Buoyant Aircraft Systems International (BASI)

Peter Lobner, updated 9 January 2023

1. Introduction

BASI, founded in 2011 by Dr. Barry Prentice in Winnipeg, Manitoba, is developing designs for large, rigid cargo airships intended for year-round operation in the harsh environment of the Arctic. You'll find the BASI website here: https://www.buoyantaircraft.ca

The first prototype airship, built jointly by BASI and ISO Polar Airships, was the 25-meter (82 foot), single-pilot MB80 named "Giizhigo-Misameg", which means "Sky Whale" in the Oji-Cree language. It was unveiled in December 2011. BASI had a research hangar and operated three prototype airships at the Winnipeg / St. Andrews airport. That hanger and the airships were destroyed in a windstorm in July 2016.

BASI currently is developing designs for two similar large, rigid airships intended for civilian service in the Arctic and in other regions of the world: the 30 metric ton (33 ton) MB-30T and the larger trans-oceanic MB-100T. These airships and a discontinued design for a 10 metric ton (11 ton) airship are addressed in this article.

In February 2018, BASI and Airship do Brazil (ADB) signed a Memorandum of Understanding (MoU) under which the two companies agreed to work together to develop the cargo airship industries in Canada and Brazil.

2. Business case for BASI airships

Arctic airships

The business case for an Arctic cargo airship is supported by BASI's observation that, "The economic boundary of an airship increases with size. A transport airship of less than 50 metric ton (50,000 kg; 110,200 lb) lift size has a market radius of about 400 kilometers (249 miles). Canada has scores of communities without road access that

live within this distance of a road. Goods can be transshipped at the road ends and delivered more economically to resource camps and remote communities." The business model for BASI is based on operating from one or more fixed end-of-the road "marshalling" sites and serving specific remote destinations that have established the needed ground facilities for these airships.

BASI also notes that, "Traditional ice roads are experiencing ever-shorter seasons of use. The construction of all-weather roads is extremely expensive. The terrain is rough, the permafrost unstable and numerous watercourses must be bridged." In Arctic regions, the average cost of building gravel roads is about $3 million per kilometer. The annual cost for establishing and maintaining a seasonal ice road also is very high.

Dr. Prentice has suggested that commercial airships regularly operating in the Arctic also could be a cost-effective solution to Canada's need for an emergency response capability in the region. He says, "Regular use of airships on scheduled services to mines and remote villages could be interrupted to carry emergence supplies from prepositioned locations to the site of a ship wreck or oil spill. In such arrangements, governments normally pay an annual stand-by (fee) to the aircraft operators that is much less than the cost of owning and operating equipment."

Airships for worldwide markets

The BASI heavy lift airships are designed to operate between fixed bases and can be configured to serve many differen markets, including:

- Mining: Ore transport from remote sites.
- Trans-ocean long haul: Medium rush goods that can be delivered in a week.
- "Big ugly freight:" Items like heavy equipment and wind turbine blades. Use of an airship reduces the need to break down the heavy equipment for transport and also enables use of bigger wind turbines on land sites.
- Fuel hauling: Provides regular supply of gasoline, diesel & propane to remote sites; reduces the need for stockpiling at the

remote site; can be performed by dedicated fuel tanker airships or as supplementary cargo on “standard” cargo airships.
- Supply chain for remote communities: Everything from produce and consumables to prefabricated housing and vehicles.
- Emergency response: Timely transportation of people and supplies for activities such as rescue at sea and oil spill remediation.

3. General features of BASI airships

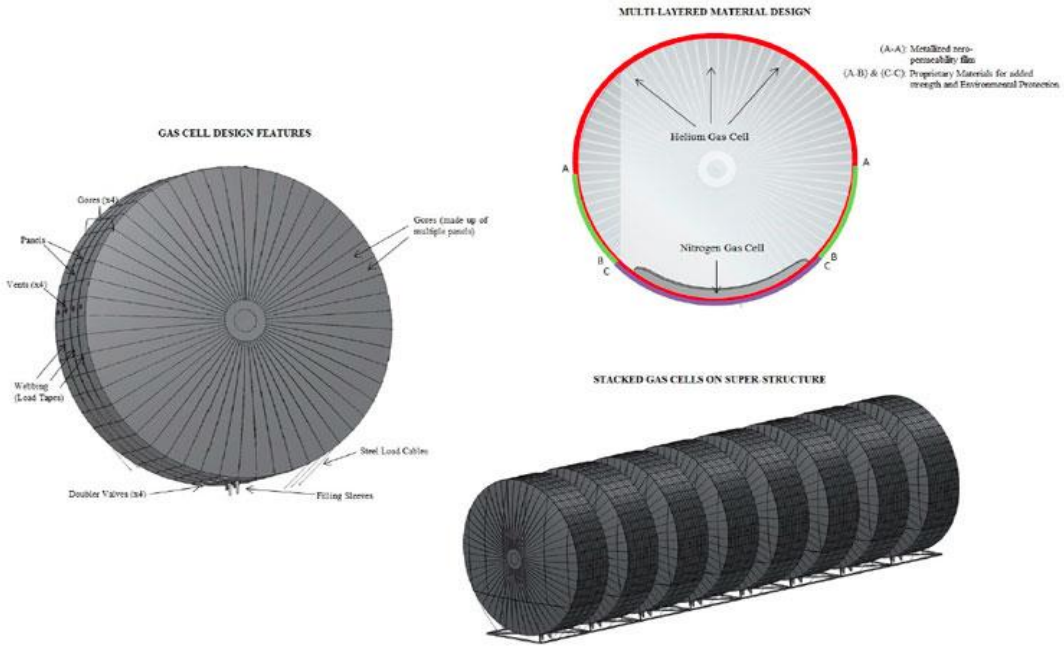
BASI airships are modern Zeppelin-style, rigid airship designs with the following features:

