NASA Facts

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Perseus B

The Perseus B is a remotely piloted aircraft developed as a design and performance testbed under NASA's Environmental Research Aircraft and Sensor Technology (ERAST) project.

The goal of ERAST is to foster new propulsion, materials, control, instrumentation, and sensor technologies that could enable development of a variety of slow-flying, high-altitude aircraft to carry out long-duration science missions in the upper stratosphere. The missions, flown either autonomously or remotely by a pilot in a ground control station, could include Earth sciences studies, storm tracking, atmospheric sampling, and spectral imaging for agricultural and natural resources monitoring. Such "atmospheric satellite" aircraft also would have potential for commercial use, serving as relay platforms for telecommunications systems.

Perseus B is one of several flight vehicles involved in the ERAST project. It is a piston engine, propeller-powered aircraft designed and built by Aurora Flight Sciences Corp., Manassas, Va. Objectives of the aircraft's ERAST flight tests are to reach and maintain horizontal flight above 60,000 feet and demonstrate the capability to fly missions lasting from 8 to 24 hours, depending on payload and altitude requirements.

The Perseus B established an unofficial altitude record of 60,280 feet for a single-engine, propeller-driven remotely piloted aircraft on its seventh flight on June 27, 1998.
Modifications to the aircraft since its last flight series are being evaluated in a series of operational readiness and test missions being conducted at NASA's Dryden Flight Research Center, Edwards, Calif., in August and September 1999. The modifications include engine, avionics, and flight control system improvements to increase flight endurance and reliability.

In addition to its role in the NASA ERAST project, Aurora Flight Sciences is developing Perseus B to become a future platform aircraft for the type of atmospheric and environmental science missions envisioned in the ERAST project's goals.

Aircraft Description

The Perseus B is a high-wing monoplane with a conventional tail design. Its narrow, straight, high aspect-ratio wing is mounted atop the fuselage. The aircraft is a pusher design with the propeller mounted at the rear, allowing use of an interchangeable payload bay in the Perseus B's forward fuselage for science experiments. This design allows for unobstructed airflow to the sensors and other devices mounted in the payload compartment. Intercooler radiators are mounted on each side of the mid-fuselage and beneath the inner portions of the wings. The Perseus B incorporates a conventional tricycle-type fixed landing gear. The aircraft was designed to meet Federal Aviation Regulations (FAR) Part 23 guidelines for structural strength, and has been limit load tested to three Gs—three times the force of gravity—at maximum gross takeoff weight.

Perseus B is powered by a Rotax 914 horizontally opposed four-cylinder piston engine mounted in the mid-fuselage area. An Aurora-developed three-stage, four-turbine turbocharger provides sea-level air pressure to the engine up to 60,000 feet. A two-blade, variable-pitch propeller mounted at the rear of the fuselage is linked to the engine by a driveshaft.

Perseus B is flown remotely by a pilot from a mobile flight control station on the ground. A Global Positioning System (GPS) unit provides way-point navigation data for continuous and precise location during flight. The ground control station features dual independent consoles for aircraft control and systems monitoring. The system includes dual independent telemetry uplinks and downlinks. Dish antennas are mounted atop the control station vehicle on a boom that is directionally controlled by GPS location information generated on the aircraft. The mobile unit includes a host of displays on which aircraft and systems performance are continually monitored during flight. The same telemetry and video imaging monitored in the mobile ground station is also viewed by NASA and Aurora Flight Sciences personnel in the Dryden Mission Control Center.

A flight termination system, required on remotely piloted aircraft being flown in military restricted airspace, includes a parachute system deployed on command, plus a C-Band radar beacon and a Mode-C transponder to aid in location.

Perseus B Development

The Perseus B now undergoing test and development is the third generation of the Perseus design which began with the Perseus Proof-Of-Concept aircraft. Perseus was initially developed as part of NASA's Small High-Altitude Science Aircraft (SHASA) program, which later evolved into the ERAST project. The Perseus Proof-Of-Concept aircraft first flew in November 1991 and made three low-altitude flights within a month to validate the Perseus aerodynamic model and flight control systems.

