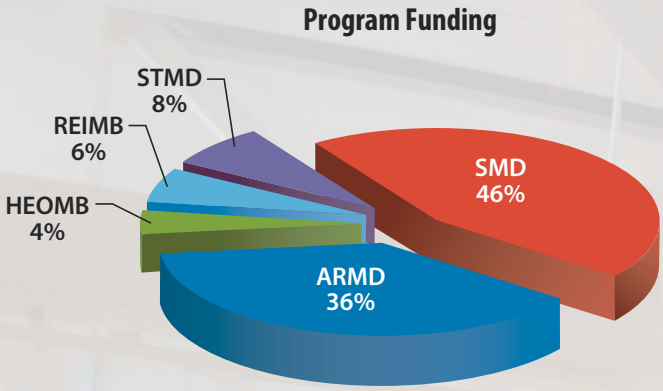
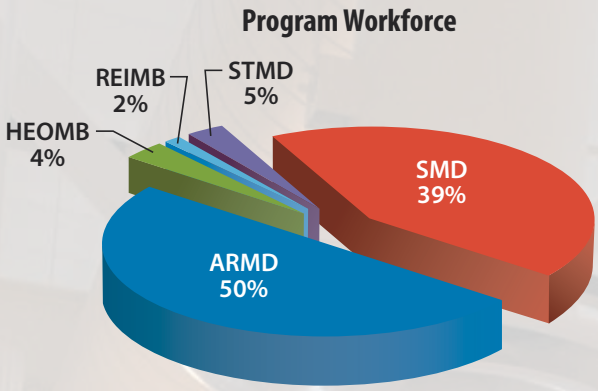
National Aeronautics and Space Administration

Citizen Report

A look at the work and impact of the Dryden Flight Research Center





Fiscal Year 2013 Vital Statistics

Civil service staff – 550
On-site contractors – 595
Total budget – $253 million (Figure includes business development)

Citizen Report

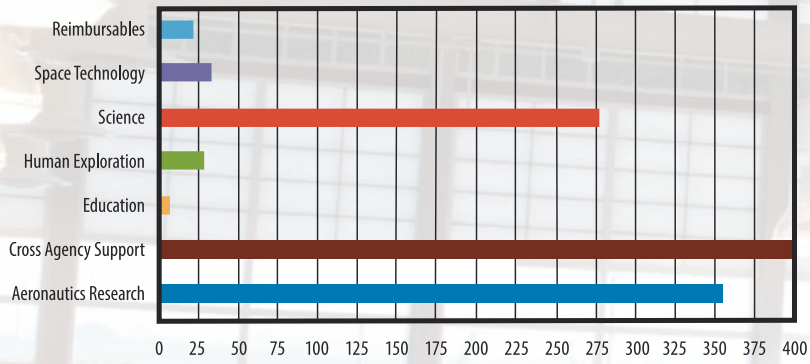
NASA Dryden Flight Research Center introduction

The Hugh L. Dryden Flight Research Center, located on the western edge of California's Mojave Desert, has made a number of significant contributions to NASA's mission since the agency was established more than five decades ago.

Dryden's history dates to late 1946, when 13 engineers and technicians arrived at what is now Edwards Air Force Base from the National Advisory Committee for Aeronautics Langley Memorial Aeronautical Laboratory. Their goal was to prepare for the first supersonic research flights by the X-1 rocket plane in a joint NACA/U.S. Army Air Forces/Bell Aircraft program. The NACA was the predecessor organization of today's NASA.

Dryden, which in 2014 will be redesignated the Neil A. Armstrong Flight Research Center, continues to pioneer programs that contribute to NASA's four key mission directorates including aeronautics research, science, human exploration and operations and space technology. Dryden completes that work for about 1 percent of NASA's $16.9 billion budget, or $244.1 million. Dryden's workforce consists of about 1,145 contractor and civil service employees.

