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Patrol *Luffships*

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Abstract

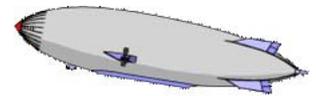
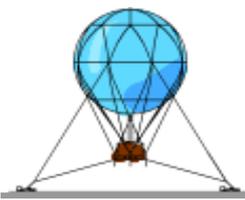
This document is to explain the circumstances and development of Patrol *Luffships* (the author's own airship proposals) particularly the Mk 1 SkyRover for just 2 people, which needs finance for a prototype and the associated certification programme before it may enter service.

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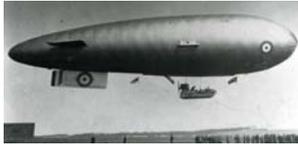
Abbreviations

6DOF	Six Degree of Freedom	MRO	Maintenance Repair and Overhaul
AI	Airship Industries	NT	New Technology
CDR	Critical Design Review	R/C	Radio or Remote Control
CofA	Certificate of Airworthiness	R&D	Research and Development
CL	CargoLifter	SKS	Skyship
HAV	Hybrid Air Vehicles	SL	SkyLifter
JAS	Japan Airship Services	SR	SkyRover
LTA	Lighter-than-air	TC	Type Certificate



Patrol Airships

Patrol airships generally are relatively small (Normal or Commuter category) lighter-than-air (LTA) aircraft with limited payload capacity, but which may have very long endurance (days, weeks and even months underway) to undertake aerial duties that need a steady (low vibration & noise) persistent aerial platform with all-round (unrestricted) viewing arrangements.



In WW1 British coastal waters were patrolled by over 200 small airships (typically as pictured left – a Sea Scout) that cost little, but successfully shepherded very expensive vulnerable sea going ship convoys against submarine attacks; saving many 1000s lives and 100s ships by preventing the marauders from their dreadful deeds. That was around 100 years ago and repeated in a similar way with USA airships (typically pictured right – a K Ship) in WW2. So why with today's advanced technology aren't there any modern airships now patrolling dangerous waters to help prevent needless 1000s of refugee losses over the relatively calm land-locked Mediterranean Sea?



It's shameful that Europe doesn't have such dedicated assets to deploy! In fact, it's not just Europe that is shamed, as there are similar circumstances around the world where there also is a need for long endurance (a natural ability) patrol airships to watch out for desperate people who need help. Airships like the SKS600 series (typically as pictured right with a deployable boat below) developed in the 1980s have been used in the recent past for such duties, but where are they now?



Expensive military assets such as fast jets, tanks and the like are useless for such purposes, but greedily consume €\$billions without a 'drop in the ocean' for airships! Where is the compassion for people and a nicer way – less destructive? Why do our politicians fail to realise that Patrol Airships are needed to support humanitarian and border control purposes in a similar way to past WW1 & 2 circumstances?

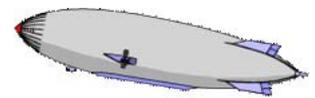
If available, patrol airships thus could help to marshal the wicked deeds of wanton traffickers and ruthless terrorists – to upset their dastardly actions for peace and order to return. Patrol airships then also could help after things settle to maintain order and support further humanitarian needs that arise.

We're not talking about €\$billions for such airships, where both WW1 & 2 demonstrated that less than 0.1% of the budget for war planes saved more than the €\$billions spent on them! Are militarists and the so called defence industry so selfish/bloody-minded/stupid that they will not consider airships seriously for such purposes?

