NASA Facts

National Aeronautics and
Space Administration

Glenn Research Center
Cleveland, Ohio 44135–3191

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The Glenn Research Center:
Expanding Horizons and Opening Frontiers

The men and women of the NASA John H. Glenn Research Center at Lewis Field have, since 1941, been the pioneers and innovators whose work has expanded horizons and opened frontiers for our explorers in air and space. The Center develops critical capabilities that address national priorities through research, technology development, and systems development for safe and reliable aeronautics, aerospace, and space applications. Glenn's efforts are focused in power, propulsion, communications, and microgravity science.

Building upon the knowledge and experience that have fueled many of the great achievements of NASA, the world-class research at the Glenn Research Center today addresses the technology needs of the future. What is more, NASA Glenn transfers much of the technology developed from that research to U.S. industry. Whether it is about new clean, efficient, renewable energy from batteries and fuel cells, understanding soot formation in combustion processes for industrial and environmental benefits, or how to reduce aircraft noise, this knowledge-expanding research is the engine that helps bring about NASA's missions and spark the American economy.

Pioneering Spirit

In groundbreaking ceremonies held at the site in Cleveland, Ohio, on January 23, 1941, the National Advisory Committee for Aeronautics (NACA) established its third aeronautics research facility, the Aircraft Engine Research Laboratory. The laboratory's initial mission was to advance American engine development to keep stride with the Europeans. Some of the laboratory's early tasks were to help in the World War II effort by developing a cooling system for the B–29 Super-Fortress and by studying aircraft icing to help planes fly "the hump" over the Himalayas into China.

In the late 1940s, the Cleveland laboratory was renamed first the Flight Propulsion Research Laboratory then, following the death of NACA aeronautics pioneer George W. Lewis in 1948, the Lewis Flight Propulsion Laboratory. The change marked the transition from a laboratory limited to aircraft engines to one free to explore all areas propulsion research.

Before most people realized that the Space Age was dawning, engineers and scientists at the Lewis laboratory were pioneering rocket-engine and fuels research. The lab first began work with liquid hydrogen as a high-powered rocket fuel in 1945. That pioneering work lead, after another name change, to one of its most significant achievements thus far—the development of the Centaur rocket, the most powerful upper stage in the U.S. space program.

The U.S. space program began in earnest in 1958 when the U.S. Space Act dissolved NACA and created in its place the National Aeronautics and Space Administration. The Lewis laboratory became part of the foundation of the new agency and was renamed the Lewis Research Center.

In 1963, the Lewis Center successfully launched its first Atlas/Centaur rocket. And for the next 35 years, Lewis experts managed the launch of the Atlas/Centaur and Titan/Centaur booster vehicles and the Agena upper-stage rockets. Those launches sent to the sky weather and communications satellites and planetary exploration spacecraft, such as Surveyor, Pioneer, Viking, and Voyager, which studied the Moon, Mars, and the outer planets. All together, Lewis managed more than 119 unmanned launches.

The Centaur technology developed in those early days was used in the upper stages of the Saturn V rockets, which propelled the Apollo Lunar landing missions, and in the Space Shuttle Main Engines, all with the continued involvement of Lewis experts.

The expertise gained in large part from the many ground-based, low-gravity studies of hydrogen fuel, lead, in the 1990s, to Lewis becoming NASA's leader in the microgravity research areas of fluid physics and combustion science.

NASA Lewis' work was always broader than propulsion. As new opportunities and challenges arose in space exploration and in the Nation, the Center conducted research in commercial communications technology and space electrical power.

When existing frequencies for television and other satellite transmissions services began to fill up, Lewis researchers applied technology from its early research with electric propulsion to invent a high-efficiency, high-powered transmitting tube. The new tube's increased efficiency and reliability greatly lowered transmission costs, opened up a new communications band, and allowed for new applications such as direct-to-home television broadcast and transmissions to remote areas.

When NASA's ambitious mission planners needed good, reliable electricity for their missions within the solar system, the Center contributed many advances in solar cells, fuel cells, and other then exotic electrical power sources for use in space. And when in the 1970s the Nation became very concerned about the use and availability of energy, the Center applied its expertise to those terrestrial environmental concerns. Aeronautics and space systems and techniques were used to improve alternative energy sources such as wind turbines and solar cells.

