AEROTECH NEWS and Review

Journal of Aerospace, Defense Industry and Veteran News

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Welcome!

The 412th Test Wing and Edwards Air Force Base are thrilled to welcome back our community and mission partners for a weekend of world-class excitement and STEM-focused education.

The 2022 Open House is a first in over a decade opportunity to showcase the technology and careers that enable our future force plus highlight the innovation that flourishes daily at The Center of the Aerospace Testing Universe.

This event is proudly dedicated to our next generation of Airmen.

MATTHEW W. HIGER
Brigadier General, USAF
Commander, 412th Test Wing

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Journal of Aerospace, Defense Industry and Veteran News

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** Subject to Change*

On the Ground

B-1B Lancer
F-22 Raptor
F-35 Lightning II
C-5M Super Galaxy
F-16 Viper
T-38
RQ-4 Global Hawk
C-12 Huron
B-52
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NASA F-15B/D Eagle
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NASA TG-14
NASA T-34 Turbo Mentor
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Scaled 281 Proteus
Rutan Long-EZ
Howard 250
Convair BT-13A
Antonov AN-2
Fairchild PT-23
Pratt & Whitney F135 Engine
L-1011 Tristar “Stargazer”
Stratolaunch Talon A Hypersonic Vehicle
Northrop Grumman Static
A-10 Thunderbolt “Warthog”
General Atomics UAV Simulator
F-22 Simulator

** Subject to Change*

Edwards Air Force Base will be open to the general public Saturday and Sunday, October 15 and 16.

Public access is via the West Gate (SR-14, Antelope Valley Freeway and Rosamond Boulevard) and the North Gate, (SR-58). South Gate WILL NOT be open to the general public. All vehicles and personal items are subject to search.

The gates open at 8:30 a.m. and will close at 11:30 a.m. All vehicles must be on base by 11:30 a.m. Anyone arriving after that time will be denied access.

The STEM Expo runs 10 a.m.-2 p.m., and is not open to the general public.

Flying runs from 11 a.m. to 3 p.m.

The air show ends at 4 p.m.

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USAF Thunderbirds Aerial Demonstration Team

The U.S. Air Force Air Demonstration Squadron, the Thunderbirds, performs precision aerial maneuvers demonstrating the capabilities of Air Force high performance aircraft to people throughout the world. The squadron exhibits the professional qualities the Air Force develops in the people who fly, maintain and support these aircraft.

The Thunderbirds squadron is an Air Combat Command unit composed of eight pilots (including six demonstration pilots), four support officers, three civilians and more than 130 enlisted personnel performing in 25 career fields.

A Thunderbirds air demonstration is a mix of formation flying and solo routines. The four-aircraft diamond formation demonstrates the training and precision of Air Force pilots, while the solo aircraft highlight the maximum capabilities of the F-16 Fighting Falcon.

The pilots perform approxi-

See THUNDERBIRDS, Page 7

Air Force photograph by Staff Sgt. Andrew Sarver

THUNDERBIRDS, from 6

mately 30 maneuvers in a demonstration. The entire show, including ground and air, runs about an hour and 15 minutes.

The season lasts from March to November, with the winter months used to train new members. Officers serve a two-year assignment with the squadron, while enlisted personnel serve three to four. Replacements must be trained for about half of the team each year, providing a constant mix of experience.

The squadron performs approximately 75 demonstrations each year and has never canceled a demonstration due to maintenance difficulty. More than 300 million people in all 50 states and 58 foreign countries have seen the red, white and blue jets in more than 4,000 aerial demonstrations.

In addition to their responsibilities as the official U.S. Air Force aerial demonstration team, the Thunderbirds are part of our combat force. If required, the team's personnel and aircraft can be rapidly integrated into a fighter unit at Nellis Air Force Base, Nev. Since the aircraft are only slightly modified, they can be made combat-ready in less than 72 hours.

The Lockheed Martin (formerly General Dynamics) F-16 represents the full range of capabilities possessed by the Air Force's tactical fighters. This highly maneuverable multi-role fighter has proven to be one of the world's best precision tactical bombers and air-to-air combat aircraft. The only modifications needed to prepare the aircraft for its air demonstration role are installing a smoke-generating system in the space normally reserved for the 20mm cannon, and the painting of the aircraft in Thunderbird colors.

The Thunderbirds were officially activated June 1, 1953, as the 3600th Air Demonstration Team at Luke Air Force Base, Ariz. Their first aircraft was the straight-winged F-84G Thunderjet, a combat fighter-bomber that had seen action in Korea. Early in 1955 the team transitioned to the swept-winged F-84F Thunderstreak.

In June 1956, the team moved to its current home at Nellis Air Force Base, Nev. At the same time theThunderbirds traded the veteran F-84 for the world's first supersonic fighter, the F-100 Super Sabre — an aerial platform that would serve the Thunderbirds for 13 years. More than 1,000 demonstrations were flown in the Super Sabre, thrilling spectators around the world. The team changed briefly to the Republic F-105 Thunderchief. After only six shows, in 1964, due to an extensive modification that became necessary on all Thunderchiefs, the Thunderbirds returned to the F-100.

From 1969 to 1973, the Thunderbirds flew the Air Force's front-line fighter, the F-4E Phantom. In 1974, the Thunderbirds converted to the T-38 Talon, the world's first supersonic trainer. The T-38 was more fuel-efficient and less costly to maintain than the larger F-4.

Early in 1983, the Thunderbirds reinstituted their traditional role of demonstrating the Air

See THUNDERBIRDS, Page 8

Force's front-line fighter capabilities. Transition to the F-16A allowed the team to retain manpower and fuel efficiency while demonstrating to spectators the latest in fighter technology.

In 1986, the Thunderbirds participated in the rededication flyby of the Statue of Liberty and in September, another milestone was attained when the team went over the 200 million mark for total attendance.

The largest crowd, 2.25 million people, to see a performance was at Coney Island, N.Y., July 4, 1987. The 1987 Far East tour marked their debut in Beijing, China — the first American military demonstration performance in a Communist country.

Operation Desert Storm cancelled the 1990 European tour and the season was shortened. The team converted to the F-16C in 1992, bringing the F-16A era to an end.

In July 1996, the team participated in opening ceremonies of the Centennial Olympics held in Atlanta which were viewed by an estimated 3.5 billion people around the world.

Air Force photographs by Staff Sgt. Andrew Sarver

The Thunderbirds made television history in 2003 while celebrating their 50th Anniversary. The commander/leader started the Coca-Cola 600 by broadcasting live from Thunderbird No. 1 as he said, "Gentlemen, start your engines."

In 2007, the Thunderbirds visited Europe for the first time since Sept. 11, 2001 with the European Goodwill Tour. The trip included shows in Poland, Romania, Bulgaria, Italy, France, and the United Kingdom — and for the first time in Thunderbird history — Ireland.

In 2009, the Thunderbirds traveled back to the Pacific Rim, performing in locations like Malaysia, Guam, Australia, Korea and Japan. The team performed more than 70 shows in 22 states and Puerto Rico.

Over the years, millions of people have witnessed the Thunderbird demonstrations. In turn, they've seen the pride, professionalism and dedication of hundreds of thousands of Airmen serving at home and abroad. Each year brings another opportunity for the team to represent those who deserve the most credit: the everyday, hard-working Airmen voluntarily serving America and defending freedom.

Air Force photograph

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USAF Academy Wings of Blue

The Wings of Blue have a long standing commitment to personal and organizational excellence as well as a storied history of success. While the airspace that the Wings of Blue operates in is one of the busiest in the world, their drop zone is one of the safest.

The primary mission of the Wings of Blue is to run the U.S. Air Force Academy's Basic Freefall Parachuting course, known as Airmanship 490 (AM-490). The team serves primarily as jumpmasters and instructors, forging leaders of character through this unique training experience.

The Wings of Blue has both a demonstration team and a competition team. The demonstration team travels across the country to airshows, sporting events, and other venues to represent the Air Force in precision parachuting. Similarly, the competition team represents the Air Force by competing with teams from around the country in six-way speed formations, four-way relative work, two-way free fly, and sport accuracy.

Air Force photograph

Photograph by Melinda Rodriguez

"On this 75th anniversary of the United States Air Force, I am grateful to honor the men and women who have served and defended our freedoms, and especially here at home at Edwards Air Force Base.

Nothing can stop the U.S. Air Force."

