Aerovehicles, Inc. (AVI) – Aerocat & AV-10

Peter Lobner, updated 11 February 2022

1. Introduction

Aerovehicles Inc. (AVI) is a multi-national firm that offers a range of aviation-related products and services. Their products include light, fixed-wing intelligence, surveillance and reconnaissance (ISR) aircraft and aerostats and multi-mission airships. Their services are focused on remote sensing applications (LIDAR, geomagnetic mapping, multi- and hyper-spectral imaging, infrared imaging, and synthetic aperture radar imaging) and related systems integration services.

AVI was incorporated in California in 2002. It is the parent company of all associated Aerovehicles offices. The AVI corporate charter is for the design, production, and operation of lighter-than-air (LTA) and fixed wing aircraft and systems.

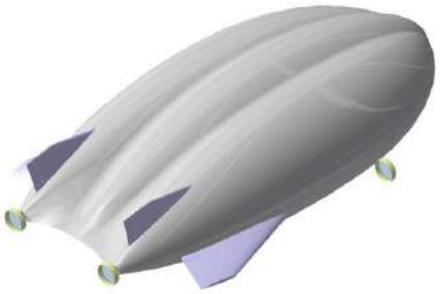
In 2014, AVI registered Aerovehicles Inc. Sucursal Extranjera in San Luis, Argentina, offering airborne mapping services, aircraft and airship sales and leasing operations within Argentina. The Aerovehicles Paraguay S.A. office opened in 2019 with medium-altitude long-endurance (MALE) drone manufacturing and product support to be located in Asuncion, Paraguay. In December 2021, AVI's newest addition, Aerovehicles Canada Inc., was opened in Calgary, Alberta, to design and install surveillance and mapping systems for all AVI aircraft and airships. Bob Fowler is the CEO of AVI. The firm's website is here: http://www.aerovehicles.net

The AVI Airship Department management team has over 250 combined years of airship experience with personnel in five countries. This flight operations department works out of the corporate office and is responsible for all LTA related tasks, including consulting, peer reviews, pilot and ground crew training, airship design, construction, and operations.

Aerovehicles has developed designs for large cargo and passenger-carrying airships that are capable of operating from small sites and being configured to perform a variety of civilian and military missions, such as:

- Cargo / passenger transport
- Tourism / advertising
- Long-endurance intelligence, surveillance & reconnaissance (ISR) platform (i.e., for military, Coast Guard, border patrol)
- Search and rescue
- Disaster relief / humanitarian aid / mobile medical facility
- Pipeline patrol, land survey and exploration
- Fighting and controlling wild fires

AVI's Aerocat and Minicat family of hybrid airships has been under development since 2002. Certification of an advanced hybrid airship depends on aviation regulatory authorities developing new regulations for this new type of airship. As of early 2022, no advanced hybrid airship has been granted a type certificate by an aviation regulatory authority anywhere in the world. Considering this regulatory risk, AVI has temporarily suspended their Aerocat and Minicat development efforts. Instead, AVI has focused their development efforts on the AV-10 multi-role blimp, which uses existing technologies and has been designed from the beginning to be certifiable within existing aviation regulations for blimps.



AVI Aerocat hybrid airship (left) and AV-10 blimp (right). Source: AVI.

This article discusses the Aerocat, Minicat and AV-10 airships and AVIs plans for the 2023 – 2024 World Sky Race. I am grateful to AVI for their thoughtful input for this article.

2. The AVI hybrid airships – Minicat & Aerocat

Aerovehicles began its hybrid airship development program in 2002 with a sub-scale concept demonstrator that could carry a 500 kg (1,102 lb) payload. Their planned airship product line includes the unmanned Minicat and the larger R12 and R40 hybrid airships.