- Rigid tubular airframe
- All-metal hull
- Large enclosed cargo bay supported under the rigid hull
- Designed for operation in extreme environmental conditions (from Arctic conditions to tropical conditions)
- A hybrid-electric power system supplies electric motor-driven vectorable thrusters for propulsion and maneuvering.
- Capable of vertical takeoff and landing (VTOL) and hovering
- Designed to operate only from fixed bases and to land on a rotating turntable (a Buoyant Aircraft Rotating Terminal, BART) that keeps the airship pointed into the wind
- The fixed-base operating concept enables some systems to be located on the ground rather than on the airship. For example:
    - Access to ground-power reduces the need for on-board electrical power after mooring and during cargo load exchanges.
    - Ground-handling equipment can be staged at the base, reducing the need for onboard cargo handling equipment.
    - A simple water-based ballasting system can be used, with water ballast available on the ground at each location to offset airship weight changes during load exchanges.
- BASI airship are not intended to deliver cargo to sites without the required BART fixed-base landing system.
- BASI airships are not intended to deliver suspended loads.

Lifting gas cells

The lifting gas cells are designed to hold either hydrogen or helium and are protected with a proprietary system of fire-resistant materials and a firewall. Canadian and U.S. aviation regulations currently prohibit the use of flammable lifting gas. The European Union Aviation Safety Agency (EASA) proposed Special Condition issued on 21 January 2022 creates an opportunity within the EU to use flammable lifting gases, subject to conditions dealing with gas toxicity, electrostatic discharges and fire protection.

BASI airships are being designed for piloted or unmanned operation between fixed bases. The unmanned airships are candidates for early introduction of hydrogen lifting gas.



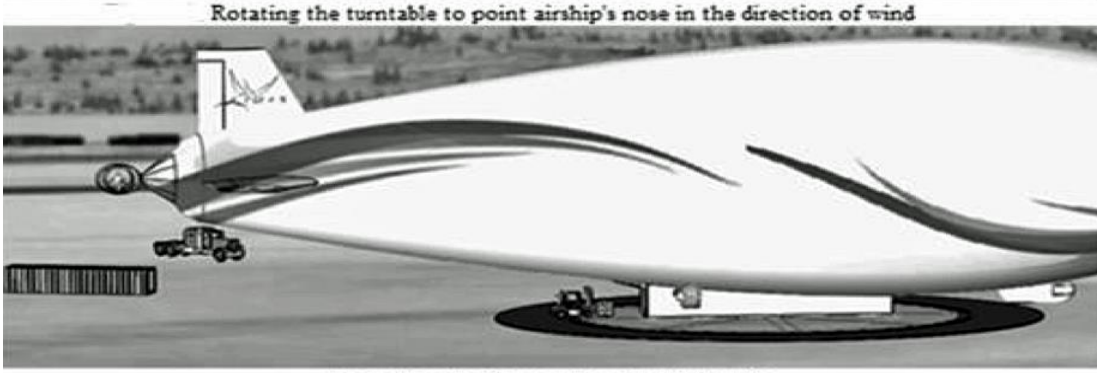
Low-permeability lifting gas cells, designed for helium or hydrogen.
Source: BASI

Airship mooring at a BART

The mooring and load exchange process for a BASI airship is shown in the following sequence of drawings that start with the airship hovering above the landing site, lowering a cable to the ground and then being winched down onto a landing pad with a rotating turntable. This system is known as a Buoyant Aircraft Rotating Terminal, (BART), which includes a loading dock for trucks, ballast water, fuel, electric power and forklifts. BART is intended to limit ground handling time to one hour or less with a small ground crew. BASI estimates that a BART turntable installation costs about $2 million. BART is designed to be disassembled and moved to a new site if needed to follow the customer's field activities (i.e., logging, mining).

Mooring the airship MB 310 using winches

Rotating the turntable to point airship's nose in the direction of wind



Unloading the Cargo using a forklift trailer

Source: Dr. Barry E. Prentice, "Airships: An idea whose time has come", University of Manitoba, 2016

4. BASI rigid airships designs

BASI is flying a 1:100-scale model and has developed designs for two rigid airships: the 30-metric ton MB-30T and the larger MB-100T. Work on a 10-metric ton airship, formerly known as the MB-310, has been discontinued. All are addressed in this section.

4.1 The BASI 1:100 scale flying model

This small flying model (about five feet in length) has the same general layout and flying characteristics as the larger 30-T heavy-lift airship.

