CargoLifter AG

Peter Lobner, updated 16 September 2023

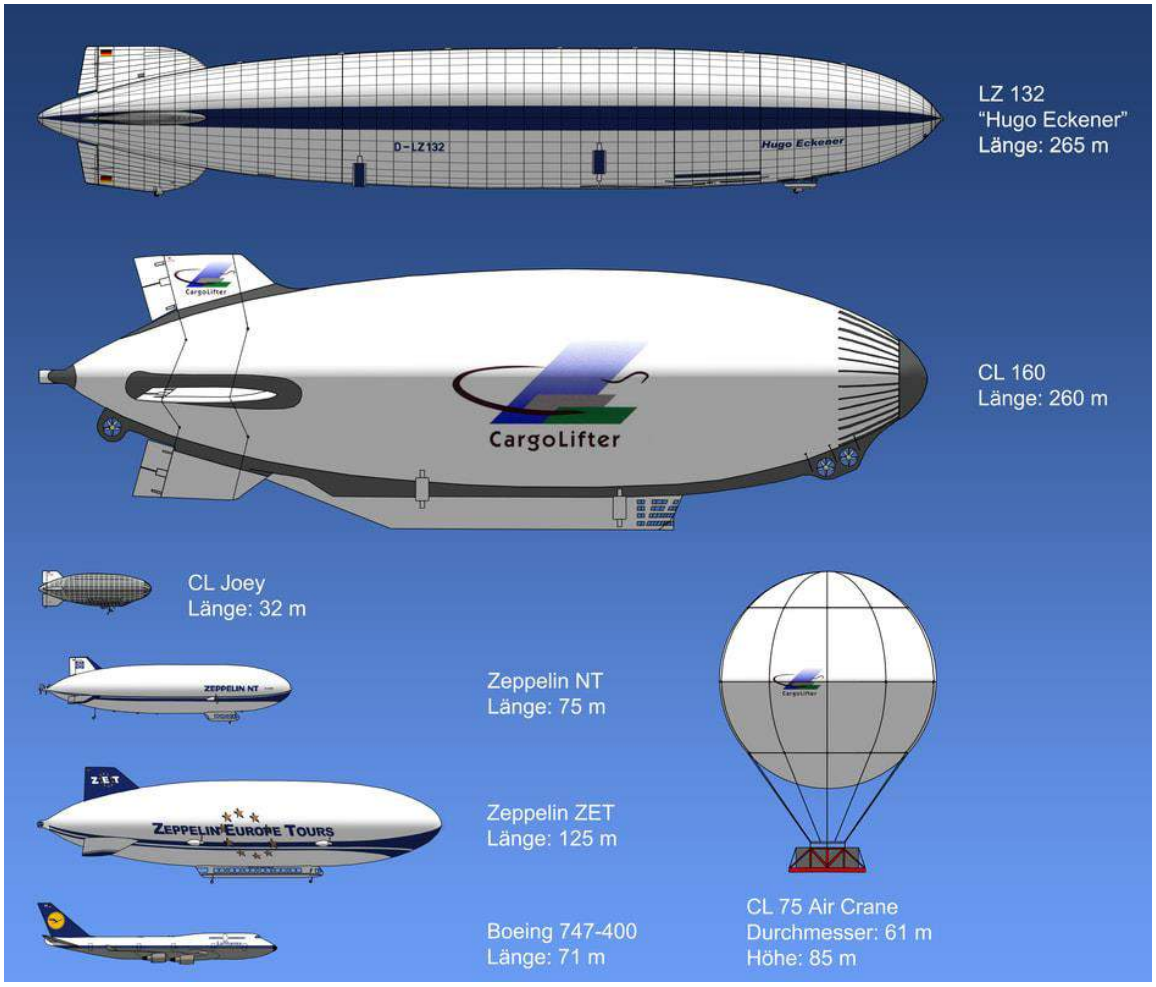
1. Introduction

Led by Carl-Heinrich Freiherr von Gablenz, CargoLifter AG was founded in September 1996 in Wiesbaden, Germany, with the objective of offering a logistics service based on the point-to point transportation of heavy and oversized loads using lighter-than-air (LTA) technology in airships of their own design. In 2000, Wired reported, “A CargoLifter study estimates that, in the US market alone, shipments heavier than 100 tons and longer than 75 feet are worth $1 billion a year.” When CargoLifter went public on 30 May 2000 on the Frankfurt Stock Exchange, the company had a valuation of almost $180 million.

An abandoned former Soviet military airbase in Brand-Briesen, south of Berlin, was selected as the site to build their production and operation center, including a giant airship hangar that in 2020 remains the largest freestanding building in the world.

CargoLifter hangar circa 2001. Source: Stefan Kühn via Wikipedia

Three different types of CargoLifter airships were planned: the 1:8 scale manned experimental airship “Joey,” the unmanned CL75 AC “AirCrane” transportation balloon and the CL160 semi-rigid airship. The CL160 was much larger than the LZ-129 Hindenburg zeppelin built in the 1930s and the similar LZ-132 concept from the 1950s.



Size comparison of CL160 CargoLifter, CL75 AC AirCrane transportation balloon, and CL “Joey” experimental airship with other air vehicles.
Source: migenda.weebly.com

First flight of the CL160 originally was planned to occur in 2003, with series production starting in 2004 / 2005. The first unit, known as P1, was intended to be certified as an experimental aircraft and used mainly for development risk reduction. The second unit, P2, would have been used to validate lift, control and maneuvering systems in a comprehensive development program leading to type certification.

CargoLifter AG planned to build up to 50 CL160 airships and 10 CL75 AC transportation balloons by 2015 and establish the global infrastructure that could support this fleet of airships. The expected price of the CL160 was about $60 million and the CL75 AC price was about $10 million.