General characteristics of AVI's Minicat & Aerocat airships

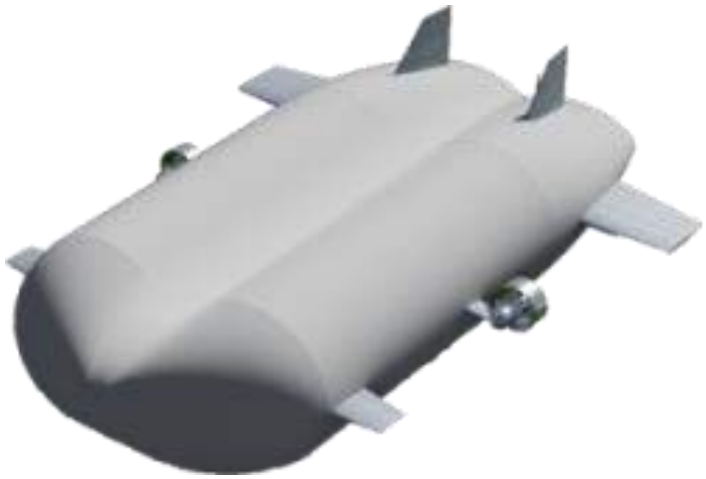
Dimensions	**Minicat**	**R12**	**R40**
Length	43 m / 141 ft	90 m / 295 ft	116 m / 381 ft
Width		45 m / 148 ft	61 m / 200 ft
Height		21 m / 69 ft	29.5 m / 97 ft
Payload bay volume		1,028 m^3 / 36,303 ft^3	1,888 m^3 / 66,674 ft^3
Payload	6 - 10 metric tons 6.6 - 11 tons	20 metric tons / 22 tons	40 metric tons / 44 tons
Range @ max payload		3,000 km / 1,864 miles	3,000 km / 1,864 miles
Max altitude @ max payload		2,500 m / 8,202 ft	2,500 m / 8,202 ft
Cruise speed @ max payload		150 kph / 93 mph	160 kph / 99 mph
Features	**Minicat**	**R12**	**R40**
VTOL	Yes	Yes	Yes
STOL		Yes	Yes
Variable buoyancy	Yes	Yes	Yes
Carry external sling load		Yes	Yes
Retractable ACLS		Yes, 4 pads	Yes, 3 pads
Anti- & de-ice systems	Yes	Yes	Yes
Full glass cockpit	Unmanned	Yes	Yes
IFR capable	Unmanned	Yes	Yes
Fly-by-wire		Yes	Yes
Roll-on / roll-off cargo capability		Yes	Yes
Endurance	35 – 48 hours	3 – 5 days	

You can view a 2010 Aerovehicles video with an overview of their Aerocat airships here:
https://www.youtube.com/watch?v=tdXeGSjibFw

Development of the Minicat and Aerocat was temporarily suspended in about 2020, when AVI redirected its airship development program to the AV-10 multi-mission blimp.

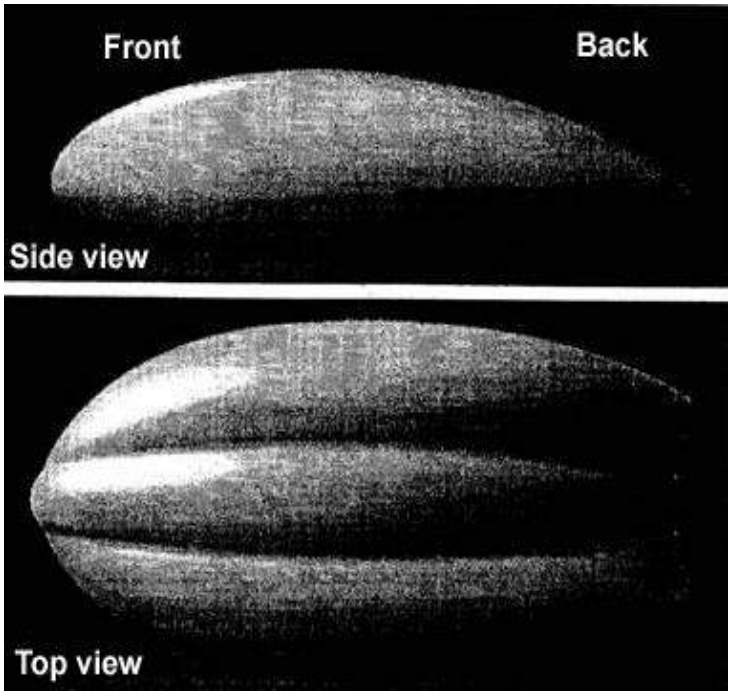
The Minicat

Aerovehicles is developing a 43 meter (141 ft) long, rigid, hybrid unmanned airship named Minicat, which is intended to serve as a prototype of the larger Aerocat-series of airships. The Minicat also can be configured for a variety of operational missions and is particularly well-suited for long-duration ISR missions. Early concept drawings of the Minicat are shown below.



Early Minicat configuration. Source: AVI

The design for the Minicat's hull evolved into a lifting-body hull shape similar to R12 and R40 Aerocats, as shown in the following figures.