Next came the redesigned Perseus A, which incorporated a closed-cycle combustion system that mixed oxygen carried aboard the aircraft with engine exhaust to compensate for the thin air at high altitudes. The Perseus A was towed into the air by a ground vehicle and its engine started after it became airborne. Prior to landing, the engine was stopped, the propeller locked in horizontal position, and the Perseus A glided to a landing on its unique bicycle-type landing gear. Two Perseus A aircraft were built, and made 21 flights in 1993-1994. One of the Perseus A aircraft reached over 50,000 feet on its third test flight. Although one of the Perseus A aircraft was destroyed in a crash after a vertical gyroscope failed in flight, the other aircraft completed its test program and remains on display at Aurora's facility in Manassas.

The present Perseus B aircraft utilizes a more conventional powerplant coupled to a powerful three-stage, four-turbine turbocharger to furnish the equivalent of sea-level air at high altitudes. It first flew Oct. 7, 1994, and made two flights in 1996 before being damaged in a hard landing on the dry lakebed after a propeller shaft failure. After a number of improvements and upgrades—including extending the original 58.5-foot wingspan to

71.5 feet to enhance high-altitude performance—the Perseus B returned to Dryden in the spring of 1998 for a series of four flights. Those flights culminated with a flight on June 27 to an altitude of 60,280 feet, establishing an unofficial altitude record for a single-engine, propeller-driven remotely piloted aircraft.

Recent Upgrades

Modifications to the prototype aircraft and its systems since its last development flight series in 1998 are expected to allow mission durations of up to 8 hours on future flights, as well as improve the overall reliability of the aircraft and its systems.

The latest modifications include external fuel pods on the wing that more than double the fuel capacity to 100 gallons. Engine power has been increased by more than 20 percent by boosting the turbocharger output, and is now flat-rated at 105 horsepower to 60,000 feet. Fuel consumption has been reduced with fuel control modifications and a leaner fuel-air mixture that does not compromise power. The propulsion changes have been tested in Aurora Flight Sciences' altitude chamber to simulated heights of 66,000 feet. This boost in engine performance is expected to give the aircraft better all-around operational capabilities, including a greater payload and better mission endurance at higher altitudes.

Improvements in the aircraft's avionics suite include a second GPS unit, a ring laser gyro to replace a mechanical unit, and installation of a longer-life emergency battery.

The aircraft's rudder has been modified by splitting it in two and installing an additional servo motor. Combined with a split elevator and independent ailerons, this gives the primary flight control system full redundancy for flight safety. The flight control software has also been modified to incorporate fault-tolerant control capability, giving the system automatic detection and compensation for any flight sensor or actuator failure.

The aircraft's air data instrumentation system has been supplemented with the installation of a second pitot tube. The new unit is a heated five-hole probe to insure accurate speed, pitch, and angle-of-attack measurements when the aircraft is at high altitudes.

Instrumentation installed on the aircraft for initial development flights has been removed or incorporated into the flight data system to free-up payload space for future mission use. Standard aircraft running lights have been installed so the aircraft can be safely flown at night.

Current Test and Readiness Missions

Aurora's Perseus B test and development team planned three missions for the aircraft during August and September 1999 to demonstrate its altitude, performance, and payload capabilities. The number of flights to achieve the three mission goals is expected to be from three to five. The operational readiness flight demonstrations are jointly sponsored and funded by ERAST and NASA's Office of Earth Science at NASA Headquarters, Washington, D.C.

The first mission is a functional check flight (FCF) with a goal of reaching an altitude of 30,000 feet in about two hours. The purpose of the FCF is to evaluate all aircraft, control, and navigation systems in a safe operational flight environment before proceeding with more demanding flights. If the FCF reveals that a system or subsystem needs to be modified or replaced, a second FCF can be scheduled.