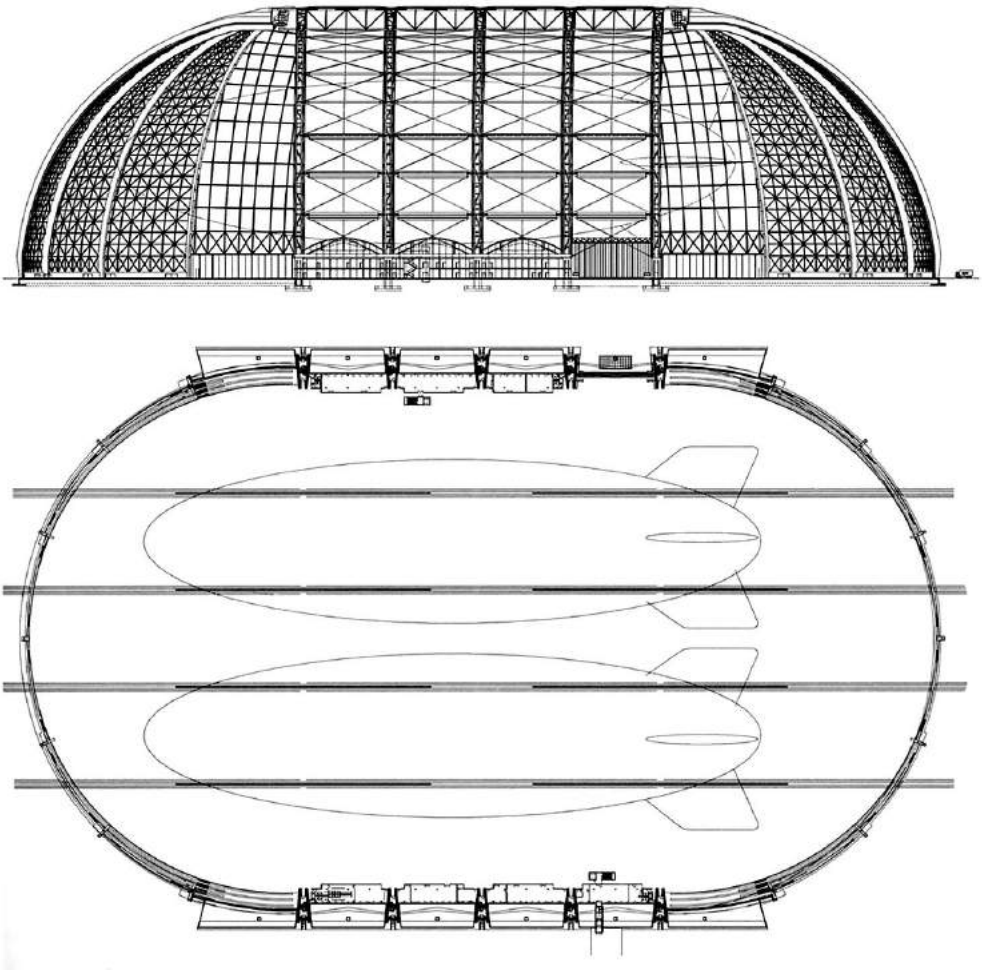
In April 2002, Forbes reported, "…CargoLifter, a would-be manufacturer of heavy-lift dirigibles that so far has lifted $263 million from investors and done precious little else." With a rapidly deteriorating financial condition, in May 2002, CargoLifter attempted to negotiate a rescue plan with its British competitor Advanced Technologies Group (ATG).

CargoLifter AG announced insolvency on 2 June 2002. This was after their giant hangar in Brand-Briesen had been completed, the Joey and CL75 AC had flown, and their purchased Skyship 600B training airship had been delivered and flown, but before the first CL160 heavy-lift airship was built. Liquidation proceedings started in July 2002.

CargoLifter CL160 airship design evolution.
Source: Zukunft-in-Brand e.V. (2006)

2. The CargoLifter hangar

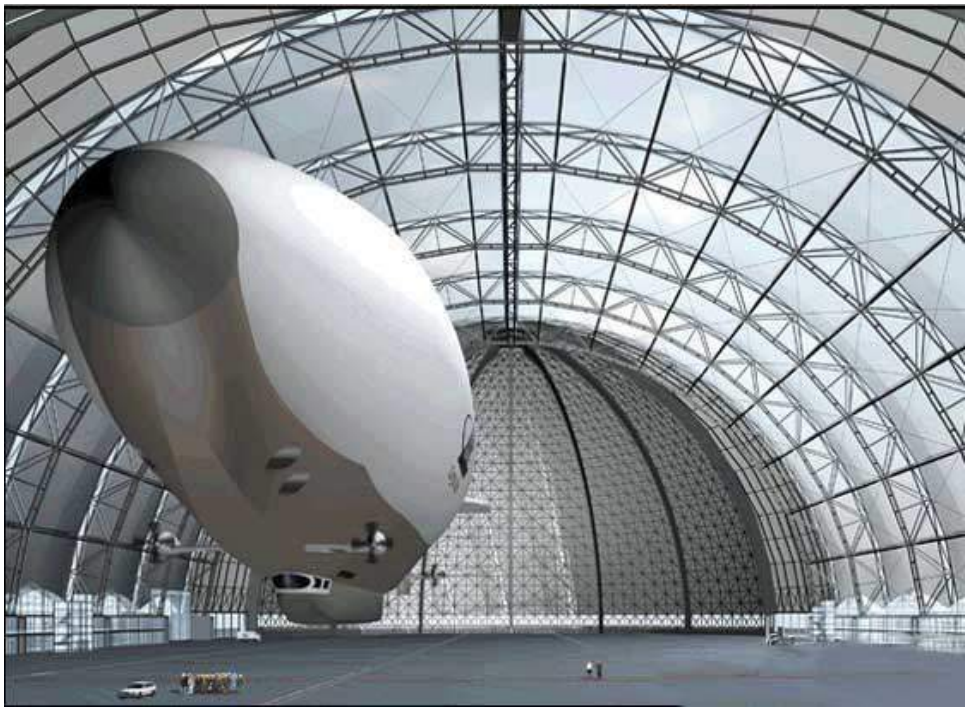
The massive hangar at Brand-Briesen measures 360 m (1,180 ft) long x 220 m (720 ft) wide x 106 m (348 ft) high and was designed to handle two CL160 airships. It would have been the site for manufacturing the CL75 AC balloons and CL160 airships.