These relatively small airships also may be arranged to serve many commercial and other needs, such as:

- Training, sport, leisure and sight-seeing tours
- Rescue aid – able to hold station over a ground position with little downdraft
- Disaster relief – humanitarian (search, assist and medical aid)
- Roving watch tower for aerial surveillance – persistent presence over a wide area
- Geostationary systems platform – used as a relay station and/or sky beacon
- Border, coast or regional patrol – facilitates policing and customs activities
- Fire watch over forests, traffic monitoring and general surveillance activities
- Area survey for mineral detection, crops analysis, pipe-line monitoring and mapping
- Offshore oil/gas platform support
- Island or difficult region commuter and postal services
- Film, camera and broadcast activities
- Scientific and archaeological studies
- Traditional advertising and events attraction duties
- Test and demonstrator vehicle for bigger types

There thus are numerous outlets for small airships with patrol capability that may be developed to suit the various purposes and serve in affordable ways that helps the industry to establish itself and grow, but



which needs political and financial support to get underway. The last item in the list also reflects a need for R&D effort in an affordable way to enable bigger airships for transport purposes that may then follow.

Circumstances Today

Basically, the industry is on its heels with few new small manned airships in production to serve the outlets listed above. Sadly, one can count the number of manned airships in production today on one hand, although one needs the digits of both hands and feet (not more) to count the number in certified service worldwide (various surviving and newer types since the 1980s) a desperate situation compared with regular aeroplanes and helicopters (counted in 1000s). It's therefore not surprising that there aren't any for Mediterranean humanitarian operations, although Zeppelin probably offered support.

People may very well ask why?

Anyone who answers the question properly undoubtedly will be type-cast as an industry pariah who shouldn't be believed and sidelined as far as possible. However, it does no good to deny the facts and pretend that it's all rosy. One needs to understand the issues to provide appropriate solutions that work!

There's no doubt that airships or dirigible LTA aircraft have demonstrated capability in the past to effectively serve such needs, proven from both WW1 & 2 action that almost 100% of the time while ship convoys were escorted by airships shepherding them led to zero losses – i.e. almost no ships sunk or lives lost during those wretched times. That was exemplary service under difficult conditions, accorded little credit when each war ended – with most airships simply scrapped and not replaced as surplus to requirements (saving cost). Capt T B Williams book (*Airship Pilot No 28* - ISBN 07183-0153-6) captures the story of the WW1 Sea Scouts and the heroic actions of such people.

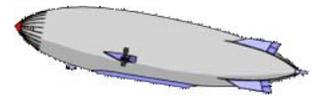
Even so, the story about these patrol airships (mainly small non-rigid types) was tarnished by numerous big rigids making newspaper front page headlines when they went up in flames (like the LZ129 *Hindenburg*) or crashed (like the R101) or broke-up in flight (like the ZR1 and R38 {ZR2} & ZRS5), downed by storms (like the ZRS4) or just were inadequately managed (like the R1 *Mayfly*). Relatively small non-rigids weren't deemed to be newsworthy and just swept away in the aftermath with little care.

Nonetheless, after WW2 the Americans (mainly the US Navy) did some interesting things with bigger non-rigid types produced by Goodyear, proving their worth for extended duties with exceptional range/endurance in all weather and introducing prototype mechanical handling methods that appeared to be viable. This was good, but eventually abandoned to save expenditure in the early 1960s without further advancement. Goodyear didn't produce any airships for some decades after that, although it continued operations with a few existing smaller "blimps" for self promotional purposes. A period of dormancy then ensued with knowledge lost when the experts of their day simply died.

Although there was a handful of private enthusiast airships produced after that, some of which flew with limited success, it wasn't until the 1980s that the industry (if one may call it that) began again in a proper way – i.e. under new airworthiness authority rules as an aircraft organisation and full type certification of modern airship designs in a similar way to aeroplanes and helicopters, requiring extensive test and development work, proof of compliance and formal auditing to meet the acceptance standards set. However, it was with new people who only had history books and the like to go from.

Airship Industries (AI) under Roger Munk's technical direction was the first company to get type certificates for its Skyship (SKS) series airship designs, enabling regular 500/600 series production and subsequent airship certificates of airworthiness for worldwide operations. This perhaps led to other organisations setting up as competitors with different airship designs, which began to emerge in the 1990s (a healthy situation) the most prominent of which was the American Blimp Corporation's airships (called Lightships). Zeppelin also started again, gaining a TC for their New Technology (NT) type in 2000.

