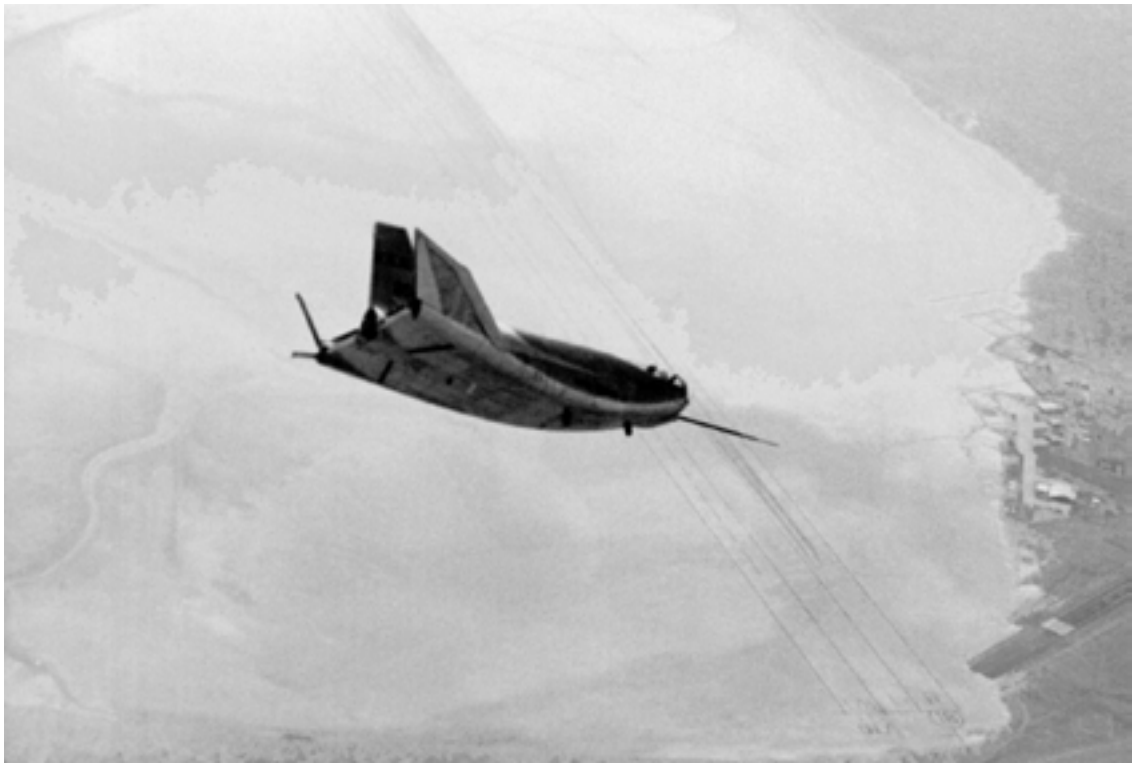
NASAfacts

HL-10 Lifting Body



The HL-10 lifting body is seen in 1969 over Rogers Dry Lake, California. (NASA Photo)

The HL-10 was one of five aircraft built in the Lifting Body Research Program. It was a NASA design and was built to evaluate an inverted airfoil lifting body with a delta planform. The HL-10 was flown 37 times during the program and logged the highest altitude and fastest speed.

The other lifting body designs were the M2-F2, M2-F3 (rebuilt M2-F2 following a landing accident), X-24A and X-24B (the rebuilt X-24A with a different aerodynamic shape).

Wingless lifting bodies attained aerodynamic stability and lift from the shape of the vehicle. Lift resulted from more air pressure on the bottom of the body than on the top. Energy and aerodynamic lift are used for in-flight maneuvering and a powerless, glider-like landing.

Background

The idea of lifting bodies was conceived in 1957 by Dr. Alfred J. Eggers Jr., then the assistant director for Research and Development Analysis and Planning at the National Advisory Committee for Aeronautics (NACA) Ames Aeronautical Laboratory (now NASA Ames Research Center) at Moffett Field, California.

