Airfloat Transport Ltd. airships

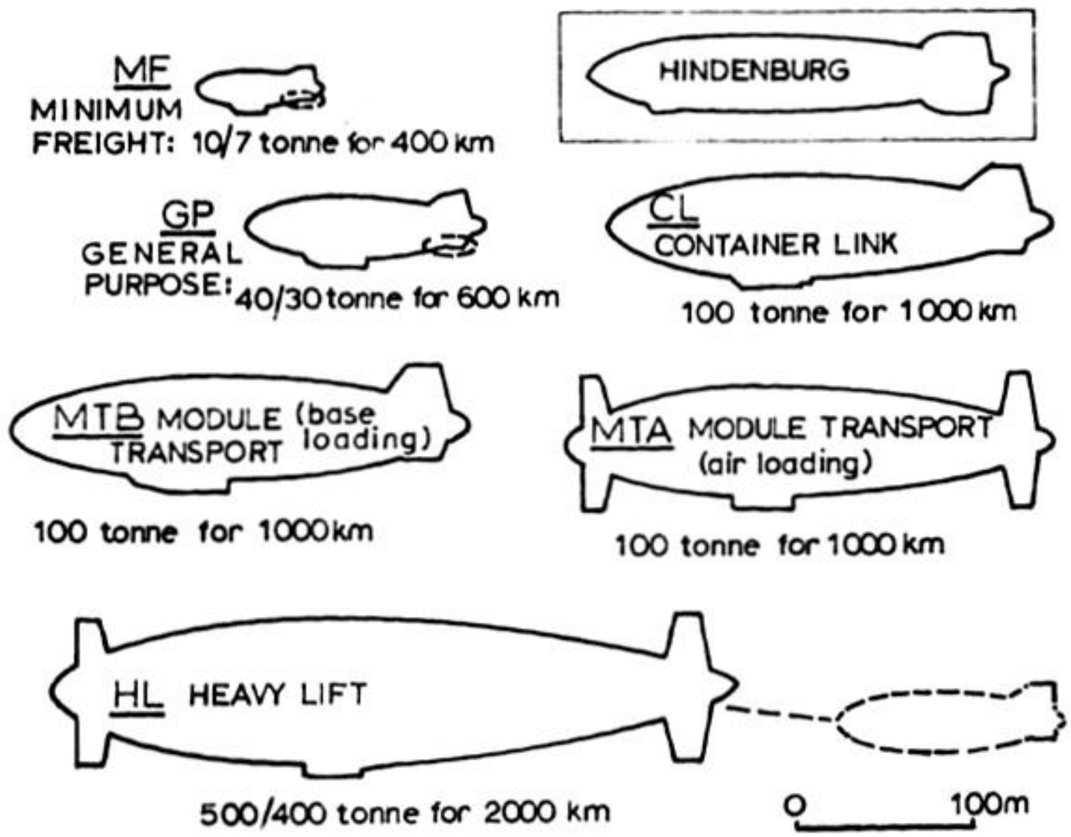
Peter Lobner, updated 8 March 2022

1. Introduction

Airfloat Transport Ltd. was founded in 1970 in Guildford, UK. Dr. Edwin Mowforth was the technical leader and served a one of the directors. The firm developed designs in the 1970s for a family of seven commercial freight transport airships for a variety of applications, as outlined in the following table.

Designation	Description	Payload / Range
HL (Heavy Lift) System	Rigid, air loading airship (in flight load exchange) for handling one heavy individual item or an aggregate load in a cargo module	500 tonne (550 ton) individual unit or 400 tonne (440 ton) aggregate cargo in a 100 tonne (110 ton) cargo module / 2,000 km (1,243 miles).
GF (Gas Ferry) System	Rigid, small "tugboat" airship to tow one or more unpowered, non-rigid natural gas envelopes to areas not served by pipelines	55,000 cubic meters (1.9 million cubic ft) of gas per towed gas envelope
CL (Container Link) System	Rigid, base loading airship (operating between fixed terminals with moorings) for moving loaded cargo containers from a congested port terminal to a distribution center	100 tonnes (110 ton) / 1,000 km (621 miles)
MTB (Base Loading Module) System	Rigid base loading airship for handling general aggregate freight	100 tonnes (110 ton) / 1,000 km (621 miles)
MTA (Air Loading Module) System	Rigid, air loading airship for handling general aggregate freight.	100 tonnes (110 ton) / 1,000 km (621 miles)
GP (General Purpose) System	Rigid, base loading airship for handling passengers and / or general aggregate freight	40 tonne (44 tons) individual item or 30 tonne (33 tons) aggregate cargo in a 10 tonne (11 ton) cargo module / 600 km (373 miles)
MF (Minimum Freight) System	Non-rigid, base loading or field loading (away from a terminal) airship for handling freight	10 tonne (11 ton) individual item or 7 tonne (7.7 ton) aggregate cargo in a 3 tonne (3.3 ton) cargo module / 400 km (249 miles)