Kevin McCarthy

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Paid for by Kevin McCarthy for Congress

Greg Colyer T-33 “Ace Maker”

A native Californian, Gregory “Wired” Colyer took his first flight at age 7 in a Cessna 172 with Dr. Lee Schaller out of the Schellville airport in Sonoma, Calif. Hooked ever since, Greg has been flying for almost three decades after earning his license in 1982 while serving in the U.S. Army from 1982-1987.

After leaving the service he served 27 years for the FAA keeping the skies safe as an Air Traffic Controller at Oakland ARTCC from 1988-2015. His passion for the cockpit never left him as he continued to fly as a hobby and an occasional airshow flying a Beech T-34 Mentor until he imported a Russian L-29 Delfin Jet in 2003.

After flying with his friend Kay Eckhart, in one of Kay’s Lockheed T-33s in 2007, Greg set his sights on an upgrade to the U.S. Air Force’s first operational jet and a real piece of U.S. aviation history. Acquiring a T-33 and naming it Ace Maker in 2008. Then founding the nonprofit (501c-3) T-33 Heritage Foundation to help in the preservation of the type.

He holds a Commercial Pilot certificate with instrument, single and multi engine ratings as well as being a Certified Flight Instructor. Type rated in Aero Vodochody’s L-29 Delfin, L-39 Albatros and the Lockheed T-33 Shooting Star. A level I Aerobatic low level card and FAST lead formation card round out his qualifications.

Courtesy photograph

Greg stays in shape for flying high performance aircraft by cycling with the Cliff Bar team and an occasional Ironman Triathlon.

Vickey Benzing Aerosports

Born and raised in California, Vicky Benzing is an accomplished pilot, skydiver, aerobatic performer, and air racer. With more than 9,000 hours of flight time and more than 1,300 parachute jumps, Vicky has a passion for everything airborne. Her flying career has spanned nearly forty years and she currently holds an airline transport pilot rating as well as a commercial rating in helicopters, seaplanes, and gliders.

Vicky still remembers her first flight in her uncle’s airplane when she was just a small child. Inspired by that flight at a very young age, Vicky learned to fly in a family friend’s antique Taylorcraft in her hometown of Watsonville, on the California coast. She was thrilled by the spins, loops, and rolls that her ex-military instructor taught her and subsequently took aerobatic instruction from legendary pilot Amelia Reid.

Vicky’s aerobatic flying took a brief back seat while she earned her Ph.D. in chemistry from UC Berkeley and began working in the Silicon Valley high-tech industry.

Courtesy photograph

But her passion for spins, loops, and rolls soon returned when she took an aerobatic flight with air show legend, Wayne Handley.

In 2005, Vicky began her aerobatic training in earnest. She began competing in aerobatic contests throughout the US, working her way up through the many categories. In between contests, Vicky also began performing in local air shows. Today Vicky holds a surface-level aerobatic waiver and has flown air show performances at venues across the united states, including as an invited performer at the greatest airshow in the world, EAA AirVenture in Oshkosh, Wisc.

In addition to aerobatics, Vicky got the racing bug when a friend invited her to “come to play in my sandbox” at the national championship air races in Reno, Nev. In her first year of racing, Vicky was chosen as “rookie of the year” after having won her first race ever, and in 2015 Vicky became the “fastest woman racer” ever in the history of the Reno Air Races when she qualified an Aero Vodochody Jet on the race course at 469.831 mph. Last September, Vicky flew her Lancair Legacy to a first place finish in the sport silver class, and next September she plans to race her historic p-51d, #64, in the unlimited class. Vicky currently serves as an officer of racing jets inc.

Vicky has also had the opportunity to work on a number of films, television, and other media projects. Vicky can be seen flying her beautiful Boeing Stearman in the documentary film “Mercury 13” which is currently airing on Netflix.

Other film and television projects include episodes of “Ice Pilot” and “NCIS LA,” and extensive stunt work in her Stearman for the short film “Niner Echo Foxtrot,” and now open in Las Vegas, Nev., is the immersive flight-ride experience, “flyover Las Vegas — the real wild west,” where Vicky can be seen barrel-rolling her red Stearman across the sky.

Wardog Airshow – AT-6 Texan

Together John and "War Dog" have been thrilling audiences with their aerial tribute to the military for 40 years.

This is John and "War Dog's" Salute to the Greatest Generation inspired by his father, a WWII veteran. John's father's military service influenced John's choice to fly the T-6 Texan. The Texan is a World War trainer celebrating its 80th year of service; known as the pilot maker because it trained more military pilots than any other airplane in history.

John's flying career started more than 50 years ago, at the age of 13, and at the age of 16, he soloed five different types of airplanes. At this time, he has logged more than 15,000 hours flying time and has been entertaining audiences across the west, with more than 1,200 air show performances at major military and civilian air shows.

His aerobatic career started with competition in 1974 in the International Aerobatic Club, where he achieved high rankings in their Gold Cup Championships. He continued to advance his career with the formation of his own aerobatic training school out of Hawthorne, Calif., and in 1982 he flew his first air show in Porterville, Calif.

Simultaneously, he was flying as a corporate pilot for Northrop Grumman where he flew everything from turbo-props to jets.

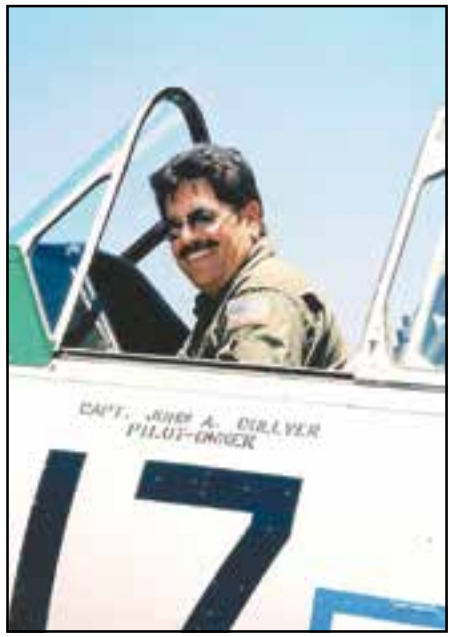
A measure of the respect John carries in the field of aerobatics is his designation as one of the air show industry's Aerobatic Competency Examiners, entrusted with ensuring the competency of other aerobatic performers.

John has served on the board and organized air show events, including the Torrance and Hawthorne Air Fairs, and assisted in organizing the Salinas Air Show and the Travis Air Force Air Show. He organized flights for the 60th Anniversary of Pearl Harbor and to commemorate the Doolittle Raider Operation for the San Diego Aero Space Museum.

John is well known for his smooth, masterful control of "War Dog". Many of the maneuvers you will see are the combat maneuvers taught to aviators during World War II. Unlike fighter aircraft, the T-6 is underpowered for its weight and although the moves appear effortless, they require a high degree of skill and planning to fly in the air show environment.

Now, enjoy John and "War Dogs" beautiful aerial ballet as they fly to the music from the movie "Pearl Harbor," sung by Faith Hill.

John's airplane "War Dog" is a 1944 Marine SNJ-5 Texan, built in Dallas, Texas. She was based in Orange County at Marine Corps Air Station El Toro on property known today as The Great Park. "War Dog" belonged to the VMT-2 training squadron. The letters VMT stand for "V," heavier than air, and "MT," for military trainer. The WD painted on "War Dog's" tail



Courtesy photograph

stands for Walt Disney. Walt Disney designed Ferdinand the bull, a red bull with small wings as the El Toro base mascot. In reciprocation, the

See TEXAN, Page 14

TEXAN, from 13

Marines painted Walt Disney's initials, WD, on all the aircraft based at El Toro.

There is another interesting connection John and "War Dog" have to Disney. For a brief time, Disney was in the air show business. Their show took place off the stern of the Queen Mary as part of a 1940's inspired entertainment venture, put on three times a day, every day, for about six months. And John and "War Dog" were one of only four acts chosen to fly in the air show.

When John acquired "War Dog," he chose to restore her to her original paint scheme, from her El Toro days. The green stripes on her wings designate her as an instrument trainer. In 1946, after serving at El Toro, she was reassigned to serve at Marine Corp Air Station Miramar. Later, she was assigned to the Naval Training Command where she was used for carrier qualifications aboard the USS *Cabot* off the coast of Pensacola,Fla. In the1950's "War Dog" was retired from the Navy and was sent to Japan to serve in the Japanese Self Defense Force. After several years of service with the Japanese, "War Dog" was retired and was due to be scrapped. Instead, she was saved along with several other T-6 Texans when they were purchased by civilians in the US. John helped with her restoration and eventually became her sole owner.

