

Hybrid Air Vehicles (HAV) / Northrop Grumman HAV-304 (LEMV)

Peter Lobner, 1 May 2019

Background

Hybrid Air Vehicles (HAV) was formed in the UK in 2007 after acquiring the rights to airship technologies developed by its predecessor, SkyCat Group Ltd., and earlier predecessors dating back to 1971. The HAV website is here:

<https://www.hybridairvehicles.com/about-us>

The HAV-3 demonstrator

In 2008, HAV built and flew the small, unmanned HAV-3 hybrid airship demonstrator. The 50 foot (15 meter) long HAV-3 flew from 2008 to 2010 and served to validate the design that would be used on the much larger HAV-304, which was proposed by the team of Northrop Grumman and HAV for the U.S. Army's Long Endurance Multi-Intelligence Vehicle (LEMV) program.



HAV-3 demonstrator in flight. Source: HAV photo via Aviation Week & Space Technology magazine, 5 July 2010

The HAV-304 (LEMV) prototype airship

In 2010, the Northrop Grumman / HAV team was awarded the LEMV contract to deploy a large, optionally manned airship capable of flying surveillance missions of up to three weeks duration, carrying a one metric ton (1,000 kg, 2,204 lb) payload at 20,000 feet (6,100 m) in uncontested airspace in conflict zones; initially in Afghanistan. An illustration showing the HAV-304 configured for the LEMV mission is shown in the following diagram.



LEMV airship mission concept, serving as a surveillance and communications hub. Source: US Army / Northrop Grumman

The HAV-304 measured 302 feet (92 m) long and 143 feet (43.5 m) wide at its wingtips. Maximum speed was 80 knots (148 kph) and maximum altitude was 16,000 feet (4,880 m). The gas envelope volume was 1,340,000 cubic feet (38,000 cubic meters). The envelope was slightly pressurized to about 0.15 psid to maintain its aerodynamic shape. Even with this low pressure differential, the inflated envelope was stiff enough for a person to walk on the top. The gas volume within the envelope was segregated into six main compartments, each of which could be individually isolated in the event of a leak.

HAV describes the airship's construction as follows:

“There is no internal structure it maintains its shape due to the pressure stabilization of the helium inside the hull, and the smart and strong Vectran material it is made of. Carbon composites are used throughout the aircraft for strength and weight savings.”

A 149 foot (45.4 meter) long rigid structure running under the gas envelope supports the optionally-manned cockpit, flight control and mission systems, cargo and fuel. Weight from this rigid structure is carried by cables into a central diaphragm inside the gas envelope, between the two main lobes. From the diaphragm, the loads are distributed out along the entire top surface of the airship.

As a hybrid airship, the HAV-304 generated only part of its lift from helium, nominally 60 – 80%. The balance of the lift is generated by vectored-thrust propulsors and by aerodynamic lift from the shaped gas envelope, which acts as a lifting body when the airship has forward speed.

This hybrid airship is negatively buoyant and cannot hover or make a vertical takeoff or landing. The HAV-304 takes off and lands on inflatable skids and requires a short takeoff and landing (STOL) run of less than 1,000 feet (305 m). For the LEMV mission, the airship would transit at a maximum speed of 80 knots, and loiter in its designated operating area at 30 knots. Airship trim is controlled much like in a conventional blimp, using multiple ballonets located fore and aft in each side of the hull.

The HAV-304's first and only flight for the Army occurred on 7 August 2012, when it made a 90 minute flight at Joint Base McGuire-Dix-Lakehurst in New Jersey, about 16 months behind its original schedule. Operations were terminated when the \$517 million LEMV contract was cancelled in February 2013: "Due to technical and performance challenges, and the limitations imposed by constrained resources, the Army has determined to discontinue the LEMV development effort."



HAV-304 in flight. Source: Northrop Grumman

Hybrid Air Vehicles bought the airship back from the Army in October 2013 for \$301,000 and agreed to give the Army access to data from future civilian flights. After removing LEMV mission-related hardware, HAV returned the HAV-304 airship to the UK to continue developing this airship as the Airlander 10 prototype.