By the turn of the century there thus was a growing airship industry with several types in production. It appeared then that the re-emergent industry could manage bigger developments, with CargoLifter (CL, which started in 1996) attempting the huge CL160 transport airship development using investment of



over €300 million, more money than any airship company had ever had to pursue things with. These were exciting times with great camaraderie within the airship industry to make it happen.

Well, it didn't last long (CL closed mid 2002) blown away on a huge hangar, a workforce rapidly built up from a student base with little experience to about 550 people (on good terms), large management plus marketing teams, no shortage of computer systems or facilities to use, supporting projects (Joey, Charlie {an AI SKS600}, a balloon ride system, the CL75 AirCrane, etc), production plus operating arrangements around the Brand airfield (bought and restructured) with mock-ups, test facilities and the Transport Category CL160 airship development programme (substantially bigger than anything flown before) with numerous sub-contractors for primary systems freely milking the situation for all it was worth!

Pursued like a military programme, if the financial institutions and politicians had stood their ground and enabled things to continue as they are doing with the new Berlin Brandenburg International Airport, it was a ready made large airship enterprise (in a way matching Airbus or Boeing) for aircraft of super-tanker proportions. However, it wasn't to be, causing considerable upset not just for the investors and people involved, but for the whole airship industry worldwide!

It wasn't all bad! In fact there were many good things about CL that should have been saved instead of crassly closing the books on it – including the people who by then had accepted aircraft procedures to follow and who had gained valuable experience/know-how to enable such airships. One has to accept that things don't always work the way they're designed, that we are fallible, but we carry on (if able to do so) to do better knowing that such airships are still viable and needed.

In fact, the impetus for transport airships is deep rooted from the big rigids of the past and where CL prompted competitors to also step up to design/produce their own versions. Indeed, the author is the originator of the SkyLifter (SL) aerial crane design (see: www.skylifter.eu), which stems from the CL75 AirCrane development, but is a new free flying dirigible LTA aircraft for serious heavy payloads of practically any size anywhere – designed to have precision position control – so another huge type.

Although there still is a market for transport airships, the know-how, experience (spade work) and airship industry capability thus isn't developed enough yet for them. This previously was shown to be the case when AI closed in 1990 due to taking on additional staff to fulfil a contract for a fairly big ($2.5 \times 10^6 \text{ ft}^3$ – $70,792 \text{ m}^3$ – illustrated right) long endurance

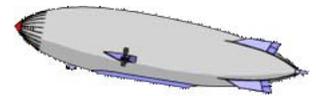


(30 days) ocean going patrol airship – the US Navy YEZ-2A with its triple deck gondola (mock-up pictured left). Funding delays caused serious problems for AI, who (as a relatively small enterprise) needed to shed staff to stay in business, but were still obligated to fulfil the US Navy contract. It was an impossible situation, leading to liquidation and then business partners (Westinghouse, with little knowledge of airships) taking over to continue the contract. Even so, after taking the programme through its critical design review (CDR) the funding was cancelled (used to help fund Desert Storm) and the contract concluded. The Sentinel 1,000 ($10,000 \text{ m}^3$, pictured right, evolved from the Skyship series) as a reduced scale patrol airship for YEZ-2A fact finding purposes, subsequently was destroyed in a hangar fire (raised to the ground) after which Westinghouse withdrew from the airship business altogether. Rather a pity, as the Sentinel 1,000 would have been a good choice for Mediterranean Sea patrol duties.



The issue here is that the emergent airship industry was and still is at a delicate fledgling stage, sensitive to extreme funding changes, needing baseline products in regular production/operation to remain in business and for use to establish additional: training facilities, operating bases (hangars, moorings and so forth), logistic infrastructure and MRO arrangements plus independent operators ready to receive them. Forcing the industry to produce transport airships before the capability (spade work) has been established puts the cart before the horse in a way that likely will result in further upset.

