

SkyLifter

Peter Lobner, updated 10 March 2022

1. Introduction

The firm SkyLifter, Ltd., which is headquartered in Worcestershire, UK, reports that it is developing designs for “a family of multi-rotor ‘omni-directional’ airships that share a single scalable design concept. The new design is proven to overcome many of the issues typically associated with traditional 'cigar-shaped' airships. Our aim is to enable sustainable access to the air space above us using practical and commercially viable structures that can float endlessly in the sky, like ships on the ocean, and thereby capture significant market positions in tourism, resources, cargo, and sport aviation.”

The SkyLifter website is here: <https://www.skylifter.eu>

2. SkyLifter sub-scale concept demonstrators

Two sub-scale concept demonstrators have flown and validated the basic design of the SkyLifter airships.



Betty: This 3 meter (10 ft) diameter fully-functional airship carrying a 1 kg (2.2 pound) payload validated basic airship dynamics.

Vikki: This 18 meter (60 ft) diameter unpowered aerostat validated the lifting envelope design and ground handling arrangements.

The Betty concept demonstrator. Source: SkyLifter Ltd.



Vikki concept demonstrator with 18 m (60 ft) diameter lifting envelope. Source: SkyLifter Ltd.



*Vikki in tethered flight.
Source: SkyLifter Ltd.*

SkyLifter expects to develop and fly a larger prototype as part of its future airship development and certification efforts.

3. General characteristics of SkyLifter airships

The SkyLifter airship is a symmetrical, lenticular (disk-shaped), aerostat that has no apparent front or side. A slightly-pressurized toroidal tube around the perimeter of the envelope maintains the flat disk shape. The aerostat operates at atmospheric pressure and all lift is aerostatic; there is no aerodynamic lift – because the airship needs to be able to hover above a geostationary ground position in no-wind conditions.

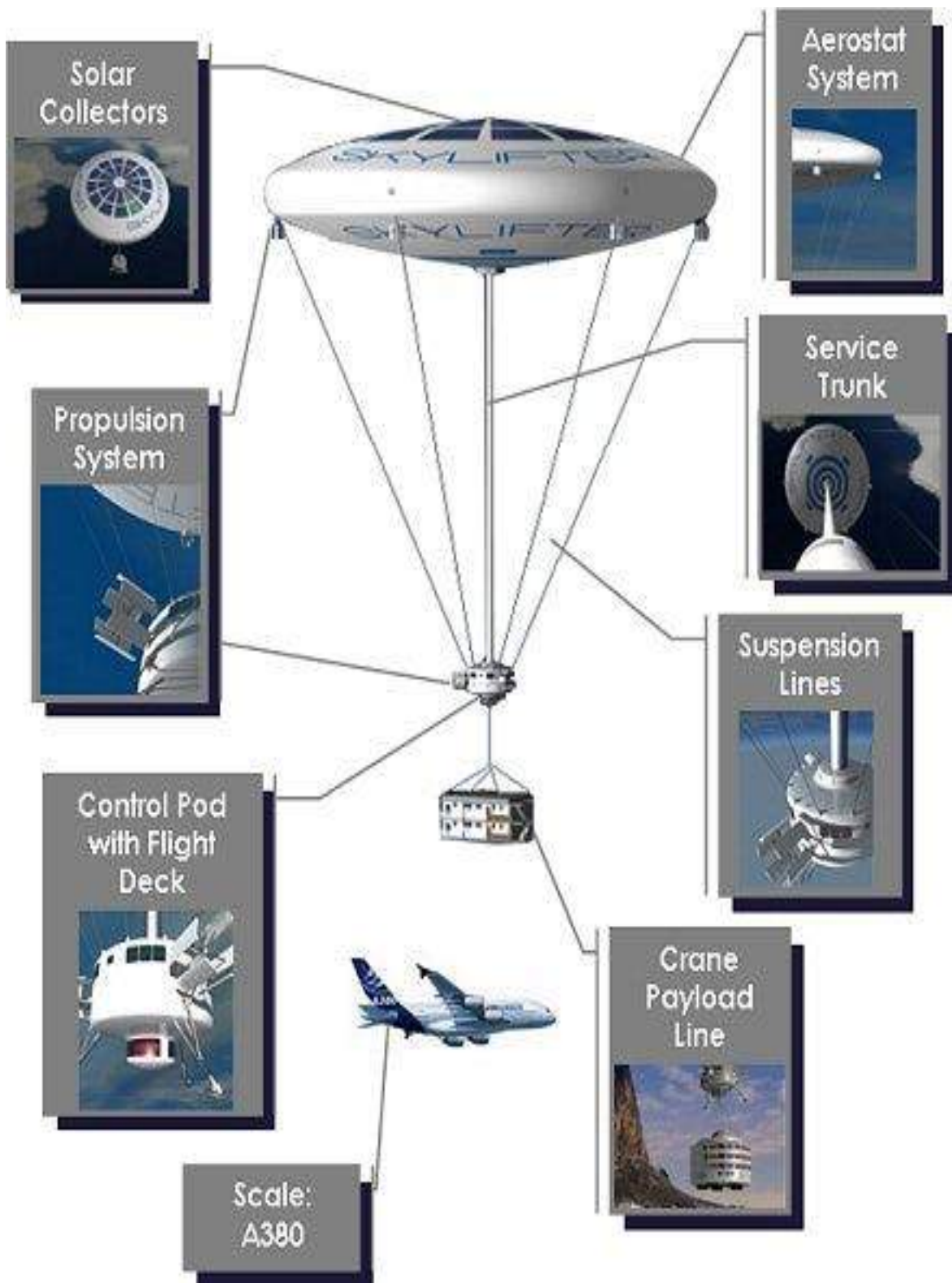
There are no rigid structural elements inside the aerostat. Inflatable ballonets within the aerostat's envelope are used to control overall buoyancy of the airship. The blowers for the ballonets are located in the envelope on smaller SkyLifter airships or on top of the suspended control pod of the largest SkyLifters. In the latter case, they blow up/down through ducts in the service trunk to supply air to, or exhaust air from, the ballonet chambers within the aerostat. There also are a series of large and small vents in the aerostat's envelope, which enable faster venting when needed.