Dryden 2013
Number of Employees by Mission*



* Total number of employees (civil service and contractors)

Our Vision

To fly what others only imagine

Our Mission

Advancing technology and science through flight

Background image:
Dryden's new $11.2 million, 38,000-square-foot Facilities Support Center is sustainable and is expected to be about 36 percent more energy efficient and use 40 percent less water than traditional construction.

Aeronautics Research

NASA's Aeronautics Research Mission Directorate works to resolve challenges in the nation's air transportation system including air traffic congestion, safety and environmental impacts. In addition, through green aviation, NASA is helping to enable fuel-efficient flight planning and reduce aircraft fuel consumption, emissions and noise.

Dryden's world-class flight research capability is built on a tradition of expertise in aeronautical engineering and its core research disciplines, including aerodynamics, aero-acoustics, materials and structures, propulsion, dynamics and control, sensor and actuator technologies, advanced computational and mathematical techniques and experimental measurement techniques.

Dryden was an exciting place to be in 2013 with more than 972 sorties in 25 different modified and unique aircraft, science missions around the world and two first flights. The contributions by Dryden's researchers and staff in 2014 will continue the center's heritage with work that will benefit NASA's key missions.

Active Compliant Trailing Edge

For the Aeronautics Research Mission Directorate, Dryden is expected to complete integration of the Adaptive Compliant Trailing Edge, or ACTE, flap on a modified Gulfstream-III research aircraft. The experimental flight research project, which is expected to fly toward the end of 2014, is a joint effort of NASA and the U.S. Air Force Research Laboratory to determine if advanced flexible trailing-edge wing flaps can improve aircraft aerodynamic efficiency and reduce airport-area noise.

Unmanned Aircraft Systems

An example of Dryden's leadership is the Unmanned Aircraft Systems Integration in the National Airspace System, or UAS in the NAS, project. The goals are to increase safety and to verify and validate technical and operational solutions for flying unmanned aircraft in the same airspace shared by commercial and civil air traffic.

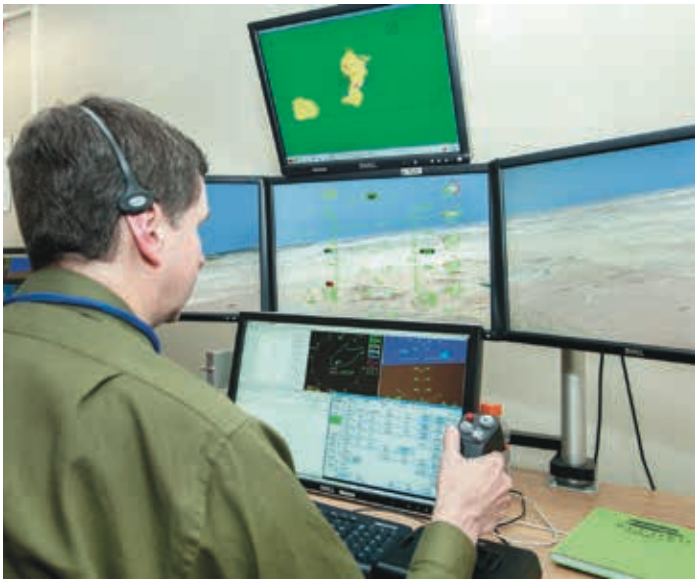
Five sub-projects focus on assurance of safe separation of unmanned aircraft from manned aircraft when flying in the same airspace; safety-critical command and control systems and radio frequencies to enable safe operation of UAS; human factors issues for ground control stations; airworthiness certification standards for UAS avionics, and integrated tests and evaluation to determine the viability of emerging UAS technology. As part of the ongoing effort, Dryden is planning integrated human-in-the-loop testing with a piloted aircraft acting as a surrogate UAS in 2014.

Supersonic Research

ARMD planning in 2014 could also lead to additional work for Dryden. For example, next steps on concepts like a quiet supersonic aircraft are ongoing.