The relative scale of these airships is shown in the following diagram. All 100 tonne (110 ton) and larger airship designs were much larger than the LZ-129 Hindenburg.

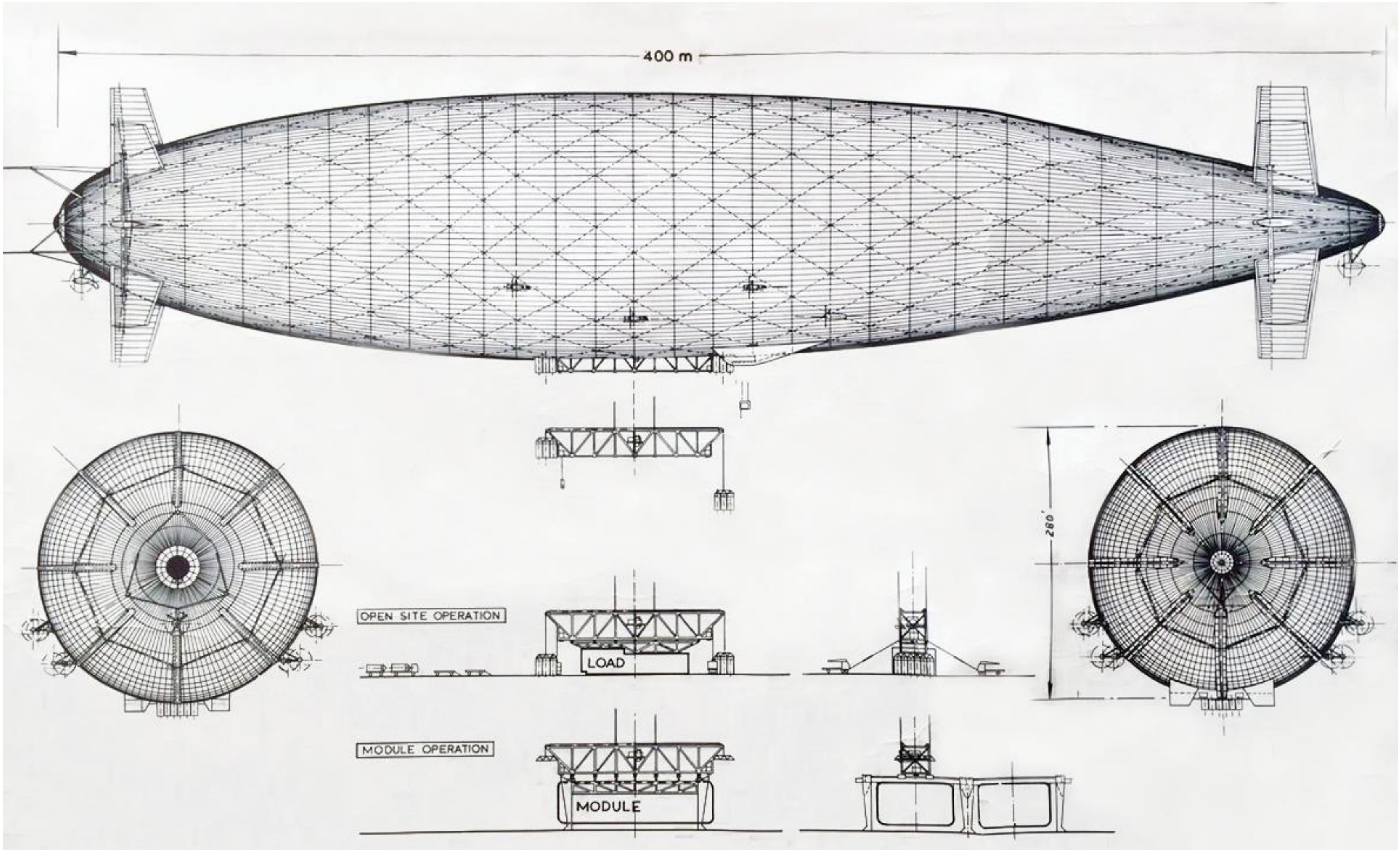


Relative scale of the Airfloat Transport Ltd. airship designs.
Source: A.W.L. Nayler (July 1979)