John's performance consists of speeds of 60 mph to over 200 mph and altitudes from the surface to 3,000 feet

The North American T-6, Texan was designed as an advanced fighter/trainer in 1938. World War II pilots started training on the primary trainer, the Stearman and then moved into the advanced trainer, the T-6 and eventually to fighter aircraft such as the P-51, Mustang.

The basic Texan design underwent constant modifications. It gave the best possible training in all types of tactics, from ground strafing to bombardment and aerial dogfighting. Some of the equipment typically found on the T-6 includes

bomb racks, blind instrumentation, standard cameras and 30-caliber fixed and flexible guns. During the Korean War, the U.S. Air Force and Marine Corps used the plane as forward air controllers.

And during the Vietnam War the French used the T-6 for light attack. Over 15,000 examples were produced. The last model was produced in the early 1950's. In the early days of the Blue Angels, they used a T-6, SNJ 5 like "War Dog" as part of their tactical demonstration. She was painted yellow and called, "Beetlebomb." During simulated dog fighting, the Blue Angels used F-6F Hellcats to shoot her down.

The military of today has bestowed a great honor on the T-6, Texan by naming its current, state of the art trainer, the Texan II.

Vertigo Airshows – Bob Carlton

Bob Carlton began flying in 1979 at the age of 19, and has since logged more than 2,000 hours in a wide variety of aircraft and holds a commercial pilot certificate.

Bob has flown hang gliders, airplanes, helicopters, and sailplanes from hundreds of sites in the United States, Canada, Mexico and Australia. Bob has flown airshows professionally since 1993. He lives in Moriarty, N.M., with his wife Laurie and their dogs, Ginger and Dewey. He is a member of SSA and ICAS.

Bob is one of the most versatile air show performers in North America. He began flying air shows in his Salto sailplane, and over the years has continued to add innovative performances such as barnstormin' biplane aerobatics, helicopter sailplane tow, night aerobatics with strobes & pyro and the world's only twin jet sailplane.

The tradition of innovation continues with the recent addition of the Super Salto jet sailplane, with more power, more speed and more aerobatic capability than any other sailplane on the planet!

Bob is the recipient of the 2017 Art Scholl Memorial Showmanship Award, 2015 Bill Barber Award for Showmanship and the 2015 Soaring Society of America's Chairman's Award.

Bob Carlton is a retired rocket scientist for a major national laboratory.

In the Air

Air Force photograph

Carrying the largest conventional payload of both guided and unguided weapons in the Air Force inventory, the multi-mission B-1 is the backbone of America's long-range bomber force. It can rapidly deliver massive quantities of precision and non-precision weapons against any adversary, anywhere in the world, at any time.

F-22 Raptor

Lockheed Martin photograph by Chad Bellay

The F-22 Raptor is the Air Force's newest fighter aircraft. Its combination of stealth, supercruise, maneuverability, and integrated avionics, coupled with improved supportability, represents an exponential leap in warfighting capabilities. The Raptor performs both air-to-air and air-to-ground missions allowing full realization of operational concepts vital to the 21st century Air Force.

The F-22, a critical component of the Global Strike Task Force, is designed to project air dominance, rapidly and at great distances and defeat threats attempting to deny access to our nation's Air Force, Army, Navy and Marine Corps. The F-22 cannot be matched by any known or projected fighter aircraft.

F-35 Lightning II

Air Force photograph by Chase Kohler

The F-35A is the U.S. Air Force's latest fifth-generation fighter. It will replace the U.S. Air Force's aging fleet of F-16 Fighting Falcons and A-10 Thunderbolt II's, which have been the primary fighter aircraft for more than 20 years, and bring with it an enhanced capability to survive in the advanced threat environment in which it was designed to operate. With its aerodynamic performance and advanced integrated avionics, the F-35A will provide next-generation stealth, enhanced situational awareness, and reduced vulnerability for the United States and allied nations.

F-16 Viper

Air Force photograph by Ethan Wagner

The F-16 Fighting Falcon is a compact, multi-role fighter aircraft. It is highly maneuverable and has proven itself in air-to-air combat and air-to-surface attack. It provides a relatively low-cost, high-performance weapon system for the United States and allied nations.

In an air combat role, the F-16's maneuverability and combat radius (distance it can fly to enter air combat, stay, fight and return) exceed that of all potential threat fighter aircraft. It can locate targets in all weather conditions and detect low flying aircraft in radar ground clutter. In an air-to-surface role, the F-16 can fly more than 500 miles (860 kilometers), deliver its weapons with superior accuracy, defend itself against enemy aircraft, and return to its starting point. An all-weather capability allows it to accurately deliver ordnance during non-visual bombing conditions.

C-17 Globemaster III

The C-17 Globemaster III is the most flexible cargo aircraft to enter the airlift force. The C-17 is capable of rapid strategic delivery of troops and all types of cargo to main operating bases or directly to forward bases in the deployment area. The aircraft can perform tactical airlift and airdrop missions and can transport litters and ambulatory patients during aeromedical evacuations. The inherent flexibility and performance of the C-17 force improve the ability of the total airlift system to fulfill the worldwide air mobility requirements of the United States. The ultimate measure of airlift effectiveness is the ability to rapidly project and sustain an effective combat force close to a potential battle area. Threats to U.S. interests have changed in recent years, and the size and weight of U.S.-mechanized firepower and equipment have grown in response to improved capabilities of potential adversaries. This trend has significantly increased air mobility requirements, particularly in the area of large or heavy outsize cargo. As a result, newer and more flexible airlift aircraft are needed to meet potential armed contingencies, peacekeeping or humanitarian missions worldwide.

Air Force photograph by Christian Turner

Air Force photograph by Danny Bazzell

The T-38 Talon is a twin-engine, high-altitude, supersonic jet trainer used in a variety of roles because of its design, economy of operations, ease of maintenance, high performance and exceptional safety record. Air Education and Training Command is the primary user of the T-38 for joint specialized undergraduate pilot training. Air Combat Command, Air Force Materiel Command and the National Aeronautics and Space Administration also use the T-38A in various roles.

Air Force photograph by Mat Williams

The B-52H Stratofortress is a long-range, heavy bomber that can perform a variety of missions. The bomber is capable of flying at high subsonic speeds at altitudes of up to 50,000 feet (15,166.6 meters). It can carry nuclear or precision guided conventional ordnance with worldwide precision navigation capability.

Air Force photograph by Christian Turner

The KC-46A Pegasus is the first phase in recapitalizing the U.S. Air Force's aging tanker fleet. With greater refueling, cargo and aeromedical evacuation capabilities compared to the KC-135, the KC-46A will provide next generation aerial refueling support to Air Force, Navy, Marine Corps and partner-nation receivers.

Air Force photograph by Bobbi Zapka

The C-12J Huron is a twin turboprop aircraft used for cargo and passenger airlift. The aircraft is a military version of the Raytheon 1900C regional airliner. In addition to providing cargo and passenger airlift, the aircraft is capable of transporting two litter or ten ambulatory patients during aeromedical evacuations.

Air Force photograph by Crosby Shaterian

The KC-135 Stratotanker provides the core aerial refueling capability for the U.S. Air Force and has excelled in this role for more than 60 years. This unique asset enhances the Air Force's capability to accomplish its primary mission of global reach. It also provides aerial refueling support to Air Force, Navy, Marine Corps and allied nation aircraft.

NASA photograph by Carla Thomas

NASA operates a highly modified McDonnell Douglas DC-8 jetliner as a flying science laboratory. The platform aircraft, based at NASA's Armstrong Aircraft Operations Facility in Palmdale, Calif., collects data for experiments in support of scientific projects serving the world's scientific community.

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NASA F-15B/D Eagle

NASA photograph by Jim Ross

NASA's Armstrong Flight Research Center, Edwards, Calif., currently flies F-15D Eagle aircraft for research support and pilot proficiency.

The F-15Ds have a two-seat cockpit and like the 2 seat Support Aircraft F-18, they are normally used for photo or video support. They will be transmitting live video from the air back to Armstrong so engineers can visually monitor the mission as it is being flown. This feature greatly enhances flight safety.

NASA research support aircraft are commonly called "chase planes" and fill the role of escort aircraft during research missions. Chase pilots are in constant radio contact with research pilots and serve as an "extra set of eyes" to help maintain total flight safety during specific tests and maneuvers. They monitor certain events for the research pilot and are an important safety feature on all research missions.

Chase aircraft also are used as camera platforms for research missions that must be photographed or videotaped. Aeronautical engineers use this pictorial coverage (photos, motion pictures, and videotape) extensively to monitor and verify various aspects of research projects. The F-15Ds are also used by Armstrong research pilots for routine flight training required by all NASA pilots.

