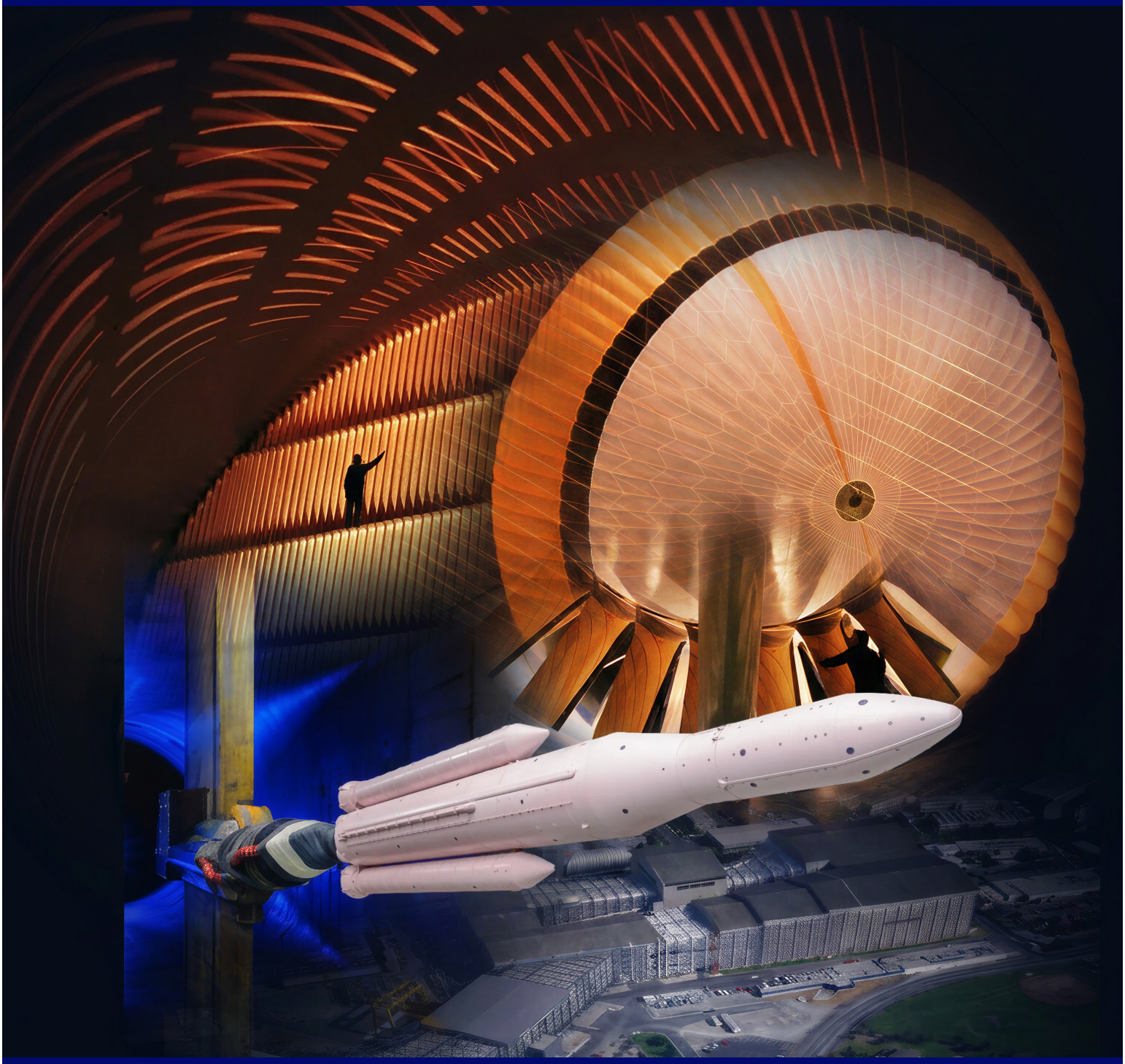
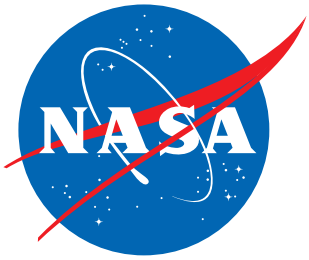
NASA
Office of Inspector General

NASA's Aerosciences Evaluation and Test Capabilities Portfolio



November 17, 2026

IG-27-002



Office of Inspector General

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RESULTS IN BRIEF

NASA's Aerosciences Evaluation and Test Capabilities Portfolio

November 17, 2026 IG-27-002 (A-25-05-00-SARD)

WHY WE PERFORMED THIS AUDIT

Aeronautics research in the United States and abroad rely on NASA's inventory of unique wind tunnels to conduct state-of-the-art ground testing. NASA continues to maintain and improve these facilities despite several of the wind tunnels being in service for around 70 years. As national assets, wind tunnels have been crucial to advancing innovative technologies, expanding human presence into space, furthering our understanding of the solar system, and promoting national and international collaboration. With the NASA Administrator stating one of the Agency's key objectives is to build more experimental aircraft, wind tunnels will become an even more critical capability.

The Aerosciences Evaluation and Test Capabilities (AETC) Portfolio Office is responsible for strategically managing, operating, sustaining, and improving NASA's world-class portfolio of wind tunnel facilities. AETC provides funding for NASA's most significant ground test facilities with a flat annual budget that has remained at about $117 million over the past 6 years. These 12 major facilities, designated as Tier 1, are located at Ames Research Center (Ames) in California, Glenn Research Center (Glenn) in Ohio, and Langley Research Center (Langley) in Virginia, and include capabilities in testing at the subsonic, transonic, supersonic, and hypersonic speed regimes, in addition to propulsion, icing research, and full-scale component testing. The AETC Portfolio directly supports the testing needs of all NASA mission directorates, as well as external customers through reimbursable agreements.

In this audit, we examined how effectively AETC is managing its portfolio of wind tunnel facilities, workforce, funding mechanisms, and approach to alternative testing methods. To accomplish our objective, we reviewed federal and NASA policies, procedures, and supporting documentation; conducted interviews with AETC officials, including the AETC Portfolio Office Director and Deputy Director, Operations Manager, Data Systems and Security Manager, and Maintenance Manager; and conducted site visits to Ames, Glenn, and Langley where we interviewed center integration managers and facility managers to ascertain the status of their facilities and workforce. Further, we interviewed officials from the center business offices responsible for processing reimbursable agreements.

WHAT WE FOUND

Despite a portfolio of aging wind tunnels and no budget increases for the past 6 years, AETC has generally improved wind tunnel performance and condition with efficiencies gained from centralized funding and data-driven management. However, finding efficiencies has its limits in the face of rising costs over this same period. For example, Glenn is grappling with power rates that have increased by nearly 800 percent over the past 5 years. AETC's tools have included applying risk-based maintenance, emphasizing reimbursable agreements, and increasing the share of costs paid by users, including NASA programs and projects. We believe that the current trajectory is unsustainable without making strategic changes to the AETC Portfolio or the resulting funding model. NASA has identified the aerosciences ground test capability as critical, but the Agency's methodology for long-term sustainment of the portfolio is incongruous to that criticality.

Driven in part by its limited budget, for several years AETC has tracked a "workforce recruitment and retention" portfolio risk. AETC found that noticeable retirement and attrition rates reduced the available skilled workforce needed to effectively operate the wind tunnels. This risk was exacerbated in 2025 and 2026 with workforce reductions. In response, AETC's risk mitigation strategy is to train each center's workforce to operate multiple tunnels—shifting from

a workforce specialized in operating a particular tunnel to a redeployable, center-wide workforce capable of operating multiple wind tunnels. In our opinion, NASA is underestimating the severity of the risk and overestimating the value of their mitigation strategy to overcome these challenges in the long run. Without a sufficient base of experienced talent and institutional knowledge, the strategy may result in reduced internal capabilities, increased program risk, and less flexibility in addressing emergent technical challenges.

Complicating management of the portfolio, deferred preventive maintenance was not always recorded or communicated. Some facility managers were not aware of their responsibility to maintain cognizance for maintenance at their wind tunnels, including proper documentation. AETC's maintenance risk tracking system was inconsistently used to track deferred preventive maintenance despite the risks. Consequently, we observed numerous instances of wind tunnels being unavailable because preventive maintenance lapses resulted in significant equipment failures. For example, in July 2024, Langley's 4-Foot Unitary Plan Wind Tunnel experienced a mishap where the main motor drive overheated and became inoperable. A subsequent investigation showed a combination of missed maintenance, cost workarounds, and improper preventive procedures were contributing causes, and the tunnel was still out of service as of August 2026. Executing planned preventive maintenance could have avoided more expensive repairs and improved operational inefficiency.

Aerosciences ground test facilities that are not part of the AETC Portfolio, but conduct similar research, are categorized as Tier 2, and AETC is required to be cognizant of and periodically assess their capabilities and condition. Tier 2 facilities also feed the early research and technology development pipeline and share the physical infrastructure and personnel talent pool with wind tunnels and laboratories in the AETC Portfolio. AETC provides no direct funding to Tier 2 facilities as centers are primarily responsible for managing the wind tunnels and seeking mission directorate-funded projects along with external customers to keep these facilities operating. Many of the same challenges facing Tier 1 facilities in the portfolio, such as staff shortages and maintenance problems, are also present in Tier 2 facilities. These conditions are sometimes worse at Tier 2 facilities because they do not benefit from the additional support that comes with the AETC centralized management structure of its Tier 1 facilities. Further, Tier 2 facilities do not have a funding model that works efficiently, leaving Tier 2 facilities at risk of further degradation, underutilization, and lost innovation opportunities in the technology development pipeline.

WHAT WE RECOMMENDED

To ensure AETC continues to effectively manage its portfolio of wind tunnels and other facilities to meet national challenges, we recommended the Associate Administrator for Research and Technology Mission Directorate direct the Aerospace Capabilities Portfolio Director (formerly the AETC Portfolio Office Director) to (1) evaluate and implement a sustainable AETC funding model that matches resource allocations to a given set of achievable capability portfolio objectives, (2) design processes that can support facility managers to identify and track unmet or additional sources of demand, (3) leverage the Agency's workforce directive strategies to attract industry and academic talent to mitigate workforce challenges, (4) design and implement best practices across all centers and facilities for tracking deferred preventive maintenance, and (5) incorporate funding and management best practices demonstrated by Tier 1 wind tunnels into the sustainment of NASA's Tier 2 facilities.

We provided a draft of this report to NASA management who concurred with our recommendations and described planned actions to address them. We consider management's comments responsive; therefore, the recommendations are resolved and will be closed upon completion and verification of the proposed corrective actions.

For more information on the NASA Office of Inspector General and to view this and other reports visit https://oig.nasa.gov/.

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Acronyms

ADAPT	AETC Data and Analytics Portfolio Transformation
AETC	Aerosciences Evaluation and Test Capabilities
ARMD	Aeronautics Research Mission Directorate
ATAB	Aerosciences Test Advisory Board
CFD	computational fluid dynamics
FY	fiscal year
NPAT	National Partnership for Aeronautical Testing
OIG	Office of Inspector General
QUEST	Quarterly Utilization Evaluation and Summary Template

INTRODUCTION

Aeronautics research in the United States and abroad rely on NASA's inventory of unique wind tunnels to conduct state-of-the-art ground testing. NASA continues to maintain and improve these facilities despite several of the wind tunnels being in service for around 70 years. As national assets, wind tunnels have been crucial to advancing innovative technologies, expanding human presence into space, furthering our understanding of the solar system, and promoting national and international collaboration. With the NASA Administrator stating one of the Agency's key objectives is to build more experimental aircraft, or X-planes, wind tunnels will become an even more critical capability.

The Aerosciences Evaluation and Test Capabilities (AETC) Portfolio Office, a part of NASA's Aeronautics Research Mission Directorate (ARMD), is responsible for strategically managing, operating, sustaining, and improving NASA's world-class portfolio of wind tunnel facilities.[1] AETC provides funding for NASA's most significant ground test facilities with a flat annual budget that has remained at about $117 million over the past 6 years. These 12 major facilities are located at Ames Research Center (Ames) in California, Glenn Research Center (Glenn) in Ohio, and Langley Research Center (Langley) in Virginia, and include capabilities in testing at the subsonic, transonic, supersonic, and hypersonic speed regimes, in addition to propulsion, icing research, and full-scale component testing. AETC also directly supports the testing needs of all NASA mission directorates, as well as external customers through reimbursable agreements.

In this audit, we examined how effectively AETC is managing its portfolio of wind tunnel facilities, workforce, funding mechanisms, and approach to alternative testing methods. See Appendix A for details of the audit's scope and methodology.

Background

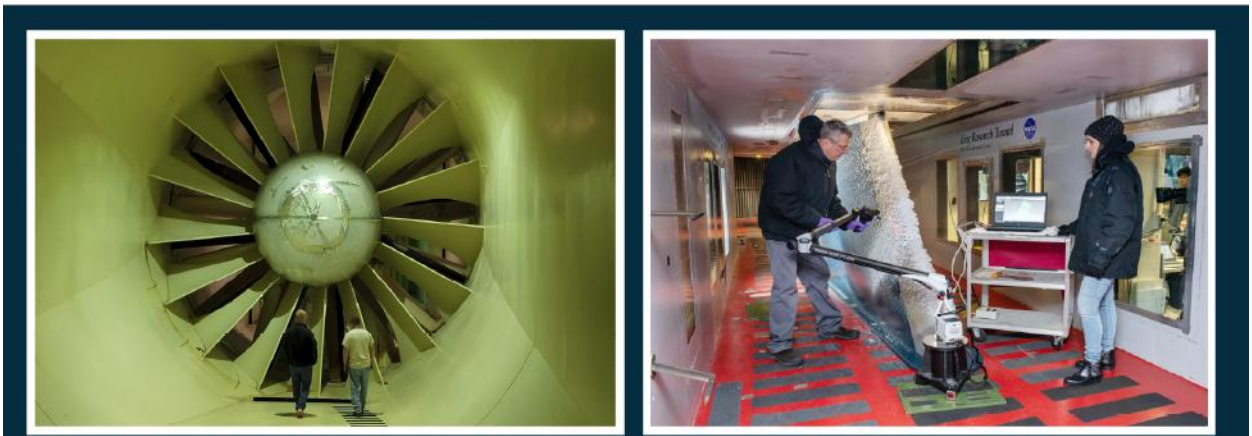
Wind tunnels are a fundamental tool for foundational aerosciences research to ensure aircraft and spacecraft are safe and efficient before they are manufactured and put into operation. A wind tunnel simulates an object moving through the air, such as an aircraft or a structural component of an aircraft, by generating a controlled stream of air that passes over a scale model or part of a design. This allows researchers and engineers to observe and measure aerodynamic effects, including lift, drag, stability, and control, under different flight conditions. Engineers can then use this data to shorten design cycles, improve the quality and manufacturing of final products, avoid costly changes during production, and identify possible design issues after flight testing.