1:100 scale model on static display (above) and in flight (below). Source, both photos: BASI

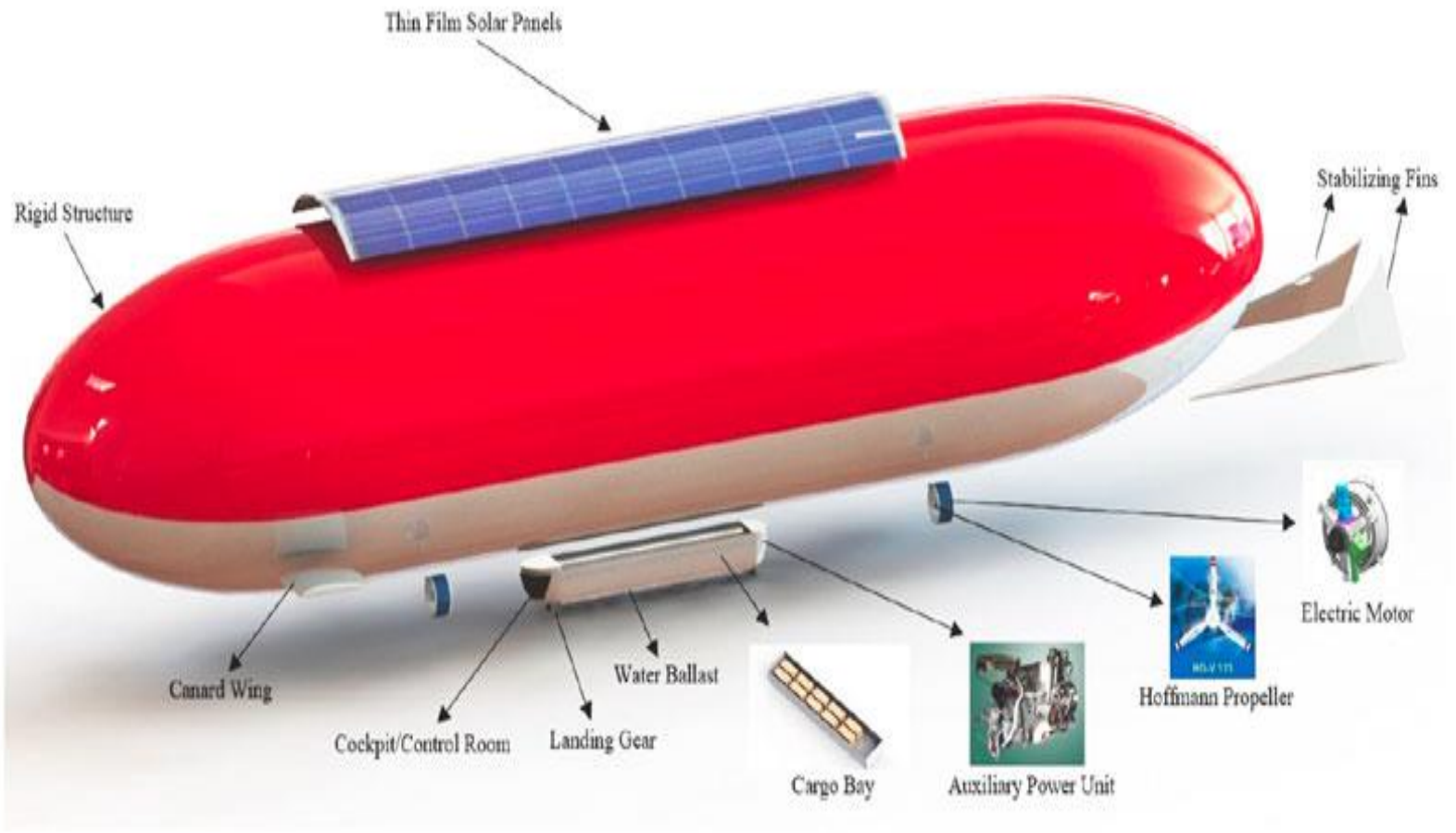
4.2 The BASI MB-30T heavy-lift airship

The MB-30T is targeted for point-to-point cargo service between fixed bases equipped with a BART.

