AT^2 Aerospace – Non-rigid hybrid airships

Peter Lobner, 17 September 2024

1. Introduction

On 9 May 2023, Lockheed Martin announced that its hybrid airship business, including intellectual property and related assets, had been transitioned to a newly formed, privately-owned, commercial company called AT^2 Aerospace. The Lockheed Martin press release reported, "AT^2 Aerospace, based in Santa Clarita, California, is extending our work to bring hybrid airships to fruition. The AT^2 team is developing airship solutions to support commercial and humanitarian applications around the world. Dr. Robert Boyd, retired Lockheed Martin Hybrid Airship program manager, is president and chief operating officer of AT^2 Aerospace." Grant Cool, formerly COO of Hybrid Enterprises, is the AT^2 Aerospace chief executive officer.

The AT^2 website is here: www.at2aero.space

2. Background on Lockheed Martin's hybrid airship program

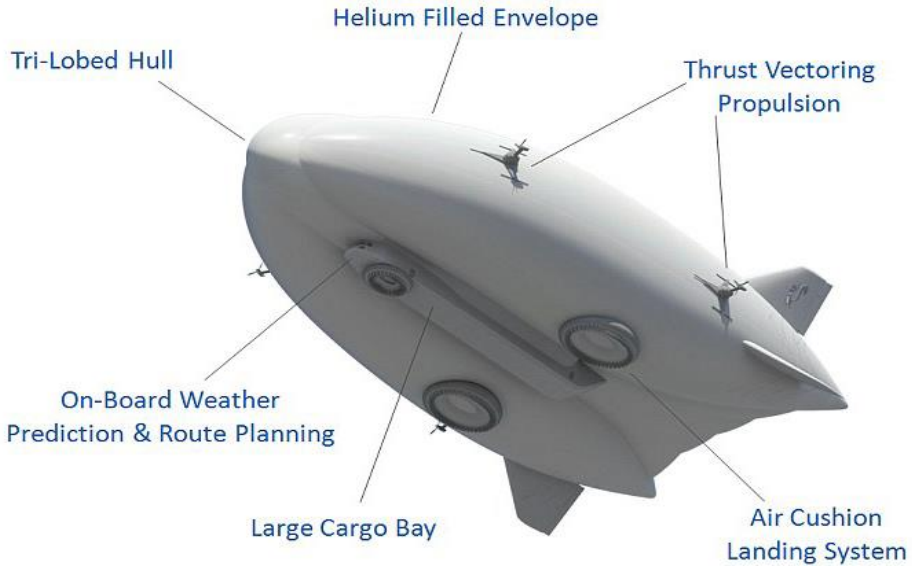
Building on Lockheed's rigid and semi-rigid hybrid airship design work since the early 1980s, Lockheed Martin continued developing design concepts for semi-buoyant hybrid airships with lifting body hulls after the two firms merged in 1995. That work became focused in Lockheed Martin's Advanced Development Programs (the Skunk Works) in Palmdale, CA, and produced an extensive series of patents related to large, hybrid airship design.

By the 2000s, Lockheed Martin's focus shifted to non-rigid hybrid airships, leading to the development of the 36.6-meter (120-foot) P-791 non-rigid technology demonstrator. This hybrid airship was developed primarily with Lockheed Martin internal funding to serve as a sub-scale demonstrator to validate technologies for use in full-scale hybrid airships. The P-791 also received funding under Phase 1 of the Defense Advanced Research Projects Agency's (DARPA's) Project WALRUS. It first flew in January 2006 in Palmdale, CA. After

a brief six-flight test program, Lockheed Martin and DARPA reported that all test objectives had been met. The P-791 is addressed in more detail in a separate article.

Lockheed Martin P-791 non-rigid hybrid airship technology demonstrator. Source: Lockheed Martin (2006)

In March 2011, Lockheed Martin announced that it planned to develop a larger commercial version of the P-791, to be called SkyTug, which would be a designed to carry at least 20 tons (18.1 metric tons) of cargo. A trademark application for the term “SkyTug” was filed on 25 August 2011. Two years later, in 2013, Lockheed Martin re-branded this hybrid airship design as the LMH-1.