The propulsion system uses thrust vectoring “cycloidal” propellers that enable the airship to move in any direction without having to turn the “hull” into the desired direction of travel (hence, the airship is “omni-directional”). This enables the SkyLifter to its change direction of flight more quickly than conventional “cigar shaped” or hybrid aerobody-shaped airships that have to physically turn the longitudinal axis of the airship onto the new heading.

Four basic design concepts have been planned for diverse markets:

- Heavy-lift Sky Crane
- Heavy-lift SL150 SkyLifter cargo airship & SL150 SkyPalace passenger airship
- Medium-lift SL50 SkyLugger cargo / utility airship
- Smaller, general purpose SL20 & SL25 SkyRover

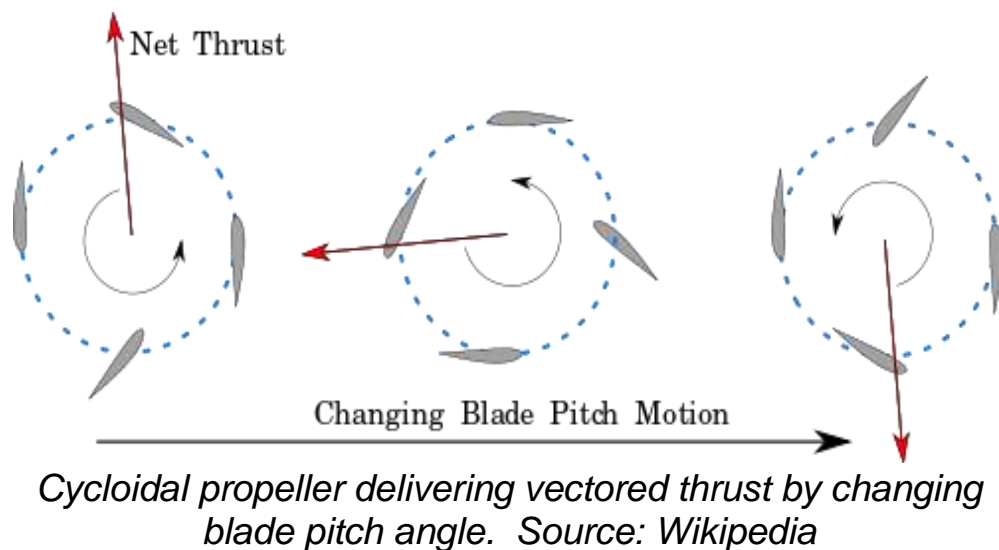
All share the general arrangement of the SL150 shown below, except for the service trunk, which is found only on the SL150.