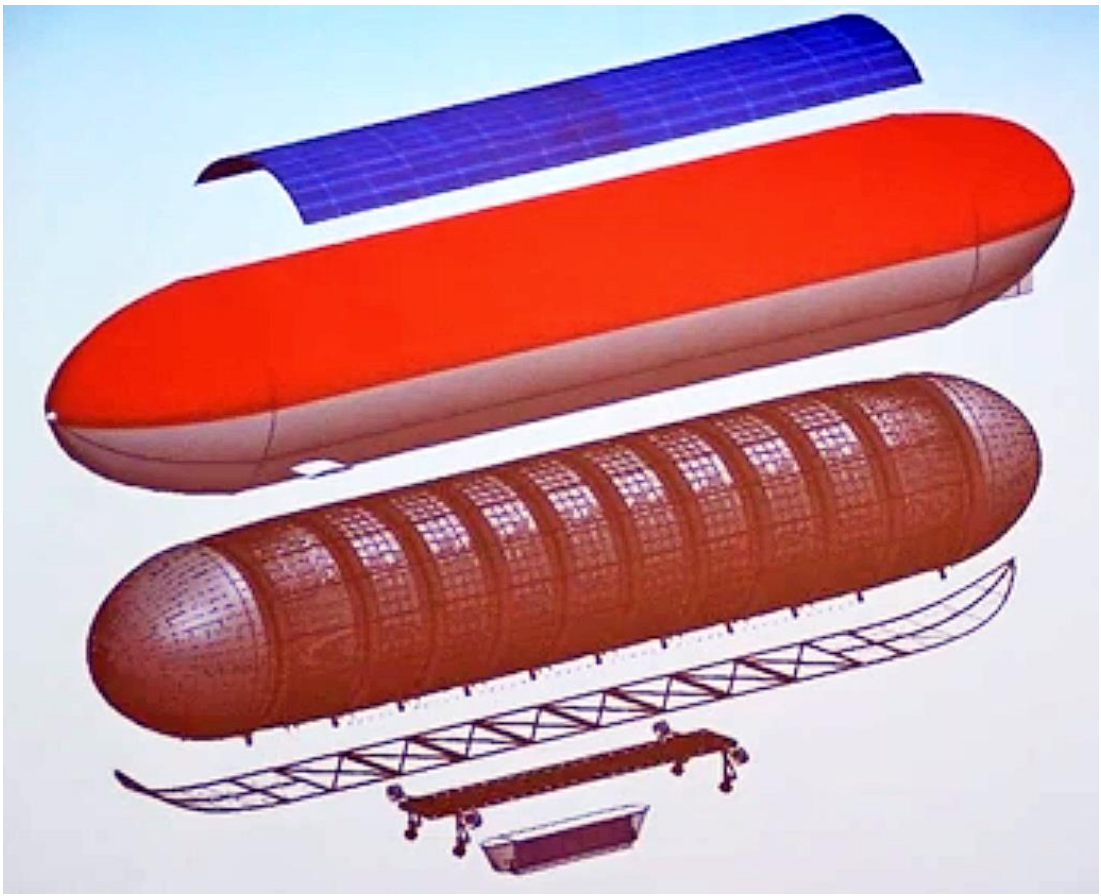
General characteristics of the MB-30T

Parameter	BASI MB-30T
Type	Rigid
Length, overall	560 ft (170.7 m)
Length, envelope	496 ft (151.2 m)
Diameter, envelope max	80 ft (24.4 m)
Fineness ratio	6.2
Volume, envelope	2,200,000 ft^3 (62,297 m^3)
Height, overall	90 ft (27.4 m)
Width, overall	100 ft (30.5 m)
Lifting gas	Helium (gas cells are designed for He or H_2)
Aerostatic lift, max gross	60 metric tons (66 tons)
Weight, max takeoff	62 metric tons (68.2 tons)
Useful load * @ sea level	30 metric tons (33 tons)
Ballast	Water
Accommodations	Pilot + copilot or unmanned
Power sources	• 2 x Pratt & Whitney PT-6 auxiliary power units • Thin-film solar panels on top of the hull
Fuel	Jet Diesel A @ 880 lb/hr for APU; fuel capacity is 1,000 US gallons + 200 US gallons reserve
Propulsion	4 x 390 kW (523 shp) Siemens electric motors, each driving a vectorable shrouded propeller mounted on the lower flanks of the rigid hull (vectoring range is 180º, from full up to full down)
Aerodynamic control surfaces	• Stern stabilizing fins / rudder • Bow canard fins functioning as elevators
Operational wind speed limits	• Max. crosswind: 25 knots (46.3 kph) @ 90º • Wind limit: 50 knots (92.6 kph)
Speed	• 80 knots (148 kph) cruise, • 100 knots (185 kph) max
Range	• 800 naut. miles (1,482 km) typical, • 1,200 naut. miles (2,222 km) max
Altitude	• 3,281 ft (1,000 m) cruise, • 5,000 ft (1,524 m) service ceiling
Endurance	10 hours

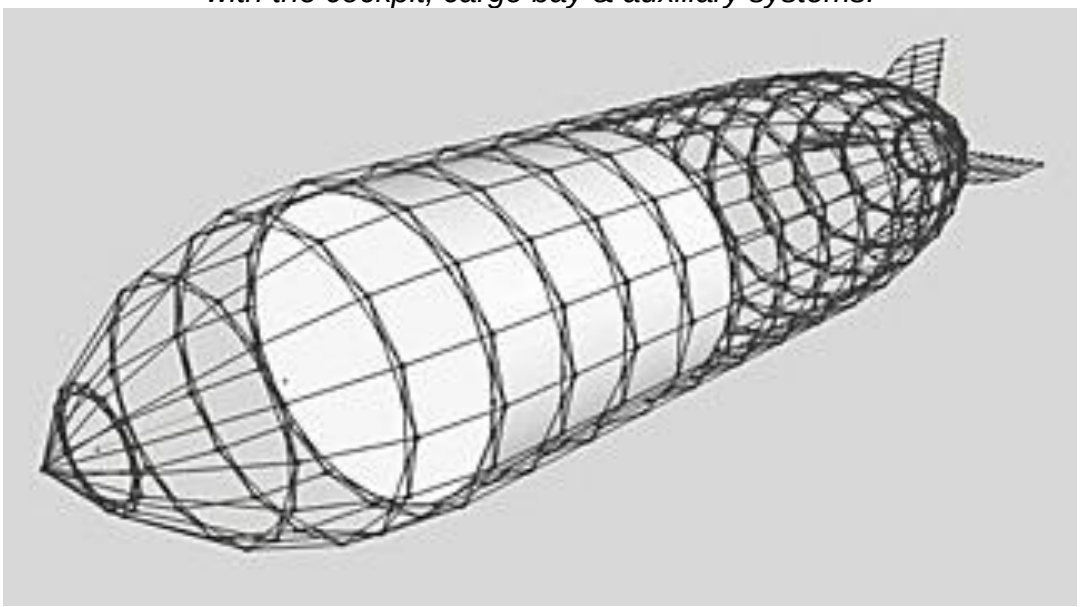
* Useful load includes the weight of the pilot, copilot, cargo, passengers, baggage, usable fuel, and drainable oil.