This article focuses on the HL heavy lift airship and its capability to perform a free-hover in-flight load exchange.

2. Design of the HL heavy lift airship

The HL heavy lift airship was designed as a low-cost, conventional, rigid airship intended to move heavy cargo between industrial sites. The cargo could be a single heavy item or an aggregate of items pre-loaded into a cargo module. Load exchanges would be made with the airship free-hovering (not tethered) above a precise geo-location, thereby minimizing the need for ground facilities to support airship cargo operations.



Airfloat HL airship 3-view drawing (bow is at left) showing the central hoist location and the "hoist frame" for handling a large external load or a pre-loaded module. Source: Airfloat Transport Ltd. via Twitter

The general design characteristics of the HL heavy lift airship are summarized below:

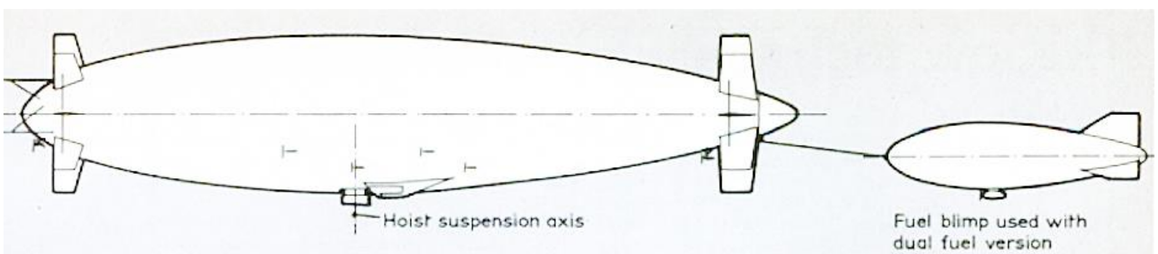
- Type: Rigid, conventional
- Hull construction: Ellipsoidal shape, light alloy shell frame construction, stabilized by radially braced transverse frames, and covered in a synthetic fabric skin
- Lift gas: Helium
- Lift gas volume: 1,130,000 m^3 (39,900,000 ft^3), highly compartmentalized into a large number (17 to 28) low-permeability, reinforced plastic lift gas cells within the hull and small lift gas cells in each of the 8 fins located at the bow and stern of the hull
- Length: 400 m (1,312 ft)
- Diameter: 80 m (262.5 ft)
- Propulsion: 10 hull-mounted Rolls-Royce Proteus turboshaft engines, each rated at just over 4,000 hp (3,000 kW) and driving a 6.4 m (21 ft) propeller
    - 8 x engines mounted amidships along the lower flanks; the two aft engines were fixed axially for propulsion only and the other six were capable of vectoring thrust vertically (up or down) when needed
    - 1 x engine mounted under the nose and 1 x engine mounted under the tail; each capable of rotating to provide axial or lateral (left or right) thrust when needed
- Cruise speed: 140 kph (87 mph) with 4 x flank engines
- Maximum altitude (pressure altitude): about 457 m (1,500 ft)
- Payload capacity:
    - 500 tonnes (550 tons) as a single indivisible load
    - 400 tonnes (440 tons) aggregated into a 100 tonne (110 ton) cargo module

To manage the in-flight weight loss from liquid fuel consumption, the airship would start its journey heavy, with vectored propulsive lift augmenting aerostatic lift. The airship would arrive at its destination light, with vectored propulsive thrust holding the airship down until it could be refueled. This operating scheme limited the maximum stage length between refuelings to about 1,100 km (680 miles), but no external ballast was added and no helium was vented to control static buoyancy.