The situation at that time was further compounded by foibles of the classic style unidirectional airships in service, which need freedom of movement to weathervane from their nose (yaw, pitch and roll) at their



moorings and while moving them across field plus into and out of hangars – needing secure ground handling methods and procedures. Although the history books and the like provided some information about ways and mechanical systems developed in the past to manage things, the foibles weren't addressed well enough at the design stage, leading to a number of incidents and airship losses from inclement weather, which LTA aircraft by nature are sensitive to.

By way of example, on one stormy day at Cardington in the 1980s, AI suffered badly with 2 airships severely damaged – the SKS500-02, when the mast broke and it then was slammed onto the ground upside down, and the SKS600-01, which deflated due to envelope failure and then collapsed on the ground looking rather sad. Also, on a snowy day in Japan, the operator's (JAS) SKS500-04 turned upside down from weight of snow on the upper envelope, smashing both of its horizontal tail surfaces from resulting pendulum rolling effects. There are numerous incidents like this that AI and other developers have suffered, upsetting operators and putting investors off.

Airships designed with simple propeller arrangements and without tried & tested mechanical handling methods also need large ground crews for their management, resulting in high operating costs – particularly when undertaking cross-country operations over long distances – needing a ground crew and equipment road train to go ahead and set up temporary mooring arrangements; heavy on hotel bills, fuel and mooring site fees.

To help reduce the number of ground crew needed for airship launch and capture, Zeppelin configured their NT semi-rigid design (see picture right) with more complex vectoring panner and stern propeller arrangements at extreme positions around the aerostat. Such arrangements also are possible for non-rigids, although few manned non-rigid airship developers have tried such arrangements so far. Although causing higher acquisition costs, the arrangements were found to be effective – fulfilling expectations to some extent. However, it didn't improve the situation for moored airships, as Zeppelin still lost one in Botswana due to poor mast behaviour – wrecked during a storm because there was no hangar for protection. They subsequently developed an automated mast flight control system to ease mast behaviour, but it needs a better (natural) way that doesn't need such complication. Zeppelin otherwise safeguard their airships with stringent nursemaid tactics, limiting operations to fine weather days – no way for a regular operator to get revenue.



These were all things that transport category airships need reliable solutions for before attempting them again. Realising the various issues (foibles) that classic style unidirectional airships must find ways for mitigation, later in the 1990s, Roger Munk instead introduced a hybrid airship type (SkyKitten, as pictured right) with hovercraft style lower air cushions designed to suck down like limpets after landing. He believed this more complex unidirectional type (as an evolutionary step) would enable operations to a certain extent like aeroplanes, which need aerodynamic lift for flight and transfer weight to the ground when they land.

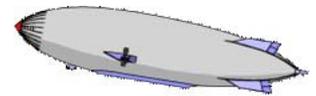
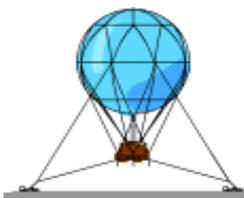


The unmanned R/C model was successful and lead to another R/C model (SkyCat, as shown right), but with inflatable skids below instead and a bow cross thruster, for further development, test and demonstration purposes. This also appears to have flown well and to impress people; where capabilities purported for aerial duties and ground operations were desired, leading to a US Army contract for a quite big manned version believed to be within transport category regulations. Sadly though, Roger died shortly before the contract was awarded, leaving others to carry the new type forward.