The second mission for the aircraft is to achieve its maximum design altitude in its present configuration, believed to be about 62,000 ft. The flight is expected to take about 5 hours to complete.

The third and final mission for Perseus B in the current series will be focused on endurance. The goal is to climb to 60,000 feet in a stair-step fashion while carrying a maximum payload weight, and to remain above 55,000 feet for at least four hours of the projected eight-hour flight. In addition, project planners hope to expand the range the aircraft can be flown from the ground control station from 20 to 60 nautical miles.

The NASA Dryden Connection

All Perseus B development flights have been conducted at the NASA Dryden Flight Research Center. A NASA project manager is assigned as coordinator and liaison for all Perseus B activities such as flight operations and scheduling, flight safety, and the use of NASA facilities by test and development personnel from Aurora Flight Sciences.

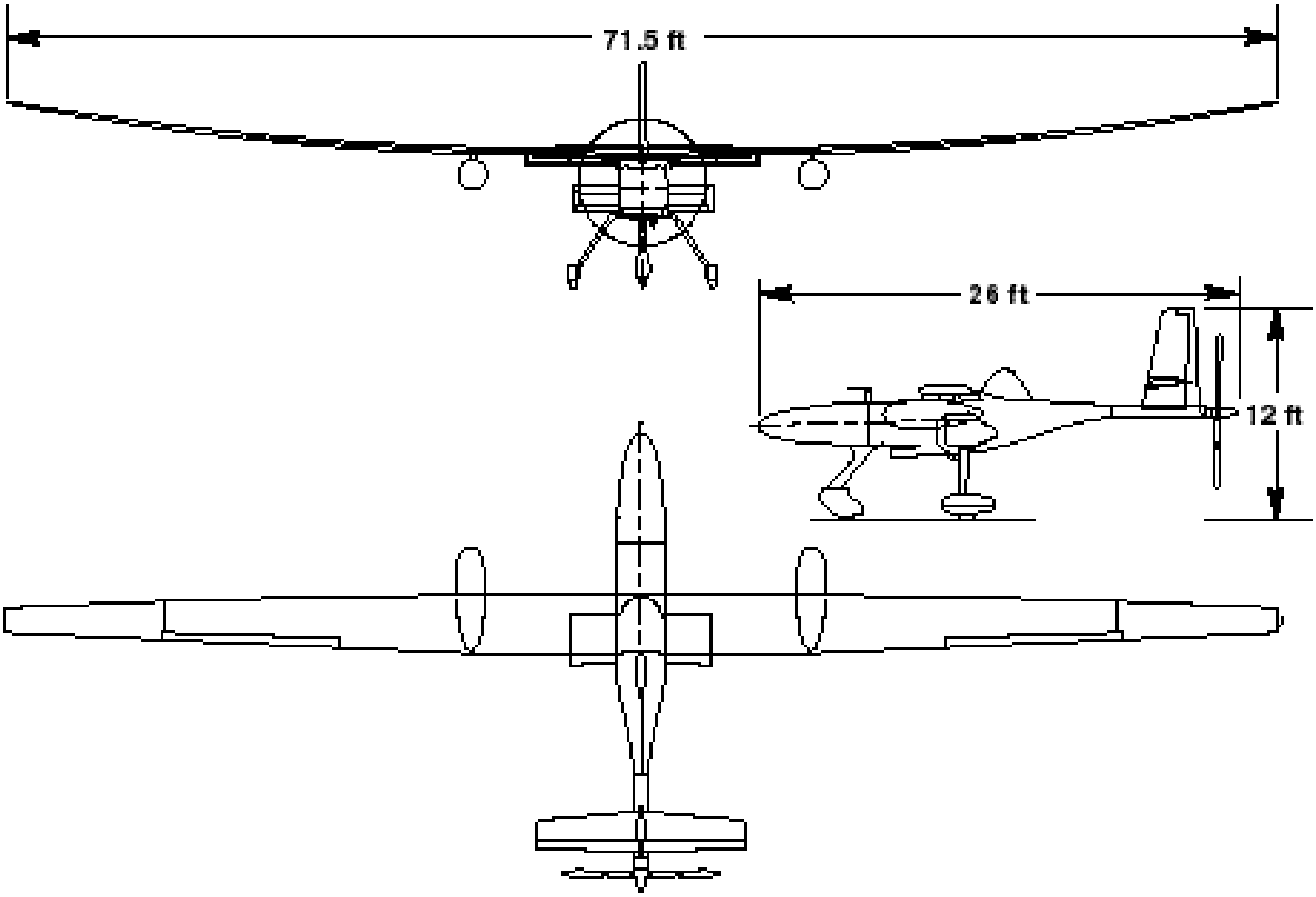
Dryden provides hangar and office space for the Perseus B aircraft and flight test and development team. During flight operations, the Dryden Mission Control Center is staffed by NASA and Aurora Flight Sciences personnel who continuously monitor the performance of the aircraft and its individual systems until the mission has ended.

