON project will build a new control room and upgrade the clean room and material handling capabilities of the 10V facility. The MILCON provides a beneficial occupancy date of April 1, 2004. In the spring and summer, an AEDC-funded optical refurbishment will be complete with the delivery and installation of a recoated primary optical train. Overall, the program is on track for activation in 2006.

The G-Range Hypervelocity Ballistic Range will continue tests for Boeing, the prime contractor for the GMD Program, to obtain data in support of flight test. The Missile Defense Agency (MDA) Program to upgrade the G-Range for conducting large-scale, high-fidelity lethality tests for the THAAD LFT&E Program will continue in fiscal 2004-2006. The G-Range Service Tunnel will be enlarged in fiscal 2004 during an MDA funded MILCON project, to provide improved range access. The first phase of development tests is also planned in fiscal 2004.

The MDA support and funding for the Advanced Signature Missile Center (ASMC) is expected to grow in 2004. Additional resources are also expected for processing legacy data, developing disaster recovery plans and capability modernization. Continued growth in the MDA boost defense segment is expected to place additional requirements on the AMSC as the lead for boost phase data. Measurement support to MDA, Defense Intelligence Agency, Air Force and Army programs is forecast to continue with several MDA high visibility measurement programs planned including Critical Measurements Program-4 and the liquid fuel surrogate target.



An AEDC outside machinist prepares a Minuteman Stage III motor before testing in J-6.

Long Range Strike

The Intercontinental Ballistic Missile Program office will continue to sustain the Minuteman III system with static fire tests well into the future. The Peacekeeper II system, although being decommissioned, will continue aging and surveillance activity to sustain the asset for other potential missions.

Developmental work in the High Enthalpy Ablation Test facility will continue on a production model positioning system for the H3 Large Arc Heater.

The Advanced Instrumentation Data and Control System Central Test and Evaluation Investment Program-funded investment will allow production testing of up to 10 models on a single run. This new system will reduce costs per model by allowing customers to test more models or piggyback on another test under the same regimes, thus reducing overall costs for all. In the meantime, testing of single specimens will correlate data preparation for transition of testing to the H3 heater. Projects to create more stable power for upcoming program requirements are an ongoing effort. The ability to test the erosion effects of dust particles is a technology improvement planned for fiscal 2004 as well.

The Aerodynamic and Propulsion Test Unit (APTU) will complete the MILCON project and ancillary investments in fiscal 2004, including installation of a sudden expansion burner, increased high-pressure air storage and an improved air ejector. These upgrades will permit testing for extended run times at Mach 8 conditions. The Navy HyFly program plans to begin engine durability demonstration test beginning in November 2004. The Vitiated Air Heater configuration will be used for the first test entry at Mach 4. Follow-on tests are planned in fiscal 2005 using APTU's Mach 8 capability with the Combustion Air Heater configuration.

Access to Space

Fiscal 2003 was a year of increased activity in the area of hypersonic research and development. Access to space and hypersonic engine technology program will continue to mature technology to high readiness levels in support of a new initiative from deputy director for Research & Engineering that concentrates specifically on hypersonic technologies.

The National Aerospace Initiative continues to direct attention to hypersonic technologies that show promise

An AEDC craftsman fabricates a reentry vehicle heat shield to test in one of the center's High Enthalpy Ablation Test units. The inset shows a reentry vehicle during an actual test at AEDC.

for future acquisition systems. The Space Shuttle Columbia accident and related NASA Return-To-Flight efforts increased the priority of hypersonic testing including ascent and re-entry. Strategic programs also continue to identify technology needs and system enhancements in both heat shield development and future application of modified systems to extend mission capabilities for global reach.

As the Air Force looks to hypersonics for access to space and other missions, it is expected that Tunnel 9 will continue to provide high Mach number test and evaluation for vehicle configurations and engine inlets.

J-6 will support the Air Force's Space and Missile Systems Center Global Positioning Satellite Program Office with the spin stabilized test of an ATK STAR 37FM rocket motor. No liquid rocket engine test programs for either commercial or Air Force Evolved Expendable Launch Vehicle programs are projected for 2004.

AEDC is in the initial planning efforts for NASA's Space Launch Initiative large cryogenic engine development program.