*SkyLifter SL150 features shown to scale with an Airbus A380 aircraft.
Source: SkyLifter Ltd.*

All SkyLifter airship designs also share the following general characteristics:

- On the ground, a SkyLifter is ballasted so aerostatic lift from helium provides 100% of the required lift.
- The aerostat's inflated envelope is made of strong, laminated 'gas-tight' fabric. The chambers inside are made of similar but lighter weight material.
- The evenly-spaced suspension lines connecting the aerostat to the pod ensure even distribution of loads from the pod and payload. The suspension lines are strong synthetic fiber ropes, similar to ship mooring lines.
- The control pod, which includes the flight deck, is constructed mostly of aluminum and composite materials.
- Most of the aircraft systems are located in the control pod and are accessible for maintenance.
- Propulsion and directional control are accomplished with cycloidal propellers mounted around the perimeter of the control cab, and in the largest models, around the aerostat. The cycloidal propellers on the control pod provide vertical thrust to ascend or assist descent. A cycloidal propeller adjusts its blade pitch to provide almost instant vectored thrust in any direction perpendicular to the axis of rotation, as shown in the following diagram.



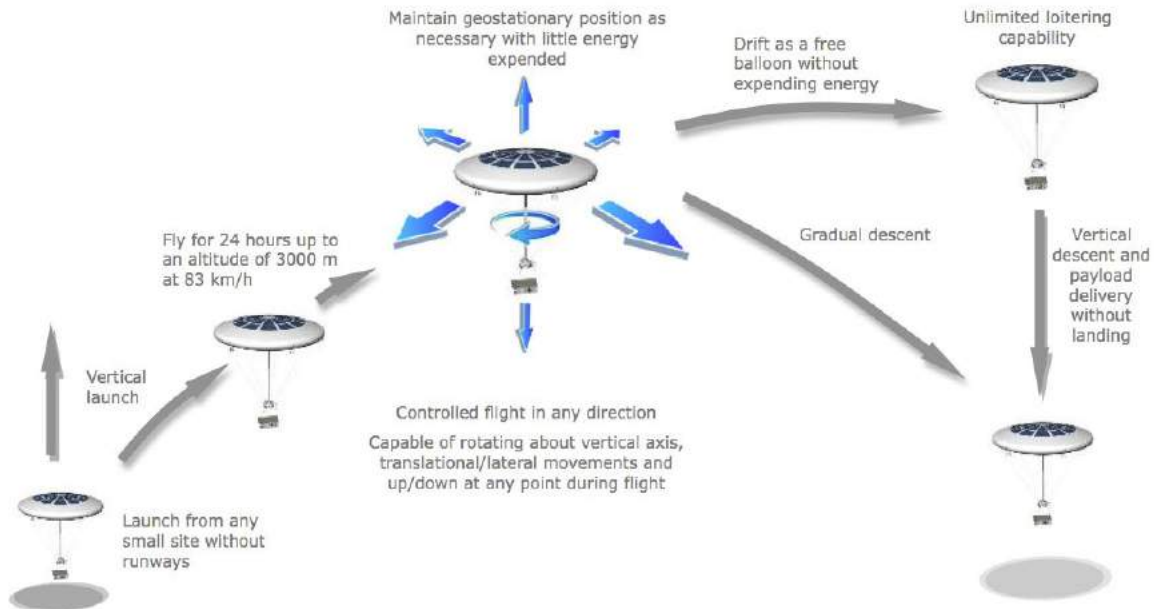
- Operation of the cycloidal propellers for propulsion, lift and station keeping is managed by an automated stability control system.
- The airship will be electrically powered, from a diesel-electric system and/or a solar-electric system using thin-film solar panels mounted on the upper surface of the airship.
- The airship can drift with the wind to save energy.
- SkyLifters require no permanent ground infrastructure or a home base mooring.
 - A site for landing needs to be a reasonably flat, secure area up to three times the diameter of the airship.
 - A delivery site may need to have provisions (material, equipment, people) for delivering ballast to the SkyLifter.
- The airship can be moored using lines equally spaced around the edge of the symmetrical aerostat, which does not need to swing into the wind like a conventional cigar-shaped or hybrid airship. In severe weather, the aerostat can be drawn close to the ground on its moorings for greater weather resilience.
- A hangar is advisable for assembly of the airship and for major maintenance tasks. SkyLifter has designed a dome-shaped hangar using air-pressure-stabilized fabric structures.



*SkyLifter SL150 concept shown flying above an inflatable hanger.
Source: SkyLifter Ltd.*

4. Flying a SkyLifter airship

A representative mission profile with vertical takeoff and landing (VTOL) is shown in the following diagram.



Mission profile. Source: SkyLifter Ltd.

Before a flight, ballast is adjusted so the SkyLifter's gross weight, including any payload, is a little more than the buoyancy from the aerostatic lift of helium. Then, the cycloidal propellers on the pod provide some vertical thrust to ascend.

Cruise altitude is less than 3,000 meters (under 10,000 feet). The SkyLifter can fly with propulsion in any direction or drift with the prevailing wind at greatly reduced power.