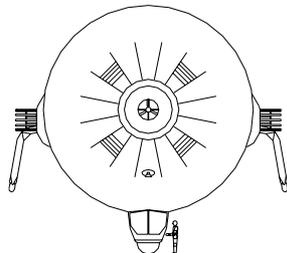
The US Army hybrid airship (LEMV pictured left – $38,000 \text{ m}^3$, $1.34 \times 10^6 \text{ ft}^3$) subsequently was designed, built, inflated/assembled at Lakehurst, flown once (8 Aug 2012) and then mothballed.

Some time later the LEMV then was sold to its development company (Hybrid Air Vehicles – HAV) and shipped to Cardington.

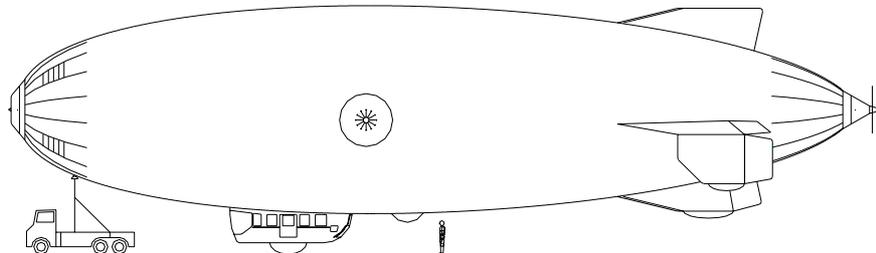


Patrol *Luffships*

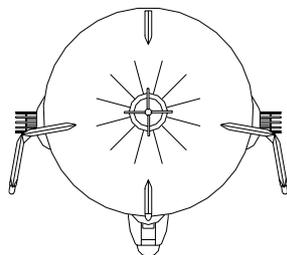
of just accepting the classic style unidirectional arrangements; shown to be good in many ways (so worth developing further), but needing foibles to be mitigated in sensible ways. This needs small airships to help iron out the issues that inevitably arise without the great cost that must be born by large aircraft developers under Transport category rules. This approach then paves the way for bigger types, helping to securely build the industry (including operators and necessary infrastructure) for future large airships to succeed when supporting arrangements are ready and the issues have been mitigated.



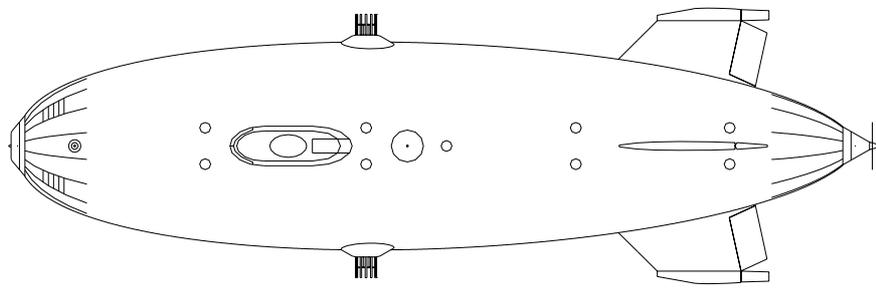
VIEW LOOKING AFT



VIEW ON PORT SIDE



VIEW LOOKING FORWARD



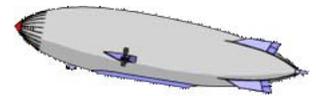
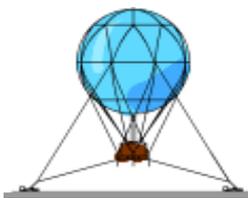
VIEW ON UNDERSIDE

Although the author has *Luffship* designs for classic (C) style airships, for example the LS-C3000 (as illustrated above) of 3000 m³ (46.75 m long) for patrol duties – arranged to also settle onto and launch from water, the above reasoning for a heavy lift aerial crane led to the design of another unique type – the LS-L20 called the Mk 1 SkyRover (Mk 1 SR), as shown right (roughly in scale), a different patrol *Luffship* with a lenticular (L, disc shaped) aerostat of 20 m diameter (gas fill: 1200 m³) that also may settle onto and launch from water – see separate leaflet for further details.