Space-Based Missions

High value space assets, if not all space assets, require the capability to autonomously isolate threat indicators allowing the appropriate operational response to safe the asset.

Improvements are needed in T&E capabilities that exercise a spacecraft's ability to maintain and report on its operational health under direct attack. Specifically, the DoD is deficient in the capability to simulate the natural space environment and various types of threats in a controlled environment. T&E capabilities that can simulate the natural environment and the full range of possible on-orbit threats are a focus of out-year T&E modernization. Work will continue to further develop the Characterization of Combined Orbital Surface Effects capabilities.

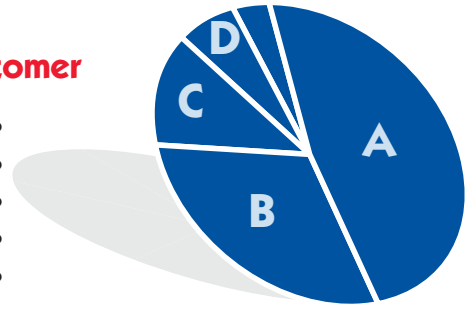
Work in the Decade Radiation Test Facility during fiscal 2004 will focus on optimizing the performance characteristics of the plasma radiation source that produces the cold (soft) X-ray portion of the X-ray spectrum produced by a nuclear blast. Efforts will, more specifically, be focused on methods to obtain 60-80 kilo-joules of Argon X-ray radiation, on design of Decade Quad debris mitigation systems, and on improving diagnostics and pulsed power components. The effort supports the Defense Threat Reduction Agency's long-range plan to consolidate its nuclear weapons effects simulation capability to AEDC.

From the broader Space and Missile perspective, the direction of the highest priority programs requiring long-term support can be categorized as needing developments in:

- Hypersonic propulsion to support stand off weapons and possible space access follow-on to the missile scale technologies developed.
- Hardware-in-the-loop techniques development to ensure effective integration of complex sub-systems for space sensors system and nuclear hardening effectives of primarily missile defense interceptors and surveillance systems.
- Development of ground test capability that more adequately represents the flight test environment for Intercontinental Ballistic Missiles.
- Development of advanced space natural and threat enhanced environment simulation capability.

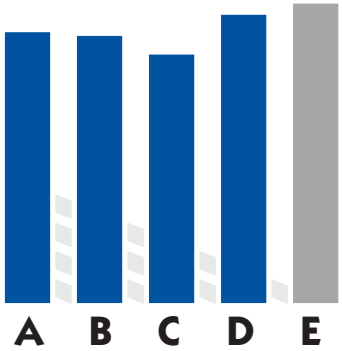
Fiscal 2003 Workload by Customer

A	Other DoD	47%
B	Commercial	29%
C	Air Force	13%
D	Army	7%
E	Navy	4%



Space and Missiles Total Revenue

A	FY00	$21.8M
B	FY01	$20.3M
C	FY02	$23.5M
D	FY03	$22.4M
E	FY04 Projected	$20.8M



Technology

Fiscal 2003 Overview

In fiscal 2003, the Applied Technology Division carried out a $31.5 million program, of which $6.6 million was internally funded.

The three AEDC product areas fund programs to benefit their specific areas. These tend to be near-term and requirements-driven. Technologies on behalf of flight mechanics include wind tunnel flow diagnostics, pressure sensitive pain and model attitude and deformation.

Propulsion technology developments have been focused on Joint Strike Fighter test techniques, improved transient total pressure distortion generator, information management, facility and plant modeling, engine structural analysis, instrumentation, diagnostics and facility technologies. The programs tackle development challenges on the F/A-22 Raptor, F-35 JSF and Unmanned Aerial Vehicles.

Space technology emphasis has been towards increased facility capability, hypersonic test techniques, instrumentation and arc heater technology.

A major part of the program was core 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 external sources funded $24.9 million of the fiscal 2003 technology program. These sources included the Small Business Innovation Research program, the DoD Test Technology, Development and Demonstration program, the Air Force Office of Scientific Research and various other technology customers.