Wind tunnels are usually designed for specific purposes, such as assessing aerodynamics in certain environments or at specific speed regimes. NASA has special tunnels for propulsion, icing research (see Figure 1), and full-scale component testing. There are also tunnels for four flight regimes—subsonic (less than the speed of sound, Mach less than 0.8); transonic (near the speed of sound,

[1] In May 2026, the NASA Administrator announced an Agency-wide reorganization that included combining ARMD and the Space Technology Mission Directorate into the singular Research and Technology Mission Directorate. For this report, we refer to ARMD and the organizational structure as it existed during our audit. Likewise, the Space Operations Mission Directorate and Exploration Systems Development Mission Directorate were combined into the Human Spaceflight Mission Directorate.

Mach 0.8 to less than 1.2); supersonic (greater than the speed of sound, Mach 1.2 to less than 5.0); and hypersonic (much greater than the speed of sound, Mach 5.0 or higher).[2] A wind tunnel may be open and draw air from outside the tunnel into the test section and then exhaust the air back to the outside, or the tunnel may be closed with the air recirculating inside the tunnel.

Figure 1: Icing Research Tunnel at Glenn



Left photo: Shown here is the Icing Research Tunnel at Glenn. While it is one of AETC's comparatively smaller tunnels, it is also one of the world's largest refrigerated wind tunnels dedicated to the study of aircraft icing. It is unique as its both operationally robust but also high precision to duplicate testing conditions, such as specific cloud types. Right photo: The facility can measure the effects of in-flight icing on actual aircraft components and models of aircraft, including helicopters. Shown here are NASA engineers measuring the shape of the ice with a laser instrument.

Source: NASA.

Wind Tunnel Historical Trends

The predecessor to NASA—the National Advisory Committee for Aeronautics—opened its first wind tunnel in 1920 at Langley, followed by over 125 more tunnels of various sizes over the next 80 years. This includes three groundbreaking Unitary Plan Wind Tunnels at Ames, Glenn, and Langley that opened in the 1950s and are still in use today.[3]

Over the years, NASA has funded wind tunnel improvements, such as upgrading facility control rooms, and more recently, standardizing Glenn's data acquisition system. The Agency has also developed new wind tunnel technologies, for example pressure-sensitive paint capabilities that were first demonstrated at Ames using the Unitary Plan Wind Tunnel and leveraging the nearby NASA Advanced Supercomputing Facility. Moreover, in July 2026, NASA opened the Flight Dynamics Research Facility at Langley, the first major new wind tunnel in over 40 years.

[2] The Mach number is the ratio of the speed of air relative to the speed of sound at a particular altitude. For comparison, on an average day at sea level Mach 1.0 is about 761 miles per hour, while Mach 5.0 equals a speed of 3,805 miles per hour.

[3] Unitary Wind Tunnel Plan Act of 1949, 50 U.S.C. §§ 511–515. Under the Act, the federal government coordinated a national plan of wind tunnel facility construction, including the National Advisory Committee for Aeronautics, the U.S. Air Force, private industry, and universities. The Unitary Plan resulted in the construction of a new series of wind tunnel complexes to support the American aircraft industry that were innovative in both scale and scope.

However, over the past several decades, many wind tunnels have been shut down for various reasons:[4]

- **An increase in maintenance and operational costs**. Maintenance costs to upkeep NASA's aging wind tunnel facilities that can date back to the 1930s, such as the cost to replace parts, continue to increase. Simultaneously, operational costs, such as those associated with the significant electrical power consumption of large infrastructure, also continue to increase.
- **A shift in wind tunnel operational financing.** Prior to the 1990s, wind tunnel operating costs were covered by the Agency—their operation was essentially without cost to specific NASA research and development programs and projects, other government agencies, and in some cases, external customers. A transition to a pay-per-use funding model for NASA programs and projects and external customers, including other agencies, led to a reduction in wind tunnel utilization across the board.
- **A reduction in the number of aeronautical systems in development.** During the post-World War II period, the nation was actively developing several fighter, bomber, and missile programs, while also pursuing major research programs for advanced civilian aviation. Today, fewer numbers of similar programs exist.
- **Advances in research.** The level of understanding of aerodynamics has increased over the past 30 to 40 years, reducing the need for the quantity of wind tunnels at some speed regimes, such as transonic. Advances include the use of computational fluid dynamics (CFD) that has supplemented and, in some cases, replaced physical wind tunnel testing, enabled by the massive improvements in computer capability.[5]

Nevertheless, wind tunnel testing will remain an important part of aerospace technology development for the foreseeable future. When developing flight vehicles, engineers rely on three primary testing methods for validation and verification—CFD simulation, flight testing, and ground testing in wind tunnels. CFD's role in technology development is still advancing and maturing, while flight testing remains prohibitively expensive and introduces safety issues as a substitute for ground testing. Therefore, aerospace technology development will generally use all three testing methods collaboratively in different amounts depending on the research. Currently, NASA operates about 30 wind tunnel facilities.

NASA's Capability Portfolios

NASA defines unique sets of skilled workforce, facilities, and computer systems as capabilities. Capabilities determined to be of critical importance to the Agency are managed as formal portfolios and governed in adherence with the policies under which they have been established. Capability portfolios are centrally managed and funded while center management is responsible for operating the

[4] NASA Office of Inspector General (OIG), *NASA'S Efforts to Reduce Unneeded Infrastructure and Facilities* (IG-13-008, February 12, 2013), noted that at least 6 of NASA's remaining 36 wind tunnels appeared to be underutilized and could not support how they were needed to meet future missions.

[5] NASA/TP-2012-217602, *Role of Computational Fluid Dynamics and Wind Tunnels in Aeronautics R&D* (September 2012). CFD applies the laws of fluid physics to mathematical equations, which are solved with high-speed supercomputers resulting in a simulation of the forces acting on aircraft and spacecraft in flight.

components of the capability.[6] Investment decisions are made within the portfolio, which can include a recommendation for divestment of facilities if they no longer meet current or anticipated critical needs.

AETC is one of NASA's five capability portfolios, with the other four listed below:[7]

- High-End Computing Capability Portfolio, which provides high-end computing, storage, and associated services to enable NASA-sponsored scientists and engineers to support NASA programs.
- Rocket Propulsion Test Program, which maintains the Agency's core capability for all aspects of chemical rocket propulsion testing.
- Aircraft Capability Management Office, which manages NASA's aircraft fleet including research aircraft, astronaut training jets, and uncrewed aerial systems.
- Space Environments Test Management Office, which manages the Agency's portfolio of arc jets, flight simulation, and space environment facilities used to reduce risks for aircraft flight and space travel.

NASA's Critical Wind Tunnels Preserved by Becoming a Capability Portfolio

The shift in wind tunnel operational funding was due to two factors that occurred simultaneously in the 1980s through the 2000s. First was NASA's implementation of federal requirements to integrate managerial cost accounting standards aimed at providing reliable and timely information on the full cost of federal programs, their activities, and outputs.[8] Second was the reductions in aeronautics research and demand for the supporting infrastructure needed for this research. In effect, wind tunnel costs were paid using a pay-per-use model where Agency users—programs and projects—and external customers paid for their use of the wind tunnels rather than NASA covering the costs. As a result, many wind tunnels were decommissioned, mothballed, or went into a declining state of maintenance. The number of NASA wind tunnels has been declining since the 1980s, with the closure of around 30 percent of wind tunnels over that period.

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[6] NASA Policy Directive 8600.1A, *Capability Portfolio Management* (November 5, 2024), establishes the responsibilities of Agency officials in the management of the capability portfolios. NASA Procedural Requirements 8600.1, *NASA Capability Portfolio Management Requirements* (April 22, 2019), defines a capability portfolio as a specific collection of functionally similar site-specific capability components and enabling infrastructure strategically and centrally managed together to meet NASA's strategic goals and objectives. This includes the identification of the sponsoring Mission Directorate Associate Administrator and funding process.

[7] NASA OIG recently reported on two of these other capability portfolios. *Audit of NASA's High-End Computing Capabilities* (IG-24-009, March 14, 2024) identified management structures at risk and a high-end computing infrastructure that was oversubscribed and overburdened. *NASA's Rocket Propulsion Test Program* (IG-24-018, September 24, 2024) found NASA's aging rocket propulsion test sites required significant funding to maintain, but the Rocket Propulsion Test Program's budget was flat and faced decreased demand of the test sites due to increased commercialization.

[8] In 1995, the Federal Accounting Standards Advisory Board published the Statement of Federal Financial Accounting Standards Number 4, *Managerial Cost Accounting Concepts and Standards for the Federal Government* (July 31, 1995). This requires federal entities to accumulate full cost information. Reporting full costs is required in the board's Statement of Federal Financial Accounting Standards Number 7, *Accounting for Revenue and Other Financial Sources* (May 10, 1996).

While some wind tunnels were no longer required, for others the transition to this new full cost, pay-per-use funding model led to lost research opportunities and a maintenance backlog reverberating to this day. This is because the connection of sustained pay-per-use and needed infrastructure were not analogous concepts. Specifically, the frequency of use between years varied—a wind tunnel may be needed extensively for several years to support a mission followed by years with reduced usage. Restarting a complex wind tunnel after not being used for a significant period is usually accompanied by increased costs due to damage from years of neglect and required staff retraining. Additionally, under NASA's pay-per-use funding model, a year's estimated costs to run a wind tunnel are allocated to Agency users and external customers. The years with reduced usage meant there was a decrease in the quantity of effective operational hours as there were less users and customers to allocate those costs to, resulting in discouragingly high wind tunnel hour cost rates. Reduced usage periods create negative feedback loops as a prospective user or customer may find they are unable to afford research hours, further increasing the estimated hourly cost to the remaining users or customers, if any.

This challenge did not go unnoticed as several independent and NASA Office of Inspector General (OIG) reports suggested the nation should identify and maintain a minimum set of strategically important wind tunnel facilities and identify shared financial support to keep underused but essential facilities from financial collapse.[9] In response, starting around 2006, ARMD spearheaded a project to meet NASA's goals of operating, sustaining, and improving this core capability for Agency and national aeronautics testing to ensure the availability of a minimum critical set of wind tunnel facilities. Over the next few years, the project evolved to include a new funding model in which NASA no longer used the pay-per-use model. Instead, the Agency's mission directorates provided a portion of their budget to a separate pool to accomplish NASA's critical wind tunnel facility goals by stabilizing funding and user pricing—the precursor to AETC.

Based on the success of that project and related studies, which helped identify critical facilities and a funding method to continue operating them in a meaningful manner, the AETC Portfolio was established in 2015 and its Capability Portfolio Commitment Agreement was signed in 2020.[10] For fiscal year (FY) 2020, Congress funded AETC for the first time as a separate budget line item within ARMD. AETC was charged with investing in workforce and assets—facilities, related systems, and support tools—necessary to meet NASA's aeroscience technical needs. This new funding model covered all testing costs at these

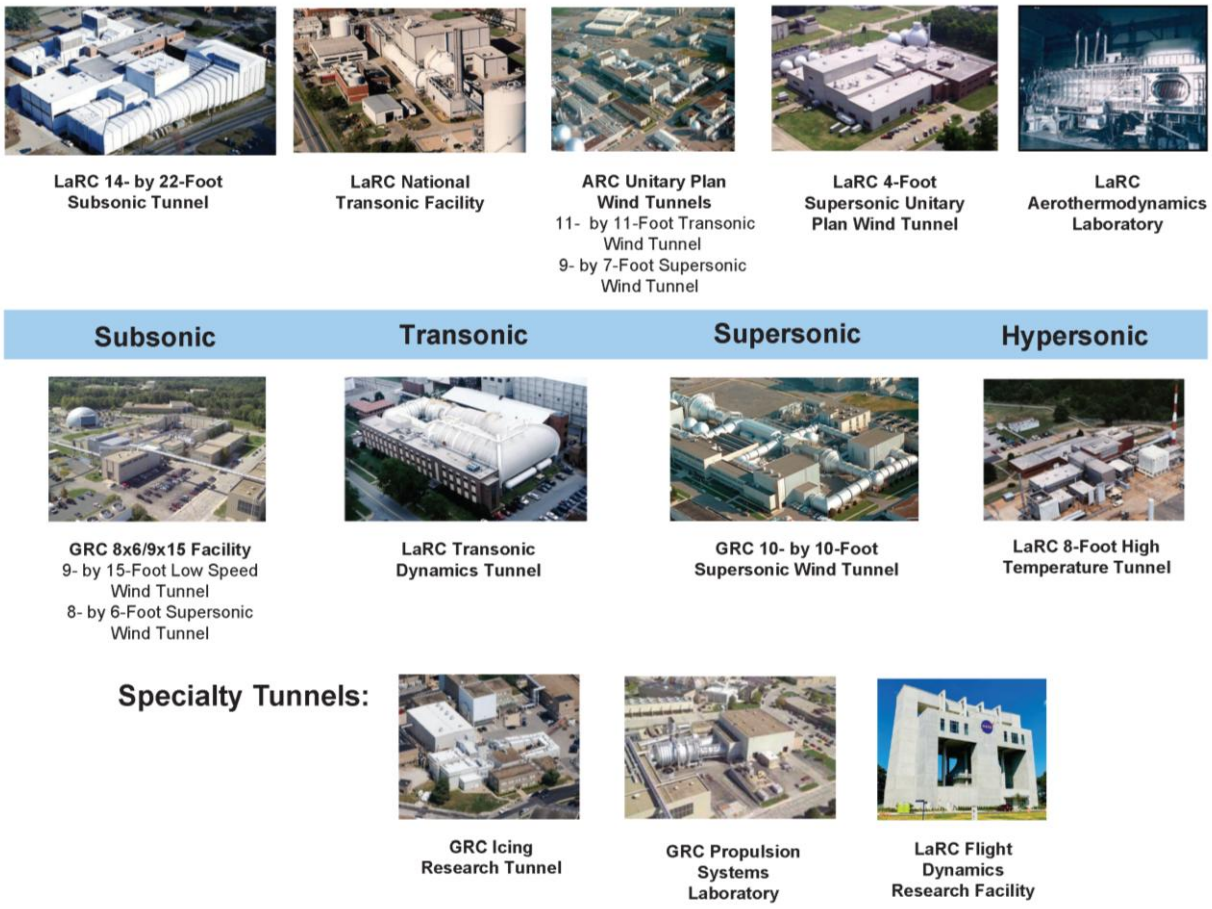
[9] RAND Corporation, *Wind Tunnel and Propulsion Test Facilities: Supporting Analyses to an Assessment of NASA's Capabilities to Serve National Needs* (2004), and its follow-up study, *An Update of the Nation's Long-Term Strategic Needs for NASA's Aeronautics Test Facilities* (2009). RAND is a nonprofit, nonpartisan research organization that develops solutions to public policy challenges to help make communities throughout the world safer, healthier, and more prosperous. NASA OIG, IG-13-008, reported on wind tunnel sustainment, and *NASA's Efforts to "Rightsize" its Workforce, Facilities, and Other Supporting Assets* (IG-17-015, March 21, 2017), reported on NASA internal studies that discussed this challenge, such as the Technical Capabilities Assessment Team.