At the destination, the cycloidal propellers on the pod are used to initiate descent. The broad disc shape of the aerostat limits descent rate, even when overall weight is substantially greater than buoyancy. SkyLifter Ltd. claims its airships can descend safely without power, similar to other free-flying gas balloons.

5. Load exchange

SkyLifter has noted that buoyancy management during an airborne load exchange is a component of a larger control problem, namely keeping the airship in a geo-stationary position in relation to the payload on the ground. Here, the omni-directional design of the SkyLifter provides an operational advantage, because its large, symmetrical envelope is relatively unaffected by changing wind directions during a load exchange and the cycloidal propellers allow the airship to move instantly in any direction.

SkyLifter Ltd. has not described how airship buoyancy is managed during a load exchange. However, the pilot is expected to have the following range of buoyancy management options available:

- Onboard water ballast carried in the control pod
- Vector thrust from the cycloidal propellers on the control pod
- Aerostat helium volume control 1 (venting)
- Aerostat helium volume control 2 (compression)
- Aerostat helium volume control 3 (thermal)

The availability of multiple processes for managing airship buoyancy during a load exchange can reduce or eliminate the need for taking on or discharging ballast at a destination. That's good, because managing a big load exchange with external ballast would be a significant task for an airborne airship. For example, 150 metric tons of cargo could be exchanged with 150 cubic meters (5,297 cubic feet, 39,626 US gallons) of water ballast, 98 cubic meters (3,464 cubic feet) of beach sand ballast, or 81.5 cubic meters (2,880 cubic feet) of gravel ballast.

The SkyLifter cargo handling system is located in the control pod. A crane engages, raises, lowers and releases cargo items that are carried externally as sling loads or on a load-platform. The aerostat remains at 150 – 200 meters (492 – 650 feet) above the ground throughout the load exchange, experiencing less ground turbulence than at lower altitude.

6. The SkyLifter Sky Crane airship

The SkyLifter Sky Crane is a heavy lift lenticular airship designed to handle payloads up to 25 metric tons. This places its lifting capacity between the SkyLifter SL150 (150 metric tons) and the SL SkyLugger SL50 (15 metric tons). All three share the same general configuration that is characteristic of SkyLifter airships.



Elevation view of the Sky Crane. Source: SkyLifter

General characteristics of the Sky Crane are as follows:

- Payload: up to 25,000 kg (55,000 lbs)
- Range: over 2,000 km (1,200 miles)
- Speed: about 45 knots (80 kph / 50 mph)
- Altitude: under 3,000 m (10,000 ft)
- Crew: 1 pilot (onboard or remote)
- Power: hybrid solar / electric (bio-fuel diesel backup)
- Useful flight duration: > 24 hours



View from beneath the Sky Crane. Source: SkyLifter

The lifting capacity of the Sky Crane is beyond the technical limits of the largest helicopters. During a lift, the payload hook position is controlled using a combination of the winches on the control pod and vectorable thrust from the cycloid propulsors to precisely move the airship. The Sky Crane can achieve hook heights of over 300 meters (984 ft), well beyond the capabilities of ground based heavy lift cranes.



Rendering of a Sky Crane installing / removing a wind turbine blade. Note that the Sky Crane is tethered at three points for added stability during this high-precision evolution. Source: SkyLifter



Rendering of an unloaded Sky Crane in flight. Source: SkyLifter

7. The SkyLifter SL150 cargo airship

The SkyLifter SL150 is the very heavy lift cargo model. It has a 150 meter (492 foot) diameter aerostat that is designed to carry a payload of 150 metric tons (330,000 pounds) over a range of over 2,000 km (more than 1,240 miles) at a cruise speed of about 80 kph (50 mph). It is intended for moving and precisely placing large equipment, bulk cargo and prefabricated structures in remote areas.

The three-level SL150 control pod shown in the following graphic is about 15 meters (49 ft) in diameter. The flight deck is at the lowest level of the control pod. The top level contains the engine, winches and water recovery system. The mid-level has about 400 cubic meters (14,126 cubic feet) of space for ballast, so can carry 400 metric tons (440 short tons) of water.

Two of the three cycloidal propellers connected to the control pod can be seen in this graphic. These propellers can generate several tons of thrust. On the heavy-lift SkyLifter airships, the vertical service trunk shown at the top of the control pod is a flexible, non-structural, two-way passageway to the aerostat for personnel and systems.



SkyLifter SL150 control pod. Note the attachment points for the suspension lines from the aerostat and the landing legs.

Source: SkyLifter Ltd.



Rendering of a SkyLifter SL150 carrying a large prefabricated structure under the control pod. Source: SkyLifter Ltd.



Rendering of a SkyLifter SL150 delivering a large prefabricated structure at a remote site. Source: SkyLifter Ltd.