Despite these new and exciting research areas, the Center never forgot its first mission: aircraft engine development. With increases in commercial aviation traffic, jet engines abounded, but early commercial jet engines were noisy and inefficient. The 1970s and 1980s energy crises and increased environmental awareness brought demands for cleaner, quieter, and more fuel efficient aircraft engines. The Center and its industry partners responded with programs such as the Advanced Turboprop and the Energy Efficient Engine and developed retrofit techniques that allowed existing engines to be made quieter.

In March 1999, the Center was formally renamed the John H. Glenn Research Center at Lewis Field. The new name honors John H. Glenn, Jr., the first

NASA Glenn celebrates its renaming on May 7, 1999.

NASA Glenn's DHC–6 Twin Otter conducts research into aircraft inflight icing.

Glenn pursues these objectives in specific areas of research including materials, structures, internal fluid mechanics, and instrumentation, controls, and systems. Through computer programs and mathematical analyses, the Center explores the overall performance and economic potential of advanced and unconventional propulsion systems, including turbine engines, all varieties of intermittent combustion engines, electric engines, hybrid engines, and all other types of engines applicable to future generations of air and space vehicle systems.

American to orbit the Earth and longtime U.S. Senator from Ohio who made history again in October 1998 by returning to space at the age of 77. The designation of the historic site upon which the Center is built as Lewis Field celebrates the legacy of George W. Lewis. As the Center's aerospace achievement continues, the Glenn Research Center remains on the critical path to achievements in the air and in space.

Innovating Tomorrow's Engines

During the 20th century, new methods of transportation transformed our society, dramatically enhancing both national security and economic growth. Today aviation is an indispensable part of our Nation's transportation system, providing unequaled speed, mobility, and freedom of movement for people and goods. But aviation is facing significant challenges. NASA Glenn researchers are working with the aviation industry to address the issues of a safer, more secure, efficient, and environmentally friendly air transportation system. Glenn continues to be the world leader in aeropropulsion research and technology developing revolutionary propulsion systems that are intelligent, whisper quiet, structurally integral to the vehicles, and clean and lean with near-zero emissions.

Flying More Safely

For all aircraft operating in cold climates, whether in flight or preparing to take off, ice is an ever-present threat. Ice formation decreases lift. This loss of lift can cause the pilot to lose control of the aircraft and could even result in a crash. NASA Glenn studies ice formation on aircraft surfaces in its Icing Research Tunnel and aboard research aircraft that intentionally fly into hazardous winter weather. The Center has helped develop revolutionary techniques for protecting aircraft from ice formation and training for pilots to handle problems resulting from unavoidable ice formation.

A fundamental part of NASA's commitment to safety is expanding our knowledge about the technology of flight. From aircraft to the environment and communications, NASA Glenn studies all aspects of flight to develop safer aircraft and flight techniques. The Center's ongoing research is geared to developing safer flights through a greater understanding of how planes and pilots perform in adverse weather conditions and getting pilots the most up-to-date information including weather conditions.

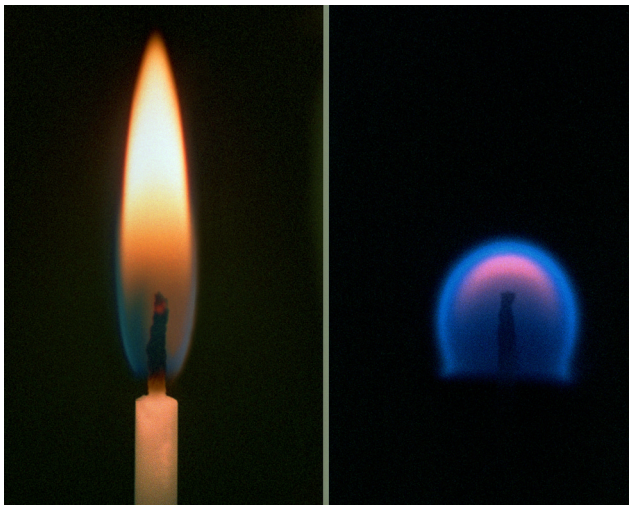
NASA's Evolutionary Xenon Thruster (NEXT) undergoes testing in the Electric Propulsion Laboratory.