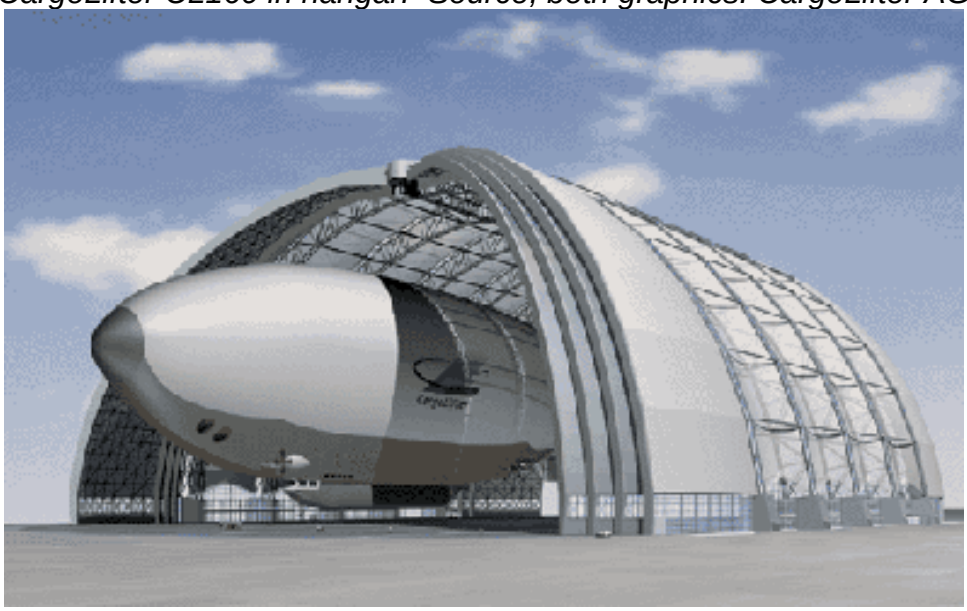
Elevation and plan views of the CargoLifter hangar.
Source: https://www.atlasofplaces.com/architecture/CargoLifter/

Most of the hangar construction work was completed by the end of 1999 at a cost of about $77 million, 50 percent or which was subsidized by the Brandenburg state government. CargoLifter also built an adjacent CargoLifter World theme park, which opened in the Spring of 2000. The park enabled the interested public to get a close-up view of the company's development activities.

You can appreciate the scale of the hangar in the following graphics, which shows a single CL160 airship inside the hangar.



CargoLifter CL160 in hangar. Source, both graphics: CargoLifter AG



The giant hangar was sold during liquidation of CargoLifter's assets in 2002 and is still in use today, not for aviation, but as the world's largest indoor tropical rainforest and water theme park named Tropical Islands Resort. Here's the link: https://www.tropical-islands.de/en

3. The CargoLifter "Joey" (renamed Ziphius 900 in 2010)

"Joey" is a small scale (1:8) experimental airship that is so named because it could fit inside a CL160's cargo bay like a kangaroo baby in its mother's pouch. It is a semi-rigid airship with a rigid, tubular carbon fiber keel attached under a non-rigid gas envelope. The keel supports the propulsion system and a small welded steel-frame gondola with side-by-side seating for a pilot and test engineer (or a pilot and more extensive measuring equipment).

General design parameters of the CargoLifter Joey airship

Parameter	**CargoLifter Joey**
Length	32 m (105 feet)
Diameter	7.9 m (26 feet)
Envelope volume	1,050 m^3 (37,080 ft^3) total, arranged in four helium cells: approx. 100 m^3 in the bow, 100 m^3 in the stern, & 400 m^3 each in port & starboard mid-ship cells
Envelope pressure	No separate ballonet. Fans maintain 450 Pa (4.5 mbar) pressure inside the envelope.
Empty weight	827 kg (1,823 lb)
Cargo capacity	220 kg (485 lb)
Accommodations	Pilot + passenger or test equipment
Propulsion	2 x 17.6 kW (24 shp) engines attached by pylons to the rigid keel, each driving a fixed propeller
Aerodynamic controls	Cruciform tail fins with control surfaces are connected to one another via a rigid internal wire-braced frame structure inside the hull.

Development of Joey started in early 1997 at the University of Stuttgart. Joey made its maiden flight on 18 October 1999, about the time that construction started on the massive CargoLifter hangar. Development and construction of Joey helped CargoLifter AG obtain approval in Germany as an aviation development company.

CargoLifter AG used Joey to support the development and validation of the software being used to design and simulate CL160 flight characteristics, to test in-flight airship behavior (i.e., of the helium cells and air cells), and to support development of airship operating processes and procedures. In addition, Joey was used to inspect airship hangar construction from the outside.

Joey in flight as hangar construction starts. Source: CargoLifter

Joey on a mobile mooring with hangar construction in progress. Source: DPA

Joey in flight near the completed hangar. Source: CargoLifter AG

Joey tailplanes and control surfaces. Source: Zukunft-in-Brand e.V. (2006)

Joey on approach to landing. The black circle visible on the side of the envelope is one of two helium valves. Source: Screenshot, Joey-Testflug video (2008)

Joey two-seat cockpit & twin engine installation, with envelope air supply ducts in the propeller slipstreams. Source: Screenshot, Joey-Testflug video (2008)

Joey in its hangar, circa 2000. Source: CargoLifter

The insolvency administrator sold Joey for € 13,000 (about $15,860 at a 2002 exchange rate of 1.22). Today it is in France, where it has been owned by Marvin Johnson since 2010 renamed Ziphius 900.