*Rendering of a SkyLifter SL150 delivering a cargo container at sea.
Source: SkyLifter Ltd.*

8. The SkyPalace SL150 passenger airship

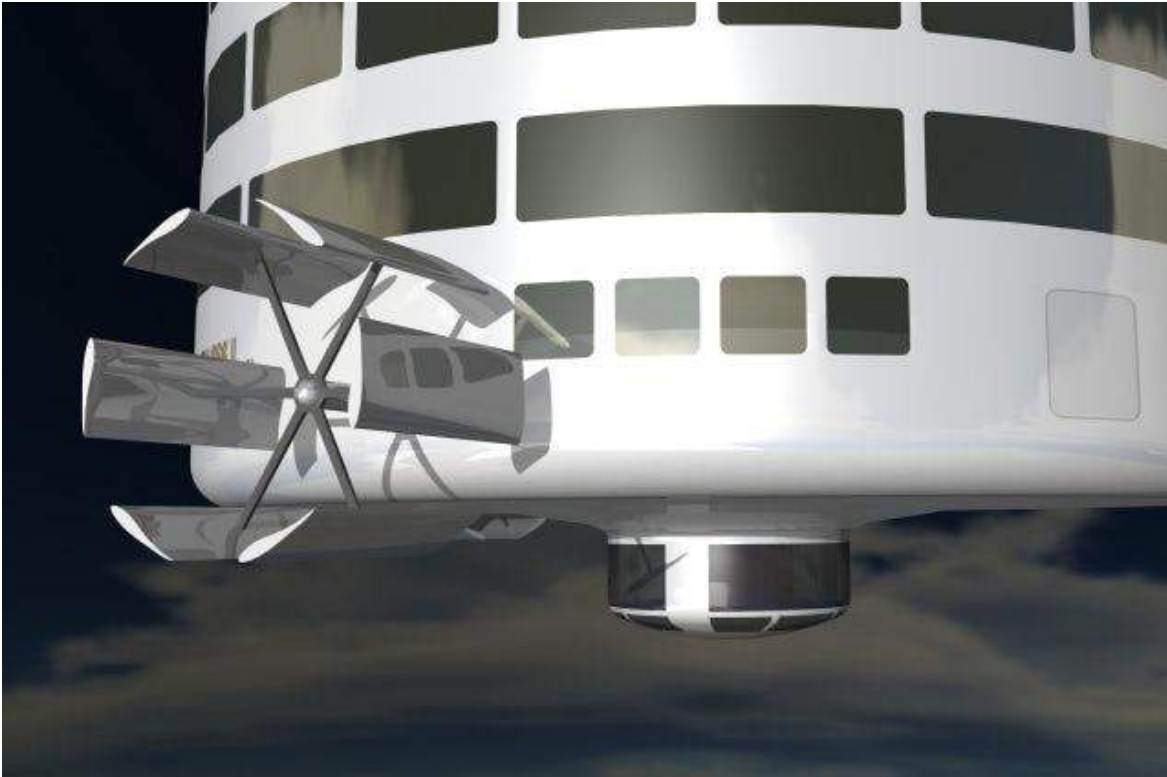
This is a future concept for an aerial passenger cruise liner, where the customer's cruising experience will be taken to an entirely new level, floating effortlessly through scenic regions of the world at low altitude. The aerostat for the SkyPalace is the same size as on the SkyLifter SL150 heavy cargo airship. The pod is enlarged to become a 25 meter (82 foot) diameter accommodation unit offering 2,000 square meters (21,527 square feet) of freely-configurable floor space over five levels. In addition, there is an outdoor roof terrace that forms a promenade deck.

The SkyPalace can be configured to carry about 600 passengers and crew on a scenic day trip, or fewer passengers on more exclusive, longer-duration aerial cruises. These airships would have self-contained habitability systems (fresh water, waste, etc.) and power systems that minimize the effects of operation on airship buoyancy.