Power To Go Beyond

NASA's space propulsion research explores and develops transportation technologies for orbital transfer missions and solar systems exploration. Glenn performs research on technology to improve travel in and beyond low Earth orbit, including electric propulsion systems, cryogenic fluid management systems, lightweight components, and system and mission analysis. NASA Glenn scientists and engineers are developing the breakthrough technologies that will enable future NASA missions, decrease trip times, and reduce the weight of the propulsion systems required in order to expand America's ability to explore and understand our universe.

NASA's Evolutionary Xenon Thruster (NEXT) system was developed by NASA Glenn and built on the four decades of ion propulsion research conducted at the Center and the successful flight of Deep Space 1. NEXT has capabilities beyond conventional chemical propulsion and will revolutionize the way we send science missions deeper into the solar system. This advanced system will use electrical power to ionize the xenon gas and electrically accelerate the ions at high speed as an exhaust that pushes the spacecraft in the opposite direction.

The Center continues to support exploration of the solar system by providing new technologies that expand our ability to explore and gain knowledge of the universe. Initial thrust testing of the High Power Electric Propulsion (HiPEP) ion engine in a vacuum chamber at Glenn recently marked the first in a series of performance tests to demonstrate new high-velocity and high-power thrust needed for use in nuclear electric propulsion applications. HiPEP is one of several candidate propulsion technologies under study by NASA's Project Prometheus for possible use on the first proposed flight mission, the Jupiter Icy Moons Orbiter.

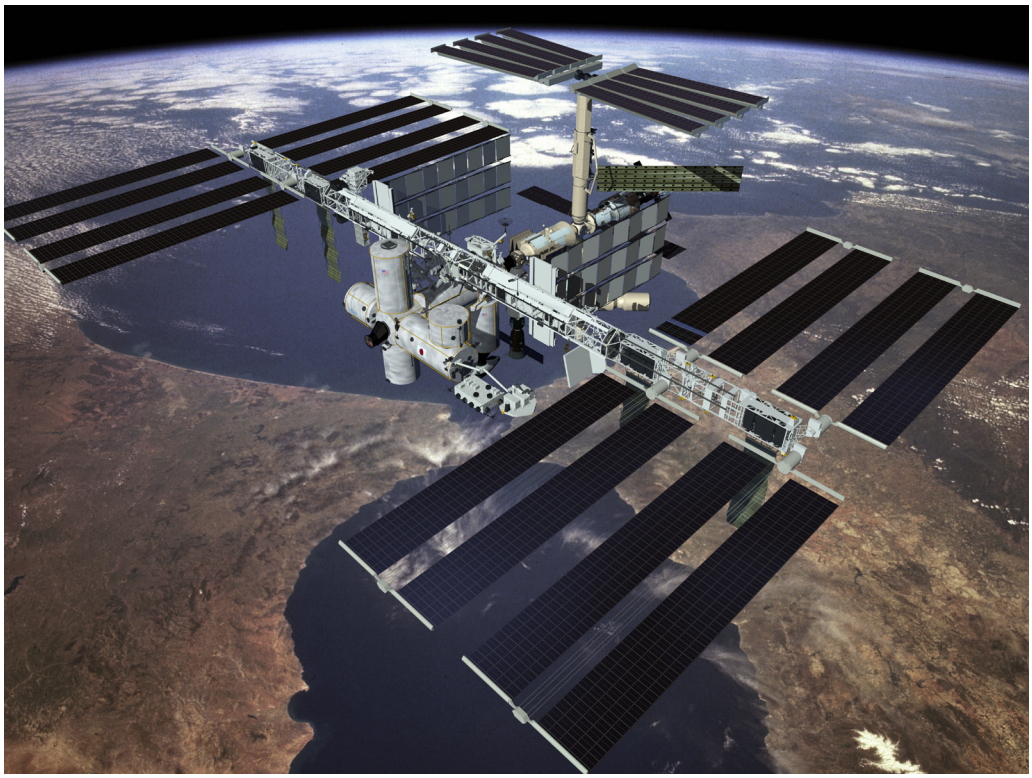


A candle burning in Earth's gravity (left) and in microgravity.