The NASA Flight Research Center (now NASA Armstrong Flight Research Center), located at Edwards Air Force Base in California, was where the lifting body concept was originally tested with a plywood prototype built in late 1962 and designated the M2-F1. It featured a plywood shell, built by William "Gus" Briegleb who was a sailplane builder from Mirage Dry Lake in California, placed over a tubular frame built at the Flight Research Center. The M2-F1 was towed aloft, first behind a modified 1963 Pontiac Catalina convertible and then a C-47 aircraft, more than 100 times to validate basic lifting body stability and control characteristics. This led to establishment of the formal program that resulted in the HL-10 and its sister vehicles.

The contract for construction of the HL-10 and the M2-F2, first of the fleet of lifting bodies flown

HL-10 is shown on Rogers Dry Lake in 1966 with its subsonic control surface configuration. (NASA Photo)

at the Flight Research Center, was awarded to Northrop Corporation in June 1964. "HL" stands for horizontal landing and "10" refers to the tenth design studied by engineers at NASA Langley Research Center in Hampton, Virginia.

The HL-10 was delivered to NASA in January 1966. During the next 10 months it was instrumented and prepared for flight. The HL-10 and the M2-F2 were tested in wind tunnels at Ames before research flights began. First flight of the HL-10 was on Dec. 22, 1966, with research pilot Bruce Peterson in the cockpit. Although an XLR-11 rocket engine was installed in the vehicle, the first 11-drop flights from the B-52 launch aircraft were powerless glide flights to assess handling qualities, stability and control.

On Feb. 18, 1970, Air Force test pilot Peter Hoag piloted the HL-10 to Mach 1.86 (1,228 mph). Nine days later, NASA pilot William H. "Bill" Dana flew the vehicle to 90,030 feet, the highest altitude reached in the program.

Typical Flight Profile

During a typical lifting body flight, the B-52 flew to a height of about 45,000 feet and a launch speed of about 450 mph. The research vehicle was attached to the pylon mount on the right wing between the fuselage and inboard engine pod. Moments after being dropped, the XLR-11 rocket engine (same type engine used in the Bell X-l) was ignited by the pilot. Speed and altitude increased until the engine was shut down by choice or fuel exhaustion, depending on the individual mission profile. The lifting bodies normally carried enough fuel for about 100 seconds of powered flight and routinely reached altitudes of 50,000 to 80,000 feet and speeds above Mach 1.

Following engine shutdown, the pilot maneuvered the vehicle through a simulated return-from-space corridor into a preplanned approach for a landing on one of the Rogers Dry Lake runways at Edwards Air Force Base. A circular approach was used to lose altitude during the landing phase. On final approach, the pilot increased his rate of descent to build up energy. At about 100 feet altitude, a "flare out" maneuver dropped air speed to about 200 mph for the landing.

The HL-10 helped develop energy management and landing techniques used presently with the space shuttle orbiters. The lifting body is on display at the entrance to NASA Armstrong Flight Research Center.

Specifications

- Dimensions: Length, 22 feet, 2 inches; width, 15 feet, 7 inches; height, 11 feet, 5 inches; minimum weight, 5,265 pounds; maximum weight, 9,000 pounds (with water ballast tanks full).
- Controls: Elevons between vertical and center fins for pitch and roll control. Split rudder on center fin for yaw and speed control. All surfaces used in three-axis stabilizer-augmenter system.
- Power: One XLR-11 four-chamber rocket engine fueled by ethyl alcohol and liquid oxygen, producing maximum of 6,000 pounds of thrust; built by Reaction Motors Inc.
- Auxiliary Power: Silver zinc batteries provided electrical power for the control system, flight instruments, radios, cockpit heat and stability augmentation system. To assist in pre-landing flare, four throttleable hydrogen peroxide rockets provided up to 400 pounds of thrust.
- Landing Gear: Main gear was a modified T-38 system that retracted manually and lowered by nitrogen pressure. Nose gear was a modified T-39 nose gear that retracted manually and lowered with nitrogen pressure.
- Pilot Ejection System: Modified F-106 system.

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