NASA F-18F/A Hornet

Three F/A-18 Hornet aircraft are flown at NASA's Armstrong Flight Research Center at Edwards, Calif., for research support and pilot proficiency.

The aircraft was obtained from the U.S. Navy between 1984 and 1991. One has a two-seat cockpit while the others are single-seat aircraft. NASA research support aircraft are commonly called chase planes and fill the role of escort aircraft during research missions.

Chase pilots are in constant radio contact with research pilots and serve as an "extra set of eyes" to help maintain total flight safety during specific tests and maneuvers. They monitor certain events for the research pilot and are an important safety feature on all research missions.

Chase aircraft also are used as camera platforms for research missions that must be documented with photographs or video. Aeronautical engineers monitor and verify various aspects of a research project by extensively using photos and video.

The two-seat F/A-18 support aircraft is normally used for photo or video chase. The aircraft is configured to transmit live video back to Armstrong so engineers can visually monitor the mission as it is flown. This feature greatly enhances flight safety.

The F/A-18 fleet is also used by Armstrong research pilots for the routine flight training and proficiency required of all NASA pilots.

NASA photograph

The formal designation of the aircraft is F/A-18, corresponding to the dual fighter-attack role of the Hornets in the U.S. Navy and U.S. Marine Corps. McDonnell Douglas, now The Boeing Company of St. Louis, Mo., built the aircraft.

NASA ER-2

NASA operates two Lockheed ER-2 Earth resources aircraft as flying laboratories in the Airborne Science Program under the Agency's Science Mission Directorate. The aircraft, based at NASA Armstrong's Building 703 in Palmdale, Calif., collect information about Earth resources, celestial observations, atmospheric chemistry and dynamics, and oceanic processes.

The aircraft also are used for electronic sensor research and development, satellite calibration, and satellite data validation.

NASA photograph by Lori Losey

On the Ground

C-5M Super Galaxy

Air Force photograph by Roland Balik

The C-5M Super Galaxy is a strategic transport aircraft and is the largest aircraft in the Air Force inventory. Its primary mission is to transport cargo and personnel for the Department of Defense. The C-5M is a modernized version of the legacy C-5 designed and manufactured by Lockheed Martin.

Currently the U.S. Air Force owns and operates 52 C-5B/C/M. They are stationed at Dover AFB, Del., Travis AFB, Calif., Lackland AFB, Texas, and Westover Air Reserve Base, Mass.

Calspan X-62 VISTA

Air Force photograph by Giancarlo Casem

The NF-16D Variable In-flight Simulator Aircraft (VISTA) has been re-designated as the X-62A, effective June 14, 2021.

The VISTA, which is operated by the U.S. Air Force Test Pilot School with the support of Calspan and Lockheed Martin, first flew in 1992 and has been a staple of the TPS curriculum. It has provided TPS students the ability to experience various flying conditions including simulation of other aircrafts' characteristics.

NASA T-34 Turbo Mentor

NASA photograph by Jim Ross

Armstrong's mission support T-34C aircraft accompanies research flights for photography and video data collection, and also as safety chase.

RQ-4 Global Hawk

Courtesy photograph

The RQ-4 Global Hawk is a high-altitude, long-endurance, remotely piloted aircraft with an integrated sensor suite that provides global all-weather, day or night intelligence, surveillance and reconnaissance capability. Global Hawk's mission is to provide a broad spectrum of ISR collection capability to support joint combatant forces in worldwide peacetime, contingency and wartime operations.

NASA TG-14

NASA photograph by Ken Ulbrich

The Advanced Air Mobility National Campaign project conducted connectivity and infrastructure flight tests with a NASA TG-14 glider aircraft at NASA's Armstrong Flight Research Center, Edwards, Calif., Sept. 30-Oct. 1, 2020. The flights were preparation for the NC Integrated Dry Run Test in December and allowed pilots to view the routes they will fly during the helicopter test.

NASA C-20A

NASA photograph by Lori Losey

NASA's Armstrong Flight Research Center operates a C-20A, a military version of the Gulfstream III business jet, as an environmental science research aircraft for a variety of geophysical research missions.

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NASA photograph

The Proteus is a unique aircraft designed as a high-altitude, long-duration telecommunications relay platform, with potential for use on atmospheric sampling and Earth monitoring science missions as well. It was designed by Burt Rutan, president of Scaled Composites, and built during 1997-98 at the firm's development facility in Mojave, Calif.

Courtsy photograph

Updated by Howard Aero as the Howard 250, the conversion was to prove popular with about 22 aircraft modified in the early 1960s in San Antonio, Texas. Lockheed began to develop a larger and updated version of the Model 14 Super Electra in 1939 after the earlier design did not prove a commercial success.

Golden Age Flight Museum

The AN-2 airplane, a firstling of the O.K. Antonov Design Bureau, got off the ground on Aug. 31, 1947. The first flight was made by test pilot Pavel Volodin. Owing to high flight performance, structural reliability and wide transport capabilities, the AN-2 airplane has become an indispensable worker on regional airlines and in agriculture.

NOAA photograph

Designed by Burt Rutan in the late 1970s, this aircraft is definitely something you need to see.

Golden Age Flight Museum

The Vultee Aircraft Corp. BT-13 "Valiant" was a single-engine, tandem-seat trainer produced for the U.S. Army Air Corps, U.S. Navy and foreign allies prior to and during World War II. The aircraft was selected and produced as a primary and follow-on intermediary trainer due to its ruggedness, forgiving flight characteristics and stability. Most of the pilots produced in the early years of World War II conducted initial training, or Basic Training, hence the BT name, on the BT-13.

Convair, previously Consolidated Vultee, was formed in 1943 with the merger of Consolidated Aircraft and Vultee Aircraft.

Golden Age Flight Museum

In 1938, while most military pilots were still receiving their initial training in biplanes, Fairchild Aircraft recognized the need for a new design more closely approximating the more advanced types of aircraft the trainees would soon be flying. The result was the development of one of the most innovative and effective primary training planes ever designed, the Fairchild Primary Trainer.

L-1011 Tristar Stargazer

Northrop Grumman photograph

In April 1972, after six grueling years of design and some unforeseen setbacks, the then-Lockheed California Company (now Lockheed Martin) delivered the most technologically advanced commercial jet of its era, the L-1011 TriStar, to its first client, Eastern Airlines.

Between 1968 and 1984, Lockheed manufactured a total of 250 TriStars at the Lockheed plan at Air Force Plant 42 in Palmdale, Calif.

Stargazer is a Lockheed L-1011 TriStar built in 1974, that was modified in 1994 to be used by Orbital Sciences (now part of Northrop Grumman) as a mother ship launch pad for the Pegasus launch vehicle. As of October 2019, 44 rockets (containing 95 satellites) have been launched from it, using the Pegasus-H and Pegasus-XL configurations.

A-10 Thunderbolt II

AirForce photograph Giancarlo Casem

The A-10C Thunderbolt II is the first Air Force aircraft specially designed for close air support of ground forces. They are simple, effective and survivable twin-engine jet aircraft that can be used against light maritime attack aircraft and all ground targets, including tanks and other armored vehicles.

General Atomics UAV Simulator

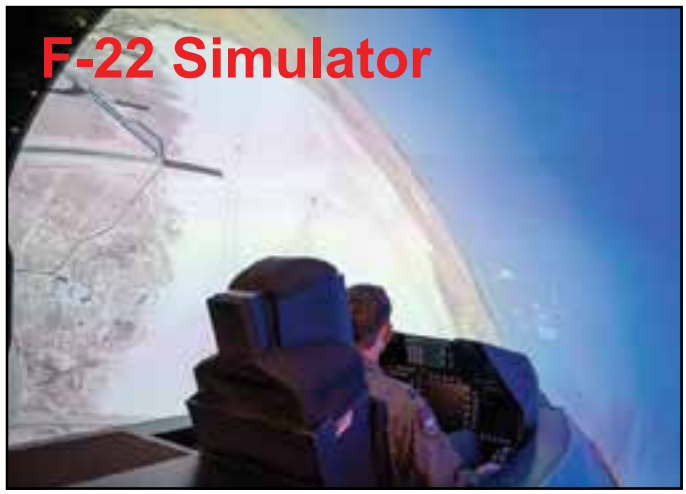
GA-ASI photograph

Stratolaunch Talon-A Hypersonic Vehicle

Stratolaunch photograph

An autonomous, reusable testbed that makes flight testing more accessible and affordable. The Stratolaunch Talon-A vehicle will be used to test and validate Roc's release system and characterize the separation dynamics of the Talon vehicle.