Joey reincarnated as Ziphius 900. Source: Marvin Johnson

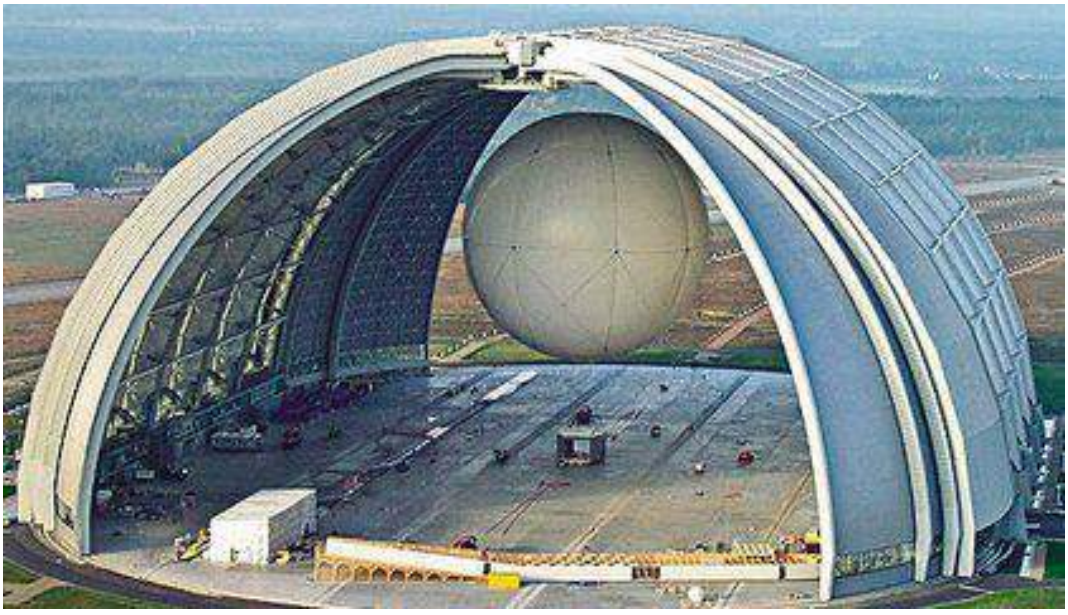
4. The CargoLifter CL75 AC transport balloon (AirCrane)

The CL75 AC, also known as the AirCrane, was an unpowered, unmanned, heavy-lift, spherical balloon designed to lift elongated, bulky, cumbersome items and be towed by ground vehicles, a ship or a large helicopter. The CL75 AC had a transport load capacity of up to 75 metric tons (75,000 kg, 165,347 lb). The basic design and operation of this type of transport balloon is described in CargoLifter AG patent application US2002/0109045 (published in 2002).

General design parameters of the CL75 AC

Parameter	CL75 AC
Diameter	61 m (200 ft)
Height, overall, incl. cargo load frame	85 m (279 ft)
Envelope volume	110,000 m^3 (3,884,600 ft^3)
Cargo capacity	75 metric tons (75,000 kg, 165,347 lb)
Load frame dimensions	13 x 6 x 6 m (42.6 x 19.7 x 19.7 ft)
Maximum altitude	762 m (2,500 ft) above sea level
Maximum transport speed (towed)	70 kph (43.5 mph)

The balloon envelope was developed by ILC Dover and TCOM and manufactured in the US. The load frame was developed and manufactured in the US by AdvanTek International LLC. The complete CL75 AC was integrated in the CargoLifter AG hangar.



CL75 AC in the CargoLifter hangar. Source: CargoLifter AG

The CL75 AC would have been integrated with CL160 airship operations in CargoLifter AG's planned worldwide heavy-lift transportation infrastructure. In operation, the CL75 AC would have been towed by one or more ground vehicles to move heavy cargo from place to place, over ranges up to 250 km (155 miles). The CL75 AC also was used to validate the tethered in-flight load exchange process to be employed by the CL160.

In 2001, CargoLifter AG received an order for one CL75 AC transportation balloon, priced at $10 million USD, from Heavy Lift Canada, Inc., which was headquartered in Calgary, Alberta. Under the agreement, CargoLifter was to deliver the CL75 AC by December 2002 and Heavy Lift Canada would deploy it in commercial operation for the transport of oilfield equipment over ice roads in Canada's Arctic and in Alaska. Heavy Lift Canada also secured an option to purchase 25 additional CL75 AC balloons for $10 million USD each. Heavy Lift Canada commented, "With its capabilities, the CL75 AC enables drilling companies to extend the current season for oil and natural gas exploration in remote Northern areas,"

The CL75 AC was severely damaged by high winds in a storm on 10 July 2002.

In August 2002, all work on the CL75 AC was halted after CargoLifter AG declared insolvency. None were ever delivered.

CL75 AC aloft on tethers during May 2002 load test with German mine-clearing tank. Source: CargoLifter

5. Load exchange experiments with CL75 AC transport balloon

The load exchange ballasting process for the CL160 was tested from 2000 – 2002 and demonstrated successfully using the CL 75 AC and a specially designed load frame that also carried water ballast when needed. In one outdoor test on 7 May 2002, a 55 metric ton (60.5 ton) German mine-clearing tank was loaded, lifted and discharged from the carriage as water ballast was unloaded and later reloaded in approximately the same time it took to secure the tank in the carriage (several minutes). In this test, the 55 metric tons cargo was exchanged with about 55 cubic meters (1,766 cubic feet, 14,530 US gallons) of water ballast.

Cargo has been loaded. The AC75 is held on the ground by the combined weight of the cargo and ballast water (blue) in the tanks of the load frame.

Pumping the ballast water from the load frame to the tanker trucks makes the balloon system lighter-than-air and it lifts off with the cargo, controlled by its tether.

At the destination, the CL75 AC is hauled down. Ballast water is pumped back into the load frame upon landing, stabilizing the balloon system safely on the ground. The cargo now can be removed from the load frame. The balloon system remains held on the ground by the weight of the ballast water.

You can watch a short video of this load exchange test and a simple animation of the water ballast transfer process at the following link. The three graphics above are screenshots from this video.
https://www.youtube.com/watch?v=lralh-LwcJQ

6. Airship Industries SkyShip 600B training airship

In April 2000, FlightGlobal reported: “CargoLifter has ordered a Skyship 600B airship with which to begin preparations for its planned CL-160 large cargo airship operations. The contract is worth $6.4 million to Orlando, Florida-based Airship Operations and UK sister company Global Skyship Industries. The Skyship will be assembled and flight tested by Airship Operations next April (2001), and delivered to CargoLifter's Brand, Germany base. Airship Operations will also help the company gain its German air operator's certificate after which CargoLifter will use the Skyship to train CL-160 flight test and line operating crews. Operation of the cargo lifters are to begin in 2002.”

The Airship Industries Skyship 600B, nicknamed “Charly,” in CargoLifter livery, sharing the hangar with the CL75 AC. Source: dpa

After CargoLifter’s insolvency in 2002, Skycruise Switzerland Ltd. acquired the Skyship 600B after its operating license had expired. The airship made no further passenger flights in Germany. However, it was used in other roles, including as a surveillance airship at the 2004 Olympic Games in Athens.