In 2013, two projects focused on supersonics. Researchers used a ground-based telescope and digital camera system to capture images of shock waves emanating from airplanes traveling at supersonic speeds. Images taken with the Ground-to-Air Schlieren Photography System will help validate computer simulations and wind tunnel test data used in designing future supersonic aircraft.

In partnership with Aerion Corporation of Reno, Nev., Dryden engineers studied supersonic airflow over a small experimental airfoil design on its F-15B Test Bed aircraft last spring in the second phase of the Supersonic Boundary Layer Transition project. Testing the airfoil at actual supersonic speeds enabled engineers to capture data that will allow more precise refinement of supersonic natural laminar flow airfoil design.



ED13-0227-19 **NASA/Ken Ulbrich**

Gary Bell flies the Ikhana simulator in support of UAS in the NAS work.

ED12-0356-81 **NASA/Tom Tschida**

A researcher sets up sonic boom detection equipment for an experiment. Dryden is expected to have a continued role in sonic boom research.

X-56A Multi-Utility Technology Test bed

The remotely piloted X-56A Multi-Utility Technology Test bed was developed by the AFRL and Lockheed Martin to investigate active aeroelastic control technologies for flutter suppression and gust-load alleviation of thin, lightweight flexible wings. It was first flown with a stiff wing in July 2013 and in 2014 will fly with one of three sets of flexible wings.

After completing tests for AFRL, the X-56A will be transferred to Dryden to support research on flexible wings for future transport aircraft. By using active control to suppress the flutter of slender, flexible wings, NASA is hoping to achieve a 25 percent reduction in wing structural weight and achieve a 30 to 40 percent increase in aspect ratio to reduce drag.

ED13-0253-106 **NASA/Ken Ulbrich**

The X-56A made a first flight in 2013 at Dryden.

Science

Dryden's Science Mission Directorate provides unique or highly modified aircraft, flight operations for scientific data collection and the development of advanced aeronautical capability to support the NASA Earth Science and Astrophysics programs.

Global Hawk

A Global Hawk traveled to Guam for the first time in January 2014. The Global Hawk was part of the Airborne Tropical Tropopause Experiment, or ATTREX, to study moisture and chemical composition in the upper atmosphere. The multi-year mission is intended to wrap up a flight series by March and fly another set of sorties in the spring. A Global Hawk also flew an ATTREX mission in early 2013 over the Pacific Ocean.

In August 2013, two Global Hawks were deployed to NASA's Wallops Flight Facility in Virginia for the Hurricane and Severe Storm Sentinel mission. This was the first simultaneous deployment of both aircraft and the first use of the new Global Hawk Operations Center East, a permanent control room for the aircraft established at Wallops.

ED13-0184-04 **NASA/Tom Tschida**

Wesley Li performs a test on the Global Hawk aircraft.

DC-8 Flying Laboratory

Key DC-8 maintenance is scheduled to be complete in the spring and then, like summer, work will heat up fast. The DC-8 is expected in May to continue work on the Alternative Fuel Effects on Contrails and Cruise, or ACCESS, project. The DC-8 is set to investigate the effects of the alternative fuel on engine performance, emissions and aircraft-generated contrails.

Two science missions are the focus of the last half of the year. In mid summer the Active Sensing of CO_2 (Carbon Dioxide) Emissions over Nights, Days and Seasons mission will continue a third year of NASA instrument development using the DC-8 as a satellite simulator. These instruments have future application on Earth-observing satellites to measure atmospheric water and carbon dioxide.

In the fall, Operation IceBridge Antarctic begins a fifth year of observations during a planned mission based in Punta Arenas, Chile. Flights over the Antarctic continent will study the annual changes of continental ice sheets and sea ice.

ER-2 Missions

A number of missions are set for 2014 that could have NASA's two ER-2 aircraft flying as many as 350 flight hours.

The ER-2 is expected to fly the Hyperspectral Infrared Imager campaign that will use spectrometers to collect data under cloud-free daylight conditions during the spring, summer and fall of 2014 over six diverse areas of California. The ER-2 assisted with a similar mission in 2013. The spectrometers are mounted in the ER-2 to collect information for the future HyspIRI satellite mission. When

NASA/JSC2013e074515

Tim Williams assists Dean Neeley into the ER-2 cockpit.

launched into low Earth orbit, the satellite mission will study the world's ecosystems and provide critical information on natural disasters.