F-22 Simulator



Lockheed Martin photograph

Step inside the immersive flight simulator of the F-22 Raptor.

Pratt & Whitney F135 engine

Pratt & Whitney photograph

A history of Edwards Air Force Base

The natural setting

A parched and forbidding wilderness to those who first see it, the northwestern Mojave Desert is a land of coyotes and jack rabbits, of ragged greasewood and, of course, Joshua trees.

It is a harsh land of sometimes stunning contrasts — a land of griddle-hot days and bone-chilling nights, of violent dust storms, bewildering mirages and mesmerizing sunsets.

Until the Southern Pacific Railroad arrived in 1876, the desert was populated mostly by occasional prospectors drifting endlessly in pursuit of elusive mineral wealth. In 1882, the Santa Fe Railroad ran a line westward out of Barstow toward Mojave and built a water stop at the edge of an immense dry lakebed, roughly 20 miles southeast of Mojave. The lonely water stop was known simply as "Rod," and the lakebed was then called Rodriguez Dry Lake.

By the early 1900s, "Rodriguez" had been anglicized into "Rodgers," which was then shortened to "Rogers." First formed in the Pleistocene Epoch and featuring an extremely flat, smooth and concrete-like surface, Rogers Dry Lakebed is a playa — or pluvial lake — that spreads out over 44 square miles, making it the largest such geological formation in the world.

Its parched clay and silt surface undergoes a timeless cycle of renewal each year, as water from winter rains is swept back and forth by desert winds, smoothing it out to an almost glass-like flatness.

The homesteaders

In 1910, the Corum family settled at the edge of this lakebed. In addition to raising alfalfa and turkeys, they located other homesteaders in the area for a fee of $1 per acre. As those settlers moved in, the Corum brothers earned contracts for drilling water wells and clearing land. They also opened a general store and post office.

Their request to have the post office stop named "Corum" was disallowed because there was already a Coram, Calif. So they simply reversed the spelling of their name and named it "Muroc." Small, isolated homesteads dotted the land over the next 20 years.

Courtesy photograph

The Airmen arrive

The early homesteaders thought of Rogers Dry Lakebed as a wasteland. However, a visionary Airman commanding March Field, Lt. Col. H. H. "Hap" Arnold, saw it as a one-of-a-kind "natural aerodrome" — one that could be acquired at virtually no cost to the taxpayer.

Thus, in September 1933, the Muroc Bombing and Gunnery Range was established by Arnold. This remote training site, now a small enclave within present-day Edwards, served the Army Air Corps' bombers and fighters for several years.

With the arrival of World War II, a permanent base sprang up for the training of combat flight crews. In July 1942, it was activated as a separate post and designated Muroc Army Air Base.

Throughout the war years, B-24s thundered through the Muroc skies and P-38s strafed the targets on the range as bomber crews and fighter pilots prepared to do battle overseas.

Sept. 10, 1940: Reflecting the nation's overall military buildup on the eve of World War II, construction began on temporary housing facilities and an administrative building for the bombing range at Muroc Air Field, now Edwards Air Force Base. Over the next several weeks, work began on barracks, a medical facility, ordnance magazines, and a railroad spur and associated utilities. Fourth Air Force also authorized several new target installations, and a hard-surfaced runway adjacent to the lakebed. This marked the beginning of the permanent facilities on the western shore of the Muroc Dry Lake bed, which eventually came to be known as South Base.

Strange shapes in the sky

In the meantime, wartime development of military aviation overwhelmed Wright Field in Ohio with an immense volume of flight test work. It was necessary to find a remote location with good flying weather where a new top-secret airplane could safely undergo tests.

In the spring of 1942, a site was chosen alongside the north shore of Rogers Dry Lakebed, about six miles away from the training base at Muroc. A wooden hangar and rudimentary facilities sprang up and on Oct. 1, 1942, Bell test pilot Bob Stanley lifted the wheels of the Bell XP-59A Airacomet off the enormous, flat surface of the dry lakebed. The turbojet revolution had arrived. America's first jet plane was shortly joined by a second, the famed Lockheed XP-80 Shooting Star.

As revolutionary as these two experimental fighter planes were, the natural runways of the lakebed served them well. The first-generation turbojet engines had a nasty habit of flaming out, and the Airacomet required an extremely long takeoff roll.

During the postwar years, all of America's first generation of jets — both Air Force and Navy — underwent testing at Muroc, and the great lakebed served as a welcome haven to countless pilots in distress.

The success of these programs attracted a new type of research activity to the base in late 1946. The rocket-powered Bell X-1 was the first in a long series of experimental airplanes designed to prove or disprove aeronautical concepts — to probe the most challenging unknowns of flight and solve its mysteries.

On Oct. 14, 1947, Capt. Charles E. "Chuck" Yeager flew the small bullet-shaped airplane to become the first human to exceed the speed of sound. With the X-1, flight testing at Muroc began to assume two distinct identities. Highly experi-

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Air Force photograph

May 1, 1951: The Experimental Flight Test Pilot School, newly transferred from Wright-Patterson Air Force Base, Ohio, and renamed, opened its first classes at Edwards Air Force Base, Calif. The TPS shared its facility with the Base Transient Maintenance Hangar, Bldg T-1011. Pictured are Royal Canadian Air Force Flight Lieutenants Christie, Bennette and Greene, who had transferred from Wright-Patterson to complete their test pilot training.

mental research programs — such as the X-3, X-4, X-5 and XF-92A — were typically flown in conjunction with the National Advisory Committee for Aeronautics, or NACA, and were conducted in a methodical fashion to answer largely theoretical questions. Then, as now, the great bulk of flight testing at Muroc focused on evaluations of the capabilities of aircraft and systems proposed for the operational inventory.

In December 1949, Muroc was renamed Edwards Air Force Base in honor of Capt. Glen W. Edwards, who was killed a year earlier in the crash of the YB-49 Flying Wing.

By that time, the base had already become the reigning center of American flight research and on June 25, 1951, this fact was finally officially recognized when its test community was designated the U.S. Air Force Flight Test Center, or AFFTC. That same year, the U.S. Air Force Test Pilot School moved to Edwards from Wright Field, Ohio.

Its curriculum focused on the traditional field of performance testing and the relatively new field of stability and control, which had suddenly assumed critical importance with the dramatic increases in speed offered by the new turbojets.

The golden age of flight test

The decade of the 1950s was a remarkable period in the history of aviation, and there was no better evidence of this than what transpired at Edwards. If the concept seemed feasible — or even just desirable — it was evaluated in the skies above the sprawling 301,000-acre base.

The experimental rocket planes, for example, continued to expand the boundaries of the high-speed and stratospheric frontiers.

As the decade opened, the first-generation X-1 reached Mach 1.45 (957 mph) and a 71,902-foot altitude, representing the edge of the envelope. The D-558-II Douglas Skyrocket soon surpassed these marks. In 1951, Douglas test pilot Bill Bridgeman flew the skyrocket to a top speed of Mach 1.88 (1,180 mph) and a peak altitude of 74,494 feet. Then, in 1953, Marine test pilot Lt. Col. Marion Carl flew the same plane to an altitude of 83,235 feet.

On Nov. 20, 1951, the National Advisory Committee for Aeronautics's Scott Crossfield became the first man to reach Mach 2 as he piloted the Skyrocket to a speed of Mach 2.005 (1,291 mph). Less than a month later, Maj. Chuck Yeager topped this record as he piloted the second-generation Bell X-1A to a top speed of Mach 2.44 (1,650 mph) and, just nine months later, Maj. Arthur "Kit" Murray flew the same airplane to a new altitude record of 90,440 feet.