[10] Authorization to proceed with AETC Portfolio implementation is documented in NASA Executive Council Decision EC-2015-06-001a (July 28, 2015), defining the AETC Portfolio under a new funding model. NASA signed the Capability Portfolio Commitment Agreement (CPCA) Aerosciences Evaluation and Test Capabilities (AETC) Portfolio on October 27, 2020.

critical wind tunnel facilities for NASA users. The full cost was still charged to external customers through reimbursable agreements, but the costs could be spread across more operational hours.[11]

As of August 2026, the AETC Portfolio included 12 wind tunnels and laboratories located at Ames, Glenn, and Langley, as shown in Figure 2. AETC directly funds and has oversight of these facilities, which have seen a trend of overall increased usage in recent years. See Appendix B for further information on these wind tunnels and laboratories.

Figure 2: AETC Funded Facilities



Source: NASA.

Note: Ames Research Center (ARC), Glenn Research Center (GRC), and Langley Research Center (LaRC). The Langley Flight Dynamics Research Facility is NASA's newest wind tunnel facility, opening on July 31, 2026.

[11] NASA regularly uses reimbursable agreements with academic, government, industry, international, and nonprofit entities to advance its science, space flight, and aeronautics missions. Under a reimbursable agreement, NASA provides external customers with goods, services, or facilities that are not being fully utilized by the Agency, enabling the customers to gain access to NASA technical capabilities, knowledge, and unique resources. NASA Advisory Implementing Instruction NAII 1050.1E, *Space Act Agreements Guide* (December 22, 2023), NASA Policy Directive 1050.7A, *Authority to Enter into Partnership Agreements* (May 23, 2024), and NASA Procedural Requirements 9090.1C, *Partnership Agreements – Financial Requirements and Administration (Updated with Change 2)* (February 23, 2023) are NASA policy documents that explain the Agency's agreement authority, requirements, and practices.

NASA categorizes wind tunnels and laboratories in the AETC Portfolio as Tier 1 facilities. Aerosciences ground test facilities that are not part of the portfolio are categorized as Tier 2. Tier 2 facilities vary from small acoustic testing rooms to engine component test facilities and large multi-purpose buildings with several laboratory-sized wind tunnels. Since AETC is responsible for promoting aerosciences facilities as a resource and assisting in Agency investment and divestment decisions, AETC is required to be cognizant of, and periodically assess, Tier 2 capabilities. In addition, AETC maintains some level of insight into Tier 2 facilities because, in many cases, they feed the early research and technology development pipeline and share the physical infrastructure and personnel talent pool with wind tunnel and laboratories in the AETC Portfolio. AETC generally provides no funding to support Tier 2 facilities as centers are primarily responsible for managing the wind tunnels and seeking mission directorate-funded projects and external customers where possible. Without funding sources, Tier 2 facilities will fall into disuse, with various impacts depending on the nature of the wind tunnel. See Appendix C for more information on Tier 2 facilities.

AETC Portfolio Office

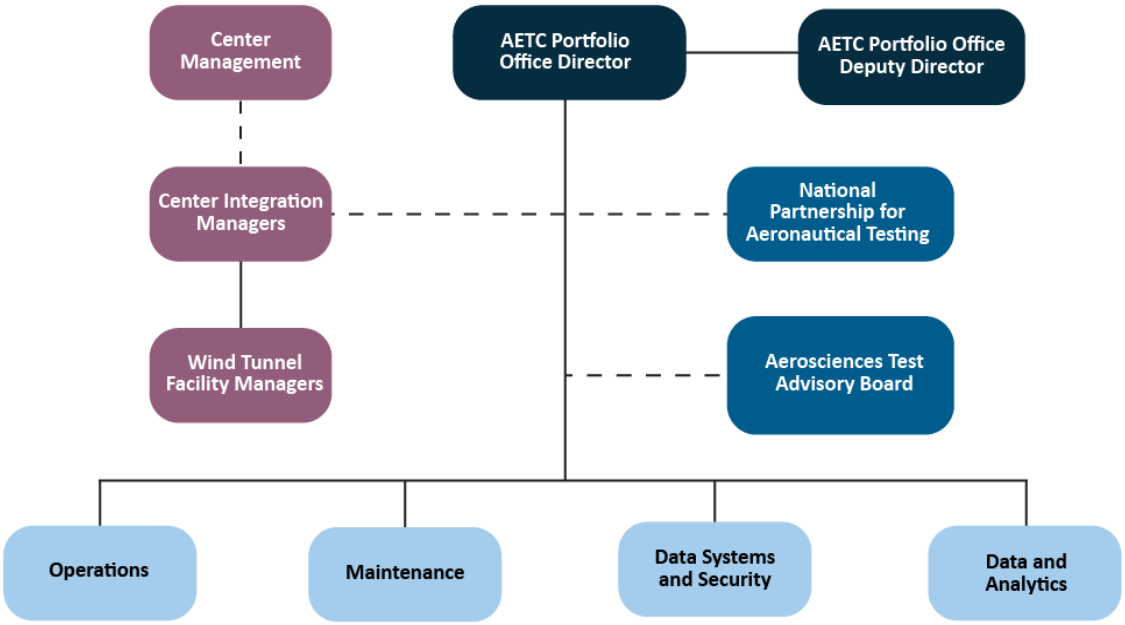
Led by the Portfolio Office Director, AETC resides within ARMD at NASA Headquarters with funded staff at Ames, Glenn, and Langley. Each of these centers has a center integration manager who is responsible for serving as the primary interface between AETC and center management for AETC-sponsored activities. Each facility at those centers also has a facility manager who is the primary interface for NASA users to determine the most appropriate and economical facility that meets their test requirements. In addition, AETC works with partner organizations, including the Aerosciences Test Advisory Board (ATAB) and National Partnership for Aeronautical Testing (NPAT).

NASA established ATAB to provide guidance to the ground test capabilities managed within ARMD and serve as the main advisory board to the AETC Portfolio. ATAB includes a Chair and Deputy Chair, representatives of the AETC Portfolio, all NASA mission directorates, and members from the NASA Engineering and Safety Center-Aerosciences Technical Discipline Team. In addition, center representatives are invited to attend and participate in ATAB meetings. The board provides guidance for strategic investments and divestments, such as future program needs, required capability and facility construction or modernization, schedule conflict adjudication, and adjustments necessary for sustainment of aerosciences ground test capabilities.

NPAT is a cooperative agreement between NASA and the U.S. Department of Defense, signed in January 2007, to serve as a framework for cooperation on individual projects related to aeronautical test facilities, particularly wind tunnels and engine test facilities. NPAT provides a forum for NASA and the Defense Department—the government's two major wind tunnel operators—to facilitate the establishment of an integrated national strategy for management of the tunnels. The NPAT Council conducts studies, addresses issues, and develops approaches and strategies for close cooperation between the parties for the management and operation of aeronautical test facilities.

AETC's organizational structure is shown in Figure 3.

Figure 3: AETC Organization (as of September 2026)



Source: NASA OIG analysis of Agency information.

Although AETC's wind tunnels are utilized by national and international customers from industry, academia, and other government agencies, the facilities are primarily used by NASA programs and projects. For example, in 2024, about 80 percent of the 74 wind tunnel test campaigns conducted were internal to NASA. Within NASA, AETC supports not only ARMD, but also directly supports the testing costs and needs for NASA's Exploration Systems Development, Science, Space Operations, and Space Technology mission directorates. AETC also works with NASA's Mission Support Directorate by supporting and participating in Agency-level real property management initiatives and programs, such as the Master Planning Program.[12]

In FY 2022, AETC established a strategic plan that organizes its portfolio around five strategic goals, which represent AETC's portfolio objectives:

- Strategic Goal 1: Operational Optimization
- Strategic Goal 2: Transformation of Facilities and Infrastructure
- Strategic Goal 3: Innovation of Advanced Test Capabilities
- Strategic Goal 4: Data Systems Transformation
- Strategic Goal 5: Maintain Workforce Excellence

[12] The Master Planning Program links the stewardship of NASA land, buildings, and other structures with Agency strategic plans and guidance. Center and site-specific master planners work with related institutional stewards, experts, and mission users to ensure that implementation of program actions offer reliable, cost effective, and environmentally sound benefits to NASA.

From FYs 2020 to 2025, AETC's budget remained flat at approximately $117 million. While receiving an initial budget of only $95 million for FY 2026, AETC was ultimately given an additional $60 million, one-time infusion as part of ARMD's investment strategy to help improve the reliability of wind tunnels. AETC plans to invest the majority of this funding to improve the overall health and reliability of its facilities while directing smaller portions of the funding to enhance the workforce and advance technology integration.

AETC Performance and Risk Monitoring

Approximately every 4 years, AETC uses an independent third-party to conduct a formal systems-based facility health assessment in collaboration with center facility managers and operators. Additionally, AETC has identified and implemented real-time performance measures to assess progress toward achieving its strategic goals. AETC has been able to show that utilization is increasing and sets new goals accordingly. To continuously monitor progress, AETC has developed and continues to improve a centralized platform for wind tunnel capability data called the AETC Data and Analytics Portfolio Transformation (ADAPT) portal. ADAPT includes scored performance, value, availability, and fiscal metrics for all Tier 1 facilities, including the following:

- each facility's operating status in real time
- weekly status reports
- annual projected demand and historical usage rates
- cost and spending data

Facility managers, center management, and other AETC personnel input data directly into ADAPT. The platform also uses data summarized from other Agency systems, including the Quarterly Utilization Evaluation and Summary Template (QUEST). AETC adopted QUEST and adapted it to be the official tracking system for maintenance needs and associated risks within the AETC Portfolio. Managing, operating, and sustaining infrastructure and essential services requires several critical institutional capabilities, including risk management, master planning, and management of real property. In turn, these support functions help revitalize the capabilities required to enable NASA's mission.

AETC focuses maintenance activities on measures to keep facility systems running on a day-to-day basis. The office also considers options to replace or upgrade systems that are at the end of their useful life; cannot be cost-effectively maintained in a safe, secure, and reliable state; or are unable to deliver the test conditions and data needed by test programs. AETC approaches these costs with the long-term goal of maintaining the portfolio's facilities to ensure they are safe, ready to run, and can complete scheduled testing.

NASA's Ability to Effectively Manage the AETC Portfolio Is Limited

Despite a portfolio of wind tunnels that are largely over 70 years old and no budget increases for the past 6 years, AETC has generally improved wind tunnel performance and condition with efficiencies gained from centralized funding and data-driven management.[13] However, finding efficiencies has its limits in the face of rising costs over this same period. AETC's tools have included applying risk-based maintenance, emphasizing reimbursable agreements, and increasing the share of costs paid by users, including NASA programs and projects. We believe that the current trajectory is unsustainable without making strategic changes to the AETC Portfolio or the resulting funding model. NASA has identified the aerosciences ground test capability as critical, but the Agency's methodology for long-term sustainment of the portfolio is incongruous to that criticality. As a result, NASA is not promoting effective usage of these national assets for internal users and external customers.

Design of AETC Portfolio Funding Model

In FY 2020, Congress fully funded AETC for the first time as a separate budget line within ARMD and provided AETC $117 million rather than consolidating funds from the other mission directorates for centralized management of the wind tunnel capability. The Capability Portfolio Commitment Agreement stated that under AETC's funding model, facilities would be continuously accessible, barring any large maintenance activities, to NASA users for testing without additional charges within baseline facility operational readiness levels. Likewise, funding for major wind tunnels would be more predictable, thereby helping to increase reliability and therefore availability between tests.

This change from prior funding models encouraged programs and projects to do more research testing and risk reduction, because the facilities were both available and free. To balance this funding model, AETC was charged with finding divestment opportunities for wind tunnels and test facilities that are not aligned with projected future Agency needs. To accomplish this, AETC monitors factors, such as wind tunnel demand, within ADAPT and obtains feedback through participation in industry boards and bodies including ATAB and NPAT. Since its establishment, AETC has not needed to eliminate any Tier 1 facilities.

With this funding model, external customers pay the full cost of conducting wind tunnel testing through reimbursable agreements. The full cost includes all things that can be allocated to wind tunnel facilities, such as workforce, facility operations, center support, information technology support, calibration, test consumables, and test model preparation. Total reimbursable revenue has varied between about $3.3 million to $15.5 million per year since AETC was established.[14] In most cases, NASA users take priority over external reimbursable customers. However, there has been a trend to prioritize

[13] As FY 2026 was ongoing during our audit, we did not include that data in our findings and focused on FYs 2020 to 2025. We do, however, note in this report the impact of FY 2026 changes in funding levels where appropriate.

[14] Under a wind tunnel reimbursable agreement, NASA provides external customers with testing services and technical knowledge in exchange for funds separate from congressional appropriations. For more information, see NASA OIG, *NASA'S Management of Reimbursable Agreements* (IG-18-018, May 29, 2018).

reimbursable work, recognizing that external reimbursable revenue reduces risk-to-test for NASA missions by offsetting operation costs that can be reallocated to high-priority maintenance needs.