A deployment to Warner Robins Air Force Base, Ga., is planned in mid 2014 for the Integrated Precipitation and Hydrology Experiment. In early 2014 NASA instruments are launching on a Japanese Rocket as part of the international Global Precipitation Measurement satellite mission. The ER-2 will calibrate measurements taken by the newly orbiting satellite. In addition, NASA will be assisting the National Oceanic and Atmospheric Administration in the validation of measurements collected at their Southeast Hydrometeorology test bed in North Carolina.

Also on the flight manifest is a mission to Alaska with the MABEL laser altimeter. The Multiple Altimeter Beam Experiment Lidar was developed at NASA's Goddard Space Flight Center to simulate a similar instrument planned for NASA's IceSat-2 satellite that is scheduled for launch in 2016.

C-20A and UAVSAR

NASA's C-20A that carries the Uninhabited Aerial Vehicle Synthetic Aperture Radar supported research in Iceland that early this year looked at the dynamics of glaciers. The radar provides a measurement system that complements satellite-based observations by allowing frequent revisits and imaging.

NASA's C-20A – the military designation for the Gulfstream III aircraft – features a high-precision autopilot Dryden engineers designed and developed. The Precision Platform Autopilot guides the aircraft using a kinematic differential Global Positioning System developed by JPL in concert with the aircraft's inertial navigation system to enable it to fly repeat paths to an accuracy of 15 feet or less. With the precision autopilot engaged, the synthetic aperture radar is able to acquire repeat-pass data that can measure land-surface changes within centimeters.

NASA/Troy Asher

NASA's C-20A research aircraft is sprayed with de-icing fluid prior to takeoff on a radar imaging mission over Iceland's glaciers.

SOFIA Airborne Observatory

The SOFIA deployment to New Zealand for three weeks in July 2013 took advantage of the Southern Hemisphere's orientation to study celestial objects that are difficult or impossible to see in the northern sky. Astronomers used SOFIA to observe a disk of gas and dust orbiting the black hole at the center of our galaxy, and two nearby dwarf galaxies, the Large and Small Magellanic Clouds.

It is expected that the SOFIA program will obtain full operational status in 2014, ending the development of the world's largest flying observatory. In fact, the German Field-Imaging Far-Infrared Line Spectrometer is set for check flights aboard the SOFIA flying observatory in early 2014.

Human Exploration and Operations

The Human Exploration and Operations Mission Directorate provides the Agency with leadership and management of NASA space operations related to human exploration in and beyond low-Earth orbit. The directorate also oversees low-level requirements development, policy and programmatic oversight. The International Space Station, currently orbiting the Earth with a crew of six, represents NASA's exploration activities in low-Earth orbit.

Exploration activities beyond low Earth orbit include the management of commercial space transportation, exploration systems development, human space flight capabilities, advanced exploration systems, and space life sciences research and applications. The directorate is similarly responsible for agency leadership and management of NASA space operations related to launch services, space transportation, and space communications in support of human and robotic exploration programs.

Commercial Crew Program

NASA partner Sierra Nevada Corporation of Louisville, Colo., completed tow tests, a captive carry and a first free flight approach and landing test in 2013. The company intends to bring their Dream Chaser engineering test vehicle back to Dryden in 2014 for additional airborne releases from a helicopter.

Space Launch System Development

The Launch Vehicle Adaptive Control experiment used a Dryden F/A-18 aircraft in 2013 to evaluate an Adaptive Augmenting Controller developed by engineers at Marshall Space Flight Center for the agency's Space Launch System rocket.

The system has been designed to autonomously adjust to unexpected environmental or vehicle conditions during actual flight rather than to preflight predictions. The ability to make real-time adjustments to the autopilot provides enhanced performance and increased crew safety.