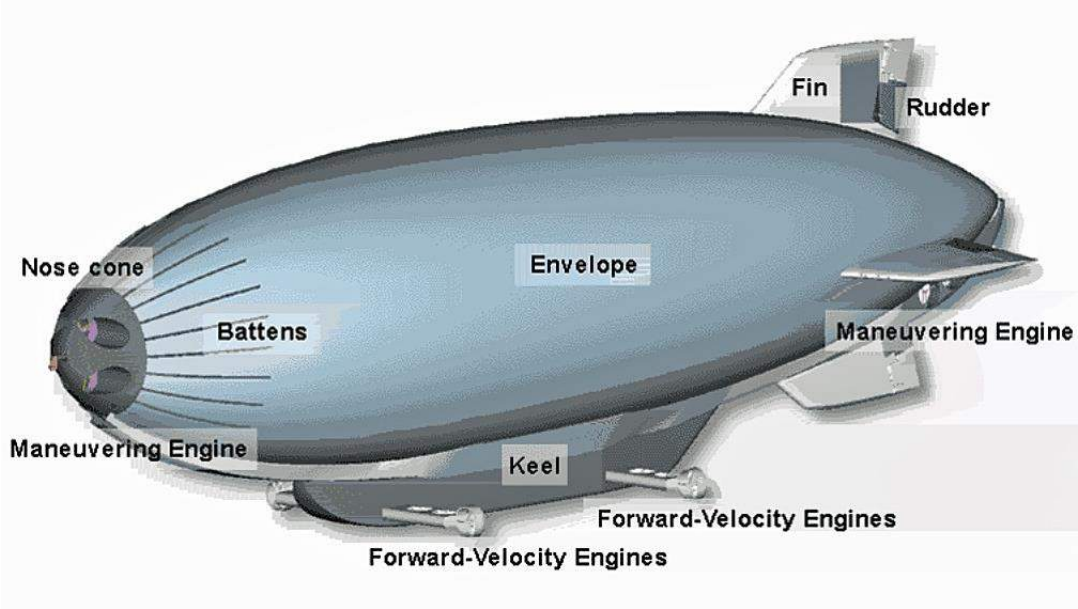
CargoLifter's Skyship 600B "Charly".
Source, both photos: Zukunft-in-Brand e.V. (2006)

Source: Frankfurter Allgemein FAZ.NET (2015)

CargoLifter's Skyship 600B "Charly".
Source: Zukunft-in-Brand e.V. (2006)

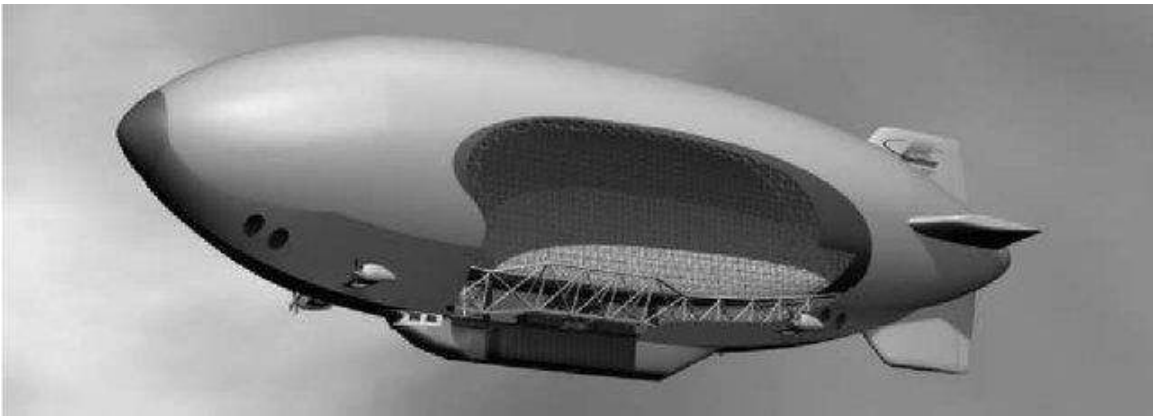
7. The CargoLifter CL160 heavy-lift airship

The CL160 was a very large, conventional, semi-rigid airship with a rigid structural keel coupled to a pressurized gas envelope that supports the full weight of the airship. The neutrally-buoyant airship can hover without the use of propulsive lift from its engines and can perform a vertical takeoff and landing (VTOL). The general arrangement of the CL160 is shown in the following diagram.

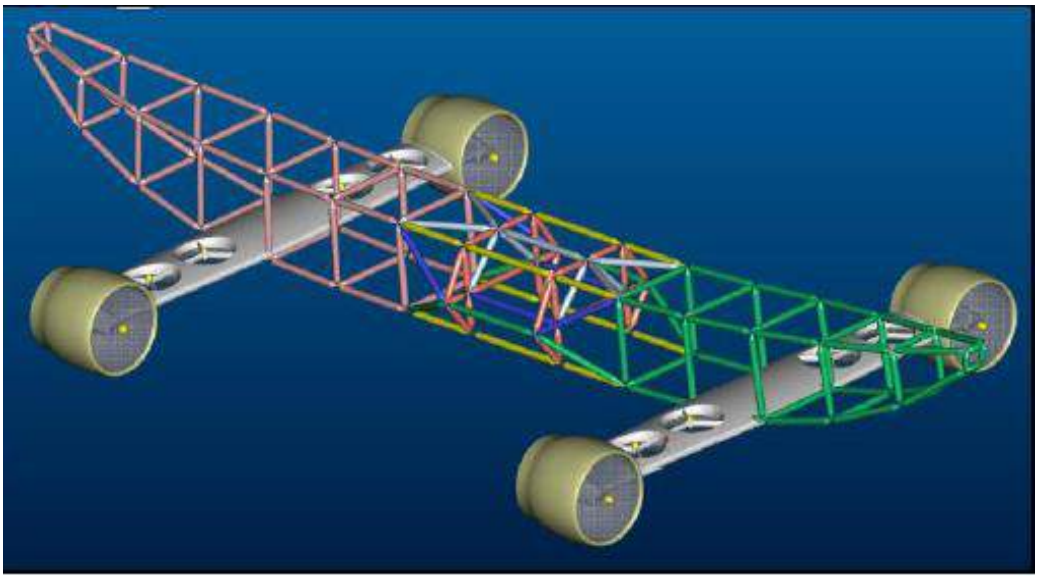


Source: CargoLifter AG

The long structural keel under the envelope carries most of the heavy structural loads. The keel is shown in the following diagrams.