Flat AETC Budget Has Forced NASA Users and External Customers to Contribute Additional Funding and Hindered Efforts to Address Deferred Maintenance

Since FY 2020, AETC has operated with a flat budget, which effectively is a shortfall given overall rising costs from inflation. Using NASA's New Start Inflation index percentages, AETC operated with $25 million less in FY 2025 than it did when it was initially funded in FY 2020, with a cumulative loss of $72 million during that time (see Table 1).[15] Moreover, this estimate may be conservative due to consumable costs outpacing general inflation. Many wind tunnel facility managers we spoke with were concerned with the increasing cost of the consumable cost of electricity. Glenn, for example, is grappling with power rates that have increased by nearly 800 percent over the last 5 years.

Table 1: AETC Historic Funding Profile

Fiscal Year	Actual Budget	NASA New Start Inflation Index Percentages	Flat Budget Indexed to Inflation	Annual Effective Shortfall from Flat Budget
2020	$117 million	2.2%		
2021	$117 million	3.8%	$120 million	$3 million
2022	$117 million	5.5%	$125 million	$8 million
2023	$117 million	3.9%	$132 million	$15 million
2024	$116 million	3.3%	$137 million	$21 million
2025	$116 million	3.8%	$141 million	$25 million
			5-Year net funding decrease from inflation	**$72 million**

Source: NASA OIG calculation of Agency data.

Note: Numbers may not add up to the noted amounts due to rounding to whole numbers.

While AETC has mitigated some of these negative effects through their centralized management, shortfalls have resulted in the need to find additional funds to operate the 12 wind tunnels. This diverges from the Capability Portfolio Commitment Agreement, an internal Agency document, signed in 2020 that stated the "funding model fully covered the operational cost for NASA users of a key set of critical aerosciences ground test facilities."

As a result, in FY 2022, AETC adjusted the funding model by charging NASA users fees to offset rising costs due to inflation. We did not review the fee calculation and application, but according to AETC management it is kept as low as possible. In FY 2023, AETC revised the model again by charging a maintenance fee on top of existing overhead rates to new external customers in their reimbursable agreements to help with wind tunnel maintenance tasks that were typically managed through center

[15] Inflation rate is the percentage change in price of an identical item from one period to the next. The NASA New Start Inflation index is one method NASA uses to account for inflation in its cost estimates. Inflation tables are provided to estimate new efforts and for normalizing historical costs from prior missions. This index is based on forecasted price changes for a market basket of goods and services that is believed to be representative of NASA work.

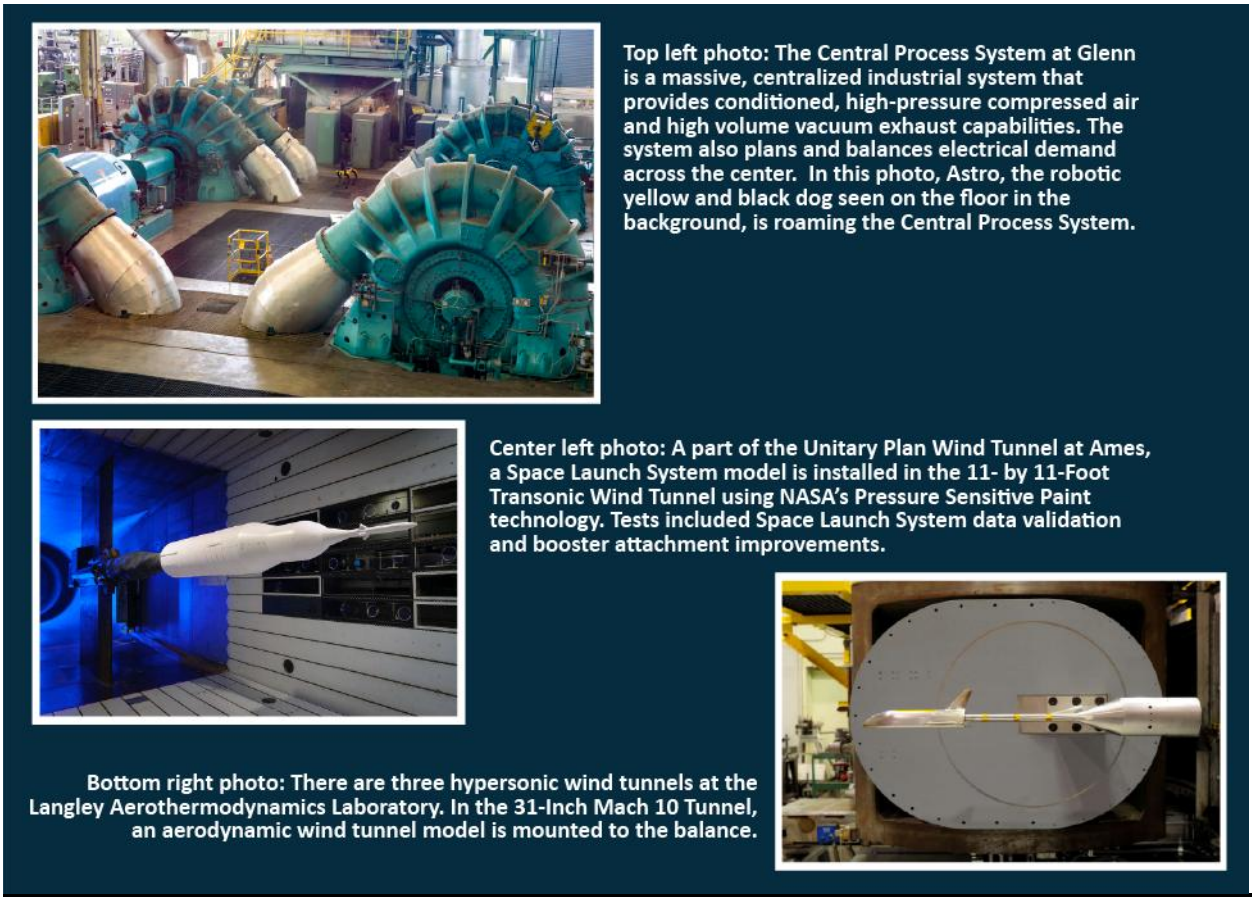
mission support. By 2024, the AETC Portfolio Capability Portfolio Management Plan, which was signed by the AETC Portfolio Office Director, center directors, and mission directorate leadership, recognized the "AETC funding model currently provides a large but decreasing percentage" of cost for NASA users.[16]

Beyond the increasing fees, mission directorates and centers are asked to contribute additional funding when infrastructure needs exceed AETC's funding ability. However, we found that contribution levels vary by center based on available funding. For example, Glenn leans into the center-wide stewardship model, collectively negotiating with both Agency users and external customers to help pay for any changes needed in the wind tunnel facility capability. Likewise, Ames and ARMD are co-funding with AETC to complete the critical Unitary Plan Wind Tunnel variable frequency drive upgrade. Similarly, Langley worked extensively to ensure there was funding for NASA's newest wind tunnel, the Flight Dynamics Research Facility. Additionally, Langley's Aerothermodynamics Laboratory, which can be used for rapid responses to thermal events (e.g., Artemis I post-flight assessment of the Orion crew capsule heat shield), has relied on the availability of funding support from the Exploration Systems Development Mission Directorate for those rapid responses.[17] Figure 4 shows photos of wind tunnel and support facilities at Glenn, Ames, and Langley.

[16] A Capability Portfolio Management Plan is a requirement from NASA Procedural Requirements 8600.1 that details how the portfolio will be managed and is used to determine if the portfolio is fulfilling its requirements. The AETC Portfolio Capability Portfolio Management Plan was last updated in August 2024.

[17] The uncrewed Artemis I test flight was successfully completed in December 2022. However, the heat shield material that helps protect the Orion crew capsule from the extreme heat of reentry wore away differently than predicted, and NASA used the Aerothermodynamics Laboratory and other facilities to conduct additional testing.

Figure 4: Central Process System at Glenn, Unitary Plan Wind Tunnel at Ames, and Aerothermodynamics Laboratory at Langley



Source: NASA OIG (top left photo) and NASA (center left and bottom right photos).

AETC is budgeted with minimal planned maintenance funds to fix the massive backlog of wind tunnel repairs for the 11 older tunnels in operation—deferred maintenance known within the portfolio as the "iceberg" due to the large number of repairs needed and the nearly $500 million estimated cost to make the repairs. This, in turn, impacts wind tunnel reliability and availability given that AETC prioritizes maintenance tasks based on risk, mission criticality, and other mitigating factors. The repairs and upgrades are therefore ranked by criticality in the AETC QUEST system.[18] AETC has, nevertheless, been able to address some critical maintenance tasks every year, despite having a minimal annual appropriated budget allocation for it, through fees, reimbursable agreements, and working with capability stewards at the centers. However, maintenance issues have caused potential NASA users and external customers to find other testing locations and, in some instances, stopped testing in progress, resulting in incomplete data, which can impact risk acceptance, cost, and schedule.

The Agency has described each of the 12 wind tunnels as a critical capability and unique national asset needed to maintain aeronautics technology development. The decision by the Agency to maintain them with an effectively declining budget has resulted in a negative loop where increased costs result in less

[18] As of July 2026, AETC QUEST was tracking 607 items for an estimated cumulative repair cost of $456.5 million that were added to the iceberg for reporting purposes. However, the database contains a total of 768 open items with an estimated cumulative value of $722.4 million as AETC continues to refine their tracking and improve data quality.

users, and less users means less funds to maintain the wind tunnel facilities—the exact situation that necessitated creating the capability portfolio in the first place. NASA users and external customers can be cost sensitive and mission directorate personnel stated they could be forced to test less or not at all, opting to accept more risk or defer technology development altogether. Less income from external customers fees or the inability of mission directorates and centers to contribute into stewardship to cover maintenance results in both declining usage and reliability. Inadequate resourcing and lack of an effective Agency-level solution has affected the depth, rigor, and continuity of the facilities—core requirements for a credible ground test capability.

Limited Communications with External Customers Exacerbate Funding Shortfalls

AETC does not have the budget to support all maintenance needs of the portfolio and therefore depends on external customers to defray these costs. AETC is reliant on a small community of external customers built on local relationships that tend to be siloed within a particular NASA center or a specific wind tunnel. The cross section of the industry that both needs advanced wind tunnels and can afford to use them is small, such as government partners and major aerospace companies like Boeing, SpaceX, and Lockheed Martin.

However, the space economy has rapidly evolved in recent years from a predominantly government-owned, government-operated endeavor to one that relies more on private-sector innovation and startup space companies. For example, Relativity Space tests unsteady flows at Langley's 4-Foot Supersonic Unitary Plan Wind Tunnel, Varda Space Industries uses Langley's Transonic Dynamics Tunnel for dynamic dampening testing, and smaller companies are now developing hypersonic technologies. There is also a sense within NASA that industry is ramping up for the next generation of commercial aircraft. Wind tunnel reimbursable revenue has generally increased and AETC expects the trend to continue. Despite the importance of external customers, there is no formal method to track wind tunnel testing requests and outcomes through a customer management system across the AETC Portfolio.

NASA Procedural Requirements 8600.1 requires capability portfolios to develop and maintain processes that foster and service community demand. These processes may include activities to establish and maintain a constructive relationship with external customers and identify additional sources of demand. We found that AETC did not design a process to fully meet those objectives. The AETC Capability Portfolio Management Plan states the need to have an "on-going collection of customer test requirements, future capability needs, and customer satisfaction surveys following a test campaign along with evaluations of the customers themselves conducted by the facility test lead." Further, in our discussions with facility managers, we found they were not consistently supported to engage in customer outreach activities, such as travel to promote their wind tunnel capabilities. This was particularly true for Tier 2 facilities that could arguably benefit the most from additional support and communication tools since AETC does not fund them as part of their portfolio.

This support is critical because it is a community-driven process. Facility managers at Ames noted researcher community word of mouth is how wind tunnel time is booked. At Glenn, facility managers act as the front doors to their respective facilities. They noted the value of attending conferences and leveraging existing relationships for customer outreach on new capabilities. Similarly, facility managers at Langley noted that most wind tunnel reimbursable work comes from researchers who are networking, but funds for facility managers to attend networking events like conferences and industry meetings have been limited. They added that even within NASA, not everyone is aware of their unique capabilities.

During our audit, we brought our concerns regarding limited communication to centrally track external customer inquiries as a function of customer relationship management to the Agency's attention. Subsequently, in June 2026, AETC updated ADAPT with several new functions to capture, share, and track demand inquiries. The impact of this update will require adoption of new procedures and communication of expectations for capturing and entering demand inquiries into ADAPT.

AETC's Workforce Risk Is Understated

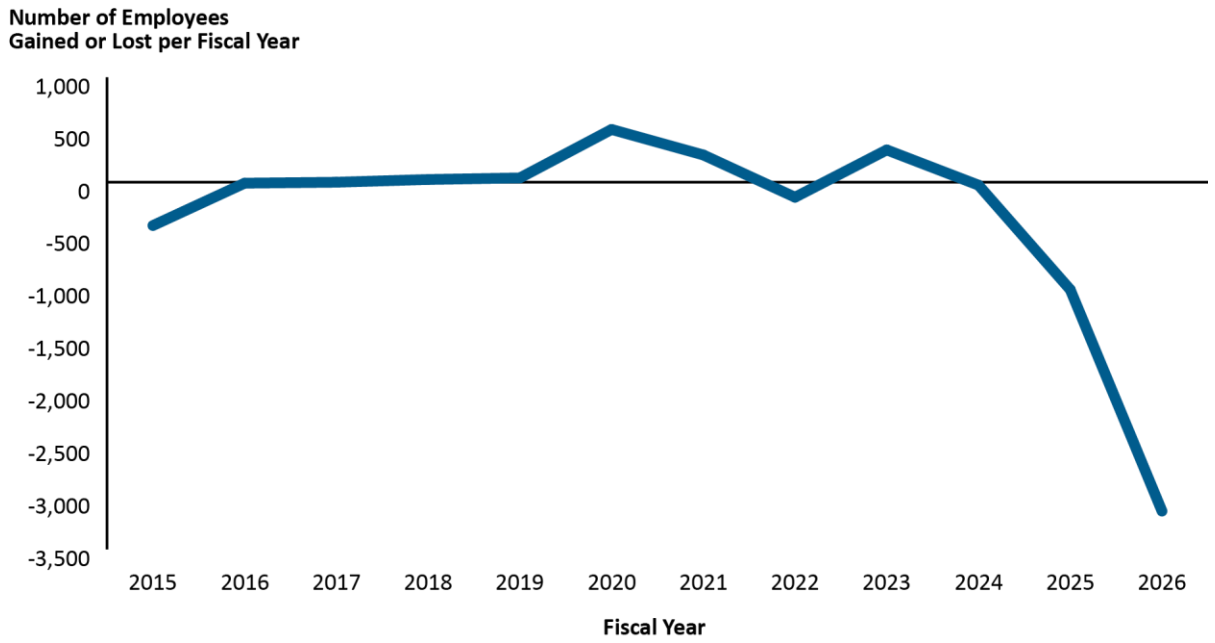
For several years AETC has tracked a "workforce recruitment and retention" portfolio risk, meaning sufficiently skilled staff may not be available to conduct wind tunnel testing when needed. AETC found that noticeable retirement and attrition rates reduced the skills needed to effectively operate the wind tunnels. This risk was exacerbated in 2025 and 2026 with workforce reductions. In response, AETC's risk mitigation strategy is to train each center's workforce over the next 2 to 3 years to operate multiple tunnels—shifting from a workforce specialized in operating a particular tunnel to a redeployable, center-wide workforce capable of operating multiple wind tunnels. Although the portfolio operates at a lower capacity that matches current Agency demand and recent funding levels, this condition is subject to change. In our opinion, AETC and ARMD are underestimating the severity of the risk and overestimating the value of their mitigation strategy to overcome these challenges in the long run. Without a sufficient base of experienced talent and institutional knowledge, the strategy may result in reduced internal capabilities, increased program risk, and less flexibility in addressing emergent technical challenges.