Configured as shown, like a dirigible balloon system with vertical axis symmetry, the Mk 1 SR has omni-directional characteristics, better for position/heading holding and vertical launch/capture, where it's designed to operate like helicopters, but with much longer endurance. Like hybrids, it also may use significant aerodynamic lift positively or negatively, but instead has rapid response quad cycloidal propellers for 6DOF control and thrust in any direction (similar to multi-rotor drones) so is quite sophisticated, but not complicated.



The new design was made to enable access in and out of tight locations similar to helicopters from small bases almost anywhere and to obviate need for cross field ground movement (reducing risk). It also is fully fixed when moored (further reducing risk) minimising base size needed for operation and the aerostat may be close hauled down to the ground and then cloaked to protect it during storms. It therefore doesn't really need a hangar and the arrangements enable simple quick inflation and assembly (or reverse) at its moorings. Due to vertical axis symmetry, time/effort for design, manufacture and certification are slashed (compared with C types) pegging acquisition costs somewhat and the fixed reduced sized mooring/protection aspects minimise operators costs significantly. Operators costs also are minimised through simple mooring arrangements (no mast – further reducing risk) that may be managed by the flight crew (2 people) alone. The road train is obviated with a network of simplified anchor bases to stop over at. What else should one do to cut costs, minimise risk and enable operations year round anywhere?