There was no hanger large enough to build the Airfloat HL airship. Therefore, it would be built outdoors, at a service facility with a turntable that docked to the airship's load bay, at the longitudinal center of the hull. The turntable would allow the airship's structure to be aligned into the prevailing wind throughout construction.

3. Design variant

The Airfloat HL airship could be used as a single vessel powered by liquid fuel, or as a dual-fuel version supplied from a towed blimp carrying 59,000 m^3 (2,070,000 ft^3) of natural gas fuel, which is a buoyant lifting gas. The density of air at standard temperature and pressure (STP) is 1.274 kg/m^3. Methane, which is the major constituent of natural gas, has a density of 0.716 kg/m^3 at STP.



Source: New Scientist, 23 July 1974

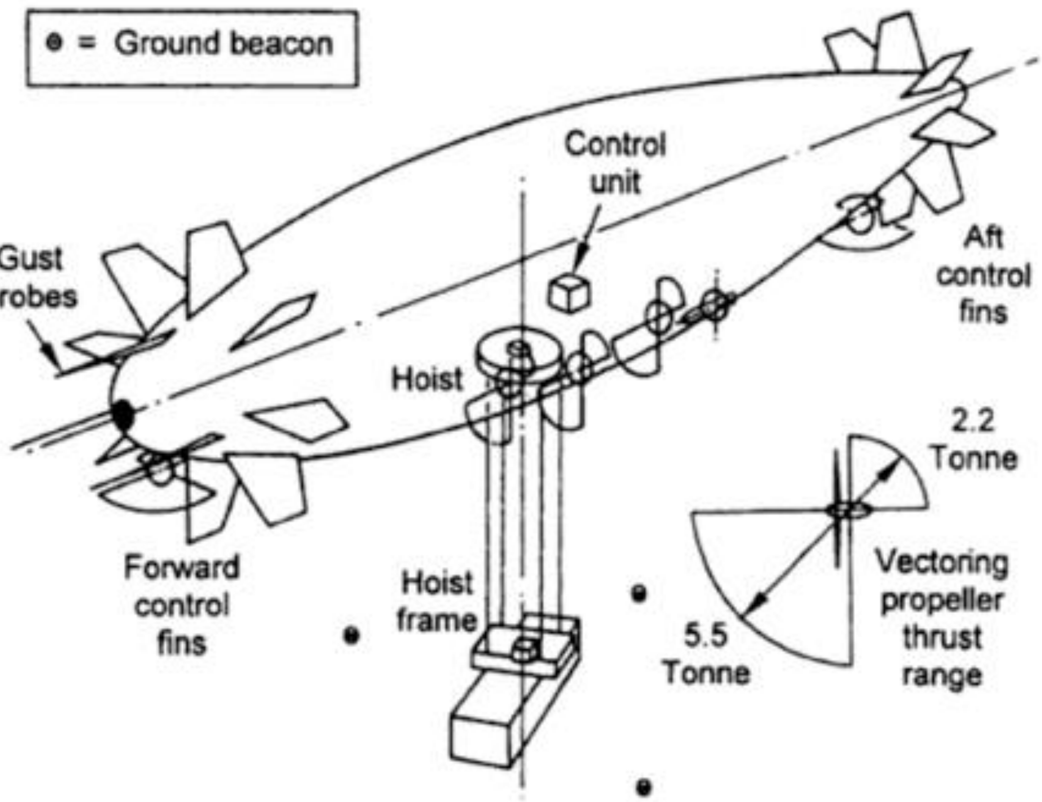
The use of natural gas fuel was expected to reduce operating costs by 20 to 30%. This variant of the Airfloat HL offered a stage length of over 2,000 km (1,243 miles) between refueling.

The fuel blimps would be self-powered, remotely-controlled, and would dock and undock with the Airfloat HL in flight.

4. Maintaining a precise geo-location for in-flight load exchange

The desired geo-location is established with a triangular set of three radio beacons on the ground. Sensors on the airship detect the beacons and the hovering control system positions the airship with its hoist suspension axis above the target. The load exchange occurs with the airship hovering at an altitude of 15 to 50 meters (49 to 164 ft) above the load.