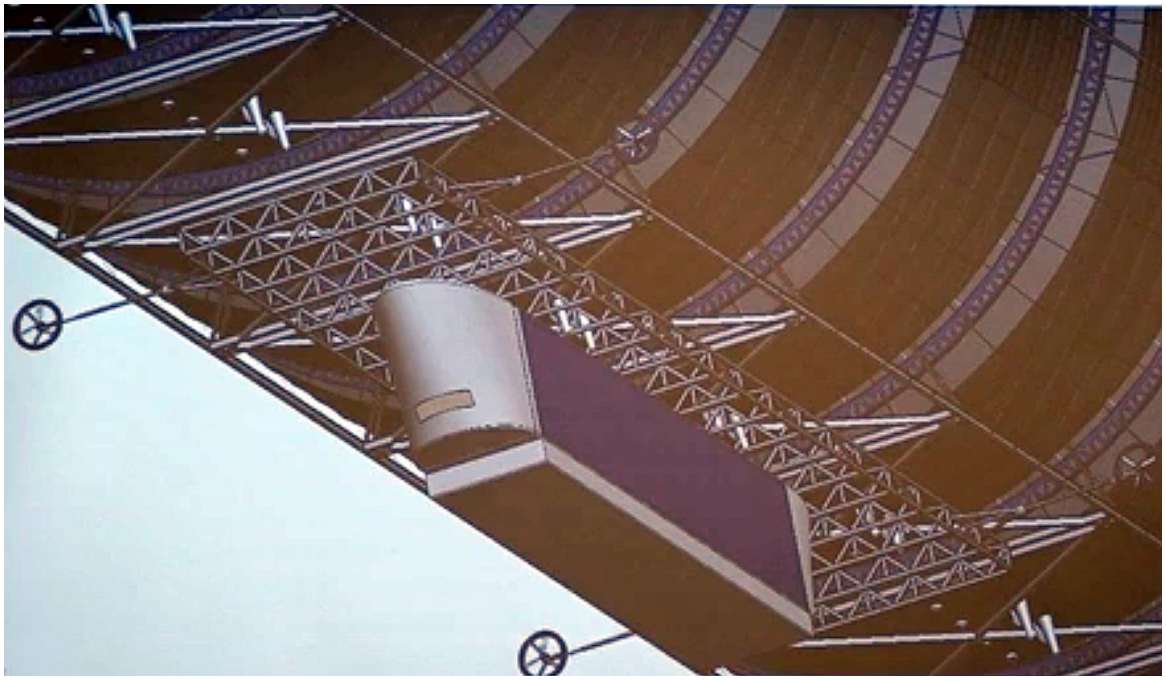
Basic design features of the BASI MB-30T cargo airship. Source: BASI



Exploded view of BASI's MB-30T cargo airship showing (top to bottom): solar array (blue), outer skin (red/white), rigid hull framework with lifting gas cells inside, reinforced keel along the bottom centerline of the hull, truss structure with four shrouded propellers and landing gear attached, and (bottom) the gondola with the cockpit, cargo bay & auxiliary systems.