Minicat & Aerocat hull shape, side view (top) and top view (below). Source: Aerovehicles, "ModelCenter™ Model for the Minicat 2002"

Minicat has the same type of variable buoyancy control system found on the larger Aerocat airships. Buoyancy inflight and on the ground is managed with a helium compression system. Buoyancy is decreased by pumping some helium from the atmospheric pressure lifting gas cells into small high-pressure storage vessels onboard the airship. When more buoyancy is required, stored helium is vented from the high-pressure storage vessels back into the lifting gas cells. With this system, the Minicat is capable of vertical takeoff and landing (VTOL). This buoyancy control process is similar to the Density Controlled Buoyancy (DCB) variable buoyancy control system developed in the mid-1970s by Michael Walden / Lighter Than Air Solar (LTAS), and the similar Control of Static Heaviness (COSH) variable buoyancy system demonstrated by Worldwide Aeros Corp. (Aeros) in 2008 on their Aeros 40D blimp and on their *Dragon Dream* airship in 2013.

The full-size Minicat airship is being designed to carry a payload of 6 to 10 metric tons (6.6 to 11 short tons) and conduct long-duration (35 to 48 hour) autonomous missions.

The Aerocat R12 airship

As a hybrid airship, the Aerocat's total lift is the sum of the aerostatic lift from buoyant helium plus the dynamic lift from the vectored thrust propulsion system and the aerodynamic lift from the shaped fuselage moving through the air. Helium provides about 60% of total lift with 40% coming from dynamic lift.

The Aerocat R12 is designed to carry 20 metric tons (44,092 pounds) of cargo 3,000 km (1,862 miles) at a maximum altitude of 2,500 meters (8,202 feet). Cruise speed will be 150 kph (84 knots).

Aerocat R12 concept shown in flight, with ACLS retracted.
Source: AVI

When fully loaded the Aerocat R12 is heavier than air. Aerovehicles reports that the Aerocat R12 will have both short takeoff and landing (STOL) and VTOL capabilities. Aerocat has the same variable buoyancy control system described previously for the Minicat. This helium compression system is used to manage buoyancy inflight and on the ground.

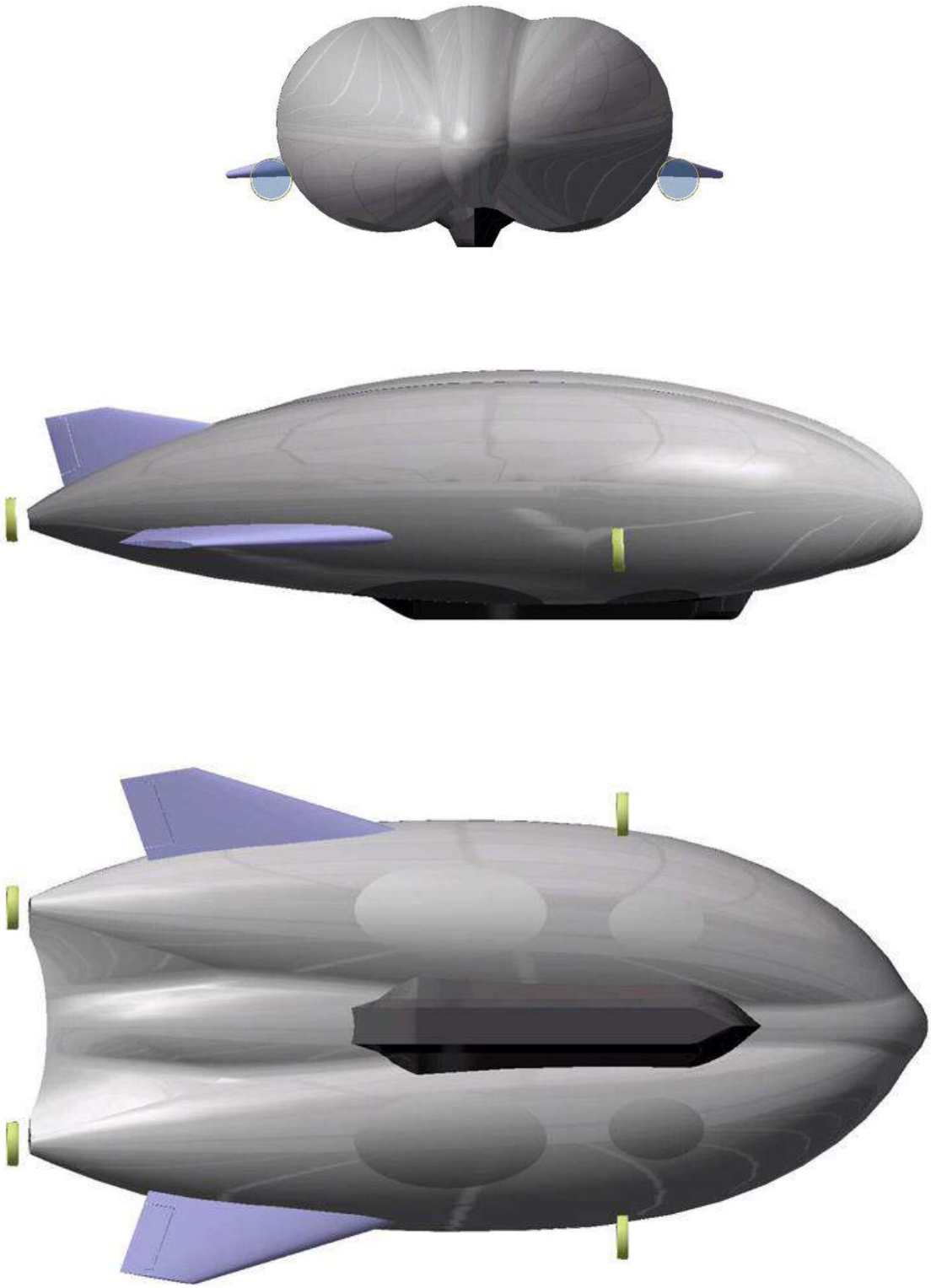
The VTOL capability likely is available only when the airship is lightly loaded and the combination of helium lift and vectored thrust is sufficient to lift the airship vertically. After a vertical takeoff, the vectored thrust system transitions the airship to horizontal flight where aerodynamic lift comes into play as airspeed builds. In cruise flight, the vectored thrust system is delivering thrust for propulsion and fuselage and wings are providing aerodynamic lift.