These records stood for less than three years. In September 1956, Capt. Iven Kincheloe became the first man to soar above 100,000 feet, as he piloted the Bell X-2 to a then-remarkable altitude of 126,200 feet. Flying the same airplane

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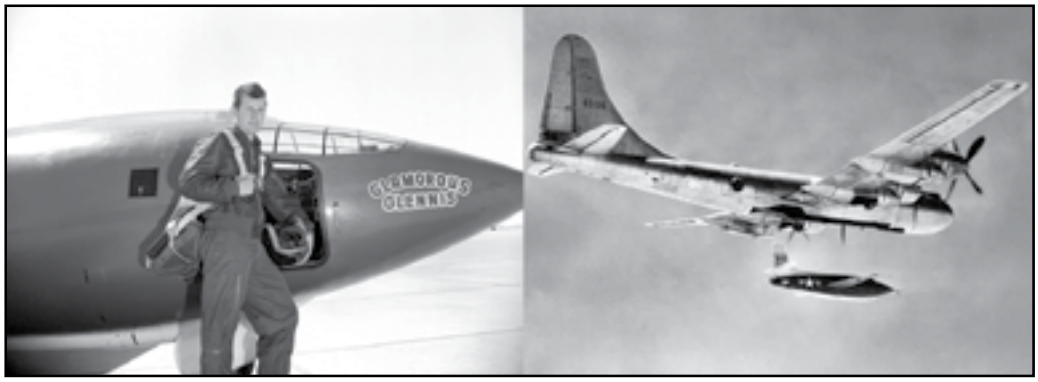
just weeks later on Sept. 27, Capt. Mel Apt became the first to exceed Mach 3, accelerating to a speed of Mach 3.2 (2,094 mph). His moment of glory was tragically brief, however. Just seconds after attaining top speed, the X-2 tumbled violently out of control and Apt was never able to recover.

With the loss of the X-2, the search for many of the answers to the riddles of high-Mach flight had to be postponed until the arrival of the most ambitious of the rocket planes — the North American X-15.

Meanwhile, the turbojet revolution had reached a high plateau at Edwards, as aircraft such as the famed "Century Series" of fighters — the F-100 Super Sabre, F-102 Delta Dagger, the Mach 2 F-104 Starfighter, F-105 Thunderchief and F-106 Delta Dart — made supersonic flight seem almost commonplace.

Incorporating many advances made possible by the experimental research programs, each of these aircraft was a technological achievement and, indeed, as a group, they defined the basic speed and altitude envelopes for fighters, which are still in effect to this day.



Air Force photographs

Oct. 14, 1947: Capt. Chuck Yeager broke the sound barrier. At approximately 45,000 feet above the desert, Yeager fired the rocket engines on the Bell X-1, nicknamed Glamorous Glennis after his wife, he was piloting. The aircraft was carried aloft beneath a modified B-29 Superfortess, where it was air launched. Accelerating to 700 mph, he became the first human to official travel faster than the speed of sound in level flight. The data from this and subsequent flights helped pave the way for many more firsts in the supersonic era.

The space age

The 1960s ushered in a new emphasis on space flight. The Test Pilot School, for example, was redesignated the Aerospace Research Pilot School as it moved into the business of training future astronauts.

High above the flightline, the X-15 was beginning to explore hypersonic and exoatmospheric flight. Indeed, in July 1962, it became the first — and, so far, the only — airplane to fly in near space as it soared above 314,000 feet, winning astronaut wings for its pilot, Maj. Robert M. White. With Maj. William J. "Pete" Knight at the controls on Oct. 3, 1967, the highly modified X-15A-2 ultimately reached a top speed of Mach 6.72 (4,520 mph), which remains the highest speed ever attained by a manned airplane.

While space-related activities captured the public's imagination, test pilots at Edwards were also continuing to expand the frontiers of atmospheric flight in air-breathing, jet-powered aircraft such as the XB-70 Valkyrie and the YF-12 and SR-71 Blackbird. The 500,000-pound Valkyrie proved itself capable of sustained triple-sonic flight operations at altitudes above 70,000 feet.

In the meantime, the mysterious Blackbirds, now described as first-generation "stealth" aircraft, provided even more dazzling performances as they routinely cruised at speeds in excess of Mach 3 (about 2,250 mph) and at altitudes well above 80,000 feet.

With the decline of the military manned space mission in the early '70s, the Aerospace Research Pilot School was once again redesignated the U.S. Air Force Test Pilot School. This change was more than symbolic. Based on a survey of graduates still active in the flight test business, the school completely revamped its curriculum to reflect major changes that had recently taken place in the aerospace world.

Experience had shown that the proliferation of increasingly sophisticated onboard avionics, sensor and fire-control systems would be a constant and that supervising modern test programs would increasingly require strong management skills. Thus, the school replaced its space-oriented phase of curriculum with a whole new battery of courses focusing on systems tests and test management.

The modern skies

New aircraft types arrived in the 1970s: the F-15 Eagle with its advanced engine and fire-control system; the single-engine F-16 Falcon with its revolutionary, "fly-by-wire" flight control system; and the B-1 Lancer with its multitude of highly sophisticated offensive and defensive systems.

These planes more than bore out the prophecy concerning the ever-increasing importance of systems testing and integration. Moreover, another major new element of complexity was soon introduced into the flight test process.

At a remote location in 1978 and 1979, an AFFTC test pilot and a pair of flight test engineers were engaged in proof-of-concept testing with Lockheed's "low-observable" technology demonstrator, dubbed "Have Blue." The successful conduct of these tests led immediately to the development of a new subsonic attack aircraft that was designated the F-117A Nighthawk.

Another aerospace revolution — the stealth revolution — was underway.

The 1980s opened with one of the most dramatic episodes in all of Edwards' history.

At 10:20 a.m. on April 14, 1981, the wheels of the Space Shuttle Columbia touched down on Rogers Dry Lakebed. Astronauts John Young and Robert Crippen had successfully landed the first orbiting space vehicle ever to leave the Earth under rocket power and return on the wings of an aircraft. The era of reusable space vehicles had dawned.

In the meantime, flight testing itself had evolved into a remarkably complex process that led to a similar revolution in the Flight Test Center's ability to acquire and process flight data. In fact, the extraordinary number of costly flying hours required to test and integrate all of the new systems under the traditional "fly-fix-fly" method had forced the AFFTC to rethink its whole approach to the business of testing. Thus, the decade also saw the development of sophisticated new facilities at Edwards that met the challenges of the new technologies.

The Integration Facility for Avionic Systems Test, the Benefield Anechoic Facility and the Test and Evaluation, Modeling and Simulation Facility — all part of the Avionics Test and Integration Complex, permitted the testing and integration of new and complex software-intensive systems on the ground before they were taken into the air.

Spectacular events have become almost commonplace at Edwards over the years, but they have always represented only a small part of the Flight Test Center's workload. The primary job has always been to assure that American aircrews go into combat with the most effective and reliable operational aircraft in the world.

The capabilities of existing aircraft such as the F-15 and F-16

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412th Test Wing at Edwards AFB

The 412th Test Wing plans, conducts, analyzes, and reports on all flight and ground testing of aircraft, weapons systems, software and components as well as modeling and simulation for the U.S. Air Force.

There are three core components for this mission: flying operations, maintenance, and engineering.

Through a maintenance group of over 2,000 people and an operations group of 3,000, the test wing maintains and flies an average of 90 aircraft with upwards of 30 different aircraft designs and performs over 7,400 missions (over 1,900 test missions) on an annual basis.

The Test Pilot School, also part of the test wing, is where the Air Force's top pilots, navigators and engineers learn how to conduct flight tests and generate the data needed to carry out test missions. Human lives and millions of dollars depend upon how carefully a test mission is planned and flown. The comprehensive curriculum of Test Pilot School is fundamental to the success of flight test and evaluation.

The Engineering Division and the Electronic Warfare Division provide the central components in the conduct of the Test and Evaluation mission. They provide the tools, talent and equipment for the core disciplines of aircraft structures, propulsion, avionics and electronic warfare evaluation of the latest weapon system technologies. They are also host to the core facilities that enable flight and ground test with the Range Division, Benefield Anechoic Facility, Integrated Flight Avionics Systems Test Facility and the Air Force Electronic Warfare Evaluation Simulator.

Rounding out the test wing are the Project and Resource Management Divisions who provide the foundation for the successful program management of test missions.

The test program

Flying units under the Operations Group are called flight test squadrons and the squadron commander also usually fulfills the role of Combined Test Force, or CTF, Director.

The CTF is an organizational construct that brings together the government developmental test and evaluation personnel (i.e., military personnel and government civilians and support contractors), the operational testers or representatives of the warfighters who will eventually employ the aerospace system in combat, and the contractors who develop and test the aerospace system.

Members of the CTF formulate the test program, develop the criteria for flight test missions, execute flight test missions, analyze data from the test flights and report on the results. The CTF military personnel, government civilians, and contractors all work together as a team. This concept enables a cheaper, faster, and more effective test program and produces a more effective aerospace system for the warfighter.

Risk is an accepted component of flight testing, but because of Edwards' benchmark flight test safety processes, the center maintains a stellar safety record. The AFTC's mission focuses on Developmental Test and Evaluation which is the process used to identify risks that need to be reduced or eliminated before fielding new systems. Once DT&E is accomplished, aircraft systems transition to Initial Operational Test and Evaluation, or IOT&E where the aircraft is evaluated for combat effectiveness and suitability for an intended mission.