Throughout the free-hovering load exchange, the position of the airship is maintained by a combination of aerodynamic forces from its many control fins and vectored thrust control. Gusts are detected with probes on the nose of the airship. These sensors provide an anticipatory input to the hovering control system, which operates the control fins to respond quickly to gusts and coordinates the engines to drive the airship forwards, backwards, up, down, and sideways to maintain position.



Source: Airship Technology,1st Ed., 1999, p. 436

A gyro on the cargo load frame senses low-frequency swinging of the suspended load, which can be actively damped by the hovering control system.

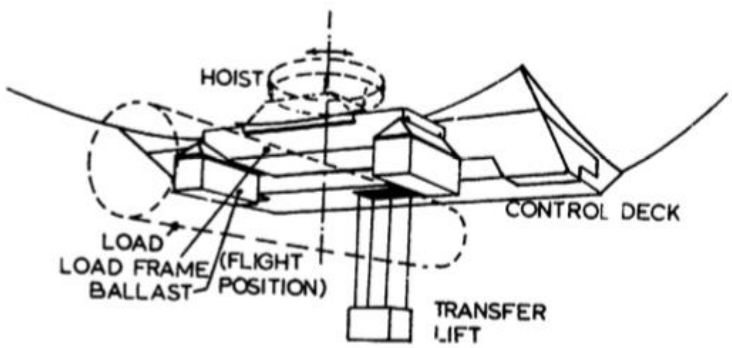
The swiveling hoist compensates for any difference between the real-time heading (yaw angle) of the airship and the intended centerline of the hoist frame.

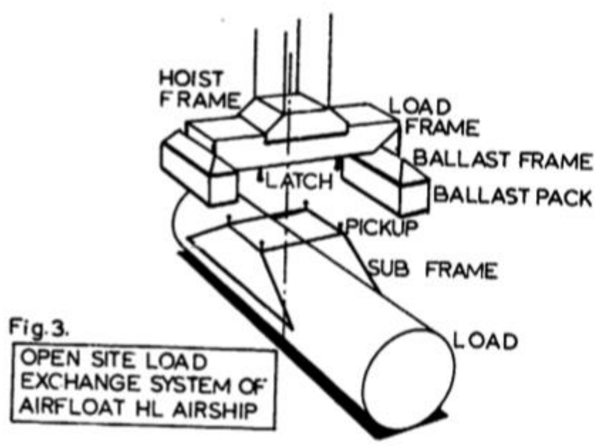
5. Executing the load exchange

The Airfloat HL uses a "hoist frame" to pick up and deliver loads and to secure the load while in flight.

For cargo operations with a single indivisible load

In this process, an "empty" hoist frame carries ballast packs with an aggregate weight equal to the weight to the load to be picked up. Each ballast pack is a 15 tonne (16.5 ton) water container. The load to be picked up can weigh up to 500 tonnes (550 tons), including the weight of the subframe needed to engage with the airship's hoist frame. At the pickup site, the hoist frame is lowered to straddle the load, the subframe is secured to the hoist frame, the ballast packs are released, and the load is hoisted up to the airship and secured for flight.





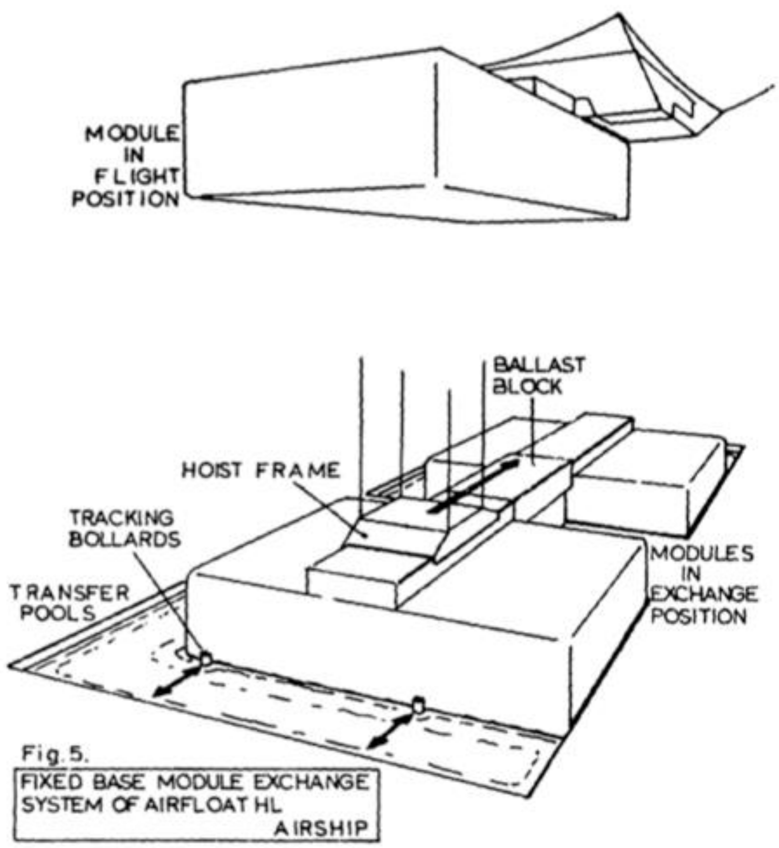
Source: Mowforth, Proceedings, Interagency Workshop on LTA Vehicles, Jan 1975