General arrangement of the LMH-1 hybrid airship. Source: Lockheed Martin

Rendering of an LMH-1, bow quarter view.
Source: Lockheed Martin via BBC (November 2019)

On March 12, 2012 the U.S. Federal Aviation Administration (FAA) announced that Lockheed Martin Aeronautics submitted an application for type certification for the model LMZ1M (LMH-1), which is "a manned cargo lifting hybrid airship incorporating a number of advanced features." The FAA assigned docket number FAA-2013-0550 to that application.

To address the gap in airship regulations head-on, Lockheed Martin submitted to the FAA their recommended criteria document, "Hybrid Certification Criteria (HCC) for Transport Category Hybrid Airships," which is a 206 page document developed specifically for the LMZ1M (LMH-1). The HCC is also known as Lockheed Martin Aeronautics Company Document Number 1008D0122, Rev. C, dated 31 January 2013. You can download the HCC document and related public docketed items from the FAA website here: https://www.regulations.gov/docket/FAA-2013-0550/document

In November 2015, the FAA's Seattle Aircraft Certification Office approved Lockheed's project-specific certification plan for the LMZ1M (LMH-1). In a 17 November 2015 press release, Lockheed Martin announced:

> "Given that Hybrid Airships did not fit within existing FAA regulations, the team worked to create a new set of criteria

> allowing non-rigid hybrid airships to safely operate in a commercial capacity. Transport Canada was also involved in the development of this criteria to ensure it included safety concerns unique to Canada."
>
> "Lockheed Martin and the FAA have been working together for more than a decade to define the criteria to certify Hybrid Airships for the Transport Category. This criteria was approved by the FAA in April 2013. Following that approval, the team has been developing the project specific certification plan over the past two years, which details how it will accomplish everything outlined in the Hybrid Certification Criteria."
>
> "Earlier this year (2015) Lockheed Martin along with Hybrid Enterprises LLC kicked off sales for the 20 ton variety of the Hybrid Airship. They are on track to deliver operational airships as early as 2018."

No new documentation was subsequently added to the FAA's public webpage for docket FAA-2013-0550 that provides details of the certification dialog between the FAA and Lockheed Martin or the status of the type certification effort.

In September 2017, Lockheed Martin reported it had Letters of Intent (LOIs) for 24 LMH-1 hybrid airships. Their two customers were UK-based Straightline Aviation with a March 2016 LOI for 12 LMH-1s (https://www.straightlineaviation.com), and Paris-based Hybrid Air Freighters (HAF) with a June 2017 LOI for up to 12 LMH-1s (http://www.hybridairfreighters.com).

In 2017, Lockheed Martin announced that the first "float out" of the LMH-1 had slipped to 2019. No "float-out" ever occurred, and in July 2022 it was reported that Lockheed Martin was no longer actively marketing its LMH-1, after investing more than $150 million in developing this hybrid airship technology.

On 9 May 2023, Lockheed Martin reported, "For some time, we have been in search of a transition partner to continue development of this important commercial work." That "transition partner" is the newly formed, commercial company AT^2 Aerospace.

3. The AT^2 Aerospace Z1 hybrid airship

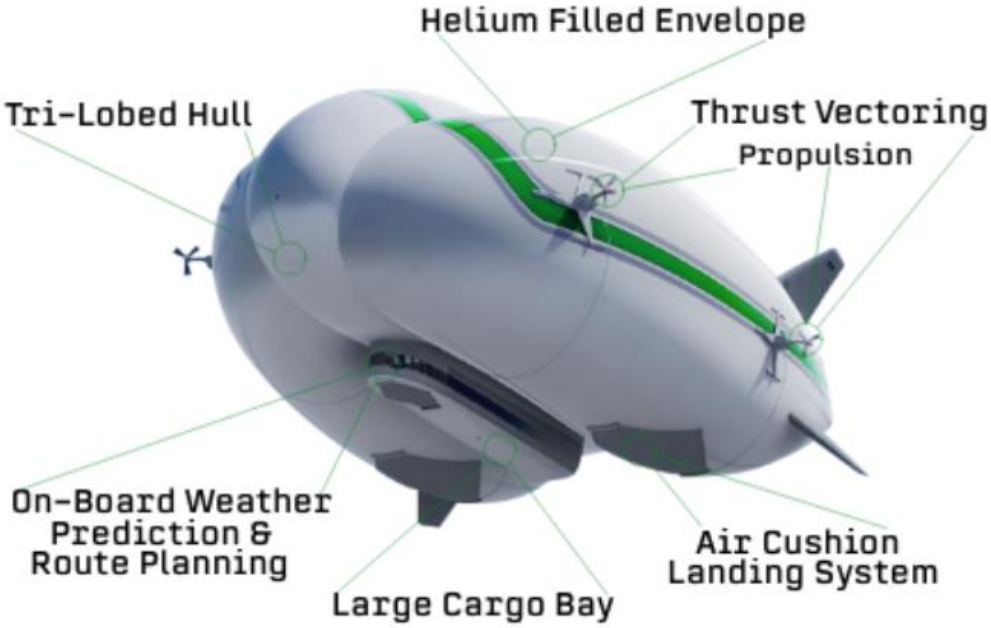
As portrayed on the AT^2 Aerospace website, their Z1 hybrid airship is the current incarnation of the former Lockheed Martin LMH-1. AT^2 Aerospace summarizes the main attributes of their Z1 hybrid airship as follows:

> "AT^2 Aerospace's revolutionary hybrid airship is the future of aviation technology. Capable of operating in the most remote and inaccessible locations, this innovative aircraft offers a cost-effective solution for heavy cargo transportation while minimizing environmental and social impact."
>
> - "The Z1's unique Air Cushion Landing System (ACLS) allows the Z1 to land and takeoff from almost any location on the planet.
> - The Z1 utilizes buoyant lift technology delivering exceptional fuel efficiency, minimizing carbon emissions, and ultimately reducing transportation costs.
> - The Z1 will connect emerging economies to global trade networks.
> - The Z1 moves cargo faster than sea and land transportation at a fraction of the cost of existing cargo aircraft, filling a major gap in the global transportation market from a speed vs. cost perspective."

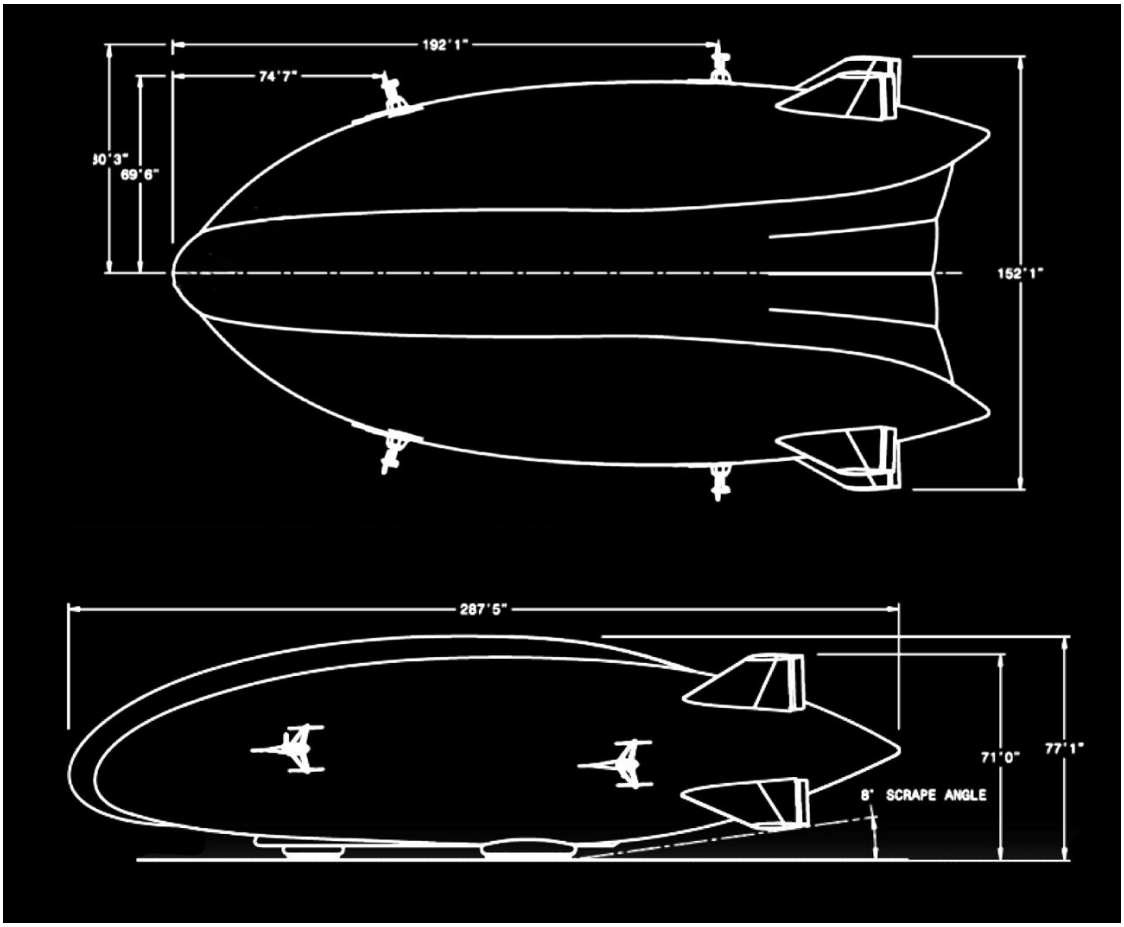
AT^2 Aerospace also identified the following attributes of their hybrid airship:

- Simple controls minimize human error
- Large volume cargo bays, larger payloads
- Safer in icing effects
- Quiet; ideal for operating in noise sensitive locations

AT^2 Aerospace expects that their Z1 hybrid airship will "open the entire world to commerce, humanitarian aid and exploration with affordable and reliable operations."



General arrangement of the Z1 hybrid airship. Source: AT² Aerospace (2023)



Z1 hybrid airship plan and elevation views. Source: AT² Aerospace (2024)

General characteristics of the AT^2 Aerospace Z1 hybrid airship

Parameter	Z1
Length, overall	287 ft (87.5 m)
Width, max.	152 ft (46.3 m)
Height, max.	77 ft (23.5 m)
Envelope type	Tri-lobe, pressure stabilized
Volume	Est. 1,285,000 ft^3 (36,387 m^3)
Lifting gas	Helium
Power source	• Near term: diesel generators • Future: zero-emission hydrogen fuel cells
Aerodynamic controls	Widely-spaced, X-configured tail fins on the outer lobes of the gas envelope with "ruddervator" control surfaces.
Propulsion and low-speed maneuvering	• 4 x flank-mounted, thrust vectoring, electric motor-driven, (likely variable pitch) propellers attached to the gas envelope with load distribution mountings. • Propellers can vector through 120° to provide cruise propulsion and maneuverability at low speeds and in hover when the aerodynamic controls surfaces lose their effectiveness.
Speed, cruise	Est. 60 knots (69 mph, 111 kph)
Payload, max.	Up to 23.5 tons (47,000 lb, 21 metric tons)
Flight crew	2 cockpit crew
Passenger accommodations	Seating for up to 19 passengers in a compartment behind the cockpit and forward of the equipment and cargo bays.
Payload accommodations	Internal cargo bay with aft loading door / ramp
Takeoff / landing modes	• Short takeoff and landing (STOL) with full load • Vertical takeoff and landing (VTOL) possible in certain lightly-loaded conditions
Operating site characteristics	Air Cushion Landing System (ACLS) enables operation on paved surfaces, unimproved fields, sand, ice, snow and water.
Range	1,400 nautical miles (2,593 km), at unspecified cruise speed and payload.

4. FAA / Transport Canada type certification

The near-term challenges for AT^2 Aerospace start with getting clarity from the FAA and Transport Canada on the actions remaining, and the approximate time scale, to conclude the first-ever type certification process for a hybrid airship in the U.S. and Canada. In parallel, AT^2 Aerospace also has the challenge of raising the funding

needed to support the FAA / Transport Canada certification effort and prepare for series production of the Z1 hybrid airship.

5. Orders for AT^2 Aerospace's Z1 hybrid airship

On 6 June 2023, Straightline Aviation Ltd announced that it had signed a Letter of Intent (LOI) to purchase three hybrid airships from AT^2 Aerospace, with options on a further 12 airships to be delivered in the first three years of production. Straightline Aviation will act as lead customer of the Z1 airship and expects to take delivery of the first airship in 2026.