Staffing Challenges Across the Agency

Since 2019, we have reported on challenges NASA faces with its technical workforce, including ensuring sufficient personnel with the right skills in technical occupations are available to support missions; attracting and retaining science, technology, engineering, and mathematics employees; and addressing a retirement wave for the technical workforce.[19] While AETC experienced these challenges in 2025 and into 2026, they were exacerbated by workforce reductions occurring across the Agency. According to the U.S. Office of Personnel Management, this was a result of the Administration's workforce reshaping initiatives, including a hiring freeze, early retirement incentives, reductions in force, and the Deferred Resignation Program, resulting in the workforce shrinking considerably in FYs 2025 and 2026. While historically NASA has retained a stable workforce topline number of employees, it has dropped by over 4,000, or more than 25 percent, in FYs 2025 and 2026 from FY 2024 levels (see Figure 5).

[19] NASA OIG, *2019 Report on NASA's Top Management and Performance Challenges* (TMC-2019, November 2019), and *2025 Report on NASA's Top Management and Performance Challenges* (TMC-2025, January 2026).

Figure 5: NASA Workforce Changes Since 2015



Source: NASA OIG presentation of U.S. Office of Personnel Management data.

The workforce reductions present difficulties maintaining institutional knowledge and ensuring the continuity of mission critical operations. NASA will also continue to be challenged to attract and retain top talent as the Agency increasingly competes with the private sector for skilled professionals.

AETC Portfolio Workforce Challenges

Historically, AETC has supported a workforce of 500 plus full-time civil service employees and contractors to operate and sustain portfolio facilities. These positions are primarily engineers and technicians. As early as FY 2023, AETC began tracking the "workforce recruitment and retention" portfolio risk because of noticeable retirement and attrition that made it more challenging to have the right skills to operate the wind tunnels. In our opinion, the deferred resignation and hiring freeze in 2025 and into 2026 further exacerbated the situation. Table 2 shows AETC's budgeted staff allocations since FY 2023.

Table 2: AETC Budgeted Portfolio Positions

Labor Source	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027 (estimated)
Civil Service	164	168	171	134	195
Contractor	362	362	362	319	260
Totals	**526**	**530**	**533**	**453**	**455**

Source: NASA.

Note: Numbers are rounded to whole numbers.

We asked the facility managers at Ames, Glenn, and Langley to rate their wind tunnel workforce risk using a stoplight scale with red as the highest risk, yellow as medium risk, and green as low risk. The summary is shown in Table 3.

Table 3: Facility Managers' Assessment of Workforce Risk

Green	Light Green	Yellow	Orange	Red	Total
3	4	3	1	1	12

Source: NASA OIG analysis of Agency responses.

The reduction in workforce for FYs 2025 and 2026, in addition to an anticipated decline in demand from NASA programs and projects, allowed the readiness state of some wind tunnels to be intentionally reduced. This allowed AETC to manage the workforce reduction by lending staff from lower, or no, planned production facilities to higher planned production facilities. We found that facility managers with higher planned production and full staff rated themselves as green at lower risk. The yellow and higher risk assessments generally came from managers that would have to return to higher production hours. If NASA transitions out of the FYs 2025 and 2026 decline in research and goes back to normal production, borrowed staff will need to return to their facilities to meet that normal demand. That return to normal production does not appear to be fully assessed in facility management's responses. Additionally, there is continued risk from some facilities being only one-person deep in some positions, pending retirements, and persistent recruiting challenges.

AETC Workforce Risk Response

AETC's primary workforce risk mitigation strategy is to do more with less using a Campaigning Operating Model. Specifically, the model expects cross-trained staff within a center to be able to operate multiple wind tunnels, redeployed based on demand and priority. After testing is completed and a wind tunnel is reset to its standby or maintenance state, some portion of that tunnel's workforce transitions to support the next wind tunnel going into a test. The benefits beyond reduced personnel costs include better talent utilization, enhanced collaboration, wider perspectives, and possible innovation in wind tunnel methods. AETC plans to continue pursuing the Campaigning Operating Model and standardizing the model's processes.

We inquired with facility managers at Ames, Glenn, and Langley about the cost and benefits of this plan. We summarized them into five major takeaways:

- There are costs to cross-train engineers and technicians and the effort will need to be sustained.
- The anticipated level of motivation of staff to participate in the Campaigning Operating Model initiative varies. Some see it as an exciting opportunity, others less so.
- The ability to synchronize staff availability across facility schedules will be challenging as critical staff cannot be in multiple places at once. Likewise, training new staff on these unique skillsets requires being present for wind tunnel operations.
- Some of the wind tunnels are old and complex with learning curves that need a stable core of experts to function.

- Even if there is a fully ready Campaigning Operating Model workforce, there is a risk that alternating wind tunnel downtime periods to accommodate a limited workforce may dictate testing schedules as opposed to mission priority dictating schedules.

Although AETC's Campaigning Operating Model plan has been a positive initiative and an appropriate risk response in the last 2 years, we believe it will be insufficient to mitigate long-standing wind tunnel capability workforce risks. Workforce planning should also be aligned to the NASA Administrator's February 2026 workforce directive on restoring NASA core competencies; retaining in-house engineering, operational, and scientific excellence; and reclaiming technical autonomy.[20] Specifically, the Administrator directed that NASA expand with a strong core of civil servants, staffed and equipped to lead the most complex engineering and operational challenges, ensuring expertise, resilience, agility, and innovation in every mission. The directive promotes conversions of contractor positions to civil service, onboarding processes, and strategies to attract industry and academic talent to mitigate workforce challenges. Moreover, this directive is in line with ARMD, which stated in FY 2024 that "AETC is an enduring capability requiring an enduring workforce" and proposed an increase to the civil service ratio. AETC's own studies found civil servants would generally stay twice as long as contractors and build the technical knowledge needed to operate these complex and massive wind tunnel facilities.

[20] NASA Administrator Jared Isaacman, *Workforce Directive: Restoring NASA's Core Competencies* (February 6, 2026).

DEFERRED PREVENTIVE MAINTENANCE RISKS ARE NOT ALWAYS TRACKED

It is NASA policy that facilities and equipment be maintained in the most cost-effective manner to minimize risk to processes and products, protect the safety and health of personnel and the environment, protect and preserve capabilities and capital investments, provide quality workplaces for NASA employees, and enable the Agency's mission.[21] Annual work plans should include preventive maintenance, which is the planned, scheduled periodic inspection, adjustment, cleaning, lubrication, parts replacement, and minor repair of equipment and systems. Preventive maintenance is the cornerstone of any good maintenance program to improve operational inefficiencies and reduce safety risks to employees and costly unplanned major repairs or replacements.

Consequently, when preventive maintenance is not completed, wind tunnels may experience significant equipment failures and become unavailable for use as we observed on our site visits to the facilities. For example, in July 2024, Langley's 4-Foot Supersonic Unitary Plan Wind Tunnel experienced a mishap where the main motor drive overheated and became inoperable. A subsequent investigation showed a combination of missed maintenance, cost workarounds, and improper preventive procedures were contributing causes. As of August 2026, ADAPT indicated that the wind tunnel was still in planned downtime with testing to be resumed later in 2026 (see Figure 6).

[21] NASA Policy Directive 8831.1E, *Maintenance and Operations of Institutional and Program Facilities and Related Equipment (Revalidated June 17, 2013 w/Change 1)* (June 19, 2003), and NASA Procedural Requirements 8831.2F, *Facilities Maintenance and Operations Management (Updated w/Change 1 on September 2, 2016)* (October 7, 2015).

Figure 6: 4-Foot Supersonic Unitary Plan Wind Tunnel at Langley Undergoing Repairs

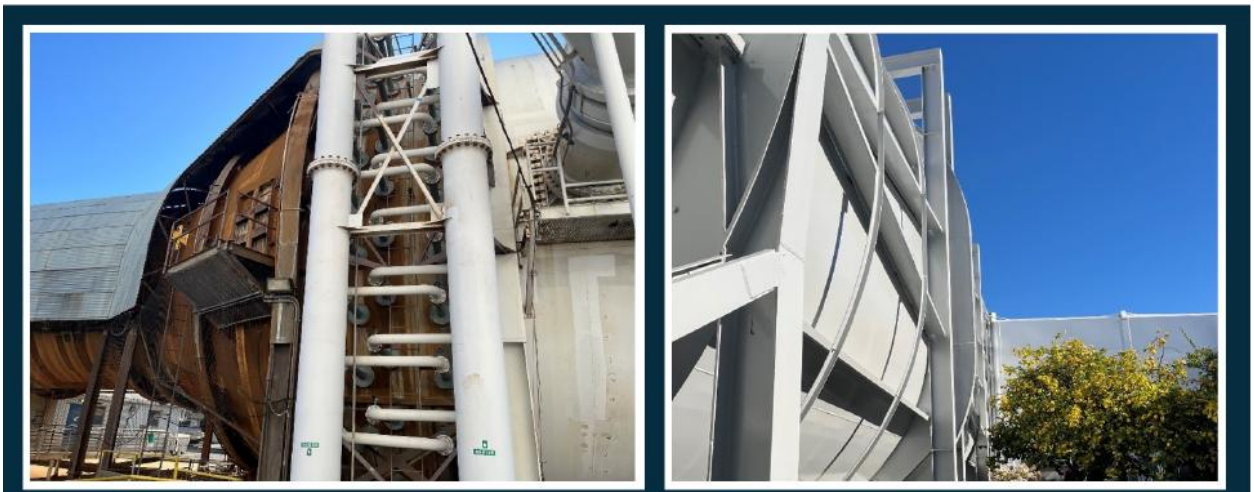


Shown here is Langley's 4-Foot Unitary Plan Wind Tunnel undergoing repairs. The mobile crane, on the left side, was brought in to assist with the repairs because the facility's existing 50-ton overhead crane, on the top in yellow, is inoperable.

Source: NASA OIG.

AETC QUEST is the tracking system for unplanned maintenance tasks, cost estimates, and risks within the AETC Portfolio. It is used by both the facility managers to show the "iceberg" of maintenance costs and associated risk levels at their center and for AETC to track and communicate the backlog to stakeholders. We found in our discussions with facility managers that some known deferred preventive maintenance—activities that did not occur as planned—were unlikely to be captured in QUEST despite the risks that they pose. However, in our review of QUEST data, we found multiple instances of deferred preventive maintenance being recorded. In our opinion, when utilized appropriately, this would be a good process to properly communicate the risk of deferred preventive maintenance to the portfolio. For example, facility managers at Ames entered corrosion concerns into QUEST, which we observed during our visit to Ames in January 2026, as shown in Figure 7.

Figure 7: Examples of Deferred and Preventive Corrosion Control at Ames



Left photo: The "Hot Section" of the Unity Plan Wind Tunnel at Ames, shown here, provides critical cooling of the tunnel shell and exhibits significant areas where paint has flaked off and no corrosion protection exists, leading to significant rusting and corrosion. Without proper corrosion protection, these areas will continue to deteriorate. Right photo: Exterior of an Army-leased wind tunnel facility at Ames, showing preventive corrosion control exterior paint.

Source: NASA OIG.

While QUEST has this capability, AETC does not utilize the system or another process to track preventive maintenance tasks once they have been deferred. The execution of preventive maintenance schedules is local to the centers. Moreover, facility managers we spoke with stated that deferred preventive maintenance was not always captured in their local systems and some were unaware of their responsibility to document, monitor, and communicate this information despite the inherent risks. While the reasons for this vary between centers and facilities, generally it was due to insufficient requirements or communication controls to do so.

Several wind tunnels with known missed preventive maintenance activities did not have a corresponding record made in QUEST. In one instance, a contractor's deferral of maintenance at a center, probably due to insufficient funding, resulted in a pump failure causing major downtime for the wind tunnel. The deferment was not tracked properly in local systems or in QUEST where it might have been assessed and mitigated or prevented. While some facility managers were better at managing their facility's deferred preventive maintenance because of good communication with their contractors, proper documentation of deferments, even if temporary, are important controls.

In our discussions with facility managers, there was some concern about whether QUEST was the appropriate location to capture deferred preventive maintenance. In our review of QUEST data, we saw entries that indicate QUEST had already been used in this manner in some capacity. In one example we noted an entry that was to "Accomplish the Annual Preventive Maintenance (PM) and Programmed Maintenance (PGM) plans for FY 2026 in accordance with the established maintenance and operational procedure(s)." This entry showed an ability for the system to be leveraged for this purpose.