The Aerocat makes its short takeoff and landing (STOL) runs on an air cushion landing system (ACLS). Functionally, this system should be similar to the ACLS demonstrated in 2006 on the Lockheed Martin P-791 and in 2013 on the Aeros *Dragon Dream*. In the “lift” mode, the ACLS enables the airship to move on a cushion of air over uneven terrain, ice and water. In the “suction” mode, the ACLS holds the airship to the ground, which can be an important feature for stabilizing the hybrid airship during a load exchange (i.e., off-loading heavy cargo) or in strong winds.

For example, after heavy cargo has been unloaded on the ground, ACLS suction may be needed to temporarily stabilize the airship while the variable buoyancy control system adjusts net buoyancy or new cargo and/or additional ballast is loaded to restore airship gross weight and maintain net buoyancy in a prescribed range.

Managing net buoyancy during a load exchange from a hovering airship with a sling load (i.e., cargo suspended under the airship) is a more difficult proposition. Aerovehicles claims that the Aerocat R12 is capable of handling a sling load, but due to the known handling characteristics of lighter-than-air aircraft, AVI does not recommend this type of operation except in calm conditions and where precision is not required.

Rendering of an Aerocat R12 in flight, rear quarter view. Source: AVI



Aerocat R12 bow view (top), profile view (middle) and plan view from below showing the centerline gondola (below). Source: AVI

Aerocat R12 concept shown in flight, with ACLS retracted.

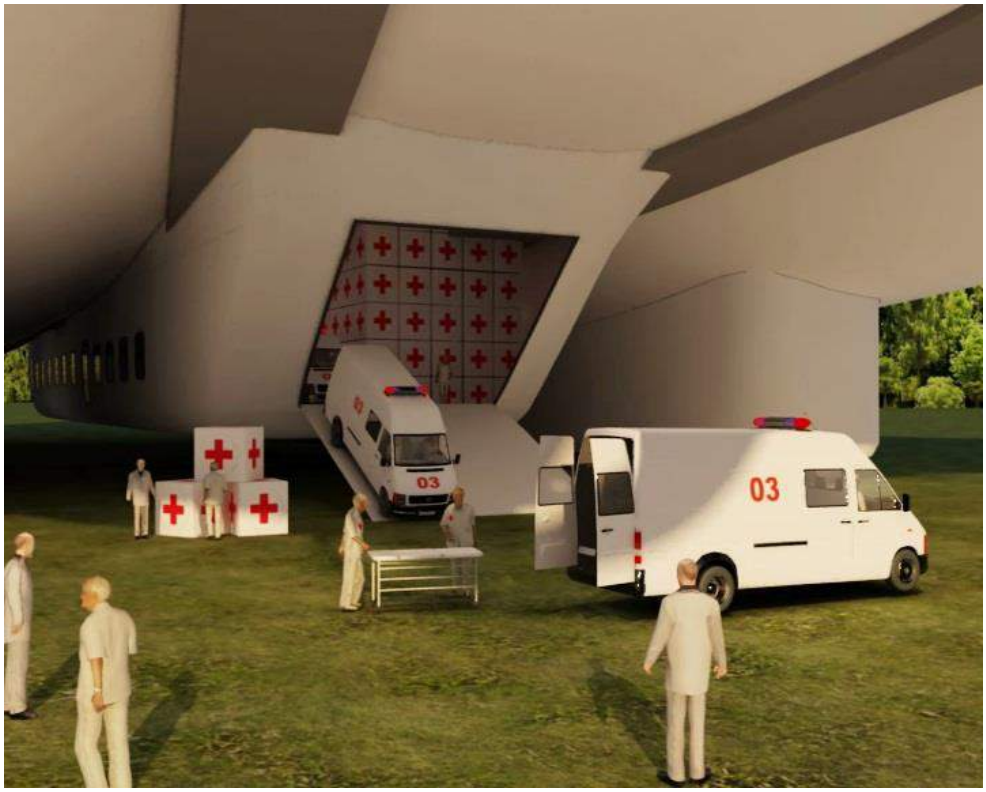
Rear quarter view of the Aerocat R12 concept shown on the ground, with ACLS extended. Source, both graphics: AVI