EC13-0300-03 NASA/Carla Thomas

Sierra Nevada Corporation's Dream Chaser engineering test vehicle is shown suspended from a cable beneath a large helicopter.

Space Technology

The Space Technology Mission Directorate rapidly develops, demonstrates and infuses revolutionary, high-payoff technologies through transparent and collaborative partnerships. The directorate invests in bold, broadly applicable technology, while reducing cost and risk for NASA, other government agencies and commercial space activities that benefit NASA's future missions in space and exploration. Dryden contributes to this effort by managing NASA's Flight Opportunities Program. The program has two primary goals – to provide flight opportunities for maturing new technologies and fostering the emerging commercial space industry.

Flight Opportunities Program

Virgin Galactic is under contract from NASA to carry Flight Opportunities space exploration technology experiments to a space-like environment in 2014.

In addition, there is solicitation for commercial space vendors. Those selected will provide vehicles for Flight Opportunities technology maturation research in 2014 and beyond.

Towed Glider

The Towed Glider Air-Launch Concept could significantly reduce the cost and improve the efficiency of sending satellites into orbit. The idea is to build a relatively inexpensive remotely or optionally piloted glider that will be towed to altitudes approaching 40,000 feet by a small business or commuter jet. The glider will carry a booster rocket capable of launching payloads into low Earth orbit.

Research flights are planned with a 24-foot wingspan, twin fuselage proof-of-concept model of the glider constructed in the Dryden Model Shop. It is towed aloft by one of Dryden's small DROID – Dryden Remotely Operated Integrated Drone – unmanned aircraft.

Hypersonic Inflatable Aerodynamic Decelerator

A giant cone of inner tubes assembled like a child's stacking ring toy may someday help cargo, or even people, land on another planet, return to Earth or any destination with an atmosphere. NASA calls it the Hypersonic Inflatable Aerodynamic Decelerator, or HIAD. The HIAD could provide more options for future planetary missions, because it would allow spacecraft to carry larger, heavier scientific instruments and other tools for exploration.

HIAD test articles continue testing in the Dryden Flight Loads Laboratory. The purpose of these tests is to obtain data to help validate computer models. The testing applies mechanical loads on each section using hydraulic jacks. Engineers continue to evaluate the circular-shaped inflatable test articles of various sizes to characterize the structural properties of the HIAD.

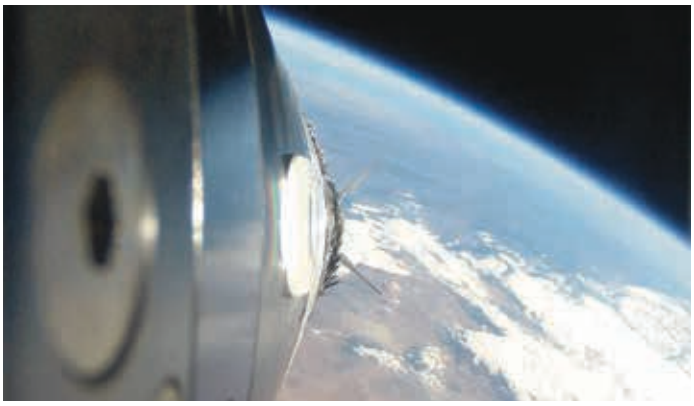
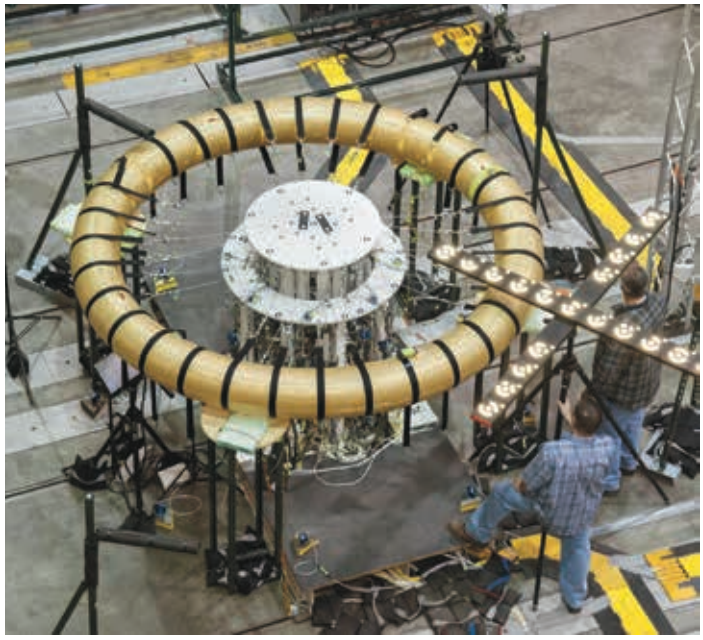