TIER 2 FACILITIES ARE UNDER SUPPORTED

Aerosciences ground test facilities that are not part of the AETC Portfolio, but perform related research, are categorized as Tier 2. AETC is required to be cognizant of and periodically assess Tier 2 facility capabilities and their condition. Tier 2 facilities feed the early research and technology development pipeline and share the physical infrastructure and personnel talent pool with wind tunnels and laboratories in the AETC Portfolio. AETC provides no direct funding to Tier 2 facilities as centers are primarily responsible for managing the wind tunnels and seeking mission directorate-funded projects and external customers to keep these facilities operating. Many of the same challenges facing Tier 1 facilities in the portfolio, such as staff shortages and maintenance problems, are also present in Tier 2 facilities. These conditions are sometimes worse at Tier 2 facilities because they do not benefit from the additional support that comes with the AETC centralized management structure of its Tier 1 facilities. Further, Tier 2 facilities do not have a funding model that works efficiently, using the previously mentioned pay-per-use model. All of these factors leave Tier 2 facilities at risk of further degradation, underutilization, and lost innovation opportunities in the technology development pipeline.

Vital Role of Tier 2 Facilities

Tier 2 facilities play a vital role in meeting the current and future needs of NASA and the nation as part of the larger test facility capability ecosystem. For example, Tier 2 facilities at Glenn were used to develop unique concepts for a commercial supersonic aircraft that meets federal noise regulations, one of the top barriers to a commercial supersonic market. Currently, civil aircraft are prohibited from flying over land at faster than Mach 1—the speed of sound—to protect the public from loud sonic booms. In 2017, as part of NASA's Commercial Supersonic Technology Project, the Agency and a team from Lockheed Martin and General Electric demonstrated how mounting the propulsion above the aircraft allowed adequate shielding of the exhaust noise to reduce the sound.[22] The technology developed from this demonstration was incorporated into NASA's supersonic X-59 research aircraft, designed to reach Mach 1.4 and provide data to help establish acceptable noise thresholds by proving a sonic boom can be reduced to a barely-audible sonic thump heard on the ground.

The concept was proposed by NASA researchers based on several years of measuring noise impacts at Glenn's Aero-Acoustic Propulsion Laboratory. When NASA was challenged to create a supersonic vehicle that could meet civilian noise requirements, the knowledge gained in early development testing was used to build an unconventional supersonic aircraft, considering noise and performance. The final validation test, made at the Nozzle Acoustic Test Rig housed in the propulsion laboratory, demonstrated the expected benefits, providing advances for industry to use in future aircraft development.

[22] The concluded Commercial Supersonic Technology Project studied supersonic vehicle research that addressed the development of tools, technologies, and knowledge to help eliminate technical barriers to practical commercial supersonic flight.

Funding Model for Tier 2 Facilities Discourages Use

The capability portfolio funding model only covers operational costs for AETC's Tier 1 facilities, while also providing some funding for capability advancements and maintenance. This means Tier 2 facilities must use the pay-per-use model, relying on funding from NASA programs and projects that want to use the facilities. This becomes more difficult as these programs and projects are forced to absorb the additional costs associated with the management and upkeep of the facility. As a result, Tier 2 facilities frequently have limited funding to maintain staff and equipment unless provided by their respective center.

This funding model often leads to higher costs for prospective NASA users and external customers as they may have to pay the entire cost of revitalizing dormant equipment and bringing back dispersed staff at underutilized Tier 2 facilities. For example, the Engine Research Building at Glenn contains more than 60 test rigs supporting research in all aspects of engine development, with specialized areas such as combustion aerochemistry and mechanical components. Engine Research Building officials stated they are losing potential users and customers due to the high testing costs at their facility. They also noted that keeping the facility open has become a challenge because of the funding model. In addition, early-stage research and technology development projects with smaller budgets may not be able to afford the costs to test in the facility, leading to lost innovation opportunities.

Staffing Shortages and Maintenance Issues at Tier 2 Facilities

Staff shortages have led to operational issues at some Tier 2 facilities that operate with a very small and shared staff. For example, the Engine Research Building's 1- by 1-Foot Supersonic Wind Tunnel has only one person who knows how to operate the tunnel, limiting how often it can be used. Facility personnel at Langley's Liner Technology Facility, used to measure the impedance of aeroacoustic liners for application to the engines and airframes of aircraft, stated they could meet additional demand and accomplish more testing if they had more staff.[23] The Quiet Flow Facility, which is part of the Flow Physics Laboratory at Langley, is used for studying aircraft noise, but shares staff with other facilities. If it did not have to share staff, tests could be run in parallel and completed in less time.

Number 76 Bladeless Compressor for the W-7 Multistage Compressor Facility at Glenn's Engine Research Building



Source: NASA.

[23] Aeroacoustic liners, usually made of perforated plates bonded to cavities, are resonating-type passive elements used in aeronautics to mitigate engine noise. Impedance is a complex, frequency-dependent quantity and is often regarded as the primary benchmark for assessing a liner's acoustic performance. In September 2026, AETC management told us that this facility is no longer considered a Tier 2 facility and therefore is not included in Appendix C.

Like Tier 1 AETC facilities, we found Tier 2 facilities were in various states of readiness due to maintenance issues. For example, the Arc-Heated Scramjet Test Facility, part of the Scramjet Complex at Langley, is used to conduct hypersonic propulsion research. However, because of poorly managed maintenance and run-to-failure practices, the facility is just now returning to operation after a 6-year hiatus due to numerous equipment issues.

Collecting Performance Data to Support Critical Capabilities

AETC evaluates performance and mission value determinations of Tier 2 facilities as part of its requirement to be cognizant of and periodically assess these facilities. AETC routinely assesses capabilities in its portfolio against NASA mission test requirements and annual capability assessments, both of which provide a limited amount of insight into Tier 2 capabilities. The AETC Portfolio Office does collect some data to develop performance and value scores for Tier 2 facilities like the data it collects in the ADAPT portal for Tier 1 wind tunnels. Performance and value scores allow AETC to better evaluate Tier 2 facilities that can inform recommendations AETC will make to the Agency concerning changes to its portfolio. However, it is a work in progress, and we found Tier 2 facility managers had varied levels of understanding and familiarity with ADAPT. Obtaining information on these facilities is vital to perform not only AETC's own stewardship responsibilities but also to support Agency facility-related initiatives.

OTHER MATTERS OF INTEREST

Computational fluid dynamics (CFD) has had a profound impact on the aircraft design process over the past five decades. With CFD, the laws of physics are applied to mathematical equations that are solved with high-speed supercomputers, resulting in a simulation of the forces acting on aircraft and spacecraft in flight. In pursuit of its goal to innovate advanced capabilities, AETC has taken an active role in CFD.

As CFD codes become more accurate, the need for comparisons with experimental data has increased. In FY 2021, AETC was involved in a CFD study involving Langley's 4-Foot Supersonic Unitary Plan Wind Tunnel, which was scheduled for demolition the following year. The purpose of the study was to determine whether the wind tunnel should remain on Langley's demolition list. The study looked at several factors, including future test demand forecasts and condition of the facility, while also assessing the ability of CFD to address prediction requirements in the speed range achievable in the tunnel—Mach 2.4 to 4.6. Study participants compared CFD pre-test predictions with experimental data from actual tests within the tunnel and determined the CFD predictions compared poorly to the actual test data. In the end, the study recommended NASA continue to operate and sustain the Unitary Plan Wind Tunnel as CFD could not replace the efficiency of the tunnel.

The maturity of CFD simulation varies across aeroscience applications, making it an unreliable means to fully replace ground testing in all scenarios as shown in the study. NASA researchers have identified several areas where work needs to be done to improve CFD simulations, including the interaction of a landing spacecraft's exhaust striking the surface of a planet, performance of decelerator systems like parachutes, impacts from icing on surfaces, and internal airflows within propulsion systems. AETC is working to integrate CFD and wind tunnel testing to better support NASA users and external customers of the wind tunnels and understand the airflow inside the tunnels.

As the physical dimension, or geometry, of a wind tunnel is important for any simulation, AETC is developing guidelines for its facilities to better understand the airflow in the wind tunnels and help NASA users and external customers interested in running simulations in the tunnels. AETC has started to create computer-aided design digital models for each tunnel, including the geometry of the tunnel walls and test nozzles. Providing these files, or "skeletons," of each tunnel to CFD modelers will help create more accurate simulations based upon the actual airflow conditions within each tunnel. AETC plans to complete the computer-aided design models of its 12 wind tunnels by the end of 2027.

In addition, AETC, in collaboration with ARMD's Advanced Air Vehicles Program and Transformative Aeronautics Concepts Program, will be leading the Near Real-Time Test Integration Initiative to compare wind tunnel test data to CFD simulations in near real time, while leveraging super intelligence to analyze the data.[24] NASA users and external customers will be able to view and interact with test data via a

[24] The Advanced Air Vehicles Program studies, evaluates, and develops technologies and capabilities for new aircraft systems, and explores far-future concepts that hold promise for revolutionary air-travel improvements. The Transformative Aeronautics Concepts Program solicits and encourages revolutionary concepts, creates the environment for researchers to experiment with new ideas, performs ground and small-scale flight tests, allows failures and learns from them, and drives rapid turnover into potential future concepts to enable aviation transformation.

hyperwall installed at Ames, with all other wind tunnel facilities having smaller, or "mini-hyperwalls."[25] These hyperwalls allow CFD modelers to quickly access the accuracy of their simulations relative to actual test data and possibly adjust their models while the tests are being conducted. Eventually, the initiative will provide the ability to integrate flight test data so users and customers can view simulation, ground testing, and flight test data all in near real time.

The proposed benefits of the initiative include the following:

- correcting testing errors and assumptions
- reducing repeated wind tunnel runs
- minimizing manual post-processing
- providing real-time analytical feedback on flow phenomena
- predicting vehicle performance beyond wind tunnel capabilities

By the end of FY 2028, NASA expects to demonstrate significant reductions in test time using the developed integrated simulation, ground testing, and flight testing, possibly leading to shorter development times for future aircraft.

Considering AETC's efforts to integrate CFD with the wind tunnels in its portfolio, we assessed CFD's impact on the future need for wind tunnel testing. Based on the engineering challenges that cannot be solved purely with simulation—due to the knowledge gaps with CFD—and with flight testing—due to cost and safety issues—both NASA and the aerospace community firmly believe CFD will not replace wind tunnel testing for at least the foreseeable future. CFD, flight testing, and wind tunnel testing will remain vital to aerospace research and development. In fact, AETC is working on developing a study to understand what wind tunnel capabilities will be needed in the future and whether new facilities need to be built or if existing tunnels can be rebuilt with enhanced capabilities.

We did not assess to what extent AETC's role should be with CFD and how super intelligence investments should be incorporated in technology and tool development. While these technologies directly relate to several AETC strategic goals, we believe AETC's investment in super intelligence is prudently prioritized below needed wind tunnel maintenance and sustainment.

[25] A hyperwall is a high-resolution, multi-screen visualization system, most notably used by NASA to display large, high-dimensional datasets and supercomputer simulations. It arranges multiple LCD screens into a large, near-seamless wall to display complex imagery, enabling researchers to compare different data viewpoints, datasets, or scientific findings simultaneously.

CONCLUSION

NASA wind tunnels are national assets and crucial for testing components and structures from aircraft to deep space flight hardware like the Space Launch System and Orion crew capsule used in the Artemis missions. As building more X-planes is one of the NASA Administrator's key objectives for the Agency, wind tunnels become even more critical for evaluating components and reducing risks. As the steward of a portfolio consisting of the Agency's 12 world-class wind tunnels, the efficient and effective functioning of AETC is essential to the health of the aerosciences ground test capability.

Although AETC has demonstrated a positive impact on efficiency and effectiveness of wind tunnel operations, NASA must make strategic changes to the portfolio or funding model to maximize the utility of these facilities. Improving communication with external customers to better track testing requests and outcomes within a customer management system is one method that may help mitigate some funding challenges. In addition, workforce and maintenance issues present an ongoing and significant impact that cannot be quickly resolved or mitigated without focused attention and Agency-level solutions. We believe restoring and sustaining workforce core competencies is essential to maximize taxpayer resources, align investments with Agency priorities, and ensure mission success. Lastly, while not technically a part of the AETC Portfolio, Tier 2 wind tunnel facilities play a vital role in NASA's ability to support early aeroscience research and technology development efforts. Without adequate support, these facilities will become less relevant in a quickly evolving environment that relies on reliability and availability.

RECOMMENDATIONS, MANAGEMENT'S RESPONSE, AND OUR EVALUATION

To ensure AETC continues to effectively manage its portfolio of wind tunnels and other facilities to meet national challenges, we recommended the Associate Administrator for Research and Technology Mission Directorate direct the Aerospace Capabilities Portfolio Director (formerly the Associate Administrator for ARMD and AETC Portfolio Office Director, respectively) to:

1. Evaluate and implement a sustainable AETC funding model that matches resource allocations to a given set of achievable capability portfolio objectives.
2. Design processes that can support facility managers to identify and track unmet or additional sources of demand.
3. Leverage the Agency's workforce directive, in particular contractor conversions to civil service, onboarding processes, and strategies, to attract industry and academic talent to mitigate workforce challenges.
4. Design and implement best practices across all centers and facilities for tracking deferred preventive maintenance, including the capture of risks from long-term deferred preventive maintenance.
5. Incorporate funding and management best practices demonstrated by AETC's Tier 1 wind tunnels into the sustainment of NASA's Tier 2 facilities.

We provided a draft of this report to NASA management who concurred with our recommendations and described planned actions to address them. We consider management's comments responsive; therefore, the recommendations are resolved and will be closed upon completion and verification of the proposed corrective actions.

Management's comments are reproduced in Appendix D. Technical comments provided by management and revisions to address them have been incorporated as appropriate.

Major contributors to this report include Ray Tolomeo, Science, Research and Technology Audits Director; John Schultz, Assistant Director; Mona Mann; Frank Martin; and Lauren Suls.

If you have questions or wish to comment on the quality or usefulness of this report, contact Laurence Hawkins, Audit Operations and Quality Assurance Director, at 202-358-1543 or laurence.b.hawkins@nasa.gov.



Kathryn D. Sheehey
NASA OIG Senior Official

APPENDIX A: SCOPE AND METHODOLOGY

While we performed this audit from July 2025 through August 2026, it was suspended during the government shutdown that occurred from October 1 to November 12, 2025. The audit was performed in accordance with generally accepted government auditing standards, which require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives. This is the third audit performed on NASA's five capability portfolios, the first two were NASA's Rocket Propulsion Testing Program and the High-End Computing Capabilities Portfolio.