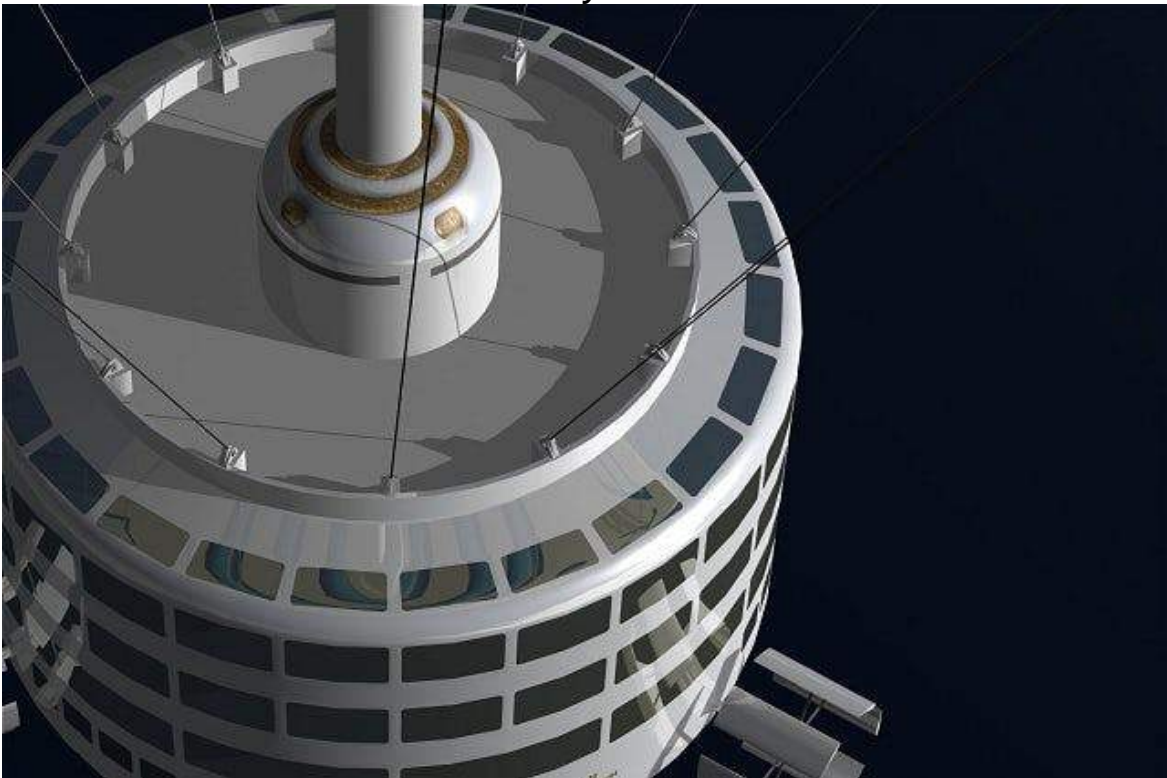


SkyPalace SL150 concept shown cruising at low altitude to view the pyramids in Egypt. Source: SkyLifter Ltd.

A model of the SL150 control / passenger pod is shown in the following graphics. The flight deck is at the bottom of the pod, with several levels for passengers located above. The open-air observation deck is on the top of the pod. Also note the vertical service trunk and the cycloidal propellers.



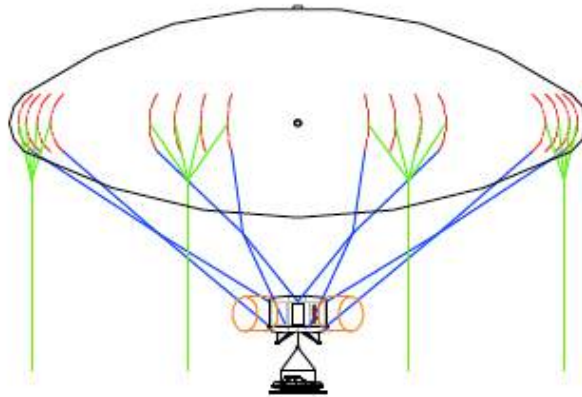
*Above and below: The SL150 control / passenger pod with multiple levels for configurable passenger accommodations.
Source: SkyLifter Ltd.*



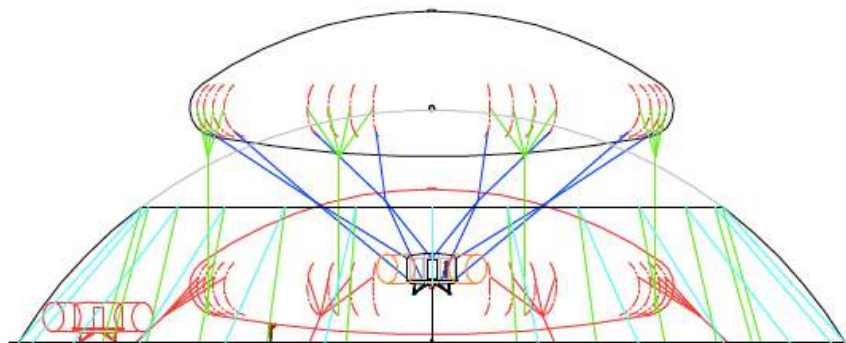
9. The SkyLugger SL50 mid-size cargo airship

This is long-range, mid-size cargo airship concept that is being developed to compete directly with heavy-lift helicopters in the 15 metric ton (15,000 kg, 33,000 lb) payload market segment. The SkyLugger also can be configured as a long-range patrol airship.