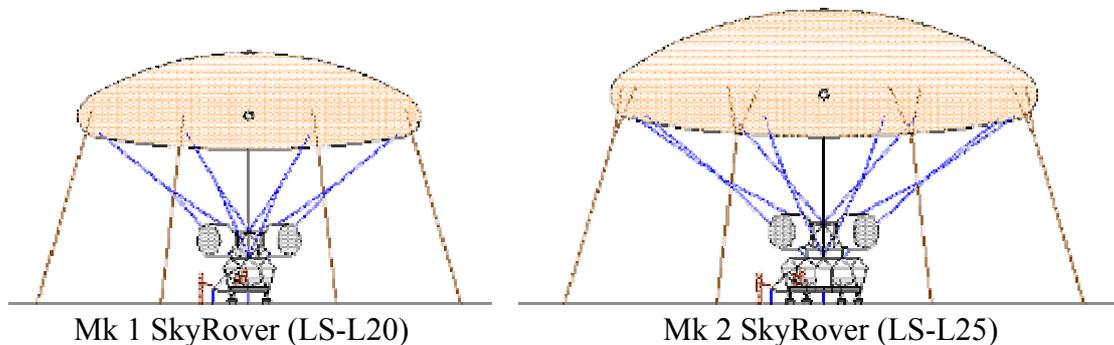


Patrol *Luffships*

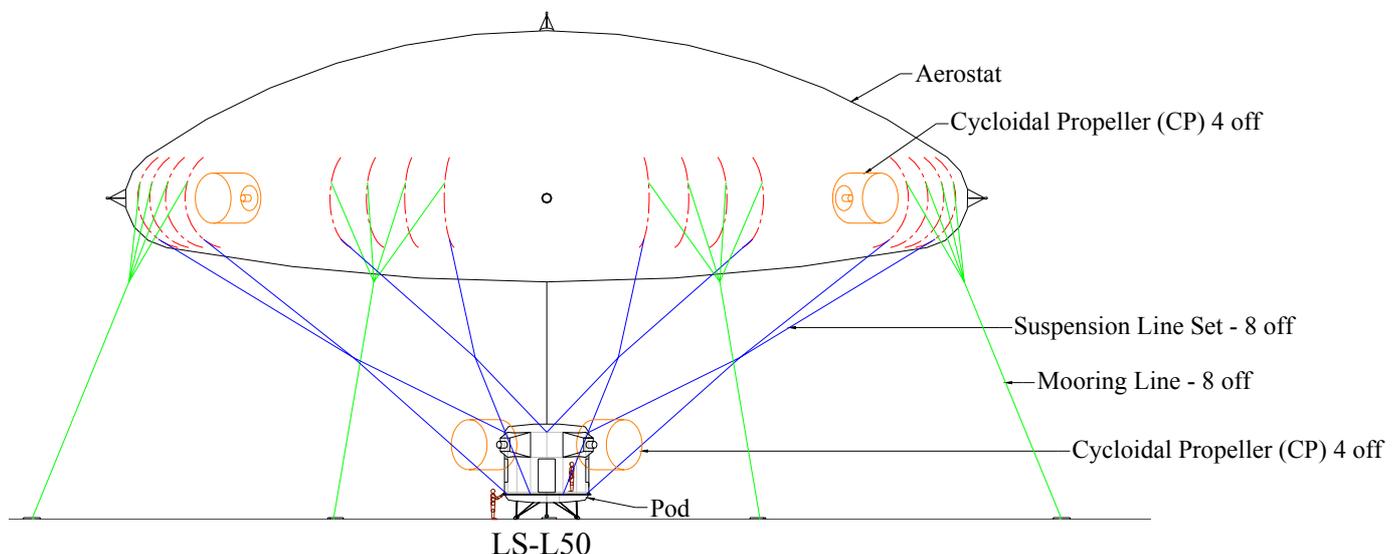
The business plan is to first produce and certify the Mk 1 SR under balloon regulations together with any aspects deemed necessary from the Normal category requirements for airships. It will be marketed as an initial small Patrol *Luffship* for light revenue earning duties with 300 kg disposable load (including payload, people and fuel), which may be for manned operations or unmanned R/C duties with a different payload unit, intended to be easily swappable within an hour.

Operators/customers may expect a quality product with a CofA plus mooring base arrangements, training and post sales support to suit their needs, enabling services with them to commence; although it will be their responsibility to satisfy any requirements necessary for approved aerial services to begin with their own people. Design of the Mk 1 SR already has passed successfully through its first assessment stage with a review held in Dec 2014 (available for review by agreement). Funding is needed to continue through its critical design stage, production, test (shakedown) and certification – expected to be less than 1 year if adequately financed/supported.

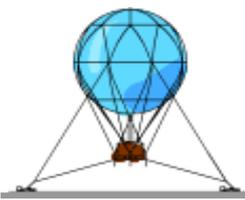
It then is planned to produce a Mk 2 variant (LS-L25) with a 25 m diameter aerostat under Normal category supplemental type certificate rules for longer range/endurance and disposable load of 900 kg, as shown below.



When these Patrol *Luffships* have enabled a secure situation for growth with knowledgeable and experienced teams for development and operation, then the time will be right for a bigger variant with transport capability for aerial crane duties. However, this involves additional development work for the crane systems, means for load exchange and an additional set of cycloidal propellers mounted on the aerostat. The plan thus is to develop a variant of the SkyRover series within existing Commuter category regulations for just 5 tonne (5,000 kg) under-slung payloads with a 50 m diameter aerostat (illustrated below) so of similar proportions to an SKS500 but with considerably more payload capability. This is possible because of the lenticular aerostat's much better volumetric capacity (compared with C types).

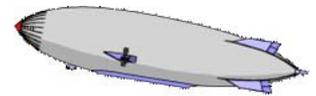


Versions of the LS-L50 also may be produced as Patrol *Luffships* with considerable range/endurance. Pursuing the aerial crane type under Commuter category regulations will help to work out the details for a



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Patrol *Luffships*

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serious aerial crane with minimum cost and time, significantly reducing risk that also helps to build the operator infrastructure that will be needed for much bigger transport category types in an assured way.

Patrol *Luffships* (urgently needed now for humanitarian purposes) thus are a way to help build the industry for future transport category types. For a glimpse of the future, which may be much sooner than people imagine, see: www.skylifter.eu

For further information contact the author.