

Flying Whales rigid airships

Peter Lobner, 28 July 2019

Background

The LCA60T (Large Capacity Airship, 60 Tons) is a rigid, heavy-lift, cargo airship being developed by the French firm Flying Whales. This airship originally was designed to meet the needs of the French Public Forest Office (ONF, Office National des Forêts) for the extraction of timber in hard-to-reach forest areas. However, the airship's abilities to carry very large, heavy loads and to perform load exchanges while hovering over a remote delivery site open a much broader market opportunity to help solve complex logistics issues in many landlocked and undeveloped regions around the world. The corporate motto is "connecting the land-locked world to the global economy."

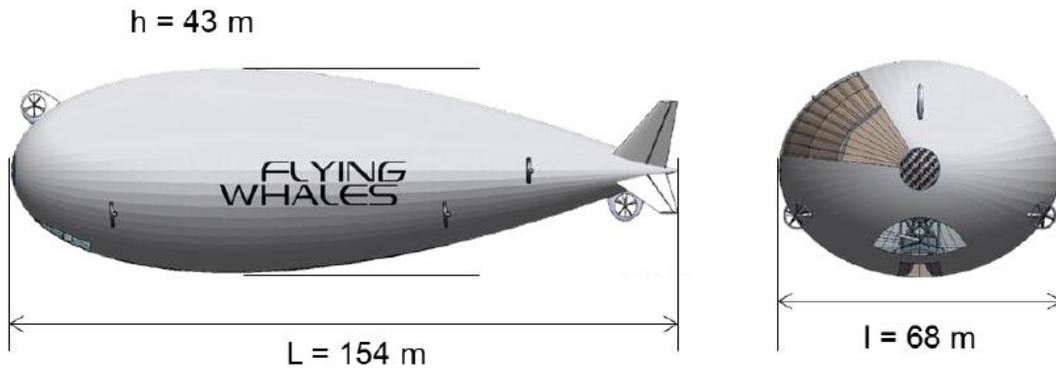
In March 2018, Flying Whales' chief executive officer, Sébastien Bougon, reported that the company has already secured about € 200 million (\$246 million) in capital. Investors include the French state fund Bpifrance, which injected € 25 million, China's state-owned aviation company AVIC General, which owns about 25% of Flying Whales, and China's Ministry Of Science and Technology (MOST). France's ONF and the Nouvelle Aquitaine region in the southwest of the country also are backing the project.

The flight test phase is scheduled to begin in 2020 and the maiden flight of the LCA60T prototype is set to take place in 2021. Flying Whales also plans an initial public offering in 2021. The LCA60T will be the world's largest cargo delivery airship when it enters commercial service in about 2022.

The Flying Whales website is here: <http://flying-whales.com/en>

The LCA60T airship

The basic configuration and dimensions of the LCA60T airship are shown in the following graphic. This rigid, heavy-lift airship is being designed to handle up to 60 metric tons (60,000 kg; 132,277 lb) of cargo that is stowed in a large, ventral cargo hold or suspended externally under the airship.



LCA60T side and front views. Source: Flying Whales

The shape of the airship is established by its rigid structural framework, which also supports the loads of the airships systems, crew compartment and cargo handling features, and provide attachments for carrying the loads from the stabilizing fins and distributed propulsors. The outer hull (envelope) is comprised of multi-layers of specialized fabrics. The helium lift gas is contained in 10 unpressurized cells within the rigid airframe and outer hull. The LCA60T will have a maximum airspeed of 100 kph (62 mph), and will operate at a maximum altitude of 3,000 meters (9,843 feet).



LCA60T front quarter view. Source: Flying Whales



LCA60T rear quarter view. Source: Flying Whales

Other basic features of the LCA60T airship include:

- Carbon-fiber composite, rigid lattice airframe structure
- Distributed hybrid propulsion system
 - Small diesel generator
 - Graphene-based ultra-capacitors can be charged and discharged faster than conventional batteries
 - Seven electrically-powered propulsors
- Capable of Vertical takeoff and landing (VTOL) and hovering
 - No landing gear. The airship will moor to a mast at a permanent or temporary operating base
- Cargo can be carried internally in a capacious ventral cargo bay measuring 80 m long x 8 m wide x 5 m high (262.5 x 26 x 16.2 ft),
- Outsized cargo, such as electric transmission pylons, wind turbines, and even entire houses, can be carried externally as sling loads.
- Load exchange can occur while the airship is airborne (hovering). Landing is not required to transfer cargo.
 - Canadian firm REEL COH Inc. is supplying 12 winches that provide the capability to lift or deliver 60 tons of cargo
 - An exchange of water ballast is required during the airborne load exchange

- The airship also can land at a permanent or temporary land base and discharge or load cargo from its internal cargo bay while on the ground.
 - An exchange of water ballast is required during the load exchange on the ground
- Maximum range: about 1,000 km (621 miles).
 - In practice, the radius of action is expected to be about 100 km (62 miles).
- Crew of 3, including pilot and loadmaster

In January 2019, Flying Whales completed a test program at an ONERA wind tunnel in Lille, France. The program produced aerodynamic measurements on a 1/150th-scale model of the LCA60T airship to be used in creating a digital model for future simulation of the airship's behavior.



LCA60T model in an ONERA wind tunnel.

Source: ONERA



Polygonal model of the Flying Whales airship (not representative of the smooth surface on the actual airship) showing the long ventral opening for the cargo bay; on display at the Paris Air Show 2019.