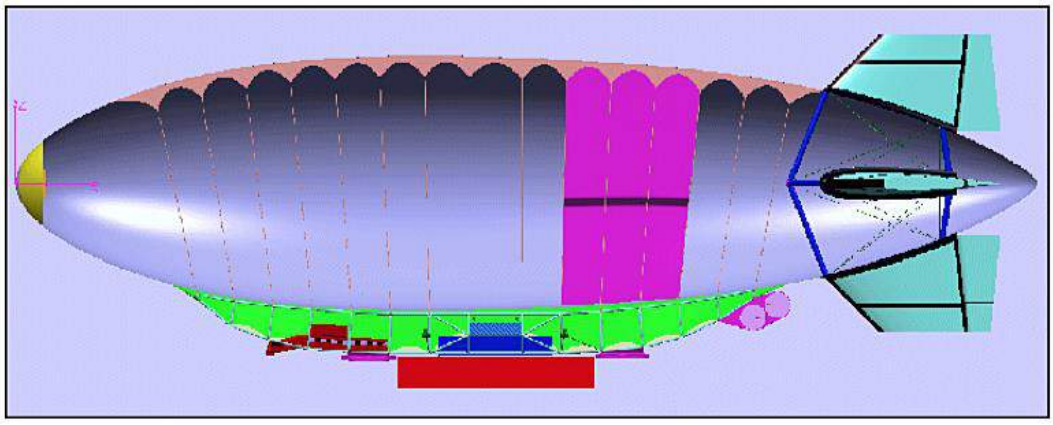


CL160 cutaway drawing showing the keel structure.
Source: Carl Schweizerhof / Wilhelm Rust, "Finite element load limit analysis of thin-walled structures….." July 2002



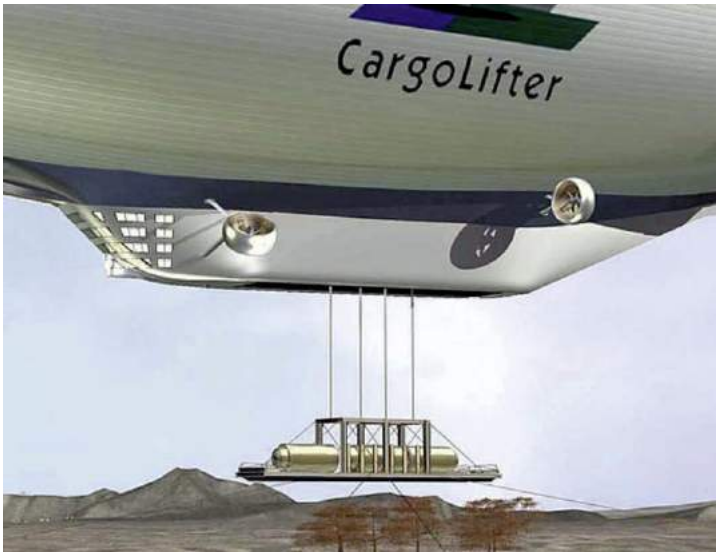
CAD rendering of the CL160 keel structure.
Source: NASA Ames Research Center, June 2016

The lift gas (helium) is in a single gas cell. The use of multiple lift gas cells was rejected due to the added complexity without a corresponding increase in safety. The weight of the loads concentrated in the keel, including up to 160 metric tons (352,000 lb) of cargo, is transferred into the upper surface of the envelope by means of traditional catenary curtains, as shown in the following diagram. Also shown in this diagram is the internal wire-braced frame structure that carries fin forces and distributes those forces into the pre-tensioned (pressurized) envelope. Each fin had a cord of 42 m (137.8 ft) and a span of 21 m (68.9 ft).



CL160 keel structure (green), catenary curtain (rose & magenta), and fin support frame (blue). Source: NASA Ames Research Center, June 2016

The CL160 was designed for conducting airborne, tethered load exchanges. The airship does not land to pick up or drop off cargo.



Instead, cargo carried in the internal cargo bay, is lowered to the ground on a load frame from a hover altitude of about 100 m (328 ft). A water ballast exchange occurs before the tether can be released and the load frame can be hoisted back to the airship.

Source: CargoLifter AG

The conceptual design was frozen in November 1998. In February 2002, the Preliminary Design Review (PDR) was completed, confirming the technical feasibility of the project and leading to the next stage in its development, the Detailed Design phase. In May 2002, CL160 development was halted due to financial problems.

General design parameters of the CL160

Parameter	**CL160**
Length	260 m (853 ft)
Diameter, max.	65 m (213 ft)
Height, overall	82 m (269 ft)
Envelope volume	550,000 m^3 (19,423,067 ft^3)
Envelope material	Proprietary two-layer laminate with embedded LCP (liquid crystal polymer) fibers
Payload bay volume	3,200 m^3 (113,000 ft^3)
Crew size	10 to 12 people
Cargo capacity	160 metric tons (176 tons, 352,000 lb)
Load frame dimensions	50 x 8 x 8 m (164 x 26.2 x 26.2 ft)
Propulsion and control	8 x GE CT7-8L turboshaft engines (2,500 – 3,000 shp class), 4 x for propulsion, 4 x for maneuvering control
Speed, cruise	90 kph (56 mph)
Speed, max.	125 kph (77.7 mph)
Altitude, max. (pressure altitude)	2,000 m (6,562 ft)
Range	up to 10,000 km (6,214 miles)

8. Executing a load exchange from a hovering CL160 airship

Among the challenges in making an in-flight load exchange from a hovering airship are station keeping over the destination, and managing the balance between lift and mass while massive cargo items are being added to, or removed from, the airship. CargoLifter AG's patent US2011/0057158, which was granted in 2001, describes a process for accomplishing these tasks by anchoring the hovering airship to the ground and transferring ballast water to or from the load frame as needed during a load transfer.