The SkyLugger can be operated by a single pilot with low workload. There are provisions for two optional crew members, a relief pilot/crane operator and a systems engineer for in-flight servicing. No specialist ground infrastructure will be required for landing and storm mooring.



General configuration of a SkyLugger airship carrying cargo on an external carriage. The mooring lines (green) attach to the aerostat envelope at the same points as the suspension lines (blue) connected to the control pod. Source: SkyLifter Ltd.



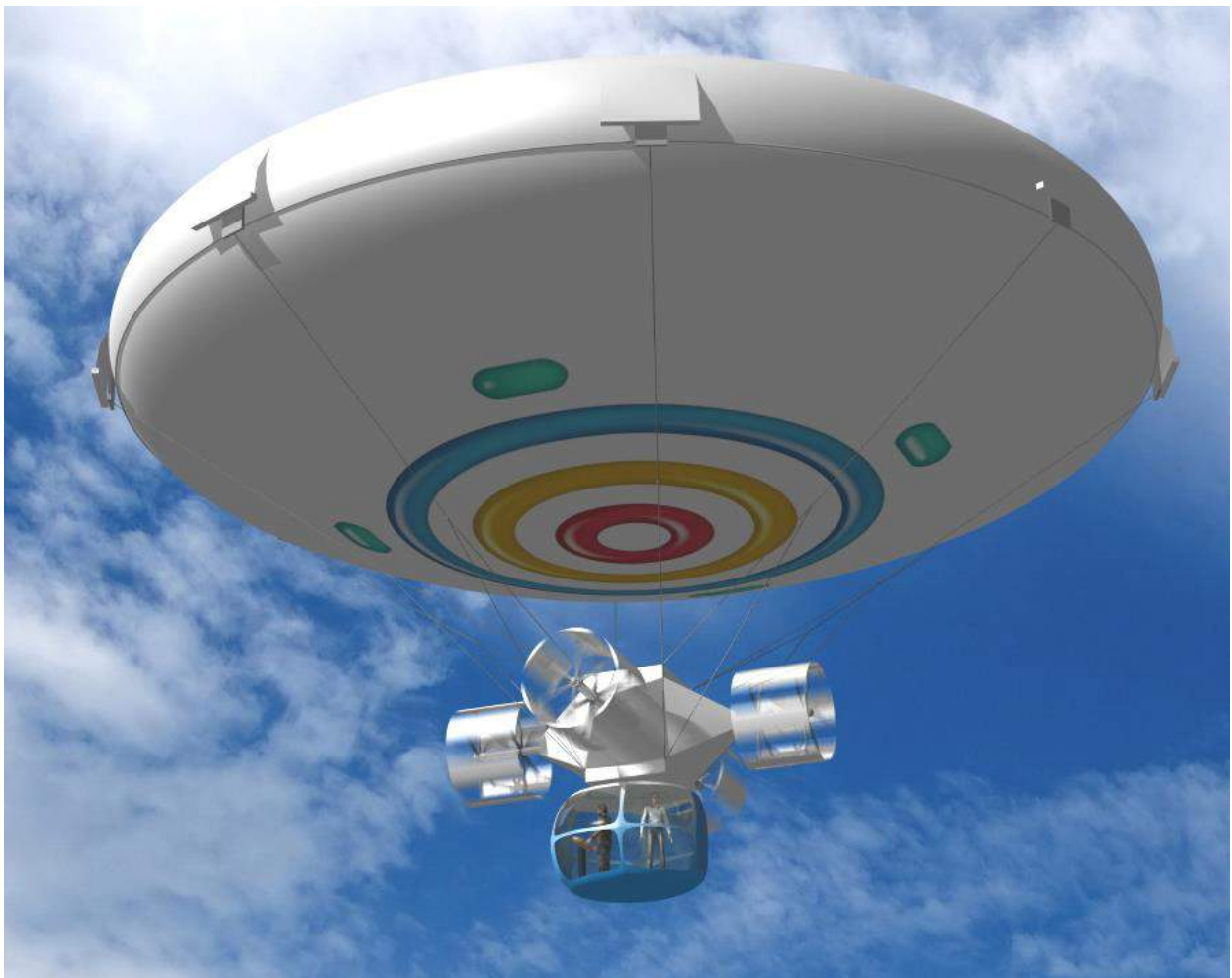
SkyLugger airship shown in two positions: moored to the ground, and cinched down within an inflatable hanger. Source: SkyLifter Ltd.