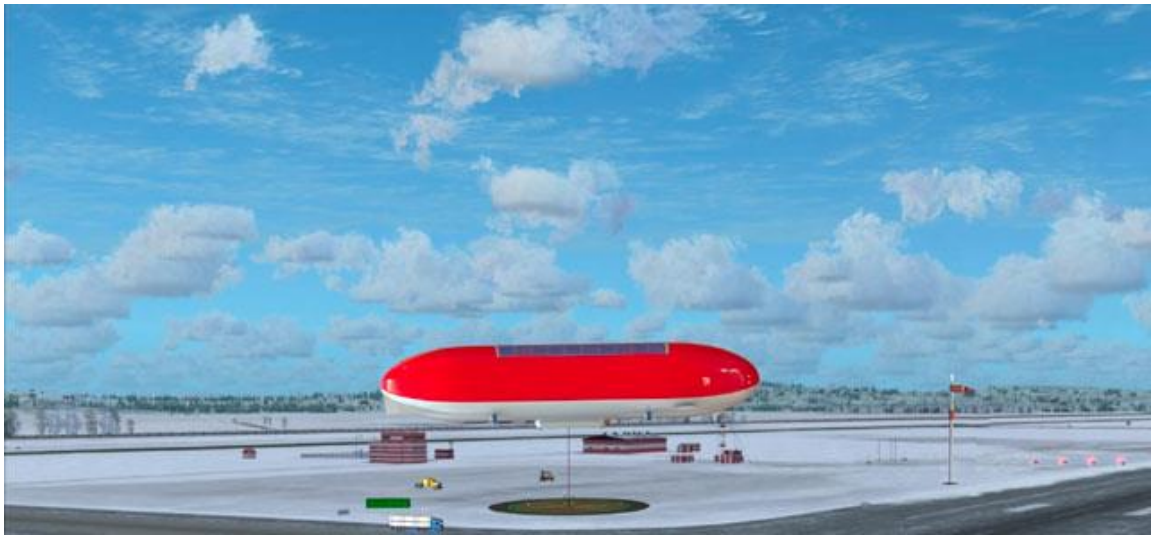


Structural design of the airship rigid frame. Source, both graphics: BASI

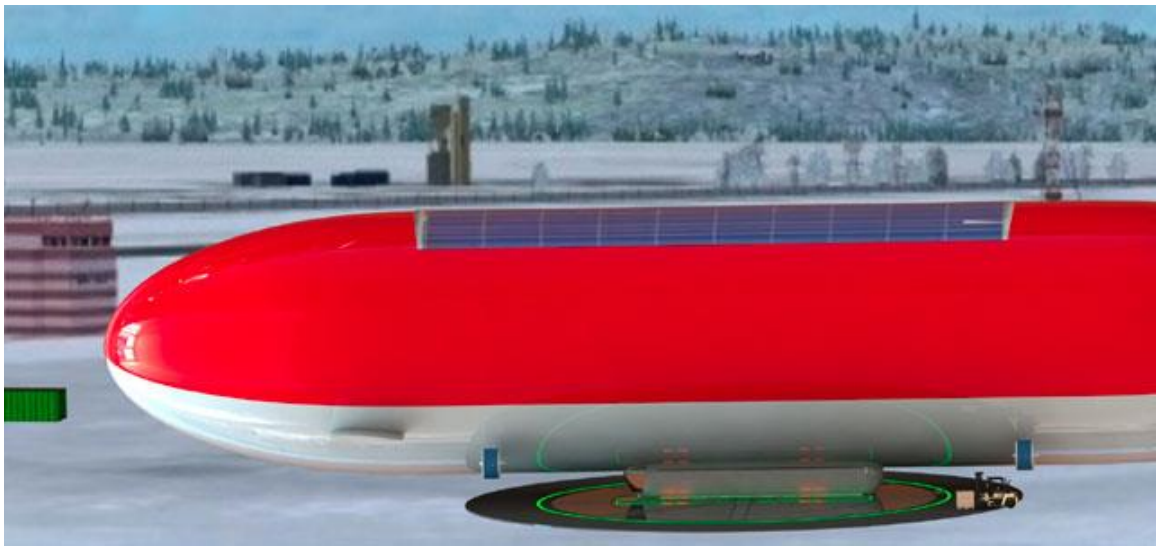


Arrangement of the gondola and the load-bearing truss structure under the hull.

Rendering of a BASI MB-30T cargo airship in flight.
Source, both graphics: BASI



Rendering of a BASI MB-30T cargo airship being winched down onto a BART rotating landing pad (above), and secured to the landing pad, with cargo transfer in progress (below). Source, both graphics: BASI

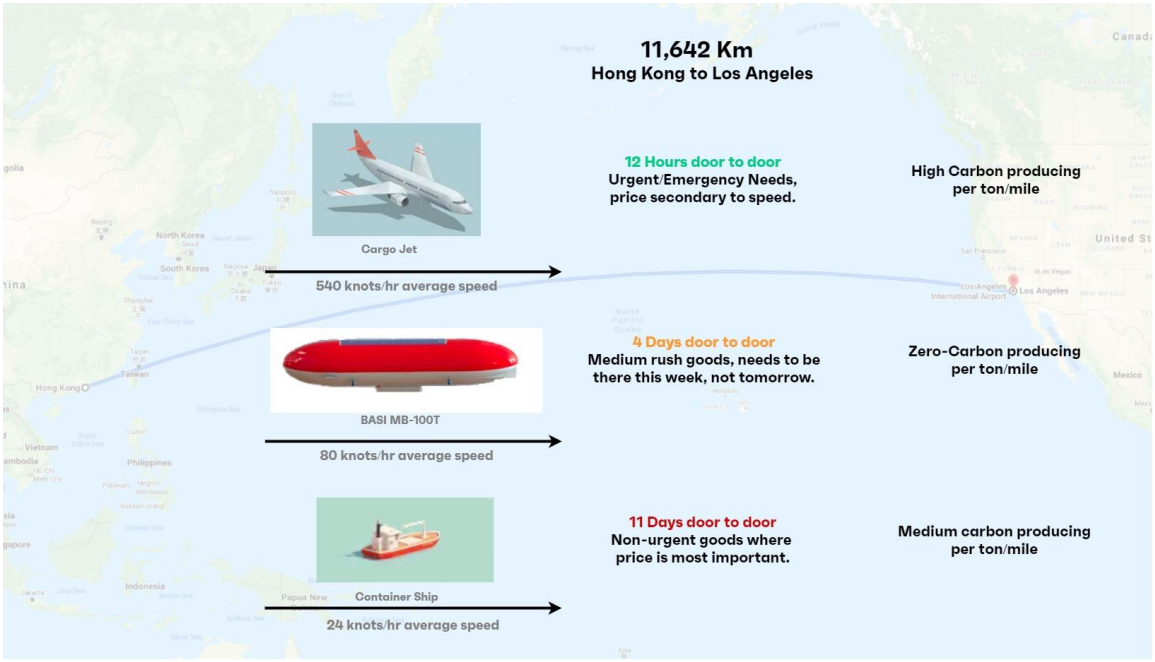


BASI's long-term goal is to transition the MB-30T from the original hybrid solar electric / APU power system with low carbon emissions to a hybrid solar electric / hydrogen fuel cell power system that will enable airship operation with zero carbon emissions.