The people

The 412th Test Wing is the host wing for Edwards Air Force Base, Calif. — the second largest base in the Air Force. The wing oversees base day-to-day operations and provides support for over 10,000 military, federal civilian and contract personnel assigned to a 470 square mile installation. Approximately 1500 Test Wing Desert Warriors directly support the test and evaluation mission of the Air Force Test Center and the 412th Test Wing.

The wing is responsible for operating the base, including the infrastructure, communication systems, security, fire protection, transportation, supply, finance, contracting, legal services, personnel and manpower support, housing, education, chapel and quality of life programs on a 301,000-acre base in the middle of the Mojave Desert, the second largest base in the U.S. Air Force.

The 412th TW is host to over 100,000 visitors annually and supports over 25,000 dependents, retirees, and veterans. Major units within the wing include the 412th Mission Support and the 412th Medical Groups, as well the 412th Civil Engineer/Transportation Directorate, 412th Security Forces Squadron and the Services and Comptroller Divisions. Staff agencies include chaplain services, base comptroller, inspector general, manpower and organization, and military equal opportunity and public affairs.

The aircraft

The Edwards flightline is the "Center of the Aeronautical Universe." This is where the future of the nation's aerospace defense system can be viewed.

There are nine flight test squadrons with as many as 20 aircraft assigned to each. The aircraft are grouped by mission representing global power (fighters and bombers); global reach (transport); and global vigilance (unmanned and airborne laser).

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have been continually refined and expanded, even as totally new aircraft and systems incorporating radical new technologies are developed for future operational use.

The dual-role F-15E, for example, was developed in the 1980s and went on to demonstrate truly remarkable combat effectiveness in the Persian Gulf conflict of the early 90s. The Low Altitude Navigation and Targeting Infrared for Night, or LANTIRN, system revolutionized air-to-ground combat operations during the same conflict by denying our adversary the once comforting sanctuary of night.

The late 1980s also witnessed the arrival of the first giant flying wing to soar over the base in nearly 40 years. The thin silhouette, compound curves and other low-observable characteristics of the B-2 Spirit bomber represented third-generation stealth technology, following the SR-71 and F-117.

The new bomber, by far the most sophisticated and complex airplane ever built, was soon followed in the early 90s by the arrival of the YF-22A and the YF-23A, both of which would soon give a new definition to the term "air superiority."

The two prototype fighters were the first airplanes to blend stealth with agility and high-speed, supersonic cruise capability. The YF-22A was selected to become the Air Force's new advanced tactical fighter after a brief demonstration and validation risk reduction flight test program. Now named the Raptor, the F-22A continues to undergo test and evaluation at Edwards.

A new group of research projects came to Edwards in the 1990s. Global Hawk, an unmanned aerial vehicle that has been used extensively in Afghanistan as well as Iraq, made its first flight at Edwards in February 1998 and has gone on to fill a critical role in America's war on terrorism. The X-24, X-33, X-34 and X-38, a series of new lifting bodies, technology demonstrators and half-scale models that might make space flight, research and development safer and more economical, were tested here by NASA during the decade.

The new millennium brought new projects with worldwide impact. The X-35A and X-32A, competing models for the Joint Strike Fighter program, made their first flights in September and October 2000. The X-35A won the competition in 2001 and will eventually be built in various versions for America's flying armed services and for foreign air forces as well. Also new are the Airborne Laser Program and the Predator Unmanned Aerial Vehicle Programs.

Where we stand today

Flight testing at Edwards has come a long way since the first olive-drab XP-59A lifted off from the lakebed more than 60 years ago. Over the years, the U.S. Air Force and the world of aerospace have continued to meet the future in the clear blue skies above the base. Every single aircraft to enter the Air Force's inventory — and a great many that failed to do so — has been put through its paces at Edwards. Some Navy and Army aircraft have been tested here as well.

Arguably, more major milestones in flight have occurred at this base than anywhere else in the world. The demands of the Global War on Terrorism and the ever-accelerating pace of technological change over the past half-century have been daunting, but the Edwards flight test community repeatedly demonstrates its ability to adapt to these changes and to master the many challenges they impose.

The turbojet revolution, the space revolution, the systems revolution and now the unmanned aircraft systems revolution have imposed seemingly insurmountable obstacles. Each barrier, however, has been overcome through a combination of technical aptitude, daring ingenuity and skillful management.

Indeed, the Air Force Flight Test Center's unique blend of natural, technical and human resources has transformed it into something much more than a benefit to the Air Force; it is an irreplaceable national asset.

NASA Armstrong Flight Research Center

As NASA's Armstrong Flight Research Center in Edwards, California, approaches its 75th anniversary on Sept. 30, the center is poised to build on its legacy to help NASA and the nation reach new flight milestones.

The National Advisory Committee for Aeronautics High-Speed Flight Facility in 1946 was established with a single mission, to support the first U.S. Air Force experimental aircraft designed to break through the perceived sound barrier.

A 13-person contingent at the California facility was tasked to assist in testing and research of the X-1, which was the first aircraft to exceed Mach 1. Mach 1 is achieved at 650 to 750 mph depending on factors such as atmospheric conditions and altitude. An aircraft breaking through the sound barrier results in a loud thunderous sound heard by those on the ground called a sonic boom.

Today, NASA's X-59 Quiet SuperSonic Technology aircraft is taking shape as it approaches construction completion, with a first flight scheduled for 2022. The X-59 will fly to validate the technology to make quiet supersonic flight a reality. The science includes the shape of the aircraft itself reducing the loudness of a sonic boom to a quiet thump.

Once NASA proves the aircraft is as quiet as it's designed to be, the X-59 will begin the third phase of its mission in 2024, where it will be flown above select U.S. communities to gather data from sensors and people on the ground to gauge public perception. That data will help regulators establish new rules that may enable commercial supersonic air travel over land, greatly reducing flight times.

NASA photograph

NACA High Speed Flight Station aircraft at South Base. Clockwise from far left: D-558-II, XF-92A, X-5, X-1, X-4, and D-558-I, circa 1952.

Transition to Space

After the X-1 project ended a number of X-planes followed, designed to find answers related to speed, temperature, structure, control and human physiology, work that continued as the agency morphed from the NACA to NASA in 1958.

One such aircraft was the X-15 rocket plane program that posted a then record 199 flights, including binders of research, and an official record of speed at Mach 6.7, or

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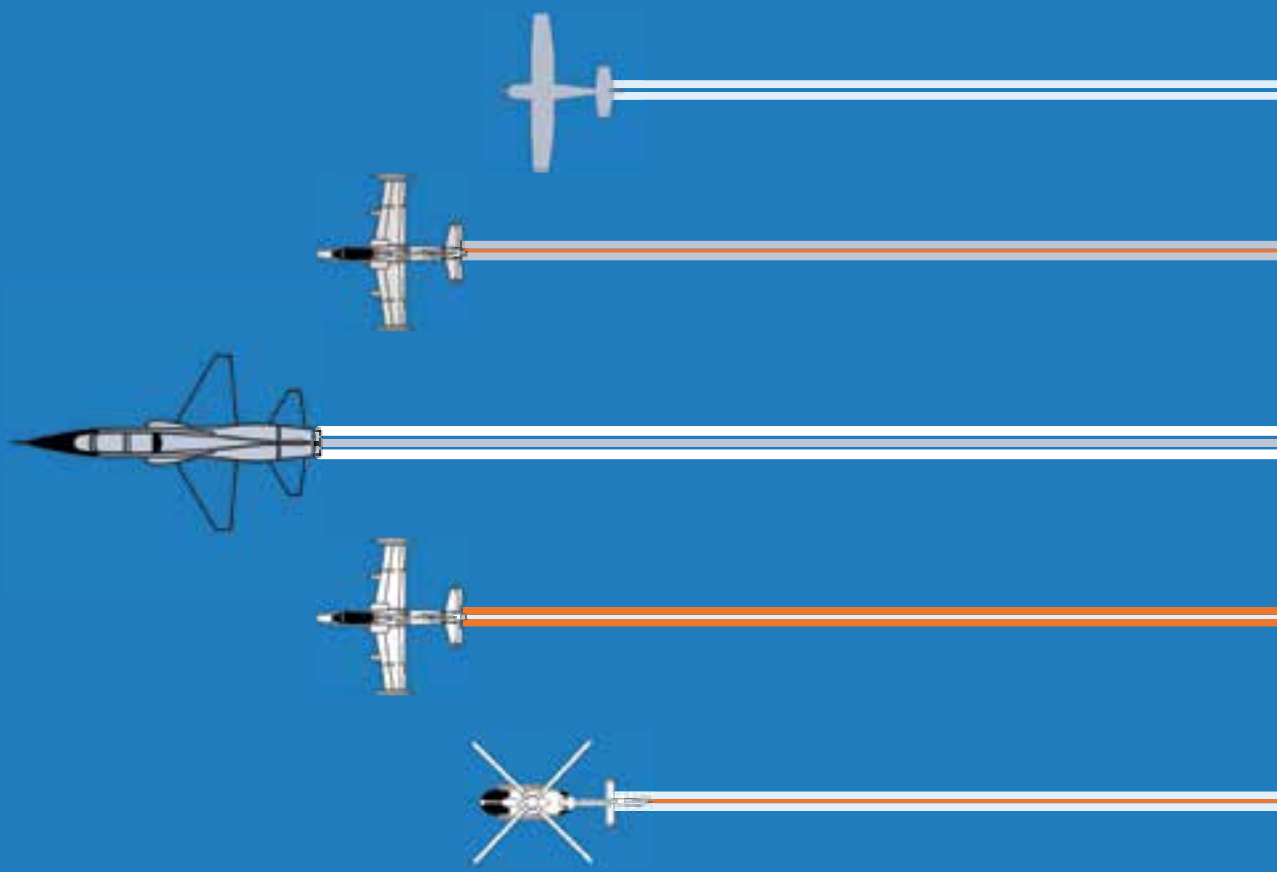