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 2004 Forecast

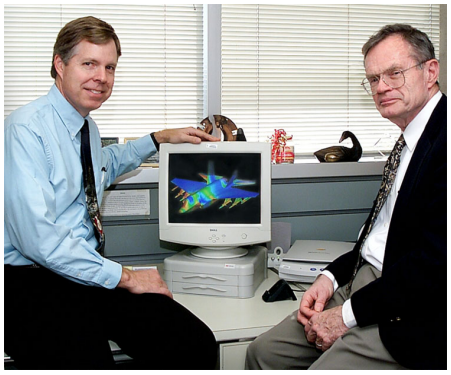
The fiscal 2004 workload is about the same as fiscal 2003 for both internally and externally funded efforts.

Providing faster, cheaper access to customer test data and analysis will be a key part of the program. The program will include facility and plant modeling, distortion modeling, high cycle fatigue instrumentation and test methods, force balance accuracy improvement, captive trajectory and store separation modeling, model-based on-line data validation for wind tunnel testing, arc heater performance improvement, hypervelocity range launch technologies, data warehousing and space chamber and sensor test technology. Cost and test efficiency will be major targets.

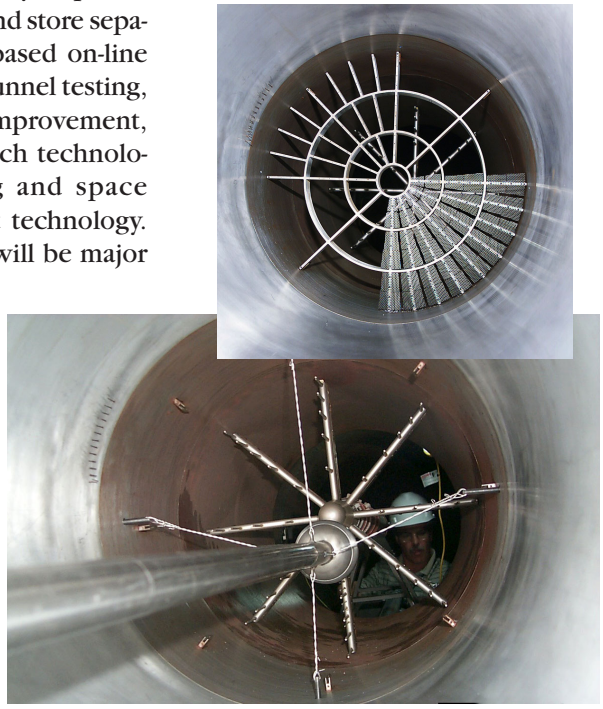
Successful collaboration will continue with the AFOSR and TTD&D, which fund development of new AEDC test or modeling and simulation techniques. The SBIR program will continue to be an important part of the total effort. The new programs for funding technology begun in fiscal 2003 will continue.

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.



Robert Crook (right) leads the Applied Technology Division assisted by Jere Matty.

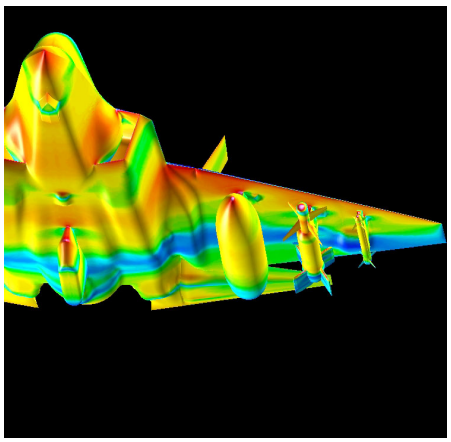


Two differnet transient distortion generator concepts under development for fighter engine inlet engine testing.

High Performance Computing

Mission

Provide the near real-time and off-line computational resources in support of Integrated Test & Evaluation mission.



Stores Loading testing visualization of the Joint Strike Fighter using Computational Fluid Dynamics.

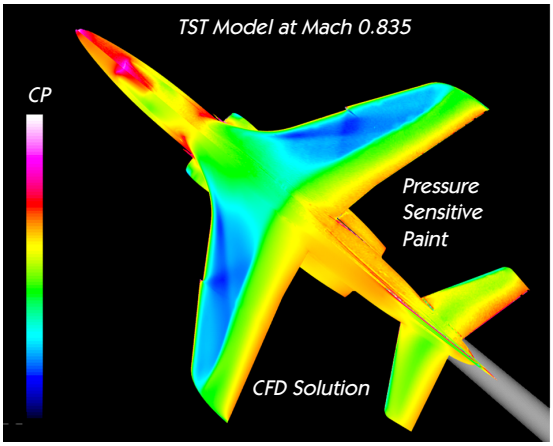
Fiscal 2003 Overview

AEDC maintains one of the Department of Defense's High Performance Computing Modernization Program Distributed Centers.