Rendering of the BASI MB-30T airship on a BART at a remote Arctic site.
Source: BASI.

4.3 The BASI MB-100T trans-oceanic airship

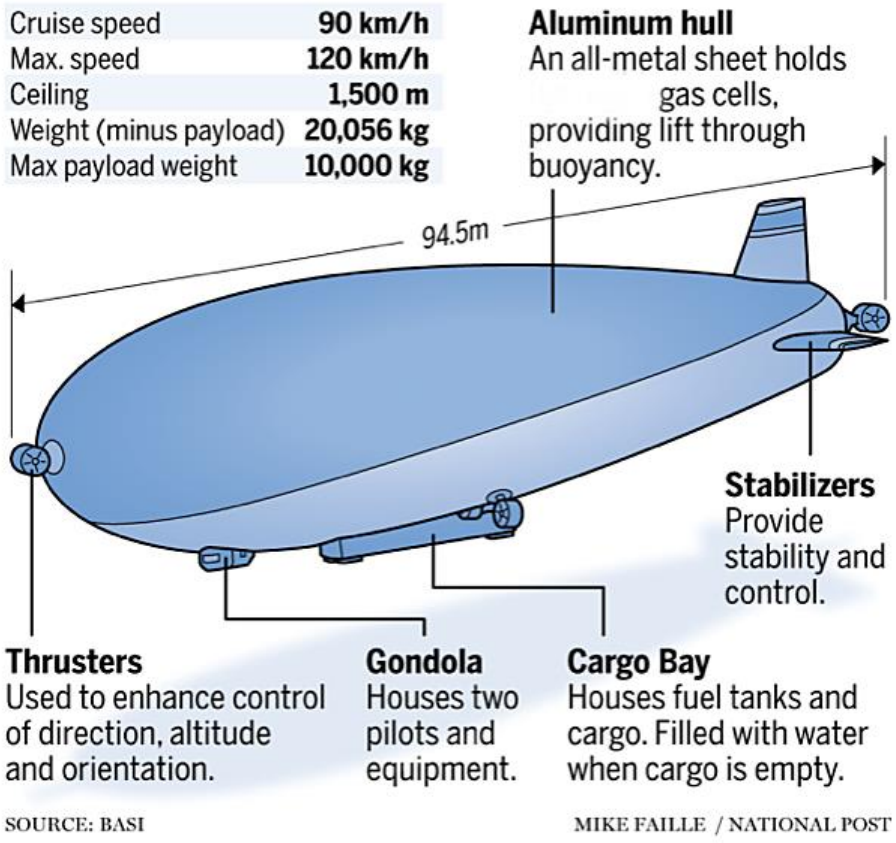
The large MB-100T airship is targeted for long-haul trans-oceanic operations, where its hybrid solar electric / hydrogen fuel cell power system provides a zero-carbon footprint and gives the airship a significant environmental advantage over cargo-carrying aircraft and cargo ships. With an average speed of 80 knots (148 kph), the MB-100T is more than three times faster than a modern container ship, making it well suited for transporting freight that does not require the shorter transit time possible with an aircraft. BASI estimates that a 125-metric ton (137.5-short ton) lift airship could carry freight across oceans at $0.20/metric ton-kilometer (~$0.30/ton-mile).



Trans-Pacific delivery characteristic of aircraft, airships and cargo vessels. Source: BASI

4.4 The discontinued BASI 10 metric ton MB-310 airship

The 10 metric ton (11 short ton) MB-310 airship design preceded BASI's current MB-30T airship design. Some design features of the original MB-310 are similar to the MB-30T airship, which became the focus of BASI's design efforts after they determined that the 30 metric ton (33 short ton) cargo capacity was a better match to the operational needs of customers in the North.