Unlocked Mysteries

NASA's Office of Biological and Physical Research creates unique cross-disciplinary research programs, bringing the basic sciences of physics, biology, and chemistry together with a wide range of engineering disciplines. NASA Glenn leads the efforts in the microgravity science disciplines of fluid physics, combustion science, and acceleration measurement. Conducting research in a microgravity environment gives researchers a unique opportunity to study the true nature of processes, materials, and new technologies without having to consider the effects of Earth's gravity. For example, although combustion provides 85 percent of the United States' energy production, it is still not well understood. Improving our understanding of combustion at its most fundamental level could lead to breakthroughs in fire safety, fuel efficiency, and pollution control here on Earth.

The Glenn microgravity program begins with ground-based low-gravity experiments in the Center's drop towers or NASA's KC–135 aircraft, and proceeds when required to space shuttle or International Space Station experiments. Almost every space shuttle science mission has had an experiment managed by Glenn, along with a wide array of similar experiments on the International Space Station. Currently, Glenn researchers are preparing the new Fluids and Combustion Facility for launch to the International Space Station that will enable an unprecedented quality and quantity of research on fluids and combustion in microgravity.



NASA Glenn is making significant contributions to the International Space Station.

A Powerful Future

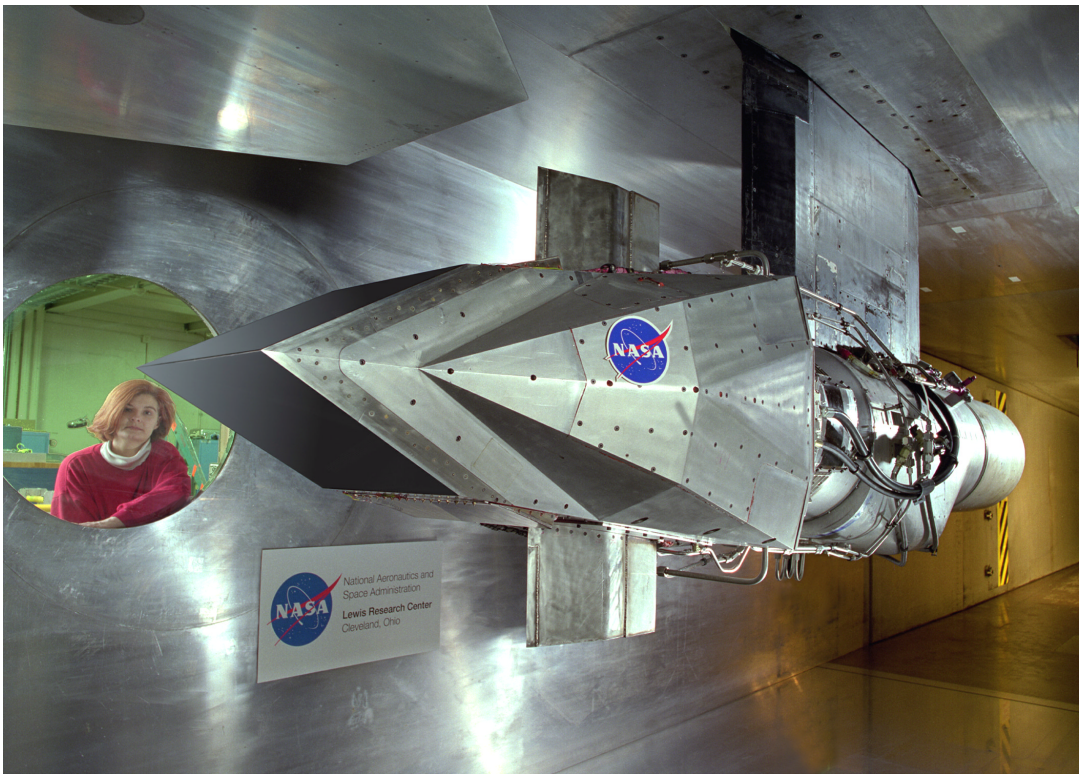
With decades of experience in designing, building, and testing space power systems, NASA Glenn has developed systems that provide power to the International Space Station, orbiting vehicles, and spacecraft that travel throughout the solar system. Engineers at Glenn have combined state-of-the-art electrical designs with complex computer-aided analyses to develop some of today's most advanced power systems.