The payload bay can be configured to carry up to 105 passengers in 5-abreast seating.

Above: Cabin configured for high-density seating.
Below: Lower density seating alternative.

Source, three graphics: AVI

Aerocat R12 water landing, configured for marine search & rescue. Source, both graphics: AVI

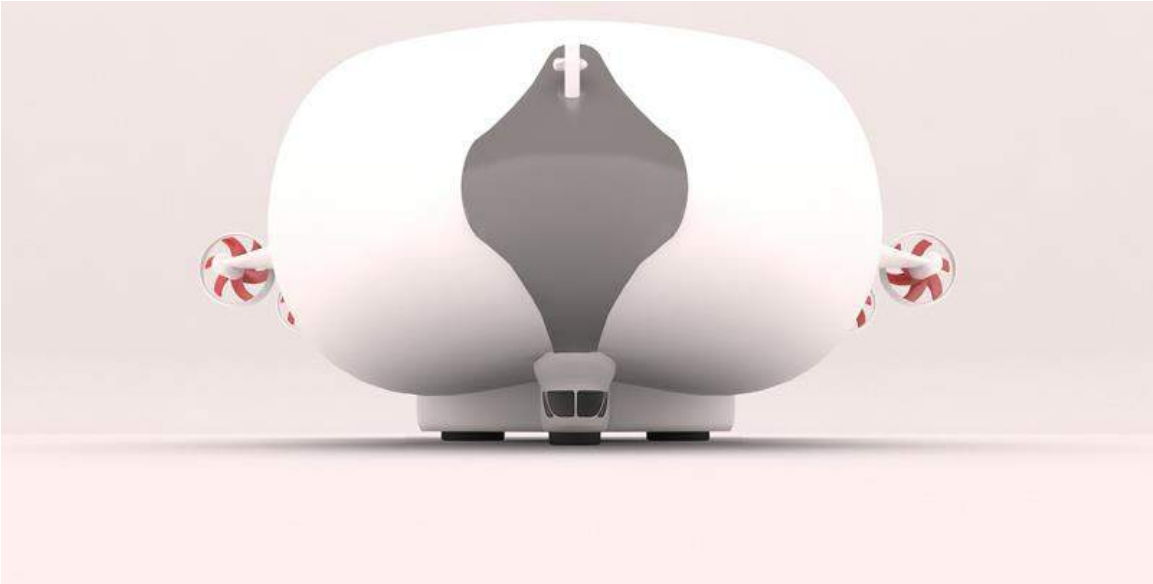


Aerocat R12 configured for disaster relief / humanitarian aid / mobile medical facility. Source, both graphics: AVI