10. The SkyRover SL20 & SL25 airships

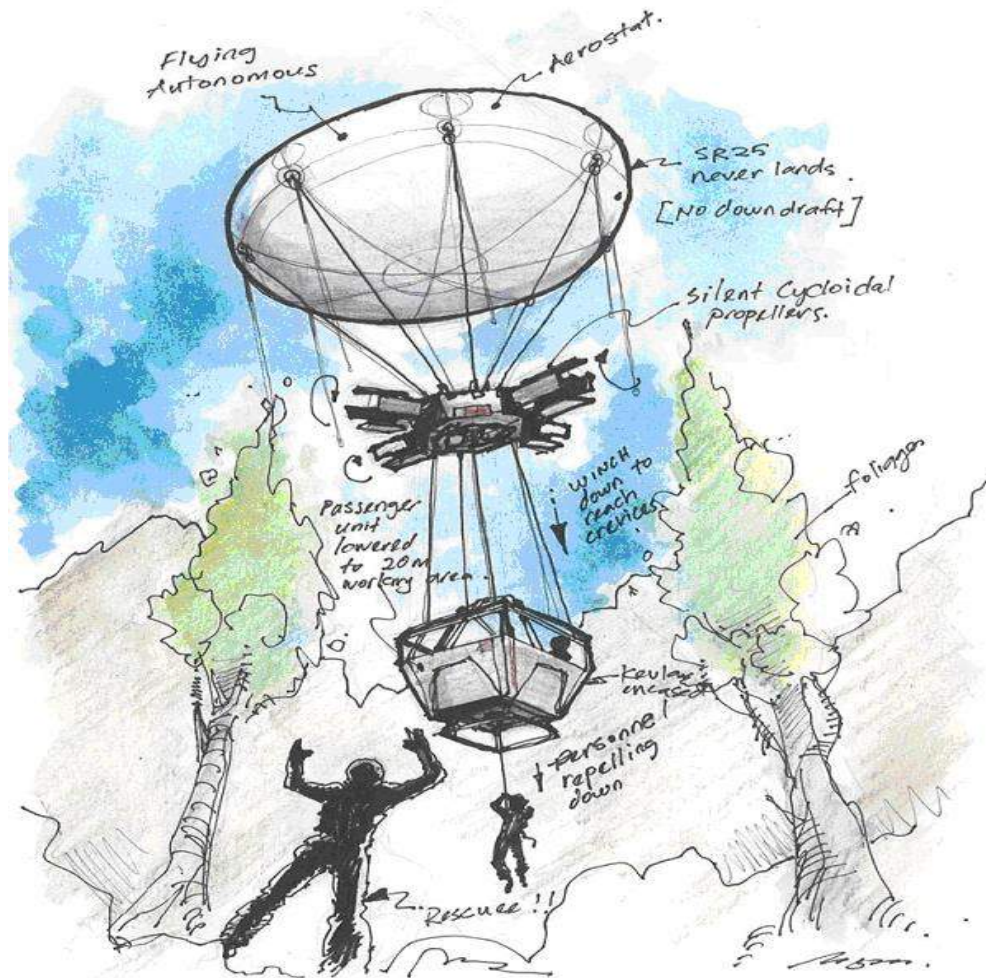
This is a small, long-endurance, optionally-manned airship that is intended for the following types of missions:

- Search and rescue (SAR)
- Intelligence, surveillance and reconnaissance (ISR)
- Oil and gas equipment transportation
- Advertising

The SkyRover SL25 has a 25 meter (75 foot) diameter aerostat that is designed to carry a payload of 800 kg (1,700 pounds) over a range of up to 2,000 km (1,240 miles) at a cruise speed of about 74 kph (46 mph). The smaller SkyRover SL20 has a 20 meter (60 foot) diameter aerostat and carries a smaller cargo, but otherwise is similar.



Rendering of a SkyRover SL20 in flight. Source: SkyLifter Ltd.



SkyRover concept drawing showing the airship performing a search and rescue operation. The rescue basket is lowered from the SkyRover's control pod. Source: SkyLifter Ltd.



Example of how a small SkyLifter airship would be secured in the field. Source: SkyLifter Ltd.

4. For additional information

- Glenda Kwek, “Introducing Skylifter, a new giant of the sky,” The Sydney Morning Herald, 7 October 2010: <https://www.smh.com.au/business/introducing-skylifter-a-new-giant-of-the-sky-20101007-168v8.html>
- Ben Coxworth, “Skylifter: heavy duty flying saucer re-thinks lighter than air transport,” New Atlas, 8 October 2010: <https://newatlas.com/skylifter-flying-saucer-airship/16611/>
- Ray Kurzweil, “Skylifter airship could carry 150-ton buildings,” Kurzweil, 11 October 2010: <https://www.kurzweilai.net/skylifter-airship-could-carry-150-ton-buildings>

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