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more than 4,500 mph, and an unofficial altitude record at the edge of space at 67 miles, or 354,200 feet.

The center's initial focus was aeronautics, but the X-15 bridged the worlds of high speed aircraft with the research needed to reach beyond Earth's atmosphere. The development of reaction control systems for the legendary X-15 was critical for spaceflight, as it provided a way to control a vehicle in the absence of dynamic pressure as is encountered in space.

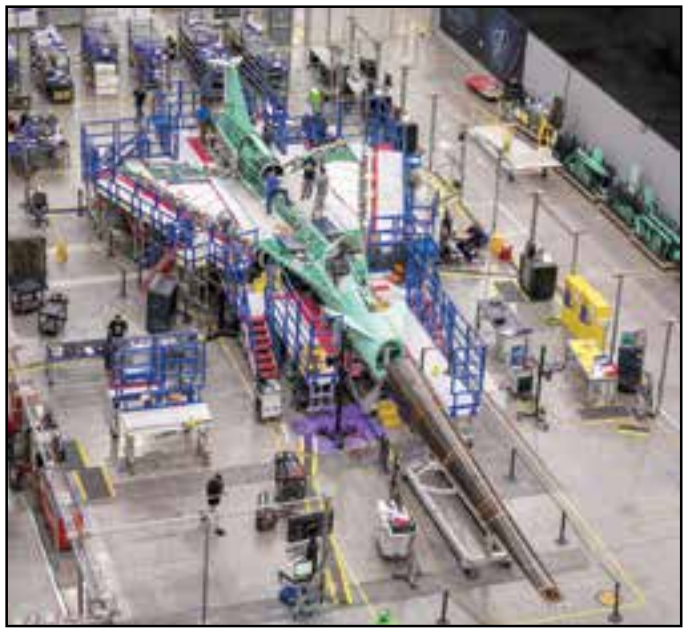
The Lunar Landing Research Vehicle also was tested at the center. The free-flight aircraft simulated the one-sixth gravity of Earth that astronauts would face on the moon. The research contributed to construction of the Lunar Landing Training Vehicles that were built and sent to NASA Johnson Space Center in Houston (then called the Manned Spaceflight Center). Apollo astronauts used the spindly aircraft to train for landing on the moon. The practice was helpful when Neil Armstrong, for whom the center was renamed in 2014, piloted the Lunar Module manually to the lunar surface to take the first steps.

Lifting body aircraft were designed to validate the shape of a space return vehicle that could land like an aircraft instead of descending under a parachute and landing in the ocean.

Space shuttles and space contributions

Space Shuttle Enterprise's approach and landing tests marked another contribution to space-related technology. A large steel gantry called the Mate Demate Device slowly lifted the shuttle onto the back of a specially modified NASA 747 Shuttle Carrier Aircraft. Enterprise was then launched from the back of the large aircraft to validate the shuttle's performance in atmospheric flight.

The center retained a role with the space shuttles during the 30-year program, often hosting landings. Most early landings and first flights of new orbiters or return to flight operations took place at the center. The shuttles concluded 54 space missions with a landing at Edwards and a return trip on the NASA 747 to NASA's Kennedy Space Center in Florida.



Lockheed Martin photograph

Lockheed Martin and NASA are currently developing the X-59 Quiet SuperSonic Technology aircraft.

NASA's Flight Opportunities program, managed by NASA Armstrong, rapidly demonstrates promising technologies for space exploration, discovery, and the expansion of space commerce through suborbital testing with industry flight providers. The program matures capabilities needed for NASA missions and commercial applications while strategically investing in the growth of the U.S. commercial spaceflight industry.

Aeronautics milestones

Speed isn't only the regime of space vehicles. Armstrong researchers explored the realm of hypersonic speed with the first integrated hypersonic scramjet engine, the X-43. The air-breathing engines propelled the vehicle to speeds of Mach 7, about 4,500 mph, and nearly to Mach 10, or roughly 7,000 mph, during separate flights in 2004, setting a Guinness World Record for air-breathing propulsion.

High speed isn't always the goal, as demonstrated during the Environmental Research Aircraft and Sensor Technology (ERAST) program. One of the aircraft that flew in that program was the Helios Prototype, which cruised at 25 mph powered by solar powered electric motors about as powerful as a hairdryer.

What's new

New innovations are part of what the center is known for and another recent X-plane, the X-57 Maxwell, is an example.

The distributed electric powered aircraft fits into an overarching NASA plan for researching regional air transportation of people and cargo. A principal goal of the X-57 project is to share the X-57 design and airworthiness process with regulators and standards organizations. Another goal is to establish the X-57 as a reference platform for integrated approaches of distributed electric propulsion technologies.

To help integrate air taxis, cargo delivery aircraft and other new air vehicle concepts into the national airspace system, NASA is working with industry, academia and other government agencies like the Federal Aviation Administration (FAA). The bulk of this work is happening under NASA's Advanced Air Mobility National Campaign.

Continuing NASA's work in autonomy, the Resilient Autonomy proejct has developed the Expandable Variable Autonomy Architecture, or EVAA, which includes autonomous elements for increased safety on a range of aircraft. This software stems from the Automatic Ground Collision Avoidance System (Auto GCAS) that has saved the lives of 11 F-16 pilots. NASA Armstrong led NASA's efforts to develop AutoGCAS with its partners the U.S. Air Force, the U.S. Air Force Research Laboratory, the Office of the Secretary of Defense and Lockheed Martin.

The Auto GCAS system takes control of an aircraft from the pilot at the last possible moment to avoid an imminent ground collision. For this activity, the team modified the algorithms of the F-16 GCAS and the Automatic Collision Avoidance Systems and rebranded them to indicate an improved functionality suitable for non-fighter aircraft. This new version of the software can be used in smaller aircraft like Cessnas and future remotely piloted or autonomous aircraft. The Joint Capability Technology Demonstration activity is in partnership with the FAA and DOD.

The X-56A suppressed potentially destructive vibration called flutter, which permitted research of the aircraft's lightweight, flexible wings. The results of the research, which also included the Air Force Research Laboratories in Ohio, could enable future airliners to use similar wing designs to conserve fuel. The X-56A team also facilitated the development of tools and technologies and acquired data to validate modeling techniques.

Airborne Science

NASA Armstrong operates a fleet of specialized aircraft of varied capabilities to support environmental and Earth science research missions under the Airborne Science program of the agency's Science Mission Directorate.

As part of the directorate's Earth Science Division, NASA's Airborne Science Program uses these unique aircraft and sensors to conduct observations and collect atmospheric data, as well as calibrate and validate satellite data.

A number of the science aircraft are based at NASA Armstrong Bldg. 703 in Palmdale, California. They include two high-altitude Lockheed ER-2s (civilian versions of the U-2Rs) and a Gulfstream C-20A (G-III). A Beechcraft B-200 Super King Air is based at Armstrong's main facility at Edwards.