The Aerocat R40 airship

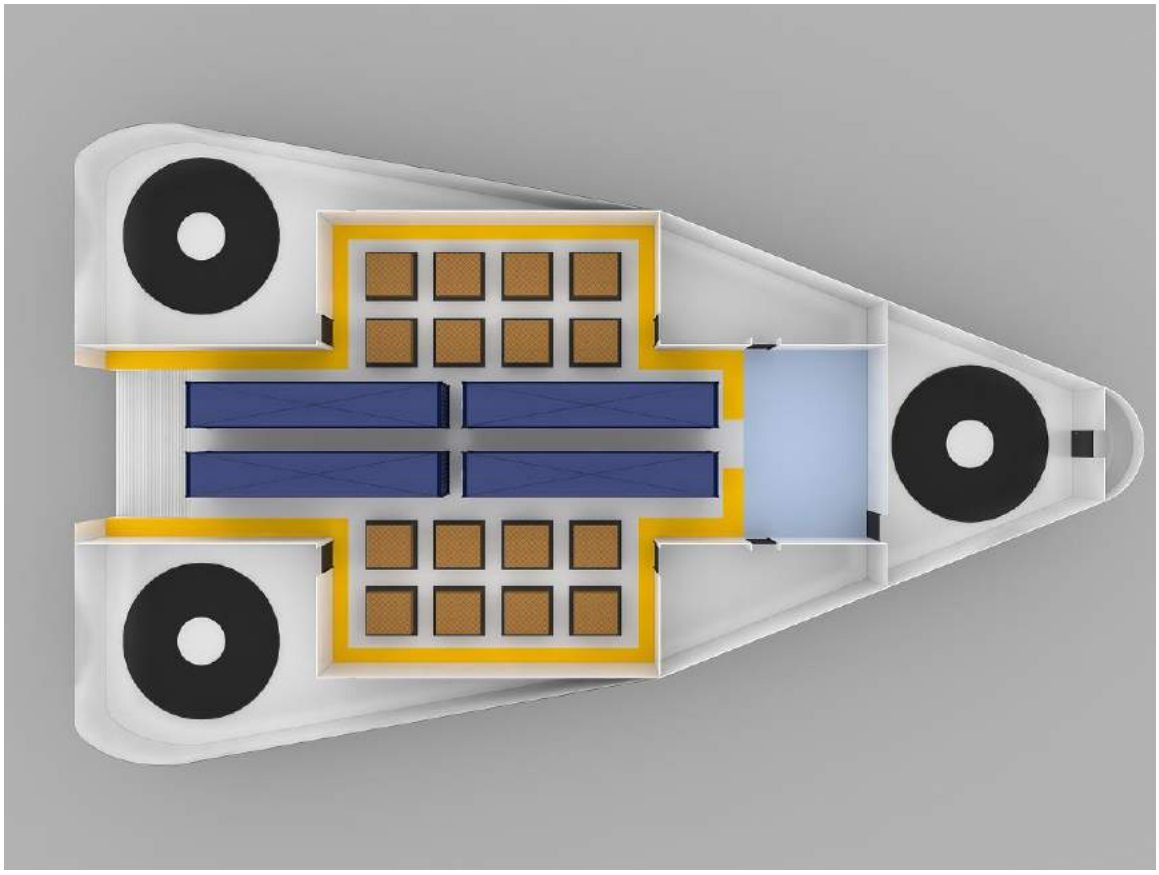
The R40 is the largest airship in the Aerovehicles product line. Major external distinguishing features are the two flank-mounted propulsors on each side plus the stern propulsors (R12 has one flank-mounted propulsor on each side plus the stern propulsors), the larger triangular cargo bay (R12 has a linear cargo bay along the centerline), and three retractable ACLS pads (R12 has four).

Aerocat R40, bow quarter view.



Aerocat R40, bow view. Source, both graphics: AVI

Aerovehicles describes their R40 airship as follows: “Per client requests, the Aerocat R40 has been designed to operate in all environments from arctic regions to arid deserts. The envelope structure includes a composite nosecone and an internal ‘rigid’ structure to give strength to the envelope. This rigid structure also removes the upper surface lobes where ice and snow accumulate and the nosecone protects the hull material from blowing sand or ice particles. Aerocat’s design includes three separate anti- and de-icing systems necessary to operate in arctic regions. Without these features a cargo airship’s ability to operate in hostile environments is greatly reduced. Additionally, the Aerocat R40’s payload bay has 1,888 cubic meters (66,674 cubic feet) of clear area with a 4 meter (13.1 ft) overhead clearance for cargo. Combined with the ability to transport 55 metric tons (60.5 tons) 900 nautical miles (1,482 km) and the R40 is an extremely efficient and versatile transport aircraft.”



Aerocat R40 cargo bay design. The three black circles are the housings for the retractable ACLS pads. The cockpit is at the extreme right. Source: AVI

3. The AVI non-rigid airship - AV-10 blimp

The AV-10 is a large, versatile blimp that can carry a 10 metric ton (11 ton) payload in a modular gondola that can be quickly configured for cargo operations, passenger flights, or both at the same time. This blimp uses existing technologies and has been designed from the beginning to be certifiable within existing aviation regulations for blimps.