Our overall objective was to examine NASA's management of its national wind tunnel facilities. To accomplish our objective, we conducted virtual interviews with AETC officials, including the AETC Portfolio Office Director and Deputy Director, Operations Manager, Data Systems and Security Project Manager, and Maintenance Project Manager. We also performed work at Ames, Glenn, and Langley. We interviewed center integration managers and facility managers for Tier 1 and Tier 2 facilities located at each center to ascertain the status of their facilities, including the workforce. Further, we interviewed officials from the center business offices responsible for processing reimbursable agreements.

Finally, we reviewed federal and NASA criteria, policies, procedures, and supporting documentation; prior audit reports; budget planning documents; internal and external reviews; strategic planning documents; and other documents related to project management. The documents we reviewed included, but were not limited to, the following:

- NASA Procedural Requirements 8600.1, *NASA Capability Portfolio Management Requirements* (April 22, 2019)
- NASA Aeronautics Strategic Implementation Plan 2023
- Aerosciences Evaluation and Test Capabilities (AETC) Portfolio Strategic Plan Version 1.0 (July 12, 2022)
- NASA Advisory Implementing Instruction (NAII) 1050-3C, *NASA Partnerships Guide* (July 1, 2024)

Assessment of Data Reliability

We relied on the fact that data derived from SAP, the Agency's financial system, had been previously validated. Additional assurance was obtained by comparing summaries provided by management and previously publicly reported totals from sources, such as annual reports, and discussing values with NASA management.

Review of Internal Controls

We evaluated the internal controls associated with NASA's management of its national wind tunnel facilities. We identified five control components relevant to the scope of our work and included steps related to several underlying principles. We also reviewed appropriate policies, procedures, and regulations and conducted interviews with relevant personnel. Our recommendations, if implemented, will improve the identified control weaknesses we have noted in our report. However, because our

review was limited to these internal control components and underlying principles, it may not have disclosed all internal control deficiencies that may have existed at the time of this audit.

Prior Coverage

NASA OIG and the Government Accountability Office have issued seven reports of significant relevance to this report. These reports can be accessed at https://oig.nasa.gov/ and https://www.gao.gov/, respectively.

NASA Office of Inspector General

NASA's Rocket Propulsion Test Program (IG-24-018, September 24, 2024)

Audit of NASA's High-End Computing Capabilities (IG-24-009, March 14, 2024)

NASA's Construction of Facilities (IG-21-027, September 8, 2021)

NASA's Management of Reimbursable Agreements (IG-18-018, May 29, 2018)

NASA's Efforts to Reduce Unneeded Infrastructure and Facilities (IG-13-008, February 12, 2013)

Government Accountability Office

Federal Real Property: Agencies Should Provide More Information About Increases in Deferred Maintenance and Repair (GAO-24-105485, November 16, 2023)

Hypersonic Weapons: DOD Should Clarify Roles and Responsibilities to Ensure Coordination across Development Efforts (GAO-21-378, March 22, 2021)

APPENDIX B: AETC TIER 1 FACILITIES

The following tables contain information for each AETC Tier 1 facility. Some facilities contain multiple wind tunnels and those not currently in use are denoted as "inactive." The values shown are for FY 2025, except deferred maintenance and the backlog of needed repairs, that are as of July 2026. Workforce numbers from the 2025 operating plan were used for calculating rates and rounded to whole persons for presentation purposes; differences in totals found in Table 2 are due to portfolio support such as management.

Ames Research Center

Unitary Plan Wind Tunnel
11- by 11-Foot Transonic Wind Tunnel and 9- by 7-Foot Supersonic Wind Tunnel
Established 1956





The Unitary Plan Wind Tunnel, recognized for its contributions to the nation's aerospace programs and engineering excellence, is a continuous flow tunnel with three separate test sections. It also has a large test chamber with high reliability and ease of transfer between test sections. Proximity to Ames's supercomputer allows for real-time data analysis.

The 11- by 11-Foot Transonic Wind Tunnel operates at Mach 0.2 to 1.4 and has been instrumental in development of nearly every domestically-produced commercial transport and military fixed-wing airframe. The wind tunnel is used extensively for airframe testing and aerodynamic studies.

The 9- by 7-Foot Supersonic Wind Tunnel operates at Mach 1.55 to 2.55 and has provided aerodynamic data for NASA's crewed space flight efforts.

The 8- by 7-Foot Supersonic Wind Tunnel is inactive.

Selected Values for FY 2025

Civil Service	26	Deferred Maintenance	$87,201,000
Contractor	66	Full Cost of Operations	$23,743,700
Total Workforce	92	Normal Capacity Hours	2,706

Glenn Research Center

8- by 6-Foot Supersonic Wind Tunnel
Established 1948
9- by 15-Foot Low-Speed Wind Tunnel
Established 1968





While housed in the same facility, these two wind tunnels were built separately and at different times.

The 8- by 6-Foot Supersonic Wind Tunnel is NASA's only transonic-propulsion wind tunnel, serving industry, academia, and NASA aerospace researchers for over 60 years. The tunnel operates either in an aerodynamic closed-loop cycle, testing aerodynamic performance models, or in a propulsion open-loop cycle, testing live fuel-burning engines and models at Mach 0 to 0.1 and Mach 0.26 to 2.0.

The 9- by 15-Foot Low-Speed Wind Tunnel, the most utilized low speed propulsion acoustic facility in the world, evaluates the aerodynamic performance and acoustic characteristics of fans, nozzles, inlets, and propellers. This is also the only national facility that can simulate takeoff, approach, and landing in a continuous, subsonic environment—operating at airspeeds from 0 to 165 mph.

This facility has been used to test aircraft, such as the Advanced Turboprop, National AeroSpace Plane, Advanced Tactical Fighter, Joint Strike Fighter, and High-Speed Civil Transport.

Selected Values for FY 2025

Civil Service	18	Deferred Maintenance	$12,788,000[a]
Contractor	44	Full Cost of Operations	$12,441,100
Total Workforce	62	Normal Capacity Hours	2,224

[a] Glenn also has center-wide wind tunnel instrumentation system upgrades estimated at $600,000 and the Central Process System that is the critical utility network that powers and controls the wind tunnel test facilities across the center, which has $34,702,000 in AETC's share of deferred maintenance.

Glenn Research Center

10- by 10-Foot Supersonic Wind Tunnel
Established 1955



The 10- by 10-Foot Supersonic Wind Tunnel, designed to test supersonic propulsion components from inlets and nozzles to full-scale jet and rocket engines, has made valuable contributions to the advancement of fundamental supersonic propulsion technology. The tunnel operates at Mach 2.0 to 3.5. It can also run at subsonic test conditions from 5 to 240 knots (Mach 0.36) and altitudes up to 50,000 feet.

Researchers have used this facility to aid in the development of the Atlas Centaur, Saturn, and Atlas-Agena-class launch vehicles. It has also been used for vehicle-focused research programs, including the High-Speed Civil Transport, National AeroSpace Plane, and Joint Strike Fighter.

Selected Values for FY 2025

Civil Service	13	Deferred Maintenance	$46,531,000
Contractor	41	Full Cost of Operations	$10,777,000
Total Workforce	54	Normal Capacity Hours	2,200

Glenn Research Center

Propulsion Systems Laboratory
Established 1972



The Propulsion Systems Laboratory is one of the premier U.S. facilities for experimental testing of advanced air-breathing propulsion systems. In this facility, altitude simulations at true flight conditions are created from sea level to 90,000 feet for advanced aircraft, space propulsion, and general aviation programs. The laboratory is NASA's only continuous flow, ground-based facility of its kind. Between its two test cells, the laboratory operates at Mach 0 to 4.0.

The Propulsion Systems Laboratory has supported aircraft programs like the SR-71, F-16, F-15, and B-52.

Selected Values for FY 2025

Civil Service	14	Deferred Maintenance	$13,611,000
Contractor	42	Full Cost of Operations	$11,337,100
Total Workforce	56	Normal Capacity Hours	2,208

Glenn Research Center

Icing Research Tunnel
Established 1944 [a]



The Icing Research Tunnel is one of the world's largest refrigerated wind tunnels dedicated to studying aircraft icing. The tunnel duplicates natural icing conditions to test the effects of in-flight icing on aircraft components and model aircraft, including helicopters. The tunnel has played a substantial role in developing, testing, and certifying methods to prevent ice buildup on aircraft.

The Icing Research Tunnel is used for the investigation of deicing and anti-icing fluids for use on the ground and deicing and anti-icing research on aircraft, including rotor systems and certification of ice protection systems for military and commercial aircraft. It is typically run at speeds up to 403 mph.

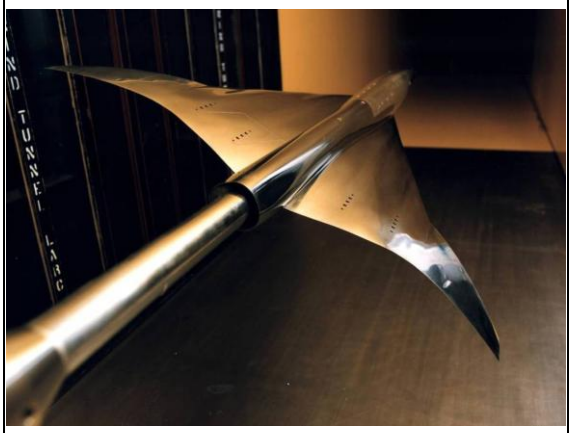
Selected Values for FY 2025

Civil Service	6	Deferred Maintenance	$11,930,000
Contractor	17	Full Cost of Operations	$4,479,600
Total Workforce	23	Normal Capacity Hours	2,464

[a] While the Icing Research Tunnel was first established in 1944, it has undergone substantial renovation and modernization projects in 1986, 1996, and 1999.

Langley Research Center

4-Foot Supersonic Unitary Plan Wind Tunnel
Established 1948



The 4-Foot Supersonic Unitary Plan Wind Tunnel is a closed-circuit, continuous-flow, variable-density supersonic tunnel with two 4- by 4- by 7-Foot test sections—one section operates at Mach 1.5 to 2.9 and the other at Mach 2.3 to 4.6. The tunnel is instrumented for force and moment studies, surface-pressure measurements, and flow visualization of on-and-off-surface flow patterns. Tests involving jet effects, dynamic stability, model deformation, global-surface and off-body flow measurements, and heat transfer can also be conducted.

The 4-Foot Supersonic Unitary Plan Wind Tunnel has made crucial contributions to the development, assessment, and optimization of advanced aerospace vehicle concepts. For example, entry, decent, and landing of the Mars Science Laboratory's Curiosity rover; the Orion crew capsule; and launch of the Space Launch System.

Selected Values for FY 2025

Civil Service	8	Deferred Maintenance	$35,705,000[a]
Contractor	18	Full Cost of Operations	$5,066,900
Total Workforce	26	Normal Capacity Hours	1,296

[a] Langley has $22,683,000 in deferred maintenance that is not specific to any one wind tunnel, such as general electrical upgrades and a shared cooling tower that needs refurbishment.

Langley Research Center

8-Foot High-Temperature Tunnel
Established 1965



The 8-Foot High-Temperature Tunnel is the nation's largest hypersonic blow down test facility, creating simulations at Mach 3.0, 4.0, 5.0, and 6.5 through a range of altitude from 50,000 to 120,000 feet. The tunnel supports large-scale thermal protection system testing, flight qualification testing, and hypersonic engine testing. It also duplicates flight conditions that would be encountered by hypersonic vehicles in the atmosphere. The tunnel's test stream is produced by burning methane, air, and liquid oxygen and expanding the combustion products through any one of several nozzles into the test section.

The 8-Foot High-Temperature Tunnel is generally utilized for hypersonic engine testing, which includes the National Aerospace Plane Concept Demonstration Engine, X43 Hyper-X engine, Office of Naval Research HyFly Dual Combustor Ramjet Engine, X43C program's Ground Demonstrator Engine No. 2, and Air Force Research Laboratory SJX61-1 and SJX61-2 engines.

Selected Values for FY 2025

Civil Service	15	Deferred Maintenance	$7,820,000
Contractor	21	Full Cost of Operations	$6,550,800
Total Workforce	36	Normal Capacity Hours	1,328

Langley Research Center

14- by 22-Foot Subsonic Tunnel
Established 1970



The 14- by 22-Foot Subsonic Tunnel assesses powered and unpowered models of fixed- and rotary-wing civil and military aircraft over a wide range of takeoff, landing, cruise, and high angle-of-attack conditions. The tunnel can be easily reconfigured for acoustic, tethered free-flight and forced-oscillation (dynamic stability) testing, as well as for motor sports studies. Investigators can choose either closed (walls, ceiling, and floor) or open (floor-only) test-section arrangements.

The 14- by 22-Foot Subsonic Tunnel is ideally suited for low-speed tests at about 237 mph to determine high-lift stability and control, aerodynamic performance, rotorcraft acoustics, turboprop performance, and basic-wake and flow-field surveys.

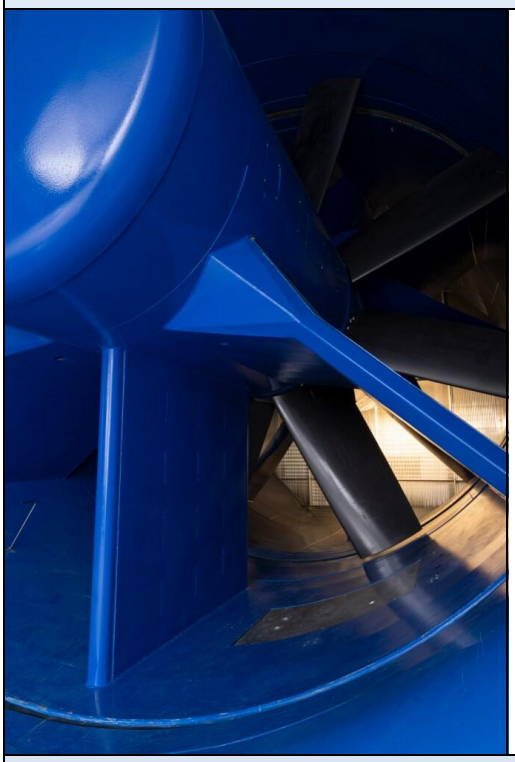
Major clients have included the U.S. Department of Defense and aircraft manufacturers, such as Boeing, Lockheed Martin, and Northrop Grumman.