In addition, AT^2 Aerospace agreed to work with Straightline in delivering a hybrid airship for a planned Round-the-World (RTW) non-stop, un-refueled, net zero emissions flight. Preliminary flight plans are described here: https://www.straightlineaviation.com/round-the-world

6. Manufacturing plans and facilities

In October 2023, *Aviation Week* reported on manufacturing plans described by AT^2 Aerospace's Chief Revenue Officer Philip Burns-O'Brien:

> "We have solidified all of the supply chain agreements that were with Lockheed but are now with us," Burns-O'Brien says. AT² plans to build its airships in Elizabeth City, North Carolina, with aerostat manufacturer TCOM to be responsible for assembling the envelope and integrating the aircraft. Knight AeroSpace is responsible for the crew and cargo gondola, its systems and interfaces."

TCOM's Elizabeth City, NC, facilities include Airdock #1 on the site of the former Weeksville Naval Air Station blimp base. Airdock #1, which was built in 1941 and purchased by TCOM in 1996, is 960 ft (292.6 m) long with a steel framework and corrugated metal skin.

Located in San Antonio, TX, Knight Aerospace is well known for design, manufacture and customization of modules and pallets for military cargo aircraft.

TCOM Airdock #1, Elizabeth City, NC. Source: Wikipedia

7. Future development plans

With a type certificate in hand, perhaps as early as 2026, the Z1 can be put to the test by a few early-adopters in what hopefully will become an emerging worldwide commercial airship market.

In October 2023, *Aviation Week* reported on AT^2 Aerospace's future development plans:

- The 100-ton-payload Z2 is planned to follow Z1 by 2029 - 30. It will incorporate a hydrogen fuel cell to enable zero-emission operation. A fuel cell power system then will be retrofitted to the Z1.
- The 500-ton-payload Z3 is targeted for the mid-2030s.

8. For more information

- "Hybrid Airship Enters The Transfer Portal," Lockheed Martin press release, 9 May 2023: https://news.lockheedmartin.com/2023-05-09-Hybrid-Airship-Enters-the-Transfer-Portal
- "Lockheed Martin Forms New Company Around Hybrid Airship Efforts," Manufacturing Net, 10 May 2023: https://www.manufacturing.net/aerospace/news/22861518/lockheed-martin-forms-new-company-around-hybrid-airship-efforts

- "AT2 Aerospace Chooses Santa Clarita for Headquarters," SCVNews, 17 May 2023: https://scvnews.com/at2-aerospace-chooses-santa-clarita-for-headquarters/
- "Move Toward Green Aviation Takes Off," Straightline Aviation Ltd. via Newswires, 6 June 2023: https://www.einnews.com/pr_news/637947234/move-toward-green-aviation-takes-off
- "ZAK Wins AT² Business To Launch Airships," Campaign Canada, 13 September 2023: https://www.campaigncanada.ca/article/1856031/zak-wins-at2-business-launch-airships
- Graham Warwick, "Lockheed Martin Passes Destiny Of Its Hybrid Airship To Startup AT²," Aviation Week, 25 October 2023 (subscription required): https://aviationweek.com/aerospace/aircraft-propulsion/lockheed-martin-passes-destiny-its-hybrid-airship-startup-at2
- Grant Cool, "How Hybrid Airships Can Help Mining Companies Reduce Greenhouse Gas Emissions," AT² Aerospace: https://www.at2aero.space/news/avnxr6t8jf36y0tb5804t2dasw9we8

Other *Modern Airships* articles

- *Modern Airships - Part 1*: https://lynceans.org/all-posts/modern-airships-part-1/
  - Hybrid Air Vehicles (HAV) - Airlander 10 prototype
  - Hybrid Air Vehicles (HAV) - Airlander 10 & 50
  - Lockheed Martin - Rigid hybrid airships
  - Lockheed Martin - Aerocraft semi-rigid hybrid airship
  - Lockheed Martin - P-791 non-rigid hybrid airship
  - Lockheed Martin - SkyTug & LMH-1 non-rigid hybrid airships
  - DARPA Project WALRUS
- *Modern Airships - Part 2*: https://lynceans.org/all-posts/modern-airships-part-2/
- *Modern Airships - Part 3*: https://lynceans.org/all-posts/modern-airships-part-3/