AEDC boasts the most powerful computational capability supporting the Test and Evaluation (T&E) community.

The center's test 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 near real-time requirement, the center supports a substantial modeling and simulation mission in support of Integrated T&E. Much of the modeling and simulation work has the same time-critical, secure processing requirements as near real-time work playing a key role in weapons system design and testing.

In fiscal 2003, HPC resources supported a wide variety of work in support of integrated test and evaluation. Efforts included flight dynamics test support, including the analysis of weapons stores separation for operational weapon systems such as the F-15 Eagle, the F-35 Joint Strike Fighter, and the new Boeing X-45C Joint Unmanned Combat Air System.



Comparison of Computational Fluid Dynamics modeling and pressure sensitive paint data of a Dassault/Dornier Alpha jet trainer.

In addition to flight dynamics testing, HPC resources were also used to support test facility modeling for commercial aircraft engines such as the Pratt & Whitney 6000 and the Rolls-Royce Trent 900. The Trent 900 is one of the future power plant of the upcoming Airbus 380 airliner. Facility modeling and simulation significantly reduced downtime of test facilities and minimized the risks to personnel and facility infrastructure during improvements. Facility models were also used to ascertain whether test facilities could simulate the environmental conditions an aircraft propulsion system will experience in flight.

The use of HPC resources at AEDC was not limited to support for aircraft systems testing. HPC resources were also used to improve the guidance system for the Army's Tube-launched Optically-tracked Wire guided missile by simulating the smoke plume created by the missile on launch. Further, HPC resources were used to analyze Plasma Radiation Source nozzles in AEDC's Decade Nuclear Weapons Effect Facility as well as to support a Hall Thruster recently installed in one of AEDC's Space Chamber facilities.

Fiscal 2004 Forecast

The center is pursuing initiatives to reduce test cycle time, cost and risk by infusing computational simulation into test processes. These initiatives depend on state-of-the-art HPC resources and include:

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) - CFD calculations are used to reduce the test schedule by reducing the amount of testing required in ground test facilities. CFD also provides critical design information to weapon system developers.

These new initiatives will provide enhanced support for continued testing of the Department of Defense's most advanced weapons systems.

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/A-22 Raptor, F-35 Joint Strike Fighter, F-105 Thunder Chief, F-111 Aardvark, F-117A Nighthawk, LAVI (Israel)

X-15 Rocket Plane.

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

F-105 Thunderchiefs with KC-135.

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

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

F-117 Nighthawk Stealth Fighter.

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

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)

Munitions

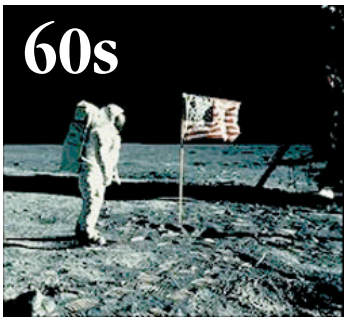
GBU-31/32 Joint Direct Attack Munition (JDAM), AGM 154 Joint Standoff Weapon (JSOW), ALS 101

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



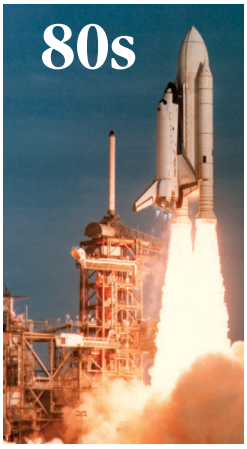
Apollo spacecraft takes man to the moon.

Manned Space Programs

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



Space Shuttle launch.

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/A-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-35 Joint Strike 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	420 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	70,000	(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.						

PRIMARY 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

* Some specific test conditions at risk
** Currently Mothballed
*** Standby Status
**** Currently Non-Operational (Significant advanced notice required)

02/04

Arnold Engineering Development Center

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