Selected Values for FY 2025

Civil Service	10	Deferred Maintenance	$27,855,000
Contractor	22	Full Cost of Operations	$5,714,800
Total Workforce	32	Normal Capacity Hours	1,496

Langley Research Center

Flight Dynamics Research Facility
Operation Began July 2026



The Flight Dynamics Research Facility, NASA's newest wind tunnel, is a large, subsonic wind tunnel that operates at speeds of up to 117 mph with a vertical test section for conducting flight dynamics research for stability, controllability, free-fall and aircraft spin, and spin recovery testing of atmospheric vehicles.

The facility is designed as a highly versatile vertical wind tunnel that will support technology development for entry, descent, and landing of missions returning from the Moon and Mars, as well as exploration of Venus and Saturn's moon Titan. The facility will also play a major role in experimental research for NASA's future development of autonomous flight vehicles, drones, and X-planes.

This new facility replaces Langley's 20-Foot Vertical Spin Tunnel and 12-Foot Low Speed Tunnel. The Flight Dynamics Research Facility consolidates the test capabilities of the two tunnels it is replacing into one new, state-of-the-art wind tunnel with significantly greater performance.

Selected Values for FY 2025
(some values based on the 20-Foot Vertical Spin Tunnel)

Civil Service	8	Deferred Maintenance	$0
Contractor	3	Full Cost of Operations	$2,165,000
Total Workforce	11	Normal Capacity Hours	1,400

Langley Research Center

Langley Aerothermodynamics Laboratory
Established 1957 [a]



The Langley Aerothermodynamics Laboratory is a suite of three hypersonic blowdown-to-vacuum tunnels—15-inch and 20-inch tunnels that operate at Mach 6 and a 31-inch tunnel that operates at Mach 10—designed for fast-paced aerodynamic and aeroheating studies. The tunnels are ideally suited for screening, assessing, optimizing, and benchmarking advanced aerospace vehicle concepts, as well as performing fundamental flow physics research.

The laboratory has contributed to most major hypersonic vehicle programs, including Apollo, Viking, the Space Shuttle Orbiter, Hyper-X, and the Mars Science Laboratory. These wind tunnels continue to play a critical role in the development of the Orion crew capsule, commercial crew capabilities, and advanced hypersonic technology demonstration vehicles.

Selected Values for FY 2025

Civil Service	13	Deferred Maintenance	$23,338,000
Contractor	11	Full Cost of Operations	$4,367,900
Total Workforce	24	Normal Capacity Hours	1,932

[a] The Langley Aerothermodynamics Laboratory 20-Inch Mach 6 Tunnel first became operational in 1958 as the 20-Inch Hypersonic Tunnel. The 31-Inch Mach 10 Tunnel first became operational in 1957 as the Continuous-Flow Hypersonic Tunnel and was converted to a conventional hypersonic blow-down facility in the 1970s. The 15-Inch Mach 6 High Temperature Tunnel first became operational in 1991. The tunnel was converted from the former Mach 10 Hypersonic Flow Apparatus to provide the capability of testing in Mach 6 air at higher reservoir temperatures.

Langley Research Center

National Transonic Facility
Established 1982



The National Transonic Facility is the world's largest pressurized cryogenic wind tunnel. Its unique capabilities enable testing of scaled models at Mach 0.1 to 1.2 and flight Reynolds numbers in support of advanced aerodynamic concept development and assessment, advanced CFD tool validation, and risk reduction for vehicle development.[a]

The facility provides the largest range of Reynolds number testing in the world. It can use either air or nitrogen gas at ambient temperatures matching conditions of conventional wind tunnels. At cryogenic temperatures, nitrogen gas is used to achieve the highest Reynolds number testing in the world. Support is provided for both full-span and semispan testing with a wide range of instrumentation and measurement techniques.

Vehicle tests include the Boeing 777 and 787 aircraft; the Space Shuttle and booster; transport, fighter, and business jets; and a blended-wing-body design such as the B–2 bomber.

Selected Values for FY 2025

Civil Service	9	Deferred Maintenance	$59,080,000
Contractor	40	Full Cost of Operations	$8,747,000
Total Workforce	49	Normal Capacity Hours	1,480

[a] The Reynolds number is a dimensionless ratio of inertial (resistant to change or motion) forces to viscous (heavy and gluey) forces. In wind tunnel testing, it acts as the primary scaling parameter to ensure the airflow behavior over a small-scale model accurately mimics how the fluid will behave on a full-scale object in the real world.

Langley Research Center

Transonic Dynamics Tunnel
Established 1960



The Transonic Dynamics Tunnel is a closed-circuit, continuous-flow, variable pressure wind tunnel capable of using either air or R-134a refrigerant as a test medium that can operate up to Mach 1.12. The tunnel is dedicated to identifying, understanding, and solving aeroelastic issues confronting fixed-wing aircraft, helicopter, and tiltrotor configurations. Rotary wing tests at the tunnel have investigated performance, loads, and stability characteristics, while fixed-wing flutter, buffet, and divergence have been scrutinized as well.

Researchers have also used the Transonic Dynamics Tunnel to study the use of active controls technologies for both fixed and rotary wing configurations to determine the effects of ground wind loads on launch vehicles, and to provide steady and unsteady aerodynamic pressure data to support computational aeroelasticity and CFD code development and validation. Most recently, NASA used the tunnel to simulate the atmosphere on Saturn's moon Titan to test the Dragonfly mission rotor system.[a]

Selected Values for FY 2025

Civil Service	10	Deferred Maintenance	$72,457,000
Contractor	29	Full Cost of Operations	$7,532,700
Total Workforce	39	Normal Capacity Hours	1,510

[a] Dragonfly, the first-of-its-kind rotorcraft to explore another world, will fly to various locations on Saturn's moon Titan and investigate the moon's habitability. NASA intends to launch the mission in 2028 for an expected arrival at Titan in 2034.

APPENDIX C: AETC TIER 2 FACILITIES

Aerosciences ground test facilities that are not part of the AETC Portfolio are categorized as Tier 2 facilities, which include small acoustic testing rooms, engine component test facilities, and large buildings with laboratory-sized wind tunnels. We did not observe the facility at Marshall Space Flight Center (Marshall). Table 4 is the current list of Tier 2 facilities monitored by AETC.

Table 4: AETC Tier 2 Facilities

Facility Name	Center
Fluid Mechanics Lab (Multiple Labs)	Ames
Hypervelocity Free-Flight Aerodynamic Facility	Ames
7- by 10-Foot Subsonic Wind Tunnel #1 (in FY 2027)	Ames
Aero-Acoustic Propulsion Laboratory	Glenn
Engine Research Building (60 test rigs)	Glenn
Flow Physics Laboratory	Langley
High Speed Low Disturbance Facility	Langley
Low Speed Aeroacoustics Wind Tunnel	Langley
Scramjet Complex	Langley
Basic Aerodynamics Research Tunnel	Langley
Probe Calibration Tunnel	Langley
Aerodynamic Research Facility	Marshall

Source: NASA.

APPENDIX D: MANAGEMENT'S COMMENTS

National Aeronautics and Space Administration

Mary W. Jackson NASA Headquarters
Washington, DC 20546-0001

Reply to Attn of: Research and Technology Mission Directorate

TO: Deputy Assistant Inspector General for Audits

FROM: Associate Administrator for Research and Technology Mission Directorate

SUBJECT: Agency Response to OIG Draft Report, "NASA's Aerosciences Evaluation and Test Capabilities Portfolio" (A-25-05-00-SARD)

The National Aeronautics and Space Administration (NASA) appreciates the opportunity to review and comment on the Office of Inspector General (OIG) draft report entitled, "NASA's Aerosciences Evaluation and Test Capabilities Portfolio" (A-25-05-00-SARD), dated October 2, 2026.

In this draft report, the OIG found that, although the Aerosciences Evaluation and Test Capabilities (AETC) Portfolio Office has improved the efficiency and effectiveness of NASA's Tier 1 wind tunnel operations, rising costs and the current funding approach present challenges to the long-term sustainment of these critical capabilities. The OIG also identified workforce and deferred maintenance risks, and found that Tier 2 facilities face similar challenges without the centralized funding and management support provided to AETC's Tier 1 facilities.

The OIG makes five recommendations addressed to the Associate Administrator for Research and Technology Mission Directorate (RTMD). Specifically, the OIG recommends the following:

Recommendation 1: Evaluate and implement a sustainable AETC funding model that matches resource allocations to a given set of achievable capability portfolio objectives.

> **Management's Response:** NASA appreciates this recommendation and concurs. RTMD and its Aeronautics Division fully recognize the critical need for a sustainable funding model to ensure resource allocations adequately meet the objectives of the AETC portfolio. To address historical shortfalls and stabilize the portfolio, RTMD (then the Aeronautics Research Mission Directorate) provided a substantial funding increase in fiscal year (FY) 2026, bringing the total AETC budget to $143 million (and an additional $11 million in Construction of Facilities funds) – a significant increase compared to the FY 2025 budget of $116 million.

This infusion of funds was directly invested into targeted maintenance efforts designed to significantly improve the overall health and reliability of NASA's wind tunnel facilities. To ensure this funding model remains sustainable long-term, RTMD's Aeronautics Division is committed to outlining sufficient resources required as part of FY 2027 and beyond, recognizing those goals are subject to appropriations.

Estimated Completion Date: Ongoing as part of the annual budget process and will provide a status update by April 1, 2027.

Recommendation 2: Design processes that can support facility managers to identify and track unmet or additional sources of demand.

Management's Response: NASA concurs with this recommendation. AETC has fundamentally restructured how it captures the customer lifecycle. In 2024, AETC established the AETC Test Lifecycle (ATL), which is housed within the AETC Data & Analytics Portfolio Transformation (ADAPT) system. ATL standardizes the test request and execution process into phases. Phases 1 (Test Inquiry), 2 (Test Request), and 3 (Test Agreement) are specifically designed to function as a Customer Relationship Management tool to capture and track unmet and additional demand.

During summer 2026, AETC updated its internal Demand system in ADAPT to strictly categorize incoming data as either "Inquiries" or "Requests," ensuring visibility into all potential demand rather than just actionable demand. In September 2026, the Agency launched the "NASA Front Door" public interface, utilizing AETC wind tunnels as one of its inaugural use cases due to ATL's well-defined structure. Together, the enhanced Demand system and NASA Front Door provide facility managers with robust processes to input, track, and manage all potential demand. This new capability actively supplements the annual data call for known NASA program demand, fully satisfying the OIG's recommendation. AETC expects to complete ATL Phases 1 and 2 in FY 2027, achieving full integration with NASA Front Door in FY 2028.

Estimated Completion Date: October 1, 2027.

Recommendation 3: Leverage the Agency's workforce directive, in particular, contractor conversions to civil service, onboarding processes, and strategies to attract industry and academic talent to mitigate workforce challenges.

Management's Response: NASA concurs with this recommendation. In strong alignment with the Agency's recent workforce directives, the Centers, working with AETC, are executing a strategic shift in the portfolio's personnel structure to ensure long-term stability and retain critical skills. Historically, the AETC-supported workforce has been heavily reliant on external support, comprising approximately 70 percent contractors and 30 percent civil servants. Moving forward, the Centers and AETC envision inverting this ratio to target a workforce composition of 30 percent contractors and 70 percent civil servants. By actively leveraging contractor

conversions to civil service and streamlining onboarding processes, the Centers will establish a highly skilled, enduring workforce capability within AETC.

The Centers and AETC remain proactive in building a sustainable talent pipeline. To that end, AETC actively conducts outreach and will continue to attract and develop student talent through Science, Technology, Engineering, and Mathematics (STEM) internships and NASA Pathways programs, ensuring a steady influx of skilled professionals into the aerosciences workforce.

Estimated Completion Date: March 1, 2027.

Recommendation 4: Design and implement best practices across all centers and facilities for tracking deferred preventive maintenance, including the capture of risks from long-term deferred preventive maintenance.

Management's Response: NASA concurs with this recommendation. AETC will work with Centers to define a comprehensive framework that clearly establishes Center and AETC roles and responsibilities to ensure preventative maintenance is planned and implemented effectively and that deferred preventative maintenance is tracked and managed. Key elements of this framework include:

Tracking Preventive Maintenance via Agency Systems
AETC will work with Centers to implement standardized maintenance tracking practices using Agency systems of record. Centers, supported by Subject Matter Experts within the NASA Office of Strategic Infrastructure, will retain primary responsibility for defining, scheduling, and executing preventative maintenance plans and tracking associated preventative maintenance data. Centers will actively monitor this data to identify and report late or deferred preferred maintenance.

Capturing Risks from Deferred Maintenance
AETC will implement a risk-tracking protocol to evaluate and document deferred preventative maintenance reported by Centers. AETC's Maintenance Manager will assess risk impacts and integrate them into AETC's portfolio for strategic oversight and management to mitigate risks from deferred preventative maintenance.

Estimated Completion Date: March 1, 2027.

Recommendation 5: Incorporate funding and management best practices demonstrated by AETC's Tier 1 wind tunnels into the sustainment of NASA's Tier 2 facilities.

Management's Response: NASA concurs with this recommendation. AETC is adapting its Agency-level approach to improve Tier 2 sustainment. Building on a 2025 assessment requested by the Office of Management and Budget, AETC has already enhanced management oversight of Tier 2 facilities by implementing Tier 1-style Performance and Value metrics.

While Centers have successfully utilized project funding to sustain Tier 2 capabilities and effectively employed campaigning of the workforce, AETC data indicates an approximately $10 million deferred maintenance backlog under this model. To apply Tier 1 funding best practices and mitigate this backlog, we are proposing a dedicated annual maintenance investment. By carving out a separate lane for maintenance, this strategic investment will replace the current ad hoc approach to repairs, providing the predictability required to keep these aging, mission-critical facilities viable.

Furthermore, to incorporate Tier 1 management best practices, AETC will assess utilizing its data-driven prioritization and portfolio management frameworks to allocate this new annual maintenance funding across the Agency. For larger maintenance requirements, AETC will act as an Agency-level broker, coordinating with Centers and Projects to coordinate resource and funding allocations for maintenance while preserving the benefits of local Center and Project engagement for operational funding.

Estimated Completion Date: January 4, 2027, for funding and management best practices.

We have reviewed the draft report for information that should not be publicly released. As a result of this review, we have not identified any information that should not be publicly released.

Once again, thank you for the opportunity to review and comment on the subject draft report. If you have any questions or require additional information regarding this response, please contact Natasha McNeill at (202) 358-2638.

James Kenyon

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James A. Kenyon, PhD
Associate Administrator for Research and Technology Mission Directorate

cc:
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