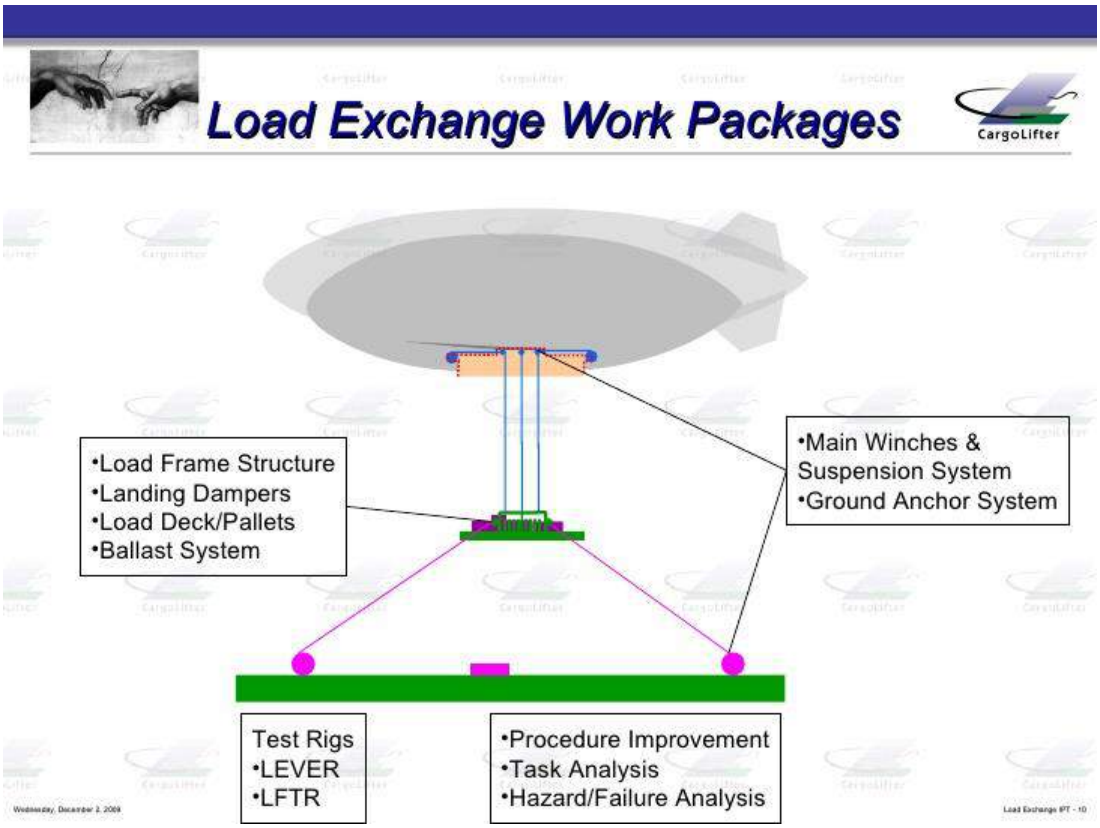
As described on the Aviation Technology website (https://www.aerospace-technology.com/projects/CargoLifter/) the CL160 would perform an in-flight delivery of cargo as follows

> "The airship's load exchange procedure makes use of a new, specially developed technology, allowing it to load and unload without landing. The airship hovers at about 100 m above the ground and a special loading frame, which is fixed during flight to the keel of the airship, is then rigged with four cable winches to the ground, a procedure which is to assure that the airship's lifting gear stays exactly above the desired position. Ballast water is then pumped into tanks on the frame and the payload can be unloaded. The anchor lines are released and the frame is pulled back into the payload bay of the airship."

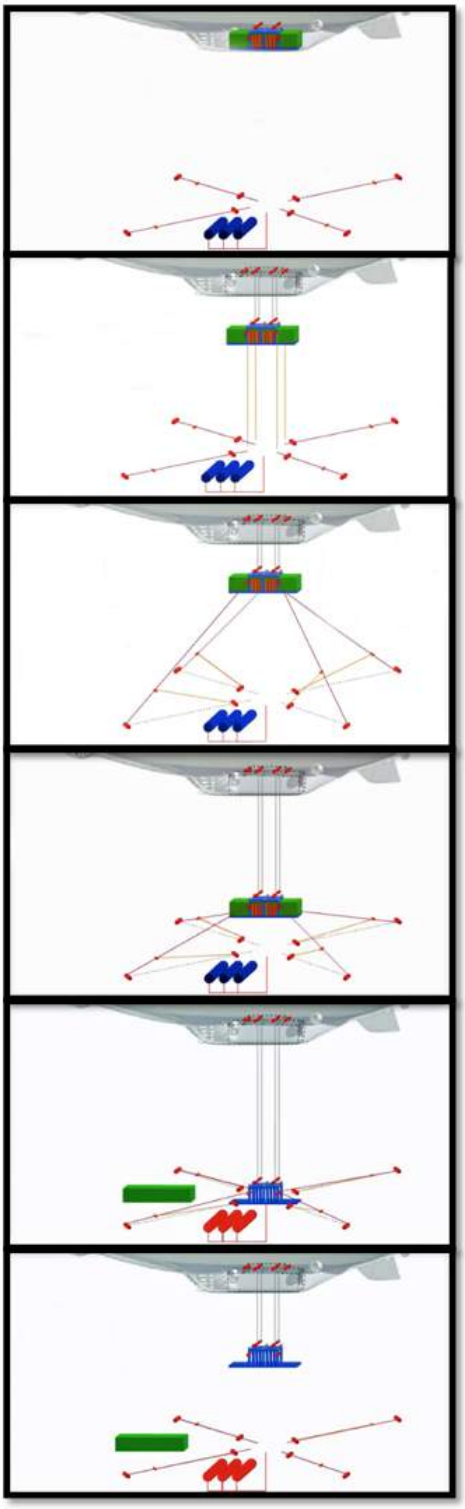
When the CL160 receives new cargo during a load exchange transaction, the weight of water ballast on the load frame needs to be reduced by the same amount as the weight of the new cargo. CargoLifter claimed that a load exchange could be conducted in steady wind up to 10 m/s (22.3 mph) or +/- 5 m/s (11 mph) gusts, comparable to operating limits for a modern construction crane.