In their design, AVI sought to optimize development funds required, payload capacity and range in a modern blimp that can enter the worldwide airship market quickly and deliver near-term value to operators. Regarding the development status of the AV-10, AVI reports: “The high-risk engineering and testing have been completed and this aircraft is ready to build.” They estimate that $30 to $35 million USD in funding is needed to build a full scale AV-10 prototype.

The AV-10 is comparable in size to the US Navy’s Goodyear ZPG-3W blimp, which was retired in 1961, but remains the largest blimp that has ever flown. The ZPG-3W gas envelope had a volume of 41,484 m^3 (1,465,000 ft^3), which is very close to the AV-10 at 40,500 m^3 (1,430,244 ft^3).

AV-10 in an all-passenger gondola configuration. Source: AVI

General characteristics of AVI's AV-10 airship

Parameters	AV-10
Construction	Non-rigid (blimp)
Lifting gas	Helium
Length, overall	107.5 m (352.7 ft)
Height, overall	33.5 m (109.9 ft)
Width, overall	26.5 m (87.0 ft)
Envelope volume	40,500 m^3 (1,430,244 ft^3)
Maximum all-up weight	21.5 metric tons (21,500 kg / 47,399 lb)
Payload weight	10 metric tons (10,000 kg / 22,046 lb)
Maximum lightness	1,500 kg (3,307 lb) – TBD
Propulsion	Diesel engines with water vapor recovery
Airspeed, max	60 Knots (111 kph) @ 2,743 m (9,000 ft) MSL
Wind speed operating limit	25 Knots (46.3 kph) – constant
Rate-of-climb, max	7.6 meters/sec (1,500 ft/min)
Rate-of-descent, max	7.6 meters/sec (1,500 ft/min)
Altitude, max	3,038 m (10,000 ft)
Range (approx.)	• 1,000 nm (1,852 km) @ 40 Knots @ 9,000ft • 1,500 nm (2,778 km) @ 30kn @ 5000 ft

AVI's reconfigurable gondola design is a modern, more flexible implementation of similar designs by Lightspeed USA, in their LS-60 rigid airship (circa 1975), and the Russian airship firms RosAeroSystems, in their MD-900 blimp design (circa 2002), and DKBA, in their DP-6000 blimp design (circa 2000).

The diesel-powered AV-10 is propelled by four thrust-vectoring, shrouded propellers mounted on the gondola just forward and aft of the reconfigurable modular bay. These propellers normally are in the horizontal position during cruise flight and can be rotated vertically to provide dynamic lift or down-force as needed.

The AV-10 has a water vapor collection system that recovers 80% of all moisture from the diesel engine exhaust. This system recovers 60% to 70% of the weight of the fuel burned. The AV-10 has a large water ballast system to store the recovered moisture and to add water ballast when necessary.

The AV-10 is equipped with an automatic landing system (ALS) that enables a pilot to make a hands-off approach and mooring with a ground crew of 4 – 6 persons.

During cruise flight, control surfaces on the X-tail provide pitch and yaw control. At slow speed and during hover, when the aerodynamic control surfaces are ineffective, a tail-mounted, thrust vectoring propeller supported from the gas envelope provides maneuvering control.