At the delivery point, the load is lowered to the ground between two sets of ballast packs and these packs are secured to the hoist frame. The load is released and the hoist frame is pulled up with the ballast packs and secured for flight.

Edwin Mowforth reported, “Within 20 minutes of arriving at the site, an airship could be on its way to its next destination. Load transfer would take just 5 minutes of this time.”

For cargo operations with a pre-loaded cargo module

In this process, many cargo items, such as standard shipping containers, are aggregated into a large cargo module measuring 60 m (197 ft) long x 25 m (82 ft) wide x 10 m (32 ft) tall, yielding an available cargo volume of about 12,460 m^3 (440,000 ft^3). This module has an empty weight of about 100 tonnes (110 tons), reducing net cargo capacity to 400 tonnes (440 tons).



Source: Mowforth, Proceedings, Interagency Workshop on LTA Vehicles, Jan 1975

A special terminal facility is needed support the use of the pre-loaded modules, which involves the exchange of two modules of equivalent weight. In addition to its cargo, a module can be ballasted to achieve the desired gross weight. The exchange takes place in two side-by-side transfer pools bridged by a ballast block that is also ballasted to the correct weight. Coordination is required to move the hoist frame from the delivered module, across the ballast block, and over to the module to be picked up.

6. Epilogue

In 1996, Edwin Mowforth was a consultant to the German firm CargoLifter AG regarding the design of their semi-rigid CL160 heavy lift airship, which also was designed for in-flight load exchanges. CargoLifter selected a tethered load exchange process, which is described in my separate article on CargoLifter.

7. For more information:

- Mike Kenward, “Son of Zeppelin - A conference at the Royal Garden Hotel on 10-11 April (1966) could herald the return of the airship,” Design 1966 Journal, pp.48-49: https://vads.ac.uk/diad/article.php?year=1966&title=30&article=d.304.33
- Edwin Mowforth, “The low technology airship,” New Scientist, 25 July 1974, pp. 178-180, via archive Google Books: https://books.google.com/books?id=WpLAekLyrtAC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
- Edwin Mowforth, “The Airfloat HL Project,” Proceedings of the Interagency Workshop on Lighter than Air Vehicles, NASA-CR-137800, pp. 405 – 414, Doc ID 19760007962, 1 January 1975: https://ntrs.nasa.gov/citations/19760007962
- Edwin Mowforth, “The Airship Debate,” New Scientist, 10 July 1975, pp. 70-73, via archive on Google Books: https://books.google.com/books?id=rgdof2nsU1oC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

- A.W.L. Nayler, "British Lighter-Than-Air Activity: A Review," American Institute of Aeronautics and Astronautics 3rd Lighter-Than-Air Systems Technology Conference, Palo Alto, CA, USA, 11-13 July 1979: https://vdocuments.mx/download/american-institute-of-aeronautics-and-astronautics-3rd-lighter-than-air-systems-5852cbbab2ccf
- G.A. Khoury & J.D. Gillett, "Airship Technology," First edition, pp. 435 – 436 (hovering control), ISBN-13: 978-0521430746, Cambridge University Press, 1999
- Edwin Mowforth, "An Introduction to the Airship," 3rd edition, pp. 102 – 105, ISBN 0-9528578-6-2, The Airship Association, 2007

Other *Modern Airships* articles

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