You can view a short CargoLifter AG video showing the load exchange process here: https://zukunft-in-brand.de/lta/lta-technik-gesellschaft/2006/cl-160.html

Load exchange in progress from a CL160 hovering at about 100m (328 ft).
Source, both graphics: CargoLifter AG



An in-flight load exchange is illustrated in the following graphics. The sequence-of-events graphic was created with screenshots from the above video. A 160 metric tons cargo requires the exchange of 160 cubic meters (5,138 cubic feet, 42,269 US gallons) of water ballast.



The CL160 arrives above the delivery site with cargo . The ground anchor system and ballast water on the ground are ready.

The CL160 lowers its load frame with the cargo and empty ballast tanks. Haul-down cables are dropped to the ground.

The CL160 haul-down cables are secured to the ground anchor system. The CL160 is now tethered to the ground via the load frame.

The load frame is hauled down to the ground while the tethered CL160 hovers above.

The load frame is ballasted from the ground storage tanks with water equivalent in weight to the cargo. Then the cargo is removed.

The ballasted load frame is released from the ground anchor system and is lifted back up into the CL160. The airship can depart the site.

9. CargoLifter AG epilogue

Almost two decades after the demise of CargoLifter AG, the CL160 business venture remains as an important milestone in the development of the technology and the business case for modern heavy cargo airships.

Work on a heavy lift airship is continuing at the successor firm, CL CargoLifter GmbH & Co. KGaA, which was founded in Berlin in 2005, and is the subject of a separate article.

10. For more information

CL160 heavy-lift airship

- Ingolf Schafer, “Structural Design Aspects of the CargoLifter CL160,” AIAA-99-3910, American Institute of Aeronautics & Astronautics, 1999: https://arc.aiaa.org/doi/pdf/10.2514/6.1999-3910
- Kevin Bonsor, “How CargoLifter's Airship Will Work,” HowStuffWorks: https://science.howstuffworks.com/transport/flight/future/CargoLifter.htm
- “CargoLifter CL160,” Aerospace Technology: https://www.aerospace-technology.com/projects/CargoLifter/
- “CargoLifter CL160,” GlobalSecurity.org: https://www.globalsecurity.org/military/systems/aircraft/CargoLifter.htm
- Mike Steere, “The Baron’s Big Balloon,” Wired, 1 August 2000: https://www.wired.com/2000/08/airships/
- “All hangar, no airship,” Forbes, 28 April 2002: https://www.forbes.com/global/2002/0429/034.html?sh=67ae273185df
- “Grund zur Hoffnung - Verhandlungen mit dem britischen Luftschiffbauer ATG sollen aus der Insolvenz führen (Reason for hope - Negotiations with the British airship builder ATG should lead out of bankruptcy),” Manager Magazin, 9 May 2002: https://www.manager-magazin.de/finanzen/artikel/a-212568.html

- “Deutsche Zeppeline und Zeppelinprojekte nach 1945 (German Zeppelins and Zeppelin Projects Since 1945),” migenda.weebly.com: https://migenda.weebly.com/deutsche-zeppeline-und-zeppelinprojekte-nach-1945.html
- “SIAT GmbH CargoLifter 1997–1999” (a detailed description of the CargoLifter hangar), 425AR, August 2018: https://www.atlasofplaces.com/architecture/CargoLifter/

CL75 AC AirCrane

- “CargoLifter sells first CL 75 AC,” CTK Protext press release, 2001: https://www.protext.cz/novy/press-release.php?id=3789

Joey experimental airship (renamed Ziphius 900)

- “Das Versuchsluftschiff ‘Joey’ (The experimental airship ‘Joey’),” Zukunft-in-Brand e.V., LTA Technik & Gesellschaft,12 May 2006: https://zukunft-in-brand.de/lta/lta-technik-gesellschaft/2006/joey.html
- “The dirigible airship: could it have a comeback?,” InOut.rennes, 11 September 2019: https://inout.rennes.fr/en/blog/the-dirigible-airship-could-it-have-a-comeback/

Skyship 600B “Charly” training airship

- (Skyship 600B) “Airship order boosts CargoLifter preparation,” FlightGlobal, 3 April 2000: https://www.flightglobal.com/airship-order-boosts-cargolifter-preparation/31549.article
- “SkyShip 600 B “Charly,” LTA Technik & Gesellschaft, 7 May 2006: https://zukunft-in-brand.de/lta/lta-technik-gesellschaft/2006/charly.html

Videos

- “CargoLifter, ein Joey-Testflug (a Joey test flight),” (1:26 min), posted by CargoLifter GmbH, 10 July 2008: https://www.youtube.com/watch?v=HkcFjt0D42o&t=1s

- “CargoLifter CL-75 - Demonstration des Lastaustauschs (Demonstration of load exchange),” (5:19 min), posted by CargoLifter GmbH, 5 May 2011: https://www.youtube.com/watch?v=lralh-LwcJQ
- “Prinzip des CargoLifter-Lastaustauschs (Principle of the CargoLifter load exchange),” (2:14 min), posted by CargoLifter GmbH, 24 July 2014: https://www.youtube.com/watch?v=sedQ_9RdKVM

CargoLifter AG patents (now assigned to successor firm CL Cargolifter GmbH and Co KGaA)

- US2002/0109045, “Spherical LTA cargo transport system,” Filed 19 November 2001; Published 15 August 2002; Assigned to CargoLifter Inc.: https://patents.google.com/patent/US20020109045A1/en
- US6231007, “Method for the precise setting down or picking up of cargo from airships,” Filed 16 June 1998; Granted 15 May 2001; Assigned to CargoLifter AG: https://patents.google.com/patent/US6231007B1/en

Other *Modern Airships* articles

- *Modern Airships - Part 1*: https://lynceans.org/all-posts/modern-airships-part-1/
    - Airship Industries - SkyShip 600B
    - CL Cargolifter GmbH and Co KGaA – rigid heavy lift airships and balloon systems
    - Lockheed Martin - Large conventional semi-rigid airship
- *Modern Airships - Part 2*: https://lynceans.org/all-posts/modern-airships-part-2/
    - Flying Whales – LCA60T
- *Modern Airships - Part 3*: https://lynceans.org/all-posts/modern-airships-part-3/