The ERAST Project

NASA's ERAST project is developing aeronautical technologies for a new generation of remotely piloted and autonomous aircraft for a variety of upper-atmospheric science missions and commercial applications. ERAST management and operations are centered at NASA Dryden Flight Research Center. A parallel effort at NASA's Ames Research Center, Moffett Field, Calif., is focused on the development of lightweight, microminiaturized sensors that will be used to carry out the environmental research.

Flying at slow speeds for long periods of time at altitudes of up to 100,000 feet, the post-ERAST vehicles could be used to gather, identify, and monitor environmental data to assess global climate changes, monitor Earth resources, and serve as telecommunications platforms at a fraction of the cost of placing satellites into space.

Also contributing to the ERAST project in the areas of propulsion, energy storage systems, structures and systems analysis are NASA's Glenn Research Center, Cleveland, Ohio, and Langley Research Center, Hampton, Va. NASA is also working closely with the Federal Aviation Administration to develop operational plans so the remotely operated aircraft can be safely flown in national airspace.



Aircraft Specifications

- **Wingspan:** 71.5 ft (21.5 m)
- **Wing area:** 194 ft^2
- **Wing aspect ratio:** About 26 to 1
- **Length:** 25 ft (7.6 m)
- **Height:** 12 ft (3.6 m)
- **Gross weight:** Approx. 2,200 lb (990 kg) with full internal fuel; approx. 2,500 lb with additional external wing-mounted fuel tanks.
- **Payload:** Up to 260 lb of sensors and instruments in nose compartment; typical payload approx 175 lb.
- **Propulsion:** Rotax 914 four-cylinder piston engine mounted in the mid-fuselage integrated with an Aurora-designed three-stage turbocharger, driving a tail-mounted lightweight two-blade pusher propeller via an eight-foot driveshaft. Engine is flat-rated at 105 hp to 60,000 ft altitude.
- **Fuel capacity:** 100 gal, including 40 gal internal and 60 gal in underwing auxiliary tanks, standard aviation gasoline.
- **Airspeed:** Approx. 60 mi/h. (52 kn) cruise, 79 mi/h (69 kn) never-exceed speed.
- **Maximum altitude:** Approximately 62,000 ft (18.9 km).
- **Endurance:** Prototype: approx. 18 hrs at 16,000 ft, 7.5 hrs at 50,000 ft, 1 hr at 60,000 ft. Production: Approx. 24 hrs at 62,000 ft.
- **Range:** Approx. 1,600 miles point-to-point (production version); radius from ground station approximately 60 miles line-of-sight communications limit.
- **Flight controls:** The aircraft has standard three-axis flight control surfaces—elevators, rudder and ailerons—for pitch, yaw, and roll motions.
- **Materials:** Perseus B is constructed primarily of composite materials such as fiberglass, graphite epoxy, Nomex honeycomb, and Kevlar. The fuselage frame is welded tubular steel.
- **Manufacturer**: Aurora Flight Sciences Corp., Manassas, Va.

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