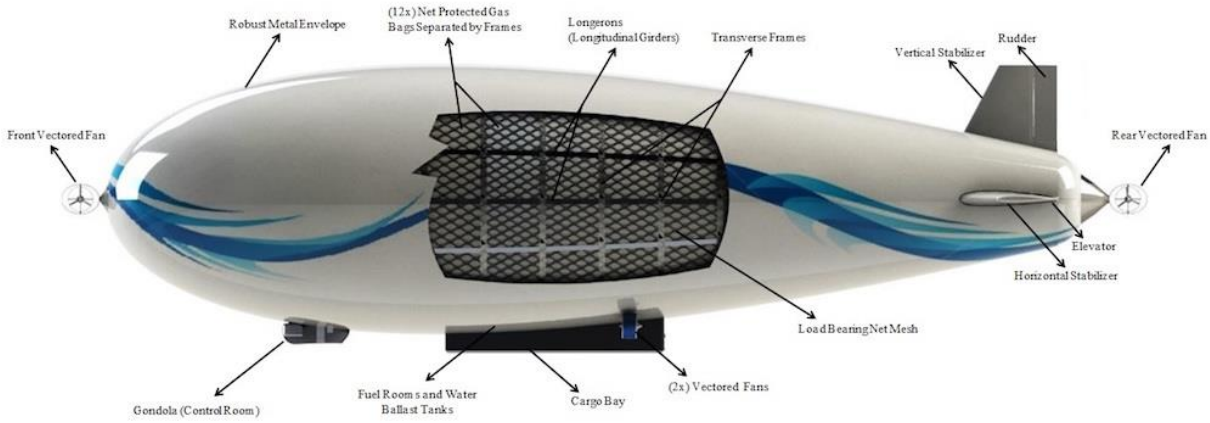


BASI MB-310 airship concept general arrangement.
Source: Adapted from BASI / National Post

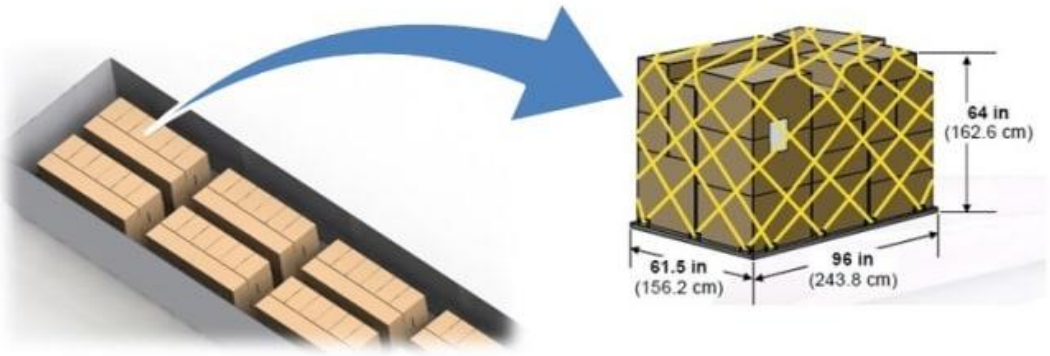
A post-MB-310 design of BASI's 10 metric ton airship adopted the same constant diameter envelope shape as the MB-30T, which would simplify manufacturing. However, all work on the 10 metric ton size airship was soon discontinued.

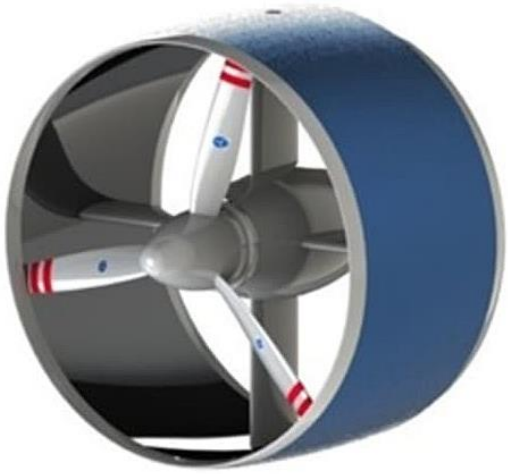
Rendering of the MB-310 airship on a BART at a remote Arctic site.
Source: BASI.

Rear quarter view of an MB-310 airship showing the crew gondola (forward) and cargo bay (amidships) along the bottom of the rigid hull.
Source: BASI.



Cargo Bay Interior with Pallets Loaded





Three views of 2016 design concept that developed into the BASI MB-310. Source: A. Sarfraz

5. Joint airship development with Airship do Brasil

The near-term goal of the 2018 MOU between BASI and Airship do Brasil was to produce Zeppelin-style rigid airships for their respective domestic markets, where vast areas of each country (about 70% of each country) do not have reliable access to road transportation or other modes of transportation. Dr. Prentice is reported to have commented, “Our problem is impenetrable areas that are cold and Arctic. (Brazil) has impenetrable areas that are hot and humid." In 2018, the first joint airship project, named the ADB 3-15/30, was planned to carry 15 metric tons (16.5 short tons) of cargo.

The ADB 3-15/30 airship is addressed in my separate article on Airship do Brasil.

6. For more information

- D. George, “Design Considerations for Cold Weather Operations,” BASI, Presentation at Airships to the Arctic VI, Seattle, WA, 2011: https://isopolar.com/wp-content/uploads/2013/04/Dale-George-presentation-Airship_design_considerations_for_cold_weather_operations.pdf
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- B. Prentice, “Cargo airships could boost northern housing,” Winnipeg Free Press, 5 October 2019: https://www.winnipegfreepress.com/opinion/analysis/cargo-airships-could-boost-northern-housing-562243532.html
- B. Prentice, “Hydrogen gas-fuelled airships could spur development in remote communities,” The Conversation, 20 January 2021: https://theconversation.com/hydrogen-gas-fuelled-airships-could-spur-development-in-remote-communities-152730

Videos

- “Floating Giants: The Barry Prentice Story” (1 hr, 20 minutes), Documentary, 2018, available from some streaming services

Other *Modern Airships* articles

- *Modern Airships - Part 1*: https://lynceans.org/all-posts/modern-airships-part-1/
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