Source: Joseph Flaig / Institution of Mechanical Engineers, 17 Jun 2019

Load exchange

The LCA60T's cargo handling system will pick up and deliver cargo carried internally in the large ventral cargo hold or carried externally as sling loads. Flying Whales plans to use water as ballast to manage buoyancy during a load exchange. For example, a load exchange of 60 metric tons can be balanced by the corresponding transfer of 15,850 US gallons of water. The process should look something like this:

- At the start of cargo delivery, the hovering airship will be carrying a heavy cargo load and little or no water ballast. Winches on the airship will lower the cargo from the airship's cargo bay to the ground. While the airship is still connected to the cargo, pumps installed at the delivery site will send an equivalent weight of water ballast up to the hovering airship, gradually unloading the winch cables and transferring the weight of the cargo to the ground. Then the ballasted airship will be at or near neutral buoyancy and it will be safe to release the airship's winch cables from the cargo on the ground.

- At the start of a cargo pickup, the hovering airship will be at or near neutral buoyancy and will be carrying a significant amount of water ballast. Winches on the airship will lower the lift cables, which will be connected to the cargo on the ground. Lifting the cargo will require the airship to discharge water ballast equal to the weight of the cargo to be picked up and reestablish neutral buoyancy with the cargo fully supported by the airship. Then the winches on the airship can lift the cargo into the internal cargo bay. The process for discharging the water from the airship has not yet been defined.

This ballasting process for the LCA60T is somewhat similar to the process developed and tested about two decades ago by the German firm CargoLifter AG for their planned, much larger CL 160 semi-rigid airship, which also was designed for airborne cargo pickup and delivery. Their load exchange process was first demonstrated successfully on 5 October 2001 using the CargoLifter CL 75AC heavy-lift aerostat, a special cargo carriage, a 25 metric ton load and 25 metric tons of water ballast. In this test, the water ballast was not pumped up to the airship, but instead was loaded and discharged from the special carriage while it was on the ground.



*LCA60T shown delivering a large item from its internal cargo hold.
Source: Flying Whales*



LCA60T shown delivering a complete housing unit as an external sling load. Source: Flying Whales



LCA60T shown delivering a set of wind turbine blades as an external sling load. Source: Flying Whales

Business case and competition

Flying Whales has said the LCA60T's current direct competitors are the few very large cargo helicopters presently in service:

- The Russian Mil Mi-26: 20 metric tons (20,000 kg, 44,092 lb) cargo capacity; latest model, the Mi-26M, can lift 25 metric tons (25,000 kg, 55,116 lb)
- The US Sikorsky / Erickson S-64 Skycrane: 9 metric tons (9,072 kg, 20,000 lb) cargo capacity

Flying Whales reported that the Russian helicopter had a daily operating cost of about US \$1 million, whereas the LCA60T is expected to be more than 20 times cheaper, which equates to a daily operating cost of about \$50,000.

Flying Whales told Lloyd's Loading List that it is one of a handful of 'serious' cargo airship projects in the world, including one in the UK (Hybrid Air Vehicles / Airlander), two in the US (likely Lockheed Martin LMH1 and Aeros Aeroscraft), one in Russia (likely ATLANT), and one in Canada (likely Millennium Airship SkyFreighter).

LCA60T manufacturing plans

In an interview with French newspaper Sud-Ouest, Flying Whales' CEO, Sébastien Bougon, stated that the company had chosen the Bordeaux region of France as the location of its first manufacturing plant, which will serve the European market. Representing an investment of €90 million, the factory is scheduled to enter service in 2021 and have a production capacity of up to a dozen airships annually in 2022.

In early March 2019, AVIC Research Institute announced the formation of a joint venture between Flying Whales and China Aviation Industry General Aircraft Co., Ltd. (AVIC) to develop large-capacity airships targeting the global market. A factory for the airships will be built in the central Chinese city of Jingmen.

Sébastien Bougon estimated likely sales at € 5 billion over 10 years from a fleet of 150 airships built in factories in France and China.

After the Canadian firm LTA Aerostructures (LTAA) failed to build its airship manufacturing center in Mirabel, Quebec, Canada, the Quebec government implemented a new plan to develop an airship industry in the Montreal area in collaboration with Flying Whales. In June 2019, Quebec's Economy Minister announced at the Paris Air Show that Quebec intends to buy a minority stake in Flying Whales and construct a production facility in the Montreal area within five years (by 2024).

Airship operational infrastructure plans

The Airdock

Flying Whales and French firm Groupe ADF signed an exclusive industrial and financial partnership at the 2019 Paris Air Show. The partnership provides for the construction of an airship interface system known as an "Airdock". This is a 30 meter (98 foot) tall mobile superstructure that is designed to dock an arriving LCA60T airship, undock a departing airship, maintain a parked airship in the correct position, and control the airship during ground maneuvers while it is being moved between a storage hangar and a launch pad.



*General configuration of the Group ADF Airdock.
Source: Intelligent Aerospace, 19 June 2019*

International airship bases

ADP Ingénierie, a division of the French firm Groupe ADP, which is an international airport operator, signed a Memorandum of Understanding with Flying Whales at the 2019 Paris Air Show to develop a long-term partnership for the design of up to 150 airship bases worldwide. Initial bases are likely to be in France, China, and Quebec, Canada. The goal is “to enable the low-cost, point-to-point transport of heavy and bulky loads by airship.” Groupe ADP plans to acquire an equity stake in Flying Whales.