Photo courtesy of UP Aerospace

UP Aerospace's SpaceLoft 8 reaches a space-like environment carrying NASA experiments.

ED14-0014-29 **NASA/Tom Tschida**

NASA's DROID aircraft, bottom left, tows a glider on a risk-reduction flight. The January 2014 flight validated the airborne systems that will be used to control the proof-of-concept twin-fuselage glider.



ED13-0264-174 **NASA/Ken Ulbrich**

Dryden researchers conduct a test on the HIAD.

Economic Impact

Dryden is a big contributor to local economy

NASA has 10 centers across the nation that enable the agency to carry out its mission. Dryden is NASA's premier installation for flight research on current and future aerospace vehicles. Dryden also plays a key role in NASA's development of next-generation access-to-space, reusable launch vehicles from commercial partners and Earth and space science research.

In past years, Dryden has employed hundreds of personnel in achieving the center's mission. In 2013, the center employed 1,145 people, about 550 civil servants and 595 private-sector contractors on or near the site.

A major source of U.S. economic output is generated from the procurements and expenditures made in support of NASA programs, including payroll, operating expenditures and construction totaling about $244.1 million.

Dryden strives to maximize benefits produced by activities conducted at the center while minimizing costs. In addition to technical and social impacts derived through these activities, the total benefit of business Dryden conducts also includes a significant economic boost in the location it operates in and among the community.

In 2013, Dryden's operations resulted in an estimated equivalent dollar value of $81.8 million in jobs created outside of the center, employing an estimated 1,557 individuals.

The combination of Dryden's annual expenditures and the estimated value of the jobs created outside of the center result in a total economic impact of $325.9 million.

Fiscal Year 2013: Indirect jobs created

Total personnel at the center:	1,145
Indirect jobs created *Using 1.36 multiplier	1,557
**Average annual pay for Local community:	$52,536
Estimated annual dollar value of jobs created:	**$81.8M**

(1,557 x $52,536 = $81.8M)

Fiscal Year 2013: Economic impact

■ Annual expenditures	**$244.1M**
■ Estimated value of jobs created	**$81.8M**
■ Grand Total	**$325.9M**

*Multipliers: LMI Economic Impact Database, Installations and Indirect/Induced Job Multipliers, February 1995

**Avg. Annual Pay: Current tables for Average Annual Pay Levels in Metropolitan Areas and Average Annual Pay by State and Industry are accessible at: http://www.bls.gov/cew/home.htm

Front cover

The Stratospheric Observatory for Infrared Astronomy met 100 percent of its science goals on its first deployment to the Southern Hemisphere in 2013. The aircraft was based, as pictured, in Christchurch, New Zealand. The observatory is poised for reaching new milestones in 2014.

ED13-0220-066
NASA/Carla Thomas

ED13-0264-174 **NASA/Ken Ulbrich**

Leo Salazar, from left, and Juan Salazar prepare a modified Gulfstream-III research aircraft for installation of the experimental Adaptive Compliant Trailing Edge flap.

ED12-0143-21 **NASA/Lori Losey**

Probes protrude from NASA's DC-8 flying laboratory on an instrument checkout flight.