X-tail and thrust vectoring propeller. Source: AVI

Conducting a load exchange

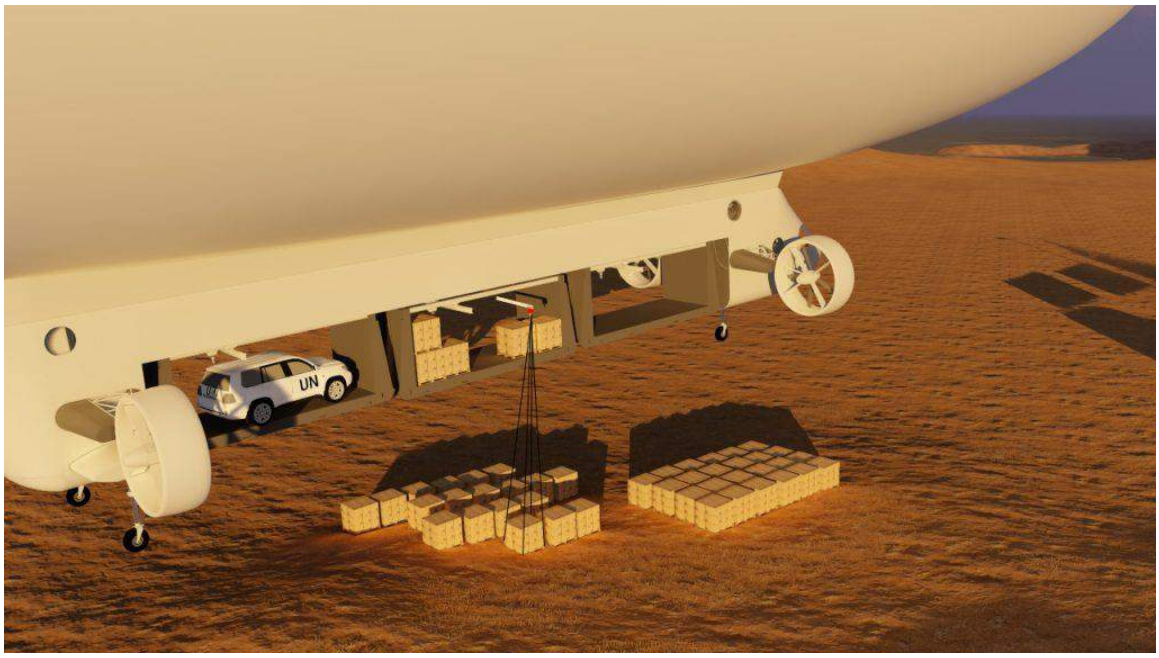
The AV-10 is designed to transport 10 metric tons (11 tons) of cargo on three large, removable “sleds”. In cargo operations, an AV-10 will deliver cargo on the outbound leg and carry out an equivalent weight of new cargo, trash or ballast on the return leg. If new cargo and trash are not available at a delivery site, then rocks, sand, water or other ballast can be loaded on pallets and then onto the cargo sleds for the return trip.

On a particular route, an AV-10 can make several stops. If the blimp starts getting light, the pilot can use the thrust-vectoring propellers to temporarily balance the lift and call ahead to the next stop and ask for additional ballast. Empty cargo sleds and pallets can be pre-position at each town or village along the route so they can be preloaded with outbound cargo, trash or ballast.

Delivering cargo from a hover requires careful management of buoyancy and altitude throughout the load exchange. A load exchange on the ground is a simpler matter that can be managed using the dynamic down-force from the propellers and full air ballonets to stabilize the blimp throughout the transaction.

Renderings of an AV-10 with the gondola configured for all-cargo operation with three large cargo sleds loaded with palletized cargo. Source: AVI

Rendering of a hovering AV-10 using its onboard crane to lower a whole cargo sled to the ground. That palletized cargo will be unloaded and replaced with new (outbound) cargo / trash / ballast or a prepositioned, loaded sled will be picked up. While not shown in the graphic, the thrust vectoring propellers would be rotated vertically during the load exchange to provide vertical dynamic thrust (up or down) as needed. Source: AVI



Rendering of a hovering AV-10 delivering or picking up palletized freight from a hover using on-board crane. Pallets delivered are replaced with pallets carrying new (outbound) cargo / trash / ballast.

Rendering of an AV-10 approaching a remote landing site with emergency supplies. Source, both graphics: AVI

4. World Sky Race

The World Air League is the organizer for an airship race around the globe that will be held between September 2023 and May 2024.

Starting preparations and planning for the global challenge, AVI's President and CEO, Bob Fowler, said, "All of the personnel at Aerovehicles Inc. are extremely happy to assist and participate in the World Sky Race. Personally, I am honored to accept the position of Chairman for the World Sky Race Argentina Local Organizing Committee ALOC and look forward to entering an airship representing all of South America."

Source: WorldSkyRace

5. For more information

- "Argentina Leads Airship Team to Represent South America," WorldSkyRace, 2 July 2019: https://www.worldskyrace.com/newsstories/09-26-19/news_092619.htm

Video

- "Aerovehicles Inc. – Aerocat," (3:05 minutes), posted by Aerovehicles, 15 August 2010: https://www.youtube.com/watch?v=tdXeGSjibFw

Other *Modern Airships* articles

- *Modern Airships - Part 1:* https://lynceans.org/all-posts/modern-airships-part-1/
    - Aeros - Dragon Dream (ACLS)
    - AVIC - AS700 blimp
    - Goodyear Aerospace - N-Class blimps
    - Walden / LTAS - Lenticular toroidal DCB airships
- *Modern Airships - Part 2*: https://lynceans.org/all-posts/modern-airships-part-2/
    - Lightspeed USA – LS-60 modular gondola rigid airship
    - RosAeroSystems – MD-900 modular gondola blimp
    - DKBA - DP-9000 modular gondola blimp
- *Modern Airships - Part 3:* https://lynceans.org/all-posts/modern-airships-part-3/