Glenn continues to develop power system technology to help expand NASA's horizon of discovery and revolutionize the aerospace industry by conducting research in solar power generation, energy storage and conversion, and power management and distribution. The Center is leading research to develop lithium-based polymer electrolyte batteries that will reduce the mass and volume of space power systems and that can enable missions operating at high and low temperature extremes. Proton Exchange Membrane fuel cell technology and next-generation fuel cell concepts are also being explored for space vehicle applications and for aircraft power and propulsion systems.

Advanced Communications

Today's information-based culture would not be possible without the vital links provided by satellites. The cutting edge of this critical communications technology is being shaped at Glenn, where researchers are developing innovative technology products that will enable the next generation of NASA space missions to have broad coverage, continuous presence, and coverage for high data rate delivery from ground, air, and space-based assets directly to the user, creating a virtual presence throughout the solar system. Glenn's efforts will serve to shrink the apparent limitations of distance and time.

The Center's development of the Advanced Communications Technology Satellite (ACTS) began the revolution in space-based, broadband communications. ACTS proved that Ka-band transmission is feasible and offered many advantages over other frequency bands. New technologies that were validated included a multibeam antenna with high-gain, hopping spot beams, onboard processing, wideband (900 MHz) transponders, and rain fade compensation. The ACTS experiments program had over 150 organizations conduct more than 100 experiments in 31 states and 6 foreign countries. Glenn shut down ACTS on April 28, 2004, after more than 10 years of highly successful on-orbit operations.



The 10- by 10-Foot Supersonic Wind Tunnel is one of five wind tunnels at NASA Glenn.

World-Class Facilities

The Glenn Research Center main site, Lewis Field, is a 350-acre campus, adjacent to Cleveland Hopkins International Airport. Lewis Field comprises over 150 buildings that contain a unique collection of world-class facilities. Key aeronautics facilities include five wind tunnels, the Aero-Acoustic Propulsion Laboratory, the Engine Components Research Laboratory, the Propulsion Systems Laboratory, and the Engine Research Building. The Flight Research Building (Hangar) supports aircraft research operations for Glenn's aeronautics, microgravity, solar cell, and icing research.

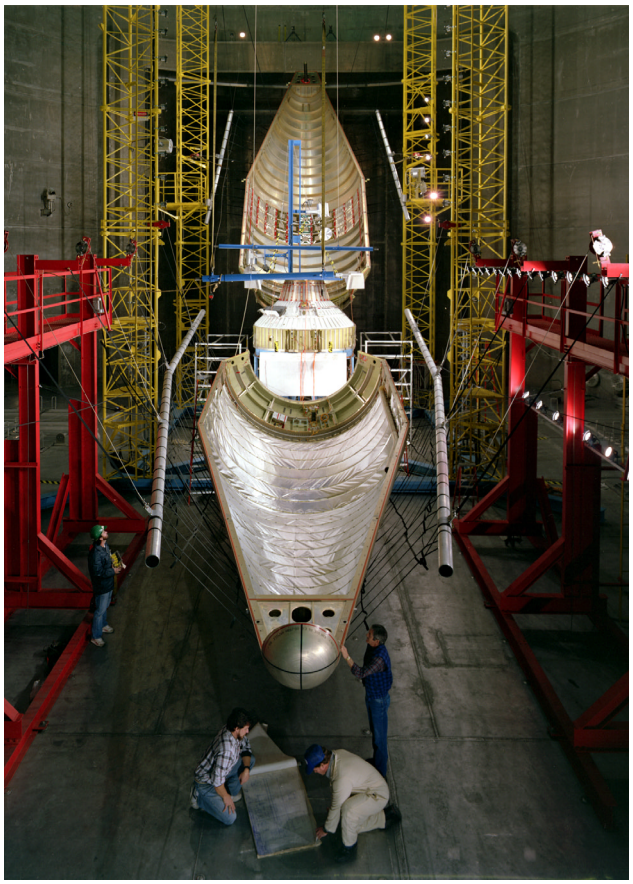
Several Lewis Field facilities are used to simulate the space environment. These include the Electric Propulsion Laboratory, the 2.2-Second Drop Tower, and the Zero Gravity Research Facility. Spaceflight operations are supported by the Space Experiments Laboratory, the Telescience Support Center, and ground stations for satellites. A Fabrication Shop, the Research Analysis Center, and a variety of other operational facilities support all of the facilities.

NASA Glenn also includes the 6400-acre Plum Brook Station near Sandusky, Ohio, 50 miles west of Cleveland. The primary facilities there are the Hypersonic Tunnel Facility, Space Power Facility, the Spacecraft Propulsion Research Facility, and the Cryogenic Propellant Tank Facility.

Since the groundbreaking at Cleveland on January 23, 1941, more than $646 million has been invested in the Center's capital plant. The estimated replacement cost is over $2 billion. While some facilities have been operational since 1944, all have been outfitted with highly complex mechanical, electrical, and data acquisition devises. The work done in Glenn's unique, world-class facilities continues to push technology to its limits and breaks through to new levels of exploration and invention.

Superior Staff

Looking back on Glenn's long and varied history of significant contributions to advances in aeronautics and spaceflight, it is easy to fix our focus on technological marvels or on the exploits of the heroes who broke the



Titan/Centaur shroud jettison testing at Plum Brook's Space Power Facility.

sound barrier and walked on the Moon. Behind them have been thousands of dedicated people, experts in their technical fields and crafts and in project management. Today, over 3200 people staff Glenn, including civil servants and support service employees. Over half of them are scientists and engineers, who plan, conduct, oversee, and report on the research tasks and projects of the Center. Technical specialists, skilled workers, and administrative staff assist them.

Leading experts and innovators—and many of America's brightest young engineers and scientists—have joined the Glenn community. Partnerships with universities and industry create a rich exchange of knowledge. Glenn Research Center's collaborative relationships with the other NASA centers makes it a vital part of an extraordinary "One NASA" team—a team that is applying their many unique capabilities in the pursuit of expanding the frontiers of air and space.

Recognized Leadership

While all technical roads may not lead to NASA Glenn, many certainly emanate from the Center, its facilities, laboratories, and researchers. Glenn experts are regularly requested to sit on technology review boards and consult with other government agencies and industry in their areas of expertise. Glenn's testing facilities are used by our industry partners and by international space agencies. The amazing success of NASA Glenn's work has garnered the Center numerous awards including an Emmy, a Collier Trophy, and 89 *Research & Development Magazine*'s IR–100 awards, which the *Chicago Tribune* has called "the Oscars of invention."

Improved Life and Living

Although thoughts about Glenn may conjure images of satellites, rocket ships, and high-tech jet engines, the Center has contributed to some very down-to-Earth products. Glenn has assisted hundreds of companies in turning aerospace technologies into marketable products. One recent example is a method to quickly clean the surface of paintings evenly and without touching the painting. The technique uses atomic oxygen, like that found in low-Earth-orbit, to create a chemical reaction that lifts smoke damage and dirt from paintings.

Along with the everyday and artistic marvels, Glenn has had considerable impact in more critical industries as well. Glenn's contributions to medicine have revolutionized diagnoses, research, treatment, and surgeries. For example, Glenn helped the Cleveland Clinic design a permanently implantable, artificial heart pump—the Innovative Ventricular Assist System. The pump takes over for the heart's damaged left ventricle, the part that does most of the pumping.

Inspiring the Next Generation of Explorers

To ensure America's place as a technology leader, NASA Glenn recognizes the vital importance of preparing tomorrow's engineers and scientists. Air and spaceflight have the unique ability to inspire young minds. Using this interest as a foundation, NASA Glenn has created many programs that encourage

students to explore and understand science and technology. Ultimately, it is hoped that by engaging these students during their academic lives, they will take up science and technology as a career.

New Horizons

The Glenn Research Center drives the engine of innovation. The Center's expertise continues to be critical to NASA's future missions in air and space. As private and commercial aviation expands, NASA Glenn will propel aircraft to new standards of performance and efficiency. With a new vision for exploring our solar system, NASA Glenn engineers and scientists are ready to pursue breakthrough technologies in advanced power, propulsion and communications to enable human and robotic missions to the Moon and beyond.

Heart pump developed